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RESCUE APPLIANCES IN THE MINES OF FRANCE.

By Jacques Boyer.

The movement for the better safeguarding of life and limb from occupational accidents, whether in mining, railway service, or mechanical industries, is gaining force and volume. Strong evidence of this in the United States is the association, on the committee of direction of the new Museum of Safety Devices and Industrial Hygiene, of leading representatives of every one of the great engineering and technical journals. Men of this calibre have no sympathy with sensationalism, but they have the best knowledge of existing ills and of the practical measures effective for reform. We take the timely occasion afforded by the exposition of safety devices and protected machinery, opened in the museum this month, to present M. Boyer's review of Continental practice in safeguarding the mine worker. It will be followed next month by another paper exhibiting the appliances for a wider range of industry assembled in the museum of the *Conservatoire des Arts et Métiers.*—THE EDITORS.

IN recent years a number of terrible explosions of fire damp have agitated public opinion on both sides of the Atlantic. To cite but a few, we may recall the sadly well-known explosion of Courrières, near Lens, France, which killed, burned, or asphyxiated 1,150 miners March 10, 1906; that of the mines of Reden at Sarrbruck, Germany, which cost the lives of 170 men January 28, 1907; more lately still the three very recent catastrophes which took place in the United States during the month of December, 1907—at Monongah, West Virginia, (305 fatalities), at Tuscaloosa, Alabama, (67 fatalities), and at Jacobs Creek, Pennsylvania, (170 fatalities).

Specialists have devoted their study toward means for avoiding catastrophes of this kind, so far as possible, or at least for diminishing their extent, by perfecting methods of mining, improving ventila-

CENTRAL RESCUE STATION ORGANIZED AT THE COURRIÈRES MINES, MAR. 10, 1906.
The soldiers are preparing to stretch piping from the air pumps.

tion, and securing the use of safety lamps and explosives in gaseous mines. Particularly, just now, engineers are focusing their attention upon respiratory apparatus, and we may with advantage consider the principal types which are in use in the mines of France.

Immediately after the catastrophe at Courrières, M. Barthou, the Minister of Public Works, brought the question before the *Conseil-Général des Mines,* and engineer Weiss was charged with an official mission to Germany and Austria in pursuit of the subject. The Colliery Commission of France, on its own part, selected MM. Bouteille, Morin, and Chavanne to accompany M. Weiss. The information gathered in the course of these inquiries led to the issuance of a ministerial decree (April 15, 1907) directing that mining companies in France should provide, for all workings where more than 100 men are employed under the fullest operation, "*portable respiratory apparatus* ready for immediate use and permitting the wearer to remain at least *one hour* in an irrespirable atmosphere." The regulations contained, further, various prescriptions relative to the apparatus to be kept at a central rescue station, where, under the direction of an engineer or an inspector, a rescue corps of at least ten should be properly trained. (Article VI.) Finally, all the requirements laid down by the Ministry in the decree were to be fulfilled within one year from the date of its publication in the official journal

—that is, to say, all the mines of France (unless specially exempted) must conform to them by April 18, 1908.

Let us now glance hastily over the history of respiratory appliances in order to estimate better the degree of perfection attained in those which are at present in use.

Certain German and Austrian constructors have presented respiratory appliances as a recent invention, but in reality apparatus of this character dates rather far back. The first practical attempts in this direction were made in 1824, and were due to French engineers. At that period the administration of the French mines addressed to all its prefects a memorandum in the course of which are found prescribed:—

1.—An apparatus with a nose clip, a mouth piece, and a respiratory tube for free air, developed experimentally by Pilâtre de Rozier in 1785 and completed later by M. Delaunaye's introduction of an anti-memphitic respirator with two valves, and of a lamp supplied with air through a branch of the respiratory tube.

2.—An apparatus with respiratory tubes attached to air reservoirs carried on a rescue car. The memorandum indicated the possibility of replacing the air in these reservoirs by oxygen, as well as that of increasing the amount of air or oxygen carried by compression within reservoirs of sufficient strength.

3.—An apparatus with respiratory tubes to be supplied by blowers and tubing or piping for the conveyance of the air.

The circular which accompanied this memorandum from the Ministry requested the mining companies to procure a number of these appliances, but the appeal was not regarded, and it is necessary to pass over a period of forty years before any new progress is to be observed.

In 1864 we may note the appearance of the Galibert respirator composed of a reservoir of pure air which the miner carries upon his back, a respiratory tube leading from the bottom of this reservoir to his mouth, and a tube for exhalation leading from his mouth to the top of the reservoir. By this arrangement, the user had between his lips an ivory mouth-piece with two orifices, and by closing these alternately with the tongue he might inhale air from the bottom of the reservoir and exhale it again to the upper part. It was possible for a man to breathe thus for fifteen to twenty minutes, but the air became greatly vitiated. To overcome the increasing discomfort which the rescuer must thus suffer Galibert conceived the idea of modifying the original form of his apparatus. He secured a partial regeneration of the air exhaled from the lungs by causing it to pass over a substance which would remove the carbonic acid. A little later (1870-1) Rouquairol-Denayrouze conceived his *aerophore*, which consists of a large sheet-steel tank containing air compressed to 20 atmospheres and carried either on the back or on a rescue car. A tube connects this reservoir with a mouth-piece provided with a pressure regulator, the nostrils of the user being closed by a pince-nez. Shortly afterwards Fayol described various types of respiratory apparatus in which he abandoned the use of compressed air in order to secure appliances little subject to derangement.

About 1884 Dr. Regnard applied, in an individual portable apparatus, the principle of revivification of the air by means of a reservoir of oxygen and of the passage of the exhaled air into another receptacle filled with pumice-stone saturated with a solution of caustic potash.

Unhappily, as M. Haton de la Goupillière states, all these appliances had a common failing, due to the infrequency of their use: "At the critical moment the parts of the apparatus would not work, and the men lacked familiarity with their use." Furthermore, the respiratory apparatus thoroughly tested from 1873 to 1880 at the mines of Commentry, under the direct inspiration of M. Fayol, little by little passed in disuse. The problem was taken up again in Germany and Austria only during the last years of the Nineteenth Century. But French inventors and constructors, working quietly, have been producing respirators which, little by little, have won their way by their own merit and without useless proclamations. In particular Lieutenant Vanginot of the Paris Fire Department has invented an apparatus of which the earlier forms appeared in 1903 and the most recent in 1907. During these four years this respirator has proved itself in many places, even as far as in Russia and Mexico.

There are now two types of rescue apparatus in use in French mines:

1.—Portable appliances which permit the bearers to move at will through the mine galleries and upon which we shall dwell particularly.

2.—Apparatus with pumps and piping, having a much more limited range of action, which are adapted for the prosecution of work rather than for rescue.

The portable appliances in their turn may be divided into two classes: First, regenerative apparatus, and second, apparatus using ordinary air; these latter, although they give a more limited working period than the former, appear to demand less nicety of manipulation. Furthermore, air exists everywhere, while at the moment of a disaster oxygen, potash, and other chemical necessaries may be lacking. In the

FIG. I. THE DRAEGER-GUGLIELMINETTI RESPIRATOR, SEEN FROM BEHIND.
Showing the oxygen reservoir, the pressure-reducer and the regenerator for exhaled gases.

former class (much more largely employed in Germany and Austria than in France) we may note particularly the ancient *pneumatophores* (Walcher, Mayer-Pilar, and Giersberg types) which generally consist of oxygen tanks delivering (usually without any regulator) into an air-tight bag, from which the man inhales and into which he exhales. An absorbent, usually liquid, contained in this reservoir, purifies this air by the removal of the carbonic acid. They did not work very well, and they have been abandoned, as has also the "Shamrock"

—an apparatus with a mouth-piece and a pince-nez, having a pressure regulator, a solid absorbent inclosed in a cage within the air-tight sack, in which, also, circulation was mechanically maintained.

The Draeger-Guglielminetti respirator merits larger notice, but its mechanism is complicated and the parts are fragile (Figure 1). It comprises a reservoir of oxygen, a pressure-reducing regulator, a respiratory mask, and a regenerator for the products of respiration. The oxygen tank consists of one or two steel reservoirs of one litre capacity each, placed horizontally and containing oxygen compressed to 110 atmospheres. This storage supply is maintained either by replacing the exhausted flasks with others, ready-filled at the oxygen-generating station, or by refilling the empty flasks in place, from larger oxygen reservoirs.

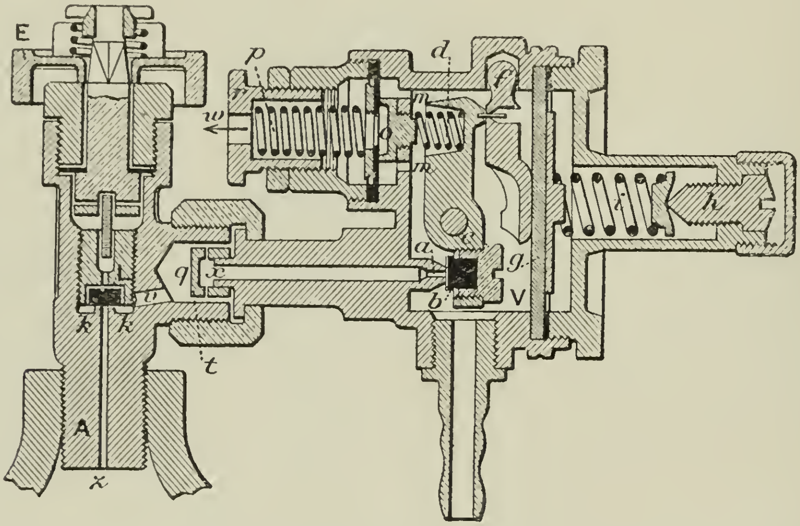

FIG. 2. SECTION OF PRESSURE-REDUCING AND REGULATING VALVE, DRAEGER-GUGLIELMINETTI APPARATUS.

The regulating and reducing valve (Figure 2) has a double purpose—to lower the pressure of the oxygen issuing from the reservoir and to control its volume. It is composed of two elements, the reducer, properly so-called, and the safety valve. The stop valve, which is shown at the outlet of the oxygen tank, is pierced by a canal z through which the gas escapes; this canal, formed by a small piece of ebonite L which is regulated by the screw E, opens into a circular chamber k. The movement of the screw E obstructs more or less the entrance of the oxygen into the passage k and its exit through v, another channel which establishes communication between the circular chamber k and the larger space q. The oxygen having reached this chamber passes out from it through the tube x, after being forced to pass through two small openings in the piece t. At a it meets an ebonite stopper b attached to the extremity of a lever c. This lever is controlled by the spring d. The oxygen issuing from a expands in a chamber V, where it presses against the membrane g against which the spring i bears in opposition to the spring d, the latter operating through the lever f. The pressure of the spring i is regulated by the screw h; this regulation is adjusted to secure a determined pressure for the oxygen in the chamber V; if the pressure of the gas decreases, the spring i forces the membrane g toward the left. This moves the lever f which, in its turn, compresses the spring d, engaging in its recoil the lever c. The ebonite piece b then in its turn enlarges a little the opening at a, affording a larger passage for the escape of the oxygen flowing from the reservoir and re-establishing the desired pressure in the chamber V. The contrary effect is produced whenever the pressure in chamber V begins to increase. Thus the expanded oxygen passing through the orifices m m, to the safety valve, is in a state of practically uniform pressure. The oxygen leaving the orifices m m enters the safety valve, where it presses upon the ebonite diaphragm o which is hollowed out at the centre and held by the spring p. The tension of this latter is regulated by the hollow screw r. The oxygen escapes at w and passes to the respiratory mask. The tension of the screws h and r is adjusted in advance. When the apparatus is to be used, the screw E is manipulated to permit the entrance of oxygen into the pressure regulator. The oxygen, after its reduction in pressure, flows to the respiratory mass, which is held in place by a sort of pneumatic gasket which fits over the face and is inflated at the moment of use. In the lower part are two sacks, one of which receives the oxygen, and the other the exhaled air, the entrance of the oxygen and the exit of the exhaled breath being governed by the play of two valves operating in opposite directions, as shown in Figure 3.

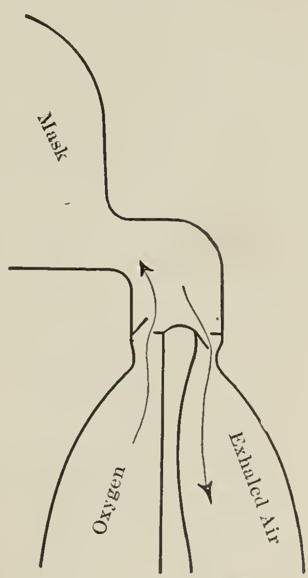

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FIG. 3. DIAGRAM OF DRAEGER-GUGLIELMINETTI RESPIRATORY MASK.

In newer forms of the apparatus a special arrangement permits the exhaled air still containing oxygen to pass two or three times to the lungs, and in cases of heavy demand this might offer an important advantage. The regenerator (Figure 4) serves the purpose of fixing the carbonic acid exhaled from the lungs and thus rendering

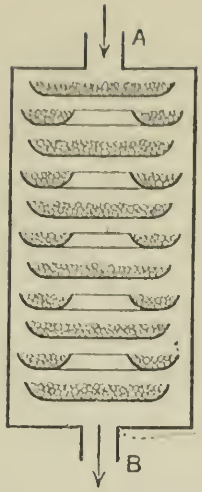


FIG. 4. SECTION OF REGENERATOR FOR EXHALED GASES, DRAEGER-GUGLIELMINETTI APPARATUS.

the air again respirable. The purified air at its exit from the regenerator passes into the inlet tube for the pure oxygen. The regenerator itself is composed of two sheet-steel cylinders placed vertically . In the interior are metallic baskets containing fragments of potash, about which the exhaled air circulates, giving up its carbonic acid to the potash before it passes out of the regenerator. As its temperature is raised by the heat given out in the chemical combination of the potash with the carbonic acid, it must be cooled before it is mixed with the oxygen flowing from the reservoir; the temperature reducer is a sheet-steel cylinder with double walls through which the air is made to circulate. As may be seen, all these devices are most ingenious and most complicated, and therefore up to the present the Draeger-Guglielminetti apparatus is little employed in French mines.

The *pneumatogène* of MM. Bamberger and Friedrich Bock is likewise a regenerative appliance. It is based on the following reactions which take place when aqueous vapor and carbonic acid (both products of respiration) are passed over the peroxide of sodium and potassium.

$$Na\,KO_3 + H_2O = Na\,OH + KOH + 2O$$
$$Na\,KO_3 + CO_2 = Na\,KCO_3 + 2O$$
$$CO_2 + Na\,OH + KOH = Na\,KCO_3 + H_2O$$

The products of respiration (CO_2 and H_2O) are absorbed and the oxygen is restored to the wearer of the rescue apparatus. The *pneumatogène* ready for operation is shown in Figure 5 and its operation is described as follows:

FIG. 5. THE "PNEUMATOGÈNE" IN USE.

The peroxide reservoir, shown in section in Figure 6, consists of a cylindrical metallic receiver A closed at both ends by caps D_1 and D_2. In the upper part is a small dome F_1, into which opens the orifice F of the respiratory tube, the mouth-piece of which the rescuer holds in his lips. In the lower part is a little reservoir G which is provided with a tube H leading to the air bag. When the apparatus is not in use, but merely ready for operation, the communicating openings a, b, are closed by little sheets of lead foil. At the moment when the device is put into operation these lead sheets are perforated with the aid of a mechanism consisting of the operating rods c and d and the perforating cutters e and f. S_1 and S_3 are filter plates which break up the circulation of the air into a number of circuits. These plates serve, also, to filter the air and to remove from it the particles of alkaline carbonates which might be entrained. As extra precaution, care is observed to place at E, between two perforated plates of metal, an asbestos composition forming a third filter which removes every trace of solid particles.

The ordinary charge is 250 grammes of peroxide of sodium and potassium, which is held between the perforated diaphragms g, h; but as there is a tendency for the mass to swell with the progress of the chemical combinations, and as this would interfere greatly with the free circulation of air in the apparatus, perforated frames C are placed at various heights within the body of the apparatus, thus preventing the difficulty. Finally, as the apparatus becomes considerably heated by the reaction, it is provided with an exterior insulating jacket with air circulation. The apparatus, as shown in Figure 5, is carried upon the chest; carriage on the back is discarded in order to avoid the long stretches of tubing, which almost always become defective.

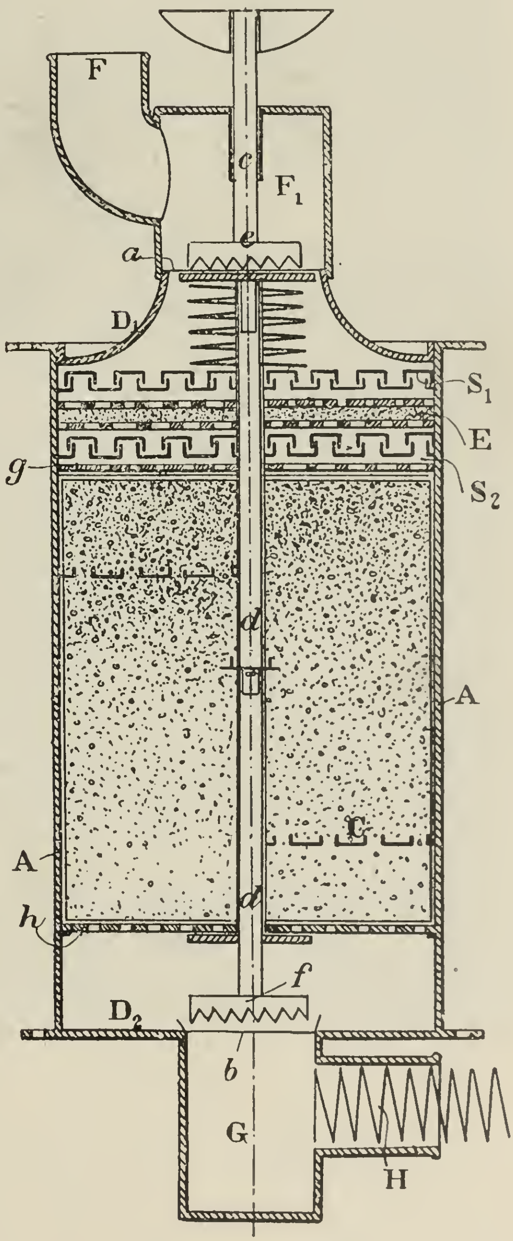


FIG. 6. SECTION OF THE RESERVOIR OF THE "PNEUMATOGÈNE."

FIG. 7. FACE VIEW OF THE TISSOT RESPIRATOR IN SERVICE.

This early type of *pneumatogène* permits 30 to 35 minutes' stay in an atmosphere of irrespirable gas; as this working period is too limited, the inventors have made various improvements in the newer model. At first it was thought that increase in the dimensions of the receiver would alone suffice, but many difficulties were found, such as poor circulation of the air, tendency to stoppage of the tubes, etc. It was therefore found necessary to double, or more exactly to triple, the old apparatus. The present type comprises, in fact, three similar receivers, of which two serve for use during the period of rescue work, the third being held in reserve for return to the air. Under ordinary operation only the two reservoirs are in service, but a little device permits the rescuer in case of need to bring the third into operation also. Having found, further, that the start is made with difficulty, and that it is necessary to force the air at first to quicken the reaction, the arrangement has been completed by the addition of a little reservoir containing 10 to 12 litres of oxygen or a small special apparatus containing binoxide of sodium capable of supplying immediately the few litres of oxygen necessary to start the operation. In order to avoid long tubing the apparatus is carried upon the chest, but the air bag is on the rescuer's back. The small apparatus with a single receiver weighs only 2 kilogrammes; the larger one complete about 3.5 kilogrammes. It serves equally well for "self rescue" or for the rescue of other persons. In the former case preference is given to the small model; in the latter to the type with three receivers. The *pneumatogène* is very light, easy to start and to operate. Finally, it is relatively inexpensive. In Austria its use is becoming more and more general. Many trials are reported in which the operators have remained for one hour, and some experimenters have been able to remain for two hours and a half without feeling serious inconvenience. In France its use is as yet but little extended.

The Tissot respirator dates only from 1907, but it appears to be one of the best conceived French apparatus of the type. Its general form and the manner of wearing it are shown in Figures 7 and 8. There are five essential parts in the appliance, which are described as follows:

1.—A nose-piece with valve, adjusted to the nostrils of the wearer by means of two nipples fixed on the tube, and attached firmly to a round cap by means of straps. The separation of the air currents of inhalation and exhalation is accomplished by two valves; a drain cock allows the discharge of accumulated water of condensation. The two valves are so constructed that it is impossible for them to stick even when they become saturated. The gas which has been inhaled is led by a rubber tube to a regenerator, where the carbonic acid is removed by a concentrated solution of potash; thence it passes to the reservoir bag.

2.—A regenerator fixed on the case, which serves also for the protection of the gas bag. This case or box is of metal, divided by partitions into four compartments designed for reception of the potash solution, and communicating by an orifice and two tubes. The height of these tubes and their flanges prevents the solution of potash from being thrown from one compartment to another. The large capacity of the lowest compartment makes any splashing of the solution finally harmless, and the wearer of the apparatus may lie down or crawl in any position without any possibility of the potash passing from one compartment to another. A special arrangement of the partitions of the lower part of each compartment prevents the reduction of the absorbing surface when the wearer is stooped over.

3.—A reservoir sack for the air, made of very pliable impermeable fabric, in which the regenerated products of respiration are accumulated.

FIG. 8. TISSOT RESPIRATORY APPARATUS; SHOWING HOW THE RESCUER MAY CRAWL FLAT ON HIS STOMACH WITHOUT INCONVENIENCE.

4.—An automatic safety or escape valve of the slide type, operated by the walls of this air reservoir. When the pressure in this latter reaches from 2 to 5 millimetres of water the sack bears against a plate, pushing it backward and by means of a rod draws aside a disc, uncovering the orifice of the tube and allowing part of the gas to escape from the apparatus. When the pressure has diminished sufficiently the disc returns to the closing position and the plate is restored to its former place by the action of a spring. The very large surface presented by the sack (800 centimetres) permits a considerable force to be exercised for the operation of the valve, making its action certain, even at a pressure so low as to be imperceptible to the wearer.

5.—A receiver for compressed oxygen, provided with a reducer and a gauge by which a constant flow of oxygen is obtained and is regulated at will by the wearer so as to give 1, 1½, 2, or 2½ litres a minute. The oxygen flowing from this reservoir is conducted by a rubber tube to the inspirator apparatus. If 1,700 to 1,800 cubic centimetres of saturated potash solution, containing 1,700 grammes of potassium hydrate, are equally distributed among the compartments of the regenerator, and if a flask containing 300 to 350 litres of oxygen is supplied, it is possible for the rescuer to remain four to five hours in an irrespirable atmosphere, walking at the pace of 5 kilometres an hour, or to remain for two hours and a half at continuous and very fatiguing work. In trials made at the mines of Lens in July last, the Tissot respirator gave satisfactory results. In one of these, thanks to the apparatus just described, a man made a stay of three hours and a half and accomplished a circuit of 3.3 kilometres through difficult mine passages. Further than this, the miner may advance, crawling upon his stomach, no part of the apparatus (as the photographs show) being borne upon the chest to obstruct him.

Among the apparatus using ordinary air, principal mention may be made of the Vanginot respirator shown in Figures 9 and 10, which is coming into increasing use in the mines of France, and which has been in service for several years in the Paris Fire Department. To begin with, the Vanginot respirator, being of the compressed-air type, furnishes the user with a continuous supply of fresh air, and this without the aid of any cooling device requiring special or delicate parts which are often the cause of poor working with similar appliances. The natural explanation of this is the large absorption of heat due to the expansion of the air, which lowers the temperature of the flasks considerably and keeps them cool even in a heated atmosphere. Its strong construction insures it against derangement, and the very simple mode of replenishment gives it the incontestable advantage of furnishing to its users a respirable, natural atmosphere for an indefinite period, without having recourse to chemical products difficultly procurable, often dangerous to the user, and sometimes likely to be found spoiled at the moment of need.

The Vanginot apparatus consists of three parts:—

1.—A battery of air accumulators.

2.—An indicating reducing gauge.

3.—A respiratory mask or helmet.

The battery of air accumulators, which is composed of two steel flasks (Figure 11), is charged at a pressure of 150 to 250 kilogrammes (2,130 to 3,150 pounds per square inch) by means of a compressor constructed specially for the service. The volume of air thus stored is sufficient for an hour to an hour and a quarter's use. We shall see later that an ingenious system of refilling permits this supply to be renewed by the replacement of the accumulators even in the midst of an irrespirable atmosphere in which the wearers may be working.

FIG. 9-10. FRONT AND REAR VIEWS OF THE VANGINOT RESPIRATOR.
The view from behind shows the air-accumulator battery, the pressure gauge, and other attachments.

The indicating reducing gauge, as its name indicates, lowers the pressure of the air contained in the flasks to an ordinary tension and supplies the user with a volume of expanded air, which may be further regulated by means of a so-called regulating valve, supplying a greater or less volume according to respiratory needs. This reducer-recorder is also employed to operate an alarm whistle, warning the rescuer of the reduction of pressure and of the approaching exhaustion of the compressed-air supply. The moment when this warning shall be given may be regulated at will, but with the ordinary ad-

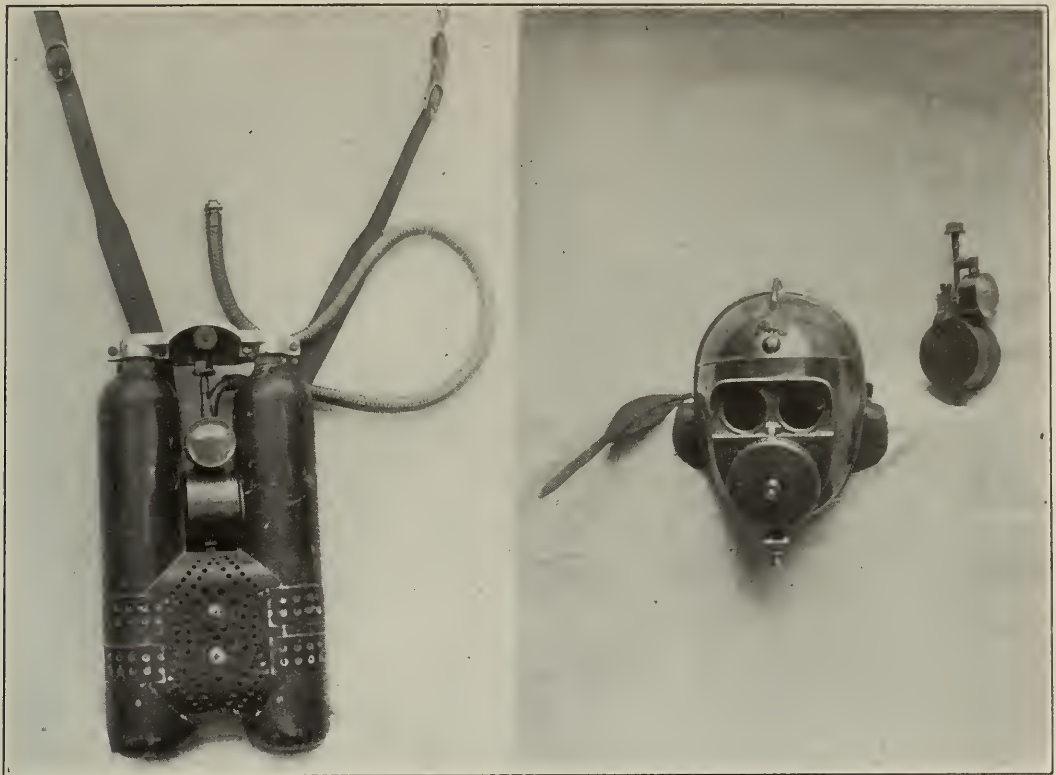


FIG. 11-12. AIR-ACCUMULATOR BATTERY, HELMET, AND REDUCING GAUGE OF THE VANGINOT RESPIRATOR.

justment the apparatus is supplied so regulated that the whistle will sound when the air supply is within fifteen to twenty minutes of exhaustion.

The respiratory mask with its crest resembles a fireman's helmet extended downward and forward so as to enclose the face completely. It is strong enough to protect the wearer's head from blows or falls of hard substances. The respirable air contained within the helmet is isolated from the external atmosphere by means of a pneumatic tube which can be inflated at will and which, adjusting itself to every contour of the face, assures most absolute safety so far as air-tightness is concerned, while it avoids all harshness of contact.

The discharge valve for the exhaled air is proof against any derangement. It consists of a simple membrane with large surface. The chest of the wearer is entirely free for carrying another person or any large burden. The wearer may stoop without fear in crawling through small openings. M. Le Breton, in a report presented to the Coal-Gas Commission, concludes as follows:

"The construction of the Vanginot apparatus is very simple, and to put it into service requires the easiest of manipulations—the opening of an easily-controlled stop cock."

In practical work the operator places the air accumulators on his

FIG. 13. RENEWAL OF AIR-ACCUMULATOR BATTERIES IN THE VANGINOT APPARATUS.

back like a knapsack, puts on the helmet, attaches this to the air battery, and opens the stop cock. Thus supplying himself with air, he may enter a deleterious atmosphere. A special arrangement permits the wearer of the apparatus to traverse any necessary distance before entering the irrespirable atmosphere without using the air supply stored in the battery. To accomplish this he raises a catch, opening a door in the helmet and putting himself in direct communication with the ordinary air, at the same time cutting off the flow from the storage supply. As he approaches the irrespirable zone he lowers the catch, closing the door, and immediately finds himself supplied with air from the battery.

Assurance of the proper working of any automatic respiratory apparatus before it is carried into actual service depends upon the reliability of its mechanical parts. In the case of the Vanginot respirator, when the operator has put it on it is necessary only to open the stop cock of the air tank and immediately close it again. This action confirms the fullness of the storage tanks and actuates the indicator whistle. The indication of the figure 150 or 175 by the needle of the gauge, followed by two distinct blasts of the whistle, assures the wearer of his air supply for a known period, and also of its proper flow into the helmet. Finally, (and this is also an essential point) the rescuer will be warned at the definite moment when he has but fifteen or twenty minutes further air supply, and he may then retire from the dangerous atmosphere in which he is working or exchange the exhausted accumulator for a full one. To effect this, as shown in Figure 13, one of his fellows attaches to the three-way stop cock at the back of his helmet one of the full batteries held in reserve near by, using for this attachment a rubber tube provided for the purpose. He opens the valve of the accumulator thus attached; then, by a quarter turn of the three-way cock he opens a passageway into the helmet for the air from this new accumulator, at the same time cutting off the nearly exhausted one. The attachment of this latter is then unscrewed and it is easily replaced by a new one. By proper manipulation of the three-way cock this last accumulator is placed in communication with the helmet. The tube connected with the reserve by which the man has been supplied during the interim is detached, and he is again free to move at will. The whole process requires scarcely two minutes. It is easily seen that with a sufficient supply of reserve compressed-air accumulators the rescue party may remain at work indefinitely if circumstances require. This is so immense an advantage for this form of respirator that M. Weiss, engineer of mines, strongly recommended its adoption in the French collieries at a conference held in 1906 before the Paris section of the Society for the Mineral Industry.

We must not leave a review of apparatus using ordinary air without referring to the Swiss respirator employing liquid air, still under experiment, but already put upon the market by the Hanseatische Apparate Bau Gesellschaft under the name of "aerolith." The apparatus is shown schematically in Figure 15. The principal part is the liquid-air reservoir e, which is carried upon the back of the rescuer. This is a rigid vessel of nickel steel, surrounded by many envelopes

FIG. 14. THE "AEROLITH" OR LIQUID-AIR RESPIRATOR IN SERVICE.

of corrugated paper-board, sheet metal, felt and leather. The liquid air is held in an absorbent material, asbestos being chosen to avoid the explosions which might possibly occur if organic absorbents were used. This air tank has in its upper part the charging opening a, provided with a screw stopper, and the tube b for the outflow of vaporized air. This air-supply tube b is intentionally made rather long so as to allow the air to become warmed to a certain extent and thus avoid discomfort to the user from breathing it at a very low temperature. It opens into a second flexible tube d, which serves also for exhalation and is of considerably larger diameter. This second tube carries at one end the mouth-piece. At the other it is attached to a metal pipe of 30 millimetres diameter, which runs diagonally across the liquid-air reservoir. The object of this arrangement is to facilitate the evaporation of the liquid air by the warmth of the respired gases. At its exit from the reservoir this transverse tube is connected to the retarding flask f, from which the vitiated atmosphere escapes through the orifice g, the rate of discharge being regulated at will. A little scraper, h, in the rigid tube allows this to be cleaned if it becomes obstructed by frost deposited within it. Like other types, the device is completed by a pince-nez. The apparatus weighs about 3.5 kilogrammes empty. It can hold about 6 kilogrammes of liquid air, say 10 kilogrammes total weight for the apparatus ready for use. This weight of air corresponds to about 4,800 litres and theoretically should suffice for about three-hours service. Figure 14 shows a rescuer equipped with an aerolith. As the liquid air is evaporated by the heat of that exhaled, the apparatus is self-regulating. The harder the work performed by the rescuer, the more active his respiration, the more rapid the circulation of

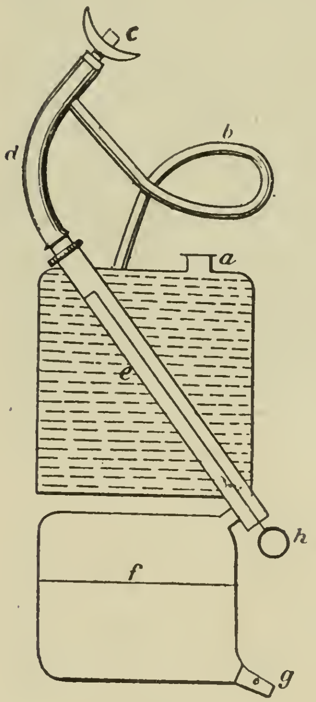


FIG. 15. SCHEMATIC SECTION OF THE "AEROLITH."

the warm "exhaust," and the greater the evolution of freshly-vaporized air. The top of the flask is provided with a little alarm clock, which may be set at will so as to warn the wearer when he has but a half-hour's supply remaining.

So far the aerolith has not been employed in French mines except experimentally. It has the disadvantage of necessitating the liquefaction of air, which is rather a costly operation, a machine with a capacity of 10 kilogrammes an hour being worth about 22,500 francs.

We may conclude with some consideration of the second great class of appliance—that of apparatus comprising pumps and piping, which is required for large work such, for instance, as the construction of earth or masonry dams. All such devices involve the same principle and consist of:

1.—First a compressed-air supply, of either pump or blower type;

2.—A helmet or similar respiratory appliance with which the worker is provided;

3.—The series of pipes through which the fresh air is supplied.

The latest of these systems commonly used in French collieries is the Fayol. Preference is sometimes given to the von Bremen apparatus, well known in Austria, or to that of Koenig, Stolz, Lieb, or Schraum, which are employed in a number of German establishments. The tube is usually of rubber, varying in diameter, reinforced with metallic windings. At the mines of Commentry it is incased in cylindrical iron boxes for transportation. The respiratory appliance may be a simple mouth-piece with pince-nez, (still employed) or a true diver's helmet with an impermeable seamless blouse, permitting the escape of the vitiated air as in the von Bremen and Koenig systems.

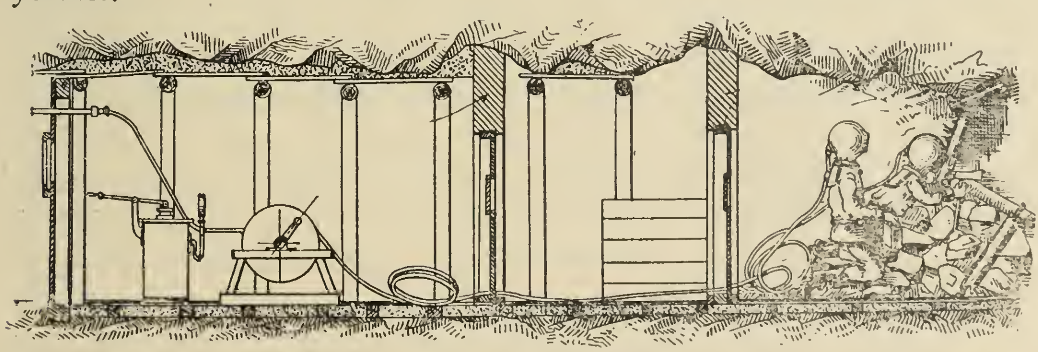


FIG. 16. SECTION OF A DRIFT SHOWING SALVAGE WORK WITH THE VON BREMEN APPARATUS.

Figure 16 represents the von Bremen apparatus in use in operations for the extinguishment of a mine fire. To begin with, the burning portion is isolated by tight barriers, to prevent the inflow of fresh air and consequent explosions which might make all salvage work impossible. Following this, as rapidly as possible, new barriers are erected of planks or of earth enclosed between planks. These are provided with doors and as soon as one is completed a second is raised a short distance behind it, thus constituting an air lock. The pumps, hose reels, etc., are behind the air lock in the open. There, also, additional rescue apparatus is held ready for the relief of the rescue party. These latter, equipped with air helmets, enter the air lock, and after closing the outer doors pass through the inner barrier into the fire zone. The reserves may watch their movements through thick glass lights placed in the doors. If the tubing is sufficient for an advance of 100 metres, it may be seen that the work of clearing the gallery can without great danger be prosecuted for a certain distance. The rescuers, thanks to the apparatus they wear, may easily remain in an insupportable atmosphere and they have nothing to fear from explosions, all access of air having been rendered impossible. When their advance has been pushed a certain distance a new air lock is constructed and the old one behind may then be torn down. When they arrive close to the fire, the salvage party may erect permanent barriers of brick and completely enclose the fire. In some cases a single air lock is not considered sufficient and a double lock with a third door is provided as shown in the figure.

Such is the present state of the art in France. If the eminent director of the *Ecole des Mines* of Paris could formerly say, to the great astonishment of his hearers in a certain conference, that "we knew the number of the victims made by these appliances, but we might find difficulty in enumerating the persons whom they have saved," it may clearly be seen that any such assertion nowadays would find many to contradict it. No doubt in certain catastrophes all rescue is impossible, even with safety appliances. It is nevertheless true that at Courrières, for example, to cite but a single case of the many which might be advanced, the Paris firemen equipped with Vanginot respirators penetrated workings where the German miners from the "Hibernia," although much more skilled in underground work, did not dare to venture. Therefore, we may state confidently that with rescue stations above ground, with refuge chambers in dangerous workings, with simple and practical salvage appliances such as those described, kept constantly in good order, and finally with properly trained rescue corps, salvage work in the collieries would be greatly improved. In this manner we might diminish the effect of coal-gas explosions which sometimes flash like a subterranean lightning stroke through the galleries even of the best ventilated mines.

ON THE SIZE OF BATTLESHIPS.

By Sidney Graves Koon.

The active discussion of naval expenditures by the great nations on both sides of the Atlantic makes very opportune this analysis showing the great sacrifice in efficiency which must be made where the size of the battleship is reduced.—The Editors.

MUCH has been written recently regarding large battleships and their great adaptability to uses where smaller ships could be employed only with large increase of numbers. In general the discussions have dealt almost wholly with the question of gun power, and have either ignored the physical relations between large and small ships, or have covered them by implication only. It is proposed to take up a representative battleship, such as the Michigan in the United States navy, and to institute a number of comparisons between this ship and two ships, each of half the displacement of the Michigan, but designed under varying conditions so far as the principal military features are concerned.

In the first place, a design might be evolved in which the various percentages of weight used for the several elements constituting the displacement of the Michigan might be retained in the smaller vessels. A second design would call for the same battery as the first, the same speed as the type ship (Michigan), and such armor protection as might be available after making due provision for these other two features. A third design calls for the same battery as the first, and for protection equal to that given the Michigan, with such speed as can be obtained in connection with this battery and armor. The fourth design calls for the same speed and protection as in the Michigan, and for such battery as may be obtained after making provision for the other two items.

While the weights allotted to the various component portions of the Michigan are not public property, and cannot, therefore, be given with any exactness, yet a sufficiently close approximation for our purpose can be made, and whatever errors there may be in this statement of weights will by no means vitiate the comparison instituted. A schedule of weights assumed for the Michigan is given on page 22. This accounts for the total displacement of 16,000 tons.

The Michigan has a length on the water line of 450 feet, a beam moulded of 80 feet, and a draft of 24 feet 6 inches. She is propelled by twin screws, the horse power of the machinery being designed as 16,500, and the designed speed, 18.5 knots. The battery consists of eight 12-inch guns mounted in pairs in four turrets on the center line, in such a way that all can be brought to bear on one broadside. The secondary battery includes twenty-two 3-inch and fourteen smaller guns, besides two torpedo tubes. The protection includes a water-line belt with a maximum thickness of 11 inches, upper belt with maximum thickness of 10 inches, turrets and barbettes with thickness of 8 to 12 inches, and a protective deck with a maximum thickness of 3 inches. The assumed schedule of weights is :—

Hull and fittings complete	6,400	tons
Equipment and stores	800	"
Battery and ammunition	1,300	"
Protective deck	900	"
Other armor	4,200	"
Machinery and water	1,500	"
Coal	900	"

The ratio between the length of one ship and the length of a ship of similar shape and half the displacement is 1 to 0.7937. Applying this ratio to the dimensions of the Michigan, we have for each of our smaller ships a length of 357 feet, a breadth of 63 feet 6 inches, and a draft of 19 feet 5 inches. Our first ship would have a schedule of weights each item of which would be just one-half the corresponding item for the Michigan, as shown in the table for weights under the four different designs. This ship would, of course, have just half the Michigan's battery, namely:—four 12-inch guns, eleven 3-inch, seven smaller, and one torpedo tube. Its armor protection would cover the same proportionate area as that of the Michigan, each linear dimension, however, being proportionate to the corresponding dimension on the Michigan, in the ratio above given. This same ratio would affect the thickness of the armor everywhere, and the 11-inch belt would become 8.73 inches thick; the upper belt would have a maximum thickness of 7.94 inches; the turret and barbette armor would vary from 6.36 to 9.54 inches; while the maximum thickness of the protective deck would be 2.38 inches, in place of the 3 inches in the Michigan.

Not only would the armor be thus decreased in value as compared with the Michigan, but the speed would also be decreased, due to the fact that it is physically relatively more economical to propel a large vessel than a small one. This fact may be brought out by analysing the expected speed performance of the Michigan by means of the Admiralty formula :—

$$V^3 = \frac{H \times K}{D^{2/3}},$$

where V is the speed in knots; H is the indicated horse power; D is the displacement in tons; and K is a coefficient of performance known as the Admiralty coefficient, and used for designing purposes. $D^{2/3}$ for the Michigan is 635; for each of the other vessels under consideration it would be 400; V^3 for the Michigan is 6,332; H for the Michigan is 16,500; K thus becomes 244. As the new ship has the same form as the Michigan, we may without sensible error assume that this same coefficient, 244, may here be used. On applying this to the formula, knowing that our horse power is 8,250, we find that V, or the speed, becomes 17.14 knots, in place of the Michigan's 18.5.

The second design calls for the same speed as the Michigan, namely 18.5 knots. In this case, by using our formula, we find that the horse power required is 10,380. This raises the weight necessary to be devoted to machinery from 750 tons to 944 tons. As the battery of this ship was to be unchanged, and the armor protection to be so adjusted as to fit the new conditions, the difference of 194 tons must be taken out of the provision for protective deck and armor, thus reducing these two items to 416 and 1,940 tons respectively. Assuming that each portion of the vessel is covered with armor of the same area as before, but of thickness reduced in the ratio of the weights allotted to armor, we find that the belt has been reduced from the original 11-inch maximum to 8.07 inches; the upper belt is reduced from a maximum of 10 inches to 7.34 inches; the turret barbette armor from 8 and 12 inches to 5.87 and 8.81 inches; and the protective deck from a maximum of 3 to 2.2 inches.

The third design uses the same armor schedule as in the Michigan, both as regards actual thickness and proportion of ship protected. This results in increasing the weight required for protective deck from 450 tons, under design 1, to 567 tons, and for the other armor from 2,100 tons, under design 1, to 2,646 tons. This total increase of 663 tons is made at the expense of the propelling machinery, the weight allotted to which thus becomes reduced to 87 tons. This accounts for only 957 horse power, or a speed, from our formula, of only 8.35 knots. This shows what a very great diminution of speed must be expected if we are to retain in the smaller ship the same relative battery power and protection as in the larger.

The fourth design calls for the same speed and armor protection as in the Michigan, and the difference in weight is taken from that allotted to the battery. As found in the second design, the required horse power is 10,380, calling for 944 tons of machinery. The armor weights will be the same as in the third design, namely, 567 tons for the protective deck, and 2,646 tons for the other armor. As we have made no change, throughout the series of designs, in weights of hull and fittings, equipment and stores, and fuel, we still have for these items a total of 4,050 tons. Adding this to the above-mentioned figures for machinery and protection, the total becomes 8,207 tons, or 207 tons more than the designed displacement of the vessel. This means that in order to float at the designed displacement with the same structure and equipment, an amount equal to 207 tons would have to be taken bodily from the vessel, or stores, or both, and it means, moreover, that there would be absolutely not one pound available for the provision of a battery of either heavy or light guns. Of course it will be recognized that we have appropriated all the necessary weight for a splendid protection to such a battery, and that no designs would ever be evolved in which such protection would be provided without allowing for the battery itself. These figures have been worked out, however, simply for the purpose of showing the immense sacrifices which have to be made in various directions in small vessels, in order to provide along other lines qualities similar to those obtained in vessels of larger size.

Item.	Type 1.	Type 2.	Type 3.	Type 4.
Hull and fittings........	3,200	3,200	3,200	3,200
Equipment and stores...	400	400	400	400
Battery and ammunition.	650	650	650	—207
Protective deck	450	416	567	567
Other armor	2,100	1,940	2,646	2,646
Machinery and water....	750	944	87	944
Fuel	450	450	450	*450

The figures above deduced show that under a given set of conditions the two small vessels having the same total battery power as the one large would require these sacrifices to be made along other lines:—

If there is the same proportionate weight for armor, there will be a sacrifice in the thickness of armor amounting to nearly 21 per cent; there will be a sacrifice in the speed amounting to about 8 per cent. If the total battery power is to be the same, and the speed is also to be equal to that of the large vessel, there will be sacrifices in the armor protection, the reduction in thickness being about 27 per cent. If the total battery is to be the same, and the armor protection equal to that of the large vessel, the sacrifice in speed will be tremendous—in fact, markedly greather than would ever be permitted in any design. The falling off would be more than 10 knots; that is, about 55 per cent. If we have the same speed and the same protec-

* Reduced to 243 on account of deficiency for weight of battery.

tion for the two smaller ships that we have in the larger, there will be no weight available for battery, and our fuel supply will be cut off more than 45 per cent.

This line of reasoning shows that there are other reasons besides those of mere gun fire which militate in favor of large ships as compared with small ones. If it were a question of gun fire alone, we might consider that a ship similar in design to the original monitor might be the ideal; for a fleet of such ships could bring all their guns to bear at any point of the compass, because the monitor had a practically unobstructed range of fire all around the horizon. As ships increased in size, demands came for a larger armament, and double-turreted monitors were the answer to the demand. The Michigan is the next in this direct line of development, although there have been many, many changes between. The double-turreted monitor design has had added to it a battery of broadside guns, only one-half of which in general could be brought to bear upon one broadside at a time. In the Michigan, however, we have gone back in general principle to the double-turreted monitor, carried one step further, for each of the four turrets has command over about three-fourths of the horizon. The small ships represented in the above figures would naturally be provided with two turrets each, instead of the four in the Michigan, and would have the same relative command of fire as in the latter ship. Whatever other battery is fitted in accordance with the above figures would be solely for the purpose of discouraging torpedo boats from too much inquisitiveness, and does not affect the general type evolved.

It has long been recognized that every man-of-war represents a compromise between conflicting military interests, and the science of naval architecture has not yet developed an ideal relationship between these interests, nor will it probably ever be reached. For some reasons, speed is an almost paramount consideration, while for other purposes the one item of prime importance is battery power. In either case a certain amount of the one must be associated with the other; for the speed is of no avail unless the battery be at hand to back it up, and the battery is of slight value unless the speed be sufficient to place it within reach of the enemy. Protection and battery go largely hand in hand, an increase in the latter calling usually for a corresponding increase in the former. This is not the case in extreme types, but it is a general principle. In all ships, however, certain sacrifices of one element have to be made to meet demands for excessive provision in another, and in no ship is this sacrifice more marked than in that of small size.

A COMPLETE SYSTEM FOR THE PURCHASING DEPARTMENT.

By J. Cecil Nuckols.

THE purchase of raw materials which enter into the manufacture of the finished product constitutes a very vital element of any factory, and it requires knowledge that comes only from a close study of one's business.

Let us first inquire closely into just what we term the "purchasing department." In most concerns the buying is looked after by one who knows thoroughly that important branch of the business, and even in small partnerships one of the partners usually assumes the duties of the purchasing agent. So then, in this article, we will deal with the purchasing agent and his records—records that are necessary to intelligent buying.

We shall not discuss the qualities that should be possessed by the successful purchasing agent. A man may be gifted with a fund of general knowledge, may possess all the qualities that tend to make a successful buyer, but without system his department can never become ideal. But, on the other hand, some of our most successful purchasing agents may have no particular qualifications save common sense, and yet their departments are models because they are systematic. They are enabled to buy right, from the right sources, and at right prices.

Vital Information.

A purchasing department may be conducted satisfactorily only by having certain information instantly available. The purchasing agent must be fully informed as to all dealers supplying the classes of goods he must buy. He must know what dealers are most favorably located as to transportation facilities. But this must not overshadow the fact that sometimes dealers at a more distant point will make certain concessions which make it obviously wise to buy from them. The purchasing agent can often, by buying far enough ahead of immediate requirements, find an opportunity of saving quite a considerable sum.

To classify properly the information about the goods supplied by the dealer, he must file and index all catalogues and other litera-

Firm *The S. Obermayer Co., Cinti., O.*

Subject	File	Catalogue	Page
Plumbago	47	#40	34

The Eng. Magazine

FORM I. INDEX CARD FOR CATALOGUE—BY FIRM NAME.

ture which will give the desired data. A catalogue file with adjustable partitions will be found the most practical, and all catalogues should be cross-indexed as shown on Forms 1 and 2. Form 1 shows

Subject *Plumbago*

Name	File	Catalogue	Page
S. Obermayer Co., Cinti.	47	#40	34

The Eng. Magazine

FORM 2. INDEX CARD FOR CATALOGUE—BY PRODUCT.

the card for the name of the dealer. These should, of course, be filed alphabetically, and I would suggest that they be blue. On this card is space for the dealer's name and address and the various goods he supplies. The file column refers to the compartment in the catalogue file, and there are also columns for the catalogue number and the page where the desired information may be found. Form 2 should be a white card and should be filed, also alphabetically, according to subjects.

Article *Plumbago*

Date	Firm Name	Address	Price	F.O.B.	Cat'g	Ord.
1/25/08	S. Obermayer Co.	Cinti.	5¢ lb.	Cinti	#40	1/29

The Eng. Magazine

FORM 3. INDEX CARD FOR QUOTATIONS.

The purchasing agent should never place an order without full information as to prices charged, etc., but often time will not permit writing for prices before the order is placed. He should have completely classified records of all quotations previously received and Form 3 will answer this purpose nicely. Not only must he get the right prices but he should know just what quality of goods may be expected from the various dealers. Of course all contracts permit the refusing of goods which do not come up to specifications, but this may mean a great loss where the materials are needed immediately. It often happens that the question of delivery is as important as the question of price. A dealer may have goods satisfactory in every way, and still be so slow in making delivery that the loss of time more than offsets any price consideration. He finds it necessary, then, to have full information about the manner in which orders are apt to be filled. On Form 3 should be entered a synopsis of each quotation received, the prices named by different concerns being seen at a glance. When the spaces on one card are filled, another is added. All quotations being entered in the order of their dates, the last card always shows current prices. These quotations should be filed under the names of the articles.

REQUISITIONS.

Not only is information on which to buy right important, but to keep a proper record of purchases is of equal importance. The purchasing agent should be able to tell instantly when an order was placed, where it was placed, why it was placed, and when he may expect delivery. This does not mean a mass of records, for proper system makes it a very simple matter, and one easily provided.

Requisition
Original

Dept.__________ Date__________

No.__________

Mr.________________P.A.

You will please furnish this department as soon as possible with the following:

____
Dept. Head

Quantity	Articles	Purpose

Ordered________________ From________________

The Eng. Magazine

FORM 4. REQUISITION BLANK.

He should demand a requisition before the order is placed, showing by whom and in what department the goods are wanted. He naturally will receive requisitions from the following sources:—From the stock department for goods to be placed in stock. From the order department for goods with which to fill orders. And from the various department heads for articles required in their particular departments. Form 4 shows a simple requisition blank. Different colors for the different departments will be found the best plan, as a glance will show from which department it comes. Each requisition

ORDER

The S. Obermayer Co.

Order No. 2293
Requisition No. 1924

Cincinnati__________ 19_____

To____

____

Please ship via____________________to us at_____________________________

the following as per your quotation of_____________________________

Important
Our order and requisition numbers must appear on bill.

Date Wanted

The S. Obermayer Co.

____
Purchasing Agent

Tear this off and mail promptly to

Order No. 2293
Req. No. 1924

The S. Obermayer Co., Cincinnati, Ohio

Gentlemen: We expect to ship_____________________________

Signed_____________________________

The Eng. Magazine

FORM 5. PURCHASE ORDER.

should give full information as to size, etc., and should be either signed or O. K'd by the department head.

When the goods have been ordered, the date and the name of the concern from whom ordered should be entered on the requisition. It is then ready for filing. It will be found most practical to file all requisitions according to departments, keeping them according to dates. A card-index drawer about 5 inches by 8 inches will be found an admirable size and place in which to file these requisitions. The indexing of these is a very simple matter. Take a set of blank guide cards, one set for each department, write the names of the different departments on the projections, and you have all the index you need. Should a larger blank than a 5 inch by 8 inch be required, file these in a vertical correspondence file.

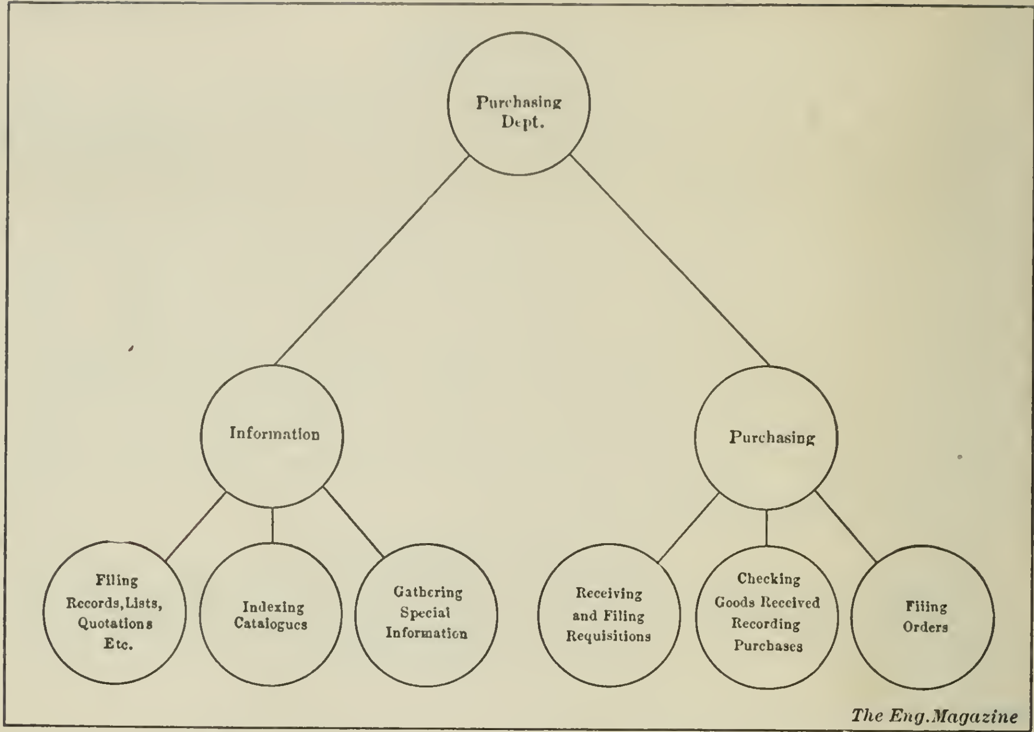
Purchase Orders.

In Form 5 is shown an order form which will answer for the average concern. This, of course, may be easily modified, but under most conditions it will answer the purpose as well as a more elaborate one.

It is, of course, necessary to keep a copy of all orders placed. As many copies as may be required may be made at one operation by using carbon paper and the typewriter, billing-machine, or by hand. In a small business one copy is sufficient, while in larger concerns as many as five or six may be necessary, depending upon the nature of the business. Ordinarily orders in triplicate will answer—the original to be sent to the concern from which the material is ordered, one copy for the purchasing agent, the third for the receiving clerk. On this latter it is not advisable to show prices. This can be provided by using a short carbon over this copy, thus leaving all blanks of uniform size. In larger concerns the purchasing agent has no direct connection with the auditing department, and here we need another copy of the order that all bills may be properly audited. Then, too, the head of the concern should also have a copy of the order that he may know in advance what obligations are being contracted.

Let us trace the disposition of each copy of the order, supposing that five copies are made.

The original is signed by the purchasing agent and mailed to the concern that is to fill the order; a copy is retained by the purchasing agent for his files; one copy is sent to the receiving clerk to be filed under the name of the firm, so that when the goods are received the order may be easily referred to for checking purposes; another copy goes to the manager for purposes stated above; and the other copy to the auditing department.



FORM 6. ORGANIZATION OF PURCHASING DEPARTMENT.

When the goods are received the receiving clerk checks the items with his copy of the order, and then returns this to the purchasing agent so that he may know that the goods have been received. The purchasing agent's copy should be used by him to follow-up the shipper. The order should be placed in a file provided with indexes (numbered one to thirty-one) under the date when an acknowledgement may be expected. Should no acknowledgement be received a letter should be sent to find out if the order has been received. Ordinarily the acknowledgement will give about the date when the goods will be shipped. Then the order should be filed ahead under the date when the invoice should be received. In this way you provide for another follow-up if no invoice is received, and even after date of shipment the order may be still placed ahead to follow-up the transportation company. After the goods are received the copy of the order in the office file should be attached to the original requisition and filed under the name of the concern. Fig. 6 shows an organization chart of the purchasing department, and a careful study of the system outlined will show that all of these records are kept with a minimum of time and labor.

Leschen Rope Tramway for San Toy Mine, Chihuahua ; 4,600 feet long.

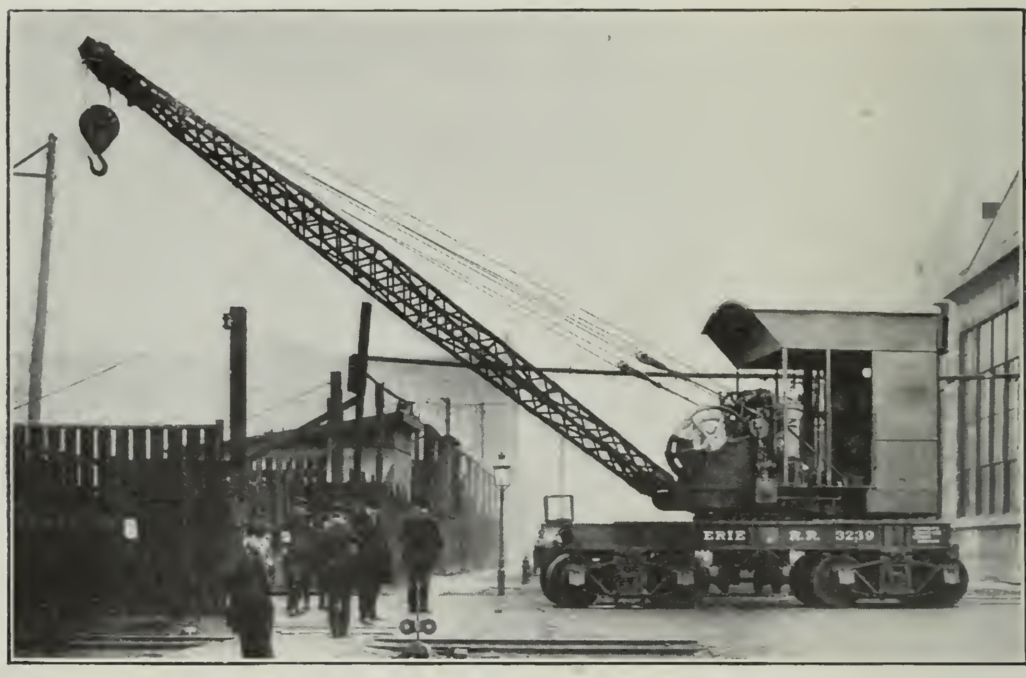
HOISTING MACHINERY FOR THE HANDLING OF MATERIALS.

By T. Kennard Thomson.

STATIONARY cranes are restricted in their usefulness to such work as can be completed within their reach—for instance, feeding a punching machine, loading or unloading cars, boats, etc; but they would not be economical where a series of cranes would be required to pass an object from one end of the shop or yard to the other. It is a well-known maxim that it costs money every time an object is picked up, even if it is put down again immediately, for it always takes more or less valuable time to hook on to a bucket, steel plate, or other piece and to unhook again. Even lifting an object at one end of a shop and placing it on a flat car to be pushed or pulled to the other end of the shop or yard and there unloaded may not secure the best economy, so we have the movable cranes such as the gantry, overhead three-motor electric traveling cranes, locomotive cranes, etc.

The locomotive crane, though invaluable in many places, is more useful where the range of work is limited but progressive in location, such as building long masonry walls, excavating canals, loading coal, or, in other words, wherever considerable work can be done between each move of the machine itself, or where the object to be picked up and held suspended while the crane moves is only to be handled occasionally and the expense of a bridge crane would not be justified. A locomotive crane was originally a pillar crane put on a truck and capable of propelling itself. As now built, however, the pillar feature has almost entirely disappeared. As the number of uses it can be put to are unlimited, so the variations of boom length, capacity, and design are legion; all, however, have a truck usually to run on a standard-gauge track until the load to be lifted exceeds about 20 tons. The truck carries the turn table with the boom and mechanism, the engine, boiler, and sometimes an additional load to act as a counterweight to prevent the crane from overturning. Vertical engines are found better for 10-ton cranes than horizontal, causing less vibration, sometimes a very important consideration. Two engines coupled at right angles facilitate the starting and equalize the power.

The same pair of engines usually lift the load, rotate the upper part of the crane, and at the same time, if necessary, propel the crane itself, the latter motion being usually obtained by means of bevel gears connected with the shafts of all four wheels, so that if the load is unbalanced, that is, throwing a greater weight on some of the truck wheels than the others, the motion will not be interrupted.

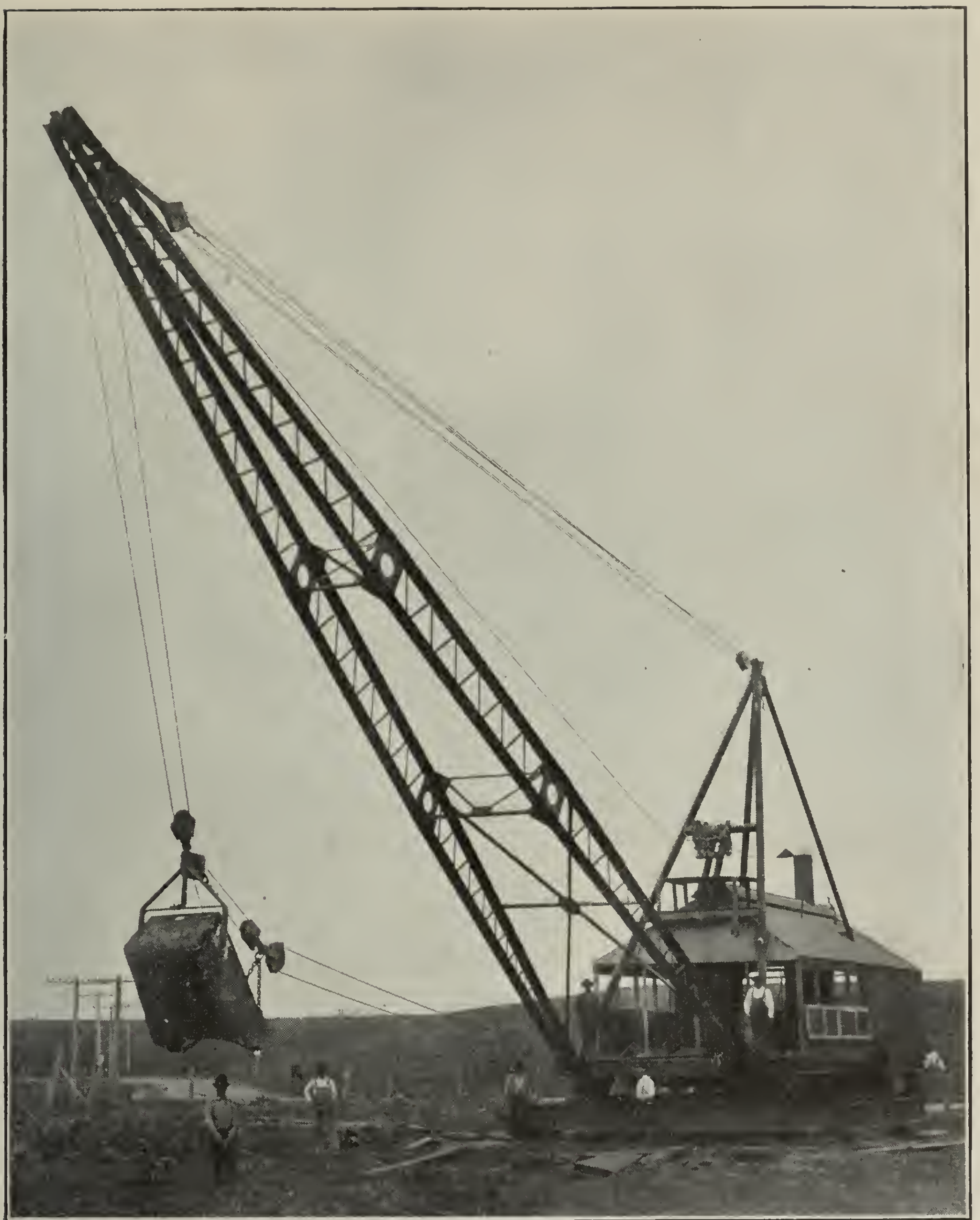


LOCOMOTIVE CRANE, 20-TON, 8-WHEEL M. C. B. TRUCK.

Brown Hoisting Machinery Co.

The boom lowering is sometimes accomplished by means of worm gearing of such pitch and lead that the wheel, of hard bronze, will not drive the worm, of tooth steel, thus holding the load in position, and, in addition, the worm shaft is locked by special means when it is wished to hold the boom in its position; if extra heavy weights are to be lifted without moving the crane itself, clamps are provided to hold it to the track. A 5-ton locomotive crane with a 30-foot boom costs about $4,000, while a 10-ton crane with same boom length is worth about $5,500.

When extra heavy loads are to be lifted with a long boom, a travelling derrick is generally substituted, having a fixed frame of wood or steel on a truck, which allows the boom to revolve by itself. The truck runs on a gauge anywhere from 10 to 30 feet.



STEEL REVOLVING-BOOM EXCAVATOR READY FOR WORK, BATON ROUGE, LA.

Weighs about 50 tons, and operates a 2 cu. yd. bucket by an 80-ft. boom. Is designed to fill, empty, and return the bucket in 60 seconds. Cost, erected in place, nearly $9,000. Installed by Page & Schnable.

The cut above shows a good example of a powerful revolving derrick with an 80-foot boom with an excavating bucket, like a plough shovel, which is lowered from the end of the boom, and then scrapes up the dirt by being drawn towards the derrick by means of the hoisting engine; when filled, the bucket can be hoisted while the derrick revolves so as to dump the load where desired.

Locomotive cranes or traveling derricks are not best adapted for quick transfers covering considerable distance, being slow and cumbersome and tending to interrupt workmen while passing; so where swift, long, and unimpeded movement is necessary they make way for the gantry and bridge traveling cranes.

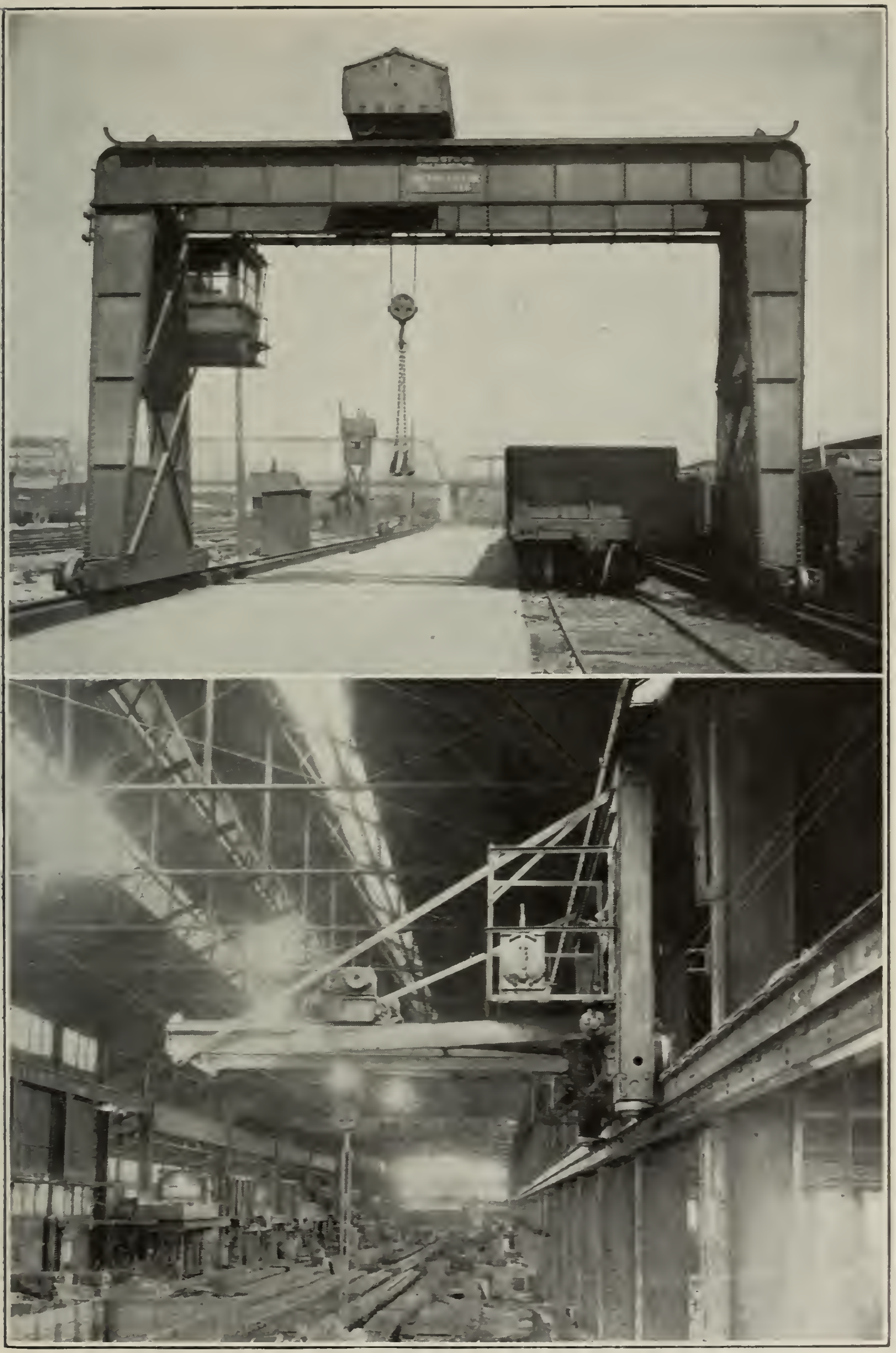
LOCOMOTIVE CRANE FOR BOILER-HOUSE COAL-HANDLING SYSTEM, PUBLIC SERVICE CORPORATION OF NEW JERSEY.

Unloads from barges and stores 10,000 tons on wharf; discharges into wide-trough chain conveyor leading to boiler house. R. H. Beaumont & Co.

Gantry cranes are very useful in freight yards and like structures where it is not advisable to raise the track and runway to the level of the bridge, doing away with the legs; but where this can be done we have the three-motor electric traveling cranes now so familiar in stone yards and all manufacturing concerns where heavy loads have to be handled quickly. These bridges can be built to span almost anything, from 10 feet up to several hundred feet, though there are very few of over 200 or 250-feet span on account of the great cost; in the case of a big dam or other structure, however, the expense is justified.

Obviously the legs of a gantry make it cost more than a plain bridge of the same capacity if the cost of the runway is disregarded, so if a number of machines were required in the same yard the increased cost would often be enough to pay for the elevated runway.

Gantries are rarely used in shops except for carrying heavy riveting or punching machines, or similar tools, as the walls of the shop afford such a good purchase for the runways; these are usually



EXAMPLES OF MODERN AMERICAN TRAVELING CRANES.

Above is a 10-ton gantry for unloading cars, C. M. & St. P. Ry., Chicago. Below is a 5-ton wall crane for the Buckeye Steel Castings Co. Both installed by the Case Mfg. Co.

ALTERNATING-CURRENT CRANE, 15-TONS CAPACITY, FOR OUTDOOR SERVICE

At the Middletown Car Company's plant. Span 105 ft.; runs on steel elevated runways supported on A-frame posts; latticed bridge-girder construction was adopted to reduce wind pressure and keep down weight. "Northern" type trolley, covered; operators' cab enclosed. Northern Engineering Works.

TWO LOCOMOTIVE CRANES WITH GRAB BUCKETS, UNLOADING COAL FROM BARGES TO STORAGE.
Browning Engineering Co.

built as near the roof as possible to give the maximum clearance for work. In the yard the track is usually placed from 15 to 25 feet above the ground. The trucks running on these rails usually have two wheels each and are rigidly connected with the traveling bridge. The bridge itself, being made in at least two parts, carries a powerfully built trolley or truck running at right angles to the bridge runway, thus moving with or without its load from one side of the shop or yard to the other, and, at the same time, the bridge can move from one end to the other—hence the name "three-motor electric traveling crane"—the motions being vertical, sideways and lengthways—and all these motions can be carried on simultaneously and without disturbing the workmen below, whereas if booms were swinging around all the men anywhere near would stop work to keep an eye out for danger, having learnt the necessity by experience.

The number, capacity, speed, etc., of the cranes are limited only by questions of economy; they can be designed to lift anything from a crowbar to a giant locomotive from any one corner of a shop and put it down in any other, with a bridge speed of say 200 feet per minute.

As in the early days of iron bridge building (not over forty years ago), when traveling cranes were first introduced into the United States, several firms started to make their own independent designs on entirely different lines, so that when I first became designing engineer for a crane company, some fifteen years ago, a very casual glance was sufficient to tell who built the bridge crane, and each company had its own pet style which it tried to work in, in every and all places, whether it was the best or not. Now, however, the best features of all are used where they are most fitted. While steam is still the best power for locomotive cranes under most conditions, electricity is the power for bridge cranes and is sometimes also used for the locomotive crane in the yard.

It was quite a problem to decide the best way to keep the traveling bridge at right angles to the track, or to prevent one end of the bridge from getting ahead of the other. Some of the early efforts resulted in an endless chain or cable so attached that the bridge was held in its correct position. It can easily be realized what an objectionable makeshift this was.

Another problem was to decide just how much side strain would be thrown on the girders from the tendency of one truck to get ahead of the other, and from the sudden starting and stopping which always tend to jerk the ends of the bridge out of the line of the center, causing the whole bridge to deflect sideways and increasing the compression in the top flanges above that already due to the dead weight of the crane and its supported load. Where, as in early days, the bridge is propelled by cog wheels on a track, there is no longer any trouble caused by one end getting ahead of the other; we still have always the horizontal deflection of the main girders to take care of.

It would seem that, if the Quebec bridge had been designed with the same regard for the theory of the column that crane engineers have always been obliged to use, that ill-fated bridge would be standing yet.

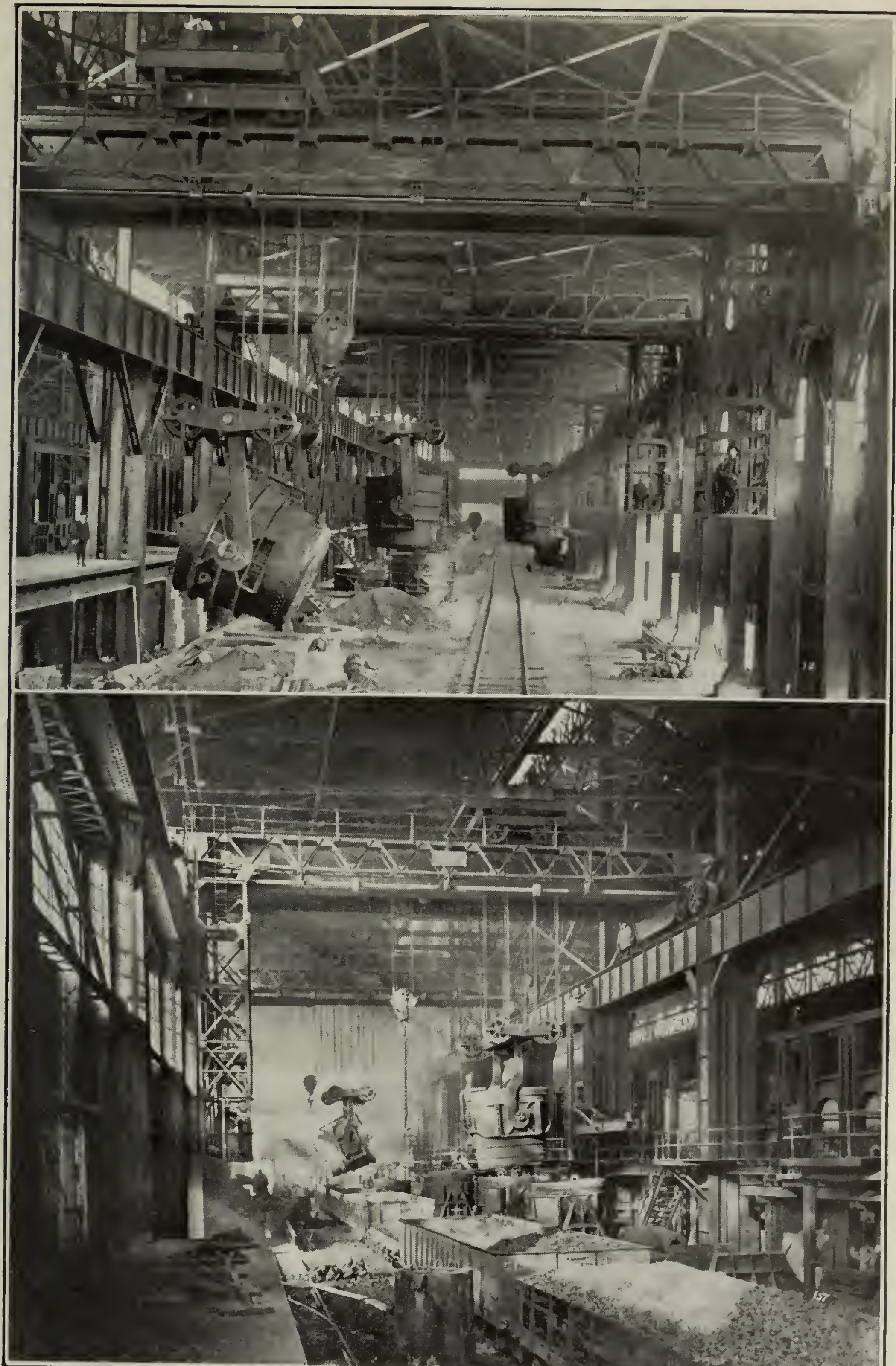
There are five distinct classes of bridge cranes:

1.—Those made of two I-beams carrying the trolley rail on the top flanges and good for short spans only. The spans, however, can be much increased by the new beam shapes being introduced by the Bethlehem Steel Co.

2.—Two ordinary plate girders placed from 2 to 6 feet apart, each carrying a trolley rail on top.

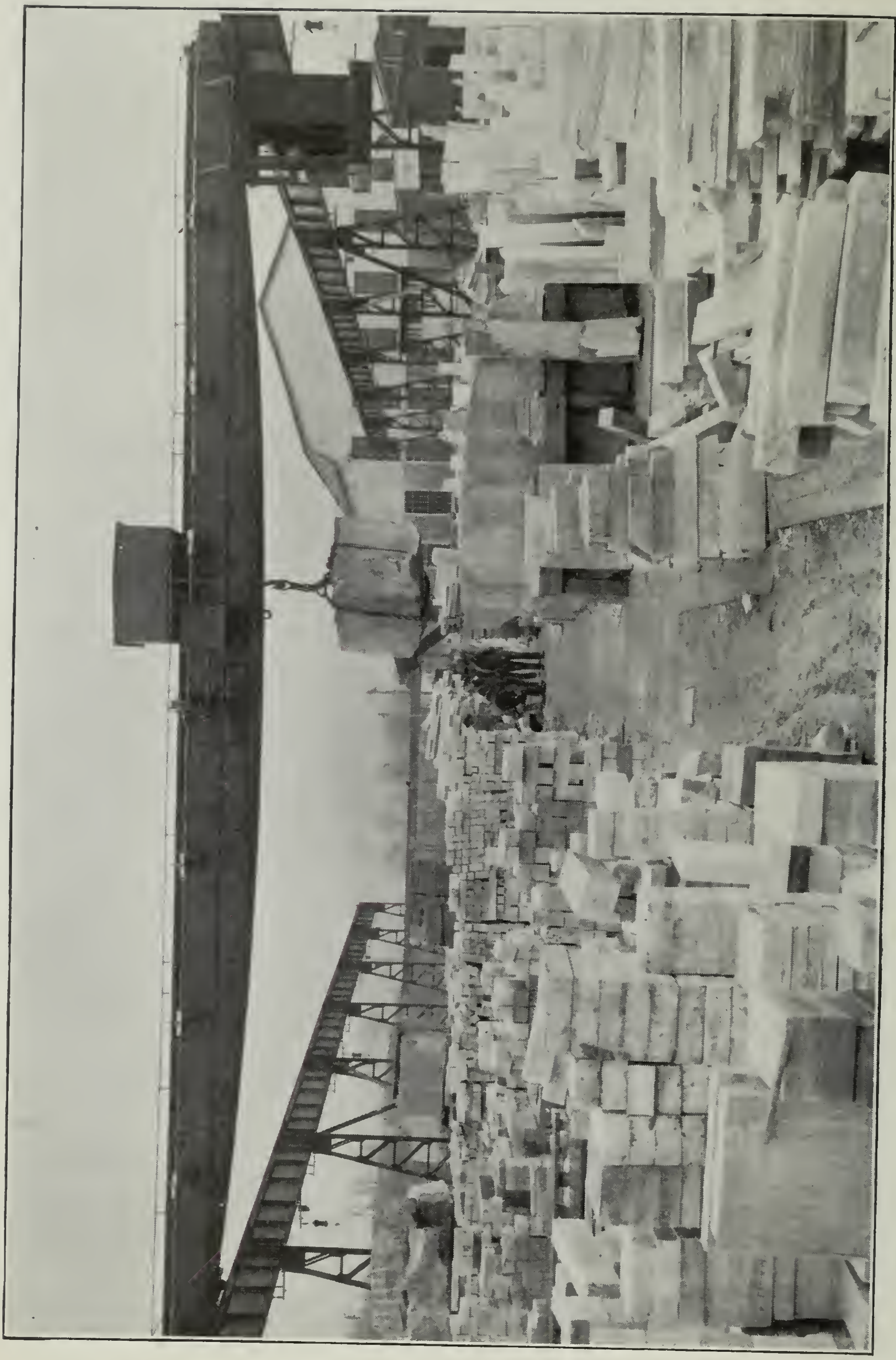
3.—Two box girders, each carrying two rails on top or four rails in all.

4.—Two plate girders placed several feet apart with their top flanges firmly braced together. In this case, the trolley rails are carried on the bottom flange or on a shelf angle bolted on the web near



HEAVY LADLE CRANES IN AMERICAN STEEL WORKS.

All are of 100-tons capacity with 25-ton auxiliary. The upper plant is the Union Steel Co., Donora, now part of the Carnegie Steel Co.; span 59 ft. 8 in., lift of main hoist 27 ft. and of auxiliary 31 ft. The lower is at the Illinois Steel Co. and is of 55 ft. span. Such an instalation is worth $29,000 to $25,000. The Wellman-Seaver-Morgan Co.



NILES CRANE, 20 TONS, 80-FOOT SPAN, WITH 5-TON AUXILIARY HOIST. RUTLAND FLORENCE MARBLE CO., FOWLER, VT.

the bottom flange, the whole trolley mechanism being inside the main girders instead of on top as in all the other cases.

5.—Two plate girders braced separately by three auxiliary lattice girders (six lattice girders in all), the eight girders forming two box girders. Here the trolley rail rests on top of the main plate girders.

There are many modifications but these five are the principal types. It was found advisable, in order to avoid complicated gearing and to make it simpler for the operator, to have a separate motor for each motion, one for lifting, one for trolley travel and one bridge travel; hence, the name three-motor electric traveling cranes.

There are places where none of the previously described machines is the best adapted for the purpose in view; such, for example, as bringing coal down the sides of a mountain, or mahogany logs to the coast, over very rough ground where a railroad would not be feasible. In this case the cableway often serves. Sometimes, as we most often see it in the city, all the work is done between two towers, and at others the cable is continued over a number of steel towers. For instance, cableways over 12 miles long have been supplied for South America, for handling mahogany logs which were cut in short lengths and bunched together before being attached to the carrying cable. As an example of how the location controls minor details of design—in this case, the towers all had iron ladders with very thin plates instead of round rungs, so that the bare-foot natives would not climb up and damage the cable or get killed by a passing load.

The first wire-rope tramway in America was introduced by John A. Roebling, of Brooklyn Bridge fame, who used a single endless wire rope ⅝-inch diameter passing around horizontal sheaves, one of which was driven by horse power. Now, however, as most have observed, we have a main stationary cable on which runs the trolley carrying the bucket or chain. This requires additional cables for raising the load from the ground and pulling the trolley back and forth, all of which have required many ingenious contrivances for taking up the slack.

With a single-span cable, the limit, of course, is the number of return trips that can be made an hour, for two cars can not pass on the same track; but on long cable tramways like the 12-mile one referred to, where all the heavy work is in one direction, it is possible to keep on attaching loads and thus have a continual series of loads moving all the time, a lighter cable carrying back the empty trolleys.

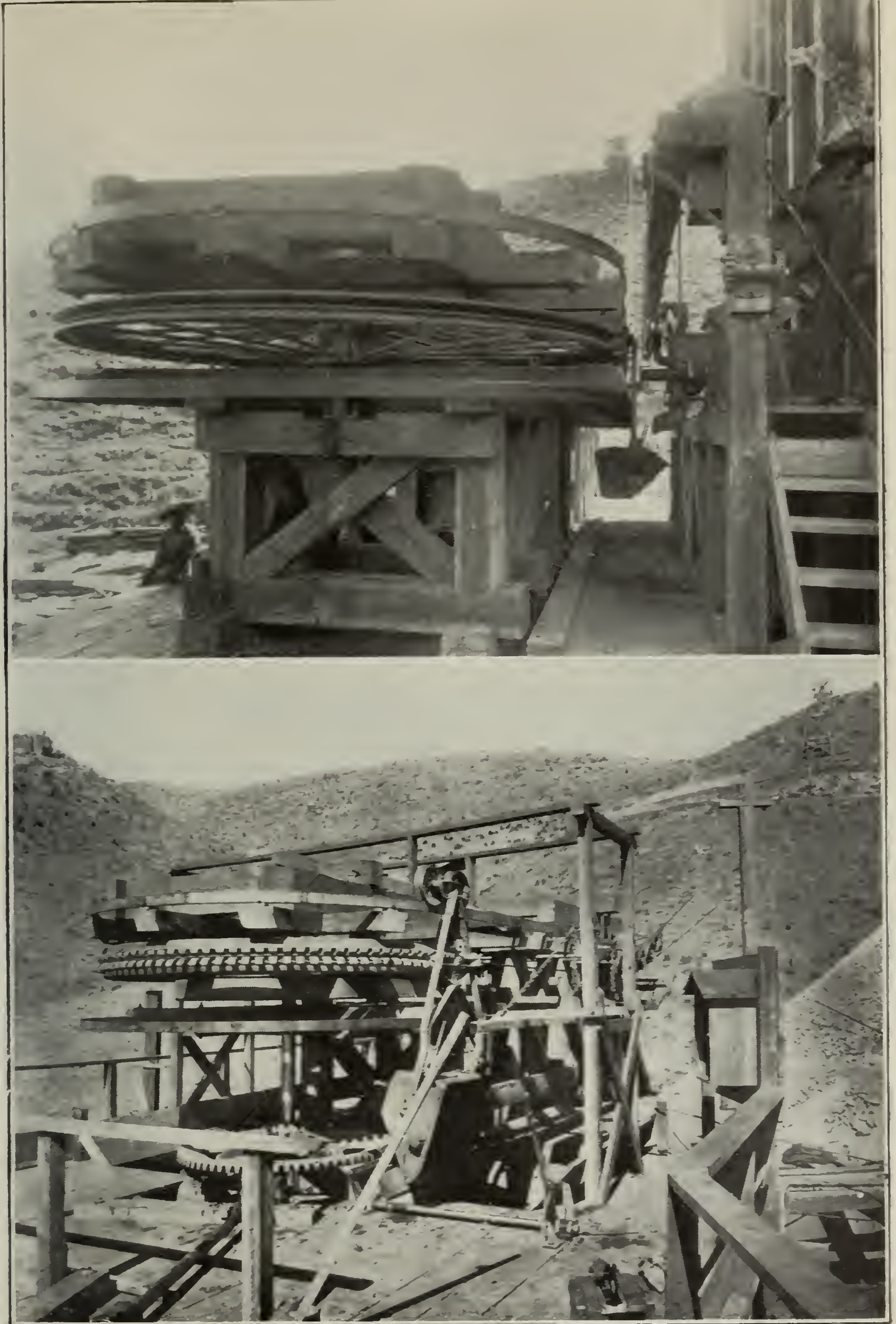
As a good example of the use of a cableway, we once put up a 1,600-foot span, 2-inch diameter cable, having a sag in the middle of the curve of 90 feet, on two 100-foot towers, and erected the cables which we had in stock. This spanned a river in which we had some piers to build; we estimated that it would cost about the same to erect a light wooden trestle, but it was thought safer to keep out of the river, which view was justified by events, for before the piers were completed, we experienced a very severe flood which would have carried away any trestle we could have put in.

On the other hand, to show how a good plant could be put in the wrong place, a contractor, successful *in other lines,* took a contract for some heavy masonry work with which he was not at all familiar, and at once ordered five complete cableways, to be placed side by side, having a span of over 1,500 feet and carried on two 90-foot towers. When the first cable was ready for use, he decided to have a grand ceremony at the setting of the first stone. The immense stone was easily picked up by the cable and brought to the right spot and carefully lowered on its bed of mortar, but, as it nearly always happens, it did not land in just exactly the right position, so the operator was signalled to raise it. At first the cable refused to budge the stone, the weight of the stone plus the suction of the mortar causing more resistance than the weight of the stone by itself, so the operator applied more power and "up she came" with a jerk as soon as the suction was overcome; naturally, the upward bound was followed by a downward plunge, which splashed mortar all over the guests, and the contractor who had got what he had ordered wanted the whole apparatus taken off of the premises. The job put him out of business. and his successor made good use of the cableway, but not for setting stones.

The cable can be used almost anywhere, so it is often only a question of dollars and cents and time whether to use it or a railroad track and derricks; but in cases like passing coal from one vessel to another at sea and many similar operations the cableway has no competitor.

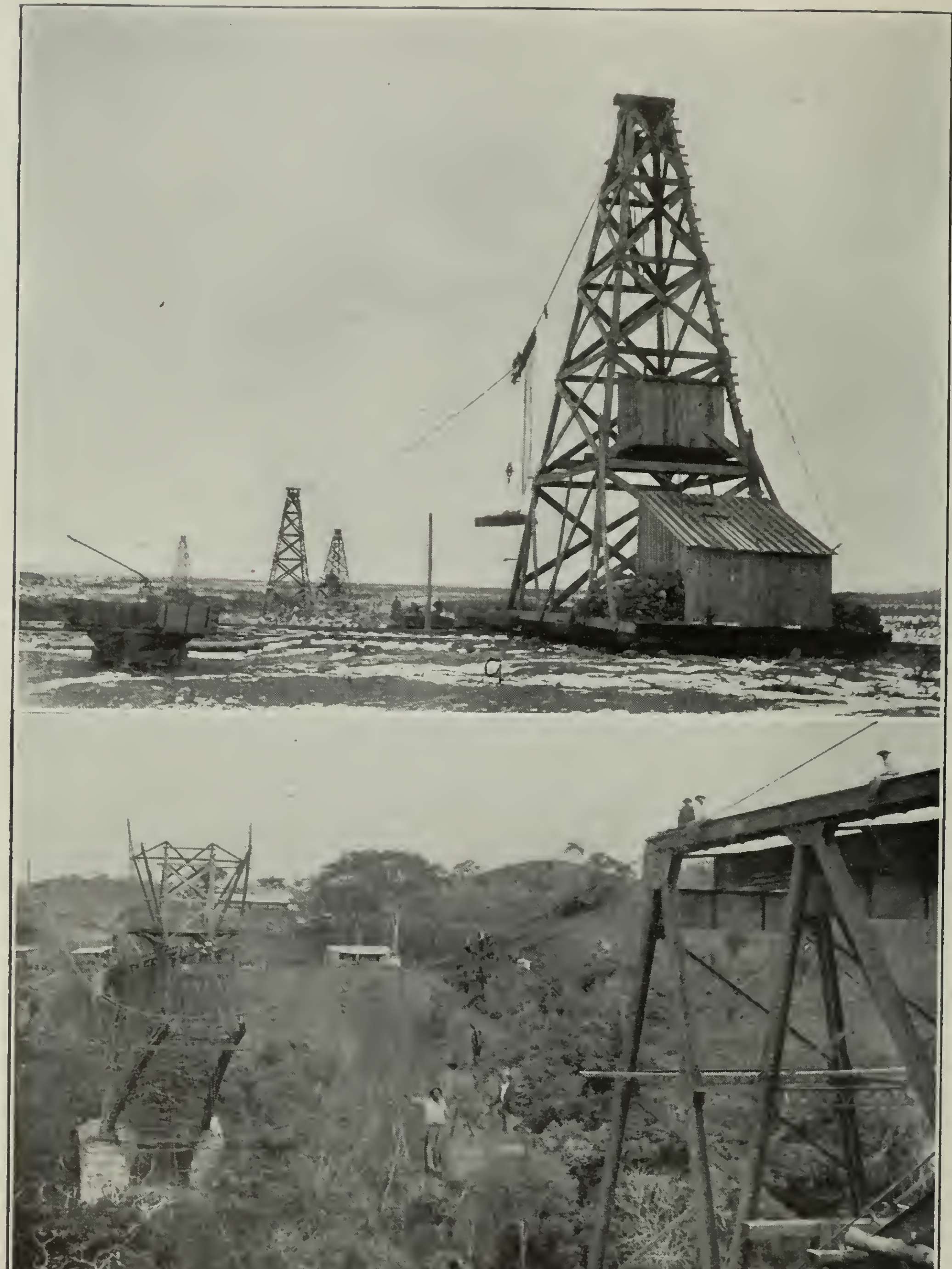
An ingenious arrangement is the balanced cableway in which the two ends of the cable are attached to movable weights just heavy enough for the greatest load to be lifted, instead of making the ends fast to a rigid anchorage. At the first glance it looks very insecure (see view of boat being carried over the waves at Coney Island); but as a matter of fact, it has many advantages over fixed anchorages, as it reduces the strain on the cable and does away with much of the sharp incline of the cable near the towers, up which the trolley has to be pulled at the cost of extra power.

One of the most recent cableways has just been completed for the



LOADING AND DISCHARGE TERMINALS OF 4,600-FOOT AUTOMATIC ROPE TRAMWAY. SAN TOY MINES, CHIHUAHUA, MEXICO.

Two Leschen flattened-strand track ropes supported on two towers are used, one for travel of loaded buckets and one for return of empties. The buckets, holding about 900 lb. of are each, are permanently attached by four band clips, preventing all slippage. They are loaded by a mechanical loader (shown above) and automatically discharged. The tramway is driven by power at the discharge terminal, as shown below, gravity being insufficient. Tension is applied at the loading terminal. Capacity 300 tons per day of 10 hours. The A. Leschen & Sons Rope Co.



CABLEWAYS IN SERVICE ON CONSTRUCTION WORK.

Above is a pair of cableways across Snake River, Minidoka, Idaho, for use in Government irrigation project. Below is a cableway used in Costa Rica in building a railroad bridge across a cañon 900 ft. wide and 300 ft. deep. The S. Flory Mfg. Co.

Geo. W. Jackson Company of Chicago to take supplies to a tunnel shaft 8,000 feet out in Lake Michigan. This is on the Elberfeld-Barmen system of Germany, and is supported by 26 towers 30 feet high, resting on steel piles. The carrying cable is 1⅜ inches diameter, while the transmission cable is ⅞ inch in diameter. The construction costs about $75,000, and the capacity is about 40 cubic yards of material per hour, requiring 15 horse power for operation.

EXPERIMENTAL BALANCED CABLEWAY AT CONEY ISLAND, N. Y.

About 800 ft. span; shears 103 ft. high; water 15 ft. deep.

A novel use for the cable was recently developed by the Williams Bros. & Morse Company of Cleveland in making a 175,000 cubic-yard fill for the Lake Erie and Pittsburgh Railway. The fill was 400 feet long and 95 feet deep. A light wooden tower was built in the middle, making the cable spans of 200 feet each. Two cables of 2¼-inch diameter were used and were spaced 7 feet apart horizontally. On top of the cables, 8-foot logs were laid and fastened with U bolts. These carried a pair of stringers which, in turn, supported the ties on which the rails were laid. The train of cars was backed out to this suspension bridge and the first car dumped as soon as it reached the edge of the fill and it was then pushed out on the cableway to permit the next car to be dumped and so on.

Light wooden bents were placed on the bank near the top of the slope to stiffen up the cable under the loaded cars. The following is

LIDGERWOOD CABLEWAY AND MARION STEAM SHOVEL IN ROCK EXCAVATION, ST. MARY'S RIVER IMPROVEMENT.

Trenton locked-wire main cable, spans 800 and 1,100 ft.; 65-ton shovel with 2½-yd dipper loading skips 2 by 2 by 10 ft.; average skip load 27 cu. yd. Record for month, 155 skips per 10-hour day.

the actual cost given by Mr. J. D. Mooney in a recent number of *Engineering Contracting* and is interesting:

1,000 feet 2¼ inch Roebling galvanized bridge cable.....	$600.00
Eye bolts, 2½ inches..................................	108.30
2 turn buckles, 3 inches..............................	120.00
2 chains 10 feet long, 2½ inch........................	62.40
4 cast washers 9 inches diameter......................	2.46
Timber for A frame (all other timber was obtained on the ground) 3,200 ft. B. M. at $34..................	108.80
Lower 50 feet round timber, 56 feet long bought on tree.	32.00
Team work	65.00
Carpenter work	231.40
Superintendent	60.00
Common labor	112.00
Nails, etc.	29.40
	$1,531.76

This is less than one cent per cubic yard of the material handled and less than one-half of the cost of a wooden trestle in the same place. This method has also been recently successfully used over a swamp where it was found impossible to maintain a timber trestle.

The logging industry by itself presents an extensive field for the cable and many new details have been worked out for this purpose. One modification is the skidder, where instead of lifting the entire weight of the log, one end is allowed to drag or skid along the ground, though it is so arranged that, when crossing a valley, the whole load could be lifted. Skidding is more useful for pine than for hard woods, as the latter are more scattered, and the skidder to be profitable requires over 8,000 feet of timber to the acre. It can log an area of from 700 to 1,500 feet in any direction from the head spar where the engine is located, or from 30 to 50 acres between moves.

Another system of logging is the pull boat method, which was the first steam logging system that was tried in the cypress swamps of Louisiana, and originated from simply placing a hoisting engine on a scow and dragging the cypress logs out of the swamp, but the condition of these swamps, being covered with the cypress knee, made it almost impossible to get the logs out without the improved methods. One of the small but very important details in snaking logs by cable is the steel cone-shaped cap or pilot placed on the end of a log in such a way that the logs will glance by stumps or other obstruction and can even be pulled around a tree.

An ingenious loading derrick is used by the Lidgerwood company. It rests on an ordinary flat car, and, on reaching the site where the loading is to be done, supports or blocking are placed at the sides of the track and the entire frame is jacked up clear of the track. Then a stationary engine on the frame pulls the car from under, so that the boom of the derrick can load the empty car. In fact, the der-

U. S. BATTLESHIP MASSACHUSETTS TAKING COAL FROM THE COLLIER MARCELLUS IN 800-POUND BAGS BY LIDGERWOOD MARINE CABLEWAY.

rick can pull a whole train load of empty cars under it, one at a time, and give each one its load in passing.

Another use for the cable is for loading and unloading ships in places where there is no harbour within two miles or so of the shore, as in many cases in South America, but a prettier use still and one where no other mechanism can take its place is in the passing of coal between two vessels, especially when both are moving at a rapid speed and the ocean is more or less rough.

The first marine cableway was successfully installed on the U. S. collier "Marcellus" where 20 to 24 tons of coal per hour were transferred, two bags being carried on each trip, and the speed of the ships being from 5 to 6 knots at the time. The second trial was on the British collier "Muriel" where 35 to 40 tons per hour were transferred over a moderate sea, and through a half gale of wind to H. M. S. Trafalgar, the battle-ship maintaining a speed of from 8 to 11 knots. Another experiment was made with the Russian battle-ship Retvizan, in which special electric hoists were designed by the General Electric Company to meet the requirements of the Russian Navy. These had a speed of 1,200 feet per minute for the full load or 2,000 feet per minute for a half load. The best record was in the fall of 1906, when the Royal Italian cruiser Liguria was coaled. In this case, the cables were guaranteed for 40 tons per hour, but actually passed 60 tons per hour, while the trial board reported the actual capacity as from 70 to 80 tons.

The entire apparatus should be carried on the battle-ship and not on the colliers, and, as Mr. Roosevelt is fond of explaining, there is only one vessel that has less available space than a battle-ship and that is a torpedo boat. So the utmost pains are taken to make the entire equipment as compact as possible, and it now only takes up about 200 cubic feet and weighs less than 7 tons, the entire cost being in the neighborhood of $20,000.

The hoisting gear, etc., is usually designed to be used for other purposes when not handling coal. Sea anchors have been invented to maintain a uniform strain on the cables, some being in tandem, umbrella shaped, and where the front one is 9 feet in diameter and the rear one 3 feet in diameter, it has been estimated that the pull exerted on the cable would be 9 tons when the ships are going at the rate of 7 knots or about 12 tons when the speed is 8 knots.

While these experiments have been eminently successful, they have so far been a labor of love to the manufacturers, although a very vital question to the navies of the world.

Another use is now being worked out, for saving life and cargoes from a wrecked vessel which cannot otherwise be approached, and in order to do away with the necessity of sea anchors, which would not be efficient in this case, Mr. Spencer Miller has recently designed a slip drum friction, using a patent cork insert. Ordinary frictional connections are designed to hold, until a positive clutch is applied, but not to slip; therefore with an ordinary frictional connection, sea anchors or some substitute would be required, for a uniform strain must be kept on the cable; one reason for this is that the coal must never be allowed to touch the water, for fear of spontaneous combustion later on. This frictional clutch is on the principle that if the force of the brake is not sufficient to make the wheel skid but just to allow it to turn, it will come to rest in half the time.

ROBINS CONVEYING BELT REMOVING EARTH AND ROCK.

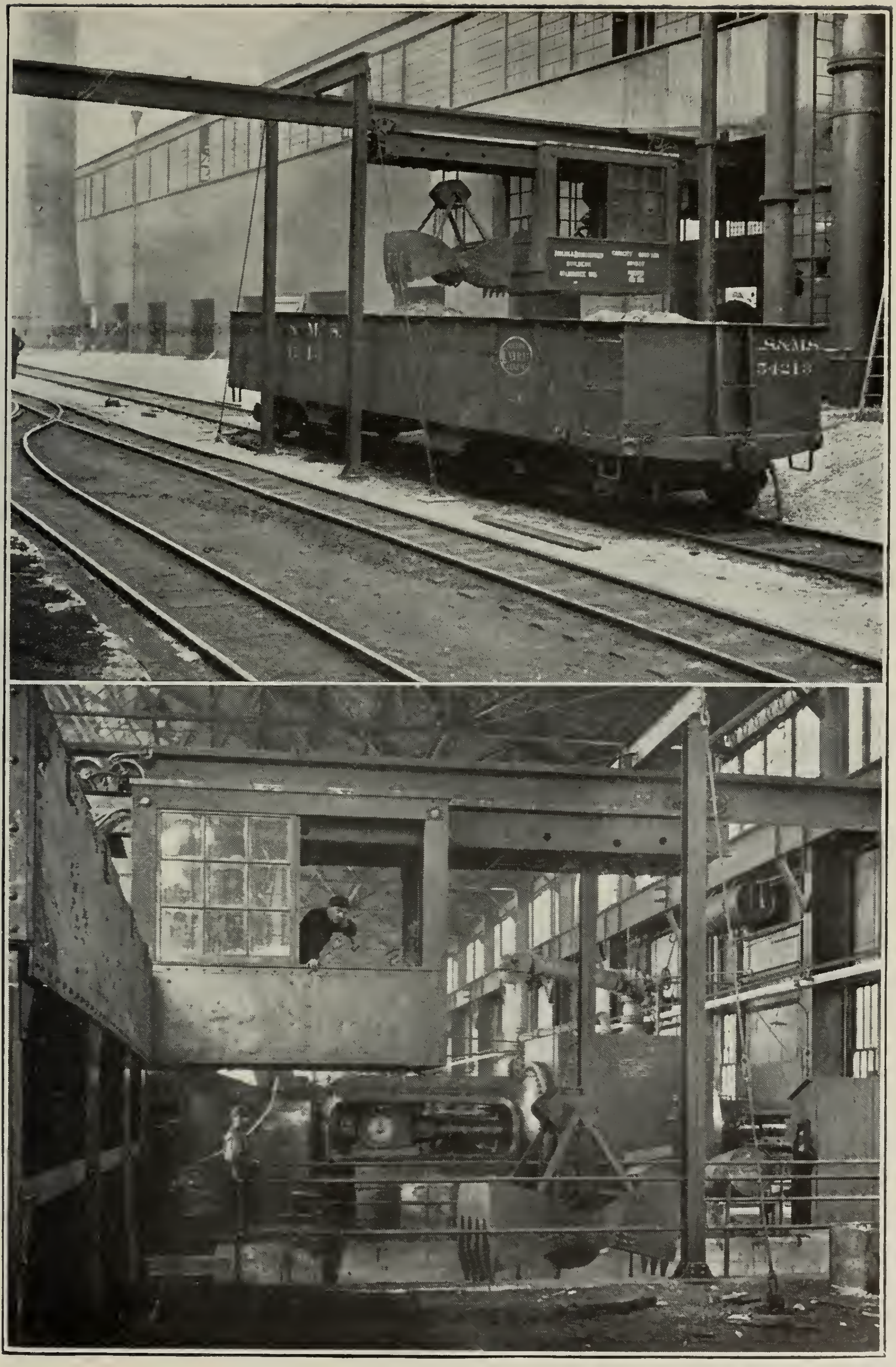
Employed by Chas. F. McCabe for handling 10,000 cu. yd., Jerome avenue, New York.

Belt conveyors occupy an important place in handling material, and when Ryan & Parker were excavating for one of their East River Bridge contracts, they asserted that their belt worked so satisfactorily that they could lift anything from heavy rocks to a hen's egg, and even handle the latter without letting it roll off or break.

Hoppers are generally arranged to feed the right amount of material automatically onto the belt, and others to receive the material at the other end. The continuous belts can be run on the level or up fairly steep inclines, and are very much used in the grain elevators. Sometimes the belts are run on plain spools and at others with spools having a dip in the center, the sides of the belt often being stiffened up to stand the extra strain. Hundred-pound boulders have been dropped on a 30-inch wide moving belt without stopping it.

It is claimed that the concrete materials, sand, and stone for making 70 cubic yards of concrete have been elevated 26 feet, by a belt conveyor, to the bins feeding the mixers, at the expense of only 7 horse power. A belt with a 500-feet horizontal and 25-feet vertical stretch has carried 900 tons in a 10-hour day using between 8 and 9 horse power.

In Cuba and elsewhere, instead of using a belt to handle the bagasse (sugar cane after all the sugar has been squeezed out) as it is



ELECTRIC TRAVELING HOIST, WISCONSIN STEEL CO., SOUTH CHICAGO.

Travels on bar rails fastened to lower flanges of an I-beam runway. Operates specially designed bucket removing scale deposit from the hot rolls. Capacity of hoist 3 tons; hoist speed 70 ft., travel 150 ft. per minute. Length over all 21 ft., lift of bucket 26 ft. Installed by Pawling & Harnischfeger.

fed to the furnace, New York contractors, like August Smith & Co., supply a sort of inclined steel trough over which a continuous carrier travels, scraping the bagasse along and dropping it through various gates and openings to feed the different fires as required.

PORTABLE LOADER AT WORK ON STREET GRADING.
This machine is said to have loaded 300 cu. yd. a day at a cost of 3 to 4 cts. per cu yd.
Whiteside Loader & Machinery Co.

Obviously when the incline is vertical or very steep, a belt by itself would be useless; so we have many different forms of bucket conveyors, the small buckets being arranged in the form of a continuous belt. These are very extensively used for coal-handling plants as well as many other purposes such as handling broken stone, sand and cement for concrete, digging ditches, on dredging machines, etc. One use, however, for which they are not to be recommended, although used, is for handling concrete or any similar mixture which would have the tendency to set and adhere to the buckets or mechanism. The buckets are designed to run around horizontal as well as vertical curves. Many of us use as a mental basis of comparison the fact that we have seen day laborers shovel dirt in the country at a cost of 25 cents per cubic yard, and we know that if the material is handled several times at this rate (as it very often is), the expense amounts up to a very considerable sum. Nature has supplied the cheapest of all methods of handling material—gravity, which should be made use of very much more than it is, in self-dumping wagons, cars, buckets, which should, where possible, be dumped into bins or

ROLLER CHAIN CONVEYORS FOR CARRYING COAL, CAMDEN COKE CO.

Trough made of two 10-in. channels with ¼-in. bottom plate; links drop-forged; weight of chain and flights taken on 5-in. self-oiling rollers. Length 300 ft.
R. H. Beaumont & Co.

onto platforms, having chutes underneath through which the sand, stone, ore, grain, or what-not can be drawn as required. Perfectly obvious facts, but not utilised to anything like the extent that they should be; for we often see material handled at the cost of from 25 cents to a dollar that a good crane would handle for 3 or 4 cents.

The gravity method evidently appealed strongly to Col. Hains,

COAL STORAGE AND DELIVERY SYSTEM FOR BOILER PLANT.
The coal is drawn from the tower, through a hopper, into an automatic railway car. The tracks run the entire length of the storage bins over the boilers, and the car discharges at any point. From the bins the coal is drawn to automatic stokers.
The C. W. Hunt Co.

for he not only uses gravity for handling concrete materials, but also for mixing them. He dumps all his material, either by derricks, belts, or other contrivances, into a hopper which in turn dumps into another, four or five being arranged one over the other, and the wet concrete comes out of the bottom ready for use. This is a very active competitor of the cubical, Smith, and other mixers. Sometimes one is the cheaper and more thorough mixer and sometimes one of the others is the best for a given locality. Of course, if the point of supply is much higher than the point where the concrete is taken from the mixer, the gravity method would have an extra advantage.

A concrete plant that can turn out 2,000 to 4,000 cubic yards of concrete a day is a very profitable investment where such an amount of material can be taken care of. We used to figure that it cost one dollar per cubic yard to mix concrete by hand, when all the material was delivered, and it would probably cost more now on account of the concrete men's union, while by the use of the best machine, the cost is now a small fraction of a dollar, according to the quantity used as well as the location.

THE FUNDAMENTAL PRINCIPLES OF WORKS ORGANIZATION AND MANAGEMENT.

II. DEVELOPING NEW PRODUCT AND DETERMINING SHOP COST.

By P. J. Darlington.

As explained in the introduction to the first section of Mr. Darlington's discussion, his object is to reduce some of the great problems of works management to their fundamental elements. The multitudinous and sometimes mysterious systems of stock keeping and cost keeping he finds to be resolvable into a very few comparatively simple ideas and methods. His object is to present these underlying principles so that the manager may recognize them, and thereafter adapt and combine them as best suits his special establishment. The preceding part dealt with stock keeping. This concluding portion deals principally with costs.—The Editors.

HAVING decided to add the manufacture of a new line of product, how can we best show, after a time, how profitable the undertaking has been and promises to be if continued or extended? Also how can we learn wherein and why our estimates were inaccurate?

Incidental to the mechanical development and commercial introduction of a new product, we often have constantly diminishing costs and expenditures in improving designs, introducing the product, and satisfying customers. During the first year labor and material costs may have been greatly reduced by standardizing design, manufacture, and stock. Prices of materials may have changed. We may have found our first selling prices too high for business or too low for profits, and adjusted them accordingly. Some large contracts may have been extraordinary. Sales may be still increasing in response to already paid advertising. Many of these things may be normal to the undertaking and to be reckoned with in the future, while others are purely accidental, a matter of which we cannot judge without knowing how they occurred.

A mere knowledge in figures of the total or average profits for the entire year would be of little value as a guide to the present or probable future profits in continuing or extending this line of manufacture. Without intelligent correction for accidents and changed prices such knowledge would be unreliable even in foretelling the result of entirely new extension of manufacture. Two modes of attacking the problem are in use:—

1.—By Separate Accounts.

2.—By Order Registers.

1.—By Separate Accounts we may isolate the equipment, production, and sales in a special set of accounts to show annual profits of this line of product separately. This would involve classifying the orders and the inventory of stock. It would also necessitate collecting and extending into money value the material cost, labor cost, special-equipment cost, and indirect cost of every repetition shop order.

After all this we would have figures representing total and average profits which, as noted above, are of comparatively little practical value.

2.—By Order Registers we file estimates and opinions of annual sales, cost of product, and cost of equipment to show, later, on what assumptions our recommendations led to the undertaking. We decide in how many years to write off the special-equipment expenditure, which, with assumed sales, gives the total assumed production.

We catalogue the new product by names, symbols and numbers and assign pages in order registers.

In the shop order register we assign a page each (one line for each order) for the following:—

a. Drawings, patterns, and tools common to all sizes.

b. Drawings, patterns, and tools this size.

c. Parts this size.

d. Complete machines this size.

The last columns are reserved for net material cost and net labor cost.

In this register we enter in condensed form mention of everything expected to affect shop costs—for example, change in design, special features, new tools and, if the order is on account of a large sale, we may enter the shipping-order number as a cross reference, and the name of the customer as a reminder.

At the end of the year we total the cost of equipment orders and divide by the assumed total production which gives the equipment cost each of product. If the actual sales have been less for the year than assumed there will be "Idle Equipment" charge against profits. The direct labor costs we average from orders selected in consideration of their dates and quantities, and in view of noted circumstances and conditions. The material cost is obtained from the latest revision of the master material list at current prices. The indirect cost is determined as hereafter discussed.

We then have the latest reliable shop cost and idle-equipment charge to compare with recent sales and selling prices, and are in position to determine present profits and the advisability of continuing or extending this line of manufacture.

We have before us in concentrated form all the attendant facts and circumstances which affected the results, together with the order numbers referring to further details if wanted. We also have the data to show separately the profits on any large sale or contract which might otherwise overshadow the averages. These figures with attendant fact and circumstance may be far more useful than bare unexplained figures in money accounts.

This plan does not require the working up and extending of the material cost and indirect cost of every repetition shop order. It is not dependent upon inventory and is therefore available at any time to help settle a question of proposed business extension or change of selling price. It shows not only present conditions but also the progress during the year in reducing costs and increasing sales and profits.

Order registers are usually necessary for reference and for stock keeping and this mere systematic arrangement of them with very few additional data often gives far more useful information than could be had from costly book keeping and accounting. The value of figures is in the facts that they tell. In the absence of attendant fact and circumstance they may fail of intelligent interpretation and may then be useless or even misleading.

This order-register plan depends upon the registering of orders, especially those for equipment; however, if all orders must be registered somewhere, the registry recorded back onto each order, and the orders audited or inspected therefor, then the plan is no less reliable than accounting processes.

SUMMARY.

Where the extension of manufacture affects a small part of the entire business and is of the same general character as other product, it would appear to be usually unnecessary and unprofitable to account it separately.

To prevent over-expenditure, special equipment such as drawings, patterns, and tools may be authorized by a limited appropriation and made on a separate development account. This is comparatively easy, as it does not involve repetition orders of production. As a practical fact such an expenditure cannot be profitably stopped at a limit and an order-register plan may be just as good to show final expenditure beyond the appropriation.

Shop Cost.

Shop cost is made up of:—

1.—Direct material,

2.—Direct labor,

3.—Special-equipment cost (Drawings, patterns, tools etc).

4.—Indirect cost (A normal share of expenditures that cannot be located to any one product).

There is no clear line between the last two items. They may be considered as one, or on the other hand, indirect cost may be further divided according as expenditures are local to the one class of product or more general to the entire works. This further division adds to theoretical accuracy, but there are very practical limits to the complication permissible, and it is not unusual to carry the subject to foolish and unprofitable extreme. However, there are many cases where the cost of special drawings, patterns, tools and experimental work is the largest part of the cost of a product and failure to show it may lead to serious and continued loss. Many works have failed and have later discovered that their capital had been spent for useless and almost unused patterns and tools for special product to catch the fancy of every customer. Whether and how to divide indirect charge must be decided in view of the business and conditions, always keeping the simplest plan until very definite and quantitative reasons call for greater refinement.

We depend upon our knowledge of shop costs to set new selling prices and to determine in what direction to extend our business; also to learn whether it is more profitable to buy or to make an article, and to compare designs and methods of manufacture. A works may be so established in its product and prices that knowledge of shop costs would not be worth much expenditure to get it. Under opposite conditions, a good knowledge of shop costs may lead to building up a profitable industry while competitors are struggling with discarded and unprofitable contracts.

The expense of getting accurate shop costs evidently depends on the range and variety of the product. If a works makes but one article the problem is solved by simply dividing normal expenditures by normal quantity produced. In short, both the value of the knowledge and the expense of getting it differ greatly, depending upon technical and commercial circumstances.

1.—Direct Material may be determined:—

a. From Material Tickets.

b. From Material List direct.

c. From Material List as authority and record.

a. From Material Tickets:—Under stock systems we considered the costs, difficulties and uncertainties of all material-ticket plans and we must now add the pricing and extending of tickets into money values. In being the basis of actual transfer from stock to shop this system contains one strong feature of reliability, but the clerical processes are often so uncertain as to more than offset it. In standardized, repetition manufacture, its continuous demand on the time of producing men and equipment may seriously reduce efficiency and output.

The plan of issuing material tickets in advance from a material list was shown to be a doubtful expedient.

On repetition orders these material-ticket plans call for weighing and recording the same thing over and over, while greater accuracy may be had at less cost from one careful weighing, independently checked with estimates.

In such material-ticket plans results are not available until long after the order is finished.

b. From Material List Direct:—From the drawings of a new product we make a list of materials to be used, we extend each item at estimated quantity and current price, and total for the material cost of the machine. For each item of material we substitute actual for estimated weight as soon as we can get it. In view of the first assembled machine we make out an independent list of its parts and materials to check with the material list for omission of items. This plan does not take account of material wasted or spoiled, for which a "safety factor" may be used. On the other hand, it may show both rough and finished weights and a scrap credit for the difference.

This plan combines the latest estimates with all actual data and is available at any time, even before the completion of the first shop order. One careful weighing and measuring of each material (checked with the estimate) replaces the many repetitions of the plan just preceding.

Material costs for different sizes of product are easily compared, whereby any serious errors may surely be discovered. When an entire line of product is established—for example, electric motors and generators—the names of items of material and stock parts may be printed down the material-list form, which makes omission impossible and comparison easy by placing the lists together, line to line.

The material list is a necessary part of the authority, instruction, and record of manufacture and stock keeping; therefore, very little of the expense of keeping it should be charged against cost keeping in this discussion.

c. From Material List as Authority and Record:—The stock room may use a copy of the material list, with quantities left blank, on which to record deliveries to the shop. On completion of the order, this may be checked with the master copy of the material list. This combines some of the elements of reliability of plan a and plan b, but it may often prove too cumbersome and costly, and it is not a good check against omission of items. A more convenient plan is to leave the estimated quantities on the stock-room copy of the material list, with columns in which to enter actual deliveries—in short, to use the material list as combined delivery authority and record, which may discover errors before they are recorded, but loses in reliability by suggesting quantities and weights to the man measuring or weighing the goods.

Summary.

Material-ticket plans would appear to be useful only in work upon repairs or upon product which cannot be reduced to material lists, and where there is no considerable repetition in manufacture.

The use of the material list direct has great advantage in simplicity, and often a small expenditure in comparing and checking it will give more reliable results than several times the expenditure in adding the delivery features.

The plan of using the material list as authority and record must be credited with any help it may give to the stock-keeping plan, but if the stock-room copy of the material list must be consulted before goods are delivered, there may be a delay to production more serious than all else. For merely getting cost of orders, the extra complication would not usually be worth the cost, and as a safeguard against theft its value was seen to be a small and not essential feature of the order-balance stock plan. For conveience the foreman usually has his own copy of the material list.

2.—Direct Labor. In many respects labor resembles material, and much of the foregoing discussion applies to both. There are, however, these important differences:—In labor and wages we are dealing with intangible values which cannot be safeguarded by physical stock keeping or by watchfulness at the gate. Also, labor cost is more within our control and more dependent upon our judgment based on experience. We may be repaid many fold the cost of any plan that makes our experience more available by better records and easier comparisons of workmen, tools, operations, and designs. Labor may be secured:—

a. From Time Tickets:—

b. From Work Registers.

a. Labor cost from time tickets compares with material costs from material tickets, and is likewise applicable only to special and unstandardized manufacture where work lists would not be possible.

b. From work registers:—When we have designed a new machine to be manufactured, we make up an "operation list" and enter for each operation its best known value, which may be a proven or proposed piece-work price or time cost. Extended for quantity in one machine and totaled, this is the operation cost of the machine. We confirm or correct each operation cost as quickly as its piece-work price is known. This work register combines all cost data to date with the latest estimates, and is always available even before a shop order is completed, and in this respect it is like the material list as used for material costs.

We may now use this operation list as a work register, entering each work ticket (piece-work or time-work) as issued and its cost as completed with extra or accidental cost in red ink.

When the order is finished we have the total cost of each operation opposite its estimate, and the total of all operations should equal the total cost of the shop order as made up independently from work tickets and checked in total with the pay roll. We now have all wages accounted for in detail of operations and compared with former record or estimate of what each operation is worth. This is the only real safeguard against theft or loss of wages, and shows us what we receive in comparison with what it is worth.

The work register of the completed order gives all available information in concentrated form with attendant fact and circumstance and reference (by ticket numbers) to all details. Accidental or extra work is located to the operation on which it occurs, with a reference to the foreman's copy of the work ticket where full explanation may be recorded. We are, therefore, in position to learn how it happened and prevent its recurrence.

The work register brings out those comparisons of men, tools, and methods necessary for low cost, large output, and high quality of product.

3.—Special Equipment Cost is a normal share, apportioned against the product, of the cost of special drawings, patterns, and tools for making it. It is determined by dividing the total shop cost of such drawings, patterns and tools by an assumed life production of the equipment. If we decide that the investment shall be written off in two years, and if we expect to make and sell 50 machines per year, then the assumed life production is 100 and the special equipment cost of each machine is 1 per cent of the cost of drawings, patterns and tools. If, during the first year, we make only 25 machines, then the difference between 25 per cent and 50 per cent, which is 25 per cent of the investment, is "idle drawings, patterns and tools," loss and should be deducted from the year's profit of the manufacture of that article.

We are interested in this analysis of costs and profits chiefly in connection with the article in question as a guide to selling price and extension of business. The information which we need is given by the order registers as discussed. It is, therefore, usually not necessary to carry special accounts for the purpose. We may carry all such special equipment for the entire works in one account and depreciate it at an equivalent rate annually from plant to expense. The life of the investment is then substantially as before assumed, and it is written off against annual profits through expense account at about the assumed rate, while the great additional expense of subdividing the account is avoided without any sacrifice of practical information.

4.—Indirect Cost is not essentially different from the foregoing, which it may include. It usually concerns all expenses or expenditures chargeable to manufacture, but not readily located to any one line of product. We must find some approximate way to apportion it fairly to the several articles made before we can intelligently compare costs and profits of widely different product. This problem is of least practical importance when our works are going along under fixed conditions of manufacture and sale.

The shop indirect expense includes interest, depreciation, and taxes, (or rent), light, heat, power, watchmen, janitors, etc. for the building, all of which may be approximately expressed as a value per square foot of floor space. We also have supervision, inspection, stock-keeping and shop-office expenses. For each machine tool, in addition to its floor space occupied, we have interest, depreciation, and power, also the floor space occupied to stack the work before and after machining it. There must also be included oil, waste, perishable small tools, and perhaps freight and express expenditures, and many others. Of these expenditures, some are measureable in time, others in weight or bulk of material and still others are almost fixed. At best we can only approximate a correct apportionment to different kinds of product, especially where the product varies over a large range in general character of the material and work. For simplicity we may put our distribution on a time basis.

We may work out the value per hour of each machine tool, of floor space per square foot, and of a bench worker's facilities and supplies. We may assume a normal activity of say 200 hours per month. We then extend and total all of these values per month and compare it with the total normal indirect expenditure for one month, and then go back and proportionately change each value per hour to make the total of the monthly equipment values approximately equal to the total monthly indirect expenditure. This gives an indirect rate per hour for a square foot of floor space, for each machine tool and for a bench worker.

If business becomes scarce and the total direct labor falls below normal, then the total of the indirect charges against product will not cover the total monthly indirect expenditure of the works. In this case there will be "idle indirect" balance to be charged directly as loss against the profits for the month.

Such falling off of business does not raise the shop cost of product. There would seem to be no reason for changing indirect costs or percentages to keep pace with such varying activity of the works. Aside from the clerical cost and confusion that would result, it would destroy comparison and cover up valuable information in the monthly statements. It would also raise so-called shop cost in the face of reduced sales, when lower selling prices may be the remedy in filling up the shop and increasing total profits. In any case the management needs correct and comparative data.

The indirect rate of a manufacturing operation is that of the smallest standard machine tool or other equipment suitable. The indirect cost of an operation is the time required (on that tool) at that rate. The indirect cost of an article is the total indirect cost of its operations.

A very large proportion of machine work is done on tools much larger than necessary for each operation. This is usually for good practical reasons, such as to keep otherwise idle equipment and operators profitably employed. For example, the largest planer in a general machine shop may be used to its full size capacity perhaps only a few days per year and is busy most of the time on much smaller work.

Evidently indirect cost must be based on the indirect rate normal to the operation, rather than on the rate of the tool on which the work happens to be done. Indirect cost based on such actual time of doing the work will be in error only due to the difference between the time required with the larger tool and that required with a normal tool. This difference is usually small, and the result is substantially correct not only as to cost of product, but also for determining the activity of any class or size of equipment in reference to questions of department efficiency, capacity for more work of any given class, or need of additional equipment of any type or size.

Evidently this normal indirect rate of the operation may be quoted from the operation list onto the work ticket when it is issued, and there is no demand on the workmen for clerical work in reporting tool used or floor space occupied. This plan is applicable to all kinds of operations, including assembling and testing, the use of portable tools perhaps on costly bed plates, and other operations where the value and rate of the tool are insignificant in comparison with the space occupied by the large work waiting and in progress, perhaps occupying costly floor space under large traveling cranes.

Mistaken theory has led to many absurd systems based on the rate of the tool actually used instead of that normal to the operation, and in many cases even the tool rate is based on actual activity instead of normal activity. The figures so obtained are evidently without meaning and work is driven away from almost idle tools by an enormous and increasing so-called indirect rate. The plan is both impracical and illogical and is usually of no value whatever in deciding questions of cost of product, activity of equipment, or efficiency of departments.

Where conditions of business do not demand the continuous recording and accounting of indirect cost from time tickets, the indirect cost of product may be estimated by dividing the indirect rate of each tool by the average hourly earnings of its operator, which gives an indirect percentage for each tool (and for floor space, etc.). On the operation list of the product each operation cost or piece-work price may be multiplied by this indirect percentage of the tool normal to the operation. The total gives the estimated indirect cost of the article, which may be divided by the total operation cost to give the estimated indirect percentage. If a medium size were selected the result may be used as the approximate indirect percentage of the entire line or class of product. As it is only approximate it may be well to adopt the nearest exact and convenient figure.

Summary.

Where it will meet all practical needs, indirect percentage may be estimated and established for each class of product and need not enter into the factory accounts. It may be very useful in fixing selling prices, in showing profits, in valuing inventory, and in directing extension and growth of business.

Where indirect cost must be continuously recorded and accounted it may be taken from time tickets at the rate of the equipment normal to the operation and based on full time activity.

In attempting to compare indirect percentages of different works it is well to remember that many expenditures are very close to the dividing line between indirect and direct cost. If any such expenditure be classed as indirect in one works and as direct labor in another works, then the fraction called indirect percentage (sometimes called "expense percentage") is doubly affected by taking this expenditure from the dividend and adding it to the divisor.

Rapid advance in mechanical devices for transferring, identification, recording time, sorting tickets, adding and tabulating elapsed time, etc., seems to promise a great improvement and cheapening of the now clerical processes in connection with gate records, pay roll, labor cost, indirect cost, and equipment activity. The correct theory of cost keeping is in every way favorable to the use of such devices, and a rapid advance in the adoption of scientific methods of management will keep pace with the improvement in such means.

STEAM PIPING FOR INDUSTRIAL PLANTS.

By W. E. Housman.

The dearth of practical discussion on the design of pipe lines is an indication of the remarkably small amount of attention given to this most important element in steam-plant design. Imperfect lay-out and construction of piping will nullify the utmost refinements of economy in steam raising and carry grave dangers to the continuity of operation of the plant, but the steam-conveying arrangements of most plants seem to indicate that designers usually concentrate their attention on the steam generators and engines and leave to chance the important link connecting the two. In the following article Mr. Housman deals with the subject in a wholly practical manner, confining his attention principally to medium sized plants designed for moderate steam pressures, but giving a few very interesting data on the distribution of steam underground in mining operations.—The Editors.

WHILE properly designed steam piping plays such an important part in the make up of the modern steam-electric plant, it seems to be neglected and often an after-thought in the more numerous industrial operations. This article will deal with moderate sized plants, and with steam pressures to 175 pounds per square inch.

Steam distribution for power service should be planned at the same time as the design of the buildings and arrangement of machinery. In no other way can the cost be kept to a reasonable amount. Properly designed piping will not only avoid pockets and expansion troubles with the attendant leaking joints, but will simplify and cheapen the cost of erection. With care, every support and sling can be placed before the erection is started, reducing the amount of scaffolding to a minimum, and making certain that the piping will be on proper grade.

To lay out pipe work requires good judgment and acquaintance with standard fittings and steam specialties. Trade catalogues are a far better guide than text books, the little information given in the latter being misleading and the illustrations often harmful.

An accurate scale plan and elevation of all buildings affected should first be made, the roof trusses located and all possible interference plotted. Then the outlines of the boilers and steam users should be drawn in, showing to scale the location of the connections furnished with the apparatus. The general scheme of steam distribution can now be determined, and the boiler-house piping, usually the big end of the work, drawn up. All pipe drawings should be to such scale as will enable all important dimensions to be given, and should show the position and character of every fitting and support; they should be so complete as to form a thorough specification of the work required.

The steam header, or main, is the natural starting point for a boiler-plant lay-out, and its diameter is determined by the number and size of the boiler connections, and the position of the leads out of the boiler house, bearing in mind that this header is intended only as a distributor, and not as a reservoir.

The connections from header to boilers must be sufficiently flexible to allow the longitudinal movement in the header due to expansion. Never locate the stop valves in a position which, when the boilers are idle, will permit a head of water to accumulate on the seat.

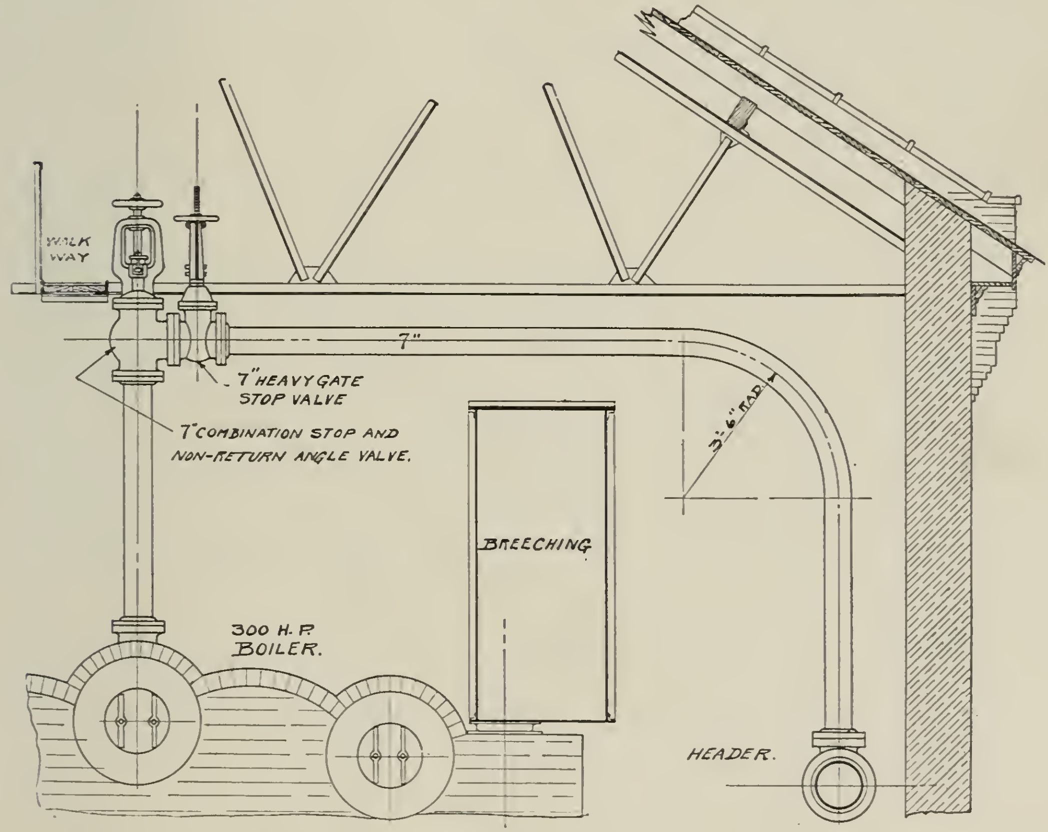


FIG. A. STOP-VALVE CONNECTION BETWEEN BOILER AND HEADER.

The 7-inch connection shown in the drawing represents only one of many in common use. The special angle stop valve illustrated has several trade names. Its purpose is to close automatically should a tube, or any port of the boiler, give way; to keep a boiler closed until its pressure equals that in the steam header; and to protect the man who is cleaning or repairing a boiler. These valves cannot be opened except by pressure from the boiler. When selecting a valve for this purpose buy one guaranteed against chattering—a fault to which some types are liable.

For small plants and situations where the header can be hung higher than the nozzle on the boilers, the simple 6-inch connection with drain connection, shown opposite, will do very well. This drain is put in at every boiler.

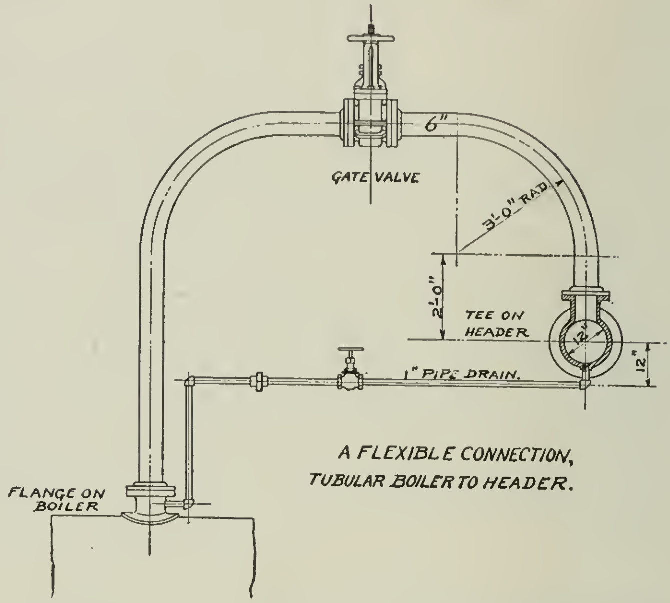


FIG. B. DRAIN CONNECTION BETWEEN BOILER AND HEADER.

To supply the boilers a feed header is carried from the pumps over the boilers, the size proportioned to the horse power of the boilers to be fed. From the header branches are carried to each boiler inlet. By placing this header well to the front of the boilers, the controlling valve on each lead is so situated that an extension valve stem may be dropped down to the reach of the operator on the floor, enabling him to see his gauge glass when handling the valve. A check valve, and an additional stop valve between check and boiler, must be inserted in each lead. The feed piping must be supported in such manner as to be free from the vibration caused by the pulsations of the pumps.

Where non-condensing engines are in use, a good feed-water heater will be installed and sufficient exhaust steam piped into it to raise the temperature of the feed water to 210 degrees. Six pounds of exhaust steam will heat one pound of feed water to this degree, making a total of seven pounds of feed water for the six pounds steam. The heater is set close to the feed pumps and a sufficient height above the floor to be sure that the hot water will gravitate to the pumps. The exhaust steam at the heater must be so piped as to permit the cutting out of the heater for cleaning or repairs.

The drawing on the next page shows one of several ways in which this by-pass can be arranged. The heater and pumps should be as near the middle of the boiler plant as convenient in order to keep pipe sizes down.

Safety valves should be piped singly to the outside of the building

—never into a header, or a leaky valve will be hard to find. When possible this escape pipe should not rise above the opening into the valve, as otherwise the condensed water will form an additional head on the seat. Vertical escape pipes must include provision for removing this water.

The separate boiler blow-offs are usually gathered in a main which will discharge into a tank or pit safely outside of the building, the purpose of the reservoir being to nullify the force of the escaping steam and water; from this point the discharge is piped or ditched to the nearest wasting point. All blow-off fittings should be very heavy, to resist the scouring action of the sediment, and the pipe is preferably cast-iron.

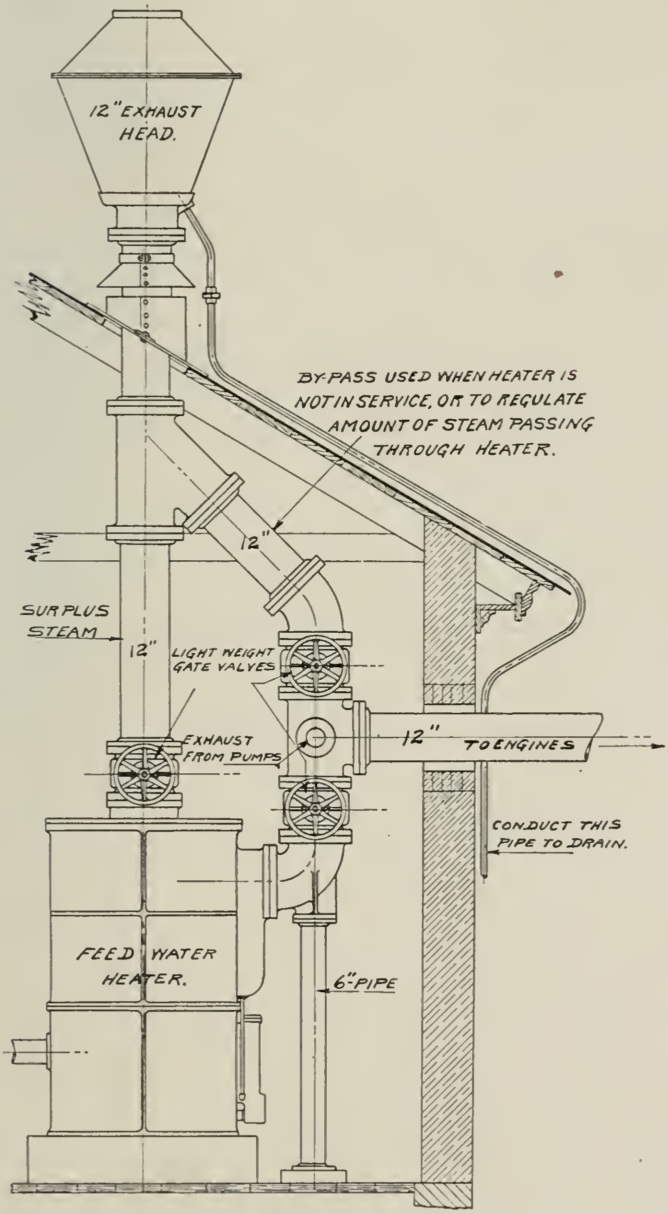


FIG. C. FEED-WATER HEATER CONNECTIONS.

The conditions governing the design of the lines radiating from the boiler plant to the engines will vary so much that only general rules can be given.

Every steam line should start with a valve placed at or very near the connection to the steam boiler, and the grade from this point on should be with the current of steam. With a stiff up grade against the flow, water will collect at the foot of the grade until a slug is formed. Finally it will be picked up and, traveling at high velocity, may wreck the first cast fitting encountered. Therefore, at the foot of every vertical rise and change of grade, a drip pocket or water leg should be placed, into which the greater part of the water will fall, to be removed by a steam trap. Too much attention cannot be given to this question of drainage. The quantity of water in the steam is variable even in the best covered lines. It will increase as the boilers are forced, or a sudden or excessive demand on the line may lift water out of the boiler.

The more economical way to take care of this water is to put a good separator on every engine connection or branch from a main, and as close to the throttle as possible. For bodies of water in the main, put drip pockets or water-legs at every change of grade, as before suggested. Where reducing fittings are used on the horizontal run, the flanges should either be eccentric or a drip pocket should be inserted next to the fitting and in the larger pipe.

It is best to lead a steam line out of the top or side of a header. However the water leg, under the dropping 10-inch line shown in the drawing below, is expected to care for the greater portion of the water dropping out of the header.

To avoid awkward and dangerous water pockets and to facilitate alteration and inspection, all live-steam lines should be carried overhead. Engine rooms in which the supply pipes drop out of sight immediately on leaving the cylinder look very neat and give the maximum overhead clearance, but the drainage of the unavoidable water pockets created is often difficult, and the location required for separators and traps insures these a minimum of attention.

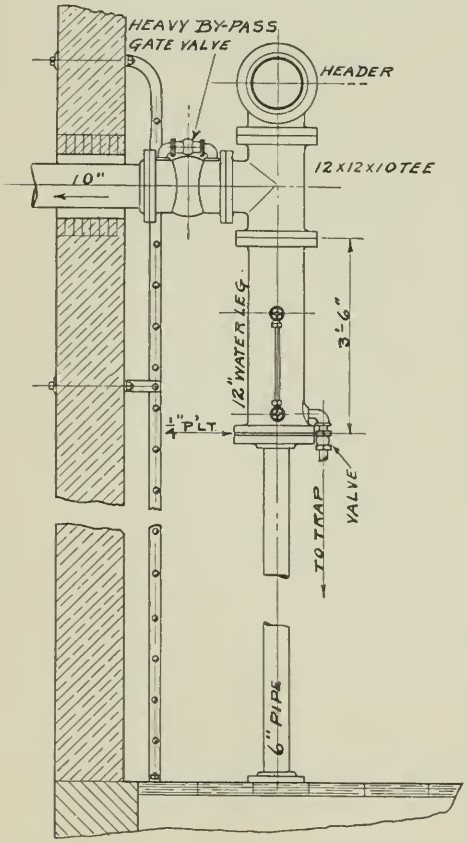


FIG. D. A WATER LEG CONNECTION.

A receiver-separator is very useful at the end of a long line. It not only takes care of large bodies of water, storing them until the trap can expel the water, but it will maintain an even flow of steam regardless of sudden demands made by the steam users. Its use will often permit a smaller line to be used for a predetermined drop in terminal pressure. With high-speed automatic engines, receiver separators are especially valuable; they insure a steady flow of steam in one direction only and serve as a cushion to receive the hammer or vibration due to the quick action of the steam valve. This vibration is otherwise communicated to the steam line and may prove dangerous to fittings and supports. The connection between receiver and cylinder must be the full size called for on the engine, but the branch from the main to the receiver need be figured only from the steam used in the first quarter of the stroke. They are made in various sizes with any desired arrangement of connections. A receiver of volume equal to seven times the contents of the engine cylinder gives very good results.

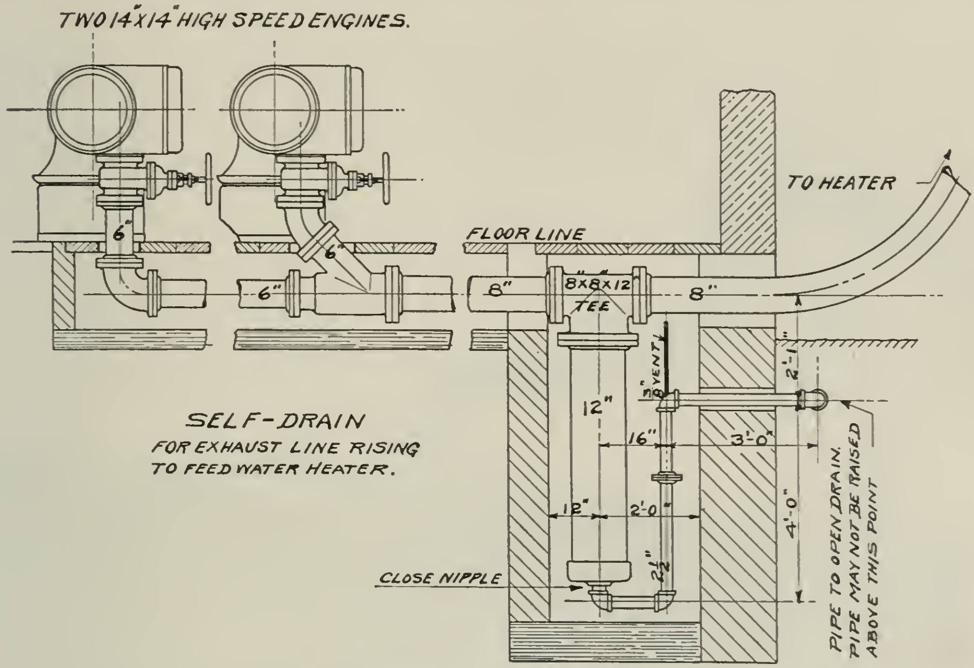


FIG. E. SELF DRAIN FOR EXHAUST LINE RISING TO FEED-WATER HEATER.

Exhaust lines should preferably drain to the feed-water heater. In any case, water must not be allowed to accumulate, otherwise it may back into an idle cylinder. Traps are a necessary evil on live-steam lines and require constant attention and inspection. On exhaust work their use may be dispensed with by using, instead, a free drain connection having in its water-leg sufficient head to cover the outlet pipe against the back pressure developed. The drawing above illustrates this very simple expedient.

An exhaust head should always be provided for every free exhaust to atmosphere, not only as a muffler but to catch water and oil which would otherwise discolor the roof.

The method of caring for expansion will depend on steam pressure, amount of expansion, size of pipe, and, perhaps, on the position of the line. With pressures under 100 pounds and piping up to 10-inch, a reasonable amount can be taken up by the movement of the threaded nipples in screw fittings. Thus four screw elbows arranged to form a swing joint will allow expansion in the same manner as the swivel joint hereafter described. The rotary nipples in such joints should be short to throw the minimum bending strain into the ells. For long lines the metallic-packed swivel joint is ideal.

The swivel joints shown in the photograph are located near the middle of a 10-inch line, 900 feet long, the expansion in each half of the line being about 11 inches. With any type of swing expansion joint, the line must be sufficiently anchored to force the expansion to the swing joint.

SWIVEL EXPANSION JOINTS AT MIDDLE OF THE LINE.

Pipe bends are coming more into use for the shorter lines but care must be exercised in their design. Pipe of no less than full weight should be used, with steel flanges. The radius of the bend must be proportioned to the amount of expansion; the longer the radius, the easier on the flanges. A long-radius full-reverse bend is good, but the best expansion bend is one formed of one "U" bend and two 90-degree bends.

The common slip expansion joint is more in use than it deserves. Its chief disadvantage is that the packing gland may be set up so tight that the joint will not slip, but instead, will push out the supports and strain connections. There are sometimes situations in which no other expansion joint can readily be used. The one then used should be provided with safety tie-rods, so that should the anchorages fail the line cannot blow apart, and the packing had best be metallic.

The anchorages must be figured strong enough not only to overcome the friction in stuffing box and pipe hangers, but also for a stress equal to the steam pressure multiplied by the unbalanced area of the joint. The steam line must be supported close to the slip joint, as a very slight sag in the pipe will cause it to bind. The location of the expansion joint must be determined by the profile of the surface over which the steam line is carried, the amount of expansion, and the type of joint used. Long lines may require several joints, since every sharp change in direction will require provision for expansion.

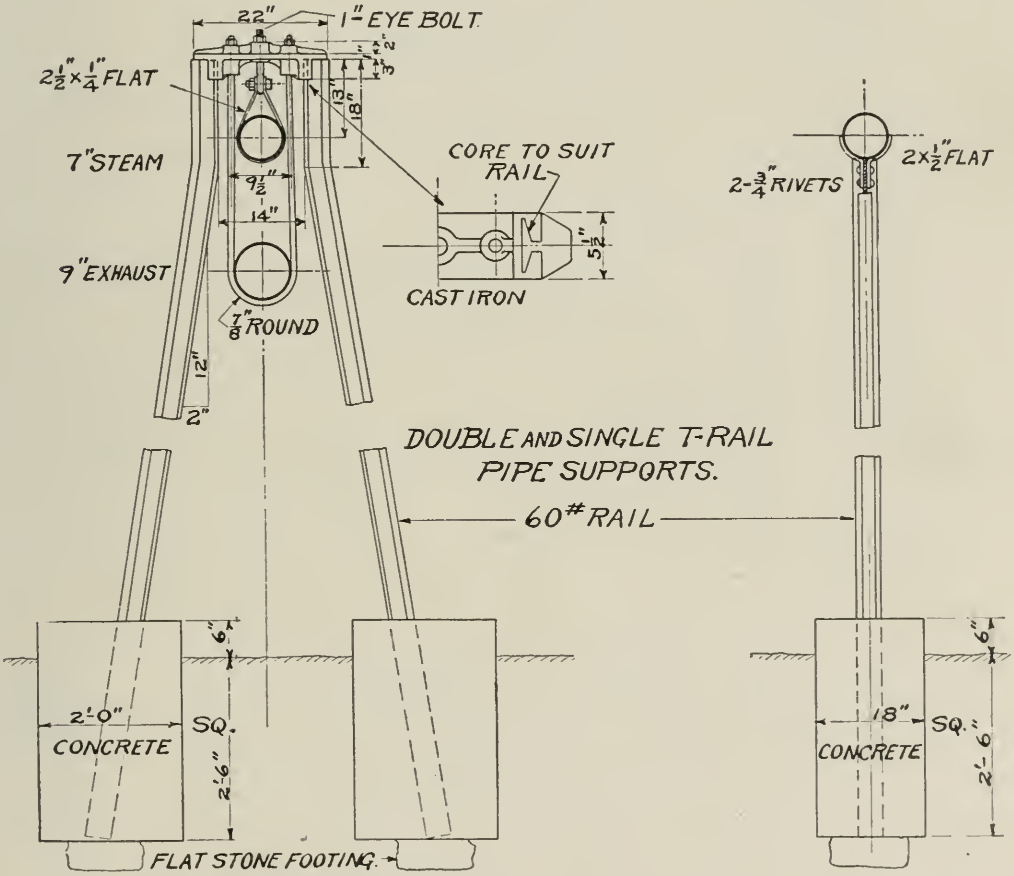


FIG. F. DOUBLE AND SINGLE T-RAIL PIPE SUPPORTS.

Pipe supports will vary with the whim of the designer, and a comprehensive treatment of them is impossible in the limits of this article. For lines where the expansion creep of the pipe is not too great for a sling, T-rail supports are economical, convenient, and neat. At the short-travel ends of the line single-rail supports can alternate the two-rail type. It will be noted on the drawing illustrating rail supports that the double-rail one can also be used to carry an exhaust line. The cast-iron bracket shown is designed for 60-pound second-hand rail.

The piping must not deflect more than 3/16 inch at the center of the span; the spacing of the supports should be figured accordingly. Additional support must be provided close to all heavy valves and fittings. When the expansion travel in the line is too great for slings, rollers are provided.

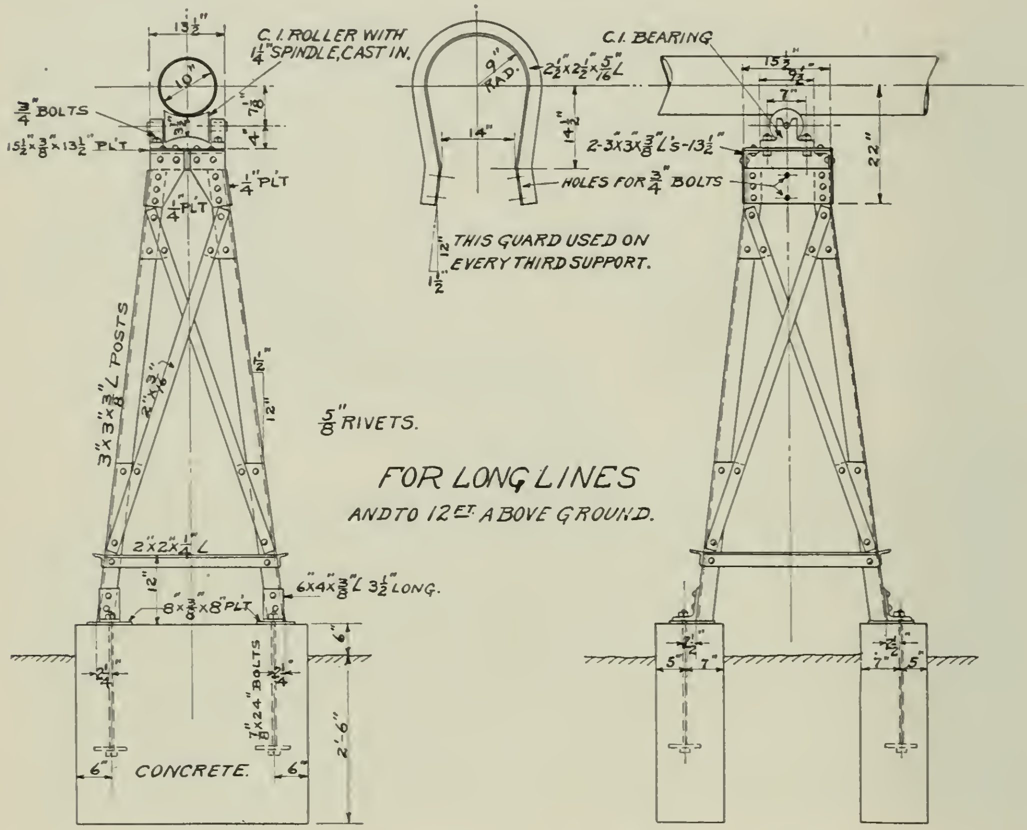


FIG. G. PIPE SUPPORTS FOR LONG AND HIGH LINES.

It may be of interest to touch very briefly on the prevailing method of carrying steam into mines. Formerly steam was taken through a small compartment in the hoisting shaft, thence through the mine to the machinery operated. The line is now carried over the surface to a drill hole put down very near the engine or pump to be supplied. This drill hole is cased, grouted in the hole from bottom to top with neat cement, and the steam line dropped through the casing, the diameter of the casing being only sufficiently large to give clearance to the pipe sleeves or couplings; no flanges are used.

In addition to the water-leg shown on the drawing of bore-hole connections, a separator is placed near the throttle. The swivel joints shown on the surface connection take up the vertical expan-

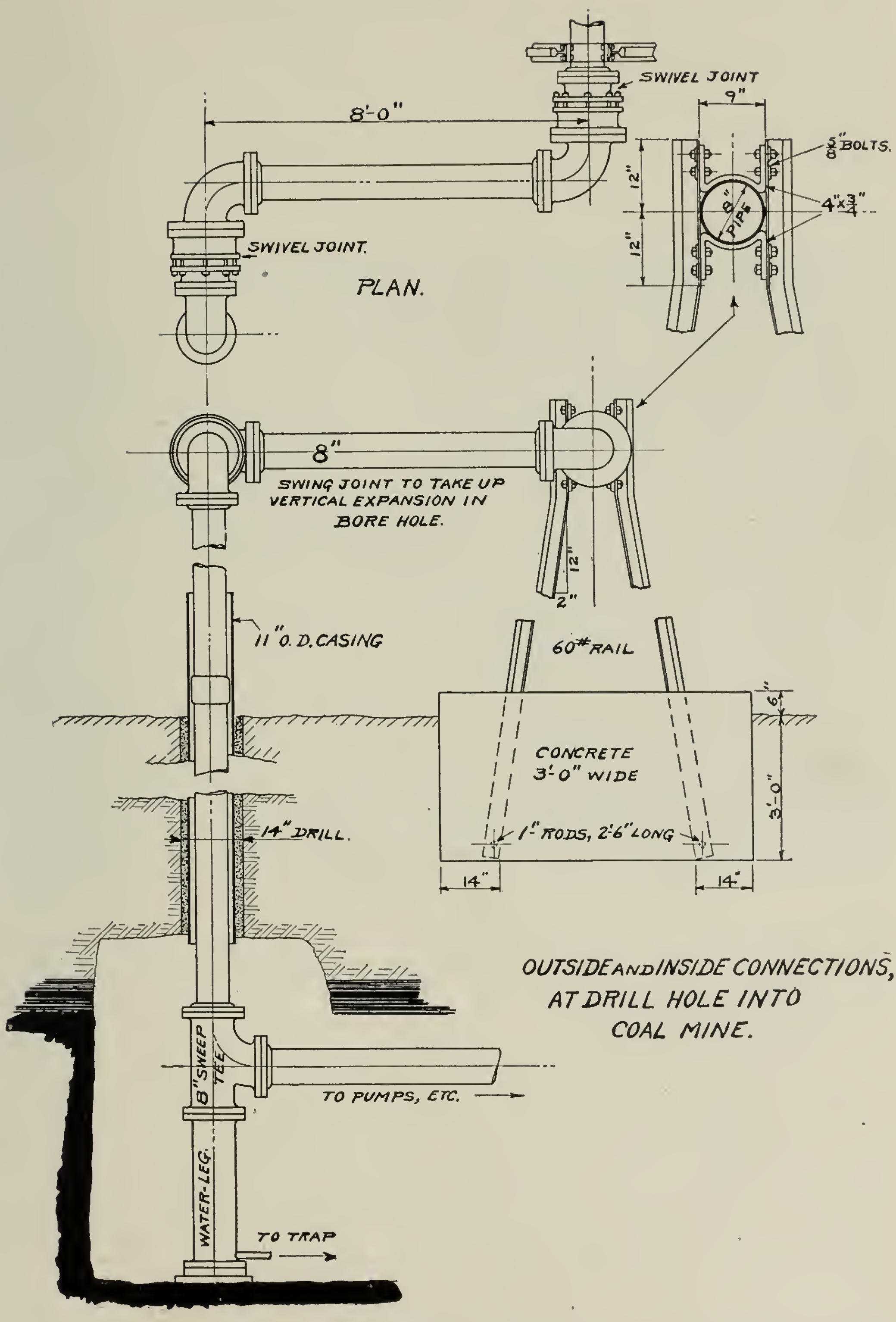


FIG. H. OUTSIDE AND INSIDE CONNECTIONS FOR A PIPE LINE ENTERING A MINE THROUGH A DRILL HOLE.

sion only. When the exhaust steam is not immediately condensed in the mine, it is conducted to a separate drill hole and connected directly to the casing pipe.

As pipe lines in the mine can be very short and direct, the supports present no difficulty; old T-rails, as transverse beams, or as posts under the pipe, are commonly used.

All pipe considered in this article is what is known as "wrought-iron." This has now become a general term which includes all butt or lap-welded pipe of either steel or iron. When material is not distinctly specified, the pipe received will usually be steel, and will be under-weight by from 5 to 10 per cent, the greater variation being on piping from 8 to 12-inch, inclusive; "full-weight" pipe will run very close to the list weight and should be specified on all live-steam work. For bends of radius less than six diameters, extra-strong pipes is often advisable to compensate for the stretch on the outer curve of the bend. Piping larger than 12-inch is listed by external diameter and is called "O. D. pipe." The thickness of metal must be specified in ordering—usually 3/8 inch for live-steam in sizes 14 to 18 inches, inclusive. O. D. pipe lighter than 5/16-inch cannot be threaded.

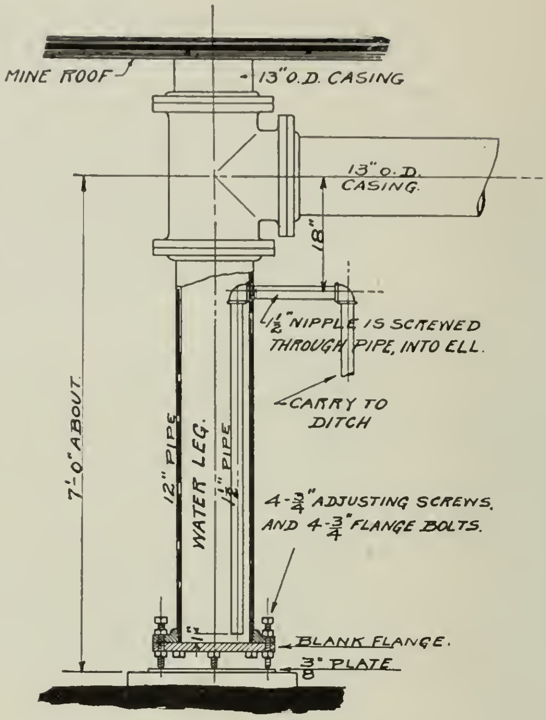
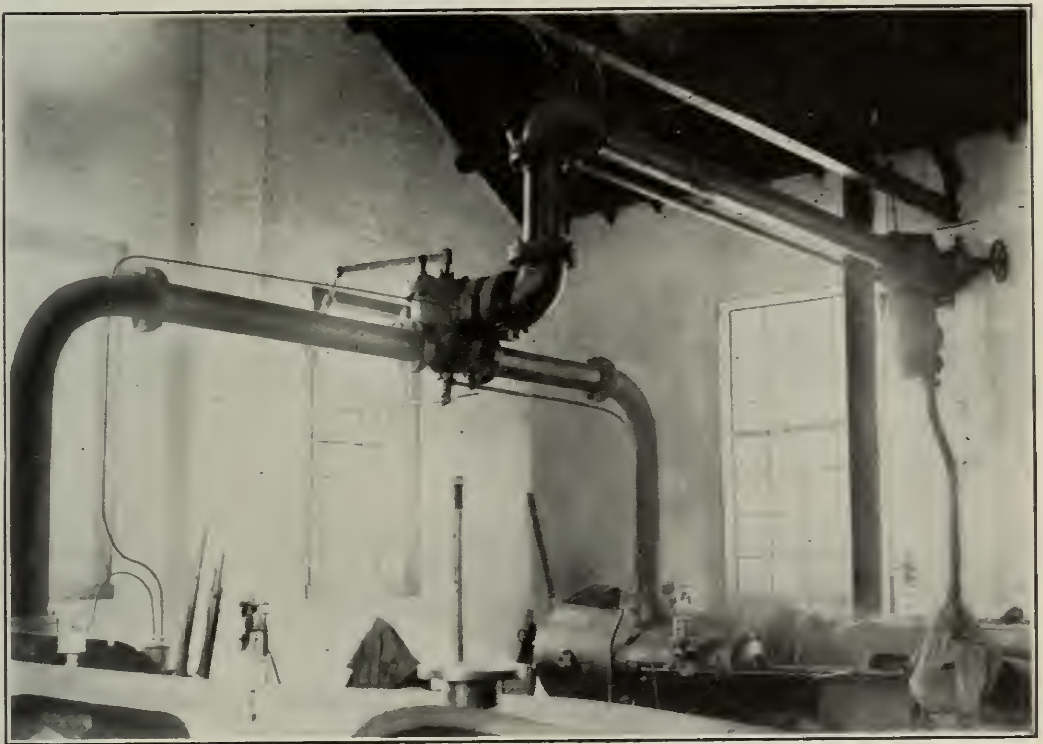


FIG. I. UNDER-GROUND EXHAUST CONNECTION.

The best three methods of attaching flanges to wrought pipe, all reliable to 200-pounds pressure, will be mentioned in the order of their cost: When properly made, the screw joint gives perfect results with the minimum cost. The prejudice existing against it in many minds is doubtless due to experience with poor workmanship and to the belief that the threads weaken the joint. It is very rarely wrought piping bursts; but when it does, the break will be found some distance back of the joint and usually not at the seam. To make a good screw joint requires only that the flange be tapped true, the threads on the pipe cut to a long true taper, and the relation between male and female such that the pipe can be screwed home to the shoulder without heating. Any grit or dirt on the threads will produce added friction and consequent heat, hence the threads must be made clean before applying the graphite or other lubricant used to reduce friction. It must be understood that when a joint becomes hot, it will afterwards leak; the lighter tube will expand more than the flange, while making the joint, and on cooling, will shrink more than the flange. If the thread is of proper length, the end of the pipe will project through the flange. This portion is faced off, at

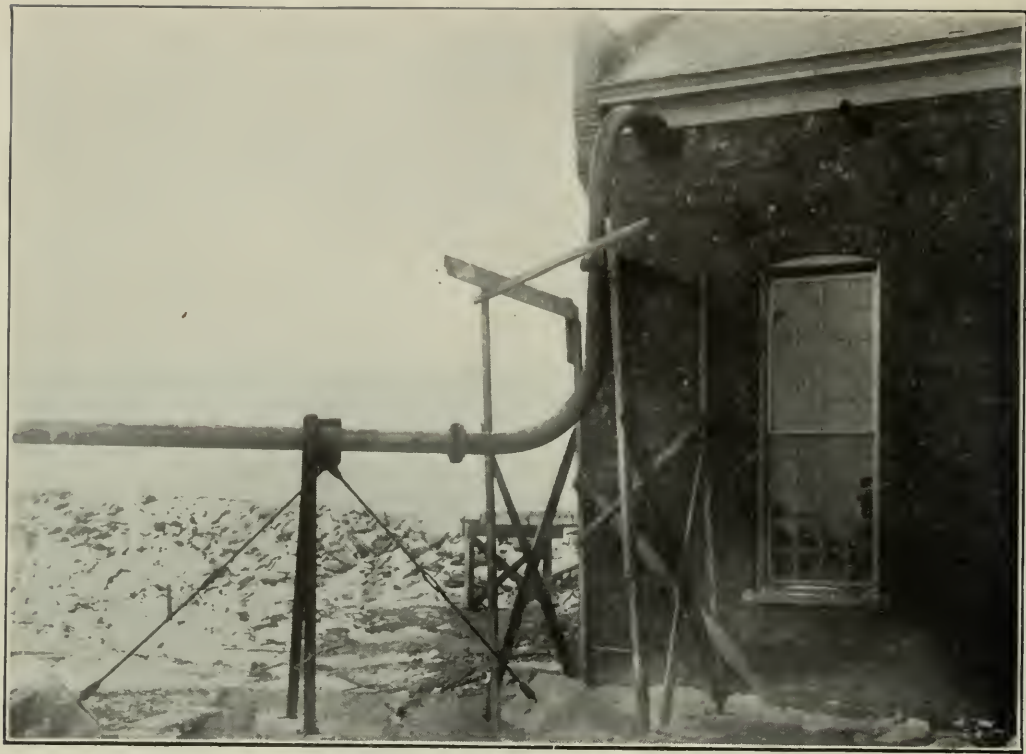


CONNECTIONS INSIDE THE HOISTING-ENGINE HOUSE.

the same time taking a light cut over the face of the flange. In long steam lines, only sufficient flange couplings are needed to facilitate a repair or alteration, the intermediate connections being the standard forged sleeves or couplings. In emergency, the closing piece of a line, or a section improperly made, can be rectified in the field, as screw pipe can be cut off and re-threaded in the ordinary engine lathe.

The lap joint, formed by machine swaging the end of the pipe over the face of the flange, is absolutely safe and has an advantage in that the flanges, being loose on the pipe, may be turned to match the holes in the fittings. Its cost is about one and one-quarter times that of a screw joint and steel flange. It follows that every joint must be flanged. This joint cannot properly be re-made in the field.

The welded joint is made by machine-welding a forged-steel flange to the pipe. Its cost is about one and three-quarters that of a screw joint and steel flange.



ILLUSTRATING ANCHORAGE AT BOILER-HOUSE END OF THE LINE.

RECEIVER AT THE HOISTING-ENGINE HOUSE.

Flanges, for live steam, should be of rolled or cast-steel, especially on expansion bends. It is the pipe flange which will fail, almost never the flange on a valve or fitting. They should be rough-faced for thin copper or rubber gaskets. For the pressures here considered, tongued-and-grooved flanges are not necessary and their use makes it difficult to remove a section of pipe or a fitting.

For piping 8-inches diameter and above, flanged fittings are recommended. They offer less resistance to the flow of steam and water and shorten the time and labor of erection. For live-steam work of any size and pressure, the screw fittings necessary should be extra heavy. Bad core setting makes the standard-weight goods unreliable.

The prevailing tendency is toward the gate or straightway valves for all steam fitting. They offer the minimum of obstruction to the flow of steam and water, and the fact that they cannot be opened so rapidly as a globe valve is an argument in their favor. Valves 6 inches and larger should be flanged type. A valve should never be placed in a vertical run of pipe, on account of the water accumulated when the valve is closed. Sizes 8 inch and larger should have a by-pass to warm up the pipe ahead, and to equalize pressures before the main valve is opened. On the larger valves they are indispensable for easy handling.

The flanges on all heavy valves and fittings are now drilled to the standard adopted by a conference of manufacturers in 1901. It is to be regretted, however, that the majority of engine builders and boiler makers have their own standards, which vary widely from each other and from that used on the fittings, requiring companion flanges which are of odd size and drilling.

It seems unnecessary to state that all live-steam and hot-water piping should be covered. Extra-thick or even double covering will be profitable on very long lines. All covering exposed to the weather, or in damp locations, should be protected by good weather-proofing. Moulded coverings are made to fit all sizes of standard screw fittings. Flange couplings are not usually covered, but moulded covering for them can be purchased. Valves, separators, and flanged fittings are protected by plastic magnesia covering put on with a trowel in coats of about one-half inch thick to amount required. On large receivers and O. D. pipe, the covering is applied in blocks of thickness required and curved to conform to the surface to be covered. Exhaust piping is usually not covered unless the heat radiated is a disadvantage.

MAXIMUM PRODUCTION THROUGH ORGANIZATION AND SUPERVISION.

By C. E. Knoeppel.

The article following is first of a group of four developing the possibilities of far-sighted and *fore-sighted* control of a manufacturing business so that it may be operated at a minimum of friction and a maximum of productiveness and profit. The first of the series in concerned chiefly with the adjustment of the internal organization to the utmost working efficiency. The following parts will take up successively systematic processing, machining, assembling and erection; the insuring of economy in the use of material and time; and the methods which secure better deliveries and more satisfied customers.—The Editors.

IN the issues of this magazine for March, April, and May, 1907, there appeared a series of three articles on "Cost Reduction Through Cost Comparison," the object of which was to show how burden, machine, group, part and operation costs could be reduced through an intelligent analysis of results, and how this important work could be so centralized and controlled by one department as to enable the work to be handled under the best of conditions. The series published was complete in so far as the consideration of proper methods for recording and analyzing data and information was concerned—complete in that the application of the principles would enable a manufacturer to locate a leak here, a sore spot there and a wrong condition of affairs somewhere else; but it was *incomplete* in that using only the methods outlined in these articles, the manufacturer would not know that the evils existed until *after* the analysis began. The accomplishment of highest efficiency does not and should not depend altogether upon the analyzing of results attained, and a manufacturer will fall far short of reaching the highest plane if he depends solely upon his information to enable him to remedy a fault in one place—and then does nothing to *anticipate* a fault which may exist in another place, but regarding which he may know nothing until advised by the proper department where the fault was and what caused it.

In any manufacturing enterprise, the securing of maximum production and minimum costs is dependent upon two factors, which being resolved, stand out very distinct as follows:—

1.—Comparison and Analysis	2.—Organization and Supervision

The first factor was considered in the series already published, while the second factor will be carefully discussed in this series; and while each will be complete in itself, their relation to each other will be too pronounced to attempt to cover the ground in the broadest way, by considering one and not the other. "Comparison and Analysis" will, under proper conditions, bring about "Organization and Supervision"; and if considered in this light, the latter, for a time at least, assumes a position of secondary importance, but eventually (when faulty conditions are discovered) the necessity for "Organization and Supervision" is apparent, and this factor then takes its proper place. If on the other hand "Organization and Supervision" receives proper consideration on the start, "Comparison and Analysis" will assume the position of secondary importance, although it must not be inferred that the value of "Comparison and Analysis" decreases as the efficiency of "Organization and Supervision" increases; for in the best managed enterprises it will be found that the former receives most careful attention.

A manufacturer would not think of having the analysis of his irons discontinued simply because he had engaged a foundryman who was skilled in the handling of the cupola, in proper methods of charging, and in the mixing of metals; nor would the engine designer think of doing away with the reading and study of the engine diagram because he knew that on the test block was a man of more than ordinary ability in assembling and adjusting engines. The engineer, through his experience, would take the various parts, assemble his engine, adjust the various motions, etc., turn on the steam, readjust where it was necessary, and take readings; these would probably show to the man trained to analyze them that the engine needed but little readjustment in order to make it come up to specification. Consequently the engine could be built in the quickest possible time and at a minimum cost, while if ordinary workmen had been employed the assembly and adjustment would have taken up the same amount of time at least, and it would then be necessary for the designer, after a diagram had been given him, to spend considerable time analyzing and picking out faults, advising what to do in order to make the engine the machine it was designed to be; this of course would mean that the readjustment would consume considerable time so that the engine would take longer and cost more to build. We can therefore say that—"Organization and Supervision" is to the enterprise what the skilled engineer is to the engine, while "Comparison and Analysis" is to the enterprise what the engine diagram is to the designer.

The doorway to success is open to all who will build their business structure on the two factors heretofore named as a foundation. The one is analytical and critical in its nature—the other creative and constructive. The one considers causes and effects—the other ways and means. The one dissects, diagnoses, and prescribes—the other contrives and devises. The one considers the work *after* it is finished—the other *before* it is commenced and *during* course of construction; and while they may seem to be two different forces at work, they unite on common ground, in that they look into the future—working along different lines for the same end.

Briefly considering this latter factor—"Organization and Supervision," we might define it by saying:—*Its ultimate purpose is to resolve the various forces at work into their component parts—to arrange them so as to enable these forces to follow well defined channels, that the work may be guided along the most logical lines and responsibility placed where it properly belongs; and finally to combine these forces firmly into one harmonious effort, placing at the head a master mind to supervise and direct.*

If consideration is given to the analogy between the business machine (the manufacturing enterprise) and the fighting machine (the company of soldiers) the importance of "Organization and Supervision" is at once apparent. A company of soldiers will accomplish results in the surest and quickest way simply because they are well organized and properly supervised. From the captain to the privates, through the lieutenants, the sergeants, and the corporals, the orders are given and executed in a methodical way without confusion, delay, and misinterpretation; and in the manufacturing enterprise, the orders can be given and executed in a methodical way without confusion, delay and misinterpretation—if, in the growth of the business, in its evolution from the old order of things to the new, proper consideration has been given to the importance of a well trained and efficient organization. I do not maintain that it is possible for the manufacturing enterprise to attain that high degree of efficiency enjoyed by the army company, but I do most emphatically maintain that it would be possible for more manufacturers to be more successful than they are if they would inject some sort of organization and supervision into their business, instead of conducting it in the hap-hazard, disjointed, hit or miss, aim-at-the-ground-hope-to-hit-the-stars way of which so many are guilty. To this class the mere mention of the word "organization" elicits the cry "red tape," although if one of them would once consent to have some of this kind of tape wound around his business, the results would be so startling as to win him to the side of those who had attained success through a well systematized organization and from whom he could learn how to conduct his own business properly if he would but once get away from his habit of jumping over dollars in an endeavor to save pennies.

If space permitted, we might go into the details regarding the evolution of business in general, from the primitive stage of barter to its present immense propositions. In its early stages business was most simple. If a man had something his neighbor needed and he needed something his neighbor had, a trade was effected; or if a man had several things of like nature, he sold them to others for whatever suited his requirements. As the demand for various articles increased, however, it was found necessary to specialize in a small way, but in a way which enabled a man to devote his entire time and attention to the manufacture of one thing. During this stage of business development, it was an easy matter for the proprietor of the little establishment to give his attention to the various details; in fact, we can safely say that he carried his office "under his hat"—many still do so. As we approach the next stage, we find that conditions, by getting a trifle more complex, necessitated a radical departure, and we find that instead of one man looking after every detail the work has been rearranged so that at least two men divide the responsibility. Tracing still further we will find that as the volume of business expanded, the amount of detail work, necessary to accomplish results, assumed such proportions as to make it utterly impossible for a few men to manage a business properly. We find, commencing at this stage, that segregation resulted and today the manufacturing enterprise, while still a unit, is divided into two distinct branches—the commercial and engineering—these branches being again divided into departments and sub-departments.

While business as it is now conducted is not as simple as it was in the barter days, it must not be inferred that this segregation of authority is synonymous with complexity, for its very purpose has been to simplify and this is what it has accomplished. It is only where this segregation has been the result of lack of thought and proper attention, or other like causes, that we find a complex and unsatisfactory condition of affairs. In fact, there is all about us sufficient evidence that many commercial enterprises are being conducted along lines that, as far as evolutional development is concerned, are several stages behind the times.

Let us suppose a case, which will apply in a greater or less degree to the majority. In the earlier development, we will say that the founder of the business was able, on account of its small size, to make what sketches he needed, solicit orders, see that they were filled, perhaps take a hand at the making if occasion required, see to the shipments, and attend to the collections and the keeping of his few accounts. He finds that business grows, and eventually places a man in charge of certain branches while he looks after others. The accounts eventually require more attention than he can give them so he engages a book keeper in order that he may be relieved of this work. He finds that the quantity of materials received and shipped amount to enough to warrant a receiving clerk as well as a shipping clerk, and to handle this material from its inception to shipment he conceives the idea of placing a man in charge as stock clerk. He then adds a purchasing agent, in order that he may be relieved of the detail and that the purchases may be made most economically; a man is placed in charge of the orders—foremen are placed in charge of certain men in the shops—the details connected with making plans, drawings, estimates, etc., are taken over by a practical man—his manager is given a person to look after the shops or engineering branch, while the commercial branch with its many details is placed in the hands of another. As the evolution continues, the selling branch is assumed by one man—cost details are looked after by another—a chief inspector is added in order that all work may be shipped according to specifications—the engineer, who before had been a sort of jack of all trades, is placed in charge of certain work while an electrician is engaged to look after this particular work—and so this segregation continues as the development continues.

Perhaps it is not to be wondered at that the founder, in looking backward, is inclined to pat himself on the back when, in a reminiscent mood, he considers what he terms "remarkable development." He considers that he has been wonderfully successful in building up a business which at the beginning was so small as to admit of his supervising every detail, while today he employs a dozen men to do the work he once did. There is no getting away from the fact that it is this same feeling of self-satisfaction that is responsible for a large number of faulty organizations, for if we should tell this manufacturer that his business is far from being as successful as it is possible for it to be he would be very much surprised and perhaps angered—in fact, he would vigorously resent any such accusation; but the fact remains that it is not the success it should be for the very reason that the development has been allowed practically to take care of itself.

New men were added, new officers created, only when absolutely necessary, each new comer being given a general idea of what was expected of him; and not knowing, not thinking, or perhaps not having the time to give more than passing attention to the matter, the proprietor did not consider the fact that his business was a unit, with each worker a part, having a distinct relation with every other worker. Hence as the efficiency of any organization is directly in proportion to the care with which these relations are considered and treated, his organization naturally fails to attain that degree of efficiency obtainable, and for this condition he and he only is responsible. As a result, we find in his establishment a condition of affairs that, shown graphically on paper, looks like Figure 1. We have here an organization composed of managers and heads of departments, but we also have a confused organization in that no one really knows where his authority begins or ends. Consequently, there is no sequence, order, or harmony, and without these it is impossible to obtain maximum results.

If, on the other hand, the proprietor had given due consideration, during the growth of his business, to the importance of a well regulated organization—if he had realized that more could be accomplished through an intelligent supervision than through a supervision where one authority conflicts with another—his organization could then be graphically shown by Figure 2. Compare these two charts, and the difference between an enterprise well organized and properly supervised and an enterprise in which the opposite is the case will be apparent without further argument. Enterprises like the one shown in Figure 1, fail to appreciate the importance of classifying work and duties under their proper authorities, and naturally the result cannot help but be confusion, conflicting orders, arguments, etc.; while the value of an organization like the one shown in Figure 2 lies in the fact that work and duties have been properly classified and placed under authorities most competent to handle them, the effect of which is to reduce to a minimum the friction between the different workers, as well as to enable them to accomplish a maximum amount of work in the shortest time possible.

It is not the purpose of this article to go into details as to work, duties, responsibilities, or authorities. Each establishment has its own peculiar conditions—its own special needs—and the introduction of methods or systems must be made only after careful thought and application. The fact remains however that no matter how complex the existing conditions in any enterprise may be, the matter of

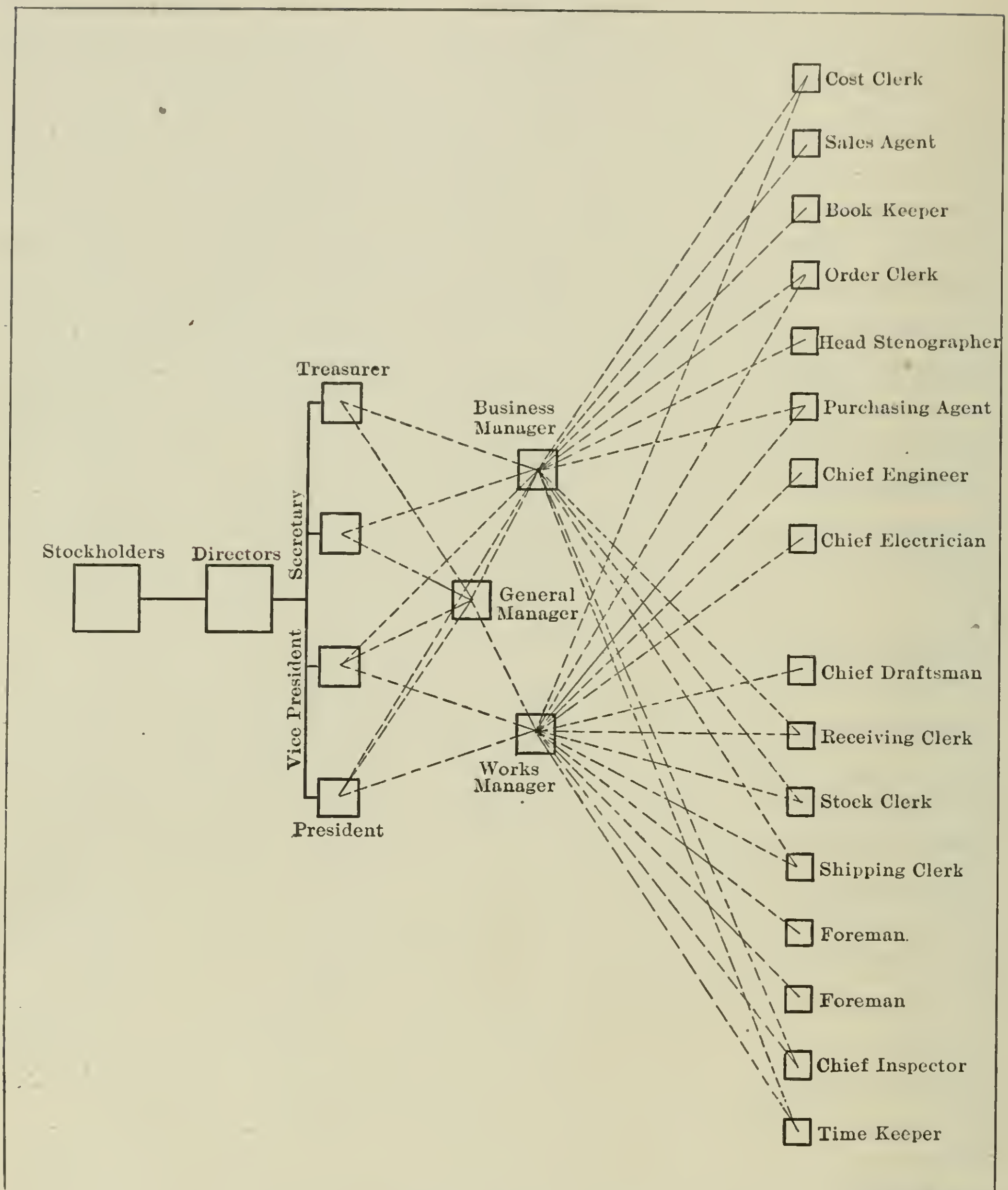


FIG. I. AN ILLUSTRATION OF POOR ORGANIZATION.

properly organizing it is not as difficult as might be imagined, and if the work is started and carried on in the right way it can be accomplished within a short time with gratifying results.

A man is hired and receives wages or a salary, as the case may be, for a distinct purpose—to perform certain duties, and upon the thoroughness with which he performs these duties depends his success; but he depends in turn upon the clearness with which these duties are defined—upon full knowledge as to whom to look to and who are to look to him; yet this part of the contract never receives any consideration at all from many manufacturers. It is therefore

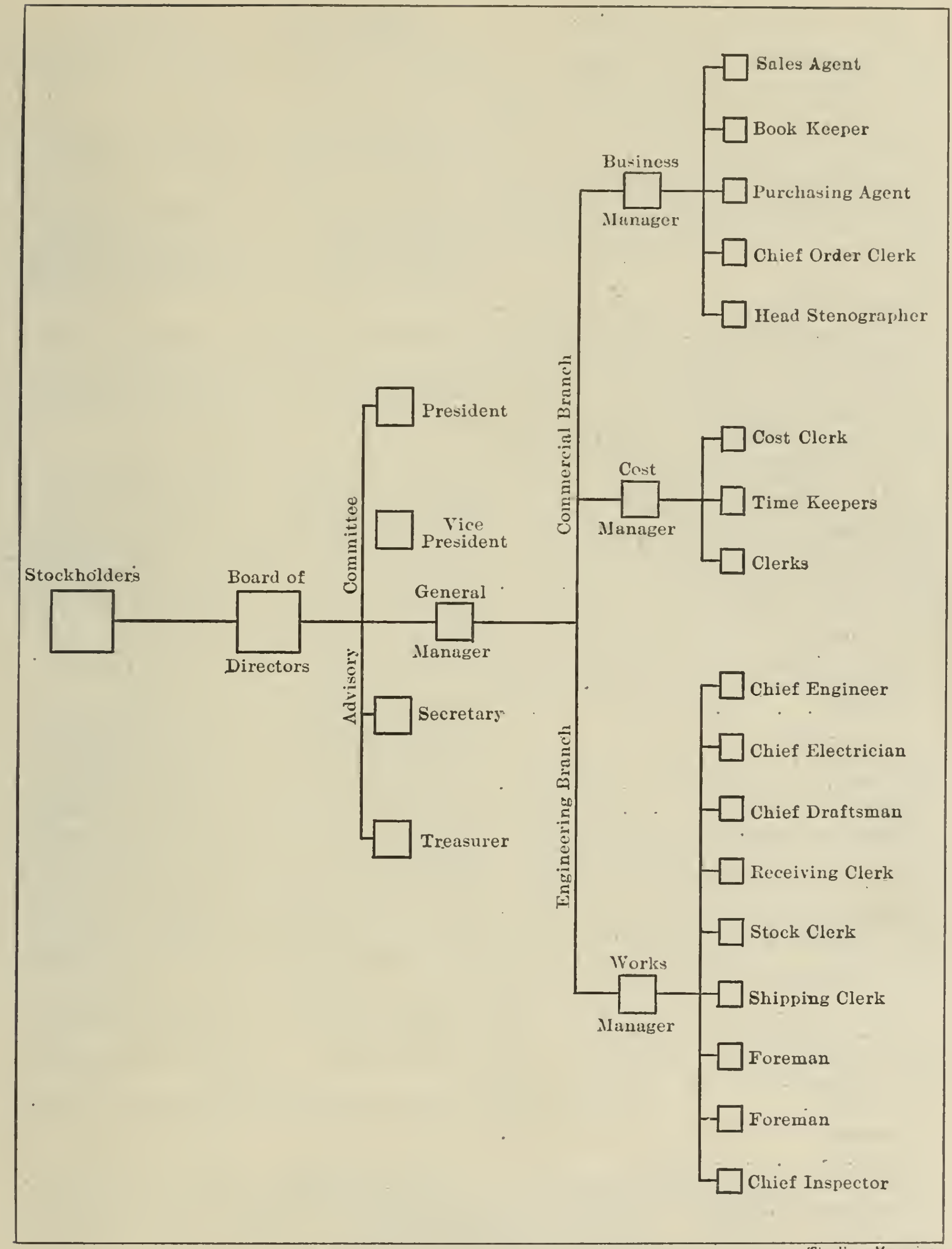


FIG. 2. DIAGRAM SUGGESTING AN ORDERLY AND EFFICIENT ORGANIZATION.

of primary importance, in organizing a business, that a complete list of work and duties be compiled. Provision should then be made for placing these duties in charge of those most competent to handle them, after which it should be decided who shall direct and supervise. It is then an easy matter to classify the details under the proper authorities and we can then draw up an organization chart along the lines shown in Figure 2.

Work and Duties.	Under the Direction of	Under the Supervision of
The figuring of depreciations . . .	Business Manager	General Manager
The purchase of special machinery .	General Manager	Advisory Com.
The purchase of materials and supplies	Purchasing Agent	Business Manager
Banking arrangements	General Manager	Advisory Com.
The checking of invoices with materials received	Receiving Clerk	Works Manager
The checking of invoices for payment	Book Keeper	Business Manager
Notes	Book Keeper	Business Manager
Fire protection	Works Manager	General Manager
Appointment of those under commercial authority	Business Manager	General Manager
Appointment of those under manufacturing authority	Works Manager	General Manager
Compilation of sales prices	Sales Agent	Business Manager
Passing on requisitions for materials and supplies:		
Engineering branch	Works Manager	General Manager
Commercial branch	Business Manager	General Manager
The following of purchase orders . .	Purchasing Agent	Business Manager
The issuing of all shipping orders .	Chief Order Clerk	Business Manager
Billing materials shipped	Book Keeper	Business Manager
Experimental work	Works Manager	General Manager
All issuing of materials on written requisition	Stock Clerk	Works Manager
Maintenance and operation of power units	Chief Engineer	Works Manager
The inspection of all work	Chief Inspector	Works Manager
New designs and changes in designs .	Chief Draftsman	Works Manager
Statements	Book Keeper	Business Manager
Payment of all bills	Business Manager	General Manager
Collections up to the point of suit .	Book Keeper	Business Manager
Collections from the point of suit .	Business Manager	General Manager
The ordering of new parts to replace	Chief Order Clerk	Business Manager
Creation of systems	General Manager	Advisory Com.
The issuing of manufacturing orders	Chief Order Clerk	Business Manager
All filing	Hd. Stenographer	Business Manager
The handling of materials for shipment	Shipping Clerk	Works Manager
The maintenance of proper stock margins	Stock Clerk	Works Manager
The determining of proper stock margins	Works Manager	General Manager
Execution of shipments from written orders	Shipping Clerk	Works Manager
Sanitary and plumbing arrangements	Works Manager	General Manager
Transportation	Shipping Clerk	Works Manager
Advertising contracts	Sales Agent	Business Manager
Passing on credits	Book Keeper	Business Manager
Maintenance and operation of electrical equipment	Chief Electrician	Works Manager
Execution of work on time:		
In charge of committee comprising	Works Manager Chief Order Clerk Stock Clerk Shipping Clerk	General Manager
The tracing of all shipments . . .	Chief Order Clerk	Business Manager

LIST OF DUTIES AND OFFICERS TO WHOM THEY ARE ASSIGNED.

The list shown on page 90 was designed to provide a means of enabling a manufacturer to compile duties and then designate the ones to look after and supervise them. The entries shown have been selected at random—the list has been purposely made incomplete on account of lack of space, and is simply suggestive in nature. After a complete list has been made, the work of classifying under proper headings is a simple matter but one of great importance, as the following will show:—

> "Book Keeper, under the supervision of Business Manager, final authority General Manager—shall have full charge of all book keeping, the giving of all notes, the issuing of statements, the billing of all materials shipped, the handling of all invoices received—their checking and passing for payment, cash, the disbursing of money when advised to do so by the Business Manager, pay rolls, time accounts, passing on credits, the enforcing of all collections up to the point where legal assistance is necessary, the hiring, paying, and full charge of assistant book keepers, bill clerks or whomever it may be necessary for him to engage in order to manage his department properly; the arrangement, classification, and handling of his accounts, the right to employ whatever methods he may elect without changing the general scheme of the accounting; and while possessing no authority outside of his own department, he shall have the right to collect such data as are or will be necessary for him properly to compile statements as to the general or detailed conditions of the business."

After this task is completed, the chart of organization can be quickly made, and we then have the proper foundation for an efficient organization. In closing it is necessary to add only that by following the suggestions outlined, a means is provided whereby conflict of authority would be almost entirely eliminated and friction greatly lessened, as we have supplied a lubricant; and as we have succeeded in arranging the various forces in the most logical way, as well as provided for their care in the most careful manner, it is well within the range of reason to expect a maximum production through this factor "Organization and Supervision."

AMERICAN INDUSTRIAL CONDITIONS FROM A WORKMAN'S VIEWPOINT.

A New England Machinist.

This commentary came to us in the form of a letter. It is given to our readers (with the consent of its author) in the belief that its sincerity and earnestness make it valuable as showing the viewpoint of the "other side"—of a member of that most interesting (and rapidly decreasing) class—the American "allround machinist."—THE EDITORS.

AS an American who wishes that the very best in every sense of the word may befall his native land, I feel impelled to comment upon Dr. Louis Bell's article entitled "Wake Up, America," which appeared in THE ENGINEERING MAGAZINE for September, 1906, and has interested me greatly.

My views, I believe, are the same in substance as those of the average working man. I am 54 years of age and have three sons. We are connected on all sides with the old New England stock. A nephew is treasurer of one of the largest plants in New England, a brother-in-law is the head of another important concern. My father was foreman of one of the largest New England foundries. I was born, so to speak, in a foundry, and worked in one from the time I left school at 16 years of age until I was 23. I feel, therefore, that I have some idea of what I am writing about.

For a number of years past, employers in the iron trade in our part of the country have hired apprentices at 65 to 85 cents a day for the first year, "to learn the trade"; instead of taking an interest in these lads and teaching them a trade, they have put them on one class of work and kept them at it, relying upon foreign workmen for their skilled labor. They are thereby taking all ambition out of our native boys, who soon lose any interest in their trade. In the old days there was ambition among apprentices to see who could do the best work. I used to stay many a night after all had gone home to practice on some difficult pattern.

Nowadays the apprentice does not stay his time out except in rare cases. The environment in the foundry and in the machine shop is such that he soon reaches the conviction that he has been and is being unfairly treated. He becomes discouraged, throws up his job, and grows up without a trade. Thus a great many bright men who would become skilled are lost to the industry; foreign workers take their places, bringing with them their labor-union ideas; when they think the time is ripe, they try and squeeze the manufacturer by strikes, etc., and so the employer reaps what he has sown.

In the old days the manufacturer was satisfied to get a fair percentage on capital invested. He looked upon his help as being next to his own children in his regard. He took an active interest in their moral and spiritual welfare. Well do I remember that when I had lung fever in 1875, William O. Grover of the firm of Grover & Baker, sewing-machine manufacturers of Boston, came to see me every day, bringing flowers or some dish that I could eat—also the surprise I had on returning to work to receive pay for all the time that I was away sick. Yet I was only one out of 1,200 men in his shop.

There was no talk of unions in those days. Nowadays it seems as though the average manufacturer is interested in his help only to get all he can out of them; they are not of as much value to him or to the city or town he lives in as a piece of machinery in his shop; it costs money to buy a machine.

I do not belong to any union or labor society, and I believe labor and capital should go hand in hand. Each has its rights, and should be respected in them. But before there is real rest and peace in the labor world the manufacturer must take the first step. The workman in the average I believe is intelligent. He has an idea how much the railroads of the United States cost, for how much they are bonded, and how much their stock is watered. He has an idea also of the amount of water in corporation and industrial stocks. He believes that he is the real tax payer and he sees the load on his back growing larger each year with no relief in sight.

Personally, I believe that inflated corporations should be compelled to reduce their capital stock out of dividends, setting aside 1 per cent or one-half of 1 per cent annually to redeem and retire the excess capitalization until the capital is reduced to a just valuation.

As mentioned already, I have three sons. They all ranked very high in manual training at school. I prepared them all for the machinists' trade, but they all refused to learn it. The eldest is with one of the great Connecticut shops as draftsman. The second is an engineer on the Boston and Maine Railroad. The third is learning dentistry. His experience, if I may be allowed to give it, is perhaps typical. He graduated from the manual-training department of the high school a year ago. His instructor there wished him to go into a sculptor's studio to study. I had educated him for the machinists' trade and could not afford to pay his way in art; so I told him to look around for a month or two and pick out the shop where he would like to work. He went to a large number of New England shops, but after his manual-training course and three summers in the drafting department of the concern where his brother is employed, none of them would offer him a better wage than 65 to 85 cents a day. I should make an exception in favor of the large concern just referred to. They offered him a place at $1.40 a day. About this time a dentist who had heard that my son was looking for work wrote me, saying that he wanted a good bright boy to learn his work and offering to pay him $5 a week for the first six months; he actually raised the pay to $6.50 a week for the last three months of this period.

My point is that after all the expense I was at in educating the boy, the manufacturers to whom he went regarded him as a greenhorn, or else to them one boy is just as good as another. The city is which I live has been trying for some time to start an industrial school under municipal and State auspices. Our mechanics as a rule are opposed to it on the ground that they will have to bear the expense of the school and that of sending their boys to it. I have heard some of them say that if the manufacturers will set a fair price which they are willing to pay the graduates of the industrial school, the opposition may be withdrawn.

The manufacturers today all belong to one or more associations for mutual interest. They employ the best legal talent and advice. The workman has no one to look after his interests. I count the walking delegate less than nothing; he only makes bad matters worse. The laborer is sure of nothing. He can only say "I worked today." He knows not of tomorrow. Industrial managers can and do water their stocks; the mechanic can not water his labor. As a workman I claim that I should have some share of profit in our modern expansion, but the cheap labor of the world confronts me on every side so that I must work for the same pay whether times are good or bad. The policy of the day is expansion, contraction, and explosion. How many times can this take place before there will be a revolution? Are we not, with all our boast of greatness, approaching the state of affairs that existed in Rome at the beginning of her decline?

I have told my boys that if labor and capital ever get into trouble they should stay in their houses and mind their own affairs, but if the United States is ever in difficulty they shall take up arms for their country. My forefathers fought against King Philip. There were seventy-nine enlistments of my name from Massachusetts alone in the American Revolution. In every war the blood of my family has been shed. There are no more loyal people than mine—but between labor and capital we will be neutral.

EDITORIAL COMMENT

The Quebec Bridge.

A SUMMARY of the report of the Royal Commission of inquiry into the Quebec bridge disaster is given elsewhere in these pages. In this definition of the objects which the commission set for themselves and in their findings—and far more clearly yet in the full report—will be found an inspiring example of the complete fulfilment of a great responsibility. In realization of the scope of the question, firmness of grasp of all its elements, and convincing justice of its pronouncements, the document has every quality of the strongest judicial decisions in their best form.

Fundamentally, the cause of the disaster was precisely that we defined editorially in our November issue—"the great vision by which vast engineering work has heretofore been carried safely into the region where 'accepted formula' must be carried forward and enlarged, was lacking." The commission metes out individual blame impartially. It lies heavy enough on some shoulders; but it appears, after all, that the failure or the insufficiency lay in the capacity of certain engineers—not, as some of our contemporaries hastily declared, in the capacity of engineering—to solve triumphantly the problems that were here involved.

Efficiency and Economy.

WHATEVER difference of opinion there may be as to the extent to which the recent business disturbance was the result of extravagance, there is very general accord in the conviction that one of its best fruits will be a widespread betterment of economy. If so, the gain may be cheap even at the price. And by "economy" we are as far as possible from meaning mere retrenchment — contraction — clinging to the dollar that circulation brings within our grasp, and faint-hearted retreat from the normal, sensible promotion of sound business. That sort of "saving" is the worst and most irreparable of waste, for it sacrifices forever the two assets that can never be replaced—time and opportunity. It is the child of panic and it begets its like.

Economy is rather the fuller use of the time and money disbursements so that the largest useful product may be returned. It leads not to contraction, but to expansion, for its immediate result is the cheapening of product, the widening of markets, the stimulus to constantly increasing consumption. It is this greater care to make the returns commensurate with the outlay that is being impressed upon both labor and capital by the tension of existing conditions. Workmen realize that when the payroll becomes an object of anxious study, the most efficient employee is the surest to keep his job. Managers find that when orders must be sought with diligence, instead of turned away from already overflowing doors, it is imperative to improve their organization and methods so as to compete with the keenest and most skilful rivals. "Economy and Efficiency" will be the watchword for months to come. With all our progress in manufacturing, the beginning is scarcely yet made in attainment along these lines. THE ENGINEERING MAGAZINE during the summer and autumn will present some of the most important and fruitful studies yet published in this field, embodying the system and practice of the ablest specialists in shop management and reorganization. Definite announcement will follow.

State and Federal Canal Work.

BARGE Canal Bulletin No. 1, lately issued by the department of the State engineer and surveyor under the authority of Frederick Skene, the present occupant of the office, is a very interesting and well prepared summary of the progress of the work to February 1, 1908, both in total and by the separate contracts in detail. The introductory comparison between the home undertaking and the Isthmian Canal, in point of excavation so far accomplished, may help to correct the false perspective in which the two enterprises appear to many persons who have not examined the figures. Work at Panama under American occupation began in May, 1904, and that on the barge canal in May, 1905. The latter is hence just one year behind in headway. For the first three complete years the relative progress in excavation shows very favorably for the State enterprise, as may be seen in the figures below given in cubic yards:

	Panama	Barge
First year's work....	243,472	716,676
Second " "	1,799,227	1,460,705
Third " "	4,948,497	4,500,459

The point is made that the climatic difficulties at Panama are offset by the winter interruption in New York State, the work here being greatly impeded or entirely suspended during four or five months; also, that the work of excavation represents much more nearly the total accomplishment at Panama than at home; of the Barge canal it makes but 40 per cent. of the undertaking, the remainder being taken up in the many structures.

In energetic execution and successful accomplishment the result is a tribute to the direction of the State engineering force. There is a striking contrast, however, between the quiet with which this work has gone on near by, under ordinary contract allotment, and the public turmoil over the Federal organization. There is also a strong suggestion that in proportion to the expenditure involved, the Barge canal has been considered very inadequately as to its economic or commercial desirability—that is, if the preliminary studies at Panama are any criterion at all of the care with which a question of such magnitude should be examined.

Acetylene and Forestry.

THE gain made by acetylene lighting in the confidence of insurers is shown by the modification of the National Board of Underwriters' rule touching the installation of generators. Formerly installation within an insured building was prohibited, although the rule was not always nor everywhere enforced. By an amendment adopted at a recent executive committee meeting, this provision is modified so as to read that "generators, especially in closely built up districts, should preferably be placed outside of insured buildings in generator houses constructed and located in compliance with" the Board's specifications elsewhere expressed. This of course changes the outside installation from a requirement to a recommendation.

It is believed that the ruling will be of benefit particularly to the better class of manufacturers and apparatus, and therefore to the more substantial advance of the industry. If only the manufacture of the illuminant could be made independent of the wholesale destruction of timber with which it is now evilly associated, its progress might be welcomed with unalloyed cordiality. It should appeal to the commercial organizers of the industry, who have shown such fair-mindedness and far-sightedness in their acceptance of the suggestions of the insurance engineers, to lend their best aid to the wise protection of the forest growth upon which they are, at present at least, vitally dependent. It would be a violent ill-balance of judgment to lay broad foundations for a business to grow through decades, and yet to take no thought of the preservation of its necessary raw material, which (if our best foresters are to be believed) is within a comparatively few years of exhaustion.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE HYGIENE OF WORK IN COMPRESSED AIR.

THE PHYSIOLOGICAL EFFECTS OF HIGH AIR PRESSURE ON MAN AND PRACTICAL MEANS OF PREVENTING CAISSON DISEASE.

Dr. J. S. Haldane—Royal Society of Arts.

THE first of the Royal Society of Arts' series of lectures on industrial hygiene, delivered by Dr. J. S. Haldane on November 29, 1907, dealt with the hygiene of work in compressed air. The dangers attending work under high air pressures are well known, but the physiological causes which lead to the dreaded caisson disease are not generally understood. The following brief abstract of Dr. Haldane's very thorough discussion of the subject should be of interest.

After outlining briefly the applications and methods of use of compressed air in diving, caisson and tunnel work, Dr. Haldane proceeded to discuss the difficulties and dangers of work under high pressures.

"One of the first things usually observed by a man going into compressed air, or a diver descending, is a sense of pressure and discomfort in the ears. This may rapidly increase to acute pain. It is due to the fact that the middle ear is an air-cavity communicating only by a very narrow passage (the Eustachian tube) with the back of the nose. If the Eustachian tube does not admit air freely the air-pressure in the middle ear becomes less than outside. As a consequence the membrane of the drum of the ear is pressed inwards, and the blood vessels of the wall of the middle ear are distended, so that either rupture of the membrane or bleeding is apt to occur, with resulting temporary impairment of hearing or inflammation, and occasional permanent effects.

"Different persons vary greatly as regards the readiness with which their Eustachian tubes allow air to pass and a cold in the head will often cause an almost complete blockage. By a peculiar swallowing movement at the back of the mouth it is, however, usually possible to open the Eustachian tube, and men accustomed to compressed air can do this without difficulty, and thus avoid all discomfort. A diver descending will naturally stop if he feels his ears uncomfortable. In an air-lock, on the other hand, the inlet tap is not usually under the direct control of the man whose ears are hurting him; and, as a consequence, there may be great risk of ear trouble. Besides the middle ear, there are other air-filled cavities, communicating by narrow openings with the nose cavity; and these also may give trouble if the openings are blocked. During decompression there is much less chance of trouble from this cause, unless the decompression is carried on at a very rapid rate."

To avoid risk of injury to the ears the rise or fall of pressure in the air lock must be regulated according to individual susceptibility. Skilled divers and men accustomed to caisson work can bear a pressure rise of an atmosphere per minute or even less time, but new hands require a much slower rate. In some cases no reasonable rate is sufficiently slow and a person suffering under very slow compression must be excluded from the work. In any case it is desirable that the air inlet should be so regulated as to prevent a very sudden rise of pressure. The maximum rate should be about one pound in four seconds and the tap should be capable of instant regulation if any one suffers discomfort.

"A second physiological trouble in connection with work in compressed air is well known to practical divers. It is commonly found that after a depth of 12 to 15 fathoms has been reached, the breathing becomes much oppressed, so that the diver's capacity for work is greatly diminished. With further increase in depth the distress becomes greater and greater. It has usually been attributed to the pressure on the body hindering the breathing."

In 1905 the troubles arising from this cause were investigated by a committee of the Admiralty. It was found that the mere pressure of water or air on the body is not responsible for respiratory distress, but that the CO_2 breathed by the diver is the real cause. Under normal conditions the breathing is always regulated so as to keep the partial pressure of the CO_2 in the lung alveoli or air cells almost exactly constant. Under constant barometric pressure, the air in the lungs of each individual contains an astonishingly constant percentage of CO_2; this percentage varies inversely with the barometric pressure and the pressure exercised by the CO_2 itself is constant. "If CO_2 is present in the air inspired the effect is to make the breathing deeper, and finally also more frequent. Unless, however, the pressure of CO_2 in the inspired air begins to approach the normal alveolar pressure, there is very little change in the alveolar CO_2 pressure, compensation being produced very easily."

In the case of a diver, however, supplied with a constant volume of air, the greater the depth to which he descends and the greater the pressure under which he works, the more nearly the alveolar CO_2 percentage approaches that of the inspired air, with the result of increasing respiratory distress. In order that the diver may work in comfort and safety, therefore, "his minimum air supply must be increased in proportion to the increase in the absolute air pressure; in other words, the volume of air supplied to him, measured at the pressure he is under, must always remain the same.

"In the caissons and tunnels it is also necessary to ensure sufficient ventilation to guard against the ill effects from CO_2. To make the effects of CO_2 practically inappreciable it would be necessary to keep the pressure of CO_2 from rising above 1 per cent. of an atmosphere. Where there is no other source of CO_2 besides the persons present, a minimum ventilation of 300 cubic feet per man and per hour, measured at the existing pressure would suffice for this end if the air were properly distributed. If this pressure were 30 pounds this would correspond to 900 cubic feet, measured at atmospheric pressure. The possibility has to be borne in mind, however, of other sources of CO_2 and other air impurities. If candles are used, or if there is blasting, or decomposition processes are occurring in the mud, there may be present not only more CO_2, but also carbon monoxide, sulphuretted hydrogen and other poisonous gases. As compressed air is expensive, it is important to avoid all unnecessary sources of air impurity so as to render any excessive ventilation unnecessary. The air ought also to be properly cooled before it is delivered as otherwise the working space becomes uncomfortably hot and the work is hindered. . . .

"I now come to what is the most important special risk in connection with work in compressed air. Since the early days of diving it has been well known that after reaching surface divers in deep water are liable to sudden attacks of illness. Sometimes death occurs within a very short time, but paralysis, particularly of the legs and bladder, is much more common, so that the illness received the popular name of 'divers' palsy.' Often the paralysis passes off after a time more or less completely, but it may be permanent or may lead to a lingering fatal illness. Among workers in caissons and tunnels at high air-pressures similar cases of death or paralysis, or attacks of syncope, sometimes occur shortly after the men leave the air-lock in coming out. By far the most common symptoms is, however, an attack of pain in one or other of the limbs, or occasionally elsewhere in the body. These pains are known to the men as 'bends' or 'screws,' probably from the fact that the affected limb is usually bent to ease the pain, and that the pain itself is sometimes so intense as to feel like something being screwed into the affected part: The pains fortunately pass off soon. They usually occur within about an hour of leaving the air-lock. The whole group of symptoms has come to be known under the somewhat unfortunate name of 'caisson disease,' which suggests some sort of chronic malady."

The explanation of these symptoms was made 30 years ago by Paul Bert, a French physiologist, but it is only recently that the value of his work has been fully recognized. The explanation depends upon the fact that when a gas is brought into contact with a liquid, the latter takes up the gas in simple solution until a state of saturation, depending on the "co-efficient of solubility" of gas in the liquid, the temperature of the liquid and the pressure of the gas, is reached. The blood passing through the lungs of the worker in compressed air takes up an increased proportion of nitrogen and oxygen in simple solution. The increased proportion of oxygen adds but slightly to the total oxygen in the blood and it practically all disappears when the blood reaches the tissues. Unlike the oxygen, however, the inert nitrogen does not enter into chemical combination with the tissues and gradually the whole body becomes saturated with nitrogen at the pressure (79 per cent. of the total atmospheric pressure) which this gas exerts in the compressed air. If the excess of air pressure is now rapidly removed, the blood and tissues will for a time be in a condition of super-saturation for the diminished pressure, and the nitrogen will tend to liberate itself within the body in the form of bubbles. Bert concluded that the clogging of the blood vessels in this manner caused the paralysis and other symptoms of caisson disease and his conclusions have been fully confirmed by recent tests on living animals, made under Dr. Haldane's direction, and by post-mortem examinations of men who have died of compressed air illness.

In order to counteract these effects decompression must be slow, but the safe rate has never been accurately determined. The rates used in ordinary practice have proved more or less unsafe when exposure has been long continued in an atmosphere in which the excess of pressure has exceeded one and one-half atmospheres. Recently very extensive investigations have been carried out by the Admiralty on goats and the results of these experiments are summarized by Dr. Haldane. They have had the important result of disproving the theory that decompression should take place at a uniform rate. Practical experience has shown that even with very rapid decompression, no symptoms of caisson disease occur with an absolute pressure of two atmospheres, and symptoms are very rare and slight until the pressure rises above 2.3 atmospheres. It was argued from this fact that, since the volume of gas tending to be liberated would be the same in each case, it would be equally safe to decompress rapidly from six to three or from four to two atmospheres, as from two to one. Experiments with goats have shown that this is the case, and that the danger of rapid decompression depends, not on the absolute difference between the final and initial pressure, but on the proportion between the two.

Dr. Haldane is confirmed in the belief that stage decompression should be used instead of regular decompression. Calculations on the principle mentioned above show that, however slow uniform decompression may be, the difference in partial pressure between the nitrogen dissolved in the tissues and the external air pressure will go on increasing and at the end of the decompression the danger will be at a maximum while the first half of the decompression time is wasted. In stage decompression the worker is brought rapidly to half the absolute pressure, stopped there for a time, and by repeating this process brought finally to atmospheric pressure, the maximum nitrogen pressure in any part of his body never becoming more than twice the nitrogen pressure of the air at the lower stage. The method has been given a trial in diving work and the results have been excellent. Dr. Haldane has no doubt that its proper application in caisson and tunnel work would remove a great part of the danger of compressed air illness and the necessity for the elaborate medical and emergency establishments now such a necessary part of all large works using compressed air.

THE QUEBEC BRIDGE DISASTER.

A SUMMARY OF THE FINDINGS OF THE COMMISSION OF INQUIRY APPOINTED BY THE CANADIAN GOVERNMENT.

Report of the Commission.

AFTER five months of continuous labor on the part of the commissioners, the unanimous report of the Commission of Inquiry on the Quebec Bridge Disaster was presented to the Canadian Parliament on March 9. We present below an outline of the investigations made and a summary of the conclusions reached by the commission, as contained in the introduction to the report:

"In carrying out our instructions we have made the following investigations:

"(a) A study of the history of the Quebec Bridge and Railway Company, the evidence at our disposal being copies of the various public acts concerning it, the minutes of the directors' meetings, the reports of its officials, its annual reports, its correspondence and copies of the agreements and contracts that it has made.

"(b) A perusal of the entire correspondence on file in the offices of the Quebec Bridge Company, the Phoenix Bridge Company and of Mr. Theodore Cooper.

"(c) A study of the working organizations of the Quebec Bridge and Railway Company, the Phoenix Bridge Company and the Phoenix Iron Company. This involved the hearing of a number of witnesses under oath and the examination of the various documents produced by these witnesses on directions of the Commission and filed as exhibits.

"(d) A personal inspection of the furnaces and rolling-mills by which most of the metal that was used in the bridge was produced. The testing equipment at each of the works was examined and the file of the record of tests made by the inspectors during production was gone over.

"(e)) A study of the methods used in the fabrication, transportation and erection of the bridge. This consisted of inspection of the shops of the Phoenix Iron Company, in which all the metal was fabricated, and an examination of the plans, records, correspondence and photographs on file in the office of the Phoenix Bridge Company. The fabricated material for the north half of the bridge was also inspected and check measurements were taken to determine certain questions of workmanship.

"(f) A study of the errors in workmanship detected by the several inspectors during the progress of the work, the evidence available being the record books kept by the shop inspectors for the Phoenix Bridge Company and for the Quebec Bridge and Railway Company, the 'field corrections' sent by the Phoenix Bridge Company's resident engineer to the erection department of that company, and the weekly reports made by the inspector of erection for the Quebec Bridge Company to the consulting engineer.

"(g) An inquiry into the history of the erection of the bridge. This inquiry was made by obtaining direct evidence from witnesses under oath and by tracing out through records and correspondence the details of all the major difficulties that had occurred in the course of construction.

"(h) An endeavor to obtain from eyewitnesses of the disaster all the details concerning it. Some twenty-five witnesses were examined for this purpose.

"(i) An examination of the meteorological records of the day of the accident and for some time previous. The records of the observatory at Quebec and those kept by the Phoenix Bridge Company's staff were available for this purpose.

"(j) A personal examination of the fallen structure made at different times and occupying several days, together with such surveys, check measurements and photographs as were considered necessary.

"(k) A study of the methods adopted in the design of the bridge. This study required an inspection of the drafting office of the Phoenix Bridge Company, and an examination of the mass of preliminary and final designs on file there. The sworn statements of all the senior engineers formed an important part of the inquiry.

"(l) A checking of the stress sheets prepared in the offices of the Phoenix Bridge Company by comparison with results obtained by Mr. C. C. Schneider, consulting engineer, who was employed subsequent to the disaster, by the Department of Railways and Canals, to report to it on the design of the bridge.

"(m) A comparison of the organization and specifications used for the Quebec Bridge with those used for existing great cantilever bridges on this continent.

"(n) A replotting of the records of tests made on full-sized compression members and a comparison of the design for the principal compression chords of the Quebec Bridge, with similar designs for other great cantilevers. In this connection special tests were made both by the Phoenix Bridge Co. and by the Commission, the details of which are given.

"(o) A study of the theory of compression members, standard books, transactions of technical societies and professional journals being consulted. The purpose of this part of the inquiry was to determine how thoroughly the designers of the Bridge availed themselves of the professional knowledge at their disposal."

In the summing up of the investigation, the report says:

"Your Commissioners find:

"(a) The collapse of the Quebec Bridge resulted from the failure of the lower chords in the achor arm near the main pier. The failure of these chords was due to their defective design.

"(b) The stresses that caused the failure were not due to abnormal weather conditions or accident, but were such as might be expected in the regular course of erection.

"(c) The design of the chords that failed was made by Mr. P. L. Szlapka, the Designing Engineer of the Phoenix Bridge Company.

"(d) The design was examined and officially approved by Mr. Theodore Cooper, Consulting Engineer of the Quebec Bridge and Railway Company.

"(e) The failure cannot be attributed directly to any cause other than errors in judgment on the part of these two engineers.

"(f) These errors of judgment cannot be attributed either to lack of common professional knowledge, to neglect of duty, or to a desire to economize. The ability of the two engineers was tried in one of the most difficult professional problems of the day and proved to be insufficient.

"(g) We do not consider that the specifications for the work were satisfactory or sufficient, the unit stresses in particular being higher than any established by past practice. The specifications were accepted without protest by all interested.

"(h) A grave error was made in assuming the dead load of the calculations at too low a value and not afterwards revising this assumption. This error was of sufficient magnitude to have required the condemnation of the bridge even if the details of the lower chords had been of sufficient strength because, if the bridge had been completed as designed, the actual stresses would have been considerably greater than those permitted by the specifications. This erroneous assumption was made by Mr. Szlapka and accepted by Mr. Cooper and tended to hasten the disaster.

"(i) We do not believe that the fall of the bridge could have been prevented by any action that might have been taken after August 27, 1907. Any effort to brace or take down the structure would have been impracticable owing to the manifest risk of human life involved.

"(j) The loss of life on August 29, 1907, might have been prevented by the exercise of better judgment on the part of those in responsible charge of the work for the Quebec Bridge and Railway Company and for the Phoenix Bridge Company.

"(k) The failure on the part of the Quebec Bridge and Railway Company to appoint an experienced bridge engineer to the position of chief engineer was a mistake. This resulted in a loose and inefficient supervision of all parts of the work on the part of the Quebec Bridge and Railway Company.

"(l) The work done by the Phoenix Bridge Company in making the detail drawings and in planning and carrying out the erection, and by the Phoenix Iron Company in fabricating the material was good and the steel used was of good quality. The serious defects were fundamental errors in design.

"(m) No one connected with the general designing fully appreciated the magnitude of the work nor the insufficiency of the data upon which they were depending. The special experimental studies and investigations that were required to confirm the judgment of the designers were not made.

"(n) The professional knowledge of the present day concerning the action of steel columns under load is not sufficient to enable engineers to economically design such structures as the Quebec Bridge. A bridge of the adopted span that will unquestionably be safe can be built, but in the present state of professional knowledge a considerably larger amount of metal would have to be used than might be required if our knowledge were more exact.

"(o) The professional record of Mr. Cooper was such that his selection for the authoritative position that he occupied was warranted and the complete confidence that was placed in his judgment by the officials of the Dominion Government, the Quebec Bridge and Railway Company, and the Phoenix Bridge Company, was deserved."

APPRÓXIMATE ESTIMATES IN CONTRACT WORK.

A DISCUSSION OF THE NECESSITY FOR THE ESTABLISHMENT OF A FIXED STANDARD OF APPROXIMATION FOR THE PROTECTION OF BOTH PARTIES.

Alexander Potter—Ohio Engineering Society.

THE approximate estimates on which bids on contract work are asked have probably given rise to more trouble and litigation between engineers and contractors than any other element in the specifications. When the estimates of the work to be done are truly approximate, that is very close to the actual amount, they serve a very useful purpose in affording a fairly accurate basis for the comparison of unit-price bids; but the uncertainties of estimation in some classes of work are so great that, besides leading to misunderstandings between the two parties to the contract, the estimates given as approximate in the specifications often defeat their own purpose in leading to the selection of a bid which would not have been the lowest had the competition been based on accurate figures. In a paper read recently before the Ohio Engineering Society, reprinted in *The Engineering Record* for February 22, Mr. Alexander Potter suggests that, for the protection of both parties to the contract, the unit prices bid on the estimates should not prevail when the quantities actually involved in the work vary from the approximation by a certain fixed percentage made a part of the contract. The following extracts give an outline of Mr. Potter's argument.

"The powers and responsibilities conferred upon an engineer in connection with public work are often vastly greater than even the engineers themselves believe or realize to be the case. The importance of setting before the contractor proper and accurate data and estimates is something the engineer must not lightly consider. If the engineer has any thought that the specifications and estimates do not represent the actual future conditions, clauses should be inserted in the contract that will give the contractor the right to demand that, for unreasonable discrepancies, the work shall be paid for at cost plus a reasonable margin of profit. This may to a certain extent suggest an innovation in the manner of letting contracts, but I believe that it is the only fair and just thing to do and will in the end save not only trouble and litigation, but be a financial saving to the communities or companies adopting it.

"Under the average specifications the engineer is not only a court of last resort and final arbitration, with powers of final decision specifically delegated to him, but he is also in reality the attorney for the defense, for the reason that he has either himself prepared all the important and vital clauses of the contract and specifications, or has inserted them from contracts which other engineers have previously prepared. It is customary for the legal representatives of the city or company letting the contract to have little to do with the preparation of technical contracts and specifications for construction work, merely passing upon the correctness of their legal form, and not at all upon their subject matter and requirements.

"The engineer is also practically a defendant in matters of dispute arising between his employer and the contractor, because it is upon the correctness of his estimates that the work is based. On this account the tendency is very strong and the temptation very great for the engineer to endeavor to make good his estimates by minimizing as much as possible the difficulties met in the construction of the work by endeavoring to force the performance of work which had clearly never entered into the mind of the engineer or the contractor when the contract was signed. Had it been foreseen the contractor would never have taken the contract under the conditions specified, and the engineer, had he known of such conditions being present, should have forewarned the contractor or given notice of them in his approximate quantities.

"Contracts written with double or uncertain meanings, evasive clauses, or unjust and arbitrary assumptions of power, in the end bring no credit upon the engineer who writes them, nor profit to the corporation in whose favor they are enforced. There are of course allowable and unavoidable variations in contracts and approximate estimates.

"In the fabrication of steel, in the manufacture of machinery, and in the erection of the superstructures of buildings, there are but few and minor elements of chance which would interfere with a contractor giving such an intelligent bid that, provided his bid is a balanced bid, no harm can come either to the city or corporation or to himself by reason of a large discrepancy between the approximate estimate advertised and the amount of work which the contractor is called upon to actually perform, saving only the fluctuation in the price of labor and materials. But in all work involving the uncertainties of excavation of any sort, whether it be in earth, quicksand, or rock, such as is encountered in the construction of reservoirs and dams, water-works, sewers, railroads, canals, docks, or deep foundations, the actual cost of the work may differ very materially from what either the engineer or the contractor assumed the work would cost when the contract was entered into. The actual cost of removing earth and rock is in many cases from 50 to 200 per cent. greater than the engineer deemed at the time to be fair unit prices for such work. In other cases the actual cost of performance of work has often proved to be from 50 to 75 per cent. less than the price bid upon the work, which price was based upon the best information available to the contractor at the time the bid was prepared.

"Often, as the work advances, the actual conditions develop a state of things which proves that the information given in the first instance was entirely misleading. On this class of work, therefore, it is seen how important it is to have the approximate estimate of quantities approach the actual quantities which are to be required to be done as closely as possible, for if on the one hand the contractor has been led to believe that there is a certain amount of material to be handled and he is being greatly overpaid for the work performed, it is not fair to the city or corporation for which the work is being done, that it should be compelled to pay such excessive prices upon an amount greatly in excess of the advertised quantities and on which the contractor estimated his profits. While on the other hand, if the contractor has agreed to the performance of work at a price which is grossly inadequate, under the honest misapprehension of conditions, it is unfair, under the omnibus clause in the contract providing for variations, additions, and changes, to compel him to perform work greatly in excess of the quantities upon which he was willing to risk his judgment and his capital as to the value of work.

"The limiting of the words 'approximate estimate' to mean a quantity within a reasonable percentage above or below the amounts called for will tend to much more intelligent bidding, and also to the eradication and elimination of much of the trouble and litigation now occupying the courts of this country, due to the involuntary fraud upon or on the part of cities permitting or compelling contractors to perform work at absurdly high or absurdly low prices upon amounts which neither the engineer nor the contractor dreamed he would be called upon to perform at the time of the signing of the contract.

"There should be no difficulty in inserting clauses in specifications providing that when the approximate estimate shall have been exceeded by a certain predetermined percentage, the unit prices bid upon the work shall no longer prevail, but that the balance of the work shall be performed at cost to the contractor plus a reasonable percentage for profit on labor and material.

"Under the ordinary form of contracts the engineer is now empowered to make any such changes as he may see fit in the work. In other words, he is given such extraordinary powers of control over the contractor, that the contractor can hardly object to having delegated to the engineer the determination of what this extra cost shall be; and the city or corporation having already placed in the hands of the engineer the responsibility of conducting its work, should have no objection to vesting him with this small additional power. The writer can conceive of no difficulties arising from such a restrictive clause as that mentioned, but believes that in the end the adjustment of all inequalities under the contract, and provisions for settling them would tend to lower the cost of contract work generally."

THE CORROSION OF STEEL.

AN EXPLANATION OF THE ELECTROLYTIC THEORY OF THE CAUSES OF CORROSION IN IRON AND STEEL.

Allerton S. Cushman—Journal of the Franklin Institute.

VARIOUS theories to account for the corrosion of iron have been put forward from time to time, but the weight of evidence seems to be strongly in favor of the most recent, the electrolytic theory, which is coming to be generally accepted. The experimental investigations on which the theory is based and its explanation of the phenomena of iron rusting are so comprehensive as to make its satisfactory presentation in short form a difficult matter. In the *Journal of the Franklin Institute* for February, however, Dr. Allerton S. Cushman, whose experimental work in the Department of Agriculture has contributed so largely to the formulation and verification of the theory, has presented in a short space a very clear and interesting outline of its main points, which we reproduce in abstract below.

Chemically speaking, structural iron or steel is not a standard substance, but varies in composition and in character. Absolutely pure iron has but a limited application in industry and the properties sought in the structural material are produced by the presence of other elements. The extent of the changes made in the chemical and physical properties of iron by the addition of even very small amounts of impurities is one of its most remarkable characteristics. A variation of a few tenths of one per cent. of carbon or a few hundredths of one per cent. of phosphorus may make all the difference between the suitability and uselessness of a steel for a given purpose. Sulphur, silicon, and manganese are other elements whose presence in extremely small amounts produce important differences in character.

Resistance to corrosion is one of the most variable characteristics of steel. Not only do the various kinds of merchant iron vary within wide limits in this regard but specimens from the same mill or furnace will often show great differences. The prevention of corrosion is of the greatest importance to the engineer and architect. Owing to the affinity of iron for oxygen absolutely unrustable steel is probably impossible of production but with a proper knowledge of its causes, the danger of serious corrosion may be removed during the processes of manufacture.

The electrolytic theory of the corrosion of iron is the one now most generally accepted. In modern chemical theory all reactions which take place in water are attended by certain readjustments of the electrical states of the reacting particles which are called ions. Under the atomic theory the molecules of compound substances are made of atoms held together by a force or forces which represent large amounts of energy. Some substances when dissolved in water will conduct electricity while others will not. The former are called electrolytes and include inorganic acids, alkalies and salts. The latter substances or non-electrolytes, are for the most part inorganic bodies. According to Arrhenius' theory of electrolytic dissociation, the molecules of electrolytes as they pass into solution in water, dissociate into ions, which are simply atoms carrying, in spite of the smallness of their mass, very heavy charges of electricity. That no energy may be lost or gained, the dissociation must produce both positive and negative ions, which are equivalent and opposite.

To illustrate this theory of solution the case of sodium chloride or common salt is taken. When salt is mixed with water it tends to go into solution owing to a force known as solution pressure. As solution goes on a back pressure, known as osmotic pressure is exerted, which to a constantly increasing extent resists the entrance of more molecules, and the solution process ceases when the solution pressure and the osmotic pressure are in equilibrium. In passing into solution the salt dissociates into its constituent sodium and chlorine ions carrying equal and opposite charges of static electricity. Osmotic pressure acts against the dissociation pressure also and in concentrated solutions an equilibrium is established between these two forces as well.

This solution theory offers the explanation of the rusting of iron. It is well known that if an iron plate is immersed in a solution of a copper salt, iron goes into solution and copper is deposited on the iron, on account of the fact that the solution pressure of the iron is greater than that of the copper ions. A similar reaction occurs when iron is immersed in pure water. Even the purest water is to a certain extent dissociated and contains positive hydrogen and negative hydroxyl ions. Hydrogen acts as a metal, and since it has a solution pressure slightly less than that of iron, the latter passes into solution in exchange with the hydrogen.

"It has been shown experimentally that iron cannot at ordinary temperature combine with oxygen unless the iron first passes into solution and it is apparent from this that the initial cause of rusting is not oxygen, but hydrogen bearing a static electrical charge, in other words, the hydrogen ion. Now all acids derive their character from the fact that they dissociate in solution with the production of hydrogen ions, and this is the reason why all acids stimulate the corrosion of iron. On the other hand, alkalies dissociate in solution with the production of hydroxyl ions, which by the reverse action already explained neutralize and remove the hydrogen ions and thus inhibit rusting.

"It is well known to engineers that sulphurous acid, as well as carbonic acid, from coal smoke produces rapid destruction of steel, whereas alkaline cements, mortars, and concretes will preserve steel imbedded in them so long as the reaction remains sufficiently alkaline. The only cases recorded in which steel is said to have corroded when imbedded in concrete, are those where percolating water under pressure has washed away the free lime and thus removed the alkaline reaction."

The role of oxygen, however, though secondary, is important. Iron exists in combination with oxygen in two states, the state of lower oxydization being called ferrous, and the higher, ferric. Oxygen always changes ferrous to ferric compounds. When the iron, therefore, appears in solution in the ferrous state, it is at once attacked by the oxygen of the air and precipitated at the point of attack as the insoluble hydrated ferric oxide known as rust. By this precipitation the iron ions are destroyed and removed from the solution and the consequent lowering of the osmotic pressure permits the formation of more iron ions to take the place of those precipitated.

As rusting proceeds the solution of the iron does not take place uniformly over the exposed surface but is stimulated at certain points and inhibited at others. This can be explained in only one way, namely, that local electrolysis is taking place. The effects of this direct local electrolysis are to be seen in the pitting which is almost always observed when iron and steel are deeply rusted. Experiment has proved that corrosion is always due to this local electrolysis on the surface of the metal itself with the establishment of positive or negative spots or areas. It is from the recognition of this fact that we may look for the improvement of conditions as they exist at present.

"It follows from what has been said that the more carefully lack of homogeneity and bad segregation are guarded against during the process of manufacture the less likely is the metal to suffer from rapid corrosion. If the iron contains metallic impurities dissolved in it, such as manganese, which differ electrochemically from iron, trouble is sure to ensue if there is a lack of homogeneity in the distribution of the impurity. In the old days when the iron was made more slowly and received more careful working than is possible than in the present day, corrosion was not the important problem it has since become.

"It would follow from the electrolytic theory that in order to have the highest resistance to corrosion a metal should either be as free as possible from certain impurities or should be by careful working and heat treatment rendered so homogeneous as not to retain localized positive and negative nodes for a long time without change.

"Manganese is an element which is almost always associated in modern metallurgy with iron and steel owing to the fact that this element is used as a flux in the great processes used to-day for changing cast iron into steel. Manganese however, increases the electrical resistance of iron and as the percentage of this element, starting from zero, rises, the electrical resistance of the metal increases up to a certain specific maximum. Now, you will see, if the dissolving of manganese in iron raises the electrical resistance, that any changes in the equilibrium or distribution of the manganese in the metal means that there will not be an even or homogeneous electrical conductivity throughout the mass.

"If we have a metal in which the electrical conductivity for any reason varies from point to point on the surface we have the precise conditions which are necessary in order to establish the local nodes of electrolytic action on the surface which lead to rapid corrosion. It is apparent, therefore, that if we are to allow the presence in structural steel of comparatively high percentages of metallic impurities, such as manganese, we must attempt to obtain an extremely homogeneous distribution of such impurities. It is for this reason principally, in the opinion of the writer, that the more quickly and more carelessly the metal is manufactured and rolled, the more quickly it disintegrates under corrosive influences. As has been pointed out before, there are two methods of meeting the problem: first, to keep the percentage of metallic impurities as low as possible, and secondly, to guard against segregation and imperfect chemical homogeneity in the metal. In experiments we have made looking to the manufacture of a corrugated steel culvert for use in road building, it has been found by the author that corrugated metal, running as low as .04 manganese, has been more resistant to the corrosive test employed than the ordinary steel of the day, which usually carries about .5 per cent. manganese. Material of this kind has not been available for a sufficient length of time to determine whether under service conditions this low manganese metal will be longer lived, but it can safely be stated that the indications are all in its favor.

"The writer has urged the manufacture of manganese-free steel for certain purposes, not because manganese is necessarily the cause of rapid corrosion, but because this impurity enables the metal to be rolled more easily and more cheaply, and in many cases permits the working in of large amounts of heterogeneous scrap. It is possible to manufacture shoddy steel as well as shoddy cloth, and though both of these materials have their legitimate uses for certain purposes, no one will claim for them high resistance to disintegrating influences. It is a hopeful sign of the times that manufacturers are beginning to pay serious attention to the manufacure of iron and steel for certain purposes which shall be to the highest possible degree rust proof.

"In conclusion it may be said that there is reason to hope that the time is not far distant when specifications may be drawn for material that is going into service under conditions which make it particularly subject to corrosive influences. The possible added cost of such specially resistant metal will be small in comparison to the benefits which will be derived from its use in the long run."

THE DESTRUCTION OF TAR IN GAS PRODUCERS.

A DISCUSSION OF THE EFFICIENCY AND PRACTICABILITY OF THE VARIOUS POSSIBLE METHODS.

H. P. Bell—Engineering.

ONE of the most important problems in connection with the extension of the application of gas power is the development of a bituminous producer which will supply gas free from tar. It has been stated recently in a contribution to this magazine that the bituminous producer working in conjunction with an elaborate gas-cleaning plant will give satisfactory service, but the considerable cost and the necessity for careful supervision of such an installation will undoubtedly prevent the general adoption of bituminous coal for gas production so long as supplies of anthracite are available for use in the more simple suction producer. The subject of bituminous producers which will, in themselves, destroy the tar produced was discussed comprehensively by Mr. H. P. Bell in *Engineering* for January 31 and February 7, 1908. We have space in this brief abstract to present only the more important of Mr. Bell's comments on the elements of the problem and the principles on which it must be solved, without touching his extended review of the various producers which have been designed or suggested as likely to fulfil the requirements of the problem.

The advantages of bituminous coal over anthracite or coke include not only its cheapness and the wide area over which it can be obtained but also the enrichment of the gas by its volatile constituents. These latter vary considerably both in quality and quantity, but in general it may be said that the calorific value of the gaseous hydrocarbons distilled from bituminous coal is about 20 per cent. of the total calorific value of the coal. While the total quantity of heat in the gas produced from bituminous coal may be no greater than that from a similar quantity of anthracite or coke, this heat is carried in a smaller volume of gas, a consideration which is, in many cases, of considerable importance. In fact the use of bituminous coal should result in increased economy in gas making, since the distilled gas is produced with a less expenditure of heat than the gas from an equivalent quantity of carbon. The aim of designers of bituminous producer plants should be either to produce a richer gas with no decrease in economy, or an increased economy with no loss in calorific value. In the future, producer gas will have to make its way chiefly as a gas made from bituminous fuel.

Most of the difficulties in bituminous producer operation have been solved more or less successfully in connection with anthracite producers. The distinctive feature of bituminous coal, the large quantity of tar carried over with the gas, however, presents a new problem and one of considerable difficulty. This tar frequently amounts to 4 or 5 per cent., and may reach 15 per cent., of the coal. Its separation from the gas before the latter reaches the engine cylinder is a matter of necessity and the size and cost of the plant for the efficient cleaning of the gas have been the principal deterrent causes of the slow extension of the use of the bituminous producer. The problem of tar destruction, however, differs from that of gas cleaning.

"There are two practicable methods by which tar may be destroyed: complete combustion with air, and decomposition at a high temperature. In the first case, that of complete combustion, the products—carbonic acid and water vapour—must, for the sake of economy, be reduced to carbon monoxide and hydrogen by passing them over hot coke. In the second case the tarry vapours are passed directly over hot coke, or through heated regenerators, and are thereby broken up into, on the one hand, gases such as marsh gas, ethylene, etc., with carbon monoxide and hydrogen; on the other hand, into heavy hydrocarbons and carbon. The heavy hydrocarbons are for the most part burnt with the coke, so that the general statement is approximately true, that the tarry vapours are decomposed into fixed gases and carbon.

"In favour of the first method it has been urged, on the one hand, that it is only by combustion that the tar can be completely destroyed, but this involves the separation of the whole of the tarry vapours, which is hardly possible, since even gas made from coke contains tar. On the other hand, this method must result in impoverishing the producer gas, since the volatile gases of the coal are burnt with the tarry vapours; so that with a really efficient plant working on this principle the final gas will consist only of carbon monoxide, hydrogen, and nitrogen, just as if the gas were made from entirely non-bituminous fuel. This method, then, while it may go far towards overcoming the defects, takes no advantage of the merits of bituminous fuel. The second method preserves most of the valuable distilled gases, and consequently yields a richer gas, even if the destruction of tar is less perfect. In any case complete destruction of tar is hardly practicable even under experimental conditions; some kind of cleaning plant will always be required—at any rate, if the gas is to be used in internal-combustion engines, and the most that can be looked for is a reduction of this plant to the smallest possible dimensions.

"In both methods the gases or vapours are passed through hot coke, and it is therefore necessary to provide for the maintenance of a temperature high enough to effect the required chemical actions, and of a column of coke long enough to make these actions complete. If, as is usually the case, the temperature is maintained by mixing air with the gases as they pass through the coke, some combustion of the gases with the air will occur; the desired reduction will only go as far as a point of equilibrium, depending on the proportion of air present, and the resulting gas will contain more or less carbonic acid and water-vapour due to this combustion. It is therefore desirable to keep as low as possible the quantity of air which is allowed to come in contact with the hot gases."

Mr. Bell then proceeds to a description and discussion of the construction and operation of the many producers which have been designed with a view to the destruction of tar, grouping them roughly according to their arrangement and manner of operation. He says, however, that "a more rational classification depends upon the actual processes which take place in the producers, which fall naturally into three classes. In the first class are those producers in which tar is destroyed by more or less complete combustion. In the second class are those which effect a compromise between the processes in the producers in the first class and the processes in the producers of the third class, in which last there is no secondary combustion, and tar is destroyed only by contact with hot coke." Concluding, he says:

"It may be conceded that the method of decomposition without combustion cannot effect the destruction of the whole of the tar from bituminous coal; it seems evident from what has already been said that such complete destruction is very difficult even by the method of combustion, and it is practically certain that really complete destruction has never been achieved with any kind of producer-plant. The tar may be so reduced in quantity that only a small purifying plant need be used, but there is little doubt that in some cases too small a purifying plant is provided. A considerable length of gas-main is not quite inefficient as a purifying apparatus, and it sometimes has to serve this purpose. The tar-destroying efficiency of a producer plant must, therefore, be judged by testing the gas as it leaves the plant, not at the engines, which may be some distance away. It is obvious that, if the combustion of the distillates is incomplete, it will be confined to the fixed gases, which are the most useful, and the lighter hydrocarbons, which are the least objectionable of the distillates; the heaviest hydrocarbons, the presence of which is the most serious drawback to the use of producer gas, will be the last to be burnt.

"The method of simple decomposition of tar has the advantage which must be set off against any deficiencies in tar-destruction, that the gaseous hydrocarbons, which are distilled from bituminous coal, are not destroyed, and that their quantity is actually increased by the addition of similar compounds resulting from the decomposition of the tar. Besides this, the proportion of nitrogen in the gas can be kept to lower limits, owing to the fact that no air is used for secondary combustion, and the generation of sensible heat need be no greater than is necessary for the chemical actions which have to take place in the producer, and for the inevitable losses by radiation and conduction.

"It is quite likely that no one type of producer can be devised which will be the most suitable for all purposes, and the same may be true of methods of tar-destruction. For purposes, however, for which freedom from tar is important, calorific value is usually also important, and for all heating purposes gaseous hydrocarbons are as suitable as any other gas. It has been said that poor gas is better adapted than rich gas for use in internal-combustion engines, because it is more capable of standing high compression without premature explosion. As a general statement this is not true, though it is true if enrichment of the gas can only be carried out by the addition of hydrogen. Explosion engines require a gas with a high flame temperature, for which a high calorific value is necessary, and producer gas enriched by the addition of hydrocarbons distilled from coal is quite capable of standing high compression without any very serious danger of premature explosion.

"A process which results in the destruction of tar in bituminous coal places such fuel on equal terms with non-bituminous coal for the production of power-gas; a process which results in the conservation of the gaseous hydrocarbons, and the consequent production of a richer gas, gives the bituminous a distinct advantage over the non-bituminous coal. It seems then a wise policy to aim at a method of gas-production which will, so far as possible, combine both these processes, and it is likely that the use of some such combination will provide the most profitable method of producing a power-gas free from tar."

THE APPLICATION OF SCIENCE TO FOUNDRY WORK.

THE NECESSITY FOR THE APPLICATION OF METALLURGICAL AND CHEMICAL SCIENCE TO THE PURCHASE OF PIG AND THE PRODUCTION OF CASTINGS.

Robert Buchanan—Royal Society of Arts.

CONDITIONS in iron founding have improved greatly within the last few years and it is no longer true that foundry practice fails to show improvement comparable with the advances in other branches of the iron industry. According to a paper by Mr. Robert Buchanan, read before the Royal Society of Arts on February 12, 1908, however, a great deal still remains to be done and the uncertainties and difficulties of foundry work can never be overcome until the principles of metallurgical and chemical science are applied generally, both to the purchase of materials and to the production of castings.

Mr. Buchanan first discusses materials and processes for the making of molds and methods of melting. Passing then to the mixing of iron for the furnace, he says:

"The mixing of iron on scientific principles is of very recent origin, but is being practised more and more by progressive, because better educated, foundrymen. Unfortunately, there exists in this as in other countries, a large number of men in charge of foundries who, however skilled they may be in the ordinary routine work of a foundry, have not had the training, nor have they the knowledge, of how to apply chemical and metallurgical principles. This, for them, unfortunate position puts them into endless difficulties if they have to leave the beaten track of 'use and wont.' Where special strength or hardness or softness is required, they have to depend on brands of iron which in the course of years have obtained a reputation for the particular quality desired. They are not aware that the particular qualities of an iron depend upon its chemical constitution, and that no make of pig-iron is always of the same quality. Indeed, some pig-irons which have the same brand as they had 20 years ago are now made from quite different ores. Hematite iron, usually considered by foundrymen as the purest iron they can use, is often worse than ordinary pig-iron in respect of sulphur. These have been rejected by steel makers on that very account, and are passed on to the ironfounder of a larger faith in continuity of quality.

"Such things would not be possible were iron foundries generally run on strictly scientific lines, as are all steel works and most blast furnaces. The blast furnacemen themselves buy iron ores and coke, subject to suitable analyses, but most of them have a marked disinclination to sell their iron to analysis. They prefer selling their iron by the well-known system of numbers—1, 2, 3, and so on—but no one has yet defined what any one of these numbers is meant to convey. In the whole domain of metals there is nothing so unscientific as this system of selling and buying pig-iron by numbers. The blast-furnacemen have objected that, did they sell to analysis, most foundrymen would not know how to use the iron when they got it. That is perfectly true of many foundrymen at the present time, but were they confronted with the difficulty, of which unfortunately there is no immediate probability, they would perforce have to study the metallurgy of cast-iron with the greatest possible resulting benefit to themselves, and to the industry in which they are engaged. At the present time, only the very large firms, whose volume of business must be secured, are enabled to buy to an analysis. Once these firms have used analysis in the purchase and use of their foundry materials, nothing would induce them to revert to old methods of purchase and of use which are haphazard in the extreme. In a word, foundries using scientific methods of work find that they pay handsomely.

"Before a foundryman can use scientific methods in his work, it is obvious that he must have some training in, at least, elementary chemistry and metallurgy. I have heard a very successful teacher of metallurgy say recently, that the number of foundrymen attending the classes had increased largely within the last two years. This is a most encouraging fact for those interested in the advance of the industry.

"When one begins to apply scientific principles to the mixing of iron in the cupola, a profound knowledge of the metallurgy of cast-iron is not necessary. A knowledge of the principles governing combustion, the function of fluxes, such as limestone, to form suitable slags, and the influence of the various constituents of cast-iron so far as they affect the general body, will do for a beginning. I have heard it said that a certain noted metallurgist, after making over three thousand tests, with iron containing varying proportions of carbon, stated that he did not know anything about the influence of carbon on iron.

"In the case of cast-iron we have not only carbon to consider, but also silicon, phosphorus, sulphur and manganese. These may naturally be thought to complicate and render more difficult the study of this metal. Each of the elements named may be helpful to the founder under one set of conditions and hurtful under other conditions. The ironfounder, using scientific principles, uses only those which serve his purpose. Before he can do so he must understand what they are going to do for him, favorably or adversely, when he has in view the production of a particular quality of iron. By doing so, he puts aside all questions of brands and numbers of pig-irons, and forms his new compound in exactly the same way as the chemist does his. Each deals with elementary substances which combine in certain definite proportions. Beyond this, however, the ironfounder has to consider the changes which take place when melting the iron, and also the influence which size of casting has upon the ultimate product, owing to fast or slow cooling."

The amount and condition of the carbon in cast iron is almost wholly controlled by the other constituents present. When silicon is in excess the carbon content is low and is nearly all in the graphitic form. Low carbon produces a soft iron liable to "sink" in local heavy parts. It also tends to increase contraction owing to the fewer number of graphite flakes which occupy more space than the combinations of carbon and iron. Castings with much graphite are both soft and weak since the flakes of graphite assist the tearing asunder of the particles of iron. Combined carbon and graphitic carbon may be made practically interchangeable under suitable conditions. The presence of sulphur, the absence of silicon and quick cooling will cause most of the carbon to take the combined form, while low sulphur, high silicon and slow cooling will produce graphitic iron. The hardness of cast iron increases with the amount of combined carbon present and, until the latter reaches about 0.6 per cent., the strength increases also.

Up to 4 per cent. silicon acts as a softening agent by causing the carbon to take the graphitic form. Above this percentage it acts as a hardener. The most important function of silicon is in increasing the power of the iron to dissolve gases. It is thus of great value as a preventative of porosity in castings.

Manganese has the property of neutralizing sulphur, which it carries into the slag. In itself it is a hardening agent but by its action on sulphur it may act as a softener, since sulphur has a hardening effect. Manganese increases the power of iron to dissolve carbon, but its action is not so powerful as that of silicon in the opposite direction. It is distinctly beneficial in that it prevents the oxidization of iron and silicon during melting.

Phosphorus has a marked influence on the rapidity and cost of melting. It lowers the melting point of iron and gives it a fluidity which makes it easy to cast. Beyond this, however, its beneficial effect does not go. Castings high in phosphorus are very brittle and do not readily resist shock. The proportion should not rise above 0.2 to 0.4 per cent. when great strength is required, though for fluidity combined with fair strength 0.7 to 0.9 per cent. is permissible.

The influences of sulphur are almost wholly deleterious and are the most difficult against which the foundryman has to contend. The proportion of this element in pig iron should never rise above .06 per cent. but since the sulphur content of pig is dependent on conditions in the blast furnace, the foundryman can protect himself only by purchase by analysis. Sulphur produces a hard iron by making the carbon take the combined form; it increases contraction and makes the casting liable to crack on cooling; and it is liable to cause unsoundness by the production of gases just at the setting point of the casting. It may be rendered inert by the use of manganese, suitable fluxes in the cupola, and very high temperatures, but the foundryman has very little power to lessen its effects. So far as possible its entrance into the cupola either in the iron or coke, must be prevented.

"Having dealt at some length with the constituents of cast-iron and the particular influence which each exerts upon the general body, we now proceed to ascertain to what degree they are affected during the melting of the iron. This is necessary to be known before we can predict what the constitution of the iron in the casting will be. To be able to predict what the constitution of the casting will be, and be able to make one's predictions come true, are only possible when using scientific methods in mixing the iron.

"When melting iron in the cupola, the constituents are altered as follows, each time the iron is melted, the sulphur in the coke being taken as 0.70 per cent.:

	Per cent.
Sulphur	gains 0.038
Manganese	loses 0.100
Silicon	loses 0.250
Phosphorus	unchanged

"Knowing the analyses of the various irons which it is proposed to use in the mixture, adding together each constituent, and adding or subtracting each gain or loss made during melting, one gets wonderfully accurate results."

THE CONTINUOUS TESTING OF GAS.

A DESCRIPTION OF A DEVICE PROPOSED FOR THE CONTINUOUS DETERMINATION OF THE CALORIFIC VALUE OF GASES AND GASEOUS MIXTURES.

M. A. Adam—Revue de Métallurgie.

IN the *Revue de Métallurgie* for January, 1908, M. A. Adam proposes an interesting device for the continuous determination of the calorific value of gases and gaseous mixtures for the operation of gas engines and the firing of furnaces and boilers. It is only by proper proportioning of the mixture that the highest economy and efficiency in these applications of gas can be secured and the problem is, both theoretically and practically, one of the most important connected with the use of gas as a motive power or heating agent. Such a device as M. Adam proposes should be of great advantage, especially in the case of blast-furnace gas, to which he particularly refers, on account of its variable quality.

In the use of gas as a fuel for gas engines or furnaces there is one mixture which is more efficient than all others. The character of this mixture depends on the calorific value of the gas, the pressure andan temperature, and the humidity of the air and the gas. On account of the constant variations in the quality of the air and gas, the mixture is undergoing constant change, and in a manner particularly important in the use of lean gas in gas engines and furnaces. The lack of some device by which the proper mixture can be determined at each moment has long been recognized as a marked deficiency in the management of these appliances.

In the firing of furnaces the appearance of the flame gives a certain amount of information and a certain amount of regulation can be accomplished in connection with analyses of the burnt gases. In gas engine operation Watt's indicator gives sufficiently precise information as to the composition of a mixture, but the taking of diagrams is not always possible and they must be taken at short intervals to be of any use. The method is not practicable. By testing, an engineer can usually arrive at an acceptable mixture, that is, one which will turn the engine at its normal speed and furnish the necessary power, but this approximate result is still insufficient. Not only is it uneconomical, but the mixture may be established at the limiting condition of operation of the engine, and a variation of the qualities of the air or gas, an excess of air or gas, or even a sudden demand for power may then suffice to stop the engine. A poor mixture is often the cause of stoppage of single-cylinder machines.

Some form of continuous testing device is, therefore, desirable, and it would seem from the following considerations that its design should not be a difficult matter. If we consider a burner supplied with a practically constant volume of mixture in which the ratio of gas and air can be varied at will, it is evident that the best mixture will be that which will give at the burner the highest flame temperature. By placing in the flame a thermo-couple connected to a galvanometer this most efficient mixture can be determined by observing the fluctuations of the galvanometer during manipulation of the gas and air cocks regulating admission to the burner.

In applying this principle to the determination of the best mixture for use in gas engines, it is necessary to have at the burner exactly the same conditions of mixture as exist in the engine cylinder into which the mixture enters on account of the vacuum produced by the suction stroke, the air at atmospheric pressure, and the gas at the pressure, generally variable, of the distributing conduits. This condition is fulfilled if the mixture to be burned at the burner is drawn into a small supply chamber during the period of admission to the cylinder or, better, during compression. By consulting the galvanometer during manipulation of the air and gas ports of the engine it is possible to obtain by this means the most efficient mixture. The best arrangement is to furnish the mixture to the motor in constant volume, but with a variable ratio of gas and air, by means of two valves with single control, regulated by watching the galvanometer, the regulation of the engine having for its object the admission of a quantity of the combustible gas in accordance with the demand for power.

It is possible that the mixture which is indicated by the galvanometer as the most suitable may not be found best for use in the engine on account of the influence of unrecognized phenomena. In such a case, a correction may be made by the taking of diagrams, first with an excess of air, and then with an excess of gas, the mixture indicated as best by the galvanometer being taken as the point of departure. The diagram of greatest area found by this method of trial will determine the mixture to be adopted.

It may be noted that, for a given admission, that is for a constant position of the regulator, the desirable means of control is always possible. The best mixture having been established for the mean position of the regulator at a time when the output of the machine is practically constant, it remains substantially the same for the other positions. The difference of speed plays only a small part in making very slight changes in the speed of admission of the gas. The only essential is that the regulator hold a fixed position during the regulation.

M. Adam says that a device embodying these principles could be arranged in a variety of ways. He illustrates one simple arrangement in which a small quantity of gas is taken from the engine cylinders during each compression stroke and conveyed to a small gasometer from which it is led under constant pressure to the burner, in the flame of which the thermo-couple connected to the galvanometer is placed. The burner, he says, could be eliminated by placing the thermo-couple within the cylinder, but in this case the variations of temperature during the four cycles would derange the readings and would necessitate the designing of a galvanometer which would register only the temperatures of successive explosions, without the position of the pointer altering for the small deviations.

In the case of furnaces, the furnace itself constitutes the burner and the thermo-couple can be placed directly in the flame, the air and gas valves being manipulated to produce the highest possible temperature. In them, as in engines, it requires only a few regulations of the mixture a day to secure the best possible working conditions.

DIAMONDS IN THE UNITED STATES.

A DESCRIPTION OF THE DIAMOND-BEARING PERIDOTITE DEPOSITS RECENTLY DISCOVERED IN ARKANSAS.

G. F. Kunz and H. S. Washington—American Institute of Mining Engineers.

PROBABLY no discovery of mineral in the United States in many years has aroused so much popular interest as the recent finding of a deposit of diamond-bearing peridotite near Murfreesboro, in Pike County, Arkansas. The deposit has been the subject of the misrepresentation common to all new mining fields and we are glad to present below an authoritative description of its character and extent, abstracted from a paper presented by George F. Kunz and Henry S. Washington at the February meeting of the American Institute of Mining Engineers.

To summarize briefly the geology of the deposit, "the igneous rock in which the diamonds are found is a vitreous peridotite, forming a stock or volcanic neck, which has broken up through the Carboniferous and Cretaceous quartzites and sandstones. After an extensive period of erosion, during which an unknown portion of the neck and presumably a previously existent volcanic cone have been removed, the surface was covered with thin beds of Post-Tertiary conglomerate. The volcanic intrusion was accompanied by the formation of several small dikes of a rock much like that of the main body. One of these dikes cuts across the stock, while another cuts the Cretaceous sandstone, but is overlaid by the conglomerate, thus giving a datum for the period of intrusion. So far as known, there was little, if any, metamorphism of the country-rock by the igneous magma, which probably followed an approximately vertical course, so that a more or less vertical extension downward of the igneous body to indefinite depths may be expected. This result should hold good, at least, for the upper and most accessible portions, though some departure from strict verticality may be expected at greater depths.

"As observed above, the igneous rock is a peridotite which, in fresh hand-specimens, is tough, hard, distinctly porphyritic, and very dark greenish or brownish-black. Microscopic study shows it to be composed of numerous crystals of olivine and some patches of biotite, imbedded in a groundmass of very small crystals of augite perofskite, and magnetite, with an abundant yellowish to colorless glass base. In all the specimens examined the olivines are more or less completely serpentinized, and the glass is apt to show an aggregate polarization due to decomposition. The rock is evidently an igneous intrusive, which probably welled up in comparative quiet, and solidified not far from the surface. It is therefore in no sense a volcanic breccia, due to explosive eruptions, as are most of the South African occurrences. Chemically and mineralogically, however, it much resembles the South African rock, although there are certain points of difference—notably the absence of inclusions."

The fresh rock is dense, hard and tough and does not crumble readily on exposure but the deposit exhibits the general tendency of peridotite to alteration by weathering. In the first stage of this alteration, the firm rock disintegrates into hard, angular fragments of various sizes, which do not themselves disintegrate readily on exposure. The second stage yields a compact mass of "green ground" which becomes yellowish in color on drying. The third stage, found nearer the surface, furnishes the "yellow ground," the color being due to further oxidation of the ferrous iron. Both the green and yellow grounds are soft and friable and crumble readily between the fingers. The fact that sharply defined, serpentinous pseudomorphs of the original olivine crystals are found in them, supplemented by the general appearance of the texture, show that the peridotite has been decomposed in place with little or no transportation of the material. Both the green and yellow grounds crush easily, when dry, to a fine powder from which the gritty particles of the less easily decomposed minerals can be sifted out; and when wet, to a fine mud which can be easily washed and concentrated.

Fresh, unaltered peridotite crops out in a few places and the product of the first stage of alteration is to be seen, but by far the greater part of the igneous area is covered by the green and yellow ground. The maximum and average depths of the deposit of decomposed peridotites have not been exactly ascertained but the borings show it to be 40 feet thick in places and the average depth will probably be not less than 20 feet. Below this is found the compact or fragmentary igneous rock which runs to an unknown depth. Drillings to depths of 80, 186 and 205 feet have remained in peridotite to the end. The area known to be underlain by the peridotite is about 40 acres, while the surface exposure of the igneous area forms a rough ellipse with major and minor axes of 2400 and 1800 feet respectively.

"Up to the present time about 140 diamonds have been discovered within the igneous area, while none have certainly been found outside of it, even in the immediate vicinity. All the stones have been found on the surface, except two, which were in the concentrates derived from washing large amounts of the green ground, and one, which was imbedded in the green ground itself about 15 ft. beneath the surface. Our careful examination of this last specimen leaves no doubt that the diamond is actually in place in the rock and was not inserted in the specimen. Consequently it constitutes a definite proof that the peridotite is the source of the diamonds, and that all the stones so far discovered have been derived from it. It would be well, however, to have this single piece of evidence corroborated by similar specimens. With regard to the quantitative relations of the diamonds to the inclosing rock, about 200 carats have been found on or immediately beneath the surface, where presumably there has been considerable concentration of the stones. From the nature of the deposit, the average yield per ton can only be ascertained by actual washing or other extraction from the rock on an extensive scale, commensurate with that of purposed commercial operations.

"Additional factors of economic importance, for which more extensive data are necessary, are the average size, color and quality of the stones, since these factors determine their value. From the 200 carats at present available for examination, it appears that the Arkansas locality compares very favorably with most, if not all, of those in South Africa. Although no stones larger than 6.5 carats have yet been found, the average size is fairly good. There is a large proportion of white stones, for the most part of a high grade in color, brilliancy, and freedom from flaws. Indeed, many are as fine as have ever been found. Some of the yellow ones, also, are of exceptional quality and color."

The deposit is favorably situated for mining operations. Supplies of water, timber and coal are easily obtainable and the transportation facilities can be made adequate with little trouble. The labor problem will present the most serious difficulty, probably the most important consideration being the prevention of loss of diamonds by theft. Regarding the extraction of the diamonds, the green and yellow grounds are amenable to the method used at Kimberley for the treatment of this kind of material and will present no difficulty. The fresh and hard peridotite may present a more serious problem but probably not a more difficult one than has been solved successfully in South Africa.

"In view of the great local excitement over the discovery of diamonds which has extended over part of the State, and in view of the danger of the repetition here of the disastrous history of many mining camps which have undergone an unwarranted 'boom', and the consequent rush and loss of time and money by many innocent individuals, it should be distinctly understood by the public that the occurrence of diamonds near Murfreesboro is an isolated one, and that it does not resemble a mineral vein or lode in any respect. Consequently, there is not the least justification for any such claims as will undoubtedly be made by ignorant or unscrupulous parties, that 'a continuation of the vein' has been struck. There can be no continuation of a vein when there is no vein.

"Should other similar igneous areas, which may possibly be diamond-bearing, be discovered elsewhere, any claims put forward for them should be received with the greatest caution. Fortunately, the characteristics of the peridotite (in which, by analogy, diamonds may be most reasonably expected to occur) are so easily recognizable by a petrographer, the localities will be presumably so isolated, and the outlines and extensions of the mass so well defined, that the report of a geologist or petrographer can surely prevent an unsuspecting or ignorant person from loss by investment in a property said to be a continuation of, or a connection with, the present deposit.

"Peridotites are not uncommon; but very few are diamond-bearing. Indeed, the great majority of these rocks found all over the world show no trace of diamonds. Even in South Africa, many peridotite pipes, resembling valuable ones, carry no diamonds, while in any given pipe some portions are found to be richer in diamonds than others."

BREATHING APPARATUS FOR USE IN MINES.

THE PHYSIOLOGICAL EFFECTS OF MINE GASES AND PRINCIPLES IN THE CONSTRUCTION OF BREATHING APPARATUS.

Leonard Hill—North Staffordshire Institute of Engineers.

AS an extension of M. Boyer's article on "Rescue Appliances in the Mines of France" on another page of this issue of THE ENGINEERING MAGAZINE we present the following abstract of an interesting and comprehensive paper on breathing apparatus read by Prof. Leonard Hill before the North Staffordshire Institute of Mining and Mechanical Engineers and reprinted in *Engineering* for January 17, 1908. M. Boyer describes the mechanical details of the leading devices used in France; Prof. Hill discusses the physiological effects of foul air on man and the general principles involved in the design of breathing apparatus.

The oxygen of the air of coal mines, owing to the processes of oxidization going on in the soil, undergoes continuous impoverishment. Pyrite in moist air is decomposed to form ferrous sulphate and sulphur dioxide. The latter combines with water to form sulphurous acid, which in its turn is oxidized to sulphuric acid and the sulphuric acid reacting with the carbonate of lime in the soil evolves carbonic acid. Pure choke or "black damp," as air impoverished by such processes is called, contains 85 to 95 per cent. nitrogen and 15 to 5 per cent. carbonic acid and is formed in enormous quantities. A frequent accompaniment is methane or fire damp which is given off by the coal. This gas is explosive in percentages above six per cent. but has no poisonous effect on man except in so far as it dilutes the oxygen of the air. The influence of deoxygenated air are, however, very serious. When the oxygen tension of the air falls below 17.3 per cent. of an atmosphere it becomes insufficient to support combustion. At 15 per cent., the effect on man is to produce slight dizziness and shortness of breath; at 10 per cent., respiration and pulse become more frequent; at 7 per cent., both mental and muscular power become impaired; and at a slightly lower tension consciousness is lost and life is in imminent danger. The most dangerous feature connected with work in an atmosphere undergoing gradual deoxygenation is that the discomfort felt is often slight and gives little warning of danger. Such an atmosphere should never be entered without breathing apparatus. With regard to breathing apparatus themselves, these effects of deoxygenated air make it essential that the gauge of the oxygen supply should be in a position visible to the wearer to prevent the possibility of an unnoticed exhaustion of the supply. On the other hand, an excess of oxygen is not without danger. An excess up to a tension of one atmosphere can be breathed with perfect safety for many hours, but long breathing of oxygen above this tension is likely to produce inflammation of the lungs, poisoning of the nervous system, and convulsions.

The effects of carbonic acid are less deleterious than is popularly supposed. Pure air contains only 0.03 per cent. of this gas, but an excess produces no noticeable effects until the proportion rises to about 3 per cent. This amount produces slightly more frequent respiration and pulse; 4 per cent., unpleasant panting; 6 to 7 per cent., marked difficulty in breathing; and 10 per cent., violent panting, throbbing of the arteries and flushing of the face. Tensions above 25 per cent. may cause death, but only after exposure for several hours. Probably no cases of carbonic acid poisoning ever occur for choke damp containing any large percentage kills by want of oxygen and not by excess of carbonic acid.

For comfort, however, it is necessary to keep the carbonic acid in breathing apparatus below 3 per cent. and advisable to keep it under 1.5 per cent., since many men suffer from headache after prolonged exposure to as much as 3 per cent. 1.5 to 2 per cent. of carbonic acid in the breathing bag is, however, a matter of no importance.

The most dangerous gas to contend against after a mine explosion is carbon monoxide which is always present, even though the mixture of gases seems to contain sufficient oxygen to sustain life. It is produced by the imperfect combustion of coal dust ignited by primary explosions of fire damp. Carbon monoxide unites with the haemoglobin of the blood and destroys life by robbing the body of oxygen. It is a poison only in so far as it is an oxygen robber. The danger in this gas lies in the particularly insidious nature of its action. When the blood is 20 per cent. saturated with carbon monoxide there occur dizziness and shortness of breath on exertion, but increasing saturation produces little additional sense of discomfort to warn the subject of the failure of his mental and physical powers. Anything above 0.15 per cent. in the air breathed is dangerous and 0.4 per cent. practically always will cause death. Owing to its insidious poisonous nature it is suicidal for a rescue party to attempt to face "after damp" without breathing appliances. To meet this peril such apparatus are absolutely necessary for the saving of life and the fighting of fire after mine explosions.

Breathing apparatus are also necessary to meet the dangers of hydrogen sulphide, an extremely poisonous gas, sometimes occurring in coal mines and almost always in stagnant sewers; and nitrogen peroxide, evolved in the accidental burning of dynamite or other gun cotton explosives, a slight exposure to which is likely to result in fatal inflammation of the lungs.

"The objects in the design of breathing apparatus are: (1) To allow the wearer to remain in an irrespirable or poisonous atmosphere for a period of time; (2) to do efficient work; and (3) to crawl through or under obstacles such as occur after a mine explosion, as much as possible with the same ease and safety as an unencumbered man. These objects are attained by connecting the mouth with a breathing-bag or box, into which oxygen is delivered, and from which the exhaled carbonic acid is absorbed; by making and arranging the required apparatus so that it is as light as possible, and is adapted to the body in such a way as to unfetter the movements of the wearer, and to increase the girth of the body as little as possible. The apparatus, too, must not project in such a way as to dislodge beams, rocks, etc., when the wearer is exploring dangerously encumbered ways after an explosion. The apparatus should fit him so that he knows he can pass through where his head and shoulders can pass. The apparatus must be air-tight from without inwards to prevent the entrance of irritating vapours, such as thick smoke, and the eyes must be protected from the same. In the case of after-damp, the latter protection is unrequired. It is of great value that the apparatus should allow of the mouthpiece being removed so that a few words of direction may be spoken or drink taken if occasion arises. There is no risk in doing this so long as the tube leading from the mouthpiece to the breathing-bag can be closed by the thumb.

"The breathing-bag must be large enough to contain the deepest inspiration or expiration quite easily. Inspiration out of an empty, or expiration into a full, bag is very distressing and not free from risk. The breathing volume while resting is about 500 cubic centimetres; while working it may reach 1500 cubic centimetres. The bag must be moderately distensible so as to act as a buffer or cushion for the ebb and flow, or inspiration and expiration.

"A man at rest requires on the average about 250 cubic centimetres of oxygen per minute, at work climbing hills 1200 to 1500 cubic centimetres of oxygen per minute. The use may rise to 2 litres per minute. This amount, therefore, must be continuously supplied, so that shortage can in no case occur, for it is very dangerous if the oxygen tension falls to less than 12 per cent. The breathing-bag should be washed out with oxygen when the wearer puts on the apparatus, so that it contains 60 to 70 per cent. oxygen. Diminution in volume of the breathing-bag will then warn the wearer by making inspiration difficult before the oxygen tension gets dangerously low.

"The carbon dioxide must be removed, so that the tension never rises to 3 per cent. It should be kept generally under 2 per cent., so as to avoid the chance of even slight discomfort.

"The dead space between the mouth and the inlet to the breathing-bag must be kept as small as possible, because the air in the dead space is breathed back into the lungs without purification. The dead space should not exceed 200 cubic centimetres at most.

"There must be some kind of gauge indicating the supply of oxygen. This gauge must be placed so that the wearer can see it, and thus time his retreat.

"It is most desirable that the apparatus should be constructed as simply and strongly as possible, so that it cannot get out of order when hung by in the store, and can be understood by an ordinary workman, and safely worn by him after no more than a few minutes' training. The apparatus, moreover, should be so designed that the man who is to wear it can put it on himself, without assistance, in the shortest possible time, and it should also be as light as possible."

Prof. Hill concludes his paper with a description of the modern form of the Fleuss-Siebe Gorman apparatus which has been under development and improvement since 1880. In Prof. Hill's opinion, this device satisfies all the requirements established by exact physiological data and combines the greatest simplicity and strength with maximum comfort and safety.

THE SAMPLING OF COAL MINES.

A DISCUSSION OF THE DISCREPANCIES LIKELY TO BE OBSERVED BETWEEN THE QUALITY OF SMALL MINE SAMPLES AND THAT OF THE REGULAR OUTPUT.

John Shober Burrows—Bulletin of the United States Geological Survey.

THE extensive fuel tests made at St. Louis during the past four years by the United States Geological Survey have not only added a large number of very valuable data to our knowledge of the conditions of efficiency and economy in boiler management but have produced also a most important body of information on a wide variety of subjects connected with the mining and preparation of coal. A recent contribution of the latter class, forming part of Bulletin 316 of the Survey's publications, deals with the subject of coal-mine sampling. The two factors which determine the value of a coal deposit are, first, the amount of workable coal available, and, second, the quality of the marketable product. The former can be ascertained by the ordinary methods of surveying and prospecting, but the latter is not so easy of determination. The usual method has been to take a small sample for chemical analysis from a freshly mined pile or car. The investigations of the Geological Survey have shown this method to be totally unreliable in that it usually produces a sample of coal much cleaner than that obtained in actual mining. The investigations have demonstrated clearly the necessity for uniform and systematic methods in coal-mine sampling and from them has been deduced a series of coefficients by which the results of analyses of carefully taken samples can be corrected to give a close approximation to the quality of the commercial product. When it is remembered that during the work of the Survey at least two mine samples and one or more cars of coal were taken from each of 159 mines in 23 different States, representing all classes of coal and secured under a great variety of climatic conditions, it will be seen that the results given in the following abstract of Mr. J. S. Burrows' summary of the sampling work form a most valuable contribution to this important subject.

The mine sampling was done by special inspectors who also supervised personally the shipment of the coal in car-load lots. On their arrival at St. Louis the cars were sampled in the following manner: the coal was passed through rolls set 1½ inches apart, from which it was discharged into the boot of a bucket elevator employed to hoist it to the storage bins. A small shovelful was taken from about every eighth or tenth bucket, the resulting sample amounting to 80 to 100 pounds. This was sent direct to the laboratory in an iron bucket, the pulverizing and quartering being done after it reached the laboratory. For the mine sampling, two or more places were selected at widely separated points where the bed had an average development and from which most of the coal was being mined for shipment. The face was cleaned of dirt, burned powder and loose coal for a space of about five feet. The sample was then taken in a perpendicular cut from floor to roof, the cuttings being caught on a waterproof blanket. In taking each sample sufficient coal was cut to make up not less than five pounds per foot of height. When shale or other partings were to be included, great care was taken to cut them the full width and depth of the groove to preserve the proportion of coal and extraneous matter. Careful notes were taken of all variations and partings in the section of the bed and from these records an estimate of the value of the sample could be made. By repeated screening and breaking on a portable bucking board the sample was all reduced in size to pass a one-half inch screen. It was then thoroughly mixed by rolling in the blanket and quartered down to a convenient size for handling. A can was filled from the last quartering and hermetically sealed for mailing to the laboratory. The whole process was carried out in less than an hour. With such rapid sampling in the native atmosphere of the coal it was assumed that there would be little or no loss in moisture.

The results of the comparative analyses of the mine and car samples are shown in tabular form and from an examination of these data the coefficients by which mine samples may be corrected are obtained. With regard to moisture, it is found that a different correction has to be made for run-of-mine coal containing less than 5 per cent. of moisture from that which must be used for coals containing more than this percentage. Coals in the former class will, under normal conditions, gain some moisture on exposure to the air, and the moisture in the mine sample must be multiplied by 1.19 to obtain the probable amount in commercial run-of-mine coal. On the other hand, coals containing more than 5 per cent. of moisture will lose a portion of it on exposure and the coefficient in this case is 0.93. A prominent feature noted in comparing these two classes is that there seems to be a tendency on the part of the high-moisture coals and the low-moisture coals to approach a common limit very close to 5 per cent. Screened coal will tend to lose moisture under normal conditions, the coefficient being 0.97. A coefficient of 1.30 was found for slack but it is based on too meagre data to be reliable.

"It appears from all the evidence that moisture is an extremely irregular constituent of coal. For this reason, in taking mine samples great care should be exercised to select a dry place in the mine for cutting the sample and to prevent an excessive amount of moisture from getting into the coal in the form of water by the drip from the roof of the mine or by contact with the sample on the floor. It is of the utmost importance to crush the sample in the atmosphere of the mine, or where it has been impossible to procure a dry sample, to dry the coal before crushing until all signs of visible moisture have been removed. More important than anything else in this connection is the manner in which the sample is packed for the laboratory. The sample should be sealed in an air-tight glass jar, bottle, or can. . . . . .

"The differences in sulphur between mine samples and commercial coal will in most cases be slight, provided too much care is not used in excluding sulphur in partings and concretions from the sample. In the results of the Survey's investigations the sulphur in the run-of-mine samples very nearly balances, the correction coefficient being 1.07 for the coals showing less than 3 per cent. of sulphur in the mine samples and 1.06 for those containing more than 3 per cent. With the screened coal, the actual results show more sulphur than in the run-of-mine coal, but the differences between mine samples and car samples remain slight, the coefficient determined being 1.10. Of course, the sulphur content in coal of this class will vary slightly, depending on the grade of coal and the size of the screen through which it is passed, as well as the form in which the sulphur occurs. If the sulphur comes from the mine in large pieces of a uniform size, it will pass into the coal of corresponding size and the other grades will show less sulphur. On this account it will be difficult to predict the amount of sulphur that is likely to be found in any particular size.

"The results of the comparison of the ash in the mine samples with the ash in the car samples show the greatest and most constant variation of all the impurities in the coals examined. The best comparisons are, of course, on the run-of-mine coal, and indicate that the ash will run higher in this grade of coal as marketed than in the mine sample. The coefficients determined, however, 1.62 for coal with less than 7 per cent. of ash and 1.28 for coal with ash over this percentage, are sufficiently accurate for correcting the mine samples, provided they are taken by the method already recommended.

"With regard to screened coal, the results are considered uncertain, and although the coefficient (1.37) determined for this class of coal may be applied to mine samples for screened coal in general as compared with run-of-mine coal, it is not recommended that it be used for a specific grade of coal, such as lump or nut.

"The coefficient determined for ash in slack coal, 1.86, is considered good for determining the amount of ash in this grade of coal when it contains a large amount of fine dust, but it will probably be found that the coefficient will not give accurate results for special grades of slack or for coals free from fine shale partings and with good roofs and floors."

THE CHINESE IRON INDUSTRY.

A DESCRIPTION OF THE HANYANG IRON AND STEEL WORKS AND FUTURE PROSPECTS OF THE CHINESE IRON INDUSTRY.

C. Blauel—Stahl und Eisen.

CONSIDERABLE interest attaches to a description of the Hanyang Iron and Steel Works, China, in *Stahl und Eisen* for January 1, in view of the fact that these works shipped to the United States during 1907 a considerable amount of basic pig and several lots of foundry iron. The article, which is abstracted below, is by C. Blauel, a former engineer of the works. Besides describing the Hanyang works, the only establishment of any importance in the country, Herr Blauel gives an interesting discussion of the past and probable future of the Chinese iron industry.

The Hanyang works lie at the confluence of the Han and Yangtse Rivers and close to the city of Hankow, the most important commercial centre on the great waterway formed by the latter stream. The distance to tidewater is about 730 miles. The works date from 1891, when they were founded by Governor Chang-Chi-Tung of the Province of Hupeh, the work being done under the direction of English engineers and most of the material coming from England. At that time the establishment consisted of two blast furnaces with a daily capacity each of 50 tons, 20 puddling furnaces arranged in groups of four with equipment of steam hammers and puddling rolls, two bessemer converters, each of 5 tons capacity, one 12-ton basic open-hearth furnace, two rolling mills, and additional equipment consisting of a foundry, smithy, machine shop, etc. Later the works became practically a branch of a large Belgian establishment and the operation was under the control of Belgian engineers and foremen. After a time, however, the return of about 80 Chinamen who were sent to Belgium for instruction drove out the foreign element and placed the direction of the works almost wholly in the hands of natives.

The blast-furnace plant has been in operation, with various interruptions, since 1894, but during the first year only one furnace was in blast. By the introduction of stoves and other improvements the capacity was later increased to 70 to 100 tons per day, according to the quality of the pig produced. The high cost of fuel prevented the puddling plant from ever becoming a commercial success and it remained in commission only a short time. Since the end of the nineties the chief output of the bessemer plant has consisted of rails for the 750-mile Hankow-Peking railway which was built between 1901 and 1905. Lately the converters and open-hearth plant have supplied steel to the plate mills. The total production of the rolling mills has never exceeded 15,000 to 25,000 tons per year and in most years has fallen considerably below these figures.

In 1896 the works were leased by Chang-Chi-Tung to a Chinese company and entered on a period of mismanagement and commercial failure. In addition to the financial incapacity of the native managers, the establishment labored under technical difficulties, chief among which was the poor quality of the coke available. On one occasion the managers nearly put an end to the whole existence of the bessemer plant by entering into an agreement to supply for thirty years to the Japanese government 100,000 tons of the best magnetite ore annually. The remaining ores were too high in phosphorus for use in the converters. In 1904 the works passed under the control of a railway magnate Sheng-Kung-Pao, who decided to increase at once the open-hearth plant in order to make all the magnetic and hematite ores available.

The ore deposits of the Tayeh district, the source of the Hanyang supply, consist chiefly of red hematite and magnetite containing on the average about 58 to 68 per cent. iron, 0.04 to 0.25 per cent. phosphorus, and 0.05 to 0.1 per cent. sulphur. Some brown hematite also is found, containing 6 to 9 per cent. manganese. The deposits are of enormous extent, occupying a mountain range about seven miles in length, and are estimated to contain more than 100,000,000 tons of available ore. Excellent limestone occurs alongside the iron ores and at a distance of about 20 miles there are large deposits of good coking coal. This district has natural advantages which should make it one of the most important centres of the Chinese iron industry.

These deposits are about 60 miles distant from Hankow and the ore is brought to the Hanyang works over a 15-mile railroad connecting with the Yangtse and thence by water. The Yangtse is navigable for the largest ocean steamers up to Hankow from April to October and transportation facilities for ores and finished product are therefore adequate. The main difficulty in the raw material supply is that the coke has to be brought from Ping-Hsiang, a distance of 60 miles by rail and 240 miles by water. The coke from these mines is of fair quality but the output so far is limited to little more than the amount required by the Hanyang works. The costs of raw materials at the furnaces are now about as follows: ore, 75 cents; limestone, 50 cents; coke, \$6.25 to \$7.50; and coal, \$4.50 per ton.

The reorganization work under Sheng-Kung-Pao resulted in 1904 and 1906 in the installation of three 30-ton open-hearth furnaces, a gas-fired mixer of 150 tons capacity with gas producer equipment, three large reversing mills and accessories, and a direct-current electric plant of 800 kilowatts capacity. Early in 1907 a third blast furnace of 300 tons capacity and two additional open-hearth furnaces were ordered and in the near future a second mixer and a fourth blast furnace of the same capacity as the last will be installed. The old bessemer plant and puddling furnaces have been dismantled. The original plant worked continuously during the past year and the new steel plant was recently set in operation. The third blast furnace will be blown in before the end of this year.

The Hanyang works are in a better position than ever before for successful operation, but it is difficult to form an estimate as to what the future may bring forth. Encouraging features are the good equipment, better labor and satisfactory arrangements for raw material supply. During 1908 the output of the steel works and rolling mills will probably reach 40,000 to 50,000 tons and by 1910 it should reach 100,000 tons. The present manager, Mr. V. K. Lee, is a native of the highest type who has been thoroughly trained for his work in European steel works.

China has great possibilities as an iron producing country. The country has not been thoroughly explored, but immense deposits of high-grade ore are known to exist in many parts of the country. Mr. Blauel thinks that the total ore resources are not much less than those of the United States. Coking coal is not available in such large deposits but the supplies are extensive and would probably be found adequate. The most serious obstacle to the development of the iron industry is the new mining law which went into effect last November. By its provisions foreign capital cannot be employed directly in mining operations, but can be used only for the purchase of stock in Chinese companies. The incapacity of the Chinese in financial matters will prevent for a great many years at least the investment of any considerable amount of money in so hazardous a venture as the exploitation of mines under these circumstances.

THE ENGINEERING INDEX

THE KEYSTONE
IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(3) A descriptive abstract,
(2) The name of its author,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Brooklyn.

The Manhattan Terminal Extension of Brooklyn Bridge. Brief illustrated description of recent changes to relieve the congestion on the elevated level of the bridge. 1200 w. Elec Ry Rev—Feb. 1, 1908. No. 90001.

New Terminal Station and Approaches of the Brooklyn Bridge. Illustrated description of the structure that will eventually take the place of the temporary building now used. 1600 w. Sci Am—Feb. 8, 1908. No. 90110.

Increasing the Capacity of Brooklyn Bridge. Illustrates and describes the most important changes recently made, with editorial on the report of the chief engineer of the Public Service Commission criticising the new system. 3200 w. R R Gaz—Feb. 21, 1908. No. 90449.

Cantilever.

Pin-Connected Highway Bridge over the Rhine between Hamburg and Ruhrort

(Pont-Route à Travées Articulées Etabli sur le Rhin entre Homburg et Ruhrort). Illustrated description of this bridge which has a cantilever span 620 feet long. 3000 w. Génie Civil—Jan. 4, 1908. No. 90332 D.

Concrete.

Progress on the Walnut Lane Bridge, Fairmount Park, Philadelphia. Construction work on the longest concrete arch in the world, 233 ft. clear span, is illustrated and described. 2500 w. Eng Rec—Feb. 15, 1908. No. 90198.

Drawbridges.

New Swing-Bridge Over the River Hull at Sculcoates, Hull. Plate, illustrations, and description of the bridge and method of erection. 1200 w. Engng—Jan. 31, 1908. Serial. 1st part. No. 90140 A.

Failures.

The Ponts-de-Cé Disaster (Die Katastrophe von Ponts-de-Cé). August Kroitzsch. Describes the failure of this steel bridge in France with an examination of causes. Ills. 2500 w. Oest Zeitschr f d Oeffent Baudienst—Jan. 25, 1908. No. 90365 D.

Reinforced Concrete.

Ferro-Concrete Highway Bridges. Illustrates and describes some recent designs in accordance with the Hennebique system. 1600 w. Surveyor—Feb. 7, 1908. No. 90241 A.

Cost of Constructing a Concrete Trestle and Three Concrete Girder Bridges with Abutments. Relates to a reinforced-concrete trestle and bridges with concrete abutments near Easton, Pa. 1300 w. Engng-Con—Feb. 5, 1908. No. 90090.

Steel.

Erection and Waterproofing of Plate Girder at Plainfield, N. J. Illustrated description of work carried out by the Central Railroad Company of New Jersey. 1200 w. Eng Rec—Feb. 1, 1908. No. 89963.

A Plate Girder Bridge Replacing a Bowstring Truss in Washington, D. C. W. J. Douglas. Illustrates both the old and new bridges, describing the work. 1500 w. Eng News—Feb. 13, 1908. No. 90165.

See also Brooklyn, Cantilever, Drawbridges, Failures, and Viaducts, under BRIDGES.

Timber.

See Trestle, under BRIDGES.

Trestles.

Formulas for Estimating the Quantities of Materials in Timber and Pile Trestles and Hints on Estimating Costs. 1000 w. Engng-Con—Feb. 12, 1908. No. 90175.

Viaducts.

The Cap Rouge Viaduct. Illustrated detailed description of a single-track steel structure for the Trans-Continental Railway, Canada, which is about 3345 ft. long, with a maximum height of nearly 173 ft. from low water to base of rail. 1500 w. Eng Rec—Feb. 22, 1908. No. 90467.

CONSTRUCTION.

Beams.

Stresses in Solid Beam Sections and the Strength of Chain Rings. Robert H. Smith. A study in the calculation of stresses in both rectangular and circular sections. 3000 w. Engr, Lond—Jan. 24, 1908. Serial. 1st part. No. 90017 A.

Buildings.

The General Equation of the Elasticity of Structures and Its Applications (L'Equation Générale de l'Elasticité des Constructions et ses Applications). Bertrand de Fontviolant. A mathematical discussion of stress determination in framed structures of various types. Ills. 20000 w. Mem Soc Ing Civ de France—Oct., 1907. No. 90303 G.

Concrete.

The Treatment of Concrete Surfaces. E. B. Green. Read before the Nat. Assn. of Cement-Users. Briefly discusses the possibilities of this material and its artistic application. 2000 w. Eng Rec—Feb. 22, 1908. No. 90466.

Methods and Costs of Concrete Construction with Separately Molded Members. W. H. Mason. From a paper before the Nat. Assn. of Cement Users. Describes a cement storage building constructed on this system. 2500 w. Munic Engng—Feb., 1908. No. 90180 C.

See also same title, under MATERIALS OF CONSTRUCTION.

Estimates.

Approximate Estimates. Alexander Potter. Read before the Ohio Engng. Soc. States the purpose of such estimates and their value in contracts. 2200 w. Eng Rec—Feb. 22, 1908. No. 90474.

Excavation.

The Use of a Water Jet to Increase the Speed of Rock Drilling and a Formula Estimating the Amount of Water Necessary. Gives a rule that may be easily applied, and a solution of this problem. 1300 w. Engng-Con—Feb. 5, 1908. No. 90091.

Failures.

See Roofs, under CONSTRUCTION.

Foundations.

Sinking Well and Cylinder Foundations. Edward W. Stoney. Gives work done by divers in sinking bridge, well, and cylinder foundations in India. 1200 w. Engng—Jan. 31, 1908. No. 90135 A.

A Steel Pile Foundation in a Quicksand Pocket. Brief description of method of solving a serious problem in erecting a 16-story building in New York. Ills. 1000 w. Eng Rec—Feb. 22, 1908. No. 90465.

Supporting a Foundation Wall on a Reinforced-Concrete Girder. Brief illustrated description of method used in connection with excavations for the Bridge Loop for the subway system, New York. 500 w. Eng Rec—Feb. 15, 1908. No. 90199.

Masonry.

How to Preserve Stonework. W. M. Brown. Brief review of methods for cleaning and preserving stonework in cities. 1500 w. Can Archt—Feb., 1908. No. 90561 C.

Piling.

Preservation of Piling Against Marine Wood Borers. C. Stowell Smith. A study of the character and extent of the damage done and of the present methods of protection. Ills. 4000 w. U S Dept of Agri —Circ 128. No. 90539 N.

See also Foundations, under CONSTRUCTION.

Reclamation.

The Improvement of the Upper Mystic River and Alewife Brook by Means of Tide Gates and Large Drainage Channels. J. R. Rablin. An account of improvements in the vicinity of Boston. 2000 w. Harvard Engng Jour—Jan., 1908. No. 90189 D.

Swamp and Overflowed Land Drainage in the Mississippi Basin. F. W. Hanna. Discusses the detrimental changes in the flow of rivers, due to the extensive changes in forest conditions, and the necessity for intelligent control in order to accomplish the greatest good. 2500 w. Eng News—Feb. 13, 1908. No. 90166.

Reinforced Concrete.

Systems of Reinforced-Concrete Construction. Emile G. Perrot. From a paper before the Nat. Assn. of Cement Users. Calls attention to important points in the construction. 1400 w. Munic Engng—Feb., 1908. No. 90181 C.

Spiral Anchorage for Concrete Reinforcement. Daniel B. Luten. Explains this form of anchorage, its principle, and the advantage of its use in certain cases. 1200 w. Eng News—Feb. 27, 1908. No. 90522.

The Necessity of Continuity in the Steel Reinforcement of Concrete Structures. E. P. Goodrich. Read before the Nat. Cement Users' Assn. Mainly a discussion of the prevention of cracks, but considering also causes of stresses in monolithic structures. 3500 w. Eng Rec—Feb. 8, 1908. No. 90095.

Reinforced Concrete for Railway Structures. Charles Augustus Harrison. Paper and discussion before the Railway Section of the Engng. Conference, 1907. 3400 w. Bul Int Ry Cong—Jan., 1908. No. 90283 E.

Self-Sustaining Reinforcement of Structural Shapes in a Cement Stock House. Illustrates and describes an example of concrete reinforcement so designed as to make a self-sustaining steel framework before the concrete is placed. 3000 w. Eng News—Feb. 6, 1908. No. 90087.

A Reinforced Concrete Hotel. Day Allen Willey. Illustrated description of the Traymore, at Atlantic City, N. J. 1200 w. Sci Am—Feb. 15, 1908. No. 90194.

A Reinforced-Concrete Building with Concrete Domes: Cincinnati Zoological Garden. Illustrations with brief description of the Herbivora Building. 900 w. Eng News—Feb. 20, 1908. No. 90404.

Market Hall in Breslau between Garten and Friedrich Streets (Markthallenbau in Breslau zwischen Garten- und Friedrichstrasse). Rudolf Heim. Illustrated description of this large arched structure. 1500 w. Serial. 1st part. Beton u Eisen —Jan. 27, 1908. No. 90377 D.

See also Roofs, under CONSTRUCTION; Concrete, under MATERIALS OF CONSTRUCTION; Septic Tanks, under MUNICIPAL; Dams, and Pipe Laying, under WATER SUPPLY; Construction, under ELECTRICAL ENGINEERING, GENERATING STATIONS; Dry Docks, under MARINE AND NAVAL ENGINEERING; and Roundhouses, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Retaining Walls.

See Flood Protection, under WATERWAYS AND HARBORS.

Roofs.

A Study of Roof Trusses. N. Clifford Ricker. Investigations made to determine a formula for the weight of roof trusses more accurate than those used. 3000 w. Bul No. 16, Univ of Illinois—Aug. 19, 1907. No. 90535 N.

The Failure of the Concrete Roof of the Lawrence, Mass., Filter. Abstract of a report by Sanford E. Thompson on the causes of this accident. 1600 w. Eng News—Feb. 27, 1908. No. 90525.

The New Roof of Charing Cross Station. Brief account of the method of removing the old roof, and illustrated detailed description of the new roof of the ridge-and-furrow type. 2000 w. Engng—Feb. 7, 1908. Serial. 1st part. No. 90255 A.

Steel Buildings.

Structural Steel Details of the Brooklyn Academy of Music. Illustrates and describes building details of a steel cage structure. 3000 w. Eng Rec—Feb. 22, 1908. No. 90469.

See also Roofs, and Warehouses, under CONSTRUCTION.

Tunnels.

See Subways, under STREET AND ELECTRIC RAILWAYS.

Warehouses.

The New Steel Warehouse Plant of the Carnegie Steel Co. at Waverly, N. J. Illustrated detailed description of the plant and its equipment. 3500 w. Ir Trd Rev—Feb. 20, 1908. No. 90419.

The Carnegie Steel Company's Newark Warehouses. Illustrates and describes the largest plant in the world for the storage of structural and merchant steel. 1500 w. Ir Age—Feb. 20, 1908. No. 90297.

Water Proofing.

See Steel, under BRIDGES; and Concrete, under MATERIALS OF CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Concrete.

Investigations of Impermeable Concrete by the Laboratory of the Board of Water Supply, New York City. James L. Davis. Read before the Nat. Cement Users' Assn. 1200 w. Engng-Con—Feb. 26, 1908. No. 90563.

Proportions of Concrete and Methods of Mixing. L. C. Wason. Read before the Nat. Assn. of Cement Users, at Buffalo. On the proportions and strength of concrete, equipment, methods, and cost. 3000 w. Eng Rec—Feb. 15, 1908. No. 90207.

Tests to Determine the Effect of Mica on the Strength of Concrete. W. N. Willis. Gives curves showing the results of tests made to determine the effect of mica on the tensile strength of concrete. 500 w. Eng News—Feb. 6, 1908. No. 90086.

Tests on Plain and Reinforced Concrete. Morton Owen Withey. A report of tests of bond; effect of compression reinforcement in beams; overhanging beams; diagonal tension failures and methods of prevention; and tee beams. Ills. 7500 w. Bul Univ of Wis, No. 175—Nov., 1907. No. 90413 C.

Concrete Brick.

The Manufacture of Concrete Bricks from Blast Furnace and Other Slag. Josiah Butler. Read before the Staffordshire Ir. & St. Inst. Illustrated description of a method of utilizing this waste material profitably. 6000 w. Ir & Coal Trds Rev—Jan. 24, 1908. No. 90020 A.

Paints.

See Protective Materials, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Reinforced Concrete.

See Concrete, under MATERIALS OF CONSTRUCTION.

Timber Preservation.

Treating Wood that is Refractory to Treatment and Also Subject to Decay. David Allerton. Abstract of a paper read before the Wood Preservers' Assn. Deals with the creosoting of the Douglas fir. 800 w. Eng News—Feb. 20, 1908. No. 90405.

The Seasoning and Preservative Treatment of Arborvitae Poles. C. Stowell Smith. An illustrated report of experimental investigations on the preserving of this wood. 6500 w. U S Dept of Agri—Circ 136. No. 90540 N.

The Preservative Treatment of Fence Posts. Howard. F. Weiss. Shows how fence posts may be treated and with what results. 3000 w. U S Dept of Agri—Circ 117. No. 90537 N.

United States Wood Preservers' Association. An account of the recent meeting, giving the secretary's report which shows the work already done; with papers on methods of treatment. 5000 w. Ry Age—Jan. 31, 1908. No. 89977.

See also Piling, under CONSTRUCTION.

MEASUREMENT.

Hydrographic Surveying.

Magnetic Survey on the Pacific Ocean. Herbert T. Wade. An illustrated account of the work being executed by the Carnegie Institution of Washington. 1800 w. Sci Am—Feb. 15, 1908. No. 90195.

Stream Flow.

The Gauging of Irrigation Waters (Aforo de las Aguas de Riego). Julian Romero. A mathematical discussion of methods, the first part dealing with the flow over weirs. Ills. 6000 w. Serial. 1st part. Ingenieria—Dec. 30, 1907. No. 90341 D.

Surveying.

Bench Level Operations on the Catskill Aqueduct Line. M. E. Zipser. Gives the principal features of the bench level work from the Ashokan Reservoir to Croton watershed. Ills. 2500 w. Eng News—Feb. 20, 1908. No. 90408.

See also Hydrographic Surveying, under MEASUREMENT; and Surveying, under MINING AND METALLURGY, MINING.

MUNICIPAL.

City Improvement.

Civic Centers and the Grouping of Public Buildings, with a Suggestion for Boston. Stephen Child. Reviews recent developments aiming to beautify cities, with a suggestive study of the possibilities at Boston. Ills. General discussion. 10000 w. Jour Assn of Engng Socs—Jan., 1908. No. 90429 C.

Drainage.

The Run-Off from Sewered Areas. Preliminary report of the committee appointed by the Boston Society of Civil Engineers to collect data bearing on this subject. 1600 w. Eng News—Feb. 27, 1908. No. 90519.

Garbage Disposal.

See Street Cleaning, under MUNICIPAL; and Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Pavements.

Hysteria in Regard to Pavements. Clifford Richardson. A discussion of the paving problem in the United States. 3000 w. Eng Rec—Feb. 15, 1908. No. 90204.

Compressed Rock Asphalts Used on London Roadways. S. A. Ionides. The use of black asphalts and mastic, the preparation, and method of laying and repairing. Ills. 1000 w. Min Sci—Feb. 6, 1908. No. 90113.

Roads.

The Cost of Grading a Wagon Road in Winter. Itemized report of costs. 1200 w. Engng-Con—Feb. 26, 1908. No. 90564.

Experiments with Tar and Oil on the Highways of Rhode Island. Arthur Horace Blanchard. Read before the Am. Assn. for the Adv. of Science. Gives a classification of the highways experimented upon, descriptions and cost data. 3500 w. Eng Rec—Feb. 8, 1908. No. 90100.

Road Resistance. C. E. Morrison. A study of the factors affecting the tractive force per unit load; viz, axle friction, rolling resistances, and grade resistances. 3800 w. Sch of Mines Qr—Jan, 1908. No. 90428 D.

The Commercial Use of Highways. H. Howard Humphreys. From a paper read before the Soc. of Road Traction Engrs., London. Discusses what has already been done in England, the repair of highways and bridges, traffic, etc. General discussion. 9500 w. Surveyor—Feb. 14, 1908. No. 90483 A.

Septic Tanks.

A Septic Tank at Ithaca, New York. Describes the construction of a reinforced concrete septic tank and new outfall. Ills. 1500 w. Eng Rec—Feb. 1, 1908. No. 89964.

See also Sewage Disposal, under MUNICIPAL.

Sewage Disposal.

Investigations on the Purification of Boston Sewage in Septic Tanks and Trickling Filters (1905-1907). C.-E. A. Winslow and Earle B. Phelps. A full account of investigations at the Sewage Experiment Station of the Massachusetts Institute of Technology, with description of the plant and methods. 18000 w. Tech Qr—Dec., 1907. No. 90542 E.

Purification of Boston Sewage: Experimental Results and Practical Possibilities. C.-E. A. Winslow and Earle B. Phelps. A report of investigations at the Sewage Experiment Station of the Massachusetts Institute of Technology, dealing with the coming problem rather than the present. Also discussion. 9500 w. Jour Assn of Engng Socs—Jan., 1908. No. 90430 C.

Discussion on Modern Methods of Sewage Disposal, with Special Reference to the Elimination of Suspended Matters. Also description of sewage disposal works at Leeds, Eng. 7000 w. Jour Roy San Inst—Feb., 1908. No. 90176 B.

Sewerage at Ithaca. Describes the system in use, illustrating the septic tanks. 1500 w. Munic Jour & Engr—Feb. 5, 1908. No. 90026.

Sewerage and Sewage Disposal at Fairmont, Minn. A. Marston. Describes the conditions to be met, and gives an illustrated description of the system as constructed. 1200 w. Eng Rec—Feb. 1, 1908. No. 89961.

Sewage Disposal Plant at the Montefiore Sanitarium. Illustrated description of the plant at Bedford Station, N. Y., designed to handle 30000 gal. per day. 1500 w. Eng Rec—Feb. 15, 1908. No. 90205.

The Use and Removal of the Products of Sewage Purification Plants (Verwertung und Beseitigung des Klärschlammes aus Reinigungsanlagen städtischer Abwässer). Herrn Metzger and Haack. Two papers. 7700 w. Gesundheits-Ing—Jan. 25, 1908. No. 90367 D.

Biological Purification of Sewage (Epuration Biologique des Eaux d'Egout). Paul Vincey. Discusses septic tanks, artificial beds, etc., giving a number of illustrations of methods and results of the best European and American practice. Ills. 16000 w. Bul Soc d'Encour—Dec., 1907. No. 90318 G.

The Utilization of Peat for the Purification of Sewage (Sur l'Utilisation de la Tourbe pour l'Epuration des Eaux d'Egout). MM. A. Müntz and E. Lainé. The results of investigations on the value of peat as an agent in the nitrification of sewage. 1800 w. Comptes Rendus—Jan. 13, 1908. No. 90331 D.

See also Septic Tanks and Sewers, under MUNICIPAL; Canals, under WATERWAYS AND HARBORS; and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Sewers.

A Cast-Iron Pressure Sewer in a Railroad Yard. Describes work at Tompkinsville, Staten Island, N. Y., in the yard of the B. & O. R. R. Ills. 1000 w. Eng Rec—Feb. 15, 1908. No. 90201.

A Suspended Sewer. W. R. Worthington. Illustrates and describes the methods used in a ravine district of Toronto. 1200 w. Can Engr—Feb. 7, 1908. No. 90146.

New Trunk Sewers and Sewage Disposal Works for the City of Regina, Sask. Extracts from the report of Lea and Smith, consulting engineers to the City Council. Describes the present and the recommended works. 7000 w. Can Engr—Feb. 7, 1908. No. 90147.

Progress on the Baltimore Sewerage Works. Notes from the report of Calvin W. Hendrick. Ills. 1500 w. Eng Rec—Feb. 8, 1908. No. 90101.

See also Drainage, under MUNICIPAL.

Street Cleaning.

Street Cleaning and Waste Disposal in New York. A review of conditions, and improvements suggested by a commission appointed by the Mayor to plan a more effective system. 3300 w. Eng Rec—Feb. 22, 1908. No. 90468.

WATER SUPPLY.

Appalachian Watersheds.

Report of the Secretary of Agriculture on the Southern Appalachian and White Mountain Watersheds. James Wilson. On the commercial importance, area, condition, advisability of their purchase for national forests, and probable cost. Maps. 15500 w. Gov Print Office—Doc. No. 91. No. 90536 N.

Aqueducts.

Preliminary Work on the Los Angeles Aqueduct. Illustrates and describes work preparatory to the carrying out of this extensive project, explaining some of the difficulties. 5000 w. Eng Rec—Feb. 8, 1908. No. 90094.

Ashokan.

The Estimated Cost of the Main Ashokan Dams. A statement of the methods followed by the engineers of the Board of Water Supply, with editorial comment. 8500 w. Eng Rec—Feb. 15, 1908. No. 90202.

The Estimated Cost of the Ashokan Reservoir and Data of Actual Cost of Similar Earth Embankments, Together with a Discussion of the Testimony Submitted in the Investigation of the Ashokan Dam Award. 4500 w. Engng-Con—Feb. 12, 1908. Serial. 1st part. No. 90174.

Quality of Bluestone in the Vicinity of the Ashokan Dam. Charles P. Berkey. A summary of the observations, arguments and conclusions from a study of the materials in the vicinity that could be safely utilized in the construction of this great dam. Ills. 3500 w. Sch of Mines Qr—Jan., 1908. No. 90427 D.

Croton Watershed.

How Large a Water Supply Can Be Drawn from Croton Drainage Area, New York City. Alfred D. Flinn. An interesting and valuable article showing the cost of storing the surplus waters in the driest and also the wettest periods, and giving much information relating to water supply. Also editorial. 4500 w. Eng News—Feb. 6, 1908. No. 90088.

Dams.

Reinforced Concrete Diaphragms for Earth Dams. B. M. Hall. Describes the Avalon dam of earth and loose rock, with a reinforced-concrete diaphragm. 700 w. Eng News—Feb. 6, 1908. No. 90085.

The Construction of the Laguna Dam, Colorado River, Arizona. States the conditions and requirements of the Yuma valley irrigation project, and the method of building a rock-filled dam 4800 ft. long and 226 ft. wide, with three concrete core walls, practically under water. Ills. 2500 w. Eng News—Feb. 27, 1908. No. 90517.

The High Needle Dams on the Big Sandy River, U. S. A. B. F. Thomas. Illustrates and describes dams of the movable type, that are lowered on to the bed of the river in times of freshet. Plates. 2200 w. Engng—Jan. 17, 1908. No. 90042 A.

The Gileppe Dam (Barrage de la Gileppe). M. Bodson, D. Detienne and F. Leclercq. Illustrated description of the design of this large masonry dam. 3500 w. All Indus—Jan., 1908. No. 90330 D.

The Construction of Earth Dams by Hydraulic Filling (La Construction des Barrages en Terre par Remblayage Hydraulique). A. Dumas. Illustrates and describes work on several dams in America built by this method. 5000 w. Génie Civil—Jan. 11. 1908. No. 90333 D.

See also Ashokan, and Sluice Gates, under WATER SUPPLY.

Evaporation.

Studies on the Rate of Evaporation at Reno, Nevada, and in the Salton Sink. Frank H. Biglow. Briefly describes this region and the formation of the Salton Sea, and gives results of studies made of the rate of evaporation. Ills. 4000 w. Nat Geog Mag—Jan., 1908. No. 90412 C.

Filtration.

The Development of the Mechanical Filter Plant. Phillip Burgess. Read before the Ohio Engng Soc. Indicates the development from the early wooden tub to the modern concrete tank. 5000 w. Eng Rec—Feb. 22, 1908. No. 90475.

The Didelon Regulator for Filter-Beds. Illustrated description of an apparatus in use in Europe. 700 w. Engng—Jan. 17, 1908. No. 90048 A.

Irrigation.

Irrigation Plants in Egypt (Aegyptische Bewässeranlagen). E. F. Huber. Illustrates and describes several large pumping plants installed by Sulzer Brothers. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 11, 1907. No. 90381 D.

New York City.

See Croton Watershed, under WATER SUPPLY.

Pipe Corrosion.

Electrolysis. Albert F. Ganz. Read before the Am. Gas Inst. A report of tests and investigations, with general discussion. 6000 w. Pro Age—Feb. 1, 1908. No. 89974.

Investigations on the Rusting of Iron (Untersuchungen über das Rosten von Eisen). A. Schleicher and G. Schultz. Results of investigations to determine whether cast iron is more susceptible to electrolytic corrosion than wrought iron. Ills. 2000 w. Stahl u Eisen—Jan. 8, 1908. No. 90345 D.

Pipe Laying.

A Traveling Mold for Making Reinforced-Concrete Pipe. F. Teichman. Illustrated description of the design and working of these forms. 2500 w. Eng. News—Feb. 20, 1908. No. 90407.

Pipe Lines.

See Water Works, under WATER SUPPLY.

Pueblo, Col.

An Unusual Water Supply for Industrial Purposes. The design, construction and operation of the water supply system of the Minnequa steel works at Pueblo, Colo., is illustrated and described. 5000 w. Eng Rec—Feb. 22, 1908. No. 90464.

Purification.

Water Purification in Ohio. Notes from a preliminary report recently made by R. Winthrop Pratt, of the State Board of Health. 3800 w. Eng Rec—Feb. 22, 1908. No. 90470.

Reservoirs.

See Pueblo, Col., and Water Works, under WATER SUPPLY.

Sluice Gates.

Electrically Operated Sluice Gates and Drop-Timber Regulator Gates for the Laguna Dam. F. W. Hanna. Illustrates and describes these large sluice gates and their operating machinery. 2000 w. Eng. News—Feb. 27, 1908. No. 90518.

Stream Flow.

A Logarithmic Diagram for the Flow of Water in Open Channels. George T. Prince. Gives a diagram based upon the Chezy formula, with explanation. 300 w. Eng News—Feb. 6, 1908. No. 90083.

Stream Gauging.

See Stream Flow, under MEASUREMENT.

Typhoid Fever

See Washington, D. C., under WATER SUPPLY.

Washington, D. C.

Water Supply and Typhoid Fever at Washington, D. C. Information presented at a meeting of the Medical Society of the District of Columbia, with editorial. 5000 w. Eng News—Feb. 27, 1908. No. 90521.

Water Works.

The Construction of Small Water Works. The Kilbirnie works, in Ayrshire, Scotland, are illustrated and described as an example of a case where gravitation supply is available. 2500 w. Engng—Jan. 31, 1908. No. 90137 A.

The Water-Works of Portland, Ore. W. P. Hardesty. History and illustrated description of the works, pipe lines, reservoir system, etc. 5500 w. Eng News—Feb. 6, 1908. No. 90082.

WATERWAYS AND HARBORS.

Barge Canal.

See Locks, under WATERWAYS AND HARBORS.

Breakwaters

History of the Reaction Breakwater at Aransas Pass, Texas. Lewis M. Haupt. Maps. 10000 w. Jour Fr Inst—Feb., 1908. No. 90431 D.

Canals.

System of Natural Transportation by Water. Brief illustrated description of a scheme, devised by an Italian civil engineer, in which the propulsion of the boat is effected by hydraulic differences of level. 1800 w. Prac Engr—Feb. 14, 1908. No. 90484 A.

The Future of the Chicago Drainage Canal. Editorial review of the various phases of sewage disposal, water supply, harbor facilities and other subjects affecting the future usefulness of this costly waterway. 4500 w. Eng News—Feb. 13, 1908. No. 90169.

See also German Canals, and Panama Canal, under WATERWAYS AND HARBORS.

Dredging.

See Dredges, under MARINE AND NAVAL ENGINEERING.

Flood Protection.

Flood Protection Along Cherry Creek in Denver, Colorado. Describes the reinforced-concrete retaining walls which form the sides of the new channel. Ills. 1400 w. Eng Rec—Feb. 15, 1908. No. 90200.

See also Dams, under WATER SUPPLY; and Levees, under WATERWAYS AND HARBORS.

Floods.

The Flood of March, 1907, in the Sacramento and San Joaquin River Basins, California. W. B. Clapp, and W. F. Martin, Jun. A study of the topography and drainage of the region, the climate, flood conditions and causes, precipitation, flood flow, effects, etc. Map. 14500 w. Pro Am Soc of Civ Engrs—Feb., 1908. No. 90554 E.

German Canals

The Development of Inland Navigation in Germany from 1875 to 1905 (Die Entwicklung der deutschen Binnenschiffahrt in den Jahren 1875-1905). Herr Ragoczy. Gives details of the waterways and statistics of the freight traffic. 4500 w. Glückauf—Jan. 4, 1908. No. 90353 D.

Harbors.

See Canals, under WATERWAYS AND HARBORS.

Italian Waterways.

The Technical Problems of Inland Navigation (Il Problema Tecnico sulla Navigazione Interna). Edoardo Sassi. Discusses the problems in the attempt to improve inland navigation in Italy. 5500 w. Ann Soc Ing Arch Italiani—Jan., 1908. No. 90338 F.

Levees.

Closing a 700-Foot Break in the Mississippi Levees. Paul J. Brand. An illustrated account of the methods and new features of this important work. 2000 w. Sci Am—Feb. 22, 1908. No. 90478.

Lighthouses.

Sangandeb Lighthouse, Red Sea. Illustrated description of the construction of this lighthouse for the new harbor of Port Sudan, the sea terminal of the new railway connecting the Nile with the Red Sea. 1500 w. Engr, Lond—Jan. 24, 1908. No. 90018 A.

Locks.

Construction of Lock 3, Erie Barge Canal. Oscar Hasbrouck. Illustrates and describes the lock at Waterford, N. Y. 1000 w. Eng Rec—Feb. 8, 1908. No. 90097.

Marine Growths.

The Water Hyacinth. G. C. Scherer. An account of what has been done to rid the streams in the south of this troublesome growth which obstructs navigation and causes other troubles. 1200 w. Eng News—Feb. 20, 1908. No. 90409.

North Sea.

The Strategical Position in the North Sea as Strengthened by the "Forth and Clyde Battleship Canal" and the "Dover and Sangatte Tube Railway." Sir Charles Campbell, with general discussion. 14500 w. Jour Roy U Serv Inst—Jan., 1908. No. 90178 E.

Panama Canal.

The Panama Canal: A Brief Statement of Work, Equipment and Finances. Condensed statement of report of the Isthmian Canal Commission. 1000 w. Eng News—Feb. 13, 1908. No. 90167.

See also Panama Railway, under RAILWAY ENGINEERING, MISCELLANY.

Piers.

Sheathing Piers on Lake Erie with Divers. Wilson T. Howe. Describes work at Huron, O. 1200 w. Eng News—Feb. 20, 1908. No. 90406.

Transfer Bridges.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Water Powers.

The Great Water Powers of the Alps (Etude des Grandes Forces Hydrauliques de la Region des Alpes). Paul Lévy-Salvador. Their importance and extent, and the work and methods of a commission recently appointed to study them. Ills. 3000 w. Serial. 1st part. Génie Civil—Jan. 18, 1908. No. 90335 D.

MISCELLANY.

Caisson Disease.

The Hygiene of Work in Compressed Air. J. S. Haldane. A short account of the causes and prevention of the troubles and dangers to health associated with work in compressed air. 9000 w. Jour Soc of Arts—Jan. 24, 1908. No. 90002 A.

Review of 1907.

The Progress of Electrical Science During 1907. E. E. Fournier d'Albe. A review of advances and theories discussed in the many papers submitted. 3300 w. Elect'n, Lond—Feb. 14, 1908. Serial. 1st part. No. 90490 A.

ELECTRICAL ENGINEERING

COMMUNICATION.

Fire Alarm.

An English Automatic Fire-Alarm System. Illustrated description of the May-Oatway system, in use in England and Scotland. 1200 w. Eng News—Feb. 6, 1908. No. 90089.

Radio-Telegraphy.

Recent Patents in Wireless Telegraphy. W. H. Eccles. Discusses the noteworthy patents of the past year. 3500 w. Elect'n, Lond—Jan. 24, 1908. Serial. 1st part. No. 90011 A.

Telegraphy.

Duplex and Quadruplex Operation with Ordinary Telegraph Instruments (Duplex et Quadruplex Réalisables au Moyen des Appareils Télégraphiques Ordinaires). M. Henry. Illustrated description of method. 2500 w. Soc Belge d'Elect'n—Jan., 1908. No. 90308 E.

elephony.

Telephone Progress During the Past Year. B. S. Cohen. Gives statistics for the United Kingdom. 1200 w. Elect'n, Lond—Feb. 7, 1908. No. 90252 A.

DISTRIBUTION.

witches.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE.

iring.

The Kuhlo System of Protected Wiring for Interiors (Conducteurs Cuirassés pour Installations Intérieures Système Ernst Kuhlo). J. A. Montpelier. Illustrated detailed description of new devices for wire suspension, insulators, etc. 2400 w. Electricien—Jan. 4, 1908. No. 90323 D.

DYNAMOS AND MOTORS.

C. Dynamos.

A High-Frequency Alternator. Louis Cohen. Suggests a building up process of attaining high frequencies from a number of alternators on a common shaft. 1200 w. Elec Wld—Feb. 15, 1908. No. 90161.

C. Dynamos.

The Armature in Direct-Current Machines (Ueber die Ausnützung der Anker von Gleichstrommaschinen). Thomas Rosskopt. A mathematical discussion of its design. Ills. 4400 w. Elektrotech u Maschinenbau—Jan. 5, 1908. No. 90368 D.

C. Motors.

See Interpoles, under DYNAMOS AND MOTORS.

fficiency.

Standard Performances of Electrical Machinery. Dr. Rudolph Goldschmidt. Puts forward suggested figures for standard performances, efficiencies, etc., which may serve as private standards. Particulars are mostly given in form of curves, with comments. 5000 w. Inst of Elec Engrs—Jan., 1908. No. 90013 N.

eating.

The Heat Conductivity of Iron Stampings. Thomas Morgan Barlow. Describes investigations made on the rate of flow of heat in electrical machines built up of iron stampings. Ills. 3500 w. Inst of Elec Engrs—Jan., 1908. No. 90010 N.

duction Motors.

See Motor Testing, under MEASUREMENT.

terpoles.

Variable-Speed Commutating-Pole Motors. A. G. Ellis. Gives calculation tending to show that the permissible maximum e. m. f. between segments is soon reached in these motors. Ills. 2500 w. Elec Wld—Feb. 8, 1908. No. 90065.

ilway Motors.

Choice Railway Motors as Influenced by Gear Ratio. P. Gesing. Abstracted from *Elek. Kraft. und Bahnen.* Explains a graphical method of arriving at the most favorable conditions as regards watt-seconds per ton-meter. Also short note by W. Bethge, on the "Effect of Gear Ratio on Energy Consumption." 1000 w. Elect'n, Lond—Jan. 31, 1908. No. 90131 A.

Slot Openings.

The Reduction of Slot Openings by Means of Iron Bridge-Pieces. Gives an account of experiments made by Dr. R. Goldschmidt. 800 w. Elec Rev, Lond—Feb. 7, 1908. No. 90249 A.

Synchronous Motors.

The Synchronous Motor. Prof. C. A. Adams. The first of a series of articles aiming to give a thorough understanding of the physical phenomena involved in synchronous motor operation. 5000 w. Harvard Engng Jour—Jan., 1908. Serial. 1st part. No. 90186 D

ELECTRO-CHEMISTRY.

Cells.

Recent Developments in Electrolytic Cells. Henry Stanley Renaud. An illustrated description of the Billitzer cell, with brief notes on other well known types. 1000 w. Eng & Min Jour—Feb. 22, 1908. No. 90458.

Corrosion.

The Corrosion of Steel. Allerton S. Cushman. An explanation of the electrochemical or electrolytic theory, now generally accepted. 3500 w. Jour Fr Inst—Feb., 1908. No. 90432 D.

See also Pipe Corrosion, under CIVIL ENGINEERING, WATER SUPPLY.

Electro-Metallurgy.

Process and Apparatus for the Production of Carbon Bi-Sulphide in the Electric Furnace. Edward R. Taylor. Illustrated detailed description. 5000 w. Jour Fr Inst—Feb., 1908. No. 90434 D.

The Manufacture of Calcium Cyanamide —The Beginnings of a New Electrical Industry. John B. C. Kershaw. Facts relative to the development of the Frank and Caro process for the fixation of nitrogen. 4000 w. Elect'n, Lond—Jan. 24, 1908. No. 90012 A.

See also same title, under MINING AND METALLURGY, IRON AND STEEL.

Indigo.

The Reduction of Indigo by Electrolysis (La Réduction de l'Indigo par Voie Electrolytique). M. Chaumat. A description of the author's researches on the use of electrolysis for breaking down organic substances. 6000 w. Bul Soc Int d'Elecns—Jan., 1908. No. 90310 F.

Nitrogen.

The Fixation of Atmospheric Nitrogen (La Fixation de l'Azote Atmosphérique au Moyen de l'Electricité). M. Blondin. The importance of the industry, methods, etc. 5000 w. Bul Soc Int d'Elecns—Jan., 1908. No. 90309 F.

Ozone.

The Actual State of the Ozone Industry (L'Etat Actuel de l'Industrie de l'Ozone). H. de la Coux. Its production by electric discharges and its industrial uses. 6800 w. Rev Gen des Sciences —Jan. 30, 1908. No. 90322 D.

ELECTRO-PHYSICS.

Solenoids.

The Self-Inductance of a Coil of Any Length Wound with Any Number of Layers of Wire. Edward B. Rosa. Shows how one may obtain accurately the self-inductance of such coils. 2200 w. Bul Bureau of Stand—Jan., 1908. Vol. 4, No. 3. No. 90528 N.

Self-Inductance of a Solenoid of Any Number of Layers. Louis Cohen. Develops a formula which will give results accurate to within one-half of 1 per cent. even for a short solenoid; the accuracy increasing with the length. 1200 w. Bul Bureau of Stand—Jan., 1908. Vol. 4, No. 3. No. 90529 N.

Thermo-Electric Properties.

Thermo-Electric Properties of Common Metals and Their Alloys. A. G. Warren and F. Murphy. A report of experimental investigations. 1000 w. Elect'n, Lond—Jan. 31, 1908. No. 90132 A.

GENERATING STATIONS.

Central Stations.

Electrical Generating Station at Brussels. Illustrated detailed description. 2500 w. Engr, Lond—Jan. 31, 1908. No. 90144 A.

Greenock Electricity Department. Brief illustrated description of the opening of a new refuse destructor station. 1700 w. Elec Engr, Lond—Feb. 14, 1908. No. 90486 A.

Power Plant of the Borough of Pennsburg, Pa. Illustrates and describes an electric plant for a borough of about 1,000 population, generating current with oil engines. 1500 w. Engr, U S A—Feb. 15, 1908. No. 90271 C.

Plant of the Urbana (Illinois) Light, Heat & Power Co. Illustrated description of the plant, which runs in close connection with the Champaign, Peoria, and Danville plants. 2500 w. Engr, U S A —Feb. 1, 1908. No. 89993 C.

See also Power Plants, under MECHANICAL ENGINEERING, Power and Transmission.

Construction.

The Westport Reinforced Concrete Power House. Illustrated description of a power house on the outskirts of Baltimore, Md. 3000 w. Eng Rec—Feb. 1, 1908. No. 89958.

Hydro-Electric.

The Sanitary District of Chicago's Hydroelectric Development on the Chicag Drainage Canal. Illustrated detailed description. 2500 w. Elec Rev, N Y—Fe 8, 1908. No. 90093.

The Largest Electric Supply System i Vermont. Illustrated description of th system of the Consolidated Lighting C of Montpelier, which supplies electricit from Bolton Falls to Williamstown, a dis tance of 26 miles. 3000 w. Elec Re N Y—Feb. 1, 1908. No. 89965.

Power Transmission from Caffaro t Brescia. Illustrated detailed descriptio of the installation on the falls of the rive Caffaro, which provides power for sod works, and for general purposes. 1800 v Elect'n, Lond—Feb. 14, 1908. Serial. 1s part. No. 90488 A.

The Brusio Power Plants and Powe Distribution in Lombardy (Die Kraft werke Brusio und die Kraftübertragun nach der Lombardei). The first part c the serial discusses the dam, sluices, etc for this station in Italy. Ills. 2500 w Serial. 1st part. Schweiz Bau—Jan. 4 1908. No. 90357 B.

See also Water Powers, under CIVIL ENGINEERING, Waterways and Harbors; and Power Plants, under MECHANICAL ENGINEERING, Power and Transmission.

Isolated Plants.

The Power Plant of a Newark Newspaper. Plan and description of the nev power plant of the New Jersey "Frei Zeitung." 2500 w. Eng Rec—Feb. 22 1908. No. 90471.

Small Turbine Plants. Abstracts o papers by J. L. Hecht, and C. W. Pe Dell, read before the N.-W. Elec. Assn. bearing on the equipment and operation o small turbo-electric steam-driven plants 2500 w. Elec Rev, N Y—Feb. 1, 1908 No. 89966.

See also Power Plants, under MECHANICAL ENGINEERING, Power and Transmission.

Portable.

The "Energy Car," a Portable Generating Set (L' "Energy Car," Groupe Electrogène Transportable). J. A. Montpellier. Illustrated description of a truck carrying an internal-combustion motor, a dynamo, and a battery of accumulators 2000 w. Electricien—Jan. 18, 1908. No 90325 D.

Testing.

See Power Plants, under MECHANICAL ENGINEERING, Power and Transmission.

LIGHTING.

Arc Lamps.

Modern Arc Lighting. William A. De

Mar. An account of modern developments in this field. Elec Age—Feb., 1908. No. 90040.

See Mechanical Plants, under MECHANICAL ENGINEERING, Power and Transmission.

Incandescent Lamps.

A Comparison of the Effects of Frequency on the Light of Incandescent and Nernst Lamps. Frederick William Huels. An experimental study. 8000 w. Bul Univ of Wis, No. 157—May, 1907. No. 90415 C.

Transformers.

The Design of Small Transformers for Metallic Filament Lamps. F. B. O'Hanlon. Considers the manufacture of transformers by any one who has a lathe and the usual bench tools, showing how good results can be obtained. 3500 w. Elec Rev, Lond—Jan. 31, 1908. No. 90128 A.

MEASUREMENT.

Inductance.

Measurement of the Coefficient of Self-Induction of a Circuit Under Normal Load. C. C. Chapin. Suggests a method employing a differential alternating-current galvanometer, and a non-inductive resistance equal to that of the line. 1500 w. Elec Wld—Feb. 8, 1908. No. 90066.

Inductance Measurements. Albert Campbell. Also, "On the Use of Variable Mutual Inductances." The latter paper describes a special form of direct reading variable inductance and some of the uses. The first article discusses some of the points of interest, as a supplement to this paper. 3500 w. Elect'n, Lond—Feb. 7, 1908. No. 90250 A.

Instrument Testing.

The Testing of Electrical Instruments (Ueber Zählerprüfeinrichtungen). Ernst Kraus. Illustrates and describes methods and devices recently developed by Siemens and Halske. 4400 w. Elektrotech u Maschinenbau—Jan. 26, 1908. No. 90-371 D.

Motor Testing.

The Hopkinson Test as Applied to Large Induction Motors. N. Pensabene-Perez. Describes a complete Hopkinson test as applied to four large induction motors. 1200 w. Elec Rev, Lond—Jan. 24, 1908. No. 90009 A.

Power Factor.

The Estimation of Power-Factor on Unbalanced Three-phase Loads. H. S. Baker. Explanation of a method found useful. 1000 w. Elec Age—Jan., 1908. No. 90038.

TRANSMISSION.

Line Construction.

Transmission Line Crossings Over Railroads. Ralph D. Mershon. Discusses possible dangers and methods of protection. 2200 w. R R Gaz—Feb. 7, 1908. No. 90080.

Line Design.

The Central Station Distributing System. H. B. Gear. An explanation of feeder calculations. 2000 w. Elec Age—Jan. 1908. No. 90039.

The Calculation of Electrical Transmission Lines (Statische Berechnung elektrischer Freileitungen). August Kann. A mathematical discussion of the stresses in transmission wires and the determination of sag, span, and size of wires. Ills. 2400 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Jan. 24, 1908. No. 90363 D.

Motor Generators.

Motor Generators: Their Use and Operation. Norman G. Meade. Explains the applications to which they are suited, illustrating the manner in which the connections are made. 1600 w. Power—Feb. 11, 1908. No. 90152.

Poles.

Recent Experiments in Concrete Pole Construction with Figures of Cost. Gives results of studies of this material for poles, with editorial on the difficulties in handling them. 2500 w. Engng-Con—Jan. 29, 1908. No. 89937.

Consumption of Poles in 1906. Information based on the number of poles purchased. 2000 w. U S Dept of Agri—Circ 137. No. 90538 N.

See also Timber Preservation, under CIVIL ENGINEERING, Materials of Construction.

Protective Devices.

The Protection of Electric Circuits and Apparatus from Lightning and Similar Disturbances. R. P. Jackson. The present article considers the causes and effects of static disturbances. Ills. 2000 w. Elec Jour—Feb., 1908. Serial. 1st part. No. 90425.

Transformers.

Systematic Testing of Oil in Transformers and Methods of Reclaiming Oil for Service. Illustrated description of methods. 1000 w. Elec Age—Jan., 1908. No. 90041.

The Berry Series Transformer Switch for Saving Light Load Losses. Illustrated detailed description of this system. 2000 w. Elec Engng—Feb. 6, 1908. No. 90217 A.

Wire Suspension.

A New Method of Supporting Overhead Conductors. Illustrates and describes the improved tangential suspension system of P. J. Pringle which overcomes many troubles. 2500 w. Elec Rev, Lond—Jan. 24, 1908. No. 90007 A.

MISCELLANY.

Electric Shocks.

Electric Shocks. Henry M. Phillips. An explanation of the nature and dangers of electric currents. 4000 w. Cassier's Mag—Feb., 1908. No. 90278 B.

Peru.

Electricity in Peru. Emile Guarini. An account of the conditions, installations, education in electrical engineering, etc. 2000 w. Elec Rev, Lond—Feb. 7, 1908. No. 90248 A.

INDUSTRIAL ECONOMY

Contracts.

The Supply of Machinery and the Law (Die Machinenlieferung und das Gesetz). Rich. Wahle. A discussion of contracts and their performance in the purchase of machinery. 2000 w. Serial. 1st part. Technik u Wirtschaft—Jan., 1908. No. 90388 D.

Cost Systems.

Engine Costs. H. Weatherall. Abstract of a paper read before the N. E. Coast Assn. of Sec. Describes method used to compute cost from the workman's time sheet to the finished article. 5500 w. Ir & Coal Trds Rev—Feb. 14, 1908. No. 90507 A.

Labor-Cost Distribution at the General Electric Shops. George Frederic Stratton. A description of the interesting system used, giving the time card, and piece slip forms, and labor sheets. 2800 w. Engineering Magazine—March, 1908. No. 90576 B.

The Efficiency Method of Determining Costs to Eliminate All Wastes from Foundry Operations. Harrington Emerson. From an address delivered before the Pittsburg Found. Assn. Describes a system which gives valuable information concerning the cost of each operation, materials, etc., before the work is begun. 2000 w. Ir Trd Rev—Jan. 30, 1908. No. 89939.

Education.

Education and the Engineer. Editorial on the recent discussions at meetings of societies. 3500 w. Engr, U S A—Feb. 15, 1908. No. 90272 C.

Is Engineering to Become a Trade? Arthur L. Rice. A discussion of the requirements of industrial education. 5000 w. Sib Jour of Engng—Feb., 1908. No. 90437 C.

The Un-Academic Side of Engineering. Frank Foster. Considers the relation of academic studies to rational engineering, discussing features essential to success, that are un-academic. 3500 w. Mech Engr—Feb. 1, 1908. No. 90127 A.

The Making of an Electrical Engineer. George Frederic Stratton. Outlines the preparation given in the shops of the General Electric Co. 1600 w. Sci Am—Feb. 8, 1908. No. 90108.

Relation of the Mining School to the Mining Industry. Robert H. Richards. Read before the Am. Min. Cong. Brief discussion of the aims the school should have in view. 1500 w. Tech Qr—Dec., 1907. No. 90541 E.

Engineering Ethics.

The Engineer as a Man Among Men. Extracts from an address by Charles Whiting Baker at the dinner of the engineering graduates and students of the University of Vermont. 1800 w. Eng News—Feb. 20, 1908. No. 90411.

Filing Systems.

A System of Filing Engineering Notes and Records. Describes a system developed by Lewis C. Kelsey. 3000 w. Eng Rec—Feb. 8, 1908. No. 90098.

Labor.

The Amalgamated Society of Railway Servants. Outlines the scheme for conciliation and arbitration. 3000 w. Bul Int Ry Cong—Jan., 1908. No. 90289 E.

Cost of Living of the Working Classes. Abstracts from a recent report issued by the British Board of Trade on the cost of living in the industrial towns of the United Kingdom. 2800 w. Ir & Coal Trds Rev—Feb. 14, 1908. Serial. 1st part. No. 90508 A.

Enforced Idleness; Its Causes and Means of Preventing It or of Lessening Its Effects (Causes du Chamage Involontaire; Moyens de le Prévenir ou d'Atténuer ses Effets). Henri Lafranc. An economic discussion of the causes which lead to unemployment and the possible solutions of the problem. 3500 w. Rev d'Econ Indus—Jan. 16, 1908. No. 90301 D.

Municipal Ownership.

An American View of Municipal Trading. Reviews the report of the Commission upon Public Ownership and Operation appointed to investigate this subject in the United Kingdom and the United States. 3500 w. Engng—Feb. 7, 1908. Serial. 1st part. No. 90259 A.

Patents.

The Reform of the Patent Law. John William Gordon. Discusses clauses of the Amending Act of 1907, in England. Also general discussion. 13500 w. Jour Soc of Arts—Jan. 31, 1908. No. 90121 A.

MARINE AND NAVAL ENGINEERING

Compasses.

The Empirical Compensation of the Mariner's Compass (Compensazione Empirica delle Bussole). Roberto M. de Bellegarde. A thorough description of the method. 2000 w. Rivista Marit—Jan., 1908. No. 90337 E + F.

Cruisers.

Cruisers—British and Foreign. A review of modern construction and armament. 2000 w. Engng—Feb. 7, 1908. No. 90256.

A German Motor Cruiser. Prof. Walter Mentz. From *Schiffbau.* Illustrated description of the "Oueslphalia." 900 w. Int Marine Engng—March 1908. No. 90510 C.

Dredges.

Hydraulic Dredge for Reclaiming Land for Lincoln Park, Chicago. Illustrated description of the dredge "Francis T. Simmons." 800 w. Eng News—Feb. 27, 1908. No. 90520.

Dry Docks.

Quay Walls for the New Dry Dock at the Charleston Navy Yard. Illustrates and describes the design and construction of exceptionally massive walls built of concrete, heavily reinforced with steel bars, and with buttresses on 15-ft. centers. 2200 w. Eng Rec—Feb. 1, 1908. No. 89959.

Hydroplanes.

The Crocco-Ricaldoni Hydroplane Boat. J. B. Van Brussel. Illustrates and describes an experimental boat, provided with hydroplanes only at the stem and stern. 500 w. Int Marine Engng—March, 1908. No. 90511 C.

Marine Transport.

The Work of Atlantic Liners. Editorial on the traffic and the recent scheme of fares which is likely to continue for three years. 1800 w. Engng—Feb. 14, 1908. No. 90499 A.

Motor Boats.

See Cruisers, under MARINE AND NAVAL ENGINEERING.

Oil Engines.

Paraffin Engine for Submarines. Illustrated description of this motor for the Italian Navy, with report of trials. 1400 w. Engr, Lond—Feb. 7, 1908. No. 90265 A.

Resistance.

A Note on the Theory of Ship's Resistance of H. Lorenz (Bemerkungen zur Schiffswiderstandstheorie von H. Lorenz). A mathematical discussion of H. Lorenz's article in the *Zeitschr. d. Ver. Deutscher Ing.* Ills. 1500 w. Serial. 1st part. Schiffbau—Jan. 8, 1908. No. 90358 D.

Shipbuilding.

The Interrelation of Theory and Practice of Shipbuilding. J. J. O'Neill. An examination of the speed-power aspect of the question. Plates. 5700 w. Inst of Engrs & Shipbldrs in Scotland—Jan. 21, 1908. No. 90555 N.

Modern Tendencies in Ship Building. J. Foster King, in *Glasgow Herald.* A review of progress and development. 3500 w. Marine Rev—Feb. 13, 1908. No. 90190.

Stability.

An Inclining Experiment. Harold F. Norton. Describes the process as performed on one of the late battleships, by which it is determined whether a ship will stand up straight and true when consigned to the water. 2200 w. Sib Jour of Engng—Feb. 1908. No. 90436 C.

Steamboats.

Stern-Wheel Steamer "Sultan" for the River Niger. Illustrated description of the vessel and its machinery. 1800 w. Engng—Jan. 31, 1908. No. 90141 A.

Steam Boilers.

Water-Tube Boilers in War Vessels (Die Wasserrohrkessel im Kriegschiffbetriebe). C. Strebel. Discusses various types of water-tube boilers and gives details and statistics of their use on war vessels. Ills. 6000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Jan. 4, 1908. No. 90379 D.

Steam Engines.

Proportions of Parts of Triple-Expansion Engines. John Green. Calls attention to the advantages of these engines for marine work, and gives details of construction. 2000 w. Engr, U S A—Feb. 1, 1908. No. 89994 C.

Steamships.

The Steam Collier "Everett," for the New England Coal and Coke Company, Boston, U S A. Illustrations, plan, and brief description. 500 w. Engng—Feb. 7, 1908. No. 90257 A.

The Iron-Ore-Carrying Steamer "Polcirkeln." Illustrated description of a vessel recently built at Gothenburg. 300 w. Engng—Jan. 17, 1908. No. 90045 A.

The Twin-Screw Allan Liner "Corsican." Plate and description of a vessel illustrated in the Jan. 10th issue. 2000 w. Engng—Jan. 24, 1908. No. 90024 A.

The New Brazilian Liner Verdi. Illustrated description of a steamship, built in Belfast, to carry cargo and passengers between New York and South America. 1000 w. Int Marine Engng—March, 1908. No. 90509 C.

Steam Turbines.

See Torsion Meters, under MECHANICAL ENGINEERING, MEASUREMENT.

Submarines.

Italy's Progress in Submarine Navigation. Interesting details of boats of the submersible type for the Italian Government. 2500 w. Engr, Lond—Feb. 14, 1908. No. 90502 A.

See also Oil Engines, under MARINE AND NAVAL ENGINEERING.

Tank Steamers.

Safety Installations for Tank Steamers (Installations de Sécurité à Bord des Tanksteamers). M. M. Dibos. Discusses the transport of oil in bulk, its dangers, history, regulation, etc., and the construction of tank steamers to secure safety from fire, explosions, etc. Ills. 15000 w. Mem Soc Ing de France—Nov., 1902. No. 90304 G.

Torpedo Boats.

The Development of Torpedo Craft. Illustrations are given, showing the development of the speed element. Also describes H. M. S. "Tartar." 800 w. Cassier's Mag—Feb., 1908. No. 90280 B.

Tugs.

Two New Dialogue-Built Tugs for Service on the Pacific Coast. Illustrated description. 1000 w. Naut Gaz—Feb. 6, 1908. No. 90037.

New Harbor Tug for New Haven Railroad. Illustrated description of Transfer No. 21, constructed for the purpose of towing large steel car-floats between terminals. 500 w. Naut Gaz—Feb. 20, 1908. No. 90290.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

The Air Cooling of Cylinders (Beitrage zur Frage der Zylinderkühlung durch Luft). Herr Schwerdtfeger. A general discussion of the question. Ills. 4000 w. Zeitschr d Mit Motorwagen-Ver—Jan. 31 1908. No. 90373 D.

Cabs.

The Fiat Cab. Illustrated detailed description of this live-axle car. 1200 w. Auto Jour—Feb. 1, 1908. Serial. 1st part. No. 90123 A.

Carbureters.

The Evolution of the Petrol Carbureter. J. Wright. An illustrated article describing modern types showing the trend toward automatic action. 4000 w. Cassier's Mag—Feb., 1908. No. 90274 B.

Some of the Venturi Tube Peculiarities. E. A. Huene. Gives conclusions from a recent article by David Landau, showing the limitations of the Venturi tube carbureter, and suggests improvements. 1500 w. Automobile—Feb. 6, 1908. No. 90067.

Commercial Vehicles.

The Royal Light Delivery-Van. Illustrations with brief description. 400 w. Engng—Jan. 31, 1908. No. 90139 A.

See also Cabs, Omnibuses, and Road Trains, under AUTOMOBILES.

Competitions.

Across Three Continents by Automobile. An illustrated description of the cars and their equipment. 3000 w. Automobile—Feb. 13, 1908. No. 90170.

Coventry Humber.

The New 10-12 H. P. Coventry Humber. Illustrates and describes the more interesting features of this car. 1500 w. Autocar—Jan. 25, 1908. No. 90005 A.

De Dion.

The 12-H. P. Four-Cylinder De Dion Car. Begins a detailed description of this small four-cylinder car. Ills. 1000 w. Autocar—Feb. 15, 1908. Serial. 1st part No. 90482 A.

Designs.

Racing Influence on Touring Car Design. S. F. Edge. Abstract of a paper read before the Coventry Engng. Soc. Names the points essential to a luxurious modern touring-car and discusses how much racing may be credited with its evolution. 3000 w. Auto Jour—Feb. 1, 1908. No. 90125 A.

See also Roller Bearings, under MACHINE ELEMENTS AND DESIGN.

Electric.

See Front Driving, and Road Trains, under AUTOMOBILES.

Front Driving.

Front Driving. H. S. Hele-Shaw. Abstract of a paper read before the Incor. Inst. of Auto. Engrs. With special reference to electric and hydraulic transmission. 2000 w. Auto Jour—Jan. 25, 1908. Serial. 1st part. No. 90003 A.

The Front Driving of Steam and Petrol Vehicles. R. W. Harvey Bailey. Abstract of a paper read before the Inst. of Auto. Engrs. A study of the effect of the application of the propelling force on the stability of the vehicle. 2000 w. Auto Jour—Jan. 25, 1908. Serial. 1st part. No. 90004 A.

Garages.

Generating Station, Garage and Equipment of the Auto Transit Company of

Philadelphia, Pa. Illustrated detailed description of plant and vehicle equipment. 2000 w. Elec Wld—Feb. 22, 1908. No. 90299.

Gasoline Meter.

A Gasoline Meter for Automobile Use. Illustrated description, with explanation of the principle on which it is based. 1500 w. Automobile—Feb. 6, 1908. No. 90068.

Gears.

Gear Arrangements and Ratios in Motor-Cars. Gives method of calculating the efficiency of various arrangements, and discusses the problem of getting the greatest speed over varying roads out of a given sized engine. 3000 w. Engng—Jan. 31, 1908. No. 90136 A.

Gregoire.

The 10-14 H. P. Gregoire. Illustrated description of this light car. 1200 w. Autocar—Feb. 1, 1908. No. 90122 A.

Ignition.

High-Tension Magneto Ignition Systems. Illustrated description of the Mira magneto. 2000 w. Auto Jour—Feb. 15, 1908. No. 90480 A.

Methods of Testing Igniting Apparatus. F. W. Springer. Gives simple methods found convenient by the writer. 1800 w. Elec Wld. Feb. 15, 1908. No. 90160.

Motors.

Sound Features of 1908 Engines. G. H. Baillie. Abstract of a paper read before the Royal Auto. Club. Information of details collected at the Olympia Show, and since. 2500 w. Auto Jour—Feb. 1, 1908. Serial. 1st part. No. 90126 A.

Omnibuses.

Automobile as a Railroad Connection. Illustrations and brief description of vehicles recently put in service in Paris. 700 w. Automobile—Feb. 20, 1908. No. 90443.

Electric Omnibuses in London (Die elektrischen Omnibusse in London). Herbert Bauer. Describes the cars of the Electrobus Company, methods of operation, costs, etc. Ills. 3600 w. Zeitschr d Mit Motorwagen-Ver—Jan. 31, 1908. No. 90372 D.

Repairing.

Problems in the Repairing of Automobiles. Thomas J. Fay. The present number deals mainly with the materials used and the importance of quality. Micrographs. 2800 w. Automobile—Feb. 20, 1908. Serial. 1st part. No. 90444.

Road Trains.

The Sampson Gas-Electric Road Train. Illustrated description. 600 w. Sci Am—Feb. 15, 1908. No. 90196.

Roydale.

The Roydale Petrol Cars. The 18-22 h. p. car is described in detail. Ills. 1000 w. Auto Jour—Feb. 1, 1908. Serial. 1st part. No. 90124 A.

Stevens-Duryea.

Stevens-Duryea Cars. Illustrates and describes the "Big-Six" and "Light-Six" models. 1200 w. Automobile—Jan. 30, 1908. No. 89938.

Transport.

Motor Transport for the Colonies. John Wells. An illustrated account of experiences in Egypt. 1400 w. Autocar—Feb. 8, 1908. Serial. 1st part. No. 90240 A.

COMBUSTION MOTORS.

Exhaust.

The Exhaust of the Internal-Combustion Engine. H. Addison Johnston. Discusses causes of trouble. 2000 w. Power—Feb. 25, 1908. No. 90463.

Gas Conduits.

A Simple Method of Cleaning Gas Conduits. W. D. Mount. Sketches and description of a system developed for cleaning without interruption to producers, conduits and furnaces. 1200 w. Pro Am Soc of Mech Engrs—Feb., 1908. No. 90531.

Gas Engine Governing.

Progress of European Governors. George B. Massey, 2d. Illustrates and describes designs for gas engine regulation. 1500 w. Cassier's Mag—Feb., 1908. No. 90277 B.

Gas Engine Lubrication.

Lubrication of the Larger Sizes of Gas Engines. R. R. Keith. On the requirements, the original method of lubrication, construction of the oil pump and its action. Ills. 1800 w. Power—Feb. 18, 1908. No. 90231.

Gas Engines.

Some Features of the Internal-Combustion Motor Problem. Joseph H. Hart. Considers the full preparation, air advent, production of the heat, etc. 2500 w. Power—Feb. 11, 1908. No. 90150.

Third Report to the Gas-Engine Research Committee. Prof. Frederic W. Burstall. Devoted to a consideration of compression and efficiency. 2 appendices. 8 plates. 7500 w. Inst of Mech Engrs—Jan. 17, 1908. No. 90022 N.

The Construction and Working of Large Gas Engines. P. R. Allen. Abstract of a paper read before the Manchester Assn. of Engrs. A review of the development and description of present practice. Ills. 6500 w. Engng—Feb. 14, 1908. No. 90500 A.

Gas Engine Guarantees Technically Considered. William T. Magruder. Outlines the history of the gas engine from 1680, and considers engine guarantees. 4000 w. Gas Engine—Feb., 1908. No. 90179.

See also Blowing Engines, and Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Gasoline Engines.

A Novel Petrol Engine. Illustrated description of the Roche engine. 1200 w. Autocar—Feb. 8, 1908. No. 90239 A.

Novel Type of Two-Stroke Engine. Illustrated description of an engine exhibited at the Chicago show, known as the "Twice-Two Cycle." 1500 w. Rudder—Feb., 1908. No. 90025 C.

Gas Power Plants.

See Power Plants, under POWER AND TRANSMISSION.

Gas Producers.

The Rational Utilization of Low-Grade Fuels. Discussion of F. E. Junge's paper on this subject. 7500 w. Pro Am Soc of Mech Engrs—Feb., 1908. No. 90533 C.

The Destruction of Tar in Gas-Producers. H. P. Bell. Reviews and criticises the more important devices adopted or proposed, and discusses the conditions necessary for success. Ills. 3000 w. Engng—Jan. 31, 1908. Serial. 1st part. No. 90138 A.

See also Gas Conduits, under COMBUSTION MOTORS.

Gas Testing.

A Method for the Continuous Testing of the Calorific Value of Gases and Gaseous Mixtures (Procédé d'Evaluation Permanente de la Valeur Calorifique des Gaz et Mélanges Gazeux). A. Adam. Illustrates and describes a simple apparatus for testing gas for engines, furnaces, etc. 1200 w. Rev de Métal—Jan., 1908. No. 90315 E + F.

Gas Turbines.

See Steam Turbines, under STEAM ENGINEERING.

Oil Engines.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Oil Engines, under MARINE AND NAVAL ENGINEERING.

Producer Gas.

See Furnaces, under MACHINE WORKS AND FOUNDRIES.

HEATING AND COOLING.

Refrigeration.

A Problem in Refrigeration. Arthur J. Wood. Considers heat losses in an ammonia compression system, and their cause. 1500 w. Ice & Refrig—Feb., 1908. No. 90070 C.

Ammonia in Refrigeration. Joseph H. Hart. Explains why ammonia is so efficient in producing artificial cold. 2500 w. Cassier's Mag—Feb., 1908. No. 90279 B.

Starting an Absorption System After Overhauling. William S. Luckenbach. Gives useful hints. 1500 w. Engr, U S A—Feb. 15, 1908. No. 90270 C.

Comparison of Bids for Ice Making and Refrigerating Machinery. Charles E. Lucke. Discusses factors to be considered by the producer of refrigerating machinery. 3500 w. Ice & Refrig—Feb., 1908. Serial. 1st part. No. 90069 C.

Ice Skating Rink for Boston. Illustrated description of a proposed ice skating rink, hippodrome, ice-making and cold-storage plant to be erected. 600 w. Ice & Refrig—Feb., 1908. No. 90071 C.

See also Mechanical Plants, under POWER AND TRANSMISSION.

Steam Heating.

See Boiler Rating, Fuels, and Steam Receivers, under STEAM ENGINEERING.

Ventilation.

The Why of Warming and Ventilating. W. H. Cosmey. Second prize paper of the Inst. of Heat. & Vent. Engrs., England. The present article discusses mainly the effect on the health. 2000 w. Met Work—Feb. 22, 1908. Serial. 1st part. No. 90438.

See also Mechanical Plants, under POWER AND TRANSMISSION.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

The Simplest Analytical and Graphical Methods for the Design of Centrifugal Pumps (Zusammenstellung der einfachsten analytischen und graphischen Lösungen zur Berechnung der Zentrifugalpumpen). Albert Achenbach. Ills. 2000 w. Die Turbine—Jan. 20, 1908. No. 90376 D.

Pumping Plants.

Lawrence Avenue Pumping Station, Chicago, Ill. An illustrated description of a station for transferring north side sewage to the river. 2500 w. Engr, U S A—Feb. 15, 1908. No. 90269 C.

Efficiency Test of a Pumping Plant Used for Rice Irrigation. W. B. Gregory. Describes a test made to determine the efficiency and fuel economy of the pumping plant of the Jennings Canal Co., about two miles east of Jennings, La. 1200 w. Sib Jour of Engng—Feb., 1908. No 90435 C.

See also Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

The Emerson Steam Pump. Illustrates and describes the pump and its operation. 1500 w. Ir Age—Feb. 6, 1908. No. 90051.

Turbine Governing.

Turbine Governors (Turbinenregler). Paul H. Muller. A complete discussion of methods and devices for the governing of hydraulic turbines. Ills. 1600 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Jan. 10, 1908. No. 90374 D.

Turbines.

Notes on the Purchase and Use of Hydraulic Turbines. W. Kennedy, Jr. Compares European and American methods of turbine design. Ills. and discussion. 4500 w. Can Soc of Civ Engrs, Bul No 2—Dec., 1907. No. 90543 N.

Water Wheels.

Speed Regulation of High-head Water Wheels. H. S. Knowlton. On the difficulties and methods of regulating, and calculating speed, as explained in a recent paper by Henry E. Warren. 2000 w. Eng & Min Jour—Feb. 15, 1908. No. 90212.

MACHINE ELEMENTS AND DESIGN.

Cams.

Friction of Cams. Con. T. Wise. An explanation of the forces acting on a cam. 1000 w. Am Mach—Vol. 31. No. 6. No. 90054.

Laying Out Cams for Rapid Motions. F. H. Sibley. Explains the elements of cam mechanisms and gives sketches illustrating how the principle may be applied. 1500 w. Mach N Y—Feb., 1908. No. 90062 C.

Chains.

See Beams, under CIVIL ENGINEERING, Construction.

Drafting.

Standard Drawing-Room Methods. M. R. Kavanagh. Suggests features of value, giving tables of data, etc. 1500 w. Mach, N Y—Feb., 1908. No. 90060 C.

Roller Bearings.

Self-Aligning Taper Roller Bearings. H. W. Alden. Read before the Soc. of Auto. Engrs. at N. Y. Concerning the design and action of certain forms of roller bearings, illustrating their application to automobile conditions. Ills. 1000 w. Automobile—Feb. 27, 1908. No. 90565.

Screws.

Screw Thread Systems. Erik Oberg. Reviews systems used in the United States and Europe. 2500 w. Mach, N Y—Feb., 1908. No. 90061 C.

MACHINE WORKS AND FOUNDRIES.

Auger Making.

Auger Making in an Old American Shop. Methods at the Pugh works, in Philadelphia, are illustrated and described. 1500 w. Am Mach—Vol. 31. No. 8. No. 90403.

Boring Machines.

Boring Multiple Cylinders. E. J. McKernan. Illustrated description of the Jacobs rapid universal locomotive cylinder machine used at the Topeka shops of the Santa Fé. 1000 w. Ir Age—Feb. 27, 1908. No. 90527.

Brass Founding.

Use of Cothias Metal for Castings. Emil B. Horne. Suggestions for brass foundrymen in regard to the use of this alloy. Ills. 1000 w. Foundry—Feb., 1908. No. 89956.

The Manufacture of Ingot Brass and the Advantages and Disadvantages in Its Use. An illustrated article giving information concerning this material and the uses for which it is suited. 3500 w. Brass Wld—Feb., 1908. No. 90548.

Cam Cutting.

Two Methods of Making Master Cams. William V. Lowe. One method cuts them on a milling machine without laying them out; the other uses a blackened zinc templet. 2000 w. Am Mach—Vol. 31. No. 9. No. 90513.

Case Hardening.

Case-Hardening Steel with Gas. E. F. Lake. Illustrated description of difficult pieces carbonized, and the construction of the furnace with its gas tank. 3000 w. Am Mach—Vol. 31. No. 8. No. 90400.

New Applications of Case-Hardening. Phillip C. Osterman. Suggests improved method and recommends many new applications. 1800 w. Am Mach—Vol. 31. No. 7. No. 90158.

Castings.

Sixteen Ways to Lose a Casting. Wilber R. Tilden. Discusses the general causes of bad castings, and the 16 defects due to opposite faults. Ills. 3000 w. Ir Age—Feb. 20, 1908. No. 90298.

Production of Malleable Castings. Richard Moldenke. The first of a series of articles aiming to discuss every phase of the malleable process. 3000 w. Foundry—Feb., 1908. Serial. 1st part. No. 89949.

The Production of Malleable Castings. Richard Moldenke. The first of a series covering every phase of the malleable process. 3000 w. Ir Trd Rev—Feb. 13, 1908. Serial. 1st part. No. 90171.

The Method of Producing Die Castings. E. Luther Lake. Illustrates and describes the process, also the molds, melting pots, casting machines, and some of the castings. 2000 w. Am Mach—Vol. 31. No. 7. No. 90155.

Core Drying.

Drying Moulds and Cores. E. L. Rhead. Considers the methods and requirements of ovens, their situation, etc. Ills. 2000 w. Mech Engr—Feb. 14, 1908. No. 90485 A.

Cupolas.

The Consumption of Coke in Cupolas (Zur Frage des Koksaufwandes bei Kupolöfen). Georg Buzek. A discussion of the various agencies affecting it. 2800 w. Serial. 1st part. Stahl u Eisen—Jan. 29. 1908. No. 90348 D.

Cutting Tools.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Fire Protection.

The Prevention of Fire in Factories (Les Moyens employés dans les Ateliers pour se Défendre contre l'Incendie). Practical suggestions for all branches of industry though relating particularly to the fire-protection system of a textile factory. 5000 w. Rev d'Econ Indus—Jan. 16, 1908. No. 90300 D.

Foundries.

A Foundry Business on the Pacific Coast. H. Cole Estep. Brief illustrated description of the Union Iron Works, Spokane, Wash. 1500 w. Ir Trd Rev—Feb. 6, 1908. No. 90072.

Foundry Practice.

The Application of Science to Foundry Work. Robert Buchanan. Discusses moulds, melting, mixtures of iron for the cupola, methods of making castings, etc. General discussion. 8500 w. Jour Soc of Arts—Feb. 14, 1908. No. 90479 A.

See also Brass Founding, Castings, Core Drying, Furnace Charging, Molding, Pipe Founding, and Pneumatic Tools, under MACHINE WORK AND FOUNDRIES.

Furnace Charging.

Annealing Furnace Charging Machine. Illustrated description of a pneumatic machine designed to replace hand trucks. 1000 w. Foundry—Feb., 1908. No. 89950.

Furnaces.

Air Supply to Furnaces. W. H. Booth. Discusses briefly good and bad practice. 1000 w. Power—Feb. 4, 1908. No. 89998.

Air Blast Gas Appliances. Papers by W. K. Eavenson, W. H. Allen, and S. Tully Wilson presented at meeting of the Am. Gas Inst., and discussed together. Ills. Deals with industrial gas appliances. 10500 w. Pro Age—Feb. 15, 1908. Discussion to be continued. No. 90213.

Air Blast Gas Appliances. Papers by W. K. Eavenson, W. H. Allen, and S. Tully Wilson, read before the American Gas Institute, and discussed. Ills. 11500 w. Am Gas Lgt Jour—Feb. 3, 1908. No. 89973.

The Advantages of Producer Gas-Firing. Dr. Oskar Nagel. Illustrates and describes gas producers and direct-fired furnaces, stating the advantages claimed. 2500 w. Cassier's Mag—Feb., 1908. No. 90276 B.

Melting, Heating, Dissolving and Eluting. Oskar Nagel. Illustrates and describes appliances and methods used. 2000 w. Elec Chem & Met Ind—Feb., 1908. Serial. 1st part. No. 90029 C.

See also Case Hardening, and Core Drying, under MACHINE WORKS AND FOUNDRIES.

Gages.

Making Thread Gages. A. L. Monrad. A method is illustrated and described. 2500 w. Mach, N Y—Feb., 1908. No. 90063 C.

Gear Cutting.

M. Louis Boisard's Method of Cutting Spur, Helicoidal and Bevel Gears (Comment M. Louis Boisard taille au Hob des Engrenages droits, hélicoidaux et coniques). J. Germain. Illustrates a new gear-hobbing machine. 4000 w. All Indus—Jan., 1908. No. 90329 D.

Grinding.

Grinding Cone Pulleys. J. H. Hollinger. Illustrates the machine used and the pulleys, giving description of work. 900 w. Am Mach—Vol. 31. No. 7. No. 90156.

Machine Tools.

Some Interesting Antique Machine Tools. E. A. Dixie. Illustrated description of an old lathe, made 74 years ago, showing modern features. 1500 w. Am Mach—Vol. 31. No. 9. No. 90516.

Reversing Mechanisms for Machine Tools. Luther D. Burlingame. An illustrated review of devices used on various types of machines. 2800 w. Am Mach—Vol. 31. No. 6. Serial. 1st part. No. 90052.

Management.

Routing Work Through the Shop. Describes the system used by the R. K. Le Blond Machine Tool Co. 1200 w. Ir Trd Rev—Feb. 27, 1908. No. 90562.

Methods of Ordering and Routing Work. Oscar E. Perrigo. Fifth of a series of articles on cost-keeping and shop management. 3000 w. Ir Trd Rev—Feb. 6, 1908. No. 90073.

The Production System of the Westinghouse Electric and Mfg. Company. H. M. Wharton. Describes the methods used by the departments directly concerned in creating the product, outlining only the general method of procedure. 4000 w. Engineering Magazine—March, 1908. No. 90571 B.

The Fundamental Principles of Works Organization and Management. P. J. Darlington. The first of two articles discussing the elements of organization and management. 4000 w. Engineering Magazine—March, 1908. No. 90579 B.

The Engineer and the Economics of Management (Ingenieur und Wirtschaftspraxis). Emil Schiff. Shows how largely economic considerations influence engineering problems of all sorts. 2000 w. Technik u Wirtschaft—Jan., 1908. No. 90387 D.

The Engineer and the Science of Management (Der Ingenieur und die Verwaltungswissenschaften). Prof. W. Franz.

Discusses the necessity for academic training in industrial management. 1600 w. Serial. 1st part. Technik u Wirtschaft—Jan., 1908. No. 90386 D.

Milling Machines.

Double-Head Milling and Profiling Machine. Illustrated description of a high-speed vertical spindle machine of large size made in Manchester, Eng., for a British Colonial railway. 800 w. Engng—Feb. 14, 1908. No. 90496 A.

Molding.

Molding a Four-way Stand Pipe. George Buchanan. Illustrates and describes the method used. 900 w. Am Mach—Vol. 31. No. 9. No. 90514.

Molding a Large Cylinder Casting. C. R. McGahey. A method pursued in a southern jobbing foundry is illustrated and described. 700 w. Foundry—Feb., 1908. No. 89951.

A Method of Molding a Web Pulley. W. W. McCarter. Illustrates and describes the method used. 1500 w. Foundry—Feb., 1908. No. 89953.

Molding Machines.

Machine Molded Drop Hangers. Illustrates and describes successful molding practice. 1500 w. Foundry—Feb., 1908. No. 89952.

Pattern Making.

A Few Pattern Shop Sanding Schemes. H. N. Tuttle. Diagrams and descriptions. 2500 w. Foundry—Feb., 1908. No. 89954.

Pattern Shops.

Organization of the Pattern Shop. Oscar E. Perrigo. Considers the arrangement of the machinery and the division of the working force. 2500 w. Foundry—Feb., 1908. No. 89955.

An Uncommon Type of Pattern-Shop. H. J. Kennedy. A shop designed and built in 8 weeks, at Sparrow's Point, Maryland, is illustrated and described. Also some useful devices installed. 3000 w. Am Mach—Vol. 31. No. 6. No. 90055.

Pipe Founding.

Casting Direct from the Blast Furnace in Pipe Founding (Der unmittelbare Guss vom Hochofen insbesondere in Rohrgiessereien). Carl Irresberger. A review of the development of this process and present practice. 3500 w. Stahl u Eisen—Jan. 22, 1908. No. 90347 D.

Pneumatic Tools.

The Applications of Compressed Air in Foundry Practice (Ueber Verwendung von Pressluft im Giessereibetriebe). Otto S. Schmidt. Illustrates various applications to moulding machines, sieves, cleaning devices, etc. 4000 w. Stahl u Eisen—Jan. 1, 1908. No. 90343 D.

Screw Cutting.

Forming Tools for Automatic Screw Machines. C. L. Goodrich and F. A. Stanley. Diagrams and descriptions of the making of circular and dovetail forming tools and applying them to screw machine work. 4000 w. Am Mach—Vol. 31. No. 9. No. 90512.

Shop Practice.

Some Contrivances from Sparrow's Point. H. J. Kennedy. Illustrated descriptions of a tool for packing condenser tubes, kerosene-burning heaters for shrink fits, a thermit weld, etc. 1000 w. Am Mach—Vol. 31. No. 7. No. 90159.

Machining Cylinders in a Glasgow Shop. Henry Munro. Illustrates and describes methods and tools used in making engines for heavy motor vehicles. 4000 w. Am Mach—Vol. 31. No. 8. No. 90401.

Machining Oil-Country Gas-Engine Cylinders. W. Osborne. Devices used and the different turning and boring operations are illustrated and described. 1200 w. Am Mach—Vol. 31. No. 6. No. 90053.

Shops.

The Felten and Guilleaume-Lahmeyerworke A.-G., Frankfort. Illustrated description of these works for the construction of electrical machinery. 3300 w. Engng—Jan. 24, 1908. No. 90023 A.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Tools.

Automatic Screw-Machine Turning Tools. C. L. Goodrich and F. A. Stanley. Explains how box tools with tangent and radial cutters and hollow mills are made and applied. Ills. 3000 w. Am Mach—Vol. 31. No. 6. No. 90056.

Welding.

The Alumino-Thermic Welding Process. A. I. Graham. Lecture before the S. Wales Inst. of Engrs. Outlines the general idea of the process and some of its applications. 1800 w. Mech Engr—Feb. 7, 1908. No. 90245 A.

Woodworking Machines.

Ransome's Electrically-Driven Squaring-Up Machine. Illustrated description of a machine for squaring-up logs of hard timber. 600 w. Engng—Jan. 17, 1908. No. 90046 A.

New Woodworking Machines (Neuere Holzbearbeitungsmaschinen). Illustrates and describes new machines made by C. L. P. Fleck's Sons, Berlin. 1800 w. Serial. 1st part. Zeitschr f Werkzenz—Jan. 25, 1908. No. 90362 D.

See also Electric Driving, under POWER AND TRANSMISSION.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Beginnings of the Metallurgy of Tungsten (Les Débuts de la Métallurgie du Tungstène). Paul Nicolardot. A review of the earliest researches on the properties of iron-tungsten alloys. 7500

w. Rev de Métal—Jan., 1908. No. 90313 E + F.

Bearing Metals.

Alloys for Railroad Bearings. G. H. Clamer. Presented at meeting of the Am. Soc. for Test. Mat. Reviews the history and development of these mixtures in the United States. 3500 w. Foundry—Feb., 1908. No. 89957.

Ferro-Alloys.

See same title, under MINING AND METALLURGY, IRON AND STEEL.

Metallography.

Observations on Recalescence Curves. W. Rosenhain. Abstract of a paper read before the Physical Soc. of London. Describes methods of obtaining these curves, and remarks on their importance in the study of metals and alloys. 2000 w. Engng—Feb. 7, 1908. No. 90258 A.

The Application of the Diagram of Equilibrium of the Iron-Carbon System to the Structure and Heat Treatment of Steels and Cast Iron (Applications du Diagramme d'Equilibre du Système Fer-Carbone à la Constitution et au Traitement Thermique des Aciers et des Fontes). A. Portevin. Ills. 4000 w. Rev de Métal—Jan., 1908. No. 90314 E + F.

Steel.

The Work Shop Treatment of Steel. Walter Rosenhain. From the Engng. Sup. of the *London Times.* Considers the effect of punching, dangers of caulking, action of a cutting tool, etc. 2000 w. Ir Trd Rev—Feb. 20, 1908. No. 90420.

Alterations of Steel in Heat-Treating. J. E. Storey. Gives tabulated and charted results of the expansion and contraction of steel with different degrees of temperature in hardening. 2500 w. Am Mach—Vol. 31. No. 8. No. 90402.

The History of Knowledge of Steel (Note sur l'Historie de la Connaissance de l'Acier). Carl Benedicks. A review of the growth of knowledge of the distinction between steel and wrought iron and of their properties. 2000 w. Rev de Métal—Jan., 1908. No. 90312 E + F.

Tool Steels.

The Treatment of High-Speed Steel. Ethan Viall. Discusses the treatment of various brands. 2500 w. Am Mach—Vol. 31. No. 9. No. 90515.

MEASUREMENT.

Pyrometry.

The New Chauvin and Arnoux Thermo-Electric Industrial Pyrometers (Nouveau Pyromètres Thermo-Electriques Industriels de MM. Chauvin et Arnaux). M. Aliamet. Illustrated detailed description. 3000 w. Serial. 1st part. Electricien—Jan. 25, 1908. No. 90327 D.

Standards.

The International Bureau of Weights and Measures. Herbert T. Wade. Explains the importance of this Bureau, located near Paris, illustrating and describing the work and some of the instruments. 1200 w. Sci Am—Feb. 8, 1908. No. 90109.

The International Bureau of Weights and Measures (Le Bureau International des Poids et Mesures). Ed. Guillaume. A description of its functions, equipment, and achievements. 3000 w. Bul Soc Int d'Elecns—Jan., 1908. No. 90311 F.

Torsion Meters.

Torsion Meters for Marine Steam Turbines. J. Hamilton Gibson. Examines and describes some of these ingenious instruments. Ills. 2000 w. Mech Engr—Feb. 7, 1908. Serial. 1st part. No. 90246 A.

POWER AND TRANSMISSION.

Air Compressors.

Setting the Valve-Gear of Air Compressors. Claude Aikens. Considers the importance of piston clearance; how to determine positions of crank-pin and eccentric; setting blowing-engine valves, etc. Ills. 2500 w. Power—Feb. 18, 1908. No. 90229.

See also Turbo-Compressors, under POWER AND TRANSMISSION.

Compressed Air.

The Transmission of Compressed Air (Note sur les Canalisations d'Air sous Pressions Elevées). M. G. Leroux. A theoretical and practical discussion of the design and construction of pipe lines for the transmission of compressed air. Ills. 10000 w. Mem Soc Ing Civ de France—Oct., 1907. No. 80302 G.

Investigations on the Friction of Gases in Cylindrical Pipes (Untersuchungen über den Strömungswiderstand der Gase in geraden zylindrischen Rohrleitungen). Herr Fritzsche. Gives in curves and tables the results of very extensive experiments. Ills. 9000 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1908. No. 90382 D.

Electric Driving.

Installation and Care of Electric Motors. Norman G. Meade. Practical advice on the installation, maintenance, and care of motors. Ills. 1000 w. Power—Feb. 18, 1908. Serial. 1st part. No. 90230.

The Electric Drive of a Woodworking Plant. Illustrated description of the application of electric motors to a plant engaged in the manufacture of lumber, sashes, doors, interior finish, etc. 2000 w. Wood Craft—Feb., 1908. No. 89975.

Development of Textile Electric Driving. J. Shaw. Discusses the advantages and advocates obtaining the power from a supply company. 1200 w. Elect'n, Lond—Feb. 7, 1908. No. 90251 A.

The Application of Electric Power to 'ulp and Paper Mills—The Watab Pulp nd Paper Company's Mill. LeRoy M. Iarvey. Explains the advantages claimed or electric power, and gives brief illusrated description of this plant at Sartoll, Ainn. 4500 w. Elec Rev, N Y—Feb. 22, 908. No. 90418.

Rolling Mills and Winding Engines Oprated by Thury Motors. Illustrated decription of the system of M. Thury on he principle of constant current at varia-le pressure. 2000 w. Elec Rev, Lond—an. 24, 1908. No. 90008 A.

Novel Electric Drive for Rolling Mills. llustrates and describes an application of lectric motors at the plant of the Illinois teel Co., South Chicago. A small mo- or drives the rolls during the passes by tilizing the stored energy of a heavy y-wheel. 1700 w. Power—Feb. 4, 1908. Jo. 89996.

The Electric Drive of a Large Rolling Iill. W. A. Dick. Illustrated descripon of the apparatus used in a recent aplication to a large rolling mill of the Illiois Steel Co., at South Chicago. 2000 w. Ilec Jour—Feb., 1908. No. 90424.

Electric Driving at the Angleur Steel Vorks (Installations Electriques des Aciries d'Angleur). Illustrates and decribes the electric driving of punches, olls, and other machines at these works. 500 w. Soc Belge d'Elecns—Jan., 1908. Io. 90307 E.

Some Applications of Electric Driving Quelques Applications de la Commande lectrique). L. Finn. Discusses the drivig of machine tools, paper mills, cotton rinting mills, etc. Ills. 2500 w. Elecicien—Jan. 25, 1908. No. 90326 D.

See also Rolling Mills, under MINING ND METALLURGY, Iron and Steel.

bricants.

See Boiler Waters, under Steam Engieering.

brication.

See Gas Engine Lubrication, under ombustion Motors.

chanical Plants.

Mechanical Plant of the Worcester old Storage & Warehouse Company. Ioward S. Knowlton. Illustrated descripon. 2000 w. Eng Rec—Feb. 8, 1908. Io. 90099.

Heating and Ventilating a Modern Deartment Store. John G. Eadie. Illusated description of the mechanical equipient of the new Altman building, in New ork. 4500 w. Heat & Vent Mag—Feb., 908. No. 90552.

Electrical Equipment of the New York ustom House. H. Thurston Owens. Ilistrated detailed description of the equipient of a building costing over $7,000,000. 1600 w. Elec Wld—Feb. 8, 1908. No. 90064.

Power Plants.

A Modern Factory Power Plant. Illustrates and describes the new plant of the Cleveland Twist Drill Company. 2000 w. Ir Age—Feb. 6, 1908. No. 90050.

Steam or Electrically Driven Auxiliaries. Frank Koester. Considers the efficiency of the different apparatus, and first cost, maintenance and convenience of operation. Ills. 2200 w. Elec Rev, N Y —Feb. 8, 1908. No. 90092.

Power Equipment for the Small Factory. Percival Robert Moses. Discusses the factors of importance for convenience and economy in manufacture. Ills. 5000 w. Engineering Magazine—March, 1908. No. 90572 B.

Calculations for Power Plants. Dr. Franz H. Hirschland. Gives a comparison of steam, gas, and hydro-electric power for a given case. 2500 w. Elec Chem & Met Ind—Feb., 1908. No. 90028 C.

Testing of Steam Electric Power Plants. Frank Koester. The first of a series of articles on methods of conducting tests of such plants. Ills. 1500 w. Elec Rev, N Y—Feb. 22, 1908. Serial. 1st part. No. 90417.

Turbo-Compressors.

Turbo-Blowers for Blast Furnaces (Ueber Hochofen-Turbinengebläse). P. Langer. Describes the various machines and their operation. Ills. 3200 w. Stahl u Eisen—Jan. 15, 1908. No. 90346 D.

STEAM ENGINEERING.

Boiler Explosions.

Greenwich Boiler Explosion. A report of the Board of Trade inquiry into the cause of the explosion of a thermal storage drum on a Babcock & Wilson boiler at the Greenwich station of the South Metropolitan Power Co. 1700 w. Engr, Lond—Jan. 17, 1908. Serial. 1st part. No. 90016 A.

Boiler Fittings.

Water-Column Connections. W. H. Wakeman. Suggestions for the care and testing of water-columns and connections. Ills. 2000 w. Power—Feb. 4, 1908. No. 89997.

Approved Safety Stand Pipes for Low-Pressure Steam Boilers (Genehmigte Sicherheits - Standrohrvorrichtungen für Niederdruckdampfkessel). Johann Irnoosky. Illustrates and describes types accepted by the Austrian Minister for Commerce. 7000 w. Oest Zeitschr f d Oeffent Baudienst—Jan. 18, 1908. No. 90364 D.

Boiler Management.

See Smoke Prevention, under Steam Engineering.

Boiler Plates.

Heat Stresses and the Formation of Cracks. Carl Sulzer. Trans. from *Zeit. des Ver. Deut. Ing.* Illustrates and describes a case which offers a striking example of the formation of cracks by heat stresses, discussing the causes. 3300 w. Boiler Maker—Feb., 1908. No. 89948.

Boiler Rating.

Rating House Heating Boilers. Methods proposed by Prof. William Kent. Presented at meeting of the Am. Soc. of Heat. & Vent. Engrs. 900 w. Eng Rec—Feb. 15, 1908. No. 90206.

Boilers.

A New Water-tube Boiler. Illustrated description of the Hay water-tube boiler, which has new features of interest. 700 w. Engr, Lond—Feb. 14, 1908. No. 90506 A.

See also Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Boiler Waters.

Simple Methods of Testing Feed-Water and Lubricants. James E. Noble. Suggests methods for testing and treating feed-water and lubricants for use in the steam plant. 2000 w. Prac Engr—Feb. 7, 1908. No. 90242 A.

Water for Economical Steam Generation. J. C. William Greth. Shows the actual savings effected by obtaining a proper water supply to feed the boilers, giving statements of actual cases under working conditions. Ills. 4000 w. Engineering Magazine—March, 1908. No. 90573 B.

See also Feed-Water Heaters, under STEAM ENGINEERS.

Engine Design.

See Pistons, and Piston Speeds, under STEAM ENGINEERING.

Engines.

See Steam Engines, under MARINE AND NAVAL ENGINEERING; Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL; and Hoisting Engines, under MINING AND METALLURGY, MINING.

Engine Troubles.

Causes of Knocks in Steam Engines. C. J. Larson. Explains some of the causes and gives directions for preventing them. 2200 w. Power—Feb. 11, 1908. Serial. 1st part. No. 90149.

Entropy.

The Question of Entropy. Sidney A. Reeve. A review of the recent discussion in British journals concerning the proper definition of the term entropy, with explanatory notes. 6500 w. Harvard Engng Jour—Jan., 1908. No. 90187 D.

Exhaust Steam.

See Turbines, under STEAM ENGINEERING.

Feed-Water Heaters.

The Use of Heater-Detartarizers. Discusses this class of apparatus for heating feed-water and removing scale-forming ingredients, and the working. 1200 w. Elec Rev, Lond—Jan. 31, 1908. No. 90130 A.

Feed-Water Heating for the Power Plant. Sidney A. Reeve. New suggestions for securing high efficiency and economy of the plant. 1800 w. Engineering Magazine—March, 1908. No. 90574 B.

The Argument for the Open Feed Heater. Reginald Pelham Bolton. A critical discussion of Prof. Reeve's proposals with Prof. Reeve's reply. 900 w. Engineering Magazine—March, 1908. No. 90575 B.

Fuels.

Indirect Gas Heating (Mittelbare Gasheizung). Franz Schäfer. Discusses gas as a boiler fuel for steam and hot-water heating and illustrates types of boiler for small plants. 3500 w. Gesundheits-Ing—Jan. 18 1908. No. 90366 D.

See also Furnaces, under MACHINE WORKS AND FOUNDRIES.

Pistons.

A Rational Method of Checking Conical Pistons for Stress. Prof. George H. Shepard. An explanation of the method, with results of its use in calculating the stress for the conical pistons of the U. S. torpedo boat destroyer, Truxtun. 1000 w. Pro Am Soc of Mech Engrs—Feb., 1908. No. 90532.

Piston Speeds.

Limits of Piston Speed. Frederick Strickland. A discussion principally of the limits of excessive wear and tear. 1500 w. Engng—Feb. 7, 1908. No. 90254 A.

Plants.

See Mechanical Plants, and Power Plants, under POWER AND TRANSMISSION; and Central Stations, and Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Smoke Prevention.

Smoke Suppression. Edward J. Kunze. Reviews methods tried for recording smoke observations, describing an instrument and system constructed by the writer. Ills. 2500 w. Engr, Lond—Jan. 31, 1908. No. 90143 A.

How to Burn Illinois Coal Without Smoke. L. P. Breckenridge. Shows that the horizontal fire-tube boiler is not adapted for the smokeless combustion of this coal; discusses how to hand-fire so as to reduce smoke, the preparation of the coal, etc. 3000 w. Boiler Maker—Feb., 1908. No. 89947.

Steam Pipes.

Layout and Installation of Steam-pipe Lines. Warren H. Miller. Discusses sizes, materials, erecting, etc. 2500 w. Am Mach—Vol. 31. No. 7. No. 90157.

Steam Receivers.

Use of Low-Pressure Steam from Compound Engines. Illustrates and describes two types of receiver pressure regulators for compound engines. 1000 w. Eng Rec —Feb. 22, 1908. No. 90473.

Superheaters.

Superheater Construction and Operation. J. Rowland Brown. A discussion of types, their location, connections and treatment, with formulae for computing area of heating service. 3500 w. Power —Feb. 25, 1908. No. 90462.

Superheating.

The Specific Heat of Superheated Steam. Prof. Sidney A. Reeve. Gives a comparative study of results obtained by various experimenters. 2500 w. Power —Feb. 18, 1908. Serial. 1st part. No. 90232.

The Regulation of Superheating (Die Regulierung der Dampfüberhitzung). Sigmund Bourdot. Illustrates and describes various methods and devices. 1500 w. Elektrotech u Maschinenbau—Jan. 19, 1908. No. 90370 D.

See also same title, under RAILWAY ENGINEERING, Motive Power and Equipment.

Turbine Balancing.

The Balancing of Rotors for High Speed. Hans Holzwarth. On the relationship between static and dynamic conditions, and discusses certain methods by which rotors may be dynamically balanced. 1500 w. Power—Feb. 11, 1908. No. 90151.

Turbine Governing.

Governing Steam Turbines. J. A. Moyer. Explanation of the different methods of governing. Ills. 4000 w. Harvard Engng Jour—Jan., 1908. No. 90188 D.

American Turbine Governors with Special Reference to the Lombard and Sturgess Governor (Ueber die amerikanischen Turbinenregulatoren mit besonderer Berücksichtigung des Lombard- und Sturgess Regulators). A. Budau. Illustrated description. 2800 w. Serial. 1st part. Elektrotech u Maschinenbau—Jan. 5, 1908. No. 90369 D.

Turbine Plants.

The Principles Governing the Design of Steam Turbine Plants. Reviews a paper by J. L. Hecht, read before the N.-W. Elec. Assn., explaining features not well understood. 2200 w. Elec Wld—Feb. 15, 1908. No. 90162.

Turbines.

The Manufacture of Small Steam Turbines. K. G. Smith. Illustrates and describes the constructive features. 1000 w. Mach., N Y—Feb., 1908. No. 90059 C.

Turbine Economies. J. R. Bibbins. A criticism of statements by W. L. R. Emmet in a comparison of the efficiency of Curtis and Parsons turbines. 4000 w. St Ry Jour—Feb. 29, 1908. No. 90567.

Some Interesting Features of Steam Turbine and Steam Engineering Construction. Describes one or two reecntly introduced features in the field of the manufacture and operation of the steam turbine and its auxiliaries. 2500 w. Mech Engr—Feb. 7, 1908. Serial. 1st part. No. 90244 A.

The Brush-Parsons Turbine Machinery. Detailed descriptions, with illustrations, of the machines of this company. 3500 w. Engng—Feb. 14, 1908. No. 90495 A.

The Curtis Steam Turbine in Practice. Fred L. Johnson. Explains details of construction, and gives directions for its operation and adjustment. Ills. 1500 w. Power—Feb. 11, 1908. Serial. 1st part. No. 90148.

Tests of a Triple Horizontal Francis Turbine (Versuche an einer dreifachen Horizontal-Francisturbine). E. A. Jacobson. Gives the results of the tests of a 400 horse power turbine in curves and tables. Ills. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Jan. 30, 1908. No. 90375 D.

Steam Turbines (Note sur les Turbines à Vapeur). P. Hoffet. The first part of the serial discusses their development, classification, etc., and begins a mathematical examination of the principles of the impulse and reaction types. Ills. 5500 w. Serial. 1st part. Bul Tech d l Suisse Rom—Jan. 10, 1908. No. 90328 D.

The Fundamental and Experimental Theory of Steam and Gas Turbines (Théorie Générique et Expérimentale des Turbines à Vapeur et à Gaz). A. Witz. The first part discusses mathematical principles, the second, the perfections attained by experimental investigations. Ills. 16500 w. Serial. 2 parts. Rev Gen des Sciences—Jan. 15 and 30, 1908. No. 90321, each D.

The Rateau System for the Utilization of Exhaust Steam in the Mining and Smelting Industries (Abdampfverwertung auf Berg- und Hüttenwesen nach Professor Rateau). Herbert Klemperer. Discusses the economies which may be effected by the use of Rateau's low-pressure turbines. 4500 w. Oest Zeitschr f Berg- u Huttenwesen—Jan. 4, 1908. No. 90350 D.

See also Isolated Plants, under ELECTRICAL ENGINEERING, Generating Stations.

TRANSPORTING AND CONVEYING.

Cableways.

Aerial Ropeway at a Colliery. An interesting aërial wire ropeway, recently erected at the Middleton Colliery, near Leeds, is illustrated and described. 500 w. Engr, Lond—Feb. 14, 1908. No. 90505 A.

Cement Plants.

The Transportation Problem in the Portland Cement Plant. C. J. Tomlinson. Considers the methods in general use and the need of improvements. 2000 w. Eng News—Feb. 13, 1908. No. 90168.

Coal Handling.

An Interesting Coal Handling Plant. Charles M. Ripley. Plans and description of a plant in Pittsburgh. 1400 w. Ir Age —Feb. 13, 1908. No. 90154.

See also Cableways, and Dock Machinery, under TRANSPORTING AND CONVEYING.

Conveyors.

Economical Material-Handling Equipments for Industrial Plants. Werner Boecklin. Illustrates and describes mechanical methods of handling materials; both intermittent and continuous. 5500 w. Engineering Magazine—March, 1908. No. 90577 B.

A Study of Conveyors (Etude sur les Conveyeurs). H. Fischer. A mathematical discussion of their design. The first part being devoted to bucket elevators. Ills. 9000 w. Serial, 1st part. Rev de Mécan—Jan., 1908. No. 90385 E + F.

Flexible Conveyors (Raumbewegliche Förderer). Geor v. Hanffstengel. Illustrates and describes various devices, principally bucket elevators and conveyors, can change their direction of motion as desired. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 25, 1908. No. 90384 D.

See also Cement Plants, under TRANSPORTING AND CONVEYING.

Cranes.

Hoisting Machinery for the Handling of Materials. T. Kennard Thomason. The first of a series of illustrated articles reviewing the mechanical appliances for labor-saving, especially their application to construction. 4500 w. Engineering Magazine—March, 1908. No. 90578 B.

See Dock Machinery, under TRANSPORTING AND CONVEYING.

Dock Machinery.

Hydraulic Plant at the Caledonian Railway Company's New Dock at Grangemouth. Illustrated description of a plant for the operation of dock machinery and crane equipment. 2000 w. Ir & Coal Trds Rev—Jan. 31, 1908. No. 90145 A.

Industrial Railways.

Design and Construction of Automatic Car Systems. Charles J. Steffens. Illustrates and describes the general arrangements of such systems, explaining their economy and advantages. 3000 w. Eng News—Feb. 13, 1908. No. 90164.

Traction Engines.

A Locomotive Sled. Illustrated description of a traction engine used on ice roads, for hauling logs. 700 w. R R Gaz —Feb. 14, 1908. No. 90226.

MISCELLANY.

Aeronautics.

The Problem of Flight. Editorial discussion of what has been accomplished in mechanical flight, and the theories of eminent aeronauts. 2000 w. Engng—Feb. 14, 1908. No. 90498 A.

Aerial Navigation. Herbert Chatley. Abstract of a paper read before the Jr. Inst. of Engrs. Deals particularly with the aeroplane. 1800 w. Auto Jour—Feb. 15, 1908. Serial. 1st part. No. 90481 A.

Air Resistance.

M. Eiffel's Investigations on the Resistance of the Air (Les Expériences de M. Eiffel sur la Résistance de l'Air). The methods and results of extensive experiments carried out at the Eiffel tower in Paris. 1700 w. Rev de Mécan—Dec., 1907. No. 90317 E + F.

Etching.

The Rubber Stamp Method of Etching Metals and Its Use in the Manufacture of Steel Knives. Brief review of the history and explanation of the principle of this method, with illustrated description of the operations. 3300 w. Brass Wld—Feb., 1908. No. 90549.

Marble Working.

New Machinery for the Application of Abrasives to Marble Working. J. Royden Peirce. Illustrates and describes the general outlines of a new process which produces work superior to any before obtained. 1500 w. Eng News—Feb. 6 1908. No. 90084.

Paper Making.

Developments in the Paper and Pulp Industry. Reviews the more important features of a recent paper by Arthur D. Little. Especially discusses sources of paper stock. 2000 w. Eng Rec—Feb. 22, 1908. No. 90472.

Machinery and Power Required for the Production of Paper Pulp, Mechanical and Chemical, and Finished Paper. John W. Thurso. Gives information necessary to make an estimate of the necessary machinery, including engine and boiler equipment. 1500 w. Eng News—Feb. 20, 1908. No. 90410.

See also Electric Driving, under POWER AND TRANSMISSION.

Printing Machinery.

Money and Money-Making Machinery. Claude E. Holgate. An interesting illustrated description of the work of the Bureau of Engraving and Printing, at Washington, D. C., the machines used, etc. 3500 w. Mach, N Y—Feb., 1908. No. 90057 C.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Centralized Consumption of Anthracite Coal. Howard McNayr Jefferson. Reviews, in the present article, the development of the anthracite industry. 5500 w. Jour of Accountancy—Jan., 1908. Serial. 1st part. No. 90177 C.

Australia.

The Brown Coal Deposits of Victoria. Reginald A. F. Murray. Brief description of the deposits, the localities of occurrence, etc. 1500 w. Aust Min Stand—Jan. 8, 1908. Serial. 1st part. No. 90293 B.

Briquetting.

The Briquetting of Coal (Die Brikettierung der Steinkohlen). F. Bock. Describes machines and processes and discusses the extent of the industry in Europe. Ills. 3500 w. Glückauf—Jan. 4, 1908. No. 90352 D.

Cape Breton.

General Description of the Sydney Coal Field. Map and illustrated description of mining operations in Cape Breton, N. S. 1500 w. Can Min Jour—Feb. 15, 1908. No. 90294.

Coking By-Products.

The Present Status of the By-Product Coke Oven in the United States. C. G. Atwater. Information in regard to the amount of coke and various by-products produced. 4000 w. Mines & Min—Feb., 1908. No. 90032 C.

Coking Plants.

A Recent Plant for the Utilization of Small Coal. E. M. Hann. Plans and description of the by-product plant recently erected at the Bargoed Colliery, South Wales. 5000 w. Col Guard—Jan. 31, 1908. No. 90134 A.

Electric Power.

Gas-Tight Switches. W. Bolton Shaw. The importance of these switches in mining work, and the principles of their design. 2000 w. Elec Rev, Lond—Jan. 31, 1908. No. 90129 A.

Explosions.

Coal-Mine Explosions, Their Cause and Prevention. Lawrence Brett. Discusses the special conditions that exist in the mines of Kansas. 4500 w. Mines & Min—Feb., 1908. No. 90036 C.

The Prevention of Coal Mine Explosions. Carl Schulz and R. S. Mors. Considers the causes and discusses preventives and precautions necessary. 2000 w. Min Wld—Feb. 8, 1908. No. 90115.

Equipment for the Prevention of Mine Explosions. Wilbur S. Mavers. Discusses this problem and suggests methods of freeing mines from dust. 2000 w. Eng & Min Jour—Feb. 22, 1908. No. 90460.

Monongah Disaster. Official reports, with verdict of the Coroner's jury. 7000 w. Mines & Min—Feb., 1908. No. 90033 C.

Report on the Monongah Mine Explosion. George Harrison. 2000 w. Eng & Min Jour—Feb. 1, 1908. No. 89972.

Yolande Mine Disaster. Official report to the Governor of the State of Alabama. 2000 w. Mines & Min—Feb., 1908. No. 90034 C.

Results of Inquiries into Recent Mine Disasters. Floyd W. Parsons. Illustrations of the Monongah disaster, with discussion of causes, though no definite conclusions have been reached. Dust has been a factor in explosions. 2500 w. Eng & Min Jour—Feb. 1, 1908. No. 89971.

Fuse.

See same title, under MINING.

Mining.

Science in Mining. Henry Briggs. Inaugural address delivered on the opening of the new Department of Mining in the Heriot-Watt College, Edinburgh. 4400 w. Ir & Coal Trds Rev—Jan. 24, 1908. No. 90021 A.

Coal Mining by the Bord-and-Pillar System. George Raylton Dixon. Illustrated description of methods. 2400 w. Eng & Min Jour—Feb. 22, 1908. No. 90461.

Mining Plants.

The Plant of the de Wendel Colliery, Herringen (Die Anlagen des Steinkohlenbergwerks de Wendel in Herringen bei Hamm i. W.). A. Hochstratl. Illustrated detailed description. 2100 w. Serial. 1st part. Glückauf—Jan. 11, 1908 No. 90354 D.

North America.

Coal and Iron in North America (Kohle und Eisen in Nordamerika). Prof. Baum. A Comparison of conditions in Canada and the United States with those of Germany. Ills. 4000 w. Serial. 1st part. Glückauf—Jan. 4, 1908. No. 90351 D.

Production.

An Interesting Article on Coal Production for the Year 1907. A review of the operations throughout the United States, prepared by the U. S. Geol. Survey. 8000 w. Ind Wld—Feb. 17, 1908. No. 90214.

Rescue Appliances.

Breathing Apparatus for Use in Mines. Leonard Hill. Lecture at the N. Staffordshire Inst. of Min. & Mech. Engrs. Some considerations of the physiological effects of foul air, and the principles of construction of breathing apparatus. 4500 w. Engng—Jan. 17, 1908. No. 90049 A.

The Rescue Methods of the Laurahütte Colliery in the Nord-Kaltowitz District (Das Rettungswesen auf dem Steinkohlenbergwerke Laurahütte im Bergrevier Nord-Kaltowitz). Herr Backwinkel. Describes the central rescue station, its equipment, training methods, etc. Ills. 2000 w. Glückauf—Jan. 11, 1908. No. 90355 D.

Tipples.

See same title, under Mining.

COPPER.

Alaska.

See same title, under Gold and Silver.

Assaying.

Sodium Peroxide in the Chemical Laboratory. Herbert W. Ross and N. M. Zoph. Outlines methods in satisfactory use in the laboratory of the Union Copper Mining Co., California. 900 w. Min & Sci Pr—Feb. 22, 1908. No. 90558.

British Columbia.

The Boundary District in 1907. Progress and results at mines and smelters. Ills. 6500 w. B C Min Rec—Dec., 1907. No. 90560 B.

Mining in the Kootenay Districts in 1907. A review of the year's operations and results in these copper and silver-lead fields. Ills. 5500 w. B C Min Rec —Dec., 1907. No. 90559 B.

Lake Superior.

See Copper, under Ore Dressing and Concentration.

Matte Handling.

Method of Handling Matte at Selby, California. James C. Bennett. The material is tapped into shallow pans of steel carried upon all-iron trucks, moved by means of long-hook bars. Ills. 700 w. Eng & Min Jour—Feb. 1, 1908. No. 89969.

Production.

The Future of Copper and the Scarcity of Gold. J. J. Cushing. Gives comparative statistics of the two metals. 2000 w. Min Sci—Feb. 6, 1908. Serial. 1st part. No. 90114.

Smelters.

The Douglas Copper Smelter at Fundicion, Mex. Percy E. Barbour. Illustrated description of a one-level blast-furnace plant having novel features of interest. 2000 w. Eng & Min Jour—Feb. 8, 1908. No. 90103.

Utah's Largest Copper Smelter. Robert B. Brinsmade. Illustrated description of the Garfield plant of the American Smelting and Refining Co., Garfield, Utah. 6500 w. Mines & Min—Feb., 1908. No. 90030 C.

Smelting.

See Matte Handling, under Copper.

Yukon.

The White Horse Copper Belt in the Yukon. William J. Elmendorf. Begins an illustrated description of the region, the climate, conditions, development, etc. 1100 w. Min Wld—Jan. 11, 1908. Serial. 1st part. No. 89978.

GOLD AND SILVER.

Alaska.

Mining in the Wrangell District, Alaska. An account of the development of the gold placers and the copper projects. 2500 w. Min & Sci Pr—Feb. 8, 1908. No. 90218.

Australia.

The Deep Leads of Victoria, Australia. Quotes statements from the recent paper of H. L. Wilkinson, showing where they need to be amended or amplified to give a correct understanding. Also added information. 2500 w. Min Jour—Jan. 25, 1908. No. 90014 A.

See also Gold Milling, under Ore Dressing and Concentration.

Brazil.

See Palladium, under Minor Minerals.

Cyaniding.

Notes on Cyanide Treatment of Gold Ores. G. E. Bray. Read before the N. Queensland Min. & Mill Mgrs. Assn. Gives details of the scope and costs of the cyanide treatment in various places. 3000 w. Min Jour—Feb. 15, 1908. Serial. 1st part. No. 90492 A.

Cyanidation in Nevada. A letter from Lochiel M. King, giving data of recent tests on ores furnished by the Goldfield Con. Mines Co., outlining the method of treatment that seems most economical to the writer. 3300 w. Min & Sci Pr—Jan. 25, 1908. No. 89933.

See also Gold Milling, under Ore Dressing and Concentration.

New Zealand.

Gold-Mining in Central Otago. Abstracts from Bul. No. 2 (new series) of the New Zealand Geol. Survey. Historical and descriptive. 4000 w. N Z Mines Rec —Dec. 16, 1907. Serial. 1st part. No. 90291 B.

Gold-Mining at Coromandel. Extracts from Bul. No. 4 (new series) of the N. Z. Geol. Survey. Description, with report of development. 3500 w. N Z Mines Rec —Dec. 16, 1907. Serial. 1st part. No. 90292 B.

Placers.

See Alaska, under Gold and Silver.

Production.

See same title, under Copper.

Smelting.

An Improvement in Tipping Pots During Smelting. W. D'Arcy Lloyd. Diagram and description of a device for pouring quickly and easily. 500 w. Jour Chem, Met, & Min Soc of S Africa—Dec., 1907. No. 90237 E.

South Africa.

The Auriferous Banded Ironstones and Associated Schists of South Africa. Owen Letcher. Describes these formations, which are the oldest known auriferous sedimentary rocks in South Africa. 4500 w. Inst of Min & Met, Bul No. 40—Jan. 9, 1908. No. 90547 N.

Consolidated Gold Fields of South Africa, Ltd. Eustace M. Weston. Notes on the last report of this company. Ills. 1000 w. Eng & Min Jour—Feb. 15, 1908. No. 90210.

IRON AND STEEL.

Blast Furnaces.

A Breakout in a Blast-Furnace of the Societa Elba at Portoferraio. Remo Catani. A contribution to the study of accidents in blast furnace practice. 2200 w. Ir & Coal Trds Rev—Feb. 7, 1908. No. 90267 A.

Blast-Furnace Slag.

See Concrete Brick, under CIVIL ENGINEERING, Materials of Construction.

Blowing Engines.

A Large Gas Blowing-Engine. Illustration and description of a new Premier engine. 500 w. Engr, Lond—Feb. 7, 1908. No. 90264 A.

Modern Gas Blowing Engines of Unique Design. Frank C. Perkins. Illustrated description of engines operating on blast-furnace gas used in steel mills in Europe and America. 2500 w. Engr, U S A—Feb. 1, 1908. No. 89995 C.

Practical Notes on the Construction and Operation of Gas Blowing Engines (Erfahrungen in Bau und Betriebe von Gasgebläsen). Herbert Baer. A general discussion. Ills. 4000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Jan. 4, 1908. No. 90378 D.

See also Turbo-Compressors, under MECHANICAL ENGINEERING, Power and Transmission.

China.

The Iron Industry in China (Aus der chinesischen Eisenindustrie). C. Blauel. Mainly devoted to a description of the Hanyang Iron and Steel Works. Ills. 3500 w. Stahl u Eisen—Jan. 1, 1908. No. 90342 D.

The Chinese Iron and Steel Industry. C. Blauel. Trans. from *Stahl und Eisen*. An illustrated article giving interesting information concerning the Hanyang works. 2000 w. Elec, Chem & Met Ind—Feb., 1908. No. 90027 C.

Chromite.

See same title, under Minor Minerals.

Electro-Metallurgy.

A New Electric Furnace for the Fusion of Steel (Nouveau Système de Four Electrique pour la Fusion de l'Acier). B. Igewsky. Describes the author's high-tension furnace. Ills. 2500 w. Rev de Métal—Jan., 1908. No. 90316 E + F.

The Electric Production of Iron (Ueber elektrische Eisendarstellung). Josef von Ehrenwerth. Discusses the progress of the electro-metallurgy of iron, products of the electric furnace, types of furnaces and processes, etc. Ills. 1600 w. Oest Zeitschr f Berg- u Hüttenwesen—Jan. 4, 1908. No. 90349 D.

Ferro-Alloys.

The Manufacture and Use of Ferro-Alloys. Brief account of the best methods of manufacturing these alloys, with descriptions of the more important works in Europe and America. Ills. 2700 w. Engr, Lond—Jan. 24, 1908. Serial. 1st part. No. 90019 A.

Ferro-Alloys and Metals for the Steel Industry (Ueber Eisenlegierungen und Metalle für die Stahlindustrie). Wilhelm Venator. An extensive discussion of their production, properties, use, etc. 6000 w. Serial. 1st part. Stahl u Eisen—Jan. 8, 1908. No. 90344 D.

Special Alloys for the Steel Industry. W. Venator, in *Stahl und Eisen*. A review of the particulars relating to the raw materials, production, composition, properties, application, price and commercial uses of these substances. 5000 w. Ir & Coal Trds Rev—Feb. 7, 1908. No. 90266 A.

New Jersey.

The Last of the Jersey Forges. Edward P. Buffet. An illustrated account of the old forges of New Jersey, and their methods. 1200 w. Eng & Min Jour—Feb. 8, 1908. No. 90105.

New York.

The Economic Geology of Northern New York. Frank S. Mills. Describes this region which contains deposits of pyrites, graphite, and iron ores. Ills. 1600 w. Eng & Min Jour—Feb. 22, 1908. No. 90457.

North America.

See same title, under Coal and Coke.

Open Hearth.

New Open-Hearth Plant of Messrs. Monks, Hall & Company. Short illustrated description of works at Warrington, Eng. 1500 w. Ir & Coal Trds Rev—Feb. 7, 1908. No. 90268 A.

Rails.

See same title, under RAILWAY ENGINEERING, Permanent Way and Buildings.

Rolling Mills.

The Driving of Modern Rolling Mills. G. Hoaghwinkel. Abstract of a paper before the Sheffield Soc. of Engrs. & Met. Discusses the driving of three-high mills of the heaviest type by steam engines, by gas engines, and by electric motors, giving particulars of cost. General discussion. 3000 w. Elect'n,—Lond—Feb. 14, 1908. No. 90489 A.

See also Electric Driving, under MECHANICAL ENGINEERING, Power and Transmission.

Steel Ingots.

The Compression of Semi-Liquid Steel Ingots. N. Lilienberg. Discusses practical manipulation for the improvement of steel. Reviews other methods and describes a patented system of compression. Ills. 7000 w. Jour Fr Inst—Feb., 1908. No. 90433 D.

Steel Works.

The Andrews Steel Company's Plant. Illustrated description of a plant at Newport, Ky., specially equipped for rolling sheet bars and billets. 1000 w. Ir Age—Feb. 20, 1908. No. 90296.

The Krupp Works at Rheinhausen. Illustrated description of the blast furnaces, coke ovens, Bessemer and open hearth steel works, blowing and finishing mills. 3500 w. Ir Age—Feb. 27, 1908. No. 90526.

The Friedrich-Alfred Steel Works at Rheinhausen (Die Friedrich-Alfred Hütte zu Rheinhausen). H. Groeck. An illustrated description of this Krupp plant. 2200 w. Zeitschr d Ver Deutscher Ing—Jan. 18, 1908. No. 90383 D.

See also China, and Open Hearth, under Iron and Steel.

Storage.

See Warehouses, under CIVIL ENGINEERING, Construction.

Tin Plate.

Tin Plate Making at Follansbee, W. Va. Illustrated description of new works, the methods and processes used. 3500 w. Met Work—Feb. 15, 1908. No. 90191.

Trade.

Conditions and Prospects in the American Iron Industry. Edwin C. Eckel. A review of the financial history and of the trade in 1907, the effect of the recent panic, etc. 4000 w. Engineering Magazine—March, 1908. No. 90570 B.

LEAD AND ZINC.

Associated Minerals.

See Gangue, and Joplin District, under Lead and Zinc.

British Columbia.

See same title, under Copper.

Colorado.

The Montezuma Mining District, Colorado. Etienne A. Ritter. An illustrated account of the revival of a lead-silver-zinc camp on an extension of the Georgetown and Silver Plume belt. 1800 w. Eng & Min Jour—Feb. 1, 1908. No. 89967.

England.

The Greenside Lead Mines, Cumberland. E. Thomas Borlase. An illustrated account of mining and milling methods in English mines which have been opened over 200 years. 3000 w. Eng & Min Jour—Feb. 8, 1908. No. 90102.

Gangue.

Gangue and Associated Minerals of Lead and Zinc. Otto Ruhl. On the recovery and utilization of fluorspar, barite, marcasite, pyrite, chalcopyrite, and the important bearing of these minerals on genesis of ores. 1800 w. Min Sci—Jan. 30, 1908. No. 89981.

Joplin District.

The Minerals of Joplin and Their Association. Doss Brittain. Some account of the minerals, of which there are over twenty. Ills. Min Wld—Feb. 15, 1908. No. 90217.

MINOR MINERALS.

Cement.

The New Mill of the Union Portland Cement Co. A mill with a rated capacity of 2,500 barrels a day, located in northeastern Utah, is illustrated and described. 4000 w. Eng Rec—Feb. 1, 1908. No. 89960.

Chromite.

Chrome Iron Mining in Canada. H. F. Strangways. First of a series of articles on the mining industries of Quebec. Outlines the history of this industry in Quebec, describing the geology, methods of mining, concentration, etc. Discussion. 6000 w. Can Soc of Civ Engrs, Bul. No. 2—Dec., 1907. No. 90544 N.

Diamonds.

The Formation and Manufacture of Diamonds. Editorial review of what is now known in regard to the origin of diamonds. 1700 w. Min Jour—Feb. 15, 1908. No. 90493 A.

Geology and Mining in Arkansas Diamond Field. Philip F. Schneider. Extract from the preliminary report to the Bureau of Mines of Arkansas. Describes the field, the gems, and discusses the value. 3500 w. Min Wld—Feb. 8, 1908. No. 90116.

The Eruptive Diamond-Bearing Breccias of the Boshof District, S. Africa. J. P. Johnson. Describes the gem-bearing rocks. 3000 w. Inst of Min & Met, Bul. No. 40—Jan. 9, 1908. No. 90546 N.

The Vaal River Diamond Diggings. Mungo Park. Describes these deposits in Africa, the methods of working, etc. 1800 w. Inst of Min & Met, Bul. No. 40—Jan. 9, 1908. No. 90545 N.

Graphite.

Some Characteristics of Natural Graphite. Frederic S. Hyde. Describes the physical and chemical properties and the characteristics of various graphites. 2000 w. Eng & Min Jour—Feb. 1, 1908. No. 89970.

Canadian Graphite. H. Mortimer Lamb. Information concerning the deposits and their development, as reported in a monograph issued by the Canadian Dept. of Mines. 2500 w. Eng & Min Jour—Feb. 15, 1908. No. 90211.

See also New York, under Iron and Steel.

Limestone.

The Composition of Limestones (Sur la Constitution Intime des Calcaires). E. Leduc. A record of extensive investigations on the physical and chemical qualities of limestones with regard to their use for the production of lime. Also tests of mortar, cement, etc. Ills. 30000 w. Bul du Lab d'Essais—No. 10, 1907. No. 90306 N.

Monazite.

See Tungsten, under Minor Minerals.

Oil.

Oil Industry of the United States. Reviews the part of the third Government Report on the Standard Oil Company that refers to prices and profits. 2500 w. Min & Sci Pr—Feb. 8, 1908. No. 90219.

Palladium.

The Occurrence of Palladium in Brazil. Dr. E. Hussak. Describes the occurrences in different mines, of forms of palladic gold. 3000 w. Min Jour—Feb. 1, 1908. No. 90133 A.

Platinum.

The Occurrence of Palladium in Brazil. Dr. E. Hussak. Describes the deposits at various places. 2500 w. Min Jour—Feb. 15, 1908. No. 90491 A.

Salt.

An Improved Method for Mining Salt. Herman Frasch. An invention is illustrated and described relating to the recovery of any saline substance soluble in water from a natural deposit. 1800 w. Min Wld—Feb. 15, 1908. No. 90215.

Tin.

Notes on Tin Mining in Cape Colony. Harry D. Griffiths. A descriptive account of the deposits and methods of mining and working. Ills. 8800 w. Jour Chem, Met, & Min Soc—Dec., 1907. No. 90238 E.

Tungsten.

Occurrence, Character and Uses of Some Rare Metals. H. P. Dickinson. The properties, determination and preparation as commercial products of tungsten and uranium; and the value of monozite in the manufacture of gas mantles. 2000 w. Min Sci— Jan. 30, 1908. No. 89983.

Uranium.

See Tungsten, under Minor Minerals.

MINING.

Accidents.

See Rescue Work, under Mining.

Claim Location.

The Location and Survey of Lode Mining Claims. Frank B. Gaudy. The first of a series of articles intended to aid in locating, surveying and patenting mining claims. The present article treats mineral land acquisitions, apex rights, location methods, etc. 1800 w. Min Sci—Feb. 20, 1908. Serial. 1st part. No. 90453.

Drilling.

Methods and Equipment for Prospecting Placers. H. C. Ludlum. Illustrated description of investigating and prospecting methods to determine the value of land for dredge mining. 4000 w. Min Wld—Feb. 1, 1908. No. 89979.

See also Excavation, under CIVIL ENGINEERING, Construction.

Drills.

A Hand Power Rock Drill. L. B. Orchard. Illustrated description of the Evans hand power rock drill, showing the advantages of its use. 900 w. Can Min Jour—Feb. 15, 1908. No. 90295.

Drills for Stoping. Algernon Del Mar. Explains the advantages of the small air-hammer stoping drill. 1400 w. Min & Sci Pr—Feb. 1, 1908. No. 90074.

Trial of Stoping Drills. An account of a most interesting test at Johannesburg, when the "Gordon drill" was declared the winner under the test conditions. Ills. 4000 w. Engr, Lond—Feb. 7, 1908. No. 90262 A.

The Merits and Demerits of Air-Hammer Drills. G. E. Wolcott. Discusses the different forms of bits and shank used, types, and related matters. Ills. 2000 w. Eng & Min Jour—Feb. 15, 1908. No. 90209.

Education.

See same title, under Industrial Economy.

Electric Hoisting.

Electrical Winding Plant at the Axwell Park Colliery. Illustrated detailed description of an installation of the Ilgner system. 2000 w. Col Guard—Feb. 7, 1908. No. 90253 A.

See also Electric Driving, under MECHANICAL ENGINEERING, Power and Transmission.

Explosives.

The Composition and Properties of Mining Explosives. W. H. Graves. On the characteristics and uses of the deflagrating and detonating varieties. 1000 w. Min Sci—Feb. 6, 1908. No. 90112.

Composition, Classification and Uses of High Explosives. W. H. Graves. Considers explosive compounds and mixtures; especially nitro-glycerin, dynamites, guncotton, Sprengel, and safety explosives. 2000 w. Min Sci—Feb. 20, 1908. No. 90452.

Fuse.

New Fuse for Increasing the Safety of Shot-Firing in Fiery Mines. M. Lheure, in *Annales des Mines.* Aims to prevent miss-fires by igniting the blasting charge along its whole length, by means of a leaden detonating tube charged with trinitrotoluene. 1200 w. Col Guard—Jan. 24, 1908. No. 90015 A.

Haulage.

See Tipples, under Mining.

Hoisting.

Winding-Ropes, Safety-Catches, and Appliances in Mine-Shafts. A discussion of recent improvements in mechanical appliances for increasing the safety of mine workers. Ills. 3000 w. Engng—Feb. 14, 1908. Serial. 1st part. No. 90494 A.

Hoisting Engines.

3,000-Horse-Power Winding-Engine. Illustrated description of a pair of winding-engines recently installed at Nine-Mile Point Colliery, South Wales. 1200 w. Engng—Jan. 17, 1908. No. 90044 A.

Law.

See Claim Location, under Mining.

Management.

Functions of the Consulting Mining Engineer. Allen Hastings Rogers. Small companies are advised to employ them as non-resident managers. 2000 w. Eng & Min Jour—Feb. 8, 1908. No. 90106.

Plants.

See Mining Plants, under Coal and Coke.

Prospecting.

Practical Prospecting in the Missouri-Kansas District. Otto Ruhl. Suggestions for careful and thorough work. Ills. 2200 w. Min Wld—Feb. 22 1908. No. 90451.

Rescue Work.

Rescuing the Men Entombed at Alpha Shaft, Near Ely, Nevada. E. W. Walter. Describes methods of sustaining and finally rescuing men imprisoned 46 days. 1700 w. Eng & Min Jour—Feb. 22, 1908. No. 90459.

Shafts.

Puddling a Wet Shaft. Henry Boursin. An account of puddling a wet shaft in a drift-gravel mine in British Columbia. Ills. 1200 w. Min & Sci Pr—Jan. 25, 1908. No. 89934.

Shaft Sinking.

Sinking a Five-Compartment Shaft on the Rand. Eustace M. Weston. Gives details of the methods employed, and an account of difficulties caused by breakage of drill steel in hard rock. Ills. 4000 w. Eng & Min Jour—Feb. 22, 1908. No. 90456.

Stoping.

See Drills, under Mining.

Surveying.

An Investigation of the Errors Occurring in the Orientation of an Underground Survey. T. Ernest Robertson. A mathematical investigation of the orientation effected by means of plumb lines suspended in vertical shafts. 2000 w. Jour S African Assn of Engrs—Dec., 1907. No. 90233 F.

See also Claim Location, under Mining.

Tipples.

A Handling and Dumping System for Mine Cars. O. V. Greene. Illustrated description of a method of combining the car haul and dumping apparatus. 4000 w. Mines & Min—Feb., 1908. No. 90035 C.

Chains and Cross-bars for Handling Mine Cars. O. V. Greene. Illustrated detailed description of a car-haul conveyor. 2500 w. Eng & Min Jour—Feb. 8, 1908. No. 90107.

Ventilation.

The Conditions Influencing Mine Ventilation. Jos. H. Hart. A discussion of modern methods and agencies found helpful. 3500 w. Min Wld—Feb. 15, 1908. No. 90216.

Note on the Daily Variation of Rand Mine Ventilation. James Moir. Gives experimental results of the variation from night to day, and on rainy and rainless days, with explanation of methods used to counteract its effects. 1200 w. Jour Chem, Met, & Min Soc of S Africa—Nov., 1907. No. 90234 E.

The Influence of Natural Currents of Air on the Mechanical Efficiency of Fans (Der Einfluss des natürlichen Wetterstromes auf den mechanischen Wirkungsgrad der Ventilatoren). Herr Kegel. A discussion both theoretical and practical. Ills. 4000 w. Glückauf—Jan. 25, 1908. No. 90356 D.

Wages.

The Incidence of Methods of Payments on the Efficiency of Miners. Kenneth Austin. Gives a summary of some of the advantages and disadvantages of the various systems. 1500 w. Jour Chem, Met, & Min Soc of S Africa—Nov., 1907. No. 90235 E.

ORE DRESSING AND CONCENTRATION

Black Sands.

Black Sands. Arthur R. Townsend. Discusses their treatment, offering suggestions. 2000 w. Eng & Min Jour—Feb. 8, 1908. No. 90104.

Copper.

Lake Superior Ore-Dressing Practice. L. S. Austin. Illustrates and describes present practice in this copper region. 800 w. Min & Sci Pr—Feb. 22, 1908. No. 90556.

Experimental Plant.

Ore Testing at Salt Lake. Ernest Gayford. Illustrated description of the plant of the General Engineering Co. and its methods. 1200 w. Min & Sci Pr—Jan. 25, 1908. No. 89936.

Gold Milling.

Metallurgy of the Kalgoorlie Goldfield. Gerard W. Williams. The complex ores are roasted either before or after concentration, and fine-grinding is necessary for extraction by cyanide. Illustrates and describes methods. 5500 w. Eng & Min Jour—Feb. 15, 1908. No. 90208.

Treatment Problem of the Republic (Wash.) Gold Ores. Fritz Cirkel. Reviews the history of the treatment of this ore, much money having been spent in research, but the problem not satisfactorily solved. 2200 w. Eng & Min Jour —Feb. 1, 1908. No. 89968.

See also Slimes Treatment, under Ore Dressing and Concentration.

Lead Milling.

Milling on the Coeur d'Alene. George Huston. A criticism of the practice. 1000 w. Min & Sci Pr—Feb. 15, 1908. No. 90455.

See also England, under Lead and Zinc.

Slimes Treatment.

Advances in Slime Concentration Practice. Edwin A. Sperry. Considers crushing, regrinding, classification and sizing, dewatering and final treatment. 2500 w. Min Sci—Jan. 30, 1908. Serial. 1st part. No. 89980.

The Treatment of Slimes in the Black Hills. S. E. Bennett. Illustrates and describes the methods in use at the Homestake plant. 1000 w. Min Wld—Feb. 22, 1908. No. 90450.

MISCELLANY.

Ore Deposits.

A Theory of Ore-Deposition. J. E. Spurr. A theory based on magmatic differentiation is explained. 4500 w. Min & Sci Pr—Feb. 22, 1908. No. 90557.

Diffusion as a Factor in Ore Deposition. Courtenay De Kalb. Explains how osmotic pressure facilitates concentration, and the effect of other forces. 1500 w. Min & Sci Pr—Feb. 15, 1908. No. 90454.

Some Interesting Experiences with Ore-Bearing Veins. Arthur Lakes. Discusses the occurrence and peculiarities of lenticular plication veins in Idaho, and the methods and profits of their mining. 1000 w. Min Sci—Jan. 30, 1908. No. 89982.

Panama.

Mining in Panama. Scott Turner. An account of the conditions prevailing and the past and present mining prospects, showing the field to be unattractive. Ills. 2500 w. Min & Sci Pr—Jan. 25, 1908. No. 89935.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Four Railway Accidents. Particulars of recent accidents reported by the British Board of Trade. 3000 w. Engr, Lond —Feb. 14, 1908. No. 90503 A.

Accident Bulletin No. 25. Information from bulletin issued by the Interstate Commerce Commission. 3500 w. R R Gaz—Feb. 7, 1908. No. 90079.

What Are We Going to Do About Railroad Accidents? W. H. Boardman. An open letter to newspaper editors discussing the many accidents in the United States, and the possible remedies. 3000 w. R R Gaz—Jan. 31, 1908. No. 89940.

Problems.

Some Joint Problems of the Mechanical and Operating Departments of a Railroad. Dexter C. Buell. Discusses power and equipment, tonnage, handling of materials, etc., showing the value of co-operation. General discussion. 8000 w. Pro Cent Ry Club—Jan. 10, 1908. No. 90551 C.

Signalling.

A System of Audible Signalling on Railways. W. Dawson. Paper and discussion before the Engng. Conference, 1907. 5800 w. Bul Int Ry Cong—Jan., 1908. No. 90286 E.

Switching.

The Application of the Bleynie et Ducousso Collective System to the Distant Electrical Working of Points in the Gravity Yard at Bordeaux-Saint-Jean Station (Application des Leviers d'Itinéraires—Système Bleynie et Ducousso—à la Commande Electrique à Distance des Aiguilles d'un Faisceau de Triage par la Gravité dans la Gare de Bordeaux-Saint-Jean). Ch. Gufflet. Ills. 11000 w. Rev Gen de Chem de Fer—Jan., 1908. No. 90319 G.

Trains.

The Continental Limited. Illustrated description of a fast train on the Boston & Maine R. R., and the interesting features of the route. 500 w. Ry & Loc Engng—Feb., 1908. No. 89984 C.

Train Service.

The Express Business. C. H. Crosby. From an address before the Traffic Club of New York. Brief review of the development, improvements, and changes. 1700 w. R R Gaz—Feb. 14, 1908. No. 90228.

Express Train Services of 1907.—British and French. Charles Rous-Marten. Comparative statistics relating to speed are given. 1500 w. Engr, Lond—Feb. 7, 1908. No. 90361 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Cleaning Locomotive Triple Valves. Directions for cleaning when there is not time to remove the triple valve. 1300 w. Ry & Loc Engng—Feb., 1908. No. 89988 C.

The Siemens Brake for Fast Trains. Illustrated description of an attempt to proportion the brake pressure to the coefficient of friction, which varies with the speed. 2300 w. Bul Int Ry Cong—Jan., 1908. No. 90281 E.

Freight Train Breaking Tests on the Hungarian State Railway, carried out on the Level Track between Pozsony and Ersekujvár (Güterzug-Bremsversuche der Kgl. Ungarischen Staatsbahn auf der Flachbahnstrecke Pozsony-Ersekujvár). Gives in curves and tables the results of extensive tests on Westinghouse brakes. Ills. 7500 w. Glasers Ann—Jan. 1, 1908. No. 90359 D.

Car Building.

See Shops, under Motive Power and Equipment.

Cars.

Indian Broad-Gauge Railways. H. Kelway Bamber. Sketches and description of third-class coaching stock. 1000 w. Engng—Jan. 17, 1908. No. 90043 A.

The Era of Steel and the Passing of Wood in Car Construction. Arthur M. Waitt. Considers the progress and changes in the construction of railway cars especially in the United States and Canada. Also discussion. 16500 w. Pro N Y R R Club—Jan. 17, 1908. No. 90185.

Car Ventilation.

The Garland Car Ventilator. Illustrated description of this device and its principles of operation. 1200 w. Ry & Engng Rev—Feb. 22, 1908. No. 90441.

Couplers.

The Exhibits of Automatic Couplers for Railway Cars at the Milan Exposition, 1906 (Il Concorso per uno Studio di Sistema Automatico di Agganciamento di Vagoni Ferroviari bandito in Occasione dell' Esposizione Internazionale di Milano, 1906). A. Campiglio. The first part describes the Pavia-Casalis coupler. Ills. 2500 w. Serial, 1st part. Monit Tech—Jan. 10, 1908. No. 90339 D.

Draft Gears.

The Draft Gear. A. Stucki. Discusses the momentum taken by the draft gear, the principle of different gears, construction, repairs, etc. Ills. General discussion. 13000 w. Pro Ry Club of Pittsburgh—Dec., 1907. No. 90530 C.

Dynamometer Cars.

Dynamometer Cars (Les Wagons Dynamométriques). A. Rodrigue. Describes the cars of the French railways and the more important types in use in other countries. Ills. 10000 w. Mem Soc Ing Civ de France—Nov., 1907. No. 90305 G.

Electrification.

Electrification of Railways. Dr. Gisbert Kapp. Lecture delivered before the Roy Inst. of Gt. Britain. Presents the advantages of electrification, and the improvements looked for in this work. Ills. 2300 w. Elec Engr, Lond—Jan. 24, 1908. Serial, 1st part. No. 90006 A.

Some Reflections on Railway Electrification. Philip Dawson. Explaining the advantages of the single-phase system, and discussing the causes which lead to the electrification of railways. 2500 w. Elec Rev, Lond—Feb. 14, 1908. No. 90487 A.

The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City. William J. Wilgus. A full paper explaining the reasons for the change from steam to electricity, describing the general features of construction and operation, and the results. Map and Ills. 10800 w. Pro Am Soc of Civ Engrs—Feb., 1908. No. 90553 E.

Feed-Water Heating.

Locomotive Feed Water Heater. Illustrated description of the F. F. Gaines heater, being tried on the Central of Georgia Railway. 900 w. Am Engr & R R Jour—Feb., 1908. No. 89992 C.

Gasoline Locomotive.

The Vanguard Gasoline Locomotive. Illustration, with brief description of a light locomotive for switching, etc. 700 w. Ir Age—Feb. 13, 1908. No. 90153.

Locomotive Design.

Some Notes on Current Locomotive Practice. Discusses present practice and the demand for power and economy. 1200 w. Prac Engr—Feb. 7, 1908. Serial, 1st part. No. 90243 A.

Locomotive Management.

Economical Locomotive Handling. Address by W. H. Bradley, at the Railroad Y. M. C. A., at Boone, Ia., on how to take advantage of, and handle a locomotive economically. 1500 w. Ry & Loc Engng—Feb., 1908. No. 89990 C.

Locomotive Oscillation.

Is the Endway Oscillation of Locomotives a Disturbing Movement? Mr. Strahl. Trans. from *Ann. für Gewerbe und Bauwesen.* Defending the utility of tests made on a testing plant. 6200 w. Bul Int Ry Cong—Jan., 1908. No. 90288 E.

Locomotives.

Engines for the Nickel Plate. Illustrates types of engines for passenger, and for freight service, recently built for the N. Y., C. & St. L. Ry. 1200 w. Ry & Loc Engng—Feb., 1908. No. 89989 C.

Wabash 2-6-2 Fast Freighter. Illustrated description of one of the 30 engines recently supplied to this road for fast freight service. 1000 w. Ry & Loc Engng—Feb., 1908. No. 89986 C.

Ten-Wheel Switching Locomotive for the Big Four. Illustrated description of engines for service in the classification yards. 500 w. Ry Age—Feb. 21, 1908. No. 90439.

A High-Power European Locomotive. Charles R. King. Illustrated description of a powerful locomotive built in Bavaria for use on the State Railways. 600 w. Sci Am—Feb. 15, 1908. No. 90193.

Ten-Wheel Locomotive for the Texas & Pacific. Illustrated description of engines for mixed service. 300 w. Ry Age—Feb. 14, 1908. No. 90223.

L. & S. W. Locomotive, No. 335. Illustrated detailed description of the largest engine on the London and South-Western Railway. 900 w. Engr, Lond—Feb. 7, 1908. No. 90260 A.

The New Great Western Locomotive. Illustrates and describes the latest development in locomotives for a road celebrated for its high speed, long-distance non-stop runs. 500 w. Engr, Lond—Feb. 14, 1908. No. 90504 A.

Rack Locomotive for the Villa Nova de Gaya Railway, Portugal. Illustrated detailed description. 600 w. Engng—Feb. 14, 1908. No. 90497 A.

Tank Locomotives for the Southern Manchuria Railway. Illustrated description of one of 69 tank engines built in America. 500 w. Ry Age—Feb. 7, 1908. No. 90118.

The Brotan Locomotive. William C. Dreher. Illustrated description of this locomotive boiler, with a water-tube firebox, used on the Austrian State Rys., and statement of the advantages claimed. 2000 w. R R Gaz—Feb. 14, 1908. No. 90225.

High-Speed Compound Locomotive for the Eastern of France (Locomotive Compound à Grande Vitesse de la Compagnie des Chemins de Fer de l'Est). Ch. Dantin. Illustrated description. 3000 w. Génie Civil—Jan. 18, 1908. No. 90334 D.

See also Gasoline Locomotive, under Motive Power and Equipment.

Locomotive Testing.

The Testing of a Locomotive. Frederic Blount Warren. Brief illustrated description of the plant at Altoona, Pa., and its operation. 2200 w. Sci Am—Feb. 22, 1908. No. 90477.

Problems.

See same title, under Conducting Transportation.

Shops.

Building Wooden Freight Cars. An account of the organization and operation of the part of the Angus shops of the C. P. R. devoted to the construction of freight cars. Describes the building of a standard box car. Ills. 2500 w. Am Engr & R R Jour—Feb. 1908. No. 89991 C.

Superheating.

The Development of Superheating Apparatus for Locomotives. J. F. Gairns. Reviews the history of the superheater locomotive, giving illustrated descriptions of European and American practice. 6000 w. Cassier's Mag—Feb., 1908. No. 90273 B.

Wheels.

The Shelling Out of Steel Wheels and Tires. George L. Fowler. An illustrated account of investigations made for the Schoen Steel Wheel Co. 1200 w. R R Gaz—Jan. 31, 1908. No. 89942.

The Car Wheel and Its Relation to the Rail and Car. S. P. Bush. Considers facts concerning car wheels and the conditions of operation in the past and present, discussing the needed improvement of quality. Discussion. Ills. 20000 w. Pro W Ry Club—Jan. 21, 1908. No. 90423 C.

See also Rails, under Permanent Way and Buildings.

Valve Gears.

Tests of Cast-Iron Distributing Valves on the Locomotives of the Orléans Railway (Essais de Tiroirs de Distribution en Fonte sur les Locomotives de la Compagnie d'Orléans). Paul Conte. Gives results of extensive tests aiming toward the substitution of cast iron for bronze in locomotive valve gears. Ills. 2400 w. Rev Gen de Chem de Fer—Jan., 1908. No. 90320 G.

NEW PROJECTS.

Switzerland.

The New Alpine Railways and Their Branches in Switzerland (Die neuen Alpenbahnen und Zufahrtlinien in der Schweiz). H. Cox. Discusses especially their economic importance to Germany. Ills. 3200 w. Serial, 1st part. Zeitschr d Ver Deutscher Ing—Jan. 4, 1908. No. 90380 D.

PERMANENT WAY AND BUILDINGS.

Ballast.

See Tracks, under Permanent Way and Buildings.

Construction.

The Construction of the Portland & Seattle Railway. W. P. Hardesty. Describes the physical characteristics of the country and gives an illustrated detailed description of the very costly construction work. 5000 w. Eng News—Feb. 13, 1908. No. 90163.

Elevated Railways.

The Fortieth Street Track Elevation of the Chicago Junction. Map, and illustrated detailed description of this work. 1500 w. R R Gaz—Feb. 21, 1908. No. 90447.

Improvement of the Union Loop, Chicago. Charles K. Mohler. Gives a tentative plan for the improvement and extension of the elevated service, explaining the purpose and the advantages to be gained. 2000 w. Ry & Engng Rev—Feb. 8, 1908. No. 90119.

Freight Sheds.

See Terminals, under Traffic.

Grade Reduction.

Operating Time as an Element in Considering Grade Reductions. Abstract of an article by A. K. Schurtleff in the *Bul. of the Am. Ry. Engng. & Main. of Way Assn.* 2000 w. Eng Rec—Feb. 1, 1908. No. 89962.

Protective Materials.

The Best Means of Preserving Iron and Steel Work in Railway Construction. Bertram Blount. Paper and discussion at the Engng. Conference, 1907. 5300 w. Bul Int Ry Cong—Jan., 1908. No. 90-284 E.

Rails.

A Compound Rail Section. A. W. Heinle. A critical discussion of the design and rolling of rails. 2000 w. R R Gaz—Jan. 31, 1908. No. 89941.

The Chemical Composition of Steel Rails and Latest Developments. Christer Peter Sandberg. (Inst. of Civ. Engrs.) Short paper, with discussion of this subject. 36400 w. Bul Int Ry Cong—Jan., 1908. No. 90282 E.

The Action Between Wheel and Rail. Henry Reginald Arnulph Mallock. Paper and discussion before the Engng. Conference, 1907. An account of conclusions from an examination of the mutual action. 7200 w. No. 90285 E.

The New Types of Rails on the Italian State Railways (I Nuovi Tipe di Armamento dello Ferrovie dello Stato). Gives extensive details of composition, of section, manufacture, cost, etc. Ills. 5500 w. Ing Ferroviaria—Jan. 16, 1908. No. 90340 D.

Roundhouses.

The Roundhouse of the Lehigh & Hudson River Railway at Warwick, N. Y. Illustrated description. The interesting feature is the special combination of steel, concrete and wood used in the framework. 1000 w. Eng Rec—Feb. 8, 1908. No. 90096.

Stations.

New Orleans Terminal Station. Illustration, plans, and brief description. 300 w. Ry Age—Feb. 14, 1908. No. 90221.

Large Railway Stations. The first of a series of articles on the large stations of Great Britain. The Paragon station at Hull, is illustrated and described. 3000 w. Engr, Lond—Feb. 14, 1908. Serial, 1st part. No. 90501 A.

Terminals.

Wabash Freight Terminal at St. Louis. Illustrated detailed description. Freight is handled on a tonnage basis. 1200 w. Ry Age—Feb. 7, 1908. No. 90117.

Solving the Terminal Problem at St. Louis. Map, and description of the methods that have been followed and the results secured and sought. 2800 w. Ry Age—Feb. 14, 1908. Serial, 1st part. No. 90220.

Ties.

The Iron Sleeper. A. Haarman. Gives a report of the efficiency of iron sleepers on the Prussian State Railways, and discusses their cost, advantages, etc. Ills. 3800 w. Engr, Lond—Feb. 21, 1908. Serial, 1st part. No. 90672 A.

Tracks.

Track and Ballast. H. Rettinghouse. Remarks on the essentials of good tracks, discussing each in detail. Also paper on same subject, by R. R. Aurbach. General discussion. 16000 w. Pro Iowa Ry Club—Jan. 10, 1908. No. 90550 C.

Transfer Bridges.

The Weehawken Transfer Bridges of the West Shore Railroad. Illustrated description of bridges for the service of handling cars by means of floating equipment. 3000 w. Eng Rec—Feb. 15, 1908. No. 90203.

Yards.

Wath Concentration Yard, Great Central Railway. Illustrated description of the large yard at Wath-on-Dearne, for the sorting of coal cars, both loaded and empties. 2000 w. Engr, Lond—Feb. 7, 1908. No. 90263 A.

TRAFFIC.

Car Sealing.

Car Seals. Charles J. Webb. Read before the Chicago Claim Conference. Considers the methods that give the best results. 1000 w. Ry Age—Feb. 14, 1908. No. 90222.

Management.

The Railway Profession; Some Important Problems and Their Handling. H. Wade Hibbard. Discusses the improvements made necessary by increased traffic and changed conditions, and the methods of best accomplishing the work. Short general discussion. 9000 w. S & S-W Ry Club—Nov. 21, 1907. No. 89842 E.

Tonnage Rating.

Tonnage Rating by Ton Mile Hour Basis. C. A. Seley. Remarks on the advantages of this method, with general discussion. 4000 w. Pro Iowa Ry Club—Dec. 13, 1907. No. 90184 C.

MISCELLANY.

Africa.

The Soudan Railroad from the Red Sea to the Nile. H. G. Prout. An interesting letter giving early history of this project. 900 w. R R Gaz—Feb. 21, 1908. No. 90446.

The Railroad from the Red Sea to the Soudan. From a letter by Frank G. Carpenter, describing this new railroad which the British have built from Atbara to Port Soudan. 1800 w. R R Gaz—Feb. 14, 1908. No. 90227.

The Otavi Railway. A. R. Bell. An illustrated account of the longest narrow gauge light railway in the world. 1200 w. Ry & Loc Engng—Feb., 1908. No. 89985 C.

British Railways.

British Railway Development, Past and Present. F. A. Lart. A discussion of the present status of British railways and some of the tendencies. 3500 w. Cassier's Mag—Feb., 1908. Serial, 1st part. No. 90275 B.

Canada.

Western Canada and the Canadian Northern Railway. From an address by D. B. Hanna before the Empire Club of Toronto. 2500 w. R R Gaz—Jan. 31, 1908. No. 89943.

Government Control.

The Regulation of Local Lines and Tramways and the Supervision of Their Tariffs (Note sur la Réglementation des Chemins de Fer d'Intérêt Local et des Tramways et sur la Rédaction de leurs Cahiers des Charges). A. Donoil. An elaborate discussion of the French law on the subject. 27000 w. Rev Gen d Chemins d Fer—Dec., 1907. No. 89720 G.

Adverse Railroad Legislation. Papers by Nathaniel S. Brown and by Herbert S. Hadley, with letters from other writers. 18700 w. Pro St Louis Ry Club—Jan. 10, 1908. No. 89901.

History.

A Decade of American Railroad History in Graphic Form. Harold Vinton Coes. Gives charts showing growth, operation and equipment, and finances, with explanatory notes. 1500 w. Engineering Magazine—Feb., 1908. No. 89883 B.

India.

Indian Railway Economics. The present number reviews the history of the railways in India down to recent times. 2000 w. Engr, Lond—Jan. 10, 1908. Serial, 1st part. No. 89660 A.

Interstate Commerce.

Interstate Commerce Report. Extracts from the last annual report which covers the first year's work under the 1906 Rate Law. Also editorial. 5000 w. R R Gaz—Jan. 10, 1908. No. 89444.

Annual Report of the Interstate Commerce Commission. Deals with portions of the report not considered in an earlier issue. 5000 w. R R Gaz—Feb. 7, 1908. No. 90078.

Light Railways.

Light-Railway Policy. William Barrington. Paper and discussion before the Engng. Conference, 1907. 7900 w. Bul Int Ry Cong—Jan., 1908. No. 90287 E.

Panama Railway.

Panama Railway and Its Relations to the Panama Canal. Ralph Budd. Also discussion. An account of the work in progress. 8500 w. Pro Iowa Ry Club—Nov. 8, 1907. No. 90183 C.

Peru.

The Railroads of Peru. J. R. Cahill. Map and illustrated account of the development and working of the railways. 3500 w. R R Gaz—Feb. 7, 1908. No. 90081.

Philippines.

Railroad Construction in the Philippine Islands. L. F. Goodale. An illustrated account of the lines, especially those built since the U. S. control; the methods used in construction work are described. 3000 w. Ry Age—Jan. 31, 1908. No. 89976.

Seaboard Line.

Seaboard Air Line. Reviews the recently issued annual report. Also editorial. 3000 w. R R Gaz—Jan. 10, 1908. No. 89442.

Southern Pacific.

Southern Pacific Company. Map, with review of the 23d annual report for the year ending June 30, 1907. 3000 w. R R Gaz—Feb. 14, 1908. No. 90224.

Union Pacific.

Union Pacific. Review of an interesting annual report showing progress. 3300 w. R R Gaz—Jan. 3, 1908. No. 89342.

Transportation.

Relations of Transportation to Modern Civilization and Its Bearing on the Question of Co-operation. F. A. Delano. An address before the Traffic Club of St. Louis. Shows that the transportation problem is related to the welfare of the whole country. 3300 w. Ry Age—Feb. 21, 1908. No. 90440.

STREET AND ELECTRIC RAILWAYS

Brakes.

Fundamental Brake Rigging for High Speed Electric Railway Cars. R. C. Taylor. Report to the Cent. Elec. Ry. Assn. on foundation gear for high-speed interurbans, including only the apparatus from the air-brake cylinder to the wheels. 900 w. St Ry Jour—Feb. 1, 1908. No. 89946.

Canada.

Electric Railways in Canada. J. L. Payne. An interesting review of progress and development. 1800 w. St Ry Jour—Feb. 1, 1908. No. 89945.

Car Houses.

New Car House Construction in New York. Plans and description of a rebuilt structure at 146th St. and Lenox Ave. 800 w. St Ry Jour—Feb. 8, 1908. No. 90076.

Cars.

Pay-as-You-Enter Cars for Mexico. Illustrated description of cars of the double-center entrance type. 700 w. Elec Ry Rev—Feb. 22, 1908. No. 90445.

The Brooklyn Rapid Transit Company's Type "1400" Elevated Car. Illustrated description of cars of the semi-convertible type. 1400 w. St Ry Jour—Feb. 8, 1908. No. 90077.

Long Single-Truck Cars Without Monitors. Descriptions and illustrations of types used by the Black River Traction Co., with criticisms by T. J. Nicholl, and replies by A. H. Lefevre. 2500 w. Elec Ry Rev—Feb. 1, 1908. No. 89999.

Notes on the Black River Traction Company of Watertown, N. Y. A. H. Lefevre. Illustrated detailed account of interesting improvements introduced in line and equipment. 3000 w. St Ry Jour —Feb. 8, 1908. No. 90075.

Typical Traction Cars. Charles A. Heron. Abstract of a paper read before the Indiana Engng. Soc., on the dimensions, weight and seating capacity of typical cars now operated. 1000 w. Elec Ry Rev—Feb. 1, 1908. No. 90000.

See also Subway Cars, under STREET AND ELECTRIC RAILWAYS.

Car Wiring.

Equipping New York's Pay-as-You-Enter Cars. Plans and description of car-wiring representing the latest practice. 900 w. St Ry Jour—Feb. 15, 1908. No. 90173.

Controllers.

Controller Handle Button. Describes the electric controller with safety button and emergency brake valve, used on the trains in the N. Y. subway. Ills. 1500 w. Ry & Loc Engng—Feb., 1908. No. 89987 C.

Economics.

The Economics of Rapid Transit in Cities (Zur Frage der Wirtschaftlichkeit städtischer Schnellbahnen). Herr Kemmann. Discusses conditions in the European and American cities which have established elevated and underground railways. Ills. 5000 w. Glasers Ann—Jan. 15, 1908. No. 90360 D.

Elevated Railways.

See same title, under RAILWAY ENGINEERING, Permanent Way and Buildings; and Economics, under STREET AND ELECTRIC RAILWAYS.

France.

See Government Control, under RAILWAY ENGINEERING, Miscellany.

Interurban.

Interurban Railways. Hugh J. McGowan. From an address before the Nat. Business League of America. Some facts in regard to the development and benefits resulting from such service. 1800 w. Munic Engng—Feb., 1908. No. 90182 C.

The Northampton Traction Company. Illustrated description of lines in eastern Pennsylvania, passing through picturesque scenery. Running from Easton to Nazareth and Bangor, and from Easton to Allentown and Philadelphia. Map. 2000 w. St Ry Jour—Feb. 1, 1908. No. 89944.

The Indianapolis & Louisville Traction Co. Illustrated description of a road operated on direct current at 1,200 volts pressure. 2500 w. Ry & Engng Rev—Feb. 8, 1908. No. 90120.

Electric Trunk Lines (Elektrische Vollbahnen). Herr Zweiling. Illustrates and describes rolling stock for both direct and alternating-current operation in Europe. 3000 w. Serial, 1st part. Glasers Ann—Jan. 15, 1908. No. 90361 D.

See also Single-Phase, under STREET AND ELECTRIC RAILWAYS.

Monorail.

The Tunis Monorail System. Illustrates and describes the general features. 1000 w. Sci Am—Feb. 15, 1908. No. 90192.

Montreal.

The Montreal Street Railways. Describes the conditions, and gives an account of the system, management and financial condition of the street railway lines. Ills. 1800 w. Tram & Ry Wld—Feb. 6, 1908. No. 90416 B.

Motors.

See Railway Motors, under ELEC-

TRICAL ENGINEERING, Dynamos and Motors.

Operation.

See Cars, under STREET AND ELECTRIC RAILWAYS.

Paris.

The Métropolitan of Paris (Le Métropolitain de Paris). A. Dumas. A description of the lines built and authorized with a discussion of the financial results. Map. 6500 w. Génie Civil—Jan. 25, 1908. No. 90336 D.

Porto Rico.

Tramway and Power Developments in Porto Rico. An illustrated account of improvements in transportation facilities since the American occupation. 2000 w. St Ry Jour—Feb. 22, 1908. No. 90422.

Schedules.

Electric Train Performance. W. S. Valentine. Describes a method in which, by the use of a celluloid templet, the amount of work, entailed in the usual methods of computing coasting distance, practiced by engineers, is greatly reduced. 1200 w. Elec Jour—Feb., 1908. No. 90426.

Single-Phase.

The Roma Civita Castellana Single-Phase Railway. B. F. Hirschauer. Illustrated description of the first single-phase railway in Italy. 2200 w. Elec Rev, N Y —Feb. 15, 1908. No. 90197.

The Washington, Baltimore & Annapolis Single-Phase Railway. Illustrated detailed description of this new high-speed line. 4000 w. St Ry Jour—Feb. 15, 1908. No. 90172.

The Oerlikon System of Single-Phase, Alternating-Current Electric Traction on European Railways (La Traction Electrique par Courant Alternatif Simple sur les Chemins de Fer en Europe, Système Oerlikon). M. Henry. Illustrated detailed description. 2000 w. Serial, 1st part. Jan. 4, 1908. No. 90324 D.

See also Electrification, under RAILWAY ENGINEERING, Motive Power and Equipment.

Subway Cars.

Report on Subway Car Design in New York. Abstract of the report of Bion J. Arnold to the Public Service Commission. 4500 w. St Ry Jour—Feb. 29, 1908. No. 90568.

Subways.

The Hudson and Manhattan Tunnels. Map, illustrations, and brief description of the lines to be opened on Feb. 25, 1908. 1200 w. R R Gaz—Feb. 21, 1908. No. 90448.

Opening of the Hudson River Tunnel System. Brief illustrated account of this project, its completion, equipment, etc. 1200 w. St Ry Jour—Feb. 29, 1908. No. 90566.

Opening of the Hudson River Tunnel System. An illustrated description of this great work, with brief review of its history. 2800 w. Sci Am—Feb. 22, 1908. No. 90476.

The Opening of the First Hudson River Tunnel. Outlines the history of this work, and describes the difficulties, and the tunnel system as finally completed. Map and Ills. 5000 w. Eng News—Feb. 27, 1908. No. 90524.

Tunnels for Passenger Traffic at New York City. Editorial on some features of design and equipment of cars for tunnel service and matters relating to tunnel operation. 1300 w. Eng News—Feb. 27, 1908. No. 90523.

The Beginning of Train Service Under the Hudson River at New York. Brief account of the opening, and illustrated description of the work. 1800 w. Eng Rec—Feb. 29, 1908. No. 90609.

The Opening of the Hudson River Tunnels. An account of the opening of the tunnels between Jersey City and New York, with brief illustrated description of this great engineering work. 4000 w. Sci Am Sup—Feb. 29, 1908. No. 90601.

Proposed Track Changes at Ninety-Sixth Street, New York Subway. Report of proposed changes at the junction of the Broadway and Lenox Ave. divisions to relieve congestion of traffic. 1000 w. St Ry Jour—Feb. 29, 1908. No. 90569.

A New Subway in Paris. Brief illustrated description of a line about 8½ miles long being driven from north to south and passing under the Seine river. 1500 w. Sci Am Sup—Feb. 15, 1908. No. 90585.

See also Economics and Paris, under STREET AND ELECTRIC RAILWAYS.

Subway Signalling.

Signalling of the East River Tunnels, New York. Illustrated description, calling attention to variations from practice in the N. Y. subway. 2000 w. R R Gaz —Feb. 28, 1908. No. 90597.

Switzerland.

See same title, under RAILWAY ENGINEERING, New Projects.

Track Construction.

The Problem of Track Support. Samuel E. Duff. An investigation of the track as a whole, discussing designs. Ills. 3500 w. Ry & Engng Rev—Feb. 22, 1908. No. 90442.

Wire Suspension.

Catenary Construction on the Syracuse, Lake Shore, and Northern Railroad. Illustrated description of catenary construction designed for single-phase current at 6,600 volts. 1000 w. Elec Ry Rev—Feb. 8, 1908. No. 90111.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.

Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. dei Lav. Pubb. e d Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Science. *w.* Denver, U. S. A.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers· *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.*- Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Technique. *b-m.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Elevators.

Elevator Service. By Reginald Pelham Bolton. Size, 11 by 8 in.; pp. 69. Ills. Price, $5. New York: Reginald Pelham Bolton.

From his wide experience as a consulting engineer in this class of work Mr. Bolton has been able to produce in this small volume a clear and concise discussion of the principles on which elevator equipment for the modern high office building should be designed, to which we have no hesitation in giving our heartiest commendation. In his introductory chapter he shows clearly the limitations of elevator service, their causes and character, and the necessity for the recognition of these limitations in the establishment of a standard rating for use both in design and in checking operating results. In the remaining chapters Mr. Bolton discusses in a very practical manner the proportioning of the elevator equipment to the building it is to serve and the influence of operating conditions, size and shape of cars, loads and speeds, and all the other elements in the problem of vertical transportation on the efficiency of elevator service. One of the most valuable features of the book is the inclusion of a large number of data obtained in actual practice in New York City, where the conditions of service are probably more severe, and elevator equipment more highly developed, than anywhere else.

Railway Operation.

The Economics of Railway Operation. By M. L. Byers. Size, 9 by 6 in.; pp., ix, 672. Ills. Price, $5. New York: The Engineering News Publishing Company; London: Archibald Constable & Company.

This addition to the literature of the science of transportation should meet with a cordial reception by all classes of railway men. Its general objects are, for the student, to so outline the operations of each department as to give those unfamiliar with their workings a sufficient insight to form the basis for the detailed information which can be acquired only by personal observation and experience; and, for the official, to bring into clear relief the underlying principles of economic operation in so far as they will enable him to increase the efficiency of his own department and gain a clearer idea of its relation to the other elements of the railway organization. The book is divided into seven parts, dealing, respectively, with organization; employment, education and discipline of forces; accounts and accounting; reports; economic operation; analysis of operations; and betterments. Mr. Byers has not written only from his own experience on the Missouri Pacific, but has drawn his illustrations liberally from the operating practice of many other roads. He has produced a very valuable review of the present development of railway transportation methods in the United States which will well repay careful study.

BOOKS RECEIVED.

The Geological Map of Illinois. By Stuart Weller. Size, 9 by 6 in.; pp., 34. Map. Urbana, Ill.: Illinois State Geological Survey.

Rapports Annuels de l'Inspection du Travail. Size, 10 by 7 in.; pp., 441. Ills. Price, fr. 4. Brussels: Department of Industry and Labor.

Statistics of the American and Foreign Iron Trades for 1906. Size, 9 by 6 in.; pp., 88. Philadelphia: The American Iron and Steel Association.

Annual Report of the Park Department of the City of Cambridge, 1907. Size, 9 by 6 in.; pp., 37. Ills. Cambridge, Mass.: Department of Parks.

Third Annual Report of the Highway Department of the State of Ohio. Size, 9 by 6 in.; pp., 288. Ills. Columbus, O.: Department of Highways.

Annual Reports of the Department of the Interior, 1906; Commissioner of Education, Vol. 2. Size, 9 by 6 in.; pp., 644-1308. Ills. Washington, D. C.: Department of the Interior.

Proceedings of the Society for the Promotion of Engineering Education, Cleveland Meeting, 1907. Size, 9 by 6 in.; pp., 690. Ills. Brooklyn, N. Y.: Published by the Secretary.

Annual Report of the Department of Public Works of the City of Buffalo for the Year Ending June 30, 1907. Size, 9 by 6 in.; pp., 1053. Buffalo, N. Y.: Department of Public Works.

A Study of Four Hundred Steaming Tests Made at the Fuel-Testing Plant, St. Louis, Mo., in 1904, 1905, and 1906. Size, 9 by 6 in.; pp., 196. Ills. Washington, D. C.: United States Geological Survey.

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JAPAN'S MANUFACTURE AND IMPORTATION OF IRON GOODS.

By M. Kawara.

Industrial interests and economic ambitions dictate modern statecraft, and it is in these factors that we shall find the solution to the increasingly interesting problem of Japan's aims and policies, internal and international. Mr. Kawara's view, typical of well and widely informed Japanese opinion, is reassuring as to the future stability of his country's relations with the Western World; for it implies so intimate and essential an interdependence between Japanese manufacturing and European or American mining and producing enterprises, that the closely cemented relationships of trade and commerce should make war impossible.—THE EDITORS.

IT is not necessary to dwell at length upon the importance of the Far Eastern market for American manufacturers. Information regarding this market, however, seems to be scanty. It is for this reason that I have undertaken to give some idea about the situation of the iron industry in Japan, one of the most important markets in the East. A brief historical sketch of Japan's home manufacture and foreign importation will be given first, then the present situation, and lastly the outlook for American manufacturers.

The Japanese were acquainted with iron from very early times. A sword that was used by one of the ancestors of the present Emperor about 800 B. C. is still in existence. Later, when the great civil war broke out in the sixth century, sword smiths and armour smiths came to occupy a prominent place. Many interesting stories are connected with sword smiths, although this is no place to go into these. From this time on down to about three-hundred years ago, no noticeable progress had been made. At the beginning of the seventeenth century, when the Tokugawa dynasty came into possession of the political power and peace was restored, all branches of industry began to prosper. The demand for iron implements increased, and the scarcity of iron supply began to be felt.

Up to this time the supply of iron was furnished by the native smelters, who reduced the magnetic ore, in the form of ferruginous sand, in crude charcoal furnaces. The product was expensive. The Dutch traders found it very profitable to import iron bars. They thus brought a considerable amount yearly.

This state of affairs continued until fifty years ago. The revolution of 1868 changed conditions entirely. The country was thrown open to foreign commerce, and for the first time Western machines and instruments were introduced to the natives. It did not take long to convince the people of the advantages of the new appliances. It was at this time that the government established a blast-furnace plant at Kamaishi, some five-hundred miles north-east of Tokio. The furnaces were built after the Dutch fashion, and charcoal was used for fuel. The quality of the product was found very unsatisfactory, so the plant was soon sold to a private corporation, which subsequently failed. This seems to have given a setback to the iron industry. For the next thirty years practically nothing was done in iron-smelting work. At the time of the Japanese-Chinese war, the government sorely felt the need of a smelting plant, so it started one at Fukuoka, on Kiushiu Island, where coal is abundant, the ore for this plant being imported from China. All necessary machines and furnaces were bought from Germany, and the actual smelting work was begun about five years ago. Bars, plates and rails are now being turned out. The quality still seems to be unsatisfactory. It is doubtful whether the plant will ever be on a paying basis so long as it remains in government hands.

Very recently, a syndicate was formed by some British and Japanese capitalists for the purpose of establishing a large smelting plant in Hokkaido, or Yezo as it is more commonly called in America. How far the work has been carried on I have not been able to find out.

In the mean time the demand for iron goods rose higher and higher. Railroad companies and steamship companies were formed one after another; factories, such as spinning, weaving, paper mills, etc., sprang up here and there in rapid succession. At this stage all machines were bought either from America or Europe; but it was absolutely necessary to have them repaired at home. Small iron works mainly for this purpose were started in the principal cities.

Then, gradually, enterprising manufacturers began to build machines of small sizes.

From this time on the growth of the iron industry has been steady. To-day there are over one-thousand iron works. The figures given in the census of 1904 are as follows:

TABLE I. JAPANESE FACTORIES AND EMPLOYEES.

Kind of Factory.	No. of Factories.	No. of Employees.
Machine-making factories	761	57,509
Ship-building yards	46	21,026
Tool-making works	228	10,754
Foundries	85	2,478
Total	1,120	91,767
Average number of employees in each shop		82

It is to be noted here that shops are very small compared to the similar shops in the Western countries, as may be seen from the number of employees. Since the census was taken, there must have been an increase both in the number of factories and employees, especially in the latter. However this increase will not exceed, roughly speaking, 20 per cent. In general, machines built in Japan are small in size and rather poor in workmanship. Larger and finer machines are imported from abroad. This does not mean that the Japanese are incapable of producing such machines. The trouble lies in the fact that capital is scarce. Given first-class facilities, they can do as well as most people can.

Now let us turn toward the importing business and see how it developed. As has been incidentally touched upon, the importation of iron goods was going on even under the Tokugawa *régime*. After the revolution of 1868, there came a sudden increase in this trade. Still, up to the time of the Japanese-Chinese war of 1894-95, the amount was insignificant. While the war was going on, the iron trade in general reached the highest mark of prosperity experienced up to that time, chiefly for the reason that the government ordered a large amount of war materials. At the conclusion of the war, the indemnity China paid Japan caused the abnormal expansion of all industries, and the importers, as well as the home manufacturers, were very busy for the following two years. Table II and the curve show these facts. A depression came after the abnormal expansion, as the natural consequence; 1899 is the year in which the reaction was felt most severely. Here the imported goods dropped down to 15,000,000 yen. or about $7,500,000, from 25,000,000 in the preceding year. Still, this is about five times as much as before the war. The revival came in 1900, and in the following three years a gradual rise took place.

TABLE II.

The Amount of Iron Goods Importation from 1892 to 1907 in Yen (Two Yen Equivalent to One Dollar.)

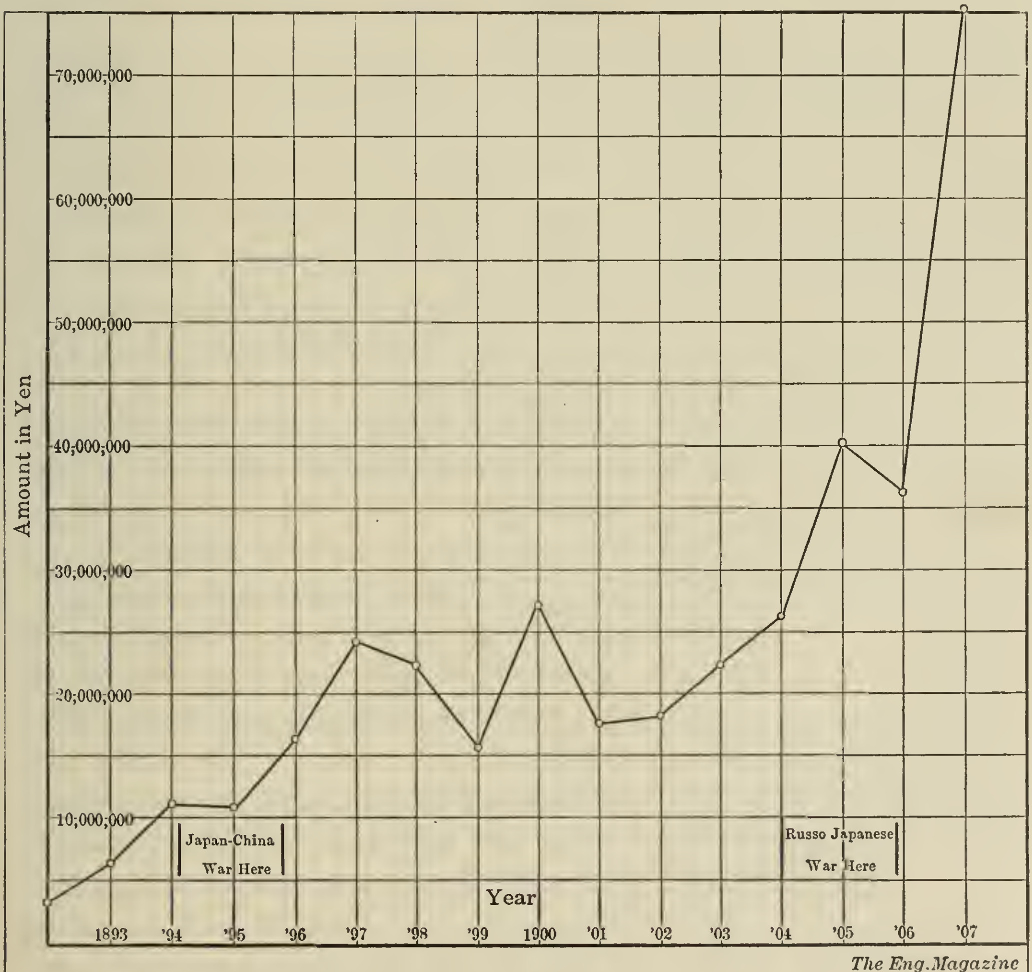
(From the Report of Department of Finance.)

Kind of Article.	1892	1893	1894	1895	1896	1897	1898	1899
Electric machinery	——	——	——	——	14,000	168,000	91,000	13,000
Locomotives and cars	200,000	357,000	1,580,000	1,164,000	1,621,000	4,236,000	4,283,000	1,968,000
Spinning machines and parts	355,000	1,913,000	2,858,000	1,896,000	2,992,000	5,401,000	3,089,000	773,000
Steam engines, boilers and machines	180,000	158,000	215,000	432,000	891,000	1,501,000	921,000	688,000
Iron nails	906,000	888,000	1,333,000	1,278,000	1,440,000	1,458,000	1,150,000	2,223,000
Iron rails	67,000	667,000	1,209,000	926,000	2,595,000	3,325,000	2,632,000	435,000
Bars and rods	872,000	976,000	1,339,000	2,086,000	2,360,000	3,046,000	4,062,000	2,604,000
Pigs, ingots and steel	476,000	740,000	1,106,000	1,177,000	1,544,000	1,413,000	2,347,000	1,920,000
Iron plates and sheets	411,000	579,000	1,338,000	1,418,000	2,129,000	2,578,000	2,683,000	4,220,000
Pipes and tubes	55,000	122,000	484,000	605,000	891,000	895,000	1,333,000	953,000
Total	3,522,000	6,400,000	11,432,000	10,982,000	16,467,000	29,023,000	22,591,000	15,567,000

Kind of Article.	1900	1901	1902	1903	1904	1905	1906	1907
Electric machinery	309,000	389,000	811,000	837,000	1,266,000	2,455,000	*	*
Locomotive and cars	1,089,000	1,749,000	1,708,000	2,267,000	2,241,000	2,466,000	2,913,000	2,938,000
Spinning machines and parts	810,000	1,279,000	701,000	672,000	830,000	1,469,000	*	*
Steam engines, boilers and machines	1,004,000	1,804,000	1,378,000	1,168,000	2,039,000	4,958,000	20,446,000	30,771,000
Iron nails	2,181,000	1,365,000	1,451,000	1,510,000	1,960,000	2,609,000	2,621,000	3,551,000
Iron rails	4,753,000	1,612,000	1,663,000	2,752,000	1,697,000	943,000	2,216,000	3,828,000
Bars and rods	5,243,000	3,512,000	3,519,000	3,558,000	4,301,000	7,198,000	5,730,000	26,672,000
Pigs, ingots and steel	2,117,000	2,287,000	1,652,000	2,035,000	2,913,000	7,893,000	18,210,000	†4,168,000
Iron plates and sheets	7,078,000	4,178,000	4,197,000	6,088,000	7,800,000	10,305,000	‡	§
Pipes and tubes	2,956,000	1,592,000	1,074,000	1,482,000	1,312,000	2,137,000	1,994,000	3,454,000
Total	27,240,000	17,727,000	18,154,000	22,369,000	26,359,000	40,413,000	36,320,000	75,382,000

* Included under machines and engines.
† Ingots alone, steel included under bars and rods.
‡ Included under pigs, ingots.
§ In bars and rods.

The Russo-Japanese war broke out in February, 1904, and continued till August of the next year, as is well-known. Here again, the imports increased by large leaps, the goods being used mainly for war purposes. Although the people were bitterly disappointed at the Portsmouth treaty because of the failure to secure the much desired indemnity, they showed an admirable courage in the work of extending the manufacturing industries. This is clearly brought out in the curve. In 1907, the imports amounted to 75,000,000 yen ($37,500,000) an increase of 2,000 per cent compared to the amount of 1892.



CURVE SHOWING THE AMOUNT OF IRON GOODS IMPORTED INTO JAPAN, 1892-1907.
In yen; two yen equal one dollar.

Thus far we have traced briefly the general lines of development. Now let us consider the future possibilities. That the iron industry in Japan will continue to expand as it has done may be taken for granted. Will further expansion of home-manufacturing mean exclusion of all foreign goods? Surely not. Then, how much will

TABLE III.

AMOUNT OF IRON GOODS IMPORTED FROM VARIOUS COUNTRIES IN YEN (TWO YEN EQUAL ONE DOLLAR.)

(From the Report of Department of Finance.)

Articles.	*Countries.*	1899	1900	1901	1902	1903	1904	1905
Engines, boilers, motors, generators, lathes, etc.	United States	1,230,000	1,493,000	2,017,000	2,746,000	2,670,000	3,465,000	6,694,000
	Great Britain	2,646,000	3,263,000	4,232,000	3,192,000	2,983,000	5,025,000	6,772,000
	Germany	326,000	226,000	177,000	334,000	326,000	724,000	1,937,000
	Other countries ...	105,000	80,000	149,000	34,000	179,000	78,000	136,000
Bars, plates, rods, rails, nails, pigs, etc.	United States	1,994,000	3,304,000	1,322,000	801,000	1,617,000	1,724,000	2,222,000
	Great Britain	7,458,000	12,642,000	7,395,000	8,797,000	9,669,000	10,678,000	18,510,000
	Germany	1,290,000	3,745,000	3,949,000	3,303,000	4,565,000	3,871,000	4,653,000
	Other countries ...	3,295,000	8,033,000	4,182,000	2,705,000	3,276,000	5,157,000	10,494,000

foreign importers suffer from the competition of the native manufacturers? To this question no definite answer can be given, at least by me. The past history of Japan tells us that, as home manufacturing expands, imports increase in direct ratio. This would be the case for some time to come. In certain lines of work it is impossible for the Japanese to compete with foreign producers. For instance, in iron-smelting work there is no danger of home-made articles replacing the imported ones. A small blast-furnace plant, with men of little experience and ore imported from the far-off interior of China, cannot compete with gigantic American plants, managed by the ablest financiers and engineers of the age. The same thing may be said of large machines. If I am not mistaken, the largest dynamo built in the Shibaura Iron Works, which has the best equipped department for the manufacture of electrical machines, was 500-kilowatt capacity. The home iron industry will grow, and at the same time importation of iron goods will increase, though the character of the goods may change gradually.

Now let us go a step further and see what chances there are for American manufacturers. America, the country which has been friendly in times of war as well as in times of peace, is honored and respected by the people of the island empire. I cannot say what tangible effect this feeling has on ordinary business transactions. It is very likely that the Japanese will buy from Americans provided the latter can offer their goods at no higher price than their European competitors. The table opposite* (Table III) shows the amount of business done by various countries in past few years. In the importation of machinery the United States is gaining much faster than other countries, as shown in the table. From the general trend of past few years, I feel that I am justified in saying that in 1906 and 1907 America must have been ahead of Great Britain. In the importation of bars, plates, rods, etc., the latter is leading, closely followed by Belgium. It is a strange fact that American manufacturers have not exported these articles, except nails, whose yearly importation usually amounts to over a million yen. I can see no reason why Americans have been so inactive in this line. At any rate it does not seem to be a very hard task for the manufacturers of the United States to take the bulk of the business in this market into their own hands if they try it with their characteristic "push."

Lately foreign manufacturers seem to have realized the advantage of utilizing the cheaper Japanese labor, and at the same time avoiding the Japanese tariff duty†, which is an obstacle in competing against the home manufacturers. The scheme is to build factories in Japan. The articles for the Eastern countries are to be made there in these factories. The British-Japanese syndicate for the smelting plant, as already stated, is an example. A branch shop of one of the largest electrical machine manufacturers in America is also being built now. As far as I can see, there is no reason that these factories should not be successful.

The people of Japan realize the fact that the fast increasing population cannot be supported by agricultural industry alone; they want to make Japan a manufacturing country. Therefore, the expansion of iron industry in Japan will continue. At the same time importation of iron goods will increase. Japan cannot make everything; division of labor is essential in all modern industries. Here is, then, a promising market, to which the United States is nearer than any of the countries participating in supplying this market, and the people of Japan are very friendly toward Americans. These advantages mean a great deal. For those interested in the Eastern market the whole matter is worth serious considerations.

* Compiled from the report issued by the Department of Finance.

† The Japanese tariff duty is 25 per cent on machines.

Table 1. Estimated Costs Per Horse Power of Steam Power Plants Complete, Simple Condensing.

Horse power of engine	10	12	14	15	20	30	40	50	75	100
Steam per horse power per hour, lb.	55.9	52.1	48.7	47.3	44.2	39.	36.2	33.	31.1	28.2
Coal per horse power per hour, running time, lb.	6.1	5.9	5.7	5.25	4.80	4.60	4.20	3.75	3.40	3.10
Total coal per horse power per hour, lb.	7.0	6.75	6.50	6.02	5.50	5.25	4.75	4.25	3.70	3.50
Boiler, including setting	$35.50	$33.10	$29.60	$28.50	$25.10	$20.50	$17.80	$15.80	$14.80	$14.20
Flues	2.28	2.28	2.28	2.28	2.20	2.15	2.10	2.05	2.05	2.00
Stack	12.	10.70	9.70	9.40	8.50	6.30	5.70	5.25	4.80	4.55
Feed pumps	5.70	5.70	5.70	5.70	5.40	3.80	3.10	2.75	2.10	1.70
Engine and condenser	57.	54.	50.	48.	41.50	32.50	27.50	24.20	19.60	17.60
Engine foundations	8.50	8.38	8.30	8.10	7.80	7.40	7.	6.70	6.	5.70
Piping	11.20	11.	10.70	10.20	9.50	8.	7.70	7.30	6.10	5.70
Heaters	2.95	2.75	2.70	2.65	2.50	2.30	2.17	2.10	1.98	1.80
Boiler house	33.70	29.60	27.50	26.20	21.60	18.20	16.	14.80	11.30	9.70
Engine house	14.40	12.60	11.30	10.90	8.60	7.75	6.40	5.35	4.90	4.30
Coal pocket	19.	17.90	16.60	15.80	13.60	11.	8.70	8.50	6.30	5.70
Incidentals	18.	17.60	17.	16.60	14.70	11.80	10.90	10.30	8.70	7.80
Total cost per horse power	$220.	$204.	$192.	$186.	$163.	$134.	$120.	$108.	$93.	$81.

Table 2. Yearly Costs of Steam Power, 308 Days, 10 Hours Per Day, Simple Condensing.

Horse power of engine	10	12	14	15	20	30	40	50	75	100
Total coal per horse power per hour, lb.	7.	6.75	6.50	6.02	5.50	5.25	4.75	4.25	3.70	3.50
Cost of plant per horse power	$220.	$204.	$192.	$186.	$163.	$134.	$120.	$108.	$93.	$81.
Fixed charges on plant at 11 per cent.	242.	270.	295.	307.	360.	440.	530.	590.	765.	890.
Cost of coal at $5 per long ton	480.	560.	625.	670.	750	1040.	1310.	1470.	1910.	2420.
Attendance	178.	190.	202.	210.	238.	297.	350.	405.	535.	670.
Oil, waste and supplies	22.80	24.80	26.70	27.60	32.50	43.	53.	64.	89.	114.
Total yearly cost, coal at $5 per ton	923.	1045.	1149.	1215.	1380.	1720.	2243.	2529.	3299.	4094.
" " " " " $4 per ton	830.	940.	1030.	1100.	1240.	1550.	2020.	2270.	2961.	3700.
" " " " " $3 per ton	730.	820.	900.	960.	1080.	1360.	1770.	2010.	2600.	3250.
Yearly cost per h.p. coal at $5 per ton	92.30	87.	82.	80.	69.	57.	56.	51.	44.	41.
" " " " " " $4 per ton	83.	78.	74.	72.	62.	51.	50.	46.	39.40	37.
" " " " " " $3 per ton	73.	68.	65.	63.	54.	44.50	43.50	40.	34.50	32.50

One man attends engine, fires boiler and is supposed to do other work besides. On the 10 horse power plant one-fourth of his time is charged to attendance, and three-fourths of his time on the 100 horse power plant.

THE COST OF POWER IN SMALL UNITS.

By Wm. E. Snow.

Data of actual costs, either of installation or operation, are notoriously hard to secure, and are correspondingly valuable when they can be had. Mr. Snow's figures are obtained from many actual installations of small plants in various parts of the United States. They were secured by him personally in the course of years of experience as engine expert. These costs of small units, particularly scarce and difficult of access, should be of permanent interest for reference and comparison by purchasers, owners, and operators.—The Editors.

WHEN a new installation is contemplated there are many questions that arise in the mind of the user of power. Having decided as to the size of unit required, he will want to know the cost of the engine, boiler, flues, stack, feed pumps, heaters, piping, boiler setting, engine foundations, engine house, boiler house, and coal pocket. He will also want to know the steam consumption of the engine, whether it is best to operate condensing or not, and the cost of attendance. As actual figures relating to these details are somewhat difficult to obtain, the following tables will be found useful in estimating upon this class of work. These tables give the general averages of data obtained in over thirty small power plants located in different parts of the United States, and the figures given will be found accurate and reliable for present conditions, having been very recently obtained.

Table 1 shows the complete cost of power plants equipped with simple, condensing engines ranging in size from 10 to 100 horse power, and also gives the cost per horse power of all apparatus and buildings. Table 2 shows the yearly cost of operation, with coal at various prices, of the power plants given in Table 1.

Table 3 shows the complete cost of power plants equipped with simple, non-condensing engines, boiler and engine combined, ranging in size from 2 to 12 horse power, and also gives the cost per horse power of all apparatus and buildings. Table 4 shows the yearly cost of operation of the power plants given in Table 3.

Table 5 shows the complete cost of power plants equipped with simple, non-condensing engines, engine and boiler independent, ranging in size from 10 to 75 horse power, and also the cost per horse power of all apparatus and buildings. Table 4 shows the yearly cost of operating, with coal at various prices, the plants given in Table 5.

Table 4. Yearly Costs of Steam Power, 308 Days, 10 Hours Per Day, Simple Non-Condensing.

Type of engine	Engine and Boiler Combined.						
Horse power of engine	2	3	4	6	8	10	12
Total coal consumption in lb. per h.p. hour	13.	10.5	8.5	7.9	7.6	7.4	7.25
Cost of plant per horse power	$200.	$152.	$133.	$110.	$89.	$83.	$78.
Fixed charges on plant at 11 per cent	44.	50.	58.20	72.50	78.20	91.50	102.
Cost of coal at $5 per long ton	180.	215.	235.	325.	420.	510.	600.
Attendance	99.	109.	116.	136.	154.	173.	184.
Oil, waste and supplies	13.20	14.30	15.40	17.60	20.	22.	23.80
Total yearly cost, coal at $5 per ton	336.	388.	424.	550.	672.	796.	910.
" " " " " $4 " "	300.	345.	385.	495.	610.	720.	810.
" " " " " $3 " "	265.	300.	340.	430.	530.	630.	710.
Yearly cost per h.p., coal at $5 per ton	168.	130.	106.	92.	84.	79.6	76.
" " " " " " $4 " "	152.	116.	95.	81.	76.	72.	68.
" " " " " " $3 " "	132.	102.	83.	72.	66.	63.	59.

Type of engine	Engine and Boiler Independent.								
Horse power of engine	10	12	14	15	20	30	40	50	75
Total coal consumption in lb. per h.p. hour	7.4	7.25	7.0	6.5	6.0	5.5	4.75	4.5	4.0
Cost of plant per horse power	$210.	$194.	$182.	$174.	$153.	$126.	$107.	$96.	$79.
Fixed charges on plant at 11 per cent	230.	255.	280.	285.	337.	415.	475.	525.	650.
Cost of coal at $5 per long ton	510.	600.	675.	690.	830.	1100.	1310.	1540.	2050.
Attendance	173.	184.	194.	202.	230.	287.	338.	390.	520.
Oil, waste and supplies	22.	23.80	25.80	26.50	31.20	41.50	51.	61.50	86.
Total yearly cost, coal at $5 per ton	935.	1063.	1175.	1203.	1428.	1843.	2194.	2516.	3306.
" " " " " $4 " "	840.	960.	1050.	1080.	1260.	1660.	1960.	2250.	3000.
" " " " " $3 " "	740.	830.	920.	950.	1100.	1450.	1710.	1960.	2650.
Yearly cost per h.p., coal at $5 per ton	93.50	88.	83.	80.	71.	60.	55.	50.	44.
" " " " " " $4 " "	84.	79.	74.	72.	64.	54.	49.	45.	39.
" " " " " " $3 " "	74.	68.	64.	62.	56.	47.	42.	39.	34.

Table 6 shows the complete cost of power plants equipped with compound condensing engines, ranging in size from 100 to 200 horse power, and also gives the cost per horse power of all apparatus and buildings. Table 7 shows the yearly cost of operation, with coal at various prices, of the power plants given in Table 6.

TABLE 3. ESTIMATED COSTS PER HORSE POWER OF STEAM POWER PLANTS COMPLETE, SIMPLE NON-CONDENSING; BOILER AND ENGINE COMBINED.

Horse power of engine.	2	3	4	6	8	10	12
Steam per horse power per hour	......	......	......	......	......	......	......
Coal per horse power per hour, running time....	......	......	......	......	......	......	......
Total coal per horse power per hour.....	......	......	......	......	......	......	......
Boiler, including setting	$146.	$108.	$95.	$77.	$63.	$59.	$57.
Feed pumps..........	......	......	......	......	......	......	......
Engine	22.80	19.40	17.	14.80	12.60	11.40	10.30
Engine foundations.....	5.70	5.70	4.50	4.50	3.40	3.40	3.40
Incidentals	19.40	13.70	12.50	10.30	8.	8.	8.
*Total cost per horse power	200.	152.	133.	110.	89.	83.	78.

From these tables* the approximate cost of any contemplated installation may be obtained and also the comparative cost of units of different sizes, together with the yearly cost of operation, thereby affording the power user a convenient basis for estimates on this class of work. For example, let us assume that it is desired to install a small power plant of 75 horse-power capacity. The first question that arises is whether it is advisable to operate condensing or not. Referring to Table 1 of simple condensing engines, we find the cost of the plant to be as follows:—

CONDENSING.

75 horse-power engine and condenser..........	$1,475
Engine and condenser foundation..........	450
Boilers and setting	1,100
Flues	154
Stack	360
Feed pumps	158
Piping	460
Heaters	148
Boiler house	850
Engine house	370
Coal pocket	470
Incidentals	650
	$6,645

* These tables were compiled from a large volume of data obtained in many small power stations at various places, with apparatus of all kinds and from divers sources. Without artificial adjustment of averages, it would be impossible to compile, from such materials, a set of tables that should be absolutely concordant at all points. This forcing of differences has not been undertaken. Some discrepancies will be found between the sum of items and the totals given, and between the unit figures used in different places. These are in no case large enough to affect appreciably any purpose of ordinary estimating, for which these approximations are designed, and the natural figures given are thought to be more reliable and to carry a smaller percentage of error than would result from an attempt to bring them into complete apparent harmony.

TABLE 5. ESTIMATED COSTS PER HORSE POWER OF STEAM POWER PLANTS COMPLETE, BOILER AND ENGINE INDEPENDENT, SIMPLE NON-CONDENSING.

Horse power of engine	10	12	14	15	20	30	40	50	75
Steam per horse power hour, lb	64.3	60.1	57.2	55.4	52.3	45.1	42.3	40.2	36.5
Coal per horse power per hour, running time	....	....	....	....	....	....	....	....	....
Total coal per horse power per hour	....	....	....	....	....	....	....	....	....
Boiler, including setting	$56.	$51.	$46.	$43.50	$32.	$26.	$24.	$20.50	$17.30
Flues	2.30	2.30	2.30	2.30	2.25	2.20	2.15	2.10	2.
Stack	16.	14.80	13.40	13.	11.60	8.70	7.30	6.30	5.60
Feed pumps	5.70	5.50	5.50	5.40	5.40	3.80	3.15	2.75	2.10
Engine	36.50	36.	35.50	35.	34.50	28.50	21.50	17.40	15.50
Engine foundations	5.70	5.50	5.40	5.35	5.25	5.15	5.05	4.90	4.60
Piping	8.30	8.	7.60	7.40	6.70	5.70	5.10	4.60	3.90
Heaters	2.96	2.75	2.70	2.60	2.50	2.20	2.15	2.05	1.90
Boiler house	37.50	33.	30.	28.50	24.50	20.50	18.	16.	13.
Engine house	4.80	4.35	4.	3.90	3.30	2.75	2.50	2.30	2.15
Coal pocket	21.	19.40	17.20	16.90	14.80	12.	10.80	9.40	7.
Incidentals	20.	18.	16.	15.	13.70	11.	9.80	8.30	6.
Total cost per horse power	218.	200.	190.	180.	156.	130.	110.	99.	82.

TABLE 6. ESTIMATED COSTS PER HORSE POWER OF STEAM POWER PLANTS COMPLETE, COMPOUND CONDENSING.

Horse power of engine	100	200	300	400	500	600	700	800	900	1000	1500	2000
Steam per horse power per hour, lb	24.1	22.3	20.2	19.5	19.	18.1	17.3	16.2	15.1	14.5	13.9	13.5
Coal per horse power per hour, running time	2.75	2.45	2.40	2.35	2.30	2.25	2.20	2.15	2.10	1.95	1.80	1.75
Total coal per horse power per hour	3.15	2.85	2.75	2.70	2.65	2.60	2.55	2.50	2.45	2.25	2.07	2.02
Boilers, including setting	$8.	$7.60	$7.40	$7.30	$7.25	$7.20	$7.15	$7.05	$6.90	$6.80	$6.60	$6.40
Flues	1.93	1.82	1.59	1.36	1.12	1.02	0.92	0.80	0.68	0.57	0.57	0.57
Stack	4.55	4.	3.65	3.30	3.08	2.95	2.90	2.85	2.80	2.75	2.70	2.68
Feed pumps	0.93	0.57	0.46	0.37	0.31	0.29	0.28	0.27	0.26	0.25	0.24	0.19
Engine and Condenser	25.	24.	23.	22.	21.50	21.25	21.	20.75	20.50	20.25	19.50	19.
Engine foundation	5.70	5.60	5.50	5.40	5.30	5.20	5.10	5.	4.90	4.80	4.40	4.10
Piping	13.80	11.20	9.10	8.	7.40	6.80	6.50	6.25	6.	5.75	5.10	4.55
Heaters	2.85	2.55	2.25	2.	1.75	1.42	1.12	1.12	1.	1.	0.95	0.95
Boiler house } Engine house	28.50	24.										
Boiler house			11.20	8.	6.40	5.70	5.35	5.	4.68	4.55	4.10	3.96
Engine house			11.20	9.35	8.50	7.20	6.20	5.60	5.35	5.	4.75	4.55
Coal pocket	5.70	4.	3.10	2.60	2.40	2.27	2.16	2.05	1.93	1.82	1.73	1.61
Incidentals	9.70	8.	6.80	6.50	6.25	6.	5.75	5.50	5.25	5.	4.75	4.60
Total cost per horse power	106.60	93.30	86.20	76.20	71.20	67.30	64.40	62.20	59.30	55.70	54.40	53.20

Referring to Table 5, of simple non-condensing engines, we find the cost of the plant to be as follows:

NON-CONDENSING.

75 horse-power engine	$1,130
Engine foundation	345
Boilers and setting	1,100
Flues	150
Stack	420
Feed pumps	158
Piping	290
Heaters	142
Boiler house	970
Engine house	160
Coal pocket	525
Incidentals	450
	$5,950

Referring to Table 2, we find the cost of yearly operation of the condensing plant to be as follows:

CONDENSING.

Coal at $5.00 per ton	$1,910
Fixed charges at 11 per cent	765
Attendance	535
Oil, waste and supplies	89
	$3,299

Referring to Table 4 we find the cost of yearly operation of the non-condensing plant to be as follows:

NON-CONDENSING.

Coal at $5.00 per ton	$2,050
Fixed charges at 11 per cent	650
Attendance	520
Oil, waste and supplies	86
	$3,306

These figures show that while the initial cost of the condensing plant is 11 per cent. higher than that of the non-condensing, the gain in economy of operation is very slight, as with an engine of but 75 horse power the proportion of steam used in driving the auxiliaries is comparatively large. For this reason it is not customary to operate power plants of less than 200 to 300 horse power condensing.

TABLE 7. YEARLY COST OF STEAM POWER, 308 DAYS OF 10 HOURS PER DAY, COMPOUND CONDENSING.

Horse power of engine	100	200	300	400	500	600	700	800	900	1000	1500	2000
Total coal per h.p. per hour, lb.	2.75	2.45	2.40	2.35	2.30	2.25	2.20	2.15	2.10	2.00	1.80	1.75
Cost of plant per h.p..	$105.60	$93.30	$86.20	$76.20	$71.20	$67.30	$64.40	$62.20	$59.30	$55.70	$54.40	$53.20
Fixed charges on plant at 11 per cent.......	1160.	2060.	2850.	3350.	3920.	4451.	4952.	5492.	5910.	6130.	9000.	11880.
Cost of coal at $5 per long ton	1910.	3370.	5100.	6700.	8380.	9650.	11000.	12500.	14300.	14500.	18600.	24200.
Attendance	880.	1220.	1220.	1760.	1930.	2100.	2650.	2700.	2930.	3480.	4400.	5200.
Oil, waste and supplies	143.	205.	240.	285.	315.	350.	385.	420.	445.	470.	600.	685.
Total yearly cost, coal at $5 per ton.......	4198.	6948.	9496.	12171.	14596.	16618.	19050.	21674.	23644.	24595.	35100.	42018.
Total yearly cost, coal at $4 per ton.......	3780.	6200.	8550.	11000.	13200.	15700.	17200.	19500.	21200.	22200.	31500.	37800.
Total yearly cost, coal at $3 per ton.......	3300.	5400.	7500.	9700.	11500.	13200.	15200.	17100.	18500.	19500.	27500.	33000.
Yearly cost per h.p., coal at $5 per ton...	42.20	35.10	31.50	30.50	29.20	27.70	27.30	26.10	25.20	24.50	23.50	21.
Yearly cost per h.p., coal at $4 per ton...	37.80	31.50	28.40	27.	26.10	24.90	24.60	23.50	22.60	22.	20.30	18.90
Yearly cost per h.p., coal at $3 per ton...	33.20	27.70	25.	23.80	23.	21.90	21.50	20.60	19.90	19.40	17.90	16.60
	1 Man $16 per week	1 Man $16 1 Man $7	1 Man $16 1 Man $7	1 Man $16 1 Man $10 1 Man $7	1 Man $16 1 Man $13 1 Man $7	1 Man $17 1 Man $13 1 Man $10	1 Man $17 2 Men $22 1 Man $10	1 Man $18 2 Men $22 1 Man $10	1 Man $18 2 Men $25 1 Man $10	1 Man $19 2 Men $26 2 Men $20	1 Man $22 3 Men $36 2 Men $20	1 Man $25 4 Men $50 2 Men $20

EXHAUST-STEAM VERSUS LIVE-STEAM HEATING.

By Charles A. Howard.

The argument as to the economy of heating boiler feed by live steam, ably maintained both on the affirmative and the negative, is active at present. A very interesting discussion in *The Engineer* is abstracted in our Review of the Engineering Press, elsewhere in this issue. Mr. Howard's criticism has been submitted to Professor Reeve for comment, and his rejoinder and Mr. Howard's summing up are presented here in immediate sequence.—The Editors.

THE scheme proposed by Professor Reeve in The Engineering Magazine for March, for heating the feed water in power plants, can be reduced to two fundamental points:—first, is live-steam heating productive of any greater economy than the present system, and second, does the method proposed, that of running the auxiliaries of the plant under a high back pressure, give any advantage over heating the feed directly by live steam from the boiler itself?

The danger of oil passing through the open heater into the boilers, which seems to be the strongest argument against the open heater, is easily avoided when the piping is of the proper design and a good oil separator is used. I say "a *good* oil separator," because there are a large number of oil separators on the market which do not separate; but there are several good ones which practically prevent the passage of any oil. I know of one large plant of water-tube boilers using open heaters entirely for feed heating, the steam coming from auxiliary engines, where only four tubes per boiler per year have been replaced, and most of these renewals have been due to the fact that the tubes were originally defective. These boilers are cleaned about once per year and no effects of oil have been noticed.

Thermodynamically, leaving out of the question for a moment that there is an economizer in the system, there is no greater economy secured by feeding the boiler with water at the steam temperature than can be had at a lower temperature.

The sources of loss in a boiler are as follows: 1, loss due to incomplete combustion; 2, loss due to combustible in the ash; 3, loss due to heat in the flue gases; and 4, loss due to radiation.

It seems pretty clear that none of these losses can be minimized by the introduction of water at steam temperature. This is shown in practical operation by the following test which was very carefully made in order to determine the economy of live-steam heating. The tests were made on two consecutive days, the live-steam heater being used the first day and cut out the second. The coal used on both tests was from the same pile, and to make sure that equal quality was used on both tests, it was weighed up in 100-pound bags and every alternate bag was used on the first test, the remaining ones being used on the second test. The water was measured in calibrated tanks.

Test of	Dry-back tubular boiler
Made by	Prof. Goodman, University of Leeds
Location	Leeds, England
Date	July 4 and 5, 1907
Purpose	Find the economy of live-steam-heating
Coal	Wombwell Steam
Draft	Induced
Method of starting test	Alternate
Duration	12 hours each

Observation.	With heater.	Without heater.
Coal fired per hour, lb. (dry)............	572	563
Steam, pressure gauge....................	98.7	97.2
Feed temperature..........................	325 degrees F.	124.8 degrees F.
Steam temperature........................	337 "	335.8 "
Temperature gases leaving boiler........	488 "	482 "
Equivalent evaporation per lb. dry coal from and at 212 degrees F............	9.96 lb.	10.02 lb.

The above test, which is probably as accurate as the best of boiler tests, substantiates the previous theoretical deductions and indicates with a considerable degree of precision that there is no direct saving due to live-steam heating. While the means advocated by Professor Reeve for heating the water are radically different from those used on this test, that makes no difference, as we are interested for the present moment in obtaining the steam temperature of the water irrespective of the method, regarding which more will be said later.

Of course when economizers are used, if they are fed with cold water, the amount of heat carried away in the gases is reduced and the boiler efficiency correspondingly increased. This is true, however, whether or not live steam is used for heating, so that it is independent of the real subject.

The system proposed of running the auxiliaries under a high back pressure and exhausting through a closed heater, at a temperature near that of the boiler steam, is open to a great many objections. First, it introduces the closed heater, which except under exceptional conditions has many disadvantages as against the open heater with only a slight pressure within it.

The condensed steam and its heat are thrown away in the closed heater, often amounting to one-eighth of the total feed water; and being at a temperature ranging from 200 to 350 degrees F., depending upon the pressure carried in the heater, this represents a considerable loss.

When the feed water is at all bad (and it never is too good) certain salts are precipitated which are taken care of in the open heater, but which cause an accumulation of scale on the tubes of the closed heater. This scale, together with the deposit of oil which is always found on the steam side of the tubes (unless a separator is used, which is usually considered unnecessary with a closed heater) will cause a large reduction in capacity and efficiency.

The heater is under high pressure; and the failure of a tube, which is a frequent occurrence, makes it necessary to by-pass the heater.

Besides involving the closed heater, this system requires that all the exhaust piping of the station shall be for high-pressure service, causing greater first cost and maintenance. Professor Reeve makes the statement that "the pump will work in one sense at its best thermodynamic efficiency when its exhaust temperature is close to its admission temperature." I judge that he means the efficiency of the pump as a pump and heater combined, as considering only the mechanical work done by the pump, the reverse of his statement is true. As a pump and heater combined, the only heat lost in the atmospheric exhaust system using an open heater is that due to radiation from the piping. In the pressure exhaust system, this radiation will be nearly twice as great as in the atmospheric system; and besides this, only the heat of vaporization of the steam is returned to the feed water, leaving the heat of the liquid at about 350 degrees F. or greater which is lost as the condensate in the closed heater.

The question of decreased wear on the boilers due to the introduction of the feed close to the steam temperature instead of at 210 degrees F. is problematic and doubtful. The strains which are hardest on a boiler are those which occur in firing up, due to variations in temperature much greater than those which are present during the normal operation, and it would hardly seem that the increase of a hundred degrees in the feed-water temperature would reduce the strains to any extent where the temperature of the gases will be anywhere from 700 to 2,800 degrees F.

There is no advantage in feeding the boilers with steam-hot water, and it does not appear to me that the plan suggested by Professor Reeve is as convenient or as efficient as live-steam heating, when the feed is first heated by the exhaust steam of the auxiliaries in an open heater.

THE SUBSTANTIAL ADVANTAGES OF STEAM-HOT FEED WATER.

By Sydney A. Reeve.

A REJOINDER TO THE CRITICISM OF MR. HOWARD.

MR. HOWARD closes his paper with the dogmatic statement that "there is no advantage in feeding the boilers with steam-hot water."

This is a statement very hard to substantiate. It is not sufficient to establish that some one boiler plant, such as that at Leeds, has not been aided thereby; for there has never been contention, I believe, that *all* boilers would be aided by steam-hot feed. It could never be urged that all boiler plants would be aided by any one of the many devices and policies which are found profitable under one set of conditions or another.

The belief that steam-hot feed aids the circulation, the life, the capacity and even the efficiency of most forms of shell boilers, and perhaps of some water-tube boilers, is widespread. I have not offered to uphold this belief. I should have great hesitancy in denying it. It is like the belief that is well-nigh universal among locomotive engineers, that a locomotive boiler taken from its wheels and used for stationary service will never make anything like the same quantity of steam, nor with the same efficiency, that it did on the rails. Can anyone deny that belief? A single instance of such change in action with removal of the wheels serves to establish the insufficiency of Mr. Howard's beautifully simple list of all the factors in boiler action, as four in number, and to uphold the faith of the railroad men. An hundred instances of failure to detect such change do not suffice to deny its frequent occurrence.

Mr. Howard says that of course, if the economizers are fed with cold water, the plant will be more efficient; but that this is independent of live or exhaust feed-heating. But is it? If the pump and auxiliary exhausts are utilized for heating pre-economizer water in open heaters, whence is the cold-water supply for the economizers to come? If the pumps and auxiliaries leave the water cold for the economizers to utilize, how about the heat losses in their exhausts?

Finally, if other and more efficient means for pumping than direct-acting non-expansive pumps are what Mr. Howard has in mind, why are they so very seldom used? They are used in England, and probably were at Leeds. But my article was premised upon the accepted American practice of using wasteful types of feed pumps, the question being merely: Shall we do our throttling of pump steam (which is always done anyhow) more profitably upon the supply or upon the exhaust?

Mr. Howard's objection to live-steam heating because it involves "closed" (and therefore tubular?) heaters is a tilt at a wind-mill. The one district of this country (the valleys of the upper Mississippi and Ohio) which affords the vilest water for boiler-feed, heavily charged with sulphates of lime and magnesia, relies almost exclusively upon a heater under pressure where the steam and water mingle freely, which possesses no tubes. But even if a tubular heater were to be used, his objections to it are imaginary. There is no difficulty in saving both the substance and the heat of the pump exhaust. With any of the coiled tubular heaters, and some of the straight-tube heaters, leaky tubes are virtually unknown.

It is to be hoped that it may be realized that such a suggestion as I offered, like any other suggestion in power-plant design, may be out of the question for many particular cases and may yet be of substantial value in many others—if used with that sense and discretion which is always indispensable in engineering affairs.

Mr. Howard, being invited by the Editors of The Engineering Magazine to close the discussion, replies as follows:

The objections which Professor Reeve takes to several of the minor points of my paper are very indirect and without basis, and he has not directly opposed any of my statements. The following instance is indicative of the remainder:

He states the "belief" in regard to the locomotive boiler steaming better on wheels than in stationary service, but he does not anywhere say that it is his own belief. Does he give any of the boiler losses which he insinuates (not states) that I have omitted? It will be noticed that I have made no mention of "more efficient means for pumping than direct acting non-expansive pumps" which Professor Reeve seems to think that I have in mind.

He admits that he does not uphold that steam-hot feed aids the circulation, the life, the capacity and the efficiency of the boiler. This granted, it is apparent that there can be no gain, either theoretically or practically, by throttling the exhausts of the auxiliaries, which is an imperfect method of attempting to produce steam-hot water.

THE IMPORTANCE OF ENGLISH IN THE WORK OF THE ENGINEER.

By William D. Ennis

THE root-idea of engineering is *form*. The engineer's work is to form, to inform, to conform; to reform, to formulate, to perform. He makes hidden things visible; he transmutes universal natural law into specific serviceable force. After the Architect of the universe, he gives form to that which was without form and void.

To present ideas as words is one of the vital phases of engineering. Pure abstractions are the subject matter of technology; their formulation in adequate and accurate language makes them the subject matter of commerce. The language of the engineer must be so clear that he who runs *must* read. His statements must appeal to the eye and mind—not challenge vision and perception by careless arrangement and faulty diction. Let two men write reports from the same data; one report will flash its meaning upon the reader; the other will bewilder him. The difference is of language.

The average matriculate of any college is highly illiterate. The freshmen in technical schools are no better. The graduates cannot spell. One young man, a year after graduation, habitually spelled incorrectly the names both of his firm and of his superintendent. We find gross errors in orthography and punctuation even in the titles of drawings, which must have challenged the attention of a half-dozen non-observers. Possibly these things result from taking too seriously the dictum of Professor Child:

> "One of the most useful things just now is to break down the respect . . . . . . for the established spelling. . . . . . I don't much care how anybody spells, so (*sic*) he spells different (!) from what is established."

There is a bland conceit in the usual technical or professional curriculum. It assumes that which it knows very well is not true, that is, that students enter professional schools after having received a fairly broad and thorough general education. Consequently, if any general branches are taught, it is in an apologetic and half-hearted manner, at such times and under such circumstances as may be provided after all professional studies have been fully taken care of.

This is like the practice first noted by Lemuel Gulliver, of constructing buildings from the roof downward, in imitation of the spider.

This article can offer no practical suggestion for increasing the digestive capacity of adolescent minds. Technical curricula are already overcrowded. Further demands must lead to further specialization, to extension of the course, or to more advanced preparatory training. The first outcome, while perhaps unfortunate, seems inevitable; the other two would advance the age of graduation and entrance upon professional life. However we choose to surmount the three-pronged dilemma, we must inevitably provide *somewhere* in the preparatory or the technical course, the means of acquirement of what has been specified as one of the evidences of an adequate education—fluency and precision in the use of the mother tongue.

There is a prevalent though wholly erroneous notion that the vocabulary necessary for the engineer is a narrow one—that to obtain sufficient command of that vocabulary is easy—that so long as one has some valuable fact to announce, it matters little how it be announced. But the vocabulary of engineering is broad, involving the use, not so much of a vast number of purely technical terms, as of a wide range of common words to express adequately the involved ideas that are presented. Passages of approximately equal length from various sources show the following extent of vocabulary:

Editorial article in the New York *Sun*	189 words;
News item	175 words;
Part of an epistle of St. Paul	158 words;
Shakespeare (Mark Antony's oration, *in verse*)	169 words;
Mr. Webber's article in THE ENGINEERING MAGAZINE, November, 1906	198 words;
Another recent technical article	184 words;
Still another practical article on steam boilers	198 words;

Evidently, therefore, the vocabulary of the engineer is not quite as bare as we are accustomed to think.

Accuracy in the use of words is the evidence and the outcome of accuracy in the operations of the mind, and should therefore be a part of the equipment of the engineer. Of course, this equipment is often independently obtained, with the progress of time. Men of scant educational training sometimes speak and write with appropriateness and dignity. So also is engineering work of the highest character produced by men who have not profited by early training in the technical school. These results are obtained not because of the absence of educational opportunities, but in spite of that absence. We have found the results to be more quickly and generally obtainable under the additional advantages of technical training, which should enable the young man more quickly to become a good engineer, and also to possess, from the start, something of

"the divine art of using words."

English studies—the language, its form and history—the literature, and logic, should give to the student the faculty for marshaling data; for arranging isolated facts in such due order and relation to one another, that comprehension will be compulsory. Men of affairs are busy; they must have all information presented in readily assimilable form. The engineer himself passes to new problems, different activities. In referring to his past work, he needs that the results shall stand out clearly so that the desired fact may be found without a second research.

A well written engineering paragraph may be good literature. The diction is pure; words have a fixed and unmistakable significance; without effort, we arrive at the exact meaning. A badly written passage is no less torturing in a technical treatise than in a novel. Take, for an example of exact diction, the following passage:—

> "A curve is obtained which approximates much more nearly to a straight line than the corresponding curve of heat or water consumption per hour per horse-power, and for this reason it can be plotted with greater accuracy when there are but few experiments." . . . . .

This is good standard English. We may find equally crisp language in Rankine:—

> "The tension of the wire is increased step by step, by successive augmentations of the load within the limits of permanent elasticity, and the elongation is observed at each step. Then by successive diminutions of the load, the tension is diminished by the same series of steps in the reverse order, and the elongation observed."

The operation described is pictured to the mind's eye by so straightforward an account as this. Another commendable example, from Darwin:—

> "These latter reefs have been formed while the land has been stationary, or, as appears from the frequent presence of upraised organic remains, while it has been slowly rising: atolls and barrier reefs, on the other hand, have grown up during the directly opposite movement of subsidence."

Good taste in language is a mark of good taste generally. Engineering involves not only the observation and discrimination of facts, and action from conclusion based on facts, but action at proper times, in proper manners, and in proper relation to other facts. Good taste in the use of English is as often violated in engineering publications as in other literary products. The better type of engineering essay, as exemplified by many writers, is characteristically matter-of-fact. There is no elation over what has been said or accomplished; but rather a steady purpose to explain, to instruct, up to the last word. This is the disposition shown in a well-known handbook:

> "The contents of this Part consist of a general survey of the subject of cranes, including an enumeration of the principal forms in which they are used, a definite system of nomenclature applied to the various forms, and finally a study of the most important elements of mechanism employed in crane construction."

We may perhaps excuse a Rankine for a bit of "fine writing" after the completion of his "Applied Mechanics":

> ". . . . . . the engineer or the mechanic, who plans and works with understanding of the natural laws that regulate the results of his operations, rises to the dignity of a sage."

We cannot, however, fail to prefer the steady purpose to impart knowledge rather than to sit in self-congratulation, that animated Regnault, in the last phrases of his paper describing the fragmentary data on the properties of vapors, left available after the catastrophes of 1870-71:

> "De plus, on est sûr d'obtenir un gaz très-purgé d'air, ce que l'on peut à peine espérer avec nos flaçons remplis de matières poreuses."

Neither can we fail to contrast with Rankine's one ebullition the patient anxiety for clearness of Spencer:

> "The relation of this work, to works preceding it in the series are such as to involve frequent reference. Containing as it does, the outcome of principles set forth in each of them, I have found it impracticable to dispense with restatements of those principles. . . . . . . I do not, however, much regret this almost unavoidable result; for only by varied iteration can alien conceptions be forced on reluctant minds."

Besides inculcating the use of pure and appropriate English, the training of the engineer should give him such exercise in the use of his powers of reasoning and analysis, as no amount of purely mathematical training can furnish. Let some never-so-knobby-brained mathematician undertake the simple task of abstracting a plain, descriptive technical article down to a predetermined compass, omitting no essentials. He will find it vigorous mental exercise.

This particular form of intellectual effort, with concurrent attention to classic literature in the vernacular, should give to the student some relief from that narrow and topsy-turvy view of the proportions of things that is so often characteristic of the young technical graduate or undergraduate. No subject is more essential to success than training in the knowledge of human nature. Good literature, in the absence of the "earnest strife of life," can do much to impart a correct view of men's reciprocal rights, privileges, and duties, and a just estimate of human values. To follow the workings of another man's mind is always a broadening thing.

The English course in the technical curriculum should be an important one—helpful to the other courses, attractive to the student, and by no means a non-essential. As to methods, there are so many that only the briefest suggestion can be made. In the English department, the student should begin to follow the advice of Nystrom:—

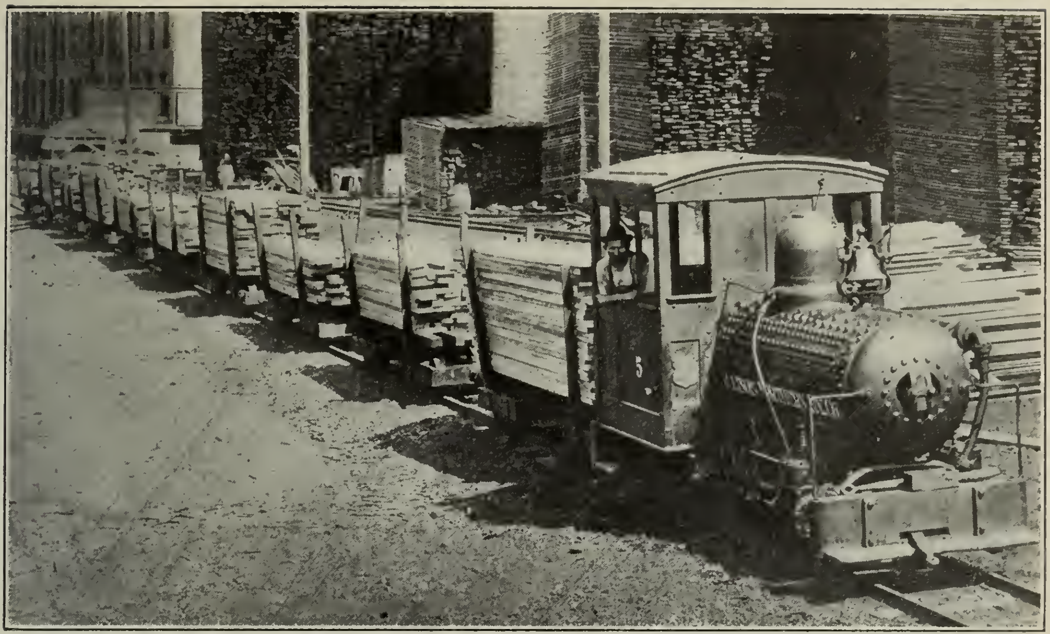
> "Every engineer should make his own pocket-book, as he proceeds in study and practice, to suit his particular business."

From the day of matriculation, the student should begin the accumulation of data. Some of it, even under supervision, may turn out to be rubbish; but he will at least have learned how to accumulate; how to be, not a bucket, but a sponge. Modern commercial systems may be adopted for classifying and filing. Practice in abstracting technical papers may in part take the place of the usual "essay writing" of a liberal training. Appropriate methods of writing specifications should be taught, including some infallible system for not "leaving anything out." In addition, let the student learn how to write (or give verbally) a shop or construction order. Many an engineer cannot write an appropriate notice regarding hours of labor. In fact, some of the best shop bulletin productions, from a literary and practical standpoint, are the work of ungrammatical and uneducated shop foremen who know how to say what they mean.

The engineering publication of the college, if it issue one, should be more or less directly supervised by the English department, with actual co-operation, in turn, by all the students. Some advantage might also be taken of the existence of an engineering club or scientific society. Students should be required to follow a standard practice in engineering abbreviations and symbols, and to apply that practice to their work in all departments. They should have exercise in the preparation of technical reports on their laboratory and testing work, of accounts of inspection trips, and the like. Let them get the atmosphere of engineering work about them early.

It would be useful to have the current technical magazines regularly reviewed, under supervision. The information thus obtained, when properly condensed, could form the basis of a card index for the use of the faculty and the students generally, and would also constitute a part of the student's embryo handbook.

It was the argument of Comenius that the proper education of the mind should comprise, last of all, the training of the critical faculties. The general education of the student is not complete until he can distinguish between what is mentally good and what is mentally evil. The study of English in the technical school should train this critical faculty.



PORTER COMPRESSED-AIR LOCOMOTIVE, LUMBER YARDS OF INTERNATIONAL HARVESTER CO.'S McCORMICK PLANT.

Cylinders 7 by 12, gauge 30 in., weight 13,000 lbs. H. K. Porter Co.

HOISTING MACHINERY FOR THE HANDLING OF MATERIALS.

By T. Kennard Thomson.

III. SHOVELS, DREDGES, AND SPECIAL UNLOADERS.

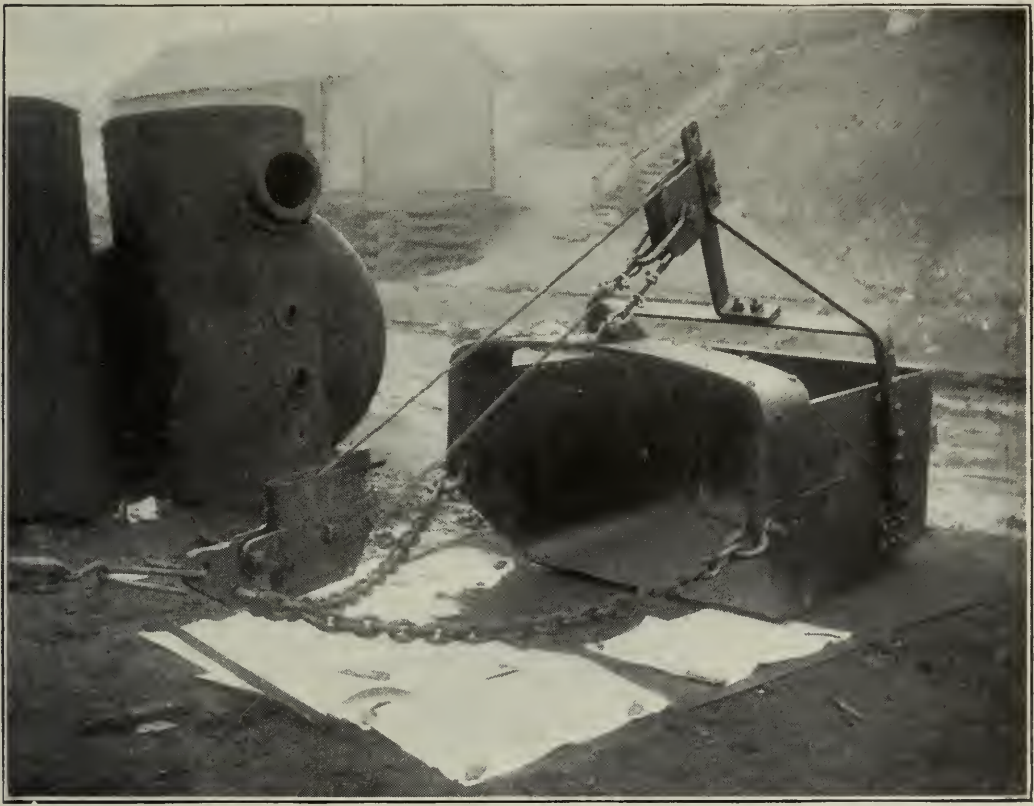
Mr. Thomson here concludes his study of handling machinery, which began in the issue of The Engineering Magazine for March last. The preceding parts have covered the influence which such appliances exercise in lowering unit costs, the forms especially suited to excavation and construction work, and cranes, cableways, and transporting conveyors.—The Editors.

IN the many forms of good buckets in use—the "clam-shell," "orange-peel," bottom-dump and trip buckets, are a multitude of variations of design and size, the latter running from ¼ cubic-yard capacity up to 8 or 10 yards, not to mention the big 10-ton automatic ore unloaders. A simple form of bucket used almost universally in caisson work is 29 inches in diameter and about 3 feet high with a hinged bale or handle, and a ring on the bottom to which a snatch line is connected as it leaves the lock; when the snatch line is held tight and hoisting line slackened the bucket, of course, turns upside down and deposits its contents where desired. The trip bucket, made in capacities up to 2 cubic yards or more, is so constructed that the bale or handle is clamped to the side in such a way

HEAVY BUCKETS IN EXCAVATING WORK.

Above, a Hayward 3 cu. yd. orange-peel used by Henry Steers, Inc., for filling for the Pennsylvania Railway, Greenville, N. J. It handles pieces up to 5 and 6 tons. Below, an English locomotive crane with Hayward 2 cu. yd. clam-shell bucket, used by S. Pearson & Sons in cleaning a mixture of clay and stone from the roof of the P. N. Y. & L. I. tunnel. The Hayward Co., N. Y.

that when the latch is knocked up with a shovel or hammer the weight of the material in the bucket upsets it just enough to allow the material to fall out; then the empty bucket swings back into a vertical position and clamps itself. These are much used on ordinary derrick work, the 2 cubic-yard size being very common.

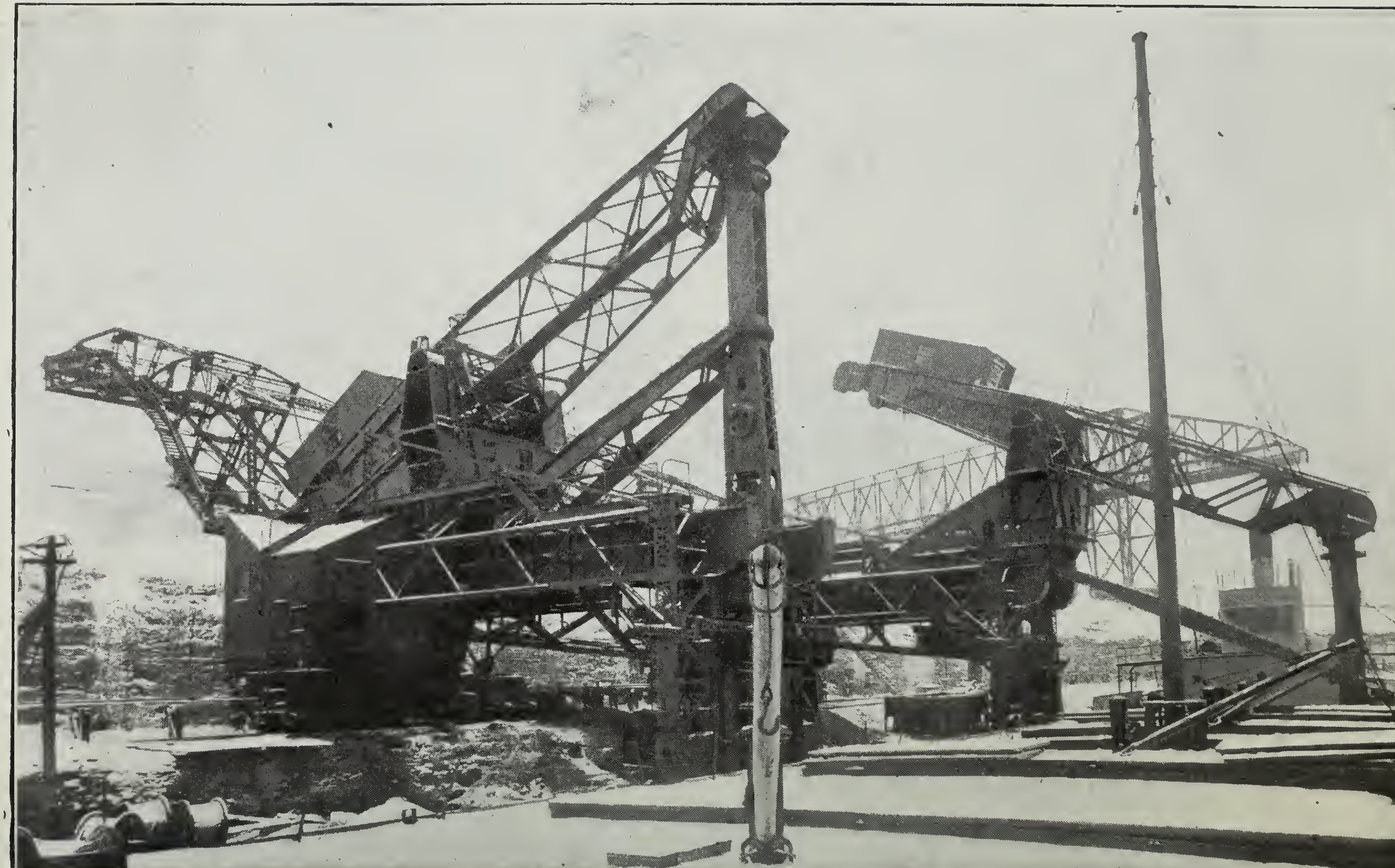


AN EXTRA HEAVY BUCKET.
Used by Page & Schnable.

In New York the laborers or cellar diggers shovel the material into the bucket which the derricks hoist over the wagons, where it is dumped, the wagons being in turn dumped onto scows, making the handling of the cellar excavation run up to $2 or $3 a yard as against 25 cents in the country. Working these buckets should soon show the advantages of the clam-shell, orange-peel, and similar forms which feed themselves, doing away with much expensive labor and the waste of time in waiting for the derrick, and in other delays.

These self-filling buckets have two or more parts which are lowered on to dirt, coal, gravel, sand, ore, etc., with wide-open jaws which shut up as soon as hoisting begins, but not before they have scooped up a full load.

Many mechanical devices are used to operate these jaws, and on the larger sizes pneumatic power is used. A 1 cubic-foot orange-peel bucket costs about $100 and is useful in cramped quarters, such as



TWO HULETT AUTOMATIC ORE UNLOADERS, WORKS OF THE NATIONAL TUBE CO., LORAIN, OHIO.

They have unloaded an average of 500,000 tons of ore each per season. Cost approximately $90,000, in place. Installed by the Wellman-Seaver-Morgan Co.

digging between piles, etc; $700 will buy a good 1 cubic-yard one, $1,400 a 3 cubic-yard, while an extra-heavy 10 cubic-yard bucket costs as much as $4,000.

Clam shells are a little cheaper; the ½ cubic-yard size being $350, the 1 cubic-yard $480, and the 5 cubic-yard $1,000 to $3,000. These prices may seem excessive, but when compared with the cost of men filling plain buckets they are insignificant. The only apology for stating such self-evident facts is that one can go almost anywhere and see a gang shoveling dirt or other material into a bucket, or waiting for the bucket to come back, and then go around the corner and see the self-feeding buckets or excavators doing the work for a fraction of the cost—though, of course, there are places where nothing but the old-fashioned forms can be used.

UNLOADER LEG AND BUCKET OF HULETT AUTOMATIC UNLOADER IN THE HOLD OF AN ORE VESSEL.

Capacity 10 tons; when open, the bucket covers on area 18 by 18 ft.; can unload 90 per cent. of an ore cargo without help from shovelers. Operated by hydraulic or electric motors.

The highest development so far has been made for ore-handling plants where the bucket is a huge complicated machine by itself, as shown in the illustration of the Hulett automatic ore unloader opposite; for there it is fully realized that every minute saved in unloading a boat is a very important consideration. Here we have a bucket with a capacity of 10 tons, covering a width of 18 feet when open; and capable (it is said) of unloading 90 per cent of a boat's cargo without the aid of shovelers. It is closed by hydraulic power when steam is used, and by an especial design of motor when electricity is the motive power. In the picture the operator is seen standing in the rigid arm of the bucket itself; so he is always in the right place to see when and where the jaws should be shut. This is a part of one of those immense cranes of the National Tube Company at Lorain, Ohio, where the Lake Boats are unloaded. Two of these machines have unloaded an average of 500,000 tons of ore each in one season. When steam power is used it is supplied from a 175 horse-power boiler of the locomotive type, operating a steam pump capable of supplying the necessary amount of water at a pressure of 1,000 pounds per square inch. Hydraulic cylinders are used to open, close, and rotate the bucket, to move the trolley, and to raise or lower the walking beam. Another engine is used for moving the machine itself along the dock and handling the bucket car. When run by electricity the motors take their current by sliding contact from lines laid along the dock, using 80 horse-power motors for handling the

REVOLVING STEAM SHOVEL IN OPERATION.

Will rotate in a complete circle; with a ¾ cu. yd. dipper, will cut 600-900 cu. yd. in a 9-hour day. Can be converted into a locomotive crane, fitted with clam-shell or orange-peel bucket, provided with timber hooks and used as a log loader, etc.

The Browning Engineering Co.

bucket, 150 horse-power for hoisting the walking beam, and a 50 horse-power motor for trolleying in and out; a 200 horse-power engine is required for moving the machine itself and the bucket car. The controllers are of magnetic type and are naturally built for heavy service. The total cost of one of these ore unloaders is about $90,000.

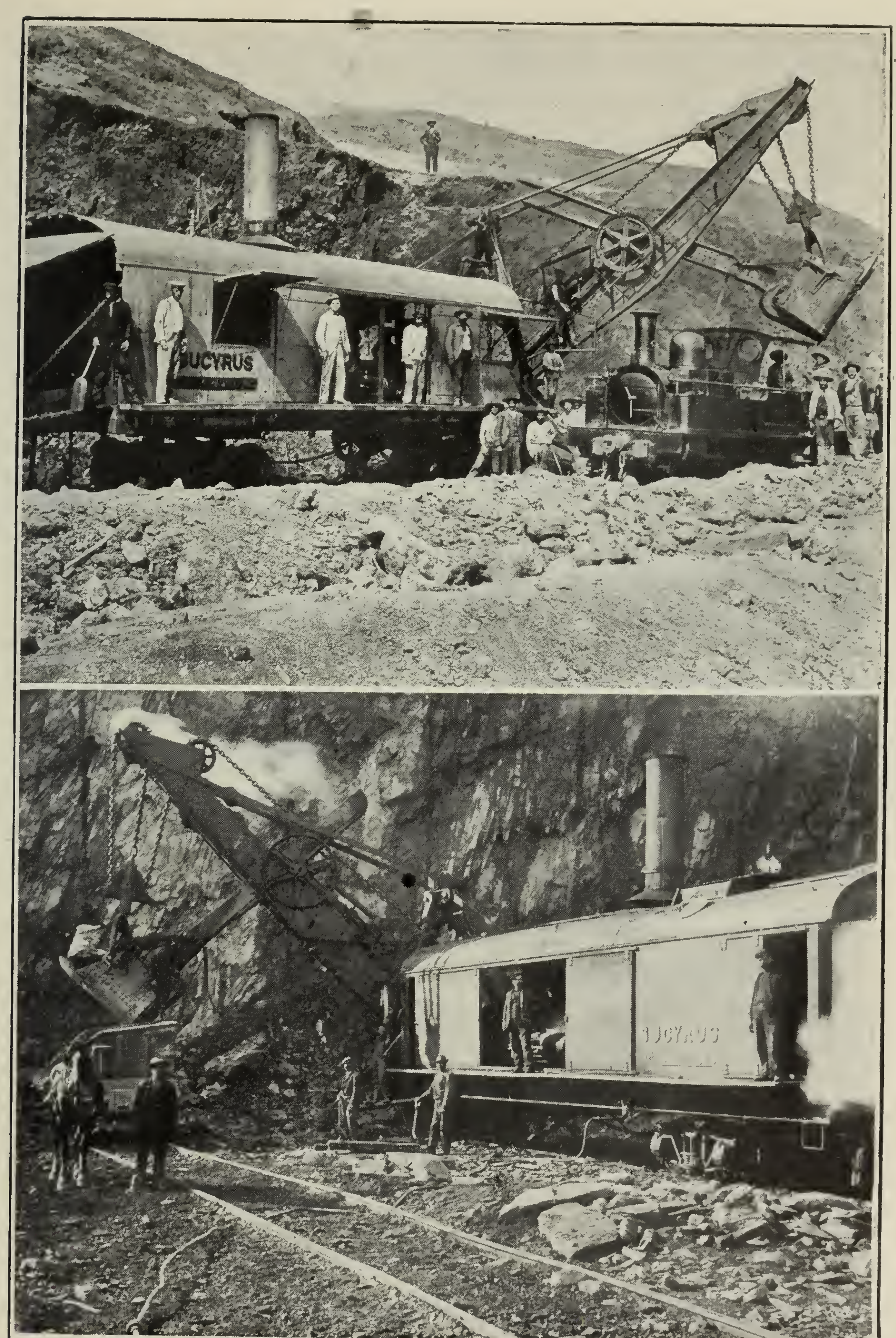
DITCHER, BUILT TO OPERATE FROM A FLAT CAR OR FROM THE GROUND.
Browning Engineering Co.

Put a scoop bucket on the end of a movable arm and we have the steam shovel, the first of which was designed by a Mr. Otis of Boston in 1840; his general outline or idea was practically the same as the modern highly finished machine, and though his attempt was very successful it took twenty-five years for the idea to take root. The early shovels were built on a sort of pillar-crane type having the boom rigidly attached to the top of the pillar by heavy bracing, or its equivalent, and it is only within the last twenty years that this has been superseded by the boom type in which the lower end of the boom is attached to a turn table and its upper end is held by a boom guy fastened to an A frame over the turn table. The height of these A frames has now been reduced so that they can now pass through bridges and tunnels, and in a few cases where higher A frames are desired they are arranged so that they can be lowered.

Contractors are rapidly realizing the fact that the steam shovel is one of the best money makers, and as a result there is such a demand for them that they are hard to obtain in a hurry. Under favorable conditions, a 2½ cubic-yard steam shovel has excavated 2,500 to 3,000 cubic yards a day at a cost of 6 cents per cubic yard; but any novice taking a contract at any such price would undoubtedly "go broke," as there are so many unforeseen contingencies—even the material to be excavated often turns out to be very different from what was anticipated. Steam shovels are generally made to take out from ¾ of a cubic yard to 5 cubic yards (135 cubic feet) at each stroke, and a 5-yard machine should handle about 4,000 cubic yards in a 10-hour day if all goes well; but one has to be very careful in making an estimate of the work to be done by multiplying the daily capacity by the number of days in a month—for, unless the operators are all experienced men, they will be continually getting the machine off the track or even overturning it, or breaking some essential part which they may expect to replace in a day or two but for which they may then have to wait several weeks.

Some of the larger sizes weigh nearly 100 tons and can scrape up almost anything but solid rock; they are usually designed to run on a standard-gauge track, which is often hurriedly laid on more or less soft ground so that it requires much ingenuity to keep the apparatus and cars on the track, for the slightest accident or delay makes a serious difference in the contractor's output; no money is made when the shovel is not actually digging, although the expense goes on. While the majority of shovels are built to run on standard-gauge tracks, a few are constructed for very broad gauges, and still others, having very wide wheels and called traction shovels, are made to travel on the ground without any track. Still another class, which is coming more and more into use, is built something after the principle of a locomotive crane so that it can revolve completely around, through 360 degrees, and is used principally for digging cellars and handling the material in yards of manufacturing concerns.

The smaller shovels have a vertical boiler, while the larger sizes carry a horizontal boiler of the locomotive type; generally 100-pounds steam pressure is used, though occasionally this is increased to 140.



BUCYRUS STEAM SHOVELS AT WORK.

The upper one is a 65-ton shovel at the Rio Tinto mines, Huelva, Spain. The lower is a 95-ton at the plant of the Edison Portland Cement Co., Stewartsville, N. J. Built by the Bucyrus Co.

The up-to-date machines have three pairs of engines. The pair for forcing the dipper into the ground is carried on the boom itself, while the pairs for hoisting and for swinging are placed on the car which also carries the coal bin and water tank. A good 1¼ cubic-yard shovel has a hoisting engine with cylinders about 7 by 10 inches and boom and swinging-gear engines of about 5 by 6-inch cylinders, with a 4-foot diameter by 8-foot high boiler. The hoisting chain is about ⅞-inch diameter, and the total weight of the machine 24 tons. A 5 cubic-yard machine weighing about 95 tons has 14 by 16-inch cylinder hoisting engines, and boom and hoisting engines with cylinders about 9 by 9 inches each, the hoisting chain being 1½ inch.

A 1¼ cubic-yard steam shovel costs about $6,000, a 2½ cubic-yard steam shovel costs from $7,500 to $9,000, and a good shovel with a 5 cubic-yard dipper brings about $12,000. A 90-ton 4 cubic-yard dipper Bucyrus steam shovel, on a 10 by 44-foot car with 12 by 16-inch cylinder main engines and independent reversible engines for swinging gear, with a 1⅜-inch swinging cable and 1½-inch hoisting chain, the locomotive boiler being 5 feet in diameter and about 13 feet high, has handled 4,000 cubic yards per day of 10 hours. The crew usually consists of an engine driver at $140 or more a month, a cranesman at $100 or more, a fireman, and from four to six laborers.

Though steam shovels, as the name would indicate, are usually operated by steam, they have in certain cases been equipped for electrical power. The different uses to which these machines can be put are rapidly increasing, as fast as they can be manufactured. There will soon be over one hundred steam shovels in use for the Panama Canal alone—probably before this appears in print.

So far they have been used to any extent only on very heavy work, on account of the expense; but a 35-ton traction-wheel steam shovel has recently been successfully used for shallow cuts, 16 feet wide and containing only about 7,000 cubic yards, for the Hanover & York Electric Railway, by Dodge & Day of Philadelphia.

The question of cost analysis has recently been brought up in connection with the Ashokan Dam bids. It is, of course, quite true that engineers should know how to analyze the cost of their work, but they must be very careful not to be misled by such analysis. For instance, we had a contract once on which were the usual steam-shovel, engineer, crane man, and fireman, and some thirty men on the dump. There was a $5,000 a year superintendent in charge who made a good profit for his employer but left before the work was completed. His successor at $3,000, with the same plant and gang, did not turn out anything like as many cubic yards of material, turning the profit into a loss. With the most exhaustive and careful calculations, therefore, it is necessary for the engineer to allow a very considerable percentage for doubt and unforeseen contingencies, among which might be mentioned the loss due to having the work held up by political investigation, which not only ties up the capital and plant, but also makes it necessary to do work in the winter that could have been done in the summer.

ATLANTIC STEAM SHOVEL AT WORK IN BLASTED ROCK, N. & W. RY. NEAR ROANOKE.

Built for Vaughan Construction Co. by the Atlantic Equipment Co.

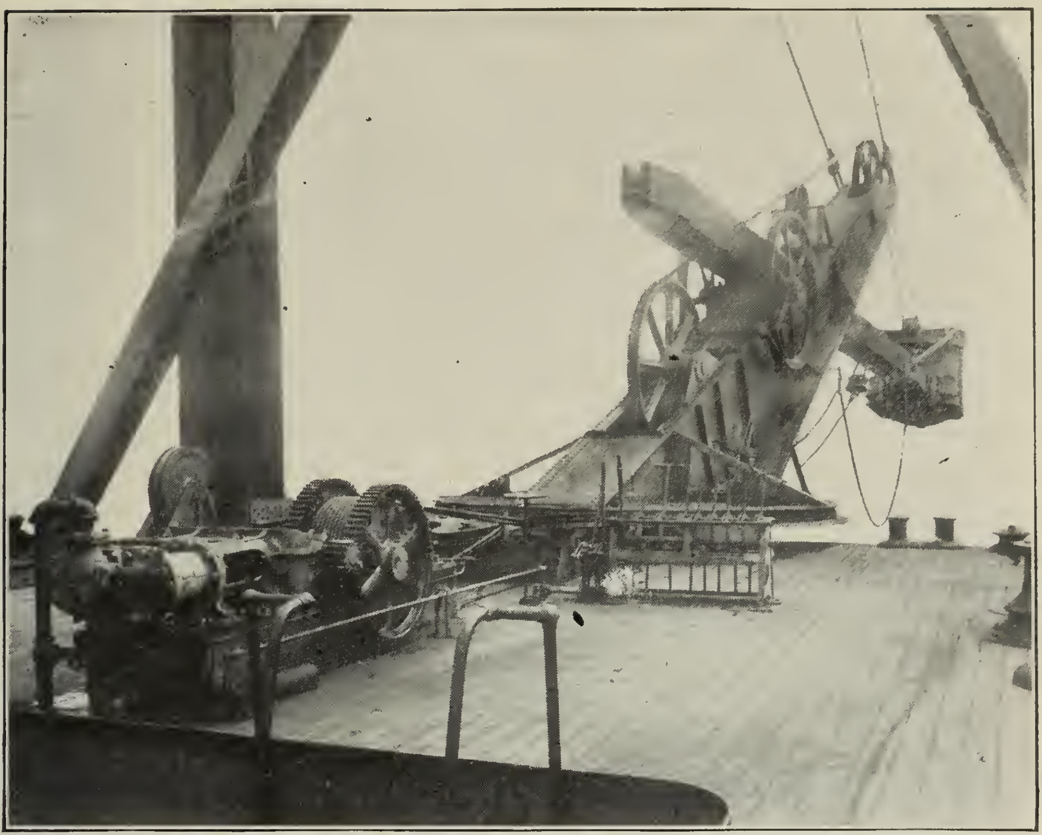
The dipper dredge does in the water what the steam shovel does on land; and indeed there are many points of similarity between the two, though the dredge is a more expensive machine and, on the other hand, capable of doing more work, the biggest one built to date having an 8-cubic yard dipper and costing complete $120,000, the boat itself being a very substantial affair. The question of "boat" has recently been the cause of a law suit to determine whether or not the operators, working in a harbor or river, should be classed as mechanics or as seamen, on Government work, the point in dispute being whether the 8-hour labor statute should apply to them or not.

The dipper dredge will rip out and lift or push aside huge boulders that the lighter and cheaper "orange peel" or "clam shell" dredges would not touch. Dredges have been designed with 10-cubic yard dippers to be operated by 18 by 24-inch cylinder hoisting engines.

While hoisting chains are still used for the smaller sizes, steel cables are much better for the bigger machines on account of being

DREDGE FOR THE CUBAN GOVERNMENT, BUILT BY THE ATLANTIC EQUIPMENT COMPANY.

The bucket is of 8 cu. yd. capacity. Hull 110 by 42 by 12 ft., spuds 40 in. square, boom 44 ft. long, all of steel. Main engines double-cylinder, 17 by 20 in. Pull upon dipper 180,000 lb.



FORWARD END AND BUCKET OF ATLANTIC EQUIPMENT COMPANY DREDGE.
Capacity of bucket 8 cu. yd.

more reliable and much quicker in action than the cumbersome chain. This can readily be understood when it is realized that the cable is now often run over a large sheave at the top of the boom direct to the drum, discarding the pulley blocks entirely.

Another dredge much used for digging gravel, sand, etc., is the chain bucket or conveyer dredge, the conveyer arrangement usually being attached to the side of the boat and readily raised or lowered as desired.

Probably the machine that can handle the greatest volume of material in the shortest time and transport it the longest distance for the least money is the suction dredge, with suction and discharge pipes all the way from 10 to 30 inches in diameter. The suction pipe is attached to a swinging arm which can be lowered to the bottom or raised up clear out of the water, like a boom; at the lower end of this arm or boom is attached a revolving cutter which will break up stiff clay or even harder material and allow it to be pumped up and discharged like so much sand and water.

The engines for operating the cutter are attached to the boat end of the swinging arm. The pumps and all the rest of the machinery are compactly placed on the boat itself, while the discharge pipes are carried on floats to the dumping ground which may be right at hand or several thousand feet away. One can easily imagine what an immense volume of material can be pumped through a 30-inch pipe when it is realized that this has a cross-sectional area of 706 square inches, or nearly 5 square feet, and, as a rule, the pumps work very smoothly, requiring very few stoppages.

Mr. A. W. Robinson, M. Am. Soc. C. E., of Montreal, has designed some of the most powerful dredges in existence. One of them for Lake St. Peter, St. Lawrence River, has pumped 750,000 cubic yards of clay a month and deposited it 2,000 feet away. Not only this, but the original pipe line has been working continuously for five years. The same engineer also designed the dredge now working

PIPE LINE OF 30-INCH HYDRAULIC DREDGE BUILT FOR THE COMMISSIONERS OF LINCOLN PARK, CHICAGO.

Steel hull, 148 by 36 by 12½ ft. Main engines triple-expansion, 1200 i.h.p. Cutter engines double tandem compound, 300 h. p Average capacity 1500 cu. yd. per hr.
Atlantic Equipment Co.

in Lake Michigan, making a fill for Lincoln Park, thus increasing the area by a strip 1,500 feet wide and a mile or so long, totaling up to 4,000,000 cubic yards. This dredge was built by the Atlantic Equipment Company and set to work in June, 1907. The pontoon is 148 feet long by 36 feet wide and 12½ feet deep. The suction and discharge pipes are 30 inches in diameter and are operated by 1,200 horse-power triple-expansion marine engines having two double-end marine boilers 11½ by 18 feet, with corrugated furnaces, condensing apparatus, electric lights, pumps, and auxiliaries. The cutter is 9 feet in diameter and 9 tons in weight and has eight curved steel blades which cut up the blue clay allowing it to be sucked up and discharged at the rate of 3,000 cubic feet per hour; it is, of course, operated by its own mechanism. The discharge pipe is carried on steel pontoons of 100-feet lengths, connected by ball and socket joints. This outfit cost in the neighborhood of $150,000.

LOCOMOTIVE CRANE EQUIPPED WITH ELECTRIC LIFTING MAGNET HANDLING LOOSE SCRAP.

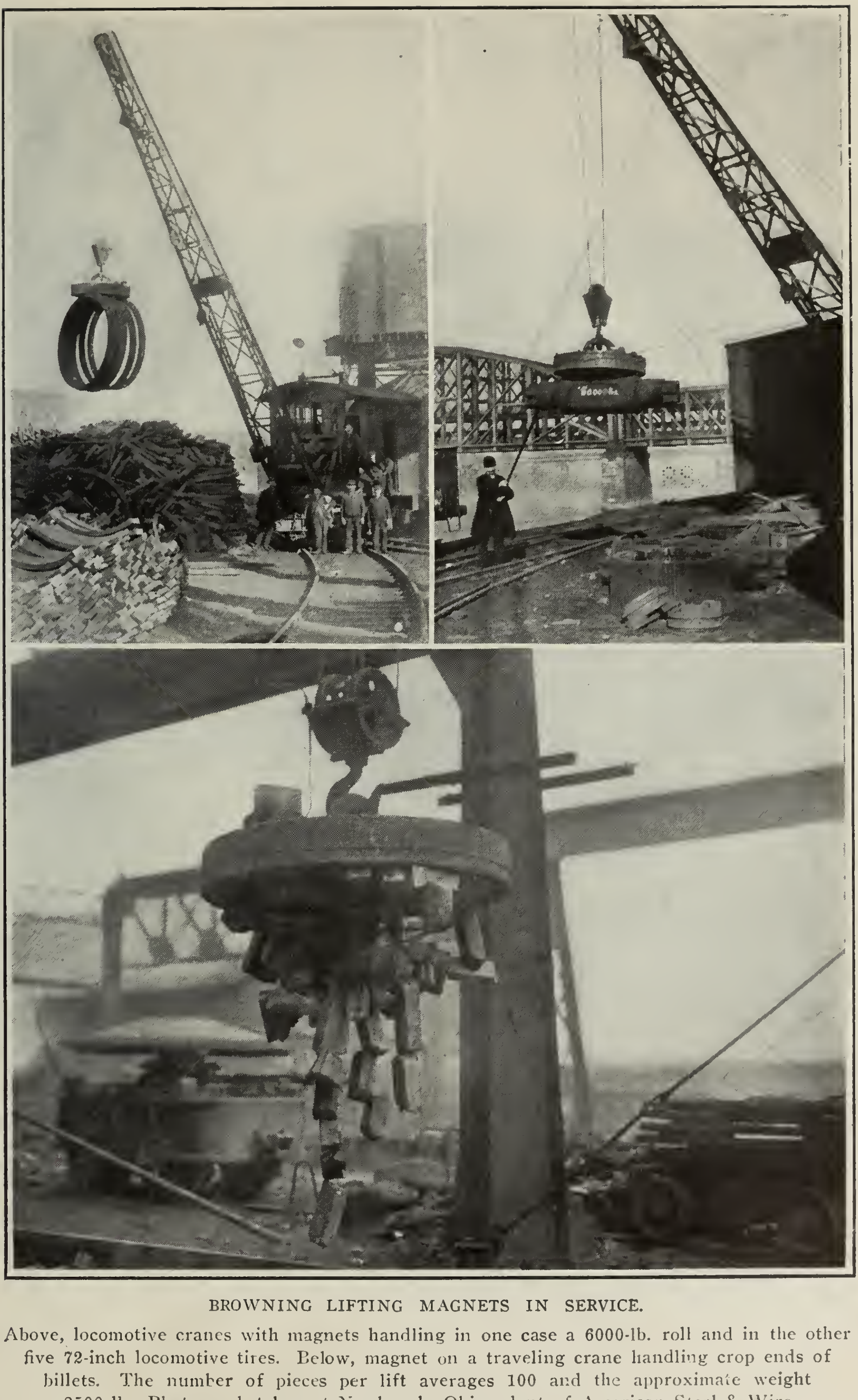
Installed by the Electric Controller & Supply Co. at the works of Moorhead Bros., Sharpsburg, Pa.

J. & J. McSpirit of New Brunswick, N. J., have handled 300 to 500 tons of rock, weighing from 6 to 7 tons, in a day of 10 hours, using a dredge with a 1½ cubic-yard orange-peel bucket; and Chas. Warren Company of Wilmington, Delaware, have handled 150 cubic

PIG MAGNET LIFTING MACHINE-CAST PIGS FROM DEEP PILE.
In the yards of the Wellman-Seaver-Morgan Co. Installed by the Electric Controller & Supply Co.

yards per hour of washed and screened sand with a derrick dredge having an A frame 40 feet high, which they built for themselves, with a 50-foot boom on a scow 32 by 87 feet, using a Lambert hoisting engine with 12½ by 16-inch double-cylinder, double-drum dredge engine, and a 2½ cubic-yard Hayward orange-peel bucket, working in 25 feet of water. The O'Rourke Construction Company, with a 3½ cubic-yard orange-peel bucket on a derrick boat has taken care of 2,000 to 2,500 cubic yards of city refuse a day.

A valuable aid in hoisting operations is the electric magnet, the properties of which have been known since 1820, although it is only recently that it has been put to commercial uses.



BROWNING LIFTING MAGNETS IN SERVICE.

Above, locomotive cranes with magnets handling in one case a 6000-lb. roll and in the other five 72-inch locomotive tires. Below, magnet on a traveling crane handling crop ends of billets. The number of pieces per lift averages 100 and the approximate weight 3500 lb, Photograph taken at Newburgh, Ohio, plant of American Steel & Wire Co. Browning Engineering Co.

CUTLER-HAMMER LIFTING MAGNET UNLOADING CASTINGS.
Handling a winding drum weighing 3200 lb. Cutler-Hammer Mfg. Co.

It has the ability to attract iron or steel when an electric current is passed through the magnet and to release the same at once when the current is turned off. It is now used to advantage in handling iron or steel in all shapes, such as lifting scrap wire out of cars, handling steel plates, lifting safes, pig iron, etc.

In handling plates a skilled operator can lower his electro-magnet onto a pile of plates and lift up half a dozen or so; then, by turning his switch for an instant, he can drop the bottom plate and turn the current on again in time to prevent the rest of the plates from falling.

It is not difficult to comprehend what a labor and time-saving device this is, doing away with all hooks or grapples and men to adjust them, especially where they would have to pry up the plates or other pieces to get the hooks or chains under.

While the principle has been known these many years, the details of the practical lifter have required much recent study and experi-

A 10-INCH CUTLER-HAMMER MAGNET LIFTING THE BODY OF A 50-INCH MAGNET.

The casting, ready for insertion of the coil and coil shield, weighs about 3000 lb. and is of awkward shape to handle with slings. An apt illustration of the advantages of this mode of handling castings is thus afforded. Cutler-Hammer Mfg. Co.

ment, as the magnets have to be adapted for each kind of work; for instance, one that will readily lift a 10,000-pound ingot will not lift a long thin piece weighing only 1,000 pounds, or even a single piece of pig iron weighing only 100 pounds from a pile of pig. The design of a magnet to lift from 20 to 25 pieces of pig at a time without having the current scattered all over the pile, gave a vast amount of trouble before success was reached. Mr. S. Piek has designed a magnet weighing 5,000 pounds, which uses 27 amperes at 220 volts in lifting about 25 pieces of pig iron from an indiscriminate pile, even causing the pig to jump vertically from 4 to 6 inches to attach itself.

Mr. S. T. Wellman, a pioneer open-hearth steel man, was one of the first to foresee the advantage and undertake the design which was afterwards advanced by Mr. Eugene B. Clark of the Illinois Steel Company and then by the Electric Controller and Supply Company of Cleveland, some of whose machines have been built for the Imperial shipyards of Yokohama, Japan. A magnet to stand the hammering due to lifting and dropping say 800 tons of pig iron a day requires considerable more study than is required merely for the magnetic circuit.

The United States Government realizes the advantages of up-to-date machines in handling mail through pneumatic chutes, etc., but the New York City government is still far behind the times in getting rid of street sweepings, snow, and like material. If the streets were kept in the condition in which Col. Waring showed they could be kept, or as they are kept in Paris, perhaps automatic street sweepers would not be needed, unless for removing snow. Would it not be possible to have one that would sweep the snow up, melt it, and turn the water into the nearest sewer?

The Standard Oil Company has shown the advantages of transporting oil under rivers across country, through pipe lines.

One naturally associates with the idea of hoisting machines the process of handling heavy objects; but we have witnessed the introduction in New York and elsewhere, so quickly and effectively as to be scarcely noticed, of an elaborate system to carry objects of almost no weight, comparatively, but with an enormous saving of time; and that is the system of handling cash in our big stores and replacing the "cash boys" and "cash girls," by the so-called "telpherage" cableways. Worked by electricity, they have also been designed to carry all sorts of loads and all sorts of speeds, running from 60 to 120 feet per minute for the hoist and from 600 to 1,000 feet for conveying.

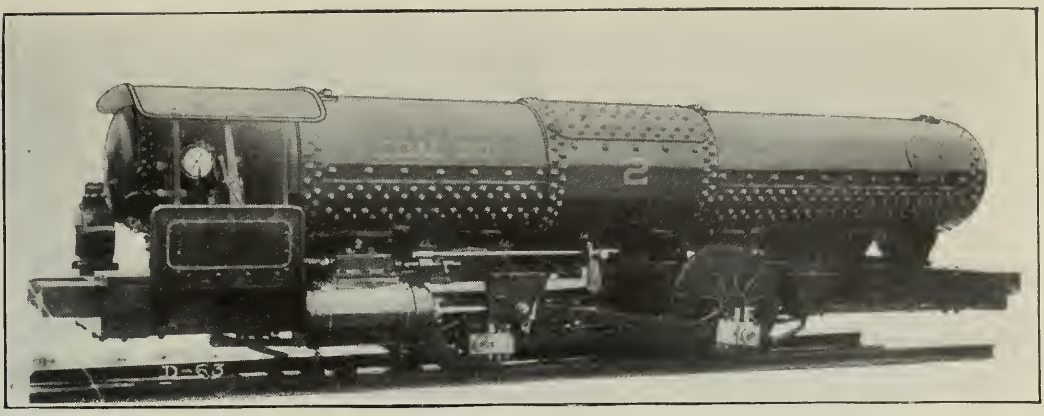
Floating cranes are very important implements and are very much more elaborate than an ordinary derrick boat, which is allowed to tilt more or less under its load, while the 100-ton floating cantilever crane built for the United States, on a steel pontoon 60 by 100 by 11 feet deep, for example, carries in addition to the usual water ballast an automatic counterweight weighing 250 tons, which travels in such a way that the keel is always kept level or horizontal, so that when the heavy turrets of a ship are handled there is not only no swaying of the boat; but it is even held so steady that an exact adjustment can be made to 1/16 of an inch, and any load not over 40 feet wide nor weighing more than 100 tons can be carried from one end of the cantilever to the other, passing between the rigid legs on the pontoon supporting the cantilever or placed on the pontoon itself. When these details, which make the floating crane almost as stable as a land derrick, are considered it will be understood why a crane like this one can cost as much as $225,000.

The locomotive, one of the most economical tools for handling material, has not been described here as its uses are more generally known than other kinds of machines. When the Manhattan Elevated introduced the third rail, they sold off nearly all the old locomotives to contractors and others, some going to Japan and in fact pretty nearly all over the world. The traction locomotive pulling a big load of logs in New York State (page 207) is probably not so familiar, nor is the use of the compressed-air engine so well known. While the compressed-air engine can be used in many

A DITCHING EXCAVATOR IN OPERATION.
The Municipal Engineering & Contracting Co.

ONE OF EIGHT UNLOADERS FURNISHED THE PANAMA RAILROAD CO. FOR USE AT LA BOCA.

The tidal variation is about 20 ft. The 80-ft. boom, in its working position as shown, will carry loads over a vessel's deck at high tide while the inner end is within the warehouse door. Main tower 62 ft. above track, with clear portal 10 ft. wide. Gantry base 11 ft. gauge, 6 ft. high in the clear. Speed of hoist and of racking each 150 ft. per minute. Hoist operated by 65 h. p. rack motion by 40 h. p., travel by 24 h. p. and boom hoist by 8 h. p. motor. All motions controlled by one operator. Shaw Electric Crane Co., Muskegon, Mich.



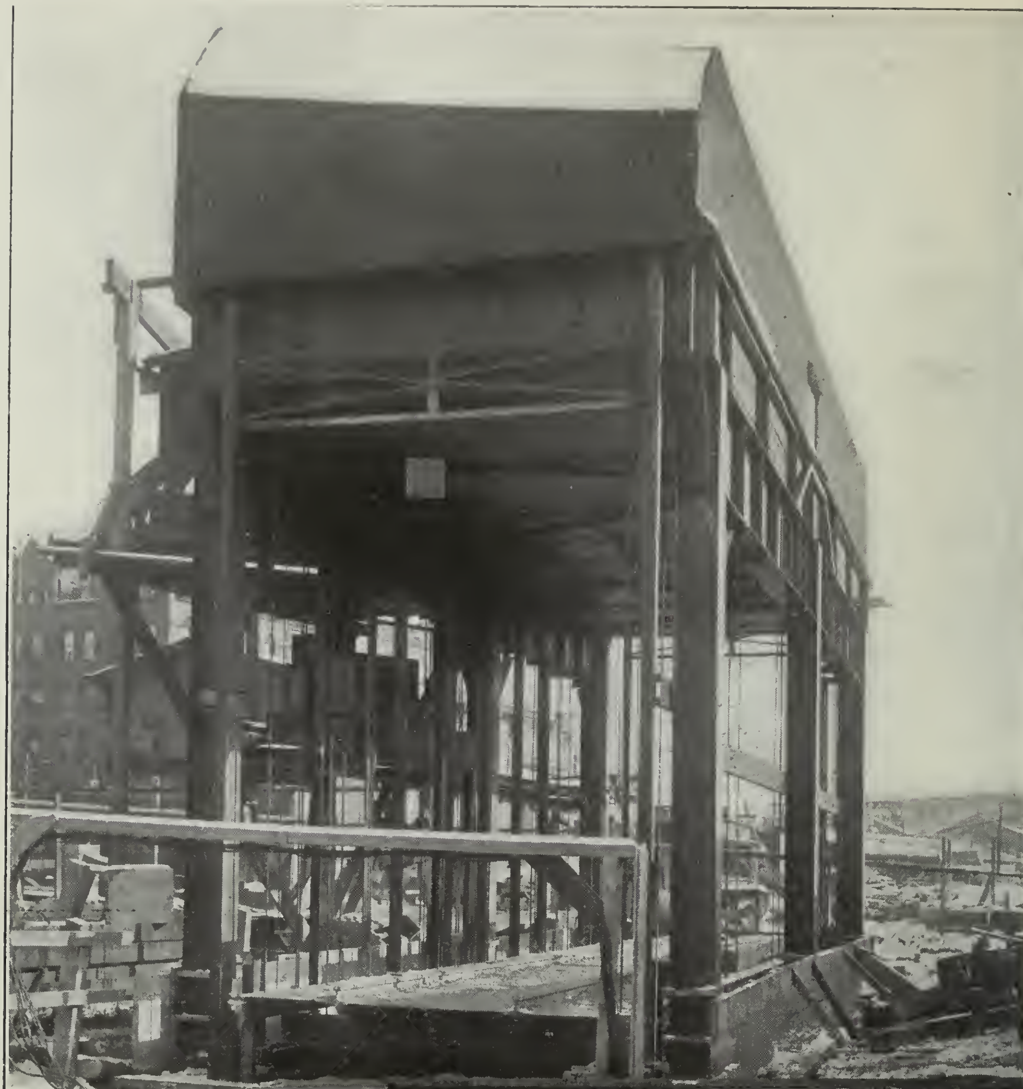
A COMPRESSED-AIR LOCOMOTIVE.

Gauge 3 ft., storage pressure 850 lb., working pressure 130 lb. Weight 22,100 lb.; tractive power (max.) 4797 lb. American Locomotive Co.

places to compete with steam and electricity, it has a decided advantage over the others wherever there is any danger of fire, such as in dangerous coal mines, powder mills, cotton mills, or wherever explosive or especialy inflammable materials are manufactured.

Instead of an ordinary locomotive boiler these engines have one or more storage tanks filled with air at a high pressure. It is stated that the plant required costs about the same as an electrical plant, but that the cost of operation is less for the compressed-air engines. These engines cost from $2,500 to $3,000.

TRACTION ENGINE HAULING A LOAD OF LOGS, SWARTWOOD, N. Y.



SPECIAL ELEVATOR EQUIPMENT FOR ELECTRIC PASSENGER CARS, HUDSON & MANHATTAN RAILWAY.

Platform 50 by 12 ft., lifting capacity 100,000 lb. Operated by 100 h. p. motor, driving two 50 ft. drum shafts through balanced worm gears. Controlled by pilot switch operated by hand shipping cable. Speed 10 to 20 ft. per minute; lift 30 ft.

Geo. T. McLauthlin Co.

Undoubtedly one of the best places to study hoisting machines is at some place like Lorain, Ohio, where the ore is taken out of the lake boats, one machine taking what it can handle best; then the boat is moved on to another machine and perhaps again—for at these places it is fully realized that different kinds of tools are required for different purposes; so we see a great many different kinds of machines at work side by side, each doing that for which it is most fitted.

This lesson should also be learned, but very often is not, by those who have to design rigid structures of steel, stone, concrete or concrete-steel, all of which have their proper places, but none of which should be used indiscriminately at all times and in all places.

THE NEW MUSEUM OF SAFETY DEVICES AT PARIS.

By Jacques Boyer.

M. Boyer's description of the leading museum of safety devices in France possesses a particularly timely interest in that it appears while the second exhibition of a similar kind in America, held under the auspices of the American Museum of Safety Devices, is still in progress in New York. In European countries such museums and exhibitions have had a most potent influence in advancing the cause of industrial betterment and we are glad to be able so opportunely to second the efforts of the American workers in this field by the publication of so interesting and comprehensive a review of the latest of the great European institutions.—The Editors.

THE new museum of safety devices for preventing accidents and promoting industrial hygiene, installed in December, 1905, at the Conservatoire des Arts at Métiers de Paris, is more a permanent exposition than a museum. As the art progresses, more highly perfected devices replace the older inventions which are relegated to the rank of curiosities in the historical collections of the same establishment.

Today, when powerful and complicated mechanism is substituted almost everywhere for the primitive tools of former times, the prevention of accidents becomes a veritable science. Numerous societies have been founded to draft laws and to study the economic and social consequences, so as to assure, as completely as possible, the safety and the cleanliness of factories now in operation throughout the world.*

The first organization of this kind was founded by a great captain of industry (Engel Dolfus, of Mulhouse) in 1867, and since that time innumerable similar societies have sprung up. There exist also museums similar to the one which is the subject of this article. Among the principal of these may be cited that at Vienna (1890), at Amsterdam (1891), at Berlin (Charlottenburg, 1903). This last one has cost about one-million marks and possesses an annual budget of forty-thousand marks.

The new Parisian museum was founded by the "Association des industriels de France contre les accidents du travail," established in 1883 by Emil Muller, and was organized entirely by private gifts.

* For a study of certain aspects of this question as developed in France, the reader is referred to an article by M. Boyer which appeared in The Engineering Magazine in December, 1902, page 418.

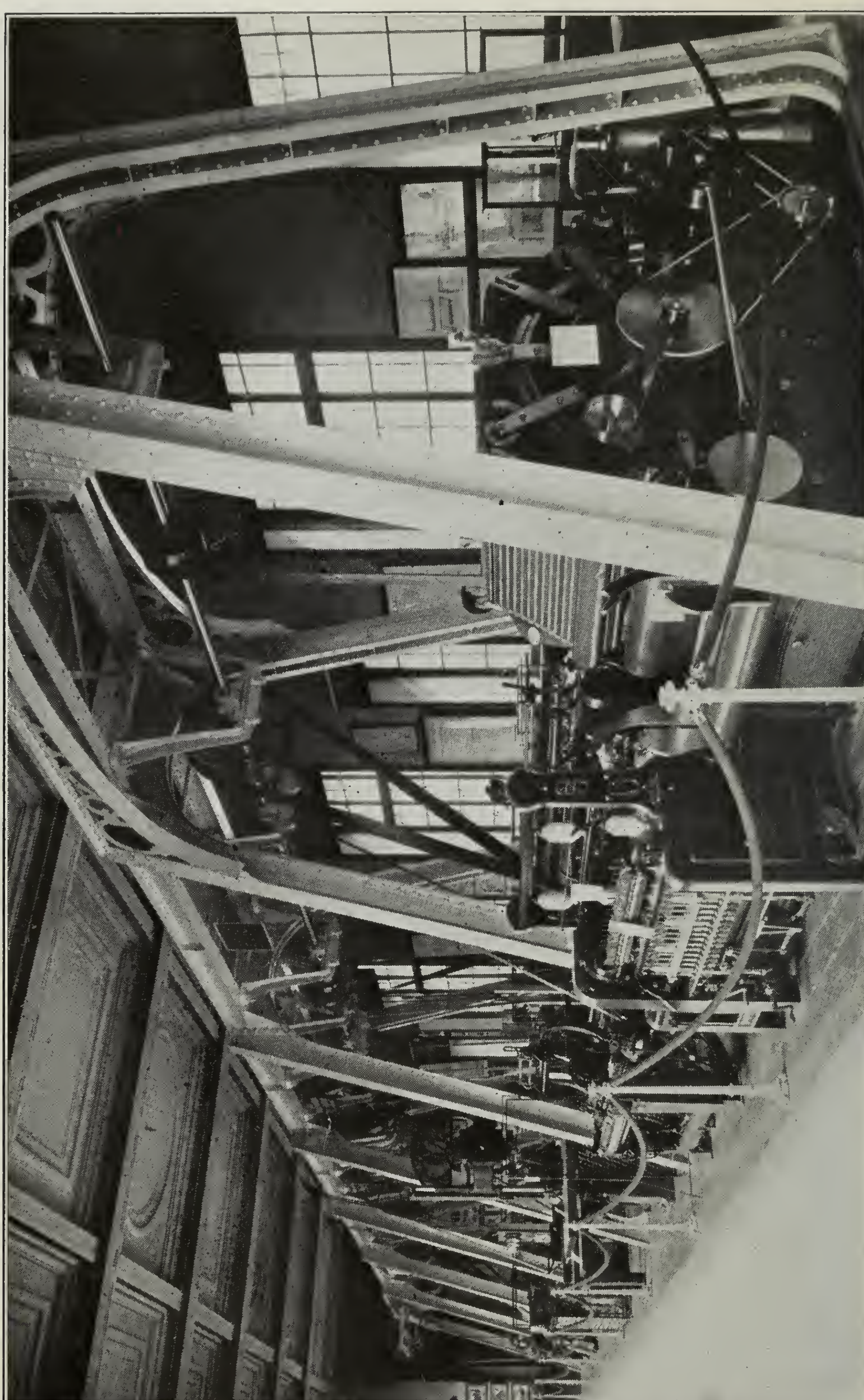


FIG. I. PRINCIPAL HALL OF THE MUSEUM OF SAFETY DEVICES, PARIS.

It had as its nucleus a unique collection of models and protective devices, brought together by the said association, the principal promoters of which were MM. Buquet, Cheysson, G. Dumont, Liébaut and Périssé. Its purpose, inspired by philanthropy, is to indicate to the present patrons the precautions to be taken, the devices and the means to employ, for protecting their workmen against risks of all sorts—unhealthful atmosphere; dangers from machines and transmission devices, harmful dusts, high electric voltages, poisoning, etc.

To start with, the new museum consists at present of three halls. In the main hall, of which Figure 1 shows a general view, a series of diverse machines are grouped, their protective devices being painted in red so as to stand out by contrast. The first machine in the picture is a carding-machine, exhibited by the "Société alsacienne de construction mécanique." This machine, which is of great importance in the spinning industry, removes some of the impurities from the cotton and begins the arrangement of the fibers in parallel directions. In this model the flats travel in a direction which is the reverse of that usually employed in machines of this kind. The cotton, which is carded by the flats, just before leaving the working surface encounters a flat which is perfectly clean and more apt, therefore, to remove the small impurities which are still there. The flats traveling in the opposite direction to that of the cotton become loaded little by little. The largest impurities are removed at the moment when the flats quit the working surface and are ready to be cleaned, therefore there is no danger that the impurities once removed will again become entangled in the cotton. The flats are regulated from a single point.

From the point of view of the prevention of accidents, the card of the "Société alsacienne" is furnished with wheel and gear covers for every part with which the workman who has charge of the machine could possibly come in contact. The parts protected are the following: the wheels driving the feeder cylinder, the comb, the flats, the brush, and the doffer.

A spinning machine is situated at the side of the carding-machine. It transforms the cotton coming from the roving-machines into yarn ready to be utilized in the further spinning operations; that is, weaving, thread making, etc. The bobbins are placed on a rack; the roving of cotton is unwound and passes through a series of drawing rolls which give it the desired fineness. Then the yarn is twisted by a flyer fastened to the extremity of the spindle or by a traveler on a ring, and is then wound on the spindle. The spindle is driven by cords passing over iron drums driven directly from the transmission.

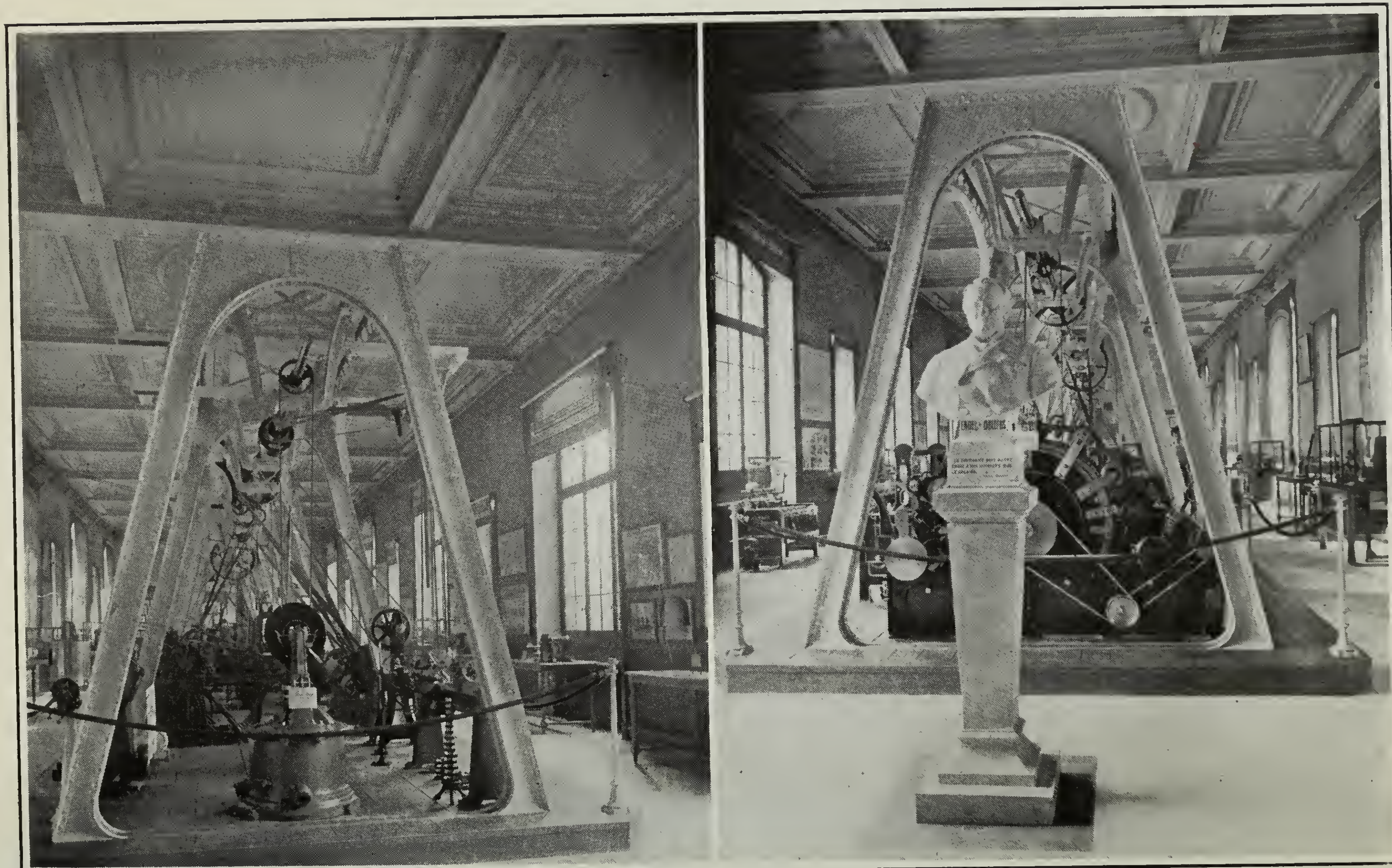


FIG. I A. TWO VIEWS OF THE MAIN HALL, TAKEN FROM OPPOSITE ENDS.

By courtesy of Dr. W. H. Tolman, Director of the American Museum of Safety Devices and Industrial Hygiene, New York.

A series of toothed gears transmit the motion to the drawing rolls. These wheels are placed on one side of the frame, and are the most dangerous parts of the machine. In this machine they are covered with cast-iron plates, and can be rendered accessible only by the removal of these plates. The wheels which transmit the motion from one drawing cylinder to another are also equipped with gear covers.

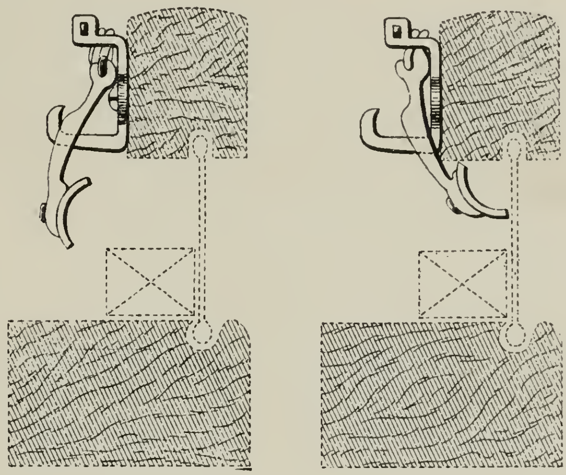


FIG. 2-3. KOCH-HURST SHUTTLE GUARD, WITH THE LOOM STOPPED AND THE REED EXPOSED, AND WITH THE LOOM IN OPERATION.

Passing rapidly to the roving-machine, which is equipped with a safety stop to the Blin protector for shears, and the Northrop loom which is located in the same hall, let us note the ingenious shuttle-guard of Koch-Hurst (Figures 2 and 3), which consists of a bar made of half-round steel and suitably supported. This bar is riveted to two pieces which are supported by two rectangular shaped malleable-iron devices screwed to the head of the lathe. Powerful springs press on the piece which supports the rod and holds it in the position shown in Figures 2 and 3. When the shuttle leaves the box this bar holds it in front. A small wooden dog in the form of a triangle fastened at the extremity of the apparatus and below the lathe head, obliges it to descend and re-enter the shuttle-box. The workman in placing his hand on the head of the lathe exercises a slight pressure with his thumb on the bar which drops down under the lathe head and completely exposes the reed. It remains in this position as long as the loom is stopped, but as soon as it starts up again the shuttle-guard goes back automatically to its former position and remains there during the operation of the loom.

Protectors for circular saws, planers, and other wood-working machines are to be found in the museum, as are also various systems of couplings for pulleys or gears; but these devices are so well-known that they will not be described here; neither can we undertake to describe the centrifugal dryers and cream separators. Suffice it to mention the novel protector for emery wheels, exhibited by "Fabriques réunies d'emeri" of Paris. The great strength of this elastic and adjustable protector (Figure 4) is due to the fact that it is built up of several layers of sheet steel, each having a thickness of from 1 to 1.5 millimetres, increasing with the number of thicknesses used. The elasticity of this protector is considerably greater for a large number of layers than for a single layer, and especially in the large sizes is far superior to the ordinary guards which consist of one piece. It is well-known that blows and shocks applied to an elastic body do not produce any noticeable effect, while the same forces acting on a rigid body would cause it to fly to pieces at the end of a short time. Because of this elastic characteristic, the effect due to the bursting of an emery wheel is quickly overcome and rendered harmless. The easy adjustment of this protector is due partly to the sheets of steel considered separately, and partly to the elasticity, which remains constant when several sheets are superposed, one upon the other.

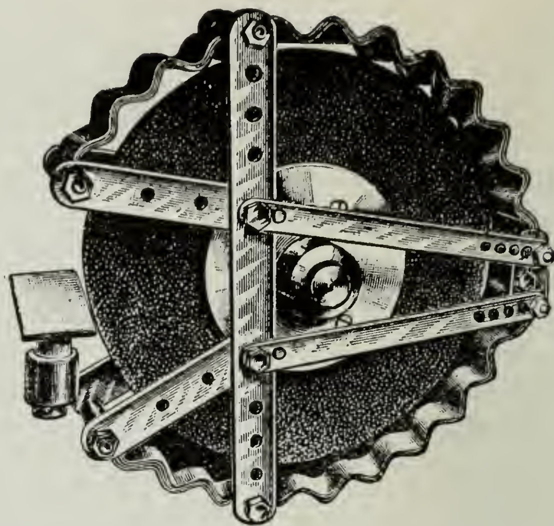


FIG. 4. ELASTIC ADJUSTABLE PROTECTOR FOR GRIND STONES.

In the main hall there are also portable belt shifters for running belts off and onto pulleys, vacuum cleaners (Chapal system) and various protective devices for printing machines. These latter include: a metal plate covering the spokes of the fly-wheel; a disk fastened to the fly-wheel and covering the head of the key; a copper plate covering the teeth of the large gear; a guard for the gearing of the fly-delivery; a corner iron covering the rack of the ink bed, and a guard for the interior wheel driving the gearing (Figure 5).

The most interesting corner of this same hall of the museum contains a show case where are exhibited, by Dr. Detourbe, on plaster-cast heads, different types of goggles and respirators for protection against dust (Figure 6). There are goggles to be used by railway operators, automobilists, etc., and goggles for use in shops to protect the eyes from explosions, flying particles, dust and light. They are in the form of two irregular truncated cones, the large base being moulded, so to speak, to fit the corresponding parts of the head, and the small base being arranged to carry the glasses. The cavity formed between the eye and the goggles is ventilated by a large number of perforations in the walls, the function of this ventilation being to

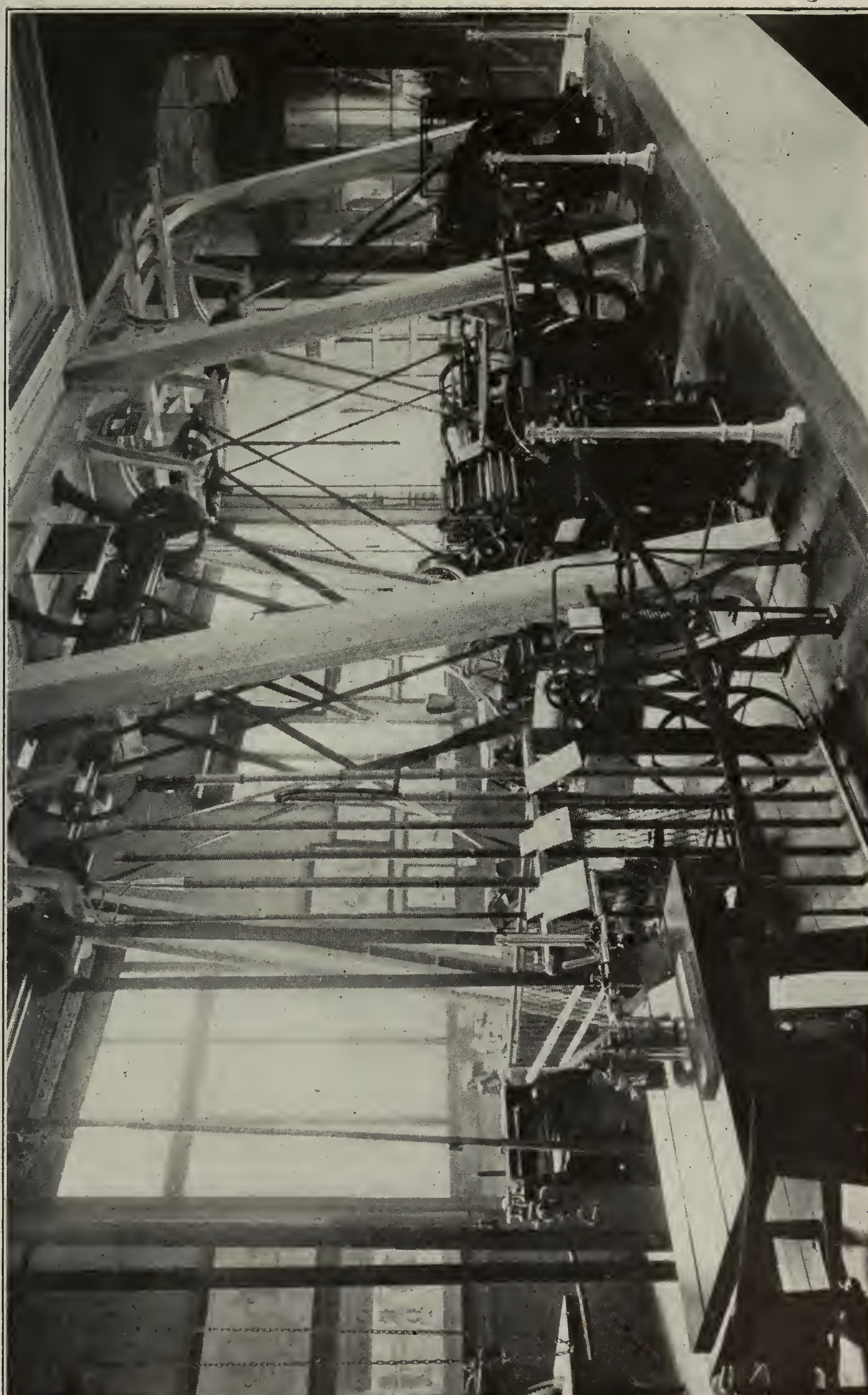


FIG. 5. BELT SHIFTERS AND PROTECTIVE DEVICES FOR PRINTING MACHINERY.

FIG. 6. PROTECTIVE SPECTACLES AND RESPIRATORY APPLIANCES FOR PROTECTION AGAINST DUST, DEVISED BY DR. DÉTOURBE.

protect the eyes from heating, and the glasses from becoming blurred with steam. The two parts are joined by a flexible nose piece which renders the device perfectly adaptable to any shaped face.

Against excessive light, Dr. Detourbe recommends the neutral smoked glasses (showing the natural color of objects). For use on the road, he recommends glasses with a considerable curvature giving an extended field of vision (140 degrees); the glass may be plain or smoked. The space between the face and the glasses is closed in by one of the following methods: strong metallic fabric (goggles for protection against explosions and flying particles); gray linen cloth (goggles for protection against dust); black cloth (goggles for protection against light).

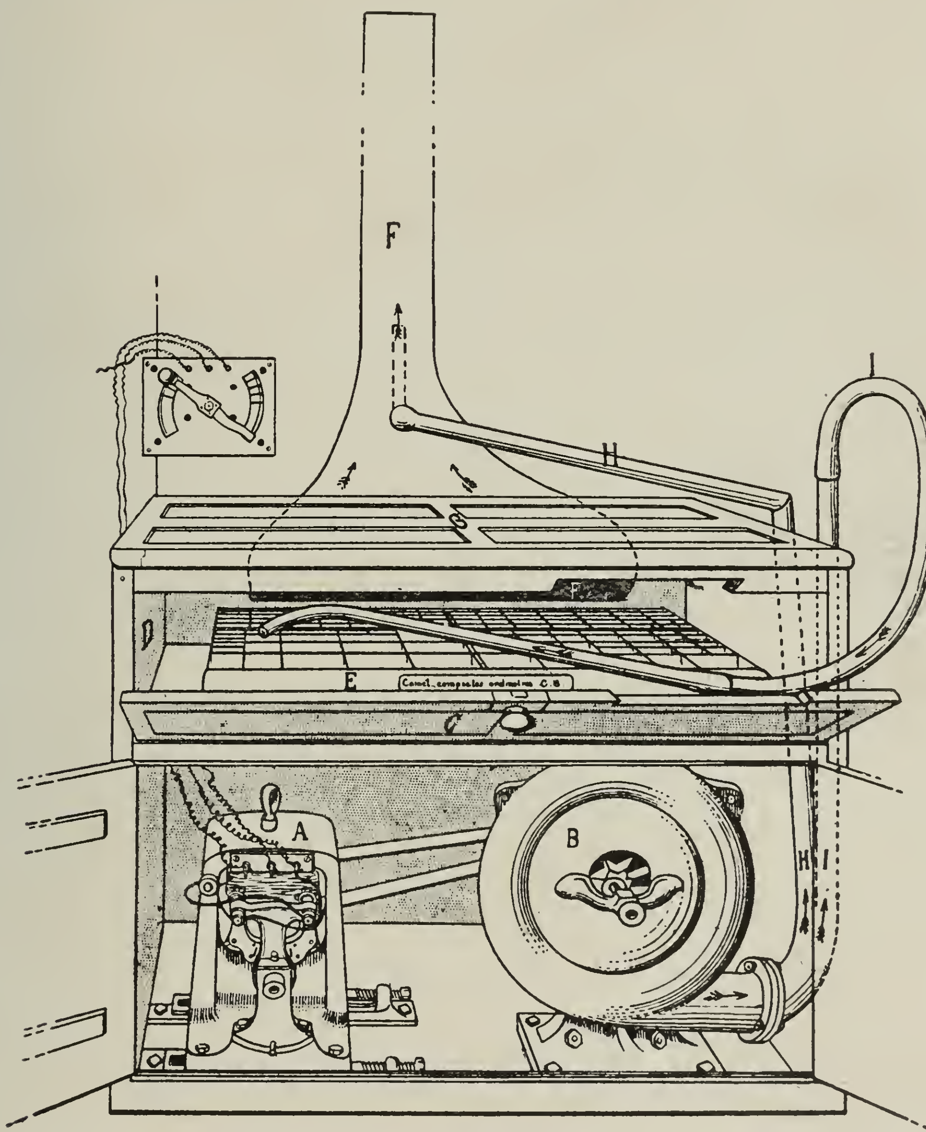


FIG. 7. DELMAS TYPE BLOWER.

The respirator of the same inventor has the form of a truncated pyramid opened at the summit on its lower face and on its upper edge. The opening for respiration and filtration of air is very large. About 5 millimetres in front of this opening is placed a hinged flap, both the opening and the flap being covered by a screen; the space between is filled with a layer of non-absorbent cotton which assures perfect filtration of the air breathed in, and the absolute interception of dust. The base surrounds the nose and the mouth, and is made up of three curves corresponding to the contour of the face on which it is, so to speak, moulded. The air chamber between the nose and the mouth and the filter prevents the heating of the face. It is lined with a woolen stuff impregnated with rubber which does not collect condensation nor become soiled with use. The absence of valves avoids the rapid obstruction of the cotton by dust breathed in. The air breathed out through the cotton presses the dust back toward the outside and cleans the filter. According to the reports of several experts, these breathing devices, which have been constructed of aluminum, or nickel-plated brass, assure a perfect protection and do not in any way inconvenience the workman.

FIG. 8. RESPIRATORY HELMET, PARIS FIRE-DEPARTMENT TYPE, AND PROTECTIVE HELMET FOR SAND-BLASTERS, CASASSA SYSTEM.

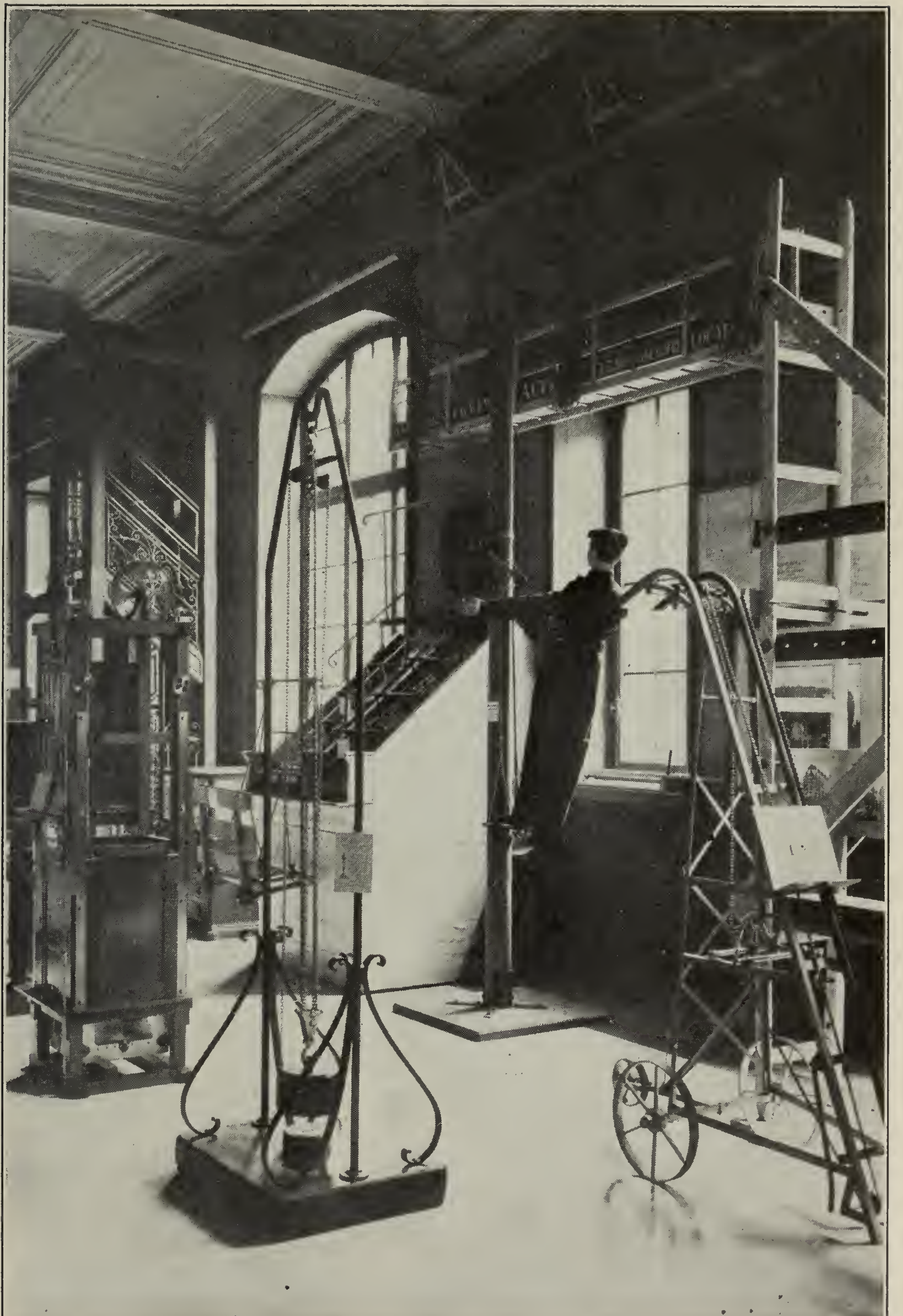


FIG. 9. CHEVENIER SAFETY HOISTS, NUGUE CLIMBING LADDERS, AND SAFETY BELTS FOR ELECTRICIANS, ETC.

FIG. 9 A. GENERAL VIEW OF THE HALL CONTAINING SAFETY HOISTING AND CLIMBING DEVICES, ELECTRIC PROTECTIVE APPARATUS, ETC.
By courtesy of Dr. W. H. Tolman, Director of the American Museum of Safety Devices and Industrial Hygiene.

While speaking of dust, we may describe the type blower of Delmas (Figure 7), the purpose of which is to clean printers' cases in a closed compartment D into which the case E is slid. The ventilating duct F is then closed. A pipe from the blower is placed in the ventilating duct at the right, and the blower started. The dust is then removed to the box and escapes by the hole F, which leads to the ventilating duct F′ which carries the dust to the exterior by suction. In the illustration herewith, the electric motor A drives the ventilator, however, it may be driven by a belt, or a foot pedal. A current of air B forced into the duct F′ produces a suction which removes the dust from the glass compartment. The use of the type blower removes the dust from the cases, thus preventing diseases which result from its absorption.

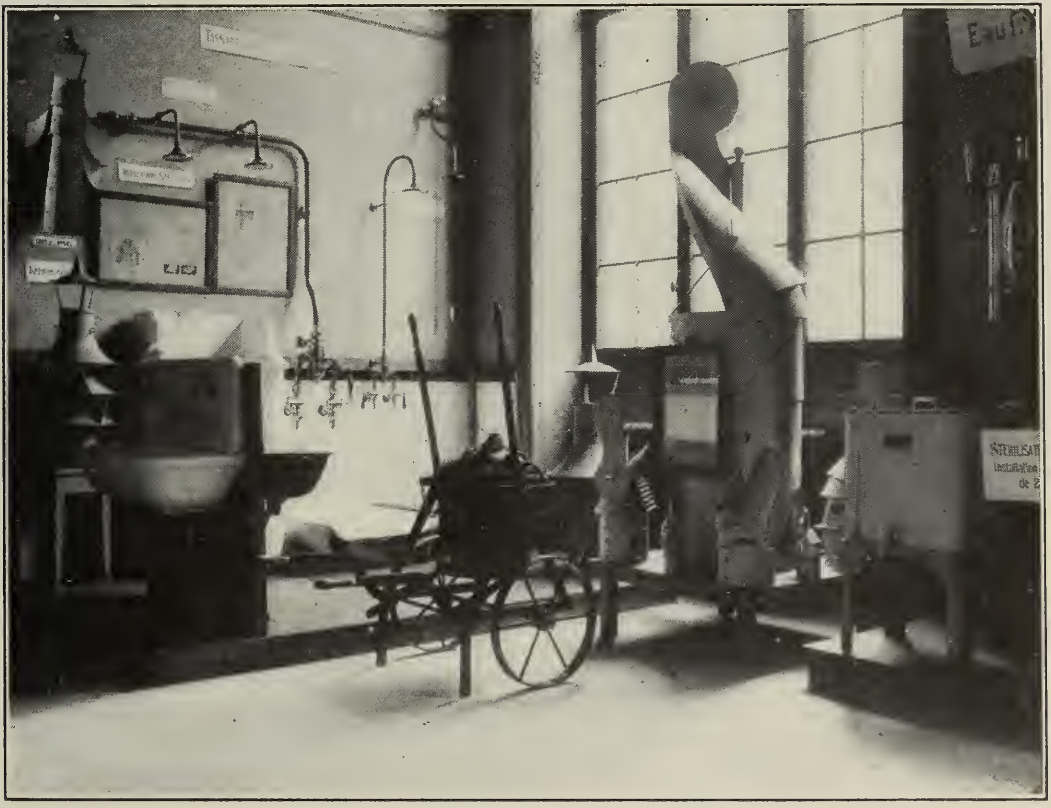


FIG. 10. SWING TOP FOR CHIMNEYS, AND SANITARY INSTALLATIONS.

Along the same line are the breathing helmet, and the helmet for sand-blasters (Figure 8), exhibited by Messrs. Casassa Sons.

In the hall situated at the other end of the museum we find a great assortment of hoisting devices, hoisting blocks, movable ladders, climbing harness for linemen, safety devices for roofers, various models of elevators and protective stair cagings (Figure 9). A little farther on, we meet with rocking devices for emptying carboys, chimney swing tops of the Laferte system for removing smoke, steam and bad odors; numerous washbowls, shower baths, and other sanitary installations (Figure 10).

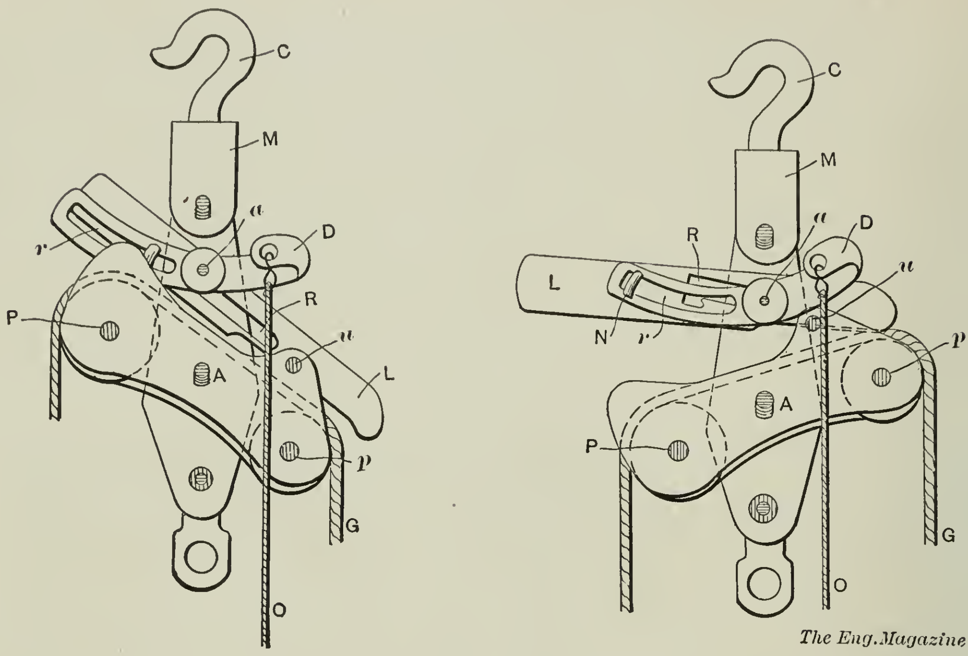


FIG. 11-12. DETAILS OF CHEVENIER HOISTING TACKLE.

A, axis of the block; *a*, axis of release lever; D, release lever; G, hoisting chain; L, clutch lever; O, operating cord of release lever; P, pulley; *p*, roller.

Since it is impossible to describe everything, we will restiict ourselves to some of the most ingenious mechanisms. We will take up first the hoisting block of Chevenier, which stops automatically and which is equipped with a safety release. It is made in ten sizes, for hoisting weights from 50 to 3,000 kilogrammes. The upper block differs from the usual form, in that the pulley over which the chain passes is replaced by a peculiarly shaped block swinging about the axis A (Figure 11). This block carries at one extremity a pulley P, and at the other a roller *p*, over which passes the chain G. A lever L which can be pressed against the roller *p*, grips the chain and thus stops the motion. If one pulls on the chain, the oscillating block tips forward, the lever L releases and allows the chain to move. If the pull on the chain ceases, the block tips back again (Figure 12) and the lever grips the chain with a force the magnitude of which is greater the greater the weight of the load. The lever and the roller having neither grooves nor projections, cannot wear out the chain. Lowering is as simple as hoisting. The clutch lever slides on a pin *a* which serves as an axle for the release lever D. The release lever can only operate when the oscillating block is tipped forward (Figure 11) by the pull on the chain. At this moment, by pulling the small cord O, which is fastened at the extremity of the release lever, the clutch lever is caused to butt against the pin *a*, and prevents the block from swinging backwards. The chain passes freely, and one has simply to let the chain run when lowering the load. To stop quickly, a pull must be exerted on the hoisting chain, which will allow the clutch lever to fall and stop the descent. It is absolutely impossible to lower the load without releasing, and this release can be made while holding the load only by pulling on the hoisting chain. Full load can be stopped when lowering, without shock and with the slightest pull on the hoisting chain.

The climbing harness of Ravasse-Luilier (Figure 13) is intended to prevent falls of linemen, carpenters, roofers, painters, ironworkers, etc. It consists of a broad, strong leather belt A, which the workman fastens around his waist, and a protective device consisting of a leather strap D, on which slides a double ring E. The further end of this strap is provided with a movable snap C, which can be hooked on one of the rings B. The running knot formed about the pole or the tree by the strap, and the ring, prevents the climber from falling. The protection is automatic, rigorous and instantaneous.

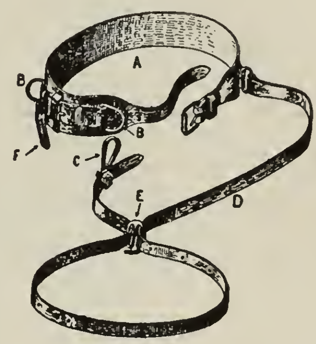


FIG. 13. RAVASSE-LUILIER SAFETY BELT.

The "Société du verre étiré" exhibits some water gauges fitted with automatic valves, and various water-level alarms. The former (Figure 14) resemble the ordinary water gauges. In the lower gauge cock the drain cock carries the small ball which rests in a hollow in the top of the passage. In the upper part of the gauge cock, the passages form a cross which allows a free circulation of water in the glass, and exhausts the steam and water when it is desired to clean the glass. In the passage which connects with the glass, there is reserved a slight hollow in which the ball will place itself whenever the tube explodes, and will stop all loss of water. The upper gauge cock is provided with an air chamber which maintains the ball at rest when the gauge is in proper operation. In front of the ball there is placed a plug provided with passages which allow the steam to pass freely into the glass. However, in case the glass should break, the sudden overbalancing of the pressure would force the ball into the hollow of this plug and effectively prevent the escape of steam.

The gauge protectors, types A and B, the first of which is shown in Figure 15, are designed to protect persons from broken glass, steam and boiling water, in case of explosions and at the same time not interfere with the reading of the glass. The type A consists of a

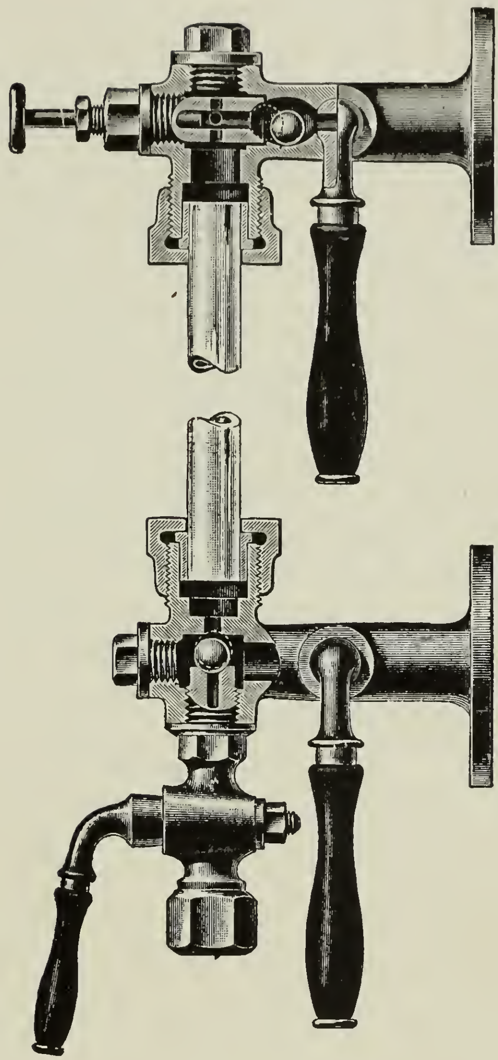


FIG. 14. WATER GAUGE WITH AUTOMATIC SAFETY VALVES.

sheet-steel shield, elliptic in form and enameled, preferably white, with grooves on the edges, in which is placed a protective glass which may be reinforced with wire. At each end of the protector there is fastened a hexagonal collar, which is clamped to the nut at the extremity of the gauge glass. These collars are supported so as to permit easy and positive longitudinal adjustment. In the back of the shell there is a scale made up of squares arranged to form a broken line, which facilitates the reading of the water level. The line of squares observed through the water glass retains its normal appearance in the part visible above the water level, while that which is seen through the water mass appears to be made up of regular horizontal stripes extending entirely across the water glass. If the protective apparatus is used with a non-reinforced glass, the water glass should be enclosed in a coil of steel wire 0.6 millimetres in diameter. It will not interfere in the least with the reading of the level, and in case of explosion of the tube will prevent flying particles from breaking the outside glass. The type B protector is of the same construction as the type A, except that the interior is painted entirely white, the scale which is colored and transparent being on the outside wall of the water glass. The interior of the apparatus being enameled white will reflect light on the water glass, and will show up very clearly the water contained in the glass. The narrow colored scale placed on the back of the water glass will impart a tint to the entire mass of water, while above the water in the empty part of the glass, the scale will appear as a narrow strip.

Finally, in the small intermediate hall of the museum there are found, among other things, six show-cases in which the "Association parisienne des propriétaires d'appareils a vapeur" have brought together a large number of specimens of defective parts of steam boilers illustrating interior corrosion, exterior corrosion, scales, pockets formed by overheating, various kinds of cracks in the shell and in the rivet seams, incrustations, damaged fire tubes and water tubes, etc. This collection is of great interest to practical operators. This is not the first service that the above mentioned society has rendered to the French engineers; their purpose is to prevent accidents and explosions of boilers, and to teach economy in the production and use of steam.

Their means of action consists in maintaining a bureau of inspectors who inspect boilers and auxiliary apparatus; in maintaining a bureau of steam experts who give theoretical and practical advice; in organizing special courses, and otherwise propagating the proper instruction of firemen and steamfitters. They guarantee to members two inspections per year per boiler. One of these inspections, called an internal inspection, which is of capital importance, is made when the boiler is shut down, and after a complete cleaning, the object being to discover faults in the sheets and rivet seams, and in general, all faults which cannot be detected while the boiler is in operation, and which if unnoticed could lead to serious accidents.

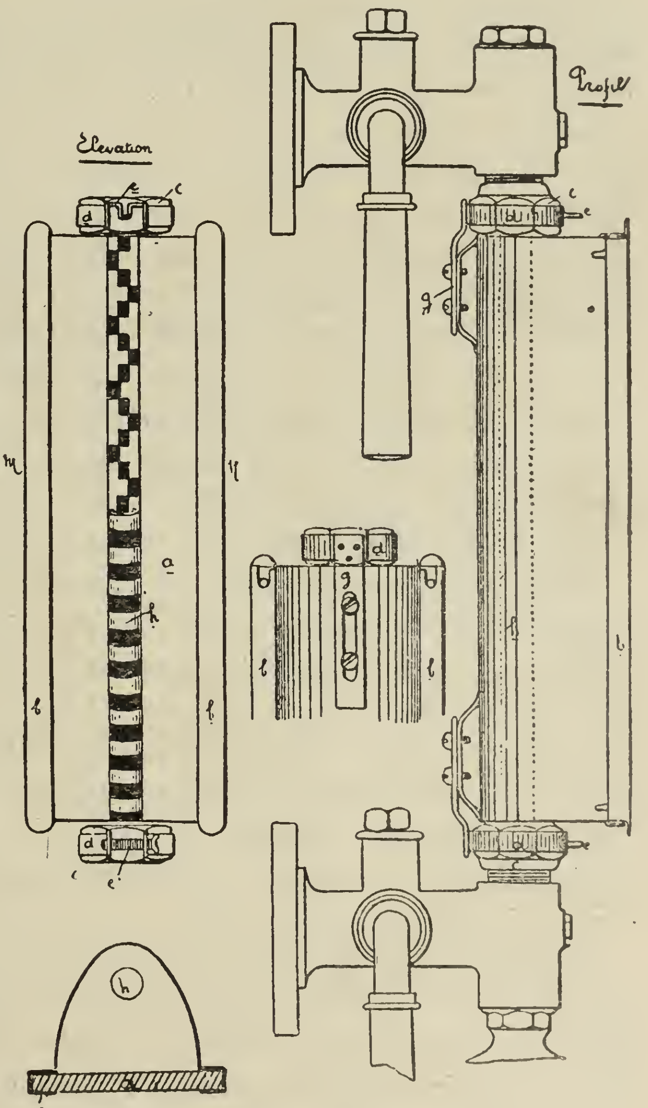


FIG. 15. WATER-GAUGE PROTECTIVE DEVICES.

a, protective glass; *b*, metal shield; *c*, gland; *d*, hexagonal collar; *e*, first mode of attachment; *é*, second mode; *g*, fastening of the protective shield; *h*, water glass.

The other inspection, called the exterior inspection, is made during operation, the object being to test the safety devices, such as gauge glasses, pressure gauges, safety valves, etc.

While the most fastidious precaution, the most vigilant attention, and the most perfect industrial hygiene all act to reduce to a minimum the number and seriousness of accidents, they cannot pretend completely to suppress them, since by definition the accident is the unforeseen. It often happens that in spite of the most perfect care, the injured one, even after the most irreproachable organic reparation, requires a complementary, functional reparation; otherwise, what appears to be a temporary disablement may render him a permanent invalid. These results of accidents which survive the medical or surgical treatment, consist most often in stiffness, leading more or less rapidly to ankylosis, in muscular retraction of tendons and aponeurosis, cicatricial adherences, atrophies, paralyses, deformities, deviations, etc., which according to their duration and their location add to the injury an aggravation often more considerable and always more annoying than the original injury itself. It is the reparation of these functional derangements following accidents, to which has been consecrated one of the most happy applications of mechanical therapy. Mechanical therapy may be described in principle as follows:

1. Exact and precise localization of the exercise or movement of a single organ which needs it to the exclusion of all others.

2. Mathematical dosage of the movement.

Mechanical therapy may be summed up as the localization and dosage of movement by means of an infinite variety of mechanical devices of extreme precision, driven by a motive power external to the patient (passive movement), or by the patient himself (active movement). The "Institut de mécanothérapie de Paris" exhibits a series of devices intended to demonstrate that this method (adopted long ago in other countries, but still new in France) can often heal the injured. The hospital cures the wound, or reduces the fracture, while mechanical therapy adds to the organic cure the functional cure.

Unfortunately we have not space to describe these devices which were invented by the members of the "Institut mécanothérapique de Paris" to achieve these results and which reveal much more of the art of medicine than of the art of the engineer.

In closing this visit to the museum, we may mention the following articles which are exhibited in the same hall: stretchers; boxes containing first aid to the injured; safety lamps for miners; shin protectors; aprons, and breeches for founders.

MAXIMUM PRODUCTION THROUGH ORGANIZATION AND SUPERVISION.

By C. E. Knoeppel.

II. SYSTEMATIC PROCESSING, MACHINING, ASSEMBLY, AND ERECTION.

Mr. Knoeppel's preceding article, published last month, introduced this series with a discussion of the adjustment of internal organization in the factory so that the utmost working efficiency may be secured. Succeeding papers will take up economy in the use of material and time, and the methods which secure better deliveries and more satisfied customers.—THE EDITORS.

A MAN once told me that a manufacturer who was not conducting his affairs in a manner to insure maximum results had absolutely no right to be in business; that he should step down and out and give way to someone who would fully appreciate the possibilities and take every advantage of them—who would leave no stone unturned until a full measure of success was his.

Such a statement might on first thought seem rather startling; in fact, it impressed me to such an extent that I asked a number of manufacturers how they felt toward those who were conducting their business in an unsystematic manner. One replied by saying that he had just been advised that his bid on a large contract had been rejected because of a much lower bid on the part of some other concern; that he was in a position to know that the work could not be made at a profit by his competitor at the price he quoted. He said that he knew how much labor and material the work would take, and as his burden rate was accurate, he knew that his bid was actual cost plus a reasonable margin of profit; but that his competitor got the work and would lose money while he lost the work and an opportunity to make a profit.

Another stated that he had spent considerable time and money in an effort to organize and systematize his business so as to enable him to secure maximum results; that he knew where his losses ceased and his profits began, as well as just what he would have to accomplish in the way of a production; and that he was willing to give to any of his competitors the benefit of this expenditure of time and money, if it would result in a more intelligent competition. While he realized that his competitor who conducts his business in a careless manner is destined either to be forced to put his house in order or go out of business, the fact remained that his business as well as the business of many others was far from being benefited by a competition that could lay absolutely no claim to intelligence.

It is not the purpose of this article to go into a detailed discussion regarding the rights and privileges of a manufacturer, and while it is a fact that he may conduct his business in any old way that he may elect, there being no law against his so doing, there should be some means to prevent him from involving others in the harm that he is bringing upon himself. Should a bank get into financial difficulties, measures are promptly taken not only to look after its affairs but to prevent other banks from becoming involved; but what protection has a manufacturer from those whose "penny-wise, pound-foolish" policies cannot fail to have a detrimental effect upon the whole business structure?

A manufacturer should certainly have no right to stand in his own way or "fool himself" if by so doing he in any way jeopardizes the success of another. Many of the readers of this article no doubt know of instances where small tools and jigs are considered as plant betterments which are charged to assets, when in reality they are items of expense and should be so charged as they have no market value other than as scrap. The result is that if a manufacturer has $5,000 worth of small tools and jigs and he classes them as assets, his resources are in reality $5,000 less than he thinks they are, while his expenses are $5,000 more than his books show; so that he is simply cheating himself. A manufacturer once told me that he did not believe in figuring depreciation into his expenses, and it is fair to assume that if there is one there certainly must be others who incline to the same view. Business men who believe this way certainly cheat themselves with a vengeance, for their books will show false profits by amounts equal to what the depreciation should be, and they either refuse to figure it into their expense because of ignorance—which is inexcusable—or in order to record a better showing then actually made—which is criminal. While foreign to the discussion, it might not be out of place to show *why* depreciation should be figured into the expense account.

A workman, whom we will consider as a machine, is hired and receives wages *after* the work is performed and the business must absorb this expenditure, in order to get at a total cost; the amount being charged as a cost to the particular orders he may work on, if he is a productive worker, or to the proper general expense classification, if he be a non-productive worker. This is conceded by all. Now as regards the machine, let us consider it as being *bought* instead of *hired*, *purchase money* instead of *wages* being turned over *before* the work is performed; the only possible result of this consideration is the conclusion that the business *must* absorb this expenditure also, during the life of the machine. If a manufacturer should hire a man for ten years and agree to pay him $12,000 *in advance*, would he not charge $100 each month against the business? Would he not charge the work performed, if he is a productive worker, with a certain rate when the employee is working, and general expense at the same rate when he is sick? If we then contrast the hiring of a man paid in advance, with the purchase of a machine tool, we have conditions which are the same in both instances, and we must therefore make the business absorb the expense of the tool as in the case of the man, charging the work performed by a rate when the machine is running and general expense when the machine is idle.

The point I desire to emphasize is simply this—*do not stand in your own way*. Conduct your business in the best and most careful manner—do not let a dollar creep into the expense account that should be to your credit in the bank—make your competition what it should be; and while it has been said: "a man always believes more readily that which he prefers to believe," a manufacturer, in the majority of instances, will be more successful if he will simply ask himself the question: "How do I know that I am not getting maximum results?" In his attempt to answer this self-imposed question, he will invariably begin to feel that after all a man is in no position to determine the merits or criticise the value of something about which he knows nothing, and will put aside partiality for his own and prejudice against other methods in order to be in a position to judge intelligently.

Business is conducted for profit and must of necessity be conducted *at* a profit in order to make it impossible for the "receiver" to take over the management of affairs. The margin of profit can be so small as to be easily wiped out through lax and careless methods, while it can never be so great as to make it impossible for the best of management to increase it to a slight degree. The margin of profit, however, depends upon the manufacturer himself, although he cannot accomplish what he desires (and all desire a maximum profit) without depending upon something that will enable him to obtain the greatest amount of efficiency from his workmen and machinery. This something we will call "organization and supervision," for it will be found in the larger industrial plants, where a maximum production is obtained at a minimum cost, that the details regarding organization have received careful consideration from able and high-priced men, and that intelligent supervision occupies a most important place as a result producer.

In analyzing the seemingly complex industrial body, the purpose of which is an output, the measure of success its percent of profit on cost, we find production dependent upon two fundamentals:—

Production	Labor
	Material

Looking still further, we find them subdivided as follows:—

Material	Raw
	Finished.

Labor	Productive
	Non-Productive

We can therefore define our production as being the outcome of a process of evolution of materials from their raw or unfinished state to finished units, through the instrumentality of labor which devotes its entire time to the producing—productive labor—assisted by labor which, while producing nothing, is necessary in order that the product may be processed and marketed most economically—non-productive labor.

We find these units, whether they be refrigerating, saw-mill, electrical, planing-mill, power, starch-making, hoisting, mining or other kind of machines, divided as follows:—

Units	Standard Units	Standard and Special Parts or All Standard Parts	Various Operations
	Special Units	Standard and Special Parts or All Special Parts	Various Operations

Before we can bridge between the operation and the completed unit, the largest proportion of all work must go through two stages of development:—

Machining or processing.

Assembly or erection.

In a small establishment, this machining may be done in one department or, depending upon the size of the business, we may have a department for the lathes, one for the planers, the milling, slotting, etc., may be done by another, the drills may be in one place by themselves, while the laying out of work from drawings may be done by one department, or each department may look after its own laying out.

We have the complete unit which is the outcome of an assembling process, a number of parts being required which have to pass through certain processes of machining, or operations, before being in the proper state for assembly with one another. It is therefore evident that the more the parts that go through the various operations of machining in a given time, the greater the number of completed parts ready for final assembly. Now if we can picture a shop containing two workmen—one to do the machining and another to do the assembling—with a man in charge, and follow two parts, say a forging and a casting, from the forge and stock room to the car, we shall have an example of a supervision of the highest order; for it would be an easy matter for the man in charge to follow the parts, from their receipt as raw material, through the stock room and blacksmith shop, the layout floor, the drills, lathes, etc., thence to the assembly floor, through the process of erection, to the car, keeping in touch with the situation until the parts reached their destination, with the result that they could be produced at a minimum cost as supervision would *force* them through in the shortest possible time. If we could transfer this same degree of efficiency to a large manufacturing establishment, making it a part of a carefully worked out organization, it would not take long before a maximum production would be the result.

If we know something we can apply this knowledge, as the architect through his knowledge of building materials, strengths, etc., can design a sky scraper. If therefore we know all that it is possible to know concerning the various details connected with a manufacturing enterprise, we are in a position to apply this knowledge successfully and with the expectation of obtaining maximum results, *providing* the application is a diligent one; for the success of any undertaking is in proportion to the care with which the many details are looked after. First knowledge, then diligence—organization, then supervision.

In the handling of any work from raw material to finished product, the most important things we must know are:—

The various parts that go to make up a completed unit.

The operations required to make a part complete.

The tools, jigs, etc., necessary to complete an operation.

The condition of the stock of materials necessary to complete a unit.

When the unit is wanted.

Where the parts are during process of construction.

How the work as a whole is progressing.

LIST OF MATERIAL						
DESCRIPTION One D. D. Machine, X Style WANTED April 1st.			FOR Jenkins Manufacturing Company ADDRESS Buffalo, N. Y. MADE UP BY F. L. Smith DATE Jany 1 1907 PRODUCTION ORDER ※ 420 SHEET ※ 1			
SPECIAL INFORMATION Regular testing instructions apply to this order.						
✓	※ PCS	PIECE NUMBER	NAME	DRAWING NUMBER	MAT'L	PRO.ORDER NUMBER
	2	X 420	Arm Brackets	2160	C. I.	420. 1
	5	X 428	Long Arms	2140	Forge	420. 2
	5	X 429	Short Arms	,,	,,	420. 3
	1	B 50	Bed	3100	C. I.	420. 4
	2	A 214	Rods	2000	Steel	420. 5

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FORM I. LIST OF MATERIAL.

In addition to possessing a knowledge concerning the above points, we must have a means of notifying:—

Works Manager, of orders for completed units.
Foremen, of orders for production and assembly of parts.
Workmen, of the work to be done.
Stock Clerk, of material to be delivered and to whom.
Office, where parts in course of construction are.
Works Manager, regarding condition of any order.
Foremen, regarding parts needing special or immediate attention.

HOURS	WGT. OF ALL PCS	COST OF MATERIALS	COST OF LABOR	TOTAL COST

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FORM I. COST DATA SLIP.

Further, we must inform:—

Shipping Clerk, regarding promises of shipments.

Office, when stock needs replenishment or to replace spoiled or rejected work.

Foremen, regarding the time spent on work.

As stated in the previous article, any introduction of methods must be made only after a careful study of the conditions. A manufacturer can no more expect to get results from a system devised to meet conditions other than his own, than a doctor can cure consumption by prescribing cough medicine or a nerve tonic. A number of plants manufacturing the same article will have conditions existing in each that are different from those in all of the others; and while principles may be the same in every instance, application must take into consideration the peculiarities and needs of each case. The aim of this series is to consider fundamental principles of organization and supervision, leaving the matter of application to the manufacturer himself. Certain methods are outlined and if the forms and suggestions meet certain conditions, well and good—if not it should not be a difficult matter to adapt them so that they will.

Units are composed of parts—parts take operations—operations as a rule require small tools, jigs, etc., and in order to facilitate processing from raw materials to finished product, detailed information concerning them is important as well as complete knowledge concerning condition of materials.

Regarding the various parts that go to make a completed unit, it must be known how many of each are wanted, their names, the number of the pattern and the drawing number, the kind of material, and the order number of each part. For this purpose a "list of material," patterned after Form 1 could be used to advantage; it should contain every item that enters into the construction of the completed unit, for the information of not only the office but the shops, and for future reference in case of repairs, etc. A check column has been provided for, the purpose of which will be explained later. To the right of the list and slightly separated from it is a form with five columns to be used for recording cost data pertaining to the various parts. The lists for the drawing room and the various shop departments are printed as shown on page 232, while the list to be used by the office and Cost Departments has the added slip shown on page 233 with the extra columns joined to the main sheet so as to make a complete list. In inserting the sheets into the typewriter—and they should be typewritten—the one for the office can be placed on the bottom with the extra part turned under. If the typewriter has a wide carriage, however, the sheet or slip for the cost department may be inserted as

PART CARD			
Name of part *Bracket*		Number of part *x 43*	
Number of Drawing *2140*		Material *C.I.*	
For what used *#1156 Machines*		Weight *250*	
Tools and jigs *#3 and #40*			
OPERATIONS			
1	*Layout*		
2	*Drill*		
3	*Plane*		
4	*Bore*		
			The Eng. Magazine

FORM 2. DETAILED RECORD OF PARTS AND OPERATIONS.

shown. For standard machines, it would be well to have the lists printed so as to save the work of typewriting.

It is also necessary to have a detailed record of the parts and operations, Form 2, which should show the name of the part, its pattern number, its drawing number, material, for what machine or machines used, its weight, the dies and jigs it takes, and the number and name of the operations. A complete record of parts is of value to any manufacturer in addition to his pattern record, for while the pattern record cards would be filed by consecutive numbers, the part

TOOLS AND JIGS			
Number	*40*	Name and description	
	Clamping Rig		
When made	*8/12/05*	For part	*x 43*
Operation	*Bore*	For job	*#2140*
Material	*C.I.*	Weight	*25#*
Where stored	*Shelf #30*	In use	*Yes*
Remarks			*The Eng. Magazine*

FORM 3. CLASSIFICATION OF TOOLS AND JIGS.

card would be filed numerically by machines, thus giving a cross reference.

In order to facilitate the work in the shops, a means should be provided for recording the tools, jigs, etc., necessary for part operations. A place should be provided for these rigs and they should be kept in their places when not in use in the shops. Many an hour has been lost by a man in looking for a certain jig with which to complete an order or operation; but by properly classifying them as shown in Form 3, it will be known what they are for and where they can be found, this knowledge going a long way toward saving considerable time in the course of a year.

After we have arranged for the proper handling and classification of details relating to units, parts, operations and tools, the next consideration of importance is a knowledge concerning the materials on hand. It seems strange that this department of a business should be as carelessly handled as it so often is, for it is a fact that will admit of no argument that there are many manufacturers who while they may have machine departments systematized to a high degree, have stock departments that are most slovenly managed. It will be found in such cases that stocks are arranged in anything but a logical order, a dozen pieces of the same part likely to be found in as many places —no one can tell whether a part is in stock or not without searching for it—the quantity of a certain kind of stock on hand can only be ascertained by counting each time—guess work is the only means of determining the amount used in a given time—work is often held up

RECORD OF FINISHED PARTS IN STOCK

ARTICLE	WHERE KEPT	MIN. TO BE CARRIED	
Guide Arm	*Bin # 18*	MAX. TO BE CARRIED	*15*

Note: MIN. TO BE CARRIED: *5*

DRAWING #	PIECE #	MATERIAL	WEIGHT
3040	*X 540*	*Steel*	*25 #*

RECEIVED				DELIVERED				BALANCE		DELIVERED				BALANCE		VALUE	
DATE	FROM WHOM	ORDER NO.	AMOUNT	DATE	TO WHOM	AMOUNT RESERV'D	AMOUNT DELIV'D	BEFORE DELIVE'Y	AFTER DELIVE'Y	DATE	TO WHOM	AMOUNT RESERV'D	AMOUNT DELIV'D	BEFORE DELIVE'Y	AFTER DELIVE'Y	@	AMOUNT
5/30	M. Dept.	2140	20	6/2	3020		2		18								
				6/3	3440		4		14								
				6/4	2160		4		10								
				6/7	1650		6		4								
				6/8	1830		1		3								
6/10	M. Dept.	2350	20						23								
				6/15	3321		4		19							1.00	19 00

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FORM 4. RECORD OF DATA CONCERNING MATERIALS IN STOCK.

because it was *thought* that the necessary stock was on hand—anyone can take what is wanted without an order or even recording the withdrawal—there is no check against tying money up in excess stock, and absolutely no protection against theft, waste, or mislaying of materials.

It would be hard, in fact, an impossible task to explain why a manufacturer will use the care he does in looking after his cash on hand and in bank, only to show an almost utter lack of concern when money is transferred into material. He would almost have heart failure if anyone would ask him for a dollar with the stipulation that no entry was to be made on the books, and he would not consider such a thing for a moment. On the other hand, so careful is he, that if only a quarter's worth of stamps are purchased, he sees to it that cash is credited and expense charged for the outlay. If he buys $100 worth of material, merchandise or whatever the account may be named is charged, and the person from whom the material was purchased is credited; but how this material is used, when it is used, or where, receives but little of his consideration. If a dollar in the office is guarded with the care that it is, a piece of brass in the stock room, costing and worth a dollar, should receive the same degree of attention; and a workman should have no more right to take this piece of brass from stock without accounting for it than he would have the right to walk into the office and remove a dollar from the cash drawer.

Material is a heavy item to the majority of manufacturers, and it is of the utmost importance that no more material be carried than the requirements of the business call for; it is an easy matter to lose the earning power of considerable money by placing it in stock that is not needed. It should be the duty of a competent person, familiar with the details of the business, to establish a maximum and minimum allowance covering every kind of material used, for the guidance not only of the purchasing department but of the shops as well. This will keep the materials within proper limits, which will mean a considerable saving to any manufacturer. If in conjunction with this we know when stock is disbursed and the purpose for which it is used, we can, if we know what is purchased, easily determine balances on hand, which can be checked against the allowances.

Materials should *not* be given out under any circumstances except by the authority of a written order; and if the proper persons are held responsible, it will be found that the stock department will count for something in the accomplishment of maximum results, for it will be known what is in stock and the quantity; purchases can be made to advantage; overstocking will be prevented; it will be known which lines are moving in a satisfactory way and which are not; responsibility will be fixed; workmen will find it a hard matter to remove material with authority to do so; mislaid and wasted materials can be traced to those responsible—and in fact, all the important facts concerning matérials will be known. Form 4 is shown as affording a means for recording all data concerning materials in stock, the entries fully explaining the method.

Knowledge is power. The most successful surgeon is he who has made the most careful study of the human body—its bones, muscles, nerves—and the most successful manufacturer is he who has made the most careful study of the industrial body—its basic elements, its anatomy, the analysis of its forces, the proper handling of its detail. It is naturally this kind of a manufacturer who realizes his ambition —maximum production.

ENGINEERING ORGANIZATION IN THE BUILDING OF INDUSTRIAL PLANTS.

By Frederic W. Bailey.

The efficiency of systems of organization in industry depends to a large extent on the arrangement of plant for continuous and harmonious working, and a body of literature is being accumulated on the design and construction of industrial plants second only in importance to that of profit-making management. Mr. Bailey's discussion of engineering organization for the purpose of design and construction, however, covers in an admirable manner, a feature seldom touched upon. Without the slightest appearance of special pleading for the contracting engineer, he contends that industrial plants can be designed and built more rapidly, more cheaply, and with more certainty of efficiency of operation by a firm of general contracting engineers than by an engineering staff superimposed upon an operating organization and subjected to the limitations inherent in the aims and principles of the latter. Mr. Bailey has seen large works executed under both systems, and knows at first hand of the conditions which he describes.—The Editors.

MUCH has been written of late years concerning shop methods and systems of organization for specialized engineering work; but little is heard of systems of organization for general engineering work. It is often a cause of comment that firms of mechanical engineers and contractors who have no shops of their own and who, therefore, manufacture nothing of themselves, are so frequently called upon to design, build, and equip industrial plants for manufacturing companies. An industrial company must acquire in time a vast amount of information concerning the best design and equipment of plants to suit its particular requirements, which no purely engineering company could be expected to have. Why is it then that engineering companies are called upon to produce industrial plants for operating companies?

It is the purpose of this paper to show that engineering companies, because of their superior organization for this class of work, by using the information and experience of the industrial companies and by following the industrial companies' wishes as to what the finished plants should be, are able to turn over to the industrial companies more satisfactory plants at a less cost than the industrial companies are likely to build for themselves. It is also the purpose to show that, because of the characteristic organization of an industrial company and the consequent training of employees, it is improbable that an industrial company will do general engineering work on a large scale with wholly satisfactory results unless it appropriates for the work the engineering company's system of organization.

Let us follow the growth of a firm of mechanical engineers and contractors (mechanical engineers because the ultimate aim is a certain mechanical equipment) and note the organization which it builds up to do its work; remembering that every order or contract which it executes is for a shop, mill, factory, or power house which in many respects differs from every other shop, mill, factory, or power house in existence; and that this class of engineering work is, therefore, a purely made-to-order one.

Suppose that a mechanical engineer starts out for himself, in a small way, to design and construct industrial plants. We will say that he gets a small contract. He hires a draftsman, a stenographer and clerk, and a good all-around construction man. The engineer will watch over and instruct the draftsman, will attend to the correspondence in connection with the purchase and delivery of materials and equipment, will also look after the inspection of such material, and will keep a general oversight of and direct the field work. Soon, perhaps, the duties become too great for the engineer and he gets an assistant who chases up the odds and ends of detail in connection with the different branches of the work.

After this contract is finished, let us suppose that the engineer gets two additional contracts. He will then take charge of one himself and put the assistant in charge of the other, keeping a general supervision over him. As time goes on, let us suppose that his business increases and he has several engineers working for him, each of whom is in charge of a separate contract, while he has the general oversight of them all.

Now we have a general engineering organization. The drafting room is under a foreman, who details men to work for the various engineers as their requirements demand. He keeps general track of what each draftsman is doing, and while he has no regular authority in matters of design, he is of great assistance to the engineers because of his knowledge of the design of all the company's work. While this foreman is wholly subservient to the engineers in matters of design, he is supreme in the drafting room in matters of discipline, record, and methods of doing drafting work. The cost of making drawings is always under the foreman's scrutiny.

A construction superintendent, like a draftsman, is working, first for one engineer on one contract, and then for another engineer on another contract. These construction men are hired by the chief engineer and report to him after the close of a job, when they are turned over to other engineers and go onto other jobs. Each construction man, therefore, so far as the contract he is working on is concerned, is working for the engineer in charge of that contract. All his correspondence is with that engineer and all his instructions are received from that engineer.

The clerical work of such a company is handled by one general department. An engineer having carried on the preliminary correspondence and having decided what material or equipment he wishes to purchase, sends a requisition to the order clerk stating exactly what the material is, from whom the material is to be bought, what the price is to be, where and when it is to be shipped, and to what contract and division of contract it is to be charged. The order clerk or head of the order department has no authority over the purchase of material, but simply sees to the making out of the official orders as instructed by the various engineers. He has, however, complete authority in the management of his own work and can demand from engineers compliance with his rules for the systematic running of his department. He is unofficially of great assistance to the engineers because of his familiarity with dealers and prices. Various branches of the clerical department take charge of the checking of bills (after material has been inspected and approved by the engineer or his erecting man) and the auditing, paying, and charging of the same for all the contracts on the company's books.

This, then, is an organization built around the engineer; making him as free as if he were working for himself, but giving him every assistance that is possible. The engineer has just two persons to look to, the chief engineer and the customer. This organization is perfectly elastic. If enough engineers can be developed or hired, it can take care of twice or ten times the volume of work without any confusion.

When a contract is to be let, the chief engineer and the engineer whom he designates look the ground over, get what information they can, and the engineer proceeds to make a detailed estimate. This estimate is subdivided in such a way that it will be useful not only during construction but also as a matter of record in making subsequent estimates. The estimate is approved by the chief engineer and upon it a proposal is made. If the bid is successful, the engineer starts to work on the contract with the estimate always before him so that he can be sure at any time of just where he stands as regards costs.

Specialization of course, is made use of in such an organization. If an engineer is successful in building one class of plants he is usually kept at that class of work. There will also be architects, structural engineers, and electrical engineers. Each of these men will take charge of his own work, including designing, purchasing, and erection on a number of contracts; but on each contract under the supervision of the engineer for that particular contract. Thus a structural engineer will be in consultation with, and receiving instructions from, one engineer on one contract and another engineer on another contract. As an instance of the use of specialists with such a concern, the case may be cited of a firm of engineers who were building many railroad repair shops and who took into their employ a railroad master mechanic to choose and arrange the equipment for these shops.

The general engineer watches over the draftsmen assigned to him to see that his designs are being put through. He is watching over the specialists to see that all is in harmony. He is shopping around buying material or equipment not ordered by any specialist. He is in constant touch with the erecting force, receiving and scrutinizing their daily letters and reports, writing letters of direction, and frequently spending a day or two on the job. Every complaint or delay is reported directly to him and he is in touch with and responsible for every bit of the work. The engineer is, of course, frequently in consultation with the chief engineer, and he keeps constantly in touch with the representatives of the company for whom the work is being done.

A draftsman for such an engineering company differs radically from a draftsman with a machine company. In an engine shop, for instance, the draftsman is also a designer. When once the general design of an engine has been settled, he works perhaps for weeks without much supervision, getting out the drawings. With the engineering company the draftsman is a draftsman pure and simple; merely an intelligent medium for putting another's ideas on paper—merely an engineering book keeper. He is watched over daily, and perhaps hourly, by the engineer and the foreman. All plans are discussed over the draftsman's board by the engineer and foreman, and frequently by the chief engineer and the customer. In detailing a given machine there are a certain number and sort of drawings that must be got out for the shop and they cannot be varied greatly. In detailing an industrial plant there are an infinite number of drawings that can be made, all costing real money, and it is for the engineer and foreman to decide just what drawings should be made to insure proper construction on the one hand, and drafting-room economy on the other. To get these results it is necessary that there should be constant supervision by some one having an intimate knowledge of the conditions under which equipment is to be purchased and under which construction work is to be carried on.

With such an engineering company young technical graduates usually spend a year or so in the drafting room, a year or two on construction work, and after this they return to the office as assistants to engineers. These assistants are recruited from such men and from exceptionally capable draftsmen and construction men. An assistant engineer looks after any and all details to which the engineer on a certain contract may assign him. Eventually, if an assistant develops properly, he is put in charge of a contract for himself and becomes a full engineer.

Let us now look at the operating organization of an industrial company, remembering that the work is always repetition and the product is hundreds, or thousands, of articles of a few similar varieties, or else tons upon tons of the same product. We no longer (as a general practice) buy articles for household or commercial use made just as we might specify them, but we buy from stock the articles which come nearest to filling our requirements. Most industrial plants, therefore, turn out a ready-made product.

The whole scheme of an industrial company's operating organization is based on specialization. Every step in the process of producing a certain given article is performed by a separate department knowing its own work thoroughly, but, perhaps, knowing comparatively little about the work of other departments. Take, for instance, a machine company. Here, besides the general office force, there will be the purchasing department, the selling department, the drafting room, the pattern shop, the foundry, the machine shop, the erecting shop, and the shipping department. Any such specialized system of organization is of gradual growth. Such a system represents the result of years of thought and the experience of many men as to the most economical way of performing the same series of operations over and over again. Such an operating organization is a rigid machine, made up of various human beings and machines bound together in such a way that it turns out its own peculiar product economically; but it is utterly unadapted, without changes, to turning out any other product.

The foremen and superintendents in any industrial plant have for their chief aim the keeping up of the quantity and quality of their product, each in his own department. The general system of the plant has been carefully worked out and the lines of demarkation between the different departments are rigidly drawn and the heads of the different departments have very little leeway. If every condition is ideal and every workman knows what to do and does it, there is very little for the heads of departments to do. It is because conditions are never ideal that these men have plenty to do. These men are, therefore, emergency men. If things go wrong, they must know what to do and act quickly, but otherwise the work is mainly routine.

The men at the head of such industrial organizations, while they have a broad knowledge of their own business, have, perhaps, comparatively little knowledge of other businesses. They have, perhaps, risen from positions as heads of departments and the principles of specialization have been drilled into them from their youth up.

Suppose that an industrial company decides to organize its own engineering force and do its own engineering in connection with the enlargement of an existing plant or the building of a new one. In the first place, the heads of the company doubtless believe that theirs is the most difficult of all businesses to manage, and having managed theirs successfully, they can manage any successfully. In the second place they have the operator's contempt for engineers and for engineering. As a successful manager once said: "Almost anyone can build a plant, but the difficult thing is to operate it." Engineering to them is a necessary evil. It is not a source of profit, but rather of loss. It is a sort of heathen god which must be propitiated before a plant can be put in operation.

Such a company has done more or less building and rearranging in the past. At first it was done perhaps with their regular repair workmen, with no plans and just verbal instructions. It is surprising what good work has been done, perhaps is being done, with no drawings. Later, perhaps, such a company employed an architect who made general plans of the buildings which were built by contractors; but there are many gaps between an architect's plans and a finished industrial plant, and so finally the company decides to have its own engineering force to do this sort of work.

As such a concern knows what it wants in the way of plants, is skilled in management and organization, all that it needs is skilled workmen in the various branches of engineering and it is ready to do business. Designers and draftsmen will be got to prepare drawings; business men with some knowledge of engineering to buy material; construction men to erect the work. I have seen a manufacturing company starting in business, having acquired an old plant, begin, as if by instinct, to form these three distinct departments when they began to enlarge and reconstruct their plant.

To show how improbable it is that an industrial company will use any but a department system in their engineering organization, just think what would happen if it were suggested to the head of such a company that engineers be allowed to purchase their own material. Immediately his mind would turn to similar conditions in the plant. He would see foremen and superintendents corresponding with various concerns and buying brooms, waste, oil, and the various other mill supplies from different concerns. He would see endless confusion and inefficiency, and would instantly reject the proposal, saying that as the purchasing department bought all supplies for the plant it should buy all supplies for engineering.

At first when the volume of work is comparatively small, this department organization does very well. The heads of the designing and purchasing department and, if the work is near at hand, of the construction department, are all close together and all are in touch with the management. No very definite rules are laid down; there is a good deal of freedom of action; each is familiar with the work of the others and they get along very nicely.

When the volume of the work increases the difficulties increase in a greater ratio. The several departments become more separated from each other and communication between them becomes more and more laborious. Each takes a certain share of the work as decided by arbitrary rules. When errors or misunderstandings occur it is a slow, tedious process to trace the records in one department and another so they may be corrected.

The drawing room makes drawings without being in touch with the actual field conditions or with all the conditions under which material and equipment are purchased. Draftsmen often take infinite pains to detail work when the detailing is absolutely unnecessary, and leave undetailed work, which if detailed would save much labor in erection. The purchasing department often buys material without having a very clear idea of what the drawing room is planning, or what the actual field requirements are. While such a purchasing department can buy material like cement, sand, stone, brick, lumber, bolts, or random-length pipe advantageously, equipment like boilers, engines, generators, motors, structural work, and conveyors could be bought more satisfactorily by an engineer who knew just how he was going to arrange such apparatus and how, where, and when he was going to erect it. The purchasing department attends to all correspondence and all information from the outside world must come through it. If an arrangement of machinery, manufactured by outside concerns, is being made in the drawing room and this arrangement makes it necessary or desirable that the designs of the machines be slightly modified, such a purchasing department becomes an absolute nuisance. Correspondence carried on through such a third party which does not appreciate fully the conditions of the case and does not fully realize the necessity for the interchange of absolutely accurate information, is most unsatisfactory and entails great wastes of time and money.

Delays are frequent, as each department waits for another to act. The whole force loses initiative. A system of order forms, report forms, and rubber stamps is inaugurated and added to till it becomes most complex. Things do not move quickly or smoothly; and this is attributed to lack of system, and the remedy given is red tape. In an operating organization the system represents years of thought as to how one train of operations should best be done. With this engineering organization the attempt is made to devise a system which will perform any series of operations. In other words, the attempt is made to devise a system which will think.

Obviously there must be some system of direction and control of such an organization. This may be accomplished by periodical conferences between the heads of the different departments and the heads of the operating organization. Greater and greater reliance is placed on these conferences and discussions to thrash out every detail of the work. Since no department in engineering is in a position (nor is it trained) to take charge of every phase of any job, the engineering force must depend on these conferences for instructions. Since the heads of the operating organization wish to control the engineering as far as possible, they desire that every detail should be brought to these conferences. An operating organization is accustomed to these conferences and discussions, from the practice of holding daily foremen's meetings. While a discussion is going on at a foreman's meeting the plant is running full tilt; but while a similar conference is held on engineering, everything under discussion is at a standstill. In a foreman's meeting of an industrial organization, a very trivial thing may be discussed to advantage because, when repeated (as it will be) a great number of times, this repetition makes it an important thing. In engineering there is no such general repetition, and details will sometimes be discussed in these engineering conferences which are ridiculously trivial. These conferences gradually become the designing medium. While designing with a firm of engineers is a constructive process, designing here becomes a destructive process. Acceptable designs are got by a process of elimination, by sending back to the drawing room drawings which are not acceptable, so that eventually one that is acceptable may be produced.

It is up to no one person on each job to think out the sequence of events for that particular job. Some parts of the work are finished quickly, and are of no practical value until other forgotten work is done. The men in the various departments have too narrow a vision to see the whole work in perspective and to judge of the relative importance of the different parts; nor are men of operative training likely to see it. If a steam-engine designer is getting out a new engine, he spends weeks over the general arrangement of the machine. He works out the correlation of all the parts on paper and in his mind before he begins detailing any of them. In this form of engineering organization, the tendency is to flit mentally from one end of the plant to the other, getting out this detail and then that detail, and these details may be more or less duplicates of one another. An enormous quantity of drawings may be made, but when it comes time for erection a good deal of redesigning is necessary to make things fit together in the field.

To the engineer with an engineering company, each problem resembles, in a general way, a mathematical problem. For a satisfactory solution he must first take into consideration the general conditions imposed. There are certain fixed constants which must remain fixed; there are certain variables which may vary within certain limits. With a clear understanding of the conditions, the engineer tries to get at the best solution for the particular case at hand, and having control of every part of the work he can thoroughly appreciate the limitations. Under the department system, the lack of training, experience, or power of control precludes any one person from stating and solving a problem as an engineer does, and the usual procedure is to cut and try until a fairly satisfactory result is arrived at.

If such an industrial company is enlarging its plant and already has a repair shop and repair mechanics, there is a chance for added inefficiency. It is very easy to get in the habit of making this and making that thing in the repair shop, although as good or better articles could be bought in the open market at a lower cost. The repair shop is fitted to do any job of repairs which emergency may bring to it; but it cannot be expected to do any one class of work as cheaply as a highly specialized shop, which is fitted to do that class of work alone.

One of the great factors which develops the foresight of engineers, and has developed the art of making drawings, with engineering and contracting companies, is the rise in the rate of pay of construction mechanics due largely to the unions. Every effort is made by an engineering company, by means of detailed drawings and by so ordering material to arrange that as much work as possible is done in specialized contract shops, so that as little labor as possible will be needed in the field. When plenty of low-priced mechanics are at hand, however, these economies are often not made use of. Although cheaper in rate of pay, it is not possible to push repair mechanics as construction mechanics are pushed on contract work, and industrial companies frequently cannot do work as cheaply, in spite of their lower priced workmen, as contractors can.

The training of men in the various departments is of necessity narrow and there is very little opportunity for them to shift from one department to another. Few of these men are likely to be technical graduates, for the reason that the heads of such a concern will consider a bright young technical man much too valuable to waste on engineering. Such a man may work for a year or so in the drawing room, but after that he is usually transferred to the operating side of the business.

Such an engineering organization as has been described is sure to produce jealousies between the different departments. Each feels in its heart that it is the most important department. The men in the drafting room are now designing engineers. In the purchasing department the men are purchasing engineers, and in the construction department they are now construction engineers. There could be designing electrical engineers, or purchasing mechanical engineers, and why not checking engineers or blue-printing engineers, since the titles only show how little of the real engineer's work each one does?

To show what jealousies may arise from the division of engineering work among a number of special departments where authority interlaps, let us take the example of the United States Navy. The Washington correspondent of the New York *Times* in a despatch describing a dispute between two of the bureaus in the Navy, dated December 26, 1907, says: "It (the dispute) shows two of the seven bureaus engaged in a bitter struggle for more power, each forgetting the real interests of the service in striving to expand its own, at the very time that it alleges the real interests of the service as the motive for its action. . . . . Everywhere they went the congressmen (investigating committee) found work tied up by conflicting orders from different bureaus. . . . . Each bureau had its own men on the ground to see that the strategy of their chiefs in Washington was fully carried out." While the organization of even the engineering side of the United States Navy is a much more complicated problem than that of an industrial company's engineering force, yet the two have some points in common. Both try to produce a made-to-order product with highly specialized departments which interlap as regards authority and neither has to show a profit directly.

The cost of engineering with such a system as has been described runs up enormously, although one of the original reasons for the organization of the force may have been to cut out the profits of engineering and contracting companies. Estimates are perhaps made for the sake of getting appropriations, but the value of making accurate estimates, carefully subdivided, before any work is begun, of keeping within these estimates during the progress of the work, and of carefully filing away the results of such work for a basis for future estimating, is usually lost sight of. Worst of all, there is no competition in such engineering. There is no rival to underbid, and so there is no basis of comparison with the cost of outside engineering work. The tendency is always toward more expensive construction though the returns may not warrant the extra expenditure. The dollar sign has been removed, and of all the signs and symbols used in engineering it is the most important. Take away the question:—"Will it pay?" from engineering, and reason and control are gone. It is like removing the governor from an engine. The engine will go, but where will it stop?

Such a system, of course, will eventually hang itself. Plants will finally cost so much to build that they cannot be operated at the profit which competitors make. Finally, perhaps upon the consolidation of several plants, a broader view of specialization will come to those in control, and it will be seen that true economy lies in letting engineers build the plants, while operators confine themselves to operating them.

Perhaps now an engineering company will be called in; but if the industrial company cannot or will not do this, it will at any rate follow the engineer's system of organization. Either by incorporating a subsidiary engineering company, or by other means, engineering will be put on a level with operating and so separated that it can show its own profit. The engineering work will be in charge of engineers who have been trained to do good work at a profit. Such men will respect the expert knowledge of the operating men as to what the finished work should be, but will refuse absolutely to let operators say how this result shall be attained. They will realize the value of repair shops and repair workmen to do repair work, but will carefully avoid them on construction work. Best of all, such engineers will see that the separate-department system is wiped out and that a system of doing made-to-order work in a made-to-order way is inaugurated.

This whole problem of engineering organization has had its counterpart in hundreds of lines of manufacture. In old times the shoemaker took the measure of a person's feet and from the raw material produced a pair of shoes. If business increased, a number of workmen did the same thing; each worked on a distinct pair of shoes. When someone discovered that human feet and human tastes could be standardized, machines were invented, factories built, and now one workman performs just one operation on thousands of shoes.

When we can order our electric railways, power houses, mills, factories, and machine shops from such and such a page in a catalogue, to be shipped from stock, knocked down, with all parts carefully numbered and accompanied by printed instructions so anyone can erect—then, and not till then, will the highly specialized, ready-made organization supersede, in general engineering, the present efficient made-to-order form of organization.

OBTAINING ACTUAL KNOWLEDGE OF THE COST OF PRODUCTION.

By F. E. Webner.

I. WHAT CONSTITUTES A KNOWLEDGE OF COSTS.

Mr. Webner's series beginning this month will extend through six parts. The successive topics will be: When and where a close knowledge of costs is needed, dealing with ordinary weaknesses and their disclosure; comparisons of costs and the profitable use thereof, treating largely of the overcoming of weaknesses in economy of manufacture; the use and abuse of mechanical aids in cost finding, discussing such appliances as directly as possible without exploiting any particular product; the organization of a cost department, covering the fitness of the men needed and the apportionment of the clerical work; and cost records as a constituent element of the general accounting plan, bringing out the opportunity and the means for accomplishing the desired end without top-heaviness. The articles are characterized throughout by freshness of viewpoint and originality of treatment. The authority of their writer needs no restatement.—The Editors.

HUMAN nature enters very largely into all phases of business practice and is a factor of no mean importance to be considered when dealing with either hypothetical or physical conditions of a factory proposition. Among his associates outside of his office the manager of a modern (or even a more or less ancient) plant will swell with pride as he relates the results of efficiency tests made of his machinery, his engines, his boilers, his fire-protection equipment—the high quality and values of his raw material and finished product. Of his personal possessions he will oftentimes expatiate, and frequently exaggerate as to values; though with no intention to boast it will be made to appear as though his motor car were absolutely peerless; his horses' veins coursing with the bluest of blue blood; the interior decorations of his house more costly than the usual run of houses in his class, etc.

These feelings of satisfaction and pride often expressed tend to exaggerate true conditions in the mind of the manager, to a point where he unconsciously believes the magnified impressions to be facts and would dispute the accuracy of figures in a statement showing otherwise. That is the result of an optimistic view of conditions more often experienced when the morning mail brings remittances and the afternoon mail brings orders. The roseate hue fades to a considerably less brilliance when the tax assessor's list is left for the listing of possessions and affixing of values.

To the salesman of accounting devices or advice, the average manufacturer will declare in good faith that he is possessed of a close knowledge of his affairs, and particularly of the cost of his product; one manufacturer may say that he contracts for his raw material on an annual basis and that therefore material prices do not fluctuate with him; that he employs his shop hands altogether on a piece-work basis and therefore knows his labor cost in its minutiæ, and that his overhead expense is quite readily distributed over product on a given percentage of labor cost. Another manufacturer may say that his records are kept so that his material, labor, and expense respectively are known for each department of his plant, and that estimates can be made of the individual articles of product coming from such department. A third manufacturer will say that he has a specialty or by some manner or means enjoys a condition of affairs wherein competiton is practically eliminated, and that while he knows he is making money he is satisfied with results as they are and does not need to know his costs any closer than he already knows them. Again, manufacturers have been heard to say that conditions and costs are known to them, but a greater source of worry is the inability to increase the volume of product without materially increasing the investment in plant account. And so the arguments run; many of the manufacturers may have equipped their office with every good accounting idea which has come under their notice and yet they are in many things away wide of the mark. Human nature prompts the manager to refute any insinuation that his plans are not of the best, and yet in the inner councils of his staff oftentimes there are shortcomings brought to an apparent existence, but their exact location and remedying is a puzzle which for the moment puts the existing accounting plans in the same category as the tangible assets when considered on a tax-appraisal basis, and exactly the same question is considered, namely: of how much real value are they?

While the assessor is on hand to aid in affixing high values to the assets, the manufacturer must alone be the final judge as to the value of his accounting plan.

A cost system which has as its ultimate aim and object the disclosure of the fact that a certain unit of production cost a certain amount of money, may serve a more or less valuable purpose; but primarily the cost of installation and maintenance of such a system is an item of expense. A cost system which has as its ultimate aim and object the disclosure of data showing *why* the unit of production cost what it did will serve as valuable a purpose as the management may choose to make it, and the first cost of such a system might well be classed as an asset rather than an expense and its upkeep will far more than pay for itself.

A good cost system is a tool for cutting down costs, and like other tools it must be kept in good condition to insure a high degree of efficiency. That manufacturer who is satisfied with his results as they are, who perchance is in the class whose product is a practical monopoly, sees no crying need for a cost system; his money is made not in manufacturing, but in the wide margin of exaggerated profit accruing to him by reason of prestige brought about by invulnerable patent rights or purchased friendship. Such a concern is gunning for eagles, so to speak, and not for sparrows; and the savings brought about by means of a more or less intricate cost system make it appear too hard work to make money by mere manufacturing processes. As a matter of fact, such a concern might, in the majority of cases, "farm out" its work to a closely watched factory at a considerably less cost than its own cost of production.

Where material, labor and expense costs are applied synthetically against a department as a whole, and not against individual shop order numbers, close costs are not obtained even though the sum of the various estimates may exactly absorb the totals in each cost element; there is no means of proving that some orders are not over-estimated and others under-estimated—in short, it is the application of the law of averages and nothing more. In the use of the law of averages in that manner the material element is the most easily determined, inasmuch as the exact amount of material in the unit can be measured and the exact amount of waste material can be determined by inventory processes; the cost of the element of labor is more or less of an *ignis fatuus*—it seems to be located but it isn't; here the human-nature element of the employee is to be dealt with, and here very often lies the difference between profit and loss in individual shop orders. I believe that workmen as a rule are honest, or at least that they think they are and mean to be, and yet every manufacturer knows the shortcomings of certain classes of individuals in the great labor army.

The man who holds back his output for a certain effect; the rapid but not careful man who makes mistakes which may or may not be discovered; the clock watcher who refrains from taking up the next job for the reason that some time in the near future the whistle might happen to blow; the "soldier" who is exceedingly deliberate in his actions and who makes frequent and prolonged visits to the toilet room; the putterer who fusses with his machine much longer than necessary—are all familiar to the manufacturer, as are a number of other classes not necessary to enumerate. Men of undesirable characteristics are naturally weeded out as fast as possible, yet no factory has a force which is the height of perfection—every factory needs a superintendent and foreman, and unfortunately these worthies are often found to have, besides the qualifications which commend them, certain undesirable features such as are at times found in the workmen. It is a well-known fact that two different foremen, with the same force of men and the same conditions, can produce widely different volumes of output and efficiency, and both foremen have the respect and friendship of the men and the management and in neither case can the foremen nor the men be considered more or less dishonest in intent than in the other case.

While corporations are characterized as soulless, yet oftentimes pensioners are found in factories where in truth their absence would do more toward dividend making than their presence; these pensioners may be in positions anywhere from the top down, but whatever the cause or effect may be in any of the foregoing, the cost is undisputedly there, and while an effective cost system may disclose startling facts the cost system *per se* cannot correct them.

On the estimate plan the labor cost on a given shop order is estimated either at about what length of time the various operations ought to take, or time is kept by or for the men, usually under conditions that are not normal; that is to say, the men knowing that they are for the time being watched will naturally "hit 'er up" at a livelier pace than is usual with them. In this connection the thought comes to my mind of a factory in New England where lot order numbers followed seriatim through a number of different departments; about once a week a so-called test was made which really was but a farce, as it was no fair test at all; for when the edict issued that a certain order number was to be a "test" the word was quickly passed along the line to all concerned and all possible preparation was made to speed the work through with as little delay as possible.

In cases where employees make out time reports each day and actual starting time and finishing time is not recorded, but where the employee apportions whatever time he chooses to the individual jobs on which he worked, such time reports are little better than the guesses which the foreman himself might make; such reports usually omit any reference to dead time between jobs, time spent on cleaning machines, shut down of power, spoiled work done over, etc. In cases of this kind it is within the province of the employee, and it is quite human nature, to equalize the report as much as possible, and he does not consider himself dishonest in so doing. Labor means the expenditure of cash and is therefore equivalent to cash, yet the average management draws more strict lines on the cash records than on the labor records. A close knowledge of costs of production hinges in a very large degree upon the accuracy of the labor reports and records, and in that connection piece-workers are identical with time workers in that the maximum capacity of the factory is not reached unless all workers are making the very best possible use of the facilities at hand. With two piece workers getting the same labor price per unit, superficially it would appear that the product of each cost the same; this, however, is not so if one does more than the other—the work of the slower one would have to absorb more burden than the work of the faster one.

The element which gives the most real worry in accurate cost finding is manufacturing expense, which includes fixed charges of various kinds, non-productive labor and other direct charges, also reserves for depreciation, repairs and renewals of plant and machinery, and numerous items under what has been called "invisible expense." It is not the purpose of this article to treat with the various and several items which make up manufacturing expense, but merely to touch upon that phase of it which has to do with diffusing such expense over product. The formerly practiced plan of spreading the expense burden over product on a percentage of material or labor costs is as absolutely wrong in theory as is the child's idea that a pound of lead weighs more than a pound of feathers. The cost of material and labor, either jointly or separately, bears no relationship whatever to the amount of expense to be distributed; and the only point about either material or labor that does affect expense is the amount of time consumed by labor in accomplishing the desired end.

Primarily, manufacturing expense for a calendar month or four-week period should be equitably segregated over the various departments of the plant, then in turn the expense of each department segregated over each machine and bench in the department, and the expense on each machine or bench divided by the number of working hours in the month to find the cost per hour. Every job done on a given machine should stand a charge or rental, so to speak, of the actual time such machine was used. Dead time of the machine should be charged against a reserve account and finally find its way back into the diffusion process as a cost like the cost of a workman's dead time.

For those factories or shops where the finer division of cost elements is a new venture, what is known as the "departmental man hour" will be adequate and come fairly near the truth. Into the total amount of manufacturing or overhead expense is divided the total number of productive hours in the department for the calendar month or four-week period, thus obtaining a constant per hour, which is applied to every job done in the department by multiplying the constant by the number of hours consumed, thus obtaining a just and fair burden.

If the starting time and finishing time is required on every job then facts are known and not guesses. There are many good devices on the market for recording time, and although the first cost may seem heavy, the installation should include enough machines so that the workmen need not consume more than forty seconds to register and return to work. By the aid of modern machines the elapsed time and money value of the tickets can be computed and printed in one operation by a bright boy at a small cost.

All the information regarding time is likely to be of no actual benefit unless it is made use of by means of comparisons of time consumed, costs involved, dead time, non-productive, etc. It is not necessary for the foreman to handle these time reports, and perhaps it is better that he does not, as they are going to tell many things, some of which more than likely will reflect upon the foreman more than on the workmen. In these cards are hidden the secrets of cutting down costs by raising the efficiency of workmen, increasing the volume of output without the installation of additional machinery, and in short getting the maximum in results with the minimum cost.

EDITORIAL COMMENT

Efficiency in Manufacturing.

IT has been frequently remarked that the electrical industry does not suffer in the same degree as others from conditions of general depression. The reason lies in the fact that though large power or traction undertakings may lag, the introduction of smaller applications of electric driving is stimulated by the sudden awakening of a demand for better economy in manufacturing. The electric motor for group (or still better, individual) operation of tools or machines affords opportunities which demand realization, and the enlargement of such uses thus makes a concrete, visible measure of the attention that owners and managers are giving not merely to turning out product in maximum quantities, but to finishing it at minimum cost.

A time of recession in business is indeed emphatically the best time of all for progression in efficiency. Extravagances which were unnoticed or which were necessary when the works were running at high pressure now become evident and call for cure. Wasteful methods that could not be changed during the rush of an overcrowded season can be replaced by economical ones without seriously disturbing the routine of work on hand. Machines known to be in bad condition and costly to run, but impossible to spare when the plant was overloaded, may be laid off and remodeled or replaced by new. Improvements in power plant, transmission, or special applications are not only feasible but imperative, if they will save money and increase the percentage of net earnings.

With the purpose of making such a lull as exists serviceable for the greatest ultimate profit, THE ENGINEERING MAGAZINE will devote much attention during the next few months to demonstrations of the best means for securing high efficiency in production. The discussion will cover betterment of mechanical plant as well as organization and methods. It will be thoroughly practical, concrete, and specific. The profitable activity of introducing improvements will afford stimulus to encouragement. Its reflex demand upon the great manufacturing industries for improved equipment will of itself be the very best introduction to an era of fuller employment, which waits only upon a little pioneer courage and the support of mutual confidence.

The Museum of Safety Devices.

M. BOYER'S article elsewhere in this issue supplements a group of papers in which we have reviewed some of the most important features of the movement abroad for safeguarding and insuring workmen against injuries incident to their occupation. Heretofore it has been necessary to go to Europe for tangible demonstrations, influential toward positive action, such as the museum of the Conservatoire. It is so no longer. The American Museum of Safety Devices, opened in New York in April, is the hopeful starting point of a better order of things in the humane administration of American industries. From this one we may build to match Europe's ten, if the courage and broad vision of the founders meet such response and support as their effort deserves.

Of the extent and interest of the collection we shall have more to say later in an illustrated article. Our immediate object is to recommend most earnestly the examination of the Museum and its purposes. Necessity limits the present plans to a brief exposition of the exhibits as now assembled. It would be greatly to the credit—and to the material interests—of American manufacturers to assure a foundation upon which the institution could be permanently established. The signs are plain that changes in the laws of employers' liability are in progress. By intelligent co-operation of all factors involved, these changes may be made wisely and to an end immensely helpful to the stability and the total economy of manufacturing, transportation, and commercial operations. A museum of this character is the natural focus for such co-operation. Its permanent organization may be made the safe governor and balance of the entire movement. Here is the answer to the problems of liability and of insurance which owners and managers may soon find more numerous and more urgent than they are now.

Conditions in the Shop.

THE comment upon American industrial conditions, by a New England machinist, which we published last month, was one of those peculiarly human revelations that arrest even a roving attention. Whether or not the listener agreed with the doctrine, he felt that a man was speaking and he stopped to hear what was said. We have received a number of inquiries and letters referring to the short article, and one reply in particular from another shop-man which we shall put before our readers next month. Like our New England correspondent, this critic grew up at the bench and on the foundry floor. Like him also, he is of the type that preserves the spirit of the old guilds—the spirit that puts mastery of one's craft as the highest ideal of the workman. From the viewpoint of a superintendent, in another part of the country, however, he forms a different idea of the influences working upon the American apprentice or the young journeyman, and especially of the proportion in which they affect his aims and his conduct. This view shall speak for itself next month.

The Apprenticeship System.

IN this connection it is most interesting to note the extension of a realizing sense that employers must take a larger part in the education and training of the new generation of workmen. Unionism, however justifiable its theory, has dwarfed its aims to the attempt to make the workman *get* more—not to make him *worth* more. The attempts to raise the pay of labor by the operation of economic laws, instead of in defiance of them, have come from outside the unions and have generally met with their violent opposition. It seems that the initiative in sane development of so vital a matter as the trade-teaching of novices must also come from the side of the employer.

When we first took up the topic in these pages, it must be admitted the response from manufacturers was not encouraging. It appealed strongly to a select few, and was greeted with scant patience by the many. Education, however, has been rapid. As indicating the advance in one of the most important of our national activities, our attention is called to the novel feature of an exhibit by the committee on the apprenticeship system, which is to form part of the railway Master Mechanics' Convention at Atlantic City. "It is expected," says the announcement, "that all the railroads operating apprentice schools will send models, drawings, and photographs to show in a comprehensive manner the rapid advancement which is being made in this phase of railroad activity." The Central Railroad of New Jersey, the Grand Trunk, the New York Central lines and the Santa Fe have already consented to exhibit. A good strong lump of the leaven of improvement here!

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE LIVE-STEAM FEED-WATER HEATER.

A DISCUSSION OF OUR PRESENT KNOWLEDGE OF THE PHENOMENA OF STEAM GENERATION AND THE UTILITY OF THE LIVE-STEAM HEATER.

The Engineer.

A PAPER read before the Institution of Mechanical Engineers on February 21, giving particulars and results of a test of a live-steam feed-water heater, has brought the unsettled question of the economy of live-steam heating again into prominence in the technical press of Great Britain. The experimenters, Prof. Goodman and Mr. D. R. Maclachlan of the University of Leeds, found that the evaporative efficiency of the boiler was entirely unaffected by the use of such a heater. This result is hailed by *The Mechanical Engineer* as a conclusive proof that the claims made on behalf of live-steam heating are entirely fallacious. To *The Engineer*, however, the result proves nothing beyond the inadequacy of our knowledge of the physics of steam generation to explain the many complex problems connected with the latter. Extracts from the extremely interesting editorial comments of *The Engineer* are given below. They have an additional interest for readers of THE ENGINEERING MAGAZINE if read in connection with the discussion of feed water heating which has run through the preceding and the present number.

"Professor Goodman and Mr. Maclachlan, approaching their subject with perfect impartiality, and, as far as possible denuding their minds of preconceived ideas, arrived at the conclusion that no increase in either the economy or efficiency of a boiler is to be had from the use of a live steam feed-water heater. Under the stated conditions of trial it did neither good nor harm; and on theoretical, limited grounds, this is just what was to be expected. Leaving loss by radiation and conduction out of consideration, water heated by steam taken from the boiler being fed can only return to the boiler heat already taken from it in the form of steam. If the feed-water contains 1000 units of heat imparted to it in the heater, then the boiler has paid for these units. There is, of course, no getting away from this truth. The results recorded in the paper are therefore perfectly consonant with theory. So far, live steam heating is no good.

"On the other hand, however, we have a fact the existence of which is equally certain. Dozens, if not hundreds, of live steam feed-water heaters are in regular use in steamships. They have been in use for about twenty years. They are much liked; the sale of them continues, and they are estimated to reduce the consumption of coal by from 7 to 12 per cent. Nor is this all. The boilers make more steam; the ships make quicker voyages; and there is an all-round benefit conferred by a small apparatus, which, as we have seen, is theoretically wrong. How are these facts to be reconciled? How is the consistence of theory with practice to be made good?

"As the gain cannot be found in the feed-water heater itself, we must search for it in the boiler. Here we enter an unknown land. The process of boiling water is so common, so freely carried on, so constantly before our eyes, that familiarity has bred contempt, and it has been quietly assumed that it is a very simple thing, presenting no physical problems, and truly not worth much examination. Those, however, who have gone a little further into the matter understand that the nature of the processes by which a plate of metal is heated, heat is passed through the plate, taken up by water, and converts the water into steam, are not really comprehended at all, probably because they have never yet received adequate attention from competent physicists. We, of course, cannot pretend to do more here than direct attention to the existence of ignorance due to lack of interest in the subject. Some inquiry has been made, it is right to add, and this inquiry has resulted in presenting problems of such interest that we can only wonder that the phenomena of ebullition, evaporation, and condensation have so long been ignored by those who are racking the universe to extract Nature's secrets.

"If we turn to any physical text-book we shall find figures setting forth the rate of conduction through copper or iron or any other metal, expressed in terms of the number of thermal units which will pass through a square foot of heating surface in any unit of time. From this we learn that copper is a much better material for boiler plates than iron; that the thinner the plate the more rapid the transmission of heat; and the colder the water, the greater being the 'thermal head,' the more rapid will be the flow. Now, so far as the operation of a steam boiler is concerned, every one of these propositions is wrong. The transfer of heat has only the most remote connection with the material of the plate; thus the copper fire-box of a locomotive is not in any way better than a steel box. A plate of either metal ½ inch thick is just as efficient and as economical as one ¼ inch thick; and, lastly, careful experiments made by the late Sir Frederick Bramwell and Mr. William Anderson independently at different times, showed that the transfer of heat proceeded about five times as fast when the water was boiling as when it was cold. Peclet demonstrated nearly fifty years ago that the conducting powers of a plate are so much greater under all circumstances than the absorbing and emitting powers of the surfaces of the plate that conduction may be left out of consideration. It can in no way affect the performance of any practicable boiler. It may be shown, indeed, that if we have two cast iron pots, one about an eighth of an inch and the other an inch thick, they will both produce the same quantity of steam in the same time. The fire side of the thicker pot will, however, become much hotter than that of the thin pot. But the conditions, of course, have no parallel in steam boiler practice.

"What then takes place inside a boiler? To obtain information experiments have been made by fitting glass ends to large model boilers, or glazed sight holes to real boilers. It is true that in neither case can much pressure be carried, but there is no reason to think that the pressure bears any relation to the mode of generation. Under all conditions steam is produced in much the same way. It comes off 'centres' in the plates. There is never, under any circumstances, a generation of steam all over a plate. Furthermore, the points of production may be very few. We have seen vast quantities of steam rising from two points only in the crown of a furnace tube. Every student who has boiled water in a glass flask knows that points in the shape of some roughness are required if he wants water to boil quietly, and when dealing with solutions to avoid 'bumping.'

"But what does this paucity of ebullition centres, the fact that scores of horse-powers may be sent away from areas not larger than a sixpence, involve? What is the nature and method of transfer of energy from the still—that is to say unboiling—water to that which is boiling? The most delicate thermometers can detect no difference in temperature, and yet violent ebullition goes on in one place and none at all elsewhere in the mass of water in the boiler. So far there has never been any satisfactory explanation of the phenomena of ebullition advanced. If we understood the whole process, and the nature of the heat transfers going on between the various portions of water inside the boiler, we would have advanced at least a step to the knowledge of why hot feed-water should make a boiler more efficient than cold feed-water.

"Leaving now the mere abstract aspect of our subject, let us consider whether there is not some practical way in which we may explain the efficiency of the live steam feed-water heater. It is evident that if a steam generator contains nothing but water hot enough to boil, the whole of the heat supplied to that water must be employed in the production of steam. It is at once converted into latent heat, or, to be strictly accurate, that form of molecular energy known as heat disappears, and is replaced by another form of thermal energy in the shape of steam. It is clear, therefore, that under these conditions the boiler ought to produce more steam than it would if employed in heating up cold water to the boiling point. But of the extra quantity of steam so produced a certain proportion will be expended in heating the feed-water. Ostensibly the entire weight of extra steam available ought to be used up in this operation. If, however, the boiler is more efficient as a boiler than it would be as a feed-water heater, then there will be a distinct gain; and it is easy to see that in that case the gain will be not only in quantity but in economy. Because it goes without saying that the greater the efficiency of a boiler, other things being equal, the greater must be its economy. It is indisputable that so far as heating water is concerned, mixing it directly with steam represents the most efficient and economical system possible, no transfer through plates taking place. In so far there is a distinct gain in that the process of heating the feed-water by live steam is more efficient and economical than that of raising its temperature by transferring heat through the boiler plates. As regards the conversion of the water into steam there is apparently, judging from the experiments to which we have already referred, an advantage to be gained by bringing only boiling hot water in contact with the plates; and, lastly, it is not impossible that the circulation in a boiler into which no cold water is put will be much better than that in a boiler within which large bodies of water may exist at a low temperature.

"If, now, we take it for granted, for the sake of argument, that an economical advantage of 10 per cent. is secured in any boiler, then there must be an equivalent reduction in the quantity of heat wasted up the chimney. It is for this reason that Professor Goodman and Mr. Maclachlan took so much trouble with the products of combustion during the heater trials they carried out. It was on the figures tabulated in their paper concerning the temperatures and characteristics of these gases that the discussion of their paper principally turned. The fact that the Leeds experiments showed no gain from the use of a heater, while experience on an infinitely larger scale at sea shows that there is a gain, tends to teach that there is something about the construction of a boiler which may determine the value or the reverse of the heater. We must not close our eyes or ears to evidence, but consider it with care, and endeavour with patience to fit our facts together, and, it may be, reconcile apparently insuperable contradictions. Thus, to mention one point, it may well be that in one type of boiler the circulation is so good that nothing is to be gained by heating the feed to boiling point, while in another it may be so bad that anything which will encourage it or accelerate it may be of use.

"To sum up, it may be stated as a fact that a large body of shipowners and marine engine builders have for many years used the live steam feed-water heater on some system, and these shrewd business men would be very unlikely to use it if they gained nothing. On the other hand, it does not admit of question that there is nothing to be gained directly by live steam heating. To reconcile the obvious contradiction, we must assume that something not understood goes on inside the boiler. Unfortunately we are here launched on a sea of conjecture, because no one at present knows what steam is, or the way in which it comes into being. Thus, it is by no means certain that water can be heated at all, the heat which we feel being that of steam diffused through it, a theory which will, of course, apply to every other substance capable of assuming three states, the moment it has passed the critical stage and becomes a liquid. Precisely what takes place inside a boiler, then, being unknown, all that can be said is that it is quite impossible to prove that live steam heating cannot be used to advantage, while there is a great deal of evidence that it can."

GASOLINE AND ALCOHOL AS MOTOR FUELS

A SUMMARY OF THE RESULTS OF ELABORATE TESTS ON THE RELATIVE VALUE OF GASOLINE AND ALCOHOL AS PRODUCERS OF POWER.

Bulletin of the United States Geological Survey.

A SERIES of tests on the relative value of gasoline and alcohol as producers of power, of more than ordinary interest and importance, has been concluded recently by the Technologic Branch of the United States Geological Survey. Investigations on this subject have not been lacking but the value of their results has been limited, in most cases, both by the small scale on which they were conducted and the restriction of the inquiry which they were designed to cover, and by an almost universal failure to take into consideration all the numerous and varied conditions influencing engine performance. The tests made by the Geological Survey, over two thousand in number, with the original research work which they have entailed, represent probably the most extensive and exact investigation of the kind ever carried out and their results present the most complete and exact body of information available concerning the operation and design of gasoline and alcohol engines. Below is given a summary of the results in regard to the comparative fuel consumption of 73 degrees B. gasoline and commercial completely denatured alcohol, per unit of power, taken from an advance report of the Survey.

Correspondingly well designed alcohol and gasoline engines when running under the most advantageous conditions for each, will consume equal volumes of the fuel for which they are designed. This statement is based on the results of many tests made under the most favorable practical conditions that could be obtained for the size and type of engines and fuel used. An average of the minimum fuel consumption values thus obtained, gives a like figure of eight-tenths of a pint per hour per brake horse power for gasoline and alcohol.

Considering that the heat value of a gallon of the denatured alcohol is only a little over six-tenths that of a gallon of the gasoline, this result of equal fuel consumption by volume for gasoline and alcohol engines probably represents the best comparative value that can be obtained for alcohol at the present time, as is also indicated by Continental practice. Though the possibility of obtaining this condition in practice here has been thoroughly demonstrated at the Government Fuel-Testing Plant, it yet remains with the engine manufacturers to make the "equal fuel consumption by volume" a commercial basis of comparison.

The gasoline engines that were used in these tests are representative of the standard American stationary engine types, rating at 10 to 15 horse power, at speeds of from 250 to 300 revolutions per minute, while the alcohol engines were of similar construction and identical in size with the gasoline engines.

The air was not preheated for the above tests on alcohol and gasoline, and the engines were equipped with the ordinary types of constant-level suction lift and constant-level pressure-spray carburetters. Many special tests with air preheated to various temperatures up to 250° Fahrenheit, and tests with special carburetters were made, but no beneficial effects traceable to better carburation were found when the engines were handled under the special test conditions, including constant speed and best load.

The commercial completely denatured alcohol referred to is 100 parts ethyl alcohol plus 10 parts methyl alcohol plus one-half of one part benzol and corresponds very closely to 94 per cent. by volume or 91 per cent. by weight ethyl alcohol (grain alcohol). No detrimental effects on the cylinder walls and valves of the engines were found from the use of this denatured alcohol. The lowest consumption values were obtained with the highest compression that it was found practicable to use; which compression for the denatured alcohol ranged from 150 to 180 pounds per square inch above atmosphere.

Eighty per cent. alcohol (alcohol and water). for use in engines of the present types would have to sell for at least 15 per cent. less per gallon than the denatured alcohol in order to compete with it. The minimum consumption values in gallons per hour per brake horse power for 80 per cent. alcohol is approximately 17.5 per cent. greater than for the denatured alcohol used or for gasoline. A series of tests made with alcohol of various percentages by volume ranging from 94 per cent. to 50 per cent. showed that the minimum consumption values in gallons per hour per brake horse power increased a little more rapidly than the alcohol decreased in percentage of pure alcohol. That is, the thermal efficiency decreased with the decrease in percentage of pure alcohol. This decrease in thermal efficiency or increase in consumption referred to pure alcohol is, however, comparatively slight from 100 per cent. alcohol down to about 80 per cent. alcohol. Within these limits it may be neglected in making the calculations necessary to compare the minimum consumption values for tests with different percentages of alcohol.

The nearer the alcohol is to pure, the greater the maximum horse power of the engine. The per cent. reduction in maximum horse power for 80 per cent. alcohol as compared with that for denatured alcohol used was less than 1 per cent., but the starting and regulating difficulties are appreciably increased.

With suitable compression, mixtures of gasoline and alcohol vapors (double carburetters) gave thermal efficiencies ranging between that for gasoline (maximum 22.2 per cent.) and that for alcohol (maximum 34.6 per cent.) but in no case were they higher than that for alcohol. The above thermal efficiencies are calculated from the brake horse power and the low calorific value of the fuel, which for the gasoline was 19,100 British thermal units per pound and for the denatured alcohol was 10,500 British thermal units per pound.

As has been previously published, alcohol can be used with more or less satisfaction in stationary and marine gasoline engines and these gasoline engines will use from one and one-half to twice as much alcohol as gasoline when operating under the same conditions. The possibilities, however, of altering the ordinary gasoline engine as required to obtain the best economies with alcohol are very limited; for the amount that the compression can be raised without entirely redesigning the cylinder head and valve arrangement is ordinarily not sufficient, nor are the gasoline engines usually built heavy enough to stand the maximum explosive pressures, which often reach 600 and 700 pounds per square inch. With the increase in weight for the same sized engine designed to use alcohol instead of gasoline, comes an increase in maximum horse power of a little over 35 per cent. so that its weight per horse power need not be greater than that of the gasoline engine and probably will be less.

The work was taken up to investigate the characteristic action of fuels used in internal combustion engines with a detailed study of the action of each fuel (gasoline and alcohol) as governed by the many variable conditions of engine manipulation, design and equipment.

These variables were isolated, so far as possible; their separate and combined effects were determined; worked out under practical operating conditions; and lead up to the conditions required for minimum fuel consumption. The results show the saving that can be obtained over conditions for maximum consumption, and also establish a definite basis of comparison under conditions most favorable to each fuel. This latter is a point of much commercial interest and a study of the comparative action of gasoline and alcohol may be of great service in solving some of the general internal-combustion engine problems where other than liquid fuels are used.

THE INSURANCE OF ELECTRICAL MACHINERY.

A DESCRIPTION OF THE ORGANIZATION AND METHODS OF COMPANIES FOR THE INSURANCE OF ELECTRICAL MACHINERY IN GREAT BRITAIN.

William R. Bowker—Cassier's Magazine.

WITHIN recent years the field of companies engaged in boiler and engine accident insurance in Great Britain has been extended to cover electrical machinery, with fairly satisfactory results to the insured and with a considerable financial profit to the companies themselves. The organization and methods of the companies engaged in this business are described in an article by Mr. William R. Bowker in *Cassier's Magazine* for March, from which the following extracts are taken.

The bulk of the business is in the hands of three companies with headquarters in Manchester. At one time these companies suffered severely from competition one with the others but finally an agreement was reached among them which established a uniform rate tariff and eliminated rate cutting. Besides the insurance of electrical plants these firms do an extensive business in the insurance of boilers, engines, gas producers, etc., employers' liability insurance, and consulting and inspection work. Their clients include power users in a great variety of industries and they insure installations of all sizes from the smallest motor drive to the largest central station.

"The three insurance companies mentioned are organized with a board of directors, a chief engineer, who also acts as general manager, a consulting department with a head engineer, assistant engineers and draughtsmen and an agency department (the commercial or business-getting department), at the head of which is the secretary of the company, who also acts as treasurer and paymaster. The insurance department worked in conjunction with the agency department; the inspection department, with a responsible head, who organizes the inspection work, and a record department, dealing with the report records, worked in conjunction with the inspection department. There is a boiler department, whose responsible head and assistant engineers deal with the boiler inspectors' reports on boiler examinations; an engine department, whose responsible head and assistant engineers deal with engine break-downs and inspectors' reports of examinations, and an electrical department, whose chief electrician and assistants deal with breakdowns of electrical machinery and with the outside electrical inspectors' reports on the examination of electrical plants. There is a general typewriting department, in which all the reports to be sent away are written. All the heads of the several departments are held responsible to the chief engineer of the company for the efficient carrying on of their department.

"The outside agents are remunerated upon a salary and commission basis and, in addition, are allowed legitimate expenses. They are supposed not to have any technical knowledge of the practical side of the business, *i. e.*, in regard to hazardous risk or the suitability of the apparatus for insurance, or otherwise. They hunt up a prospective client and, if he is favourably inclined, obtain a signed proposal form at a specified quoted premium, based upon the size and type of the apparatus, and the premium quoted is determined by the keenness of competition for business.

"After the proposal form is filled up and duly signed by the prospective insurer, it is immediately sent to the head office, and the apparatus or appliance is subjected to a first inspection by a member of the companies' experienced staff of engineers.

"The electrical inspector or surveyor should be a thoroughly experienced and competent engineer, with good technical qualifications, some commercial experience, tact in the handling of clients, and a very essential qualification is the using of sound judgment in reference to the suitability or non-suitability of apparatus for acceptance or rejection by the company. The breakdowns from accident are so frequent that nothing but a first-class risk should be recommended to head office for acceptance.

"The first inspections are the most important duties that the inspector has to undertake, for it is on his sound judgment and ability and his recommendation that the company acts. He should recommend only first-class risks and, at the same time, should be very careful not to refuse business for the company. Many unprofitable clients and very hazardous risks have been recommended and accepted by the companies by giving too much consideration towards the latter element, and the most prudent and safest policy an inspector can adopt is to recommend no machinery or plant to head office for acceptance that he would not personally accept as a safe risk. Then if the company is doubtful about refusing the business, it can send another inspector to accept or refuse the risk.

"First inspections are very important and, in addition to judging the suitability of the risk, the inspector has to take what is called first inspection particulars. This consists in executing rough sketches in a note-book, including plan, elevation and side views of the machine foundation, location of machine in the building, method of securing machine to foundation, sketches of armature, field magnets, brush gear, brushes, insulating rings and many over-all and detail dimensions of the machine and accessories, size of bed-plate foundation, slide rails, bolts (used in construction and fixing), diameter and length of armature and commutator, size of armature shaft, size of commutator wires, how wound, binding wires, number and sizes of other parts, number and depth of commutator segments, field magnet particulars, thickness of insulation, etc.

"After these particulars have been obtained they have to be drafted out and recorded in ink on a four-page sketch sheet of squared, non-destructible parchment paper. This is the company's permanent record of the machine for reference and recognition, and this is kept at head office. The companies are very particular as regards the size of fuse wires they allow for certain sizes of machines, and from a very extensive and valuable experience they strongly recommend the use of copper.

"In addition to first inspections, the inspector has to make periodical examinations of insured electrical plant, which occur three times a year, and are for the purpose of seeing what condition it is in. In these superficial inspections there are many points of vital moment to be looked at, such as sizes of fuse wires, condition of commutators, brushes, brush gear, etc., the presence of oil, dust or grease, the insulation in general, condition of bearings, controlling switches, accessories, etc. These inspections save the companies payment for many breakdowns of a more or less expensive nature, for developing faults are frequently discovered which, if left unattended to or neglected would sooner or later lead to breakdowns of more or less serious moment. . . .

"A report is forwarded to the head office as regards the general condition of machines or plant, any special points of neglect or weakness being recorded, so that the chief engineer can enumerate them in his report to the client, with suggestions and methods of immediate remedying thereof. The machine should be thoroughly examined when both at work and at rest.

"Another important and responsible

feature of the inspector's duties is the immediate visiting of firms where a breakdown has occurred. The damage, cause thereof, etc., are carefully inquired into and, if it is a legitimate breakdown, the inspector recommends head office to accept liability, and the repair is put in hand at earliest convenience.

"If it is a rewinding job (say, on armature or field magnets), the firm who is doing it is visited several times during the repair to see to its satisfactory progress. When machines are located in damp places an insulation resistance test of the armature and field magnets is, or should be, annually conducted.

"These companies do considerable consulting work, advising on power, lighting and equipment schemes, specifications for machines, supervision and testing of materials, etc., and one of the duties of the inspector is to visit manufacturing firms to supervise machines under construction, examine materials used and measure sizes of parts to see if they conform to the specification requirements, and generally see if the assembling and workmanship are of a high order, and, after completion, to make a final visit and be present at the test when machine is on the test bed. Efficiency, brake-horse-power and temperature-rise tests on full-load run for several hours are also carried out."

Tables are given at the end of Mr. Bowkers' article of the premium rates charged by the companies on dynamos, motors, and gas engines. The risks are divided into three classes but the rates established depend not on working conditions but on the conditions of competition. Mr. Bowker says, in conclusion, that the insurance of electrical machinery cannot be placed on a sound financial basis until the conditions of operation are taken into account in fixing rates. "A study of surrounding conditions, as regards location of machines, class of work done, and whether attendant is experienced or otherwise, will generally give a sound basis on which to judge the suitability for insurance and more or less hazardous nature of risk, and this very forcibly suggests and points out that the logical and sound commercial basis upon which to organize and administer an accident insurance business of this kind is by apportioning the premium or rate tariff according to hazard or degree of risk of the machinery or plant under consideration, instead of quoting one set premium for a certain size of machine, irrespective of its working conditions, such as is now adopted by the British companies."

ELECTROLYSIS SURVEYS.

THE GENERAL METHODS OF CONDUCTING SURVEYS FOR THE DETECTION OF STRAY CURRENTS IN GAS AND WATER PIPES.

Albert F. Ganz—American Gas Institute.

THE following brief extracts from a paper by Prof. Albert F. Ganz, read at the last annual convention of the American Gas Institute, give a concise outline of the general methods to be employed in making surveys for the detection of stray currents in pipe lines. Prof. Ganz's paper, which was most comprehensive and contained much detailed information which the limitations of space will not permit us to reproduce, had particular reference to the electrolysis of gas pipes, but the methods he describes are applicable to investigations of water mains as well.

"The first step in making an electrolysis survey of a piping system is to measure potential differences between pipes and rails in a large number of places throughout the system in order to locate these points of current flow between pipes and rails. As gas mains are not generally accessible, service or drip connections are used for making connection with the voltmeter; for this purpose one voltmeter wire is clasped or otherwise fastened to the drip or service connection, care being taken to clean with a file the part where the wire is fastened on so as to insure a good metallic contact. The other voltmeter wire is best soldered to a rough flat file which is held on the rail for the contact, and which can be quickly removed and replaced when a car passes. The voltmeter for these measurements should have a high resistance so that an accidental contact at a drip or service connection will not seriously interfere with the measurement. A suitable instrument is a portable high resistance Weston voltmeter with zero center, having ranges of 1.5, 15 and 150 volts. Readings should be taken every 10 seconds for 10 minutes at each point, and the maximum, minimum and average reading noted.

"The average readings are then conveniently marked upon a map showing the principal pipes and tracks, red numbers being used where the pipes are positive to the rails and black or blue numbers where these are negative. An excellent plan is also to plot these potential differences graphically upon a map on which the pipes are shown as lines and using these lines for axes, and the voltmeter readings for ordinates; by shading the areas between the potential curves and the pipe lines with red where the pipe is positive and with black or blue where it is negative to the rails, a clear representation of the potential distribution is obtained. If the negative busbar of the power station is connected to ground plates or to other buried metal as cable sheaths, measurements of potential differences between these and the pipes should also be made and plotted upon a separate map.

"The existence of potential differences betwen pipes and rails, even if large, is, however, no conclusive evidence of stray currents, but indicates at what points current may be flowing from rails to pipes and at what points it may be flowing from pipes to rails or to other return conductors. A high potential difference is in fact usually a sign of a high ground resistance and consequently of but a small current flowing.

"The next step is to determine the direction of the probable current flowing in the pipes. This is done by measuring potential differences between two points in a pipe by means of a millivoltmeter. A convenient instrument for these measurements is a zero center Weston millivoltmeter with two scales, one of 10 and the other of 100 millivolts. These measurements may be made between drips or service connections from 50 to 200 feet apart. These measurements cannot be used, however, for calculating the current strength in the pipes, but only to indicate the probable existence and direction of this current. This direction of flow is then marked upon the map together with the potential readings. . . . . .

"A study of the map will show at what points determinations of current strength should be made. This is done by measuring the drop in potential between two points in the pipe by means of a millivoltmeter, and dividing this by the resistance of the included length of pipe. If this length contains one or more joints this resistance must be measured and not estimated, because joints make contacts of extremely variable resistance. As this resistance measurement is troublesome to make, it is generally more convenient to measure the drop in potential between two points in one continuous length of pipe. With very large pipes and small current this drop is a fraction of a millivolt and requires a specially sensitive millivoltmeter reading to hundredths of a millivolt for its measurement. The resistance of the length of pipe can be calculated from its dimensions and from an assumed figure for the conductivity. . . . . .

"By tracing the flow of currents found in the pipes from these measurements, points can usually be located at which current must be leaving the pipes, and the pipes should be exposed here and examined for evidence of electrolytic corrosion. It must be remembered that all current which is found flowing in a pipe must leave it somewhere in order to return to the negative pole of the generator. This follows from the fact that every electric circuit must be completely closed so that every ampere which leaves the positive pole of the generator must eventually return to the negative pole, no matter how long or how complicated the path through which it passes may be.

"There may be many other endangered points which these simple tests will not reveal. Stray currents do not always take the simple path from rail to pipe, along the pipe and back to rail or other return conductor, but frequently take roundabout paths, passing from one piping system to another piping system, from this perhaps to a third system or passing across pipes, shunting around high-resistance joints, etc., producing electrolytic corrosion at every point of leaving the pipe for ground. Wherever there are two or more independent piping systems, as for instance water and gas pipes, measurements of potential difference between these should be made to see if any points can be located where current is likely to be passing from one to the other. Current measurements must then be made at these points and plotted and studied as before."

THE ECONOMIC IMPORTANCE OF THE PANAMA CANAL.

THE STRATEGIC POSITION OF THE UNITED STATES AND GREAT BRITAIN IN THE CARRIBBEAN AND THE INFLUENCE OF THE CANAL ON TRADE ROUTES.

Archibald R. Colquhoun—Royal United Service Institute.

THE *Journal of the Royal United Service Institute* for February contains an address by Mr. Archibald R. Colquhoun, presented before the Institute on November 6, 1907, on the strategic and economic effect of the opening of the Panama canal. Mr. Colquhoun prefaces his paper by a short review of the engineering problems connected with the subject. His information as to the present state of affairs seems to be at fault, since he fails to note that the lock type of canal has been finally decided upon and considers that though a temporary lock canal is in course of construction, it will ultimately be converted into a canal of the sea-level type. His comments on the strategic position of the United States and Great Britain in the Caribbean and the influence of the canal on trade routes, however, are interesting and we present them in abstract below.

The strategic value of the canal is recognized by many of the public men of the United States. The growth of Japan as a world power and the awakening of China are phenomena which must be reckoned with and the recent voyage of the American fleet from Atlantic to Pacific home waters has proved a valuable object lesson to the nation generally. The advantage of reducing the distance between the two coast lines by over 9,000 miles and the time of the journey from three months to as many weeks is being generally recognized.

Naturally the United States intends absolutely to control the canal and to that end is strengthening as much as possible her command over the Atlantic approaches to it. A glance at the map will show how powerfully the United States already controls the Caribbean. The three main passages from the Caribbean to the Atlantic lie between Cuba and Haiti, between Haiti and Puerto Rico, and between Puerto Rico and St. Thomas. Cuba is practically American territory, Haiti will be occupied by the United States before long and Puerto Rico is already hers. The third passage mentioned above lies through the Danish West Indies but international influence will keep these islands neutral for a time at least, though both the United States and Germany would no doubt like to obtain them. Of minor alternative routes, the United States controls that between Cuba and the mainland of Florida; the others lie through the group of British islands in the eastern Caribbean. On the mainland surrounding the Caribbean the influence of the United States is supreme, the weak Central American and South American states being almost wholly under her domination.

The position of Jamaica, a strategic point of the greatest potential importance, is the one weak point in the

American control of the Caribbean. The Panama canal is of almost as great importance strategically to Great Britain as to the United States since it offers a line of communication between England and the British possessions in Asia and Australasia alternative to the vulnerable Suez Canal route. There is no reason to doubt that if Great Britain were involved in a war with a European Power the United States would be friendly to her or at least neutral. It is, however, of the highest importance to Great Britain that, without prejudice to American control of the Caribbean, the fullest advantage should be taken of the strategic position of Jamaica, St. Lucia, and the rest of the British West Indies. Most of the British possessions lie outside the American sphere but they exercise an important influence in the Caribbean.

"The strategic and economic effects of a Trans-Isthmian Canal are so intimately interwoven that it is difficult to separate them, but, if we look at it from the point of view of trade routes, we find that Europe is by no means so much affected as the North American continent. The volume of trade between Europe and the East and Australasia will probably continue to go *viâ* Suez, and one result of the competing route may be to lower rates on that canal, and probably will be to widen and deepen it. The long Pacific journey, especially for European Powers not well supplied with coaling stations—a most important consideration—will prove an impediment to the Panama route to the East, and the distance from New York is only slightly in favour of Panama to Australasia, and even to Yokohama. But, when we come to consider trade routes from the Eastern States, and especially those on the Gulf of Mexico, it is a very different matter. Japan and Melbourne are about equidistant by either Panama or Suez, from New York, but the extreme Far East and Australasia represent an immense saving of distance for the States generally by the projected canal. From New Orleans, which will attain great economic importance by the development of the Mississippi and the opening of the canal, the advantage is, of course, correspondingly greater. When we remember the great changes taking place in China and the undoubted increase in the demand of Asia generally for manufactured goods, we cannot doubt that the linking of the oceans will bring a great accession of trade to America generally, and also to Japan, which, as a manufacturing country still possessing cheap labour, will largely benefit by a trade route to the Atlantic seaboard of the United States and (in a lesser degree) the northern coasts of South America. The most striking development, however, and the one which may have the most far-reaching consequences, will be the linking together of the Atlantic and Pacific sea-boards of North and South America. At present Europe competes on practically even terms with North America for the trade of the Pacific slope of the southern continent, but the opening of a short route from New York, and, still more, from New Orleans, to such ports as Callao and Valparaiso, will largely revolutionise the conditions of trade. So far, South America altogether has clung to her connection with Europe, and her ties with that continent are far more intimate than with North America, despite the Monroe doctrine. This state of affairs will not be shaken easily, but the political and commercial pressure which the United States will be able to bring to bear must in the long run have their effect.

"It may be useful at this point to make some mention of an enterprise which has already provided a means of communication across the Isthmus, and owes its existence chiefly to British enterprise. I refer to the Tehuantepec railway, which was opened for traffic at the beginning of this year (1907). This important line crosses the Isthmus through Mexico, and is 189 miles in length and attains a maximum elevation of 735 feet. The terminal points, where magnificent harbours have been made, are Coatzecoalcos, on the Gulf of Mexico, and Salina Cruz on the Pacific. The railway has been built by Messrs. Pearson and Sons, who are partners with the

Mexican Government for the construction, operation, and maintenance of both railway and ports. From first to last the work, which was begun at a time when the canal scheme was in abeyance, has cost some ten millions sterling. The idea of the constructors was not so much to compete with the sea-route *viâ* Cape Horn, as with the trans-continental lines in the United States. This railway has already a great and growing volume of business, though so far it handles only American 'domestic' traffic, viz., that in transportation (in bond) between New York, etc. (on the Atlantic), and San Francisco and Honolulu (on the Pacific). The development of the Mississippi basin opens great possibilities for trade in the Gulf of Mexico, and, despite the trans-shipment difficulty, there is a promising opening for a trans-isthmian line at this point. For the next ten or fifteen years it will have the field to itself, and will build up a traffic which may be a genuine competitor to any lock canal, and a serious rival to the ineffective Panama Railway, though it can hardly hope to stand against a sea-level canal for large vessels from ocean to ocean. The advantage of distance, however, will always be in favour of this route as regards the Eastern and Western States, since it brings New York nearly 1,200, and New Orleans 1,850 miles nearer to San Francisco than they will be by the Panama Canal."

THE INLAND WATERWAYS OF THE UNITED STATES.

THE RECOMMENDATIONS OF THE INLAND WATERWAYS COMMISSION.

Report of the Commission.

ALTHOUGH the report of the Inland Waterways Commission contains no definite plan of waterway improvement, it is in many respects an interesting and important document. The omission of suggestions for the improvement of particular waterways has no doubt caused considerable disappointment but the disabilities under which the Commission labored, its lack of legal status and of funds, and the fact that it was composed of men already burdened with departmental duties in other branches of the public service, were such as to put the extended investigations necessary for the formulation of an intelligent plan of waterway improvement out of the question. The report, however, does an important service in showing how numerous and vital are the interests connected with the question and its first section, devoted to a discussion of the relation which waterway improvement bears to railway transportation, stream pollution, water powers, and irrigation and reclamation works, among other problems of an engineering nature, is worthy of careful study. With this part of the report we have not space to deal but we present below the text of the recommendations of the Commission as to how the work of investigation and improvement should be carried on and administered.

"A. We recommend that hereafter plans for the improvement of navigation in inland waterways, or for any use of these waterways in connection with interstate commerce, shall take account of the purification of the waters, the development of power, the control of floods, the reclamation of lands by irrigation and drainage, and all other uses of the waters or benefits to be derived from their control.

"B. We recommend that hereafter both local and general benefits to the people shall be fully considered in any such plans for the improvement of navigation in inland waterways, or for any use of these waterways in connection with interstate commerce; and that wherever practicable Federal agencies shall cooperate with States, municipalities, communities, corporations, and individuals with a view to an equitable distribution of costs and benefits.

"C. We recommend that hereafter any plans for the navigation or other use of inland waterways in connection with interstate commerce shall take full account of transfer facilities and sites, and of the location of tracks, grades, bridges, dams, depots, and other works on navigable and source streams with a view to equitable co-operation between waterway and railway facilities for the promotion of commerce and the benefit of the people.

"D. We recommend that any plans for improving the inland waterways shall take account of the present and prospective relation of rail lines to such waterways, and shall ascertain so far as may be whether such waterways when improved will be effectively used in the face of railway competition; and that the relations between railways and waterways be further examined with the purpose of devising means of rendering the two systems complementary and harmonious and making such fair division of traffic that rates and management may be co-ordinated economically and with benefit to the country.

"E. We recommend that the adoption of means for ascertaining regularly all facts related to traffic on the inland waterways, and for publishing the same in a form suitable for general use.

"F. We recommend the adoption of means for ascertaining and rendering available, at such rate as to meet public necessities, all requisite data related to the physical character and general utility of the navigable and source streams of the country.

"G. We recommend that hereafter any plans for the use of inland waterways in connection with interstate commerce shall regard the streams of the country as an asset of the people, shall take full account of the conservation of all resources connected with running waters, and shall look to the protection of these resources from monopoly and to their administration in the interests of the people.

"H. We recommend that the Congress be asked to make suitable provision for improving the inland waterways of the United States at a rate commensurate with the needs of the people as determined by competent authority; and we suggest that such provision meet these requisites, viz., expert framing of a definite policy; certainty of continuity and co-ordination of plan and work; expert initiative in the choice of projects and the succession of works; freedom in selection of projects in accordance with terms of co-operation; and the widest opportunity for applying modern business methods.

"I. We recommend that the Congress be asked to authorize the co-ordination and proper development of existing public services connected with waterways; and we suggest that such enactment might provide that the President of the United States be authorized, with the advice and consent of the Senate, to appoint and organize a National Waterways Commission to bring into co-ordination the Corps of Engineers of the Army, the Bureau of Soils, the Forest Service, the Bureau of Corporations, the Reclamation Service, and other branches of the public service in so far as their work relates to inland waterways, and that he be authorized to make such details and require such duties from these branches of the public service in connection with navigable and source streams as are not inconsistent with law; the said Commission to continue the investigation of all questions relating to the development and improvement and utilization of the inland waterways of the country and the conservation of its natural resources related thereto, and to consider and co-ordinate therewith all matters of irrigation, swamp and overflow land reclamation, clarification and purification of streams, prevention of soil-waste, utilization of water-power, preservation and extension of forests, regulation of flow and control of floods, transfer facilities and sites and the regulation and control thereof, and the relations between waterways and railways; and that the Commission be empowered to frame and recommend plans for developing the waterways and utilizing the waters, and as authorized by Congress to carry out the same, through established agencies when such are available, in co-operation with States, municipalities, communities, corporations, and individuals, in such manner as to secure an equitable distribution of costs and benefits."

A RAILWAY IN GERMAN EAST AFRICA.

DETAILS OF THE RECENTLY OPENED DARESSALAM-MOROGORO LINE.

Herr Schubert—Glasers Annalen.

AN interesting general survey of the activity and progress in railway building in the Dark Continent was given by Mr. J. Hartley Knight in THE ENGINEERING MAGAZINE for January, 1908. The purpose of the following review is to give a few of the more important details of the railway in German East Africa from Daressalam to Morogoro, to which Mr. Knight gave only a passing notice, after a paper by Herr Schubert, published in *Glasers Annalen* for February 1.

The Daressalam-Morogoro railway was originally conceived as the beginning of a Central African railway which should be extended to Kilossa, Mpapua, Kilimatinde and Tabora, and ultimately reach Udjidji. In 1895 the Colonial Administration joined with the German Bank and the German East African Company to carry out, under the direction of a committee established for the purpose, the preliminary explorations for a railway from the coast to Udjidji in the heart of the lake country. The preliminary work was begun immediately and in 1896 a project was put forward for a 75-centimetre gauge line to Morogoro which was to form the first section of the larger work. Further developments, however, were disappointing and it was not until July, 1904, that a statute providing for the construction of a metre-gauge line from Daressalam to Morogoro was passed. The Imperial Government undertook to guarantee the interest at 3 per cent. on a capital of 21 million marks and also guaranteed the repayment of the capital originally invested in the company at 120 per cent. of the par value of the shares. The East African Railway Company was organized on this basis and was given special land and mineral rights. The Imperial Government is given a share of the profits of the company and at the end of 88 years the road reverts to the Government free from debt and without compensation.

According to the statute the gauge of the road was to be 1 metre. The maximum grade allowable was limited to 3 per cent. but if possible grades were to be limited to 2½ per cent. As a rule curves of not less than 100 metres radius were to be chosen; only when curves of this radius could not be obtained without great difficulty and expense was the use of a smaller radius, limited to 60 metres, permissible. The width of the embankment was to be at least 3.5 metres in the open stretches. The track was to be designed to carry safely a concentrated wheel load of 4 tons moving at the rate of 40 kilometres per hour. The rails were to be able to carry a moving wheel load of 4½ tons when carried on steel ties spaced 75 centimetres, centre to centre. Screened gravel or broken stone was to be used for ballast.

The first line projected for the Morogoro line passed to the north of the Pugu Mountains and contemplated the establishment of a branch to Bagamojo. The importance of the latter port in the trade with Zanzibar is even greater than that of Daressalam but Daressalam was chosen as the starting point of the Central African Railway on account of its superior dock and harbor accommodations. The second projected line passed to the south of the Pugu Mountains. The length of the first line was 257 kilometres, exclusive of the Bagamojo branch. The second line reduced this to 220 kilometres. The latter line crossed the passes of the Pugu Mountains at elevations of 244 and 260 metres, dropping between these two points to an elevation 56 metres below that of the lower pass.

Notwithstanding the opposition of various persons familiar with the country, the engineers in charge of the exploratory work persisted in seeking a shorter line through the Pugu Mountains by way of the Msimbasi valley. They were rewarded in 1903 by finding the route finally adopted, which shortened the Daressalam-Morogoro line to 209 kilometres. The line follows the Msimbasi valley closely to the Pugu Mountains, and crosses the passes of the latter at elevations of 194.45 and 195.90 metres, dropping between these two points only 44.45 metres. The total saving of elevation over the more southerly line amounts to 125.15 metres. Between the two passes of the Pugus the line crosses the Mpiji river and after crossing the second ridge it falls by repeated short grades to the Ruvu river which runs through a valley about 4 kilometres wide. Over this depression the road is carried on an embankment and a bridge 488 metres long. From this point the line gradually rises, crosses the Ngerengere on three short bridges and winds along the Lukonde through the foothills of the Uluguru Mountains to Morogoro, reaching at the terminal an elevation of about 497 metres.

Remarkable progress has been made in the construction of the road. Herr Schubert gives a very interesting description of the engineering problems which had to be solved, which we have not space to record. It must be mentioned, however, in conclusion, that on October 9, 1907, a passenger train ran over the whole length of the line and that its opening for regular traffic may be expected in the near future.

THE PROBLEMS OF ROAD CONSTRUCTION.

A DISCUSSION OF THE RELATION BETWEEN ROAD AND WHEEL, AND A NEW METHOD IN MACADAM ROAD CONSTRUCTION.

H. S. Hele-Shaw and Douglas Mackenzie—Royal Society of Arts.

THE problems of road construction as they exist at present in England are very much altered from those of a few years ago. So long as the roads were used only by comparatively slow, horse-drawn vehicles with moderate axle loads, they could be kept in fairly good condition for a considerable traffic, even when of comparatively inferior construction. The phenomenal development of motor traffic, however, has changed these conditions, and the effect of the change is to be seen in the large increases in the expenditures for road construction and maintenance with which the municipalities are burdened. The problems confronting municipal engineers are of a very difficult nature, for, though the limit of possible taxation in the country districts has been almost reached, the conditions responsible for the increased cost of road maintenance have by no means reached a state of finality and the probable rapid development of heavy motor traffic in the near future is likely to present difficulties of even greater magnitude than those which exist at present. The problems of road construction with a view to modern and future requirements were the subject of an interesting paper by H. S. Hele-Shaw and Douglas Mackenzie, read before the Royal Society of Arts on February 26, which is abstracted below. The authors devote their attention to a discussion of the best engineering construction to secure the most efficient road at the lowest cost and their paper contains many suggestions of universal interest.

The only sound way in which the problems of construction may be approached is to consider the road as one element of a mechanical contrivance of which the wheel is the other element. The end for which these two elements are designed is that they may run smoothly and in contact with each other, resisting considerable mutual pressures without permanent deformation and without undue wear or loss of energy. The ideal condition would be, obviously, to have a perfectly hard and circular wheel running on a perfectly hard and level road and a steel wheel and a steel road might seem as suitable for common roads as they are for railway practice. Apart from the question of cost, however, the metal road would not possess the qualities of adhesion necessary in highways. Though a really hard road is not practicable, it is reasonable to suppose that, if a moderately hard road could be kept level and free from unevenness of surface, the cheap and durable, circular metal wheel would be universally employed as the most satisfactory.

"But a thing so desirable as a truly level surface is exactly what it is impossible to maintain, and it is in order to mitigate the shocks caused by the tendency to deflect a vehicle from its movement in the straight course, that yielding material such as solid rubber or pneumatic tyres are employed on the periphery of a wheel. Now we cannot employ this soft material without paying the penalty, not merely of wearing the wheel but of wearing the road itself, and as a matter of fact in so much as the contact between the wheel and the road departs from a point in the side elevation, or a line looked at in plan, by so much is wear between the surfaces in contact introduced. In the next place let us consider what goes on beneath the surface. If the road is not hard, then a certain amount of deformation must take place.

"The injury done by this deformation will depend on two things:—

(1) The depth to which it will extend (*i. e.*, magnitude of deformation).

(2) The extent of permanent disintegration of the internal substance of the road.

"It is obvious from the foregoing remarks that both as far as the surface is concerned, and also the body of the road, what is required is a tough elastic material, or if on the score of expense it is impossible to have such a material for the whole road, then the material of which the road is actually composed should be cemented or bound together by such a material.

"In any case as the road is exposed to the action of the weather one of the very first conditions of its efficiency is that it must be waterproof, and that the surface must be sufficiently hard to prevent as much as possible the formation of liquid material—let us call it mud—in wet weather, and loose, finely-divided particles—let us say dust—in dry weather. . . . . . Not only is a waterproof road with a tough and durable surface valuable because it prevents the formation of dust and mud, but for the even more important reason that a dustless road is necessarily a waterproof one, and if the interstices are filled with some tough material, the bodily destruction of the road is to a great extent prevented, and the road becomes an ideal one."

Of the three types of road in common use, asphalt, wood and stone, the two first more nearly fulfil the requirements of a perfect road than the last but their cost is prohibitive for anything but town use. Stone roads are of two types, paved and macadam. The paved road, when once laid down, lasts for many years with but small maintenance charges and is fairly satisfactory when a level surface is not required. It is totally unsuited, however, for motor traffic and especially heavy motor traffic which demands a much smoother road than will serve when the traffic is slow and horse-drawn.

In the construction of a good macadam road three conditions must be fulfilled, namely, first, that the road must be of as hard a stone as can be obtained at a reasonable cost; second, the spaces between the stone must be filled with a material of as nearly the same nature as the stone itself; and third, the whole road crust must be consolidated with some binding material. The sprinkling of roads with crude oil, which seemed at first a fairly successful expedient for dust prevention and waterproofing, has been practically abandoned because the oil does not bind the material with sufficient tenacity to resist really heavy traffic. Sprinkling with tar has marked a great advance but the results are very contradictory. In some cases very good results have been obtained, the tar being absorbed by the mud between the stones and forming a compact tenacious binding material; but in others the tar has been prevented by some injurious cause from penetrating into the substance of the road and it has merely formed a carpet on the surface, liquid in summer and brittle in winter. In these unsuccessful attempts the black slime formed by the tar has been most objectionable. The great difficulty in the use of tar lies in the changes it shows at different temperatures. Many investigations have been made on the treatment of tar to produce a resultant material of a more suitable nature and a number of satisfactory materials have been produced. The high first cost of roads on which these materials are used has, however, militated against their general adoption.

"It has been left to the surveyor of one of our rural districts, Mr. A. Gladwell, to prove that a dustless road need cost but a very small amount more than the old waterbound roads by applying the binding material in a novel manner. He uses a suitable tar preparation to make a matrix of fine granite chippings mixed in this tar preparation. He lays this matrix on the old surface of the worn road to a depth of ½ to ¾ inch. He then spreads the broken road stone on the top of this to a thickness not exceeding 4 inches, and rolls it immediately with a steam-roller. The roller forces the stone down into the matrix, and squeezes up the matrix into the interstices, and, if they have been laid in the right proportion, a little rolling will bring the matrix almost up to the surface. A small quantity of matrix can now be laid over the surface, and brushed in, and a final rolling will produce a thoroughly waterproof surface. The cost of this system need not exceed 2½ pence per superficial yard above the cost of a similar coating of granite on the old waterbound system, and it is known that it will last twice as long, and with more favourable conditions, possibly from three, five, to even seven times as long. Mr. Gladwell has thus produced a system of road construction that is applicable to all the roads of this country, and will enable surveyors to use local material, if it is not of too soft a nature, and to produce roads that will be unaffected by the temperature or by the weather, and strong enough to carry anything in reason that may be put upon them. At the same time, the stones will be securely held in position, and there will be no dry mud to be sucked out of the interstices by the pneumatic tyres of motor-cars. It looks as if the destruction of the roads by motor-cars can thus be completely obviated, and almost the only source of wear to this kind of road surface will be the attrition of horseshoes and the steel tyres of horse-drawn vehicles. The rolling contact made by self-propelled traffic on rubber tyres seems likely to produce little appreciable wear or injury to such surfaces, and its waterproof nature saves any necessity for scraping or scavenging other than that which nature supplies by occasional heavy rain storms.

"Having devoted considerable space to the road, something must be said about the other element working in conjunction with it, namely, the wheel. Restrictions have very properly been devised and are enforced by law with a view of protecting the roads from undue destruction by wheels; but it is clear that just as there are demands made for road improvement on the one hand, so will demands be made and vigorously voiced for further restrictions in the matter of wheels on the other. The use of studded tyres is a case in point, and the authors think that, concerning their use, road surveyors have a just grievance at the present time. A new studded tyre with projecting steel studs and rotated by an engine of 40 to 60 horse-power, is capable, in passing along the road, especially in climbing hills at a high rate of speed, of doing a considerable amount of damage to the surface of a road, and when scores, if not hundreds, of such tyres pass along one piece of road in a day, it is obvious that there is no road surface, unless made of steel itself, that would not be cut to pieces in a short time by such means.

"With regard to the types of heavy commercial vehicles, it is certain that unless the diameter of their wheels is increased, they will form, as this class of traffic increases in future, a very serious problem to the road constructor. It is astonishing how much the injury to a road surface is reduced by the comparatively small increase in the size of wheels of steam tractors, which only average about 4 feet 6 inches in diameter, as against 3 feet 6 inches of a heavy motor vehicle. Of course, even better comparative results are obtained with the much larger wheels of the heavy traction engine, and the authors do not think it is going too far to say that if the wheels of such traction engines were not of the size they are, the passage of one such traction engine on a road, in certain states of the weather, drawing of course its full load, would be sufficient to do incalculable damage, that is, assuming it were able to pull its load at all. The authors do not wish to enter farther into the question of the wheel. They have drawn attention to some of the chief points which are of pressing importance in the matter of road construction, and wish, in conclusion, to remark that while they have shown that there must be sympathetic co-operation between the designer of the wheels of a motor vehicle, and the surveyor who is responsible for the maintenance of the road, there is a third party, who has a serious responsibility in the matter, namely, the user of the road.

"However good the road, and, however well designed are the wheels, a great responsibility must rest with the driver of a motor vehicle. By the incessant use of the crown of the road, leading to tracking, by the injudicious use of brakes, by the rushing of corners at unreasonable speeds, and in many other ways, the driver of a motor vehicle can do more damage in a week to the roads, as well as to the vehicle he is responsible for, than would be otherwise the result of twelve months fair usage. The authors trust they have shown that if the drivers and manufacturers do their part, the science of road construction has now advanced sufficiently for the road surveyor to be able to do his part without putting an undue and even prohibitive burden upon the community."

AN ACID RESISTING ALLOY.

A RECORD OF RECENT ADVANCES IN APPLIANCES FOR THE MANUFACTURE AND CONCENTRATION OF ACIDS.

A. Jouve—Société des Ingénieurs Civils de France.

ACCORDING to a paper by M. A. Jouve, presented at a recent meeting of the *Société des Ingénieurs Civils de France,* the chemical industry is to benefit materially by recent advances in the study of alloys of iron and silicon. The great difficulty in that branch of the chemical industry which is concerned with the manufacture and concentration of acids has been the lack of a satisfactory material for the construction of the vessels in which these processes are carried on. The function of acids in their industrial applications is to attack and dissolve materials, but the same property which makes them of industrial value renders their manufacture a difficult and expensive operation. Recent investigations, of which the following abstract of M. Jouve's paper gives a brief outline, have found in certain metallic compounds in which iron and silicon are the predominating elements, a combination of properties which enables them wholly to remove the most troublesome and costly features of acid manufacture

To illustrate the importance of the discovery, M. Jouve takes the case of the concentration of sulphuric acid, in which, he says, the difficulties are typical of all acid processes. A variety of materials is used for the vessels in which the concentration process is carried on but all of them possess serious disadvantages. From the point of view of resistance to the action of acids, glass and porcelain, which are largely used, give every satisfaction. These materials are made into evaporators or retorts which are directly exposed to the fire or are protected by a cast iron covering which, in case of breakage, receives the acid and prevents its entrance into the furnace. Besides their fragility which renders them liable to breakage under sudden changes of temperature, these appliances have the great inconvenience of being very limited in size. When their diameter exceeds 40 centimetres the cost of manufacture is very high and most works find it necessary to be satisfied with the inconvenient arrangement of a very large battery of small vessels. Stoneware is cheaper than glass or porcelain but has the same disadvantage of being liable to breakage, with consequent loss of material. Breakage is very hard to prevent, even by making the vessels very thick, since hot acid seems to produce a peculiar molecular disintegration in addition to a slight chemical action. Alloys of platinum and iridium or platinum and gold and combinations of platinum with iron or lead are widely used but their cost is very high and the consumption of the platinum by the acid increases rapidly with the degree of concentration. Lead is attacked only slightly by acid at 50 to 52 degrees Beaumé but cannot be used for concentration above 60 degrees. The final concentration has to be made in porcelain or platinum vessels. Iron, on the other hand, is attacked by dilute acid but only slightly by concentrated. Among minor materials may be mentioned silica which is very satisfactory so far as its resistance to acid is concerned but the appliances made from it are limited in size. For the larger sizes, above 30 to 40 centimetres in diameter, the price is prohibitive.

To sum up, therefore, none of the ordinary materials in use will permit an uninterrupted concentration of sulphuric acid to 66 degrees Beaumé in one vessel, except glass, porcelain or silica, and the use of these is attended by the disadvantages enumerated above. Since 1900 researches have been carried on to discover a satisfactory material but practical success was attained only last year. The researches were based on a laboratory observation, that of the difficulty of dissolving in acid the iron-silicon alloys, and the practical impossibility when they contain over a certain percentage of silicon. The acid-resisting properties of these alloys immediately suggested their utilization for the construction of appliances for acid manufacture but their other properties presented great difficulties in the practical solution of the problem. The aims of the investigators were to produce at a moderate price a metal or metallic compound which no acid would attack and which could be cast in any desired form, and to give it such mechanical properties that it would resist a considerable amount of stress, either tension or compression, and shock.

The alloys experimented with were complex metallic silicides of high silicon content, in which the silicides of iron formed the principal part of the mixture. It was found that the percentage of silicon had to be varied according to the purpose for which the material was intended. No fixed rule can be laid down as to the amount of silicon necessary to produce a compound satisfactory for all purposes but each case presents a problem in itself. Though all chemists who have analysed iron-silicon alloys will agree that these substances, even when pulverized, are absolutely unattacked by even the strongest acids, it was found in these investigations that alloys containing as much as 65 per cent. of silicon are attacked to a certain extent under the conditions met in industry, an anomaly which can be explained only by the influence of temperature and mass. The difficulty met with here was the one usually encountered in applying a laboratory process to industry and a large amount of experimenting was necessary before success was finally attained.

After a compound with the necessary acid-resisting qualities had been produced, great difficulties were met in giving it the required form, especially when dealing with considerable masses of the material. The difficulties of handling ferro-silicon are well known to metallurgists. The commercial article containing about 20 to 25 per cent, of silicon can be melted, though with difficulty, but it is almost impossible to cast it, the molten metal having a drossy appearance and moulding badly. Even when the casting is successfully accomplished, when the mould is carefully dried and every precaution is taken to cool the casting slowly, the piece will be found broken or at least badly cracked when the mould is broken up. This is due to the fact that compounds of iron and silicon are not, properly speaking, alloys, but binary combinations of a metal, iron, with a metalloid, silicon, and the shrinkage differences are so great as to cause cracking even at red heat.

This difficulty was overcome by the addition of certain other substances to the compound of iron and silicon. The ferro-silicon used is prepared in an electric furnace and before it leaves the furnace all impurities are eliminated, suitable reagents being employed to render them volatile. The materials which make it possible to cast the compound are added in the casting ladle. M. Jouve does not say what these materials are. They vary, he says, according to the purpose for which the casting is to be used and as yet they must remain a trade secret. Their use, however, produces a metal which is very hot and absolutely fluid and which moulds perfectly. The resulting castings fulfil all the requirements of acid manufacture.

These materials are already applied extensively to the processes of the concentration of sulphuric acid and the condensation of vapors of nitric acid, both in France and abroad, and they are also being used for the construction of fans for handling corrosive gases, pumps for acid waters, and in other ways. M. Jouve concludes with a comment on the entire success which has attended their use for the concentration of sulphuric acid. In concentrating directly from 50 to 66 degrees Beaumé the vessels were absolutely unattacked except for a slight, temporary, surface scouring, due to the slight modification of the alloy by its contact with the moulding sand.

REFRACTORY MATERIALS.

A DISCUSSION OF THE APPLICATION OF THE LAWS OF PHYSICAL CHEMISTRY TO THE ESTIMATION OF THEIR EFFICIENCY.

Thos. Holgate—Engineering.

ONE of the most remarkable features in the close relation between pure science and modern engineering is the extent to which the laws of physical chemistry have been applied to the explanation of phenomena met in every day practice, the causes of which have long been obscure. The usefulness of these laws is not confined to any one branch of physical or natural science nor to any one branch of industry but it is perhaps most striking in the engineering side of chemistry and metallurgy, where prominent examples are to be found in the explanation of the corrosion of steel, mentioned in this department in the April issue of THE ENGINEERING MAGAZINE, and the formation and heat treatment of alloys. In *Engineering* for February 21, 1908, Mr. Thos. Holgate gives an interesting discussion, abstracted below, of the application of these laws to the elucidation of another complex question of metallurgical interest, namely, the nature of materials in their refractoriness to heat.

The problem is one of the utmost importance economically. In the manufacture of iron and steel and all other high-temperature operations, the cost of renewal of fire-clay materials is a large item. Further, the output of a set of furnaces over a given period of time is dependent largely on the life of the brickwork. The urgency of the question has been shown from time to time but the discussions of technical societies have had little or no effect in remedying the prevailing lack of knowledge of even practical technical men, both makers and users. Up to a few years ago very few makers could state with precision the amount of heat their products could stand. The engineer was further handicapped by the fact that a chemical analysis of the finished product not only is very difficult to make but, unless complete and accurate, may be misleading. A certain amount of general knowledge has been current among skilled technicians as to the effects of certain constituents of fire-brick on their life and efficiency but what was long lacking was a co-ordination of the knowledge of the maker, the chemist and the user that should show with some degree of consistency why various constituents should act as they do and what their relation to one another in increasing fusibility.

The acquisition of this knowledge has been made possible by the formulation of the physico-chemical laws relation to solid solutions and their behavior, notably the law of the depression of the freezing point. Mr. Holgate mentions as examples of the ways in which these laws have been applied to explain the complex phenomena of refractory materials, the invention of Seger's cones and the investigations of Prof. Vogt on iron blast-furnace slags. He concludes with a discussion of their application to the solution of the problems which arise in ordinary practice.

"The usual method of finding out the value of a firebrick is to expose it to heat under conditions as nearly alike as possible to those under which the bulk will be used, and after this preliminary, if found satisfactory, it is used in succession on the small, medium, and large industrial scale. Only after such prolonged trial is its quality assessed, and a further precaution is taken to have made an analysis of a sample of the bricks thus found satisfactory. The analysis so obtained is employed as a check upon the future deliveries of so-called similar bricks, used under similar conditions. Such a method occupies a long time, and may be costly, and is always accompanied by uncertainties such that no responsible man cares to be compelled to repeat it more than is absolutely necessary. It is, however, the ultimate test to which any newly-proposed brick must be submitted; for whilst there may be much other evidence, it can be only regarded as collateral, and cannot be accepted as a substitute for the succession of tests—or, in other words, the practical experience. What other information can do, therefore, is to enable one to say whether a certain composition, as revealed by analysis, is at all likely to be worthy of testing upon the working scale, and to connote more explicitly the observed behaviour in relation to the chemical composition and the conditions under which the material has been proved. For the value of a fire-brick for a given purpose is made up of many factors. Not only must it resist a high temperature, but in many cases it must do this when in contact with gases or with molten liquids, slags, or ashes of fuels that enter into combination with the fire-brick as a whole or with its separate parts. Again, a brick may be required of special composition or compactness, to resist the action of a low temperature coupled with the action of gases or slags. These practical considerations of the sum total of causes and effects, when fully realised, point in the same direction as those derived from the investigations of physicists and chemists when examining each influence singly. They show that the chemical composition in relation to temperature and to liquid and gaseous surroundings must, firstly, be such as to limit combination between the two; and, secondly, such as to reduce to the minimum the chance of combination among the components of the brick. Should there be bases (metallic oxides) present, they should be those that do not readily combine with the principal acid constituent — silica. The alkalies, potash and soda, are pre-eminently those that combine at the lowest temperature with silica, and may form a softening mixture which behaves like a matrix for a solid solution. That once formed, there begins the effect of the 'depression of the melting-point of the compound,' by the solution in the matrix or solvent, of the various other oxides present, or it may be of other acids, such as titanic acid, for example. The way in which these oxides and acids act to increase fusibility—that is, in other words, to depress the freezing-point—has been found to be in the ratio, not of their percentages by weight, but in the ratio of that percentage divided by the molecular weight of the substance dissolved. In this way it is clearly explained why, for a given weight of iron in a fire-clay, it has double the effect in increasing fusibility when in the state of ferrous oxide to what it has when in the state of ferric oxide. The important question of the relation of silica to alumina is worthy of lengthened consideration here; but the more striking results exemplified by the constituents usually regarded as responsible for increase of fusibility must suffice. The conclusions of Herr Ludwig, of the Chemical Laboratory für Thon-Industrie, Berlin, concisely expressed as follows, sum up the case most clearly:—'It is impossible to judge of the character of a clay by merely adding together the quantities of the impurities it contains. It must be considered molecularly.' Herr Ludwig analysed eighty-five clays, and compared their theoretical melting-points, deduced from their molecular proportions, with the actual temperatures of fusion as shown by heating alongside Seger cones. In the majority of cases there was close, and in the others reasonable, agreement."

THE POSSIBILITIES OF ELECTRIC SMELTING.

A DISCUSSION OF THE ECONOMICAL POSSIBILITIES OF THE ELECTRO-THERMIC PROCESS FOR THE PRODUCTION OF PIG IRON AND STEEL.

A. Stansfield—Canadian Mining Institute.

THE following abstract of a paper by Dr. A. Stansfield, read at the recent annual meeting of the Canadian Mining Institute, presents an interesting review of the present development and future possibilities of the electrical process for the smelting of iron ores. As yet the electric furnace has proved a commercial success only in the production of crucible cast steel but its technical success in the direct smelting of ore has amply demonstrated that, in certain localities and under certain conditions at least, it will be able successfully to compete with the blast furnace at no very distant date. Dr. Stansfields' paper gives a very clear view of what can probably be accomplished in this direction, the manner in which the successful results can be obtained, and the advantages and drawbacks of the electrical process.

"Electrical energy has recently been employed to replace, in certain operations, the heat which is ordinarily obtained by burning fuel. Electrical energy is somewhat expensive, and it was naturally employed at first for the production of the more valuable products, such as crucible steel, where the cost is of less importance. The electrical production of cast steel for tools and similar purposes may be accomplished in two ways—(1) by melting down pure varieties of iron and steel with suitable additions of carbon and other ingredients, just as in the crucible process, but using electrical energy for heating instead of coke or gas; (2) by melting a mixture of pig-iron and scrap steel as in the open-hearth process, and removing the impurities, such as sulphur and phosphorus so thoroughly by repeated washing with basic slags that a pure molten iron is at last obtained. This can then be recarburized and poured into moulds. Both of these methods are now employed commercially for the production of good qualities of tool steel. The larger sizes of electrical furnace that have already been constructed hold 5 or 10 tons, while the crucible will hold only about 80 pounds, and the high efficiency of the electrical method of heating more than compensates for the greater initial cost of electrical energy as compared with heat derived from fuel. The resulting steel is found to be even better than crucible steel, and can be produced at less cost. It is, therefore, only a question of time until the crucible process shall be entirely replaced by the electrical process in all localities where electrical energy can be produced at a moderate figure."

Two types of furnace have been used for making cast steel, the Héroult and the induction furnace. The former is essentially an open hearth furnace in which the heat is produced by electric arcs maintained between the molten slag and two carbon electrodes which hang through the roof. It has been found very suitable for the refining of mixtures of pig iron and scrap steel for the production of crucible steel. The induction furnace is better suited to the simple melting of pure iron for carburisation, as in the crucible process, than to refining. In this furnace no electrodes are used. It consists of an annular trough containing the steel, which acts as the secondary of an alternating-current transformer. An alternating current supplied to a primary winding induces a very high current in the secondary, the ring of steel, and enough heat is produced to melt the steel. This type of furnace has lately been constructed in sizes with a capacity of 8 tons of steel and consuming 1,000 electrical horse power. In both types of furnace the consumption of energy is about 800 to 900 kilowatt-hours per ton of steel when cold stock is used, or 600 to 700 kilowatt-hours per ton using melted pig iron. The cost is higher than that of the open hearth process but a vastly superior steel is produced.

In direct smelting in the electric furnace carbonaceous fuel is used in the charge only to eliminate the oxygen of the ore, and its amount can be regulated so that the furnace will yield either pure iron, steel or pig iron at will. Certain difficulties in the steel process, however, have prevented it from being as far developed as the process for the production of pig iron, which has advanced satisfactorily under the work of Héroult, Keller and others. In his latest experiments, those at Sault Ste. Marie, Héroult used a furnace consisting of a vertical shaft, similar to a small blast furnace. One carbon electrode was suspended in this shaft and the other was formed by the carbon lining of the furnace crucible. The ore, fluxes and the necessary carbon was fed down the shaft, around the vertical electrode, and the heat produced by the current was sufficient to carry out the chemical reactions involved in the reduction of the ore and the fusion of the pig iron and slag. The Keller furnace is the same in principle as the Héroult but consists of two vertical shafts, each containing a suspended vertical electrode, connected by a trough to permit the passage of the current from one shaft to the other and for the collection of the molten iron and slag. Furnaces of this type consume about 0.3 horse-power year of electrical energy and 800 to 900 pounds of coke per long ton of pig iron produced. Assuming the general costs of operation of the electric and blast furnaces to be equal, these figures would indicate that the electric furnace would need to obtain energy at a cost per horse-power year of less than that of two tons of coke in order to compete with the blast furnace. When it is taken into consideration that the heating value of one electrical horse-power year is about the same as that of three-quarters of a ton of good coke, it is obvious that the electric furnace, even in its present state of development, is much more economical of heat than the blast furnace.

The electric furnace possesses certain advantages over the blast furnace which may in some cases outweigh the disadvantage of the high cost of electrical energy. Owing to the absence of a blast, sandy or powdery ores which cause so much trouble in blast furnace operation can be smelted without difficulty. Another advantage is in regard to the smelting of titaniferous or other difficultly fusible ores, which the high temperature of the electric furnace accomplishes with ease. The high temperature is advantageous also in the treatment of high-sulphur ores, since it enables a larger proportion of lime to be used in the charge and even more strongly reducing conditions to be obtained in the furnace. A final point in favor of the electric furnace is that it does not require a high quality of coke for fuel but will operate successfully with carbon in any form. Coke or charcoal is used only as a chemical reagent and the physical qualities of the fuel have no effect on the operation of the furnace.

Commercially, however, the electric furnace has many difficulties to overcome, one of the most important being the small scale on which it has been constructed so far. In the Héroult furnace the height of the shaft is limited by the length of the electrode, though in an improved furnace designed by Haanel and Turnbull a greater height of ore column was obtained by a system of inclined shafts. Another weak point in the construction of the electric furnace is that no provision has been made for utilizing the heat of the waste gases. Turnbull has proposed for the furnace mentioned above the addition of a rotating tube furnace through which the ore may pass on its way to the electric furnace and be preheated by the burning of the waste gases.

"In view of the importance of reducing the consumption of fuel and electrical energy to the lowest possible point, the writer has calculated what could be expected in this way if the gases arising from the reaction between the charcoal and the ore were used partly for the reduction of the ore and partly for preheating the ore. Such a result could be attained in a furnace consisting essentially of three parts. In the upper part the otherwise waste gases are burned by air introduced there and communicate their heat to the incoming ore to which the fluxes but not the charcoal have been added. In the middle portion of the furnace the gases arising from the lowest portion, which may be considered to be wholly carbon monoxide, react on the heated ferric oxide, if that were the variety of ore to be treated, and reduces it to ferrous oxide. The charcoal is introduced in the lowest section of the furnace and completes the reduction of the ore to metal. Electrical energy is introduced into this section of the furnace and serves to melt the resulting pig-iron and slag, and to supply the heat necessary for the preceding chemical reactions. The details of the construction of such a furnace have not been worked out at present. In a furnace of this kind it can be calculated that one ton of pig-iron can be obtained from an average ore by the use of 0.2 horse-power years of electrical energy and about 600 to 800 pounds of coke or good charcoal. This includes a reasonable allowance for loss of heat. A further allowance should be made for irregularity in the use of the electrical power and, taking this into account, we may consider that one-quarter of a horse-power year and 600 to 800 pounds of coke or charcoal would be required for reducing one long ton of pig-iron from the ore.

"Considering these figures, it will be seen that the use of ¼ electrical horse-power year will save about 2/3 of a ton of coke, or that 1 electrical horse-power year should not cost more than 2 2/3 tons of coke if the electric furnace is to compete with the blast-furnace. Thus an electrical horse-power year at $12.00 would correspond to coke at $4.50 a ton. The considerations previously mentioned in regard to the use of cheaper fuel and cheaper ore in the electric furnace would also apply in this case, and with improved design and construction the size of the electric furnace may be increased so as to admit of a large and economical output of pig iron."

No economical scheme for the direct reduction of steel from the ore has ever been put into operation on a large scale. Both Stassano and Héroult have been successful in producing steel but they abandoned the process as uneconomical. Among the difficulties of the problem may be mentioned as most important:

"1. The difficulty of eliminating sulphur when this is present in the ore, the blast-furnace producing pig-iron being far more efficient in this particular than a steel furnace such as the open-hearth. It may possibly be necessary on this account only to use ores that are relatively free from sulphur in the direct production of steel.

"2. Another difficulty lies in the different conditions required for the reduction of the ore and the final refining treatment to which the resulting steel must be subjected. Thus the operation of making steel must always be intermittent in character, while the reduction of ore in the blast-furnace is continuous.

"Until these and other difficulties have been overcome, it is not likely that we shall have any successful production of steel directly from iron ore on a commercial scale. Nevertheless, the high price of steel as compared with pig-iron renders this proposition particularly attractive to the electro-metallurgist. At present the most satisfactory method appears to be that of reducing the ore to pig-iron in one furnace, and turning this into steel in a separate furnace as in ordinary metallurgical practice."

THE ENGINEERING INDEX

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The following pages form a descriptive index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

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The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Arches.

Symmetrical Masonry Arches. Malverd A. Howe. A mathematical article showing the method of procedure in applying summation formulæ. 2700 w. R R Gaz—March 13, 1908. No. 90866.

Bascule.

Rolling-Lift Bascule Bridge for the Baltimore & Ohio Ry. at Cleveland, Ohio. Illustrated description of a single-leaf bascule and its operating machinery. 600 w. Eng News—March 12, 1908. No. 90790.

The Bascule Bridge Between Portsmouth and Tiverton, R. I. Illustrated description of a stone bridge with fortress bascule spans. 2500 w. Eng Rec—Feb. 29, 1908. No. 90605.

Blackwell's Island.

Joining of Last Span of Blackwell's Island Bridge. Illustrations with brief account of this cantilever structure. 1800 w. Sci Am—March 28, 1908. No. 91176.

We supply copies of these articles. See page 322.

Cantilever.

See Blackwell's Island, and Quebec, under BRIDGES.

Concrete.

The Connecticut Avenue Bridge at Washington, D. C. Views and descriptive notes of this concrete seven-arch bridge. 600 w. Eng News—March 26, 1908. No. 91172.

Deflection.

See Bridge Deflection, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Design.

A Decade of Bridge Design and Construction. Editorial review of the changes introduced in rebuilding bridges and building of new roads. 2500 w. R R Gaz—March 13, 1908. No. 90861.

Bridge Building in the United States (Der Brückenbau in den Vereinigten Staaten von Nordamerika). F. Dircksen. A discussion of present practice in bridge design. 10500 w. Serial, 1st part. Zeitschr d Ver Deutscher Ing—Feb. 29, 1908. No. 90978 D.

Floors.

Standard Overhead Bridge Floors, Philadelphia. Describes the details of a heavy plate-girder skew bridge carried over seven depressed tracks, and the difficulties overcome. Ills. 1500 w. Eng Rec—March 7, 1908. No. 90700.

Waterproofing Ballasted Bridge Floors at Schenectady, N. Y. In the track elevation of the N. Y. C. & H. R. lines in this city it was important that there should be no leakage in the overhead bridges and viaducts. The methods used are illustrated and described. 3500 w. Eng Rec—March 28, 1908. No. 91201.

Masonry.

The New Stone Bridge Over the Connecticut River at Hartford. E. W. Winans. An illustrated detailed description of a bridge costing about 3,000,000 dollars, composed of nine spans and having a total length of 1192.5 feet. 5000 w. Cassier's Mag—March, 1908. No. 90821 B.

See also Arches, under BRIDGES.

Piers.

Renewing Illinois River Bridge Piers, Toledo, Peoria, and Western. Illustrated description of conditions, and of methods used for this work. 1000 w. Ry Age—March 20, 1908. No. 91102.

Quebec.

Report of the Royal Commission on the Cause of the Collapse of the Quebec Bridge. Henry Holgate, J. G. G. Kerry, John Galbraith, Commissioners. Full report with appendices. 60000 w. Eng Rec—March 14, 1908. No. 90845.

Lessons for the Engineering Profession in the Quebec Bridge Commissioners' Report. Editorial discussion of facts brought out by the report of the Canadian Commission of Engineers. 2000 w. Eng News—March 19, 1908. No. 91020.

Reinforced Concrete.

A Three-Hinge Reinforced-Concrete Skew Arch Bridge in Denver, Col. Illustrated detailed description of a bridge involving special features of interest. 3800 w. Eng Rec—March 21, 1908. No. 91079.

The Wagaraw Bridge at Paterson, N. J. Illustrated description of a three-span reinforced-concrete structure recently built over the Passaic River. 1200 w. Eng Rec—March 7, 1908. No. 90702.

See also Steel, under BRIDGES.

Steel.

New Road Bridges Over the Nile at Cairo. Plan and elevation and other details are shown, with descriptive notes. 1500 w. Engr, Lond—March 13, 1908. Serial, 1st part. No. 91147 A.

A Peculiar Concrete and Steel Bridge in France. Illustrated detailed description of a 3-hinged arch bridge over the Guindy with the haunch hinges some distance up the ring. The material is a curious combination of concrete and steel. 800 w. Eng News—March 26, 1908. No. 91174.

The Bridging of the Columbia and Willamette Rivers Between Vancouver, Wash., and Portland, Ore. Ralph Modjeski. Plate, and illustrated description of two double-track bridges on the Spokane, Portland & Seattle Ry., designed for heavy modern loading, without roadways. 1300 w. Ry Age—March 20, 1908. No. 91101.

See also Bascule, Blackwell's Island, Floors, and Quebec, under BRIDGES.

CONSTRUCTION.

Caissons.

See Foundations, under CONSTRUCTION; and Breakwaters, under WATERWAYS AND HARBORS.

Concrete.

See Piling, under CONSTRUCTION; Concrete, under MATERIALS OF CONSTRUCTION; and Dams, under WATER SUPPLY.

Earthquakes.

The San Francisco Earthquake of April 18, 1906. Joseph H. Harper. Reviews the writer's experience and gives results of personal observations, and lessons to be drawn. 6000 w. Jour Assn of Engng Socs—Feb., 1908. No. 91047 C.

Excavation.

See Dredging, under WATERWAYS AND HARBORS.

Factories.

A Concrete Manufacturing Building. Illustrates and describes the reinforced-concrete factory for the Wolf Mfg. Co., at Philadelphia. 1000 w. Cement Age—March, 1908. No. 91053.

Failures.

Investigation of Collapse of Filter Roof During Construction at Lawrence, Mass. Sanford E. Thompson. Paper (condensed) read before the N. Eng. W.-Wks. Assn., explaining the causes of failure of this reinforced-concrete roof. 2500 w. Eng Rec—Feb. 29, 1908. No. 90606.

Fireproofing.

See Steel Buildings, and Warehouses, under CONSTRUCTION.

Floors.

Steel Construction for Long Span Floors in the Chicago Athletic Association Building. No interior columns are used. 43-ft. plate girders are used in the floor system. 600 w. Eng News—March 19, 1908. No. 91019.

Foundations.

Defective Foundations at Mt. Royal Water-Works Pumping Station, Baltimore, Md. Alfred M. Quick. An illustrated detailed description of the conditions and the method of strengthening and reconstructing. 5000 w. Eng News—March 12, 1908. No. 90787.

The Construction of the Base of Baltimore Light, in Chesapeake Bay. H. Prime Kieffer. An illustrated account of a unique salvage undertaking for a large pneumatic caisson, describing this difficult and hazardous work. 5500 w. Eng Rec—March 14, 1908. No. 90837.

Caisson Foundations of Skyscrapers. T. Kennard Thomson, in the *N. Y. Herald.* Illustrated description of the methods of carrying on the work. 2500 w. Sci Am Sup—March 7, 1908. No. 90719.

Foundations: The Use of Divers and the Grouting Machine. Francis Fox. Illustrates and describes interesting applications of the grouting machine to the repairing of old walls and strengthening old foundations. Discussion. 8500 w. Jour Roy Inst of Brit Archts—Feb. 22, 1908. No. 90879 B.

The Effect of Tunneling Operations on St. Paul's Cathedral, London. Notes from an explanation made by Mervyn Macartney to the Royal Institute of British Architects, as to why tunneling near the foundations of St. Paul's Cathedral would cause unequal settlement of the building. 3000 w. Eng Rec—March 28, 1908. No. 91200.

See also Underpinning, under CONSTRUCTION.

Hydraulic Filling.

See Construction, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Industrial Buildings.

See Factories, Reinforced Concrete, and Steel Buildings, under CONSTRUCTION; and Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Masonry.

See Arches, under BRIDGES; Warehouses, under CONSTRUCTION; and Dams, under WATER SUPPLY.

Piling.

Test Loading of a "Compressol" Pile (Probebelastung einer "Compressol"-Pylone). Fritz von Emperger. A discussion of piling as foundation for buildings and test results on a "Compressol" concrete pile. Ills. 5500 w. Beton u Eisen—Feb. 19, 1908. No. 90968 F.

See also Breakwaters, under WATERWAYS AND HARBORS.

Reclamation.

Reclamation Projects in Montana. H. N. Savage. Describes the Huntley project, the Sun River project, the lower Yellowstone, and the St. Mary projects. 1800 w. Jour Assn of Engng Socs—Feb., 1908. No. 91048 C.

The Enclosure of the Zuyder Zee. Reviews the plans for the enclosure and drainage of the Zuyder Zee and the proposed methods of carrying out the work. 1700 w. Engr, Lond—Feb. 28, 1908. No. 90774 A.

Reinforced Concrete.

The Fire of the Dayton Motor Car Works. J. B. Gilbert. An illustrated article showing the effect of the fire on this reinforced-concrete building. 2000 w. Eng Rec—March 28, 1908. No. 91206.

The Foundry Building of Williams, White & Co., Moline, Ill. Brief illustrated description of a reinforced concrete, one-story foundry. 500 w. Eng Rec—March 14, 1908. No. 90841.

The New Freight Depot of the Wisconsin Central Ry. at Minneapolis. S. G. Harwood. Illustrates and describes a reinforced-concrete structure. 1600 w. Eng Rec—March 28, 1908. No. 91202.

Concrete Storehouse and Oilhouse, Battle Creek Mich. Illustrates and describes the interesting features of these buildings in connection with the new shops of the Grand Trunk Railway system. 700 w. Ry Age—March 20, 1908. No. 91099.

The Use of Reinforced Concrete in Engineering and Architectural Construction in America. Ernest R. Matthews. Deals with the use of this material in the construction of water-works, sewers, and sewage disposal works, railway engineering, harbors, building construction, etc., showing its extensive use. Discussion. Ills. 14000 w. Jour Soc of Arts—March 13, 1908. No. 91121 A.

The Edison Concrete House. E. S. Larned. Conclusions of engineers concerning the practicability of the project. Also paper by Percy H. Wilson on "The Practical Problems Involved." 6000 w. Cement Age—March, 1908. No. 91050.

Concrete Shop Construction with Separately Molded Members. W. H. Mason. Read before the Nat. Assn. of Cement Users. Illustrated detailed description of the cement storage building, erected by the Edison system of casting the members separately. 2500 w. Eng Rec—Feb. 29, 1908. No. 90603.

The Question of Bond. H. F. Porter. A review of the best practice, comparing various types of reinforcement. 1500 w. Cornell Civ Engr—Feb., 1908. No. 90-804 C.

A Practical System of Reinforcing Concrete. H. F. Porter. Read before the Engng. Soc. of the University of Toronto. Explains a system based entirely on the use of plain bars. 800 w. Can Engr —March 6, 1908. No. 90778.

The Unit versus the Loose Bar System of Reinforced Concrete Construction. Emile G. Perrot. Read before the Nat. Assn. of Cement Users. Explains how to construct a building with Unit reinforcement for columns, beams, girders, floor and roof slabs. 2000 w. Cement Age—March, 1908. No. 91052.

Economical Design of Reinforced Concrete Beams. Elie Cannes. Gives results of the writer's investigations to determine what percentage of reinforcement will give the least expensive reinforced concrete beam under conditions in New York City. 1200 w. Eng Rec—March 7, 1908. No. 90704.

The Graphical Design of Reinforced-Concrete Structures (Graphostatische Berechnung von Konstruktionen aus Eisenbeton). G. Ramisch. A mathematical discussion of the application of graphical statics to reinforced-concrete design. Ills. 3300 w. Beton u Eisen—Feb. 19, 1908. No. 90969 F.

See also Factories, Failures, and Stacks, under CONSTRUCTION; Sewers, and Sewer Trestle, under MUNICIPAL; Dams, and Reservoirs, under WATER SUPPLY; Breakwaters, under WATERWAYS AND HARBORS; Steel Works, under MINING AND METALLURGY, IRON AND STEEL; and Subways, under STREET AND ELECTRIC RAILWAYS.

Roofs.

See Failures, under CONSTRUCTION.

Stacks.

The Removal of a Tall Steel and Brick Smoke Stack. Brief description of method adopted. Ills. 900 w. Eng Rec—March 14, 1908. No. 90838.

The Design of Ferro-Concrete Chimneys. C. Percy Taylor, Charles Glenday, and Oscar Faber. A study of the stresses allowable in the concrete and steel, referring to two failures in America, and their causes. 3800 w. Engng—March 13, 1908. No. 91140 A.

See also Tanks, under WATER SUPPLY.

Steel Buildings.

The New Open-Hearth Furnace Building, Pennsylvania Steel Works. Illustrates and describes the framework of the furnaces at the Steelton Plant. 2500 w. Eng Rec—Feb. 29, 1908. No. 90607.

Brooklyn Academy of Music. Harry J. Arnold. Description of this new building and the safeguards introduced to prevent fire loss, and loss of life. 2000 w. Ins Engng—March, 1908. No. 90799 C.

New Gas Producer Building, Pennsylvania Steel Works. Illustrated description of the producer house at Steelton, Pa., which will supply gas for the five new 75-ton open-hearth furnaces. 1700 w. Eng Rec—March 21, 1908. No. 91082.

The Phelan Building, San Francisco. Illustrated description of original methods of construction applied to a 11-story building in the earthquake district. 3000 w. Eng Rec—March 28, 1908. No. 91199.

See also Floors, under CONSTRUCTION.

Tunnels.

The Engineering Difficulties of the Hudson & Manhattan Tunnel. From an address by Charles M. Jacobs before the Yale Club, describing some of the problems. 1600 w. R R Gaz—March 20, 1908. No. 91075.

The New York Subaqueous Tunnels (Les Tunnels Sous--marines de New York). Edmond Henry. A general description of the various railway tunnels entering the city under the North and East Rivers. Ills. 4500 w. Génie Civil—Feb. 29, 1908. No. 90926 D.

See also Foundations, under CONSTRUCTION; and Subways, under STREET AND ELECTRIC RAILWAYS.

Underpinning.

Underpinning Buildings Adjacent to the Bridge Loop Subway, New York. States the conditions and describes the methods used. Ills. 1200 w. Eng Rec—March 7, 1908. No. 90701.

Warehouses.

Fireproof Storage Warehouses. Joseph B. Baker. Illustrates and describes the solid brick building of the Security Storage Co., of Washington, D. C., which is built in units having independent walls, designed with the idea of localizing losses from fires. 1500 w. Ins Engng—March, 1908. No. 90798 C.

Waterproofing.

See Floors, under BRIDGES.

MATERIALS OF CONSTRUCTION.

Brick.

Working Loads on Brickwork. Compares the results of values from the Royal Institute tests, the Watertown Arsenal tests, and other sources. 2000 w. Builder—March 14, 1908. No. 91125 A.

Cement Tiles.

Results of Tests of Cement Drain Tiles. A report of tests made at the laboratories of the Iowa State College. 1800 w. Engng-Con—March 25, 1908. No. 91191.

Concrete.

Fundamental Formulæ for the Testing of Concrete (Entwicklung von Grundformeln für Untersuchung von Körpern aus Beton). Prof. Ramisch. A mathematical paper. Ills. 2500 w. Elektrotech Rundschau—Feb. 19, 1908. No. 90951 D.

Concrete Blocks.

Standard Rules and Regulations Governing Concrete Hollow Block. Gives rules and test requirements adopted by the National Assn. of Cement Users. 3000 w. Eng Rec—March 7, 1908. No. 90699.

Standard Specifications for Concrete Hollow Blocks. Gives the rules and regulations proposed by the Committee of the National Assn. of Cement Users. 5500 w. Cement Age—Feb., 1908. No. 91039.

Steel.

New Forms of Steel for New Uses. R. B. Woodworth. Considers the factors that have caused the substitution of steel for wood in building construction, and modern methods of substructure construction; illustrates and describes many types of bars, piling, etc., and uses made of steel in dam-building, coal mining, etc. Also discussion. 10000 w. Pro Engrs' Soc of W Penn—Feb., 1908. No. 90835 D.

MEASUREMENT.

Surveying.

Practical Points on Surveying. Charles L. Hubbard. Describes briefly the use of transit and level, methods of taking measurements, arrangement of notes, and the plotting of results. Ills. 3500 w. Mach, N Y—March, 1908. No. 90641 C.

MUNICIPAL.

Garbage Disposal.

The Chicago Garbage Reduction Plant. Emmons J. Alden. Illustrated detailed description of an extensive plant and its operation. Also editorial on "Garbage Reduction and Incineration Plants in the Larger Cities of the United States." 3500 w. Eng News—March 12, 1908. No. 90792.

Pavements.

Pavements in Salt Lake City, Utah. Photographs of streets showing various kinds of paving materials, and information from the report of L. C. Kelsey, City Engineer. 1500 w. Munic Engng—March, 1908. No. 91036 C.

Vitrified Brick Pavement Construction. Will P. Blair. Gives points on the best construction. Ills. 1200 w. Munic Jour & Engr—March 4, 1908. No. 90684.

Good Pavements and How to Secure Them. J. W. Howard. From an address before the Civic Assn. of Morristown, N. J. Considers the influence of good pavements, and outlines the general principles of construction. 2000 w. Munic Engng—March, 1908. No. 91037 C.

Peking.

The Public Works of Peking. J. D. Smedley. An illustrated description of the city, its streets, sewers, water supply, etc. 3000 w. Pub Works—Jan., 1908. No. 90652 B.

Public Baths.

The Public Bath. Harold Werner and August P. Windolph. Discusses the development of the types of public baths, with suggestions on planning, structural peculiarities, etc. Ils. 2500 w. Br Build —Feb., 1908. No. 90722 D.

Roads.

Improved Roads—The "Durax" Granite System. Illustrated description of this form of paving. 1500 w. Auto Jour—Feb. 22, 1908. No. 90648 A.

Object Lesson Roads Built in 1906-07 by U. S. Office of Public Roads, with Data on Their Cost. Descriptions and data from the report of Logan Waller Page. 2500 w. Engng-Con—March 4, 1908. No. 90713.

Gravel and Macadam Roads and Their Cost. G. C. Houston. From a paper before the Indiana Engng. Soc. Information concerning road construction in Southern Indiana. 2000 w. Munic Engng —March, 1908. No. 91038 C.

Some Points in Road Construction. E. B. B. Newton. Read before the Munic. & Allied Foremen's Inst. The present number considers foundations, selection of materials, camber, channels and crossings, and paving materials. 2500 w. Surveyor—March 13, 1908. Serial, 1st part. No. 91124 A.

Present-Day Road Requirements in Town and Country. A. Brown. States the requirements, describes city pavements, discussing how far they meet these requirements, the dust problem, etc. General discussion. 8400 w. Surveyor—Feb. 21, 1908. No. 90655 A.

The Problem of Road Construction with a View to Modern and Future Requirements. H. S. Hele-Shaw, and Douglas Mackenzie. Considers how far the various improvements in road-making satisfy modern requirements. General discussion. 8500 w. Jour Soc of Arts—Feb. 28, 1908. No. 90755 A.

Treatment and Formation of Road Surfaces. A. J. Metcalfe. Indicates how the construction of motor cars might be improved so as to lessen the dust trouble, and discusses road improvements, materials and methods. 8800 w. Soc of Engrs—March 2, 1908. No. 91211 N.

The Use of Tar on Macadam Roads (L'Emploi du Goudron sur les Chaussées Empierrées). P. Caufourier. A discussion of its effect on the cost of maintenance. 3200 w. Génie Civil—Feb. 15, 1908. No. 90922 D.

Sewage Disposal.

A Sewage Disposal Plant for a Large Hotel at Bedford, Pa. T. Chalkley Hatton. States the conditions and describes the method of solving the problem. Ills. 1500 w. Eng Rec—March 28, 1908. No. 91203.

The New Sewage Purification Works for Berlin-Wilmersdorf, Germany. William Paul Gerhard. Illustrated detailed description. 3300 w. Eng News—March 19, 1908. No. 91018.

Sewage Purification in Ohio. Notes from a preliminary report by R. Winthrop Pratt, on the conditions at the sewage-purification plants of the state. 3000 w. Eng Rec—Feb. 29, 1908. No. 90604.

Sewage Purification for the City of New York. Walter E. Parfitt. Gives a map showing the vast amount of sewage emptied into New York Bay, discussing the need of its purification, and describing a purification system in which hypochlorous gas is forced into sewage under pressure. Ills. Discussion. 8000 w. Pro Brooklyn Engrs' Club, No. 73—Vol. XI, 1907. No. 91237 N.

The Birmingham Sewage Purification Plant and the Action of Tamworth Against Birmingham (Die Abwasserreinigungsanlagen von Birmingham und der Prozess Tamworth contra Birmingham). Dr. Dunbar. Illustrated description of the Birmingham plant and its effects on Tamworth which resulted in a long litigation. 8500 w. Gesundheits-Ing—Feb. 29, 1908. No. 90972 D.

The Intensive Biological Treatment of Sewage (L'Epuration Biologique Intensive des Eaux d'Egout). M. B. Bezault. A reply to M. Vincey's paper. Defends biological treatment as against the spreading process. Ills. 8500 w. Bul Soc d'Encour—Jan., 1908. No. 90909 G.

See also Filtration, under WATER SUPPLY; and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Sewers.

Reinforced - Concrete Intercepting and Outfall Sewer, Waterbury, Conn. William Gavin Taylor. States the conditions and gives an illustrated detailed description of the combined intercepting and outfall sewer nearing completion. 3500 w. Eng News—March 26, 1908. No. 91175.

The Graphical Determination of the Maximum Capacity of a City Sewerage System (Ueber die zeichnerische Bestimmung der Grösstabflussmengen in städtischen Kanalnetzen). Herr Range. Illustrated description and explanation of method. 3600 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Feb. 7, 1908. No. 90966 D.

Sewer Trestle.

A Reinforced-Concrete Sewer Pipe Trestle. Illustrates and describes a trestle built in Los Angeles, Cal., to carry an intercepting sewer across a river. 1400 w. Eng Rec—March 14, 1908. No. 90842.

Snow Removal.

The Economies of Snow Removal and a Suggested Improvement Over the Present Methods Used in New York. Richard T. Dana. Outlines a method of weighing the snow removed. 1400 w. Engng-Con—March 4, 1908. No. 90714.

Street Cleaning.

See Snow Removal, under MUNICIPAL.

WATER SUPPLY.

Aqueducts.

See Reservoirs, under WATER SUPPLY.

Conduits.

See Los Angeles, Cal., under WATER SUPPLY.

Dams.

The Raising of the Assuan Dam. Gives the reasons for the heightening of the dam, and answers criticisms. 1700 w. Engr, Lond—Feb. 21, 1908. No. 90670 A.

The Construction of the Main Dam of the Croton Falls Reservoir. Illustrates and describes the methods of construction used in building this masonry and concrete dam. 4500 w. Eng Rec—March 28, 1908. No. 91204.

A Concrete and Earth Diversion Dam in California. Detailed account of the design and construction of a dam on the Eel River, which involves features of interest due to the character of the stream and to foundation conditions. 4500 w. Eng Rev—March 14, 1908. No. 90839.

Filtration.

The Design of a Rapid-Sand Water Filtration Plant. H. A. Gehring. Describes a plant for a village under 3000, allowing for a daily per capita consumption of 100 gallons. 3000 w. Cornell Civ Engr—Feb., 1908. No. 90805 C.

Novelties in Filtration and Their Theory. Ad. Kemna. A review of special features introduced in various countries, considering their value. Also editorial on the removal of suspended matters from water and sewage. 8000 w. Eng News—March 26, 1908. No. 91173.

Operating Results at the Harrisburg Filters. Information from the annual report of the Harrisburg, Pa., water-works. 2000 w. Eng Rec—March 14, 1908. No. 90843.

Continuous Filtration of Bath Water: A Description of Its Working. Robert J. Angel. Read before the Assn. of Munic. & Co. Engrs. Describes a system for maintaining the purity of water used in swimming baths, stating the advantages claimed. Ills. Discussion. 6500 w. Surveyor—March 13, 1908. No. 91123 A.

The Filter Plant of the Vienna Water Supply at Tullnerbach (Das Filterwerk der Wientalwasserleitung in Tullnerbach). Johann Vogler. A description of the plant and the results obtained. Ills. 10000 w. Oest Zeit f d Oeffent Baudienst—Feb. 8, 1908. No. 90973 D.

See also Tanks, under WATER SUPPLY.

Fire Protection.

New York's Electrically-Operated, High Pressure Water System for Fire Protection. Illustrates and describes both the Brooklyn and Manhattan systems. 2200 w. Elec Wld—March 14, 1908. No. 90784.

The Fire Department and the High Pressure System. Peter J. McKeon. A critical discussion of the advantages and shortcomings of the high-pressure system. Ills. 4500 w. Cassier's Mag—March, 1908. No. 90818 B.

High Pressure.

See Fire Protection, under WATER SUPPLY.

Irrigation.

Irrigation in Egypt Under British Direction. Sir Hanbury Brown. A review of what has been done under British direction, exclusive of the basin tracts of Upper Egypt and the Sudan. General discussion. 11400 w. Jour Soc of Arts—March 13, 1908. No. 91120 A.

Los Angeles, Cal.

The Water Supply System of Los Angeles, Cal. Outlines the history, and gives an illustrated description of the works recently built to increase the supply. 6000 w. Eng Rec—Feb. 29, 1908. No. 90602.

Pollution.

The Pollution of Waters at Common Law and Under Statutes. Charles F. Choate, Jr. Discusses the property rights as protected by the common law, and the statutes for the protection of public health. General discussion. 9500 w. Jour Assn of Engng Socs—Feb., 1908. No. 91046 C.

Reservoirs.

The Reinforced Concrete Reservoirs and Aqueduct of Mexico City. James D. Schuyler. Illustrated detailed description of extensive and unusual construction of four large circular reservoirs, lined and roofed with armored concrete, and also a large conduit of the same material. 4000 w. Eng Rec—March 28, 1908. No. 91198.

See also Los Angeles, Cal., under WATER SUPPLY.

Salt Lake City.

The Water-Supply System of Salt Lake City, Utah. Describes the conditions in this semi-arid region, and the water rights; Utah Lake pumping station and the conduit system. Ills. 4000 w. Eng Rec—March 21, 1908. No. 91083.

Tanks.

Sand Filters and Clear-Water Tanks for Small Water-Works. Drawings for the Hamilton Water Supply Works, in Lanarkshire, with description. 1500 w. Engng—March 6, 1908. No. 91002 A.

The Construction of a Combined Smokestack and Water Tank. H. Stoffels. Plans and detailed description of this structure and the calculation of the stresses. 800 w. Engng News—March 12, 1908. No. 90789.

Water Meters.

Notes on the Measurement of Flowing Water. Ernest W. Schoder. Some of the more simple and common methods of measurement and their accuracy are discussed. 2000 w. Cornell Civ Engr—March, 1908. No. 91227 C.

Water Towers.

A Very Large Water Tower. A tank, supported on a tall steel tower, recently constructed at Louisville, Ky., is illustrated and described. 2200 w. Eng Rec—March 7, 1908. No. 90703.

Water Works.

Small Water Supplies. H. C. H. Shenton. Discusses in detail the general design of a water-works system, and how the supply may be best conducted to the required places. Ills. 12700 w. Pub Works—Jan., 1908. No. 90651 B.

Gas Engine Water Works Plant at Brookville, O. H. E. Couts. Illustrated description of a small plant serving a population of 1200. Water is obtained from four artesian wells, the engine room equipment consists of power pumps and air compressors belted to gas engines. 1200 w. Engr, U S A—March 16, 1908. No. 90859 C.

See Salt Lake City, under WATER SUPPLY.

Well Driving.

California Stove-Pipe Wells on Long Island. Describes the method of driving these wells, and the outfit used. Ills. 2500 w. Eng Rec—Feb. 29, 1908. No. 90608.

WATERWAYS AND HARBORS.

Barge Canal.

The New York Barge Canal vs. the Deep Waterway. A critical letter from Col. Thomas W. Symons, with editorial comments on the questions discussed. 3500 w. Eng News—March 5, 1908. No. 90696.

Blyth.

Blyth Harbor Improvements. Brief review of the development of this port and illustrated description of the extensive improvements now in progress, including the reconstruction of piers, erection of lighthouse, underpinning quay wall, deepening of the harbor, etc. 2500 w. Engr, Lond—March 6, 1908. No. 91006 A.

Breakwaters.

A Novel Breakwater for Algoma Harbor, Wis. Brief description of a breakwater consisting of reinforced concrete caissons, resting on pile foundations. Ills. 1000 w. Eng Rec—March 21, 1908. No. 91084.

Canal Haulage.

Notes on Electric Haulage of Canal Boats. Lewis B. Stillwell and H. St. Clair Putnam. An account of tests made on the Lehigh Canal, near Mauch Chunk, Pa., and the results. Ills. 4500 w. Pro Am Inst of Elec Engrs—March, 1908. No. 90832 D.

Mechanical Haulage on Canals. Editorial discussion of the report recently issued by the British royal commission dealing with this subject. 1400 w. Ry Age—March 6, 1908. No. 90753.

Canals.

See Barge Canal, Georgian Bay Canal, and Panama Canal, under WATERWAYS AND HARBORS.

Coast Defense.

Some Engineering Features of Coast Defense. Kingsley L. Martin. Considers the engineering methods which enter into the work done. Discussion. 6000 w. Pro Brooklyn Engrs Club, No. 78—Vol. XI, 1907. No. 91242 N.

Coast Protection.

Erosion of the Coast and Its Prevention. F. W. S. Stanton. The first of a series of articles discussing the agents of destruction and construction, especially their effects on the English coast, and methods of coast defense. 2800 w. Pub Works—Jan., 1908. No. 90654 B.

Dredging.

Subaqueous Rock Removal. Brysson Cunningham. Illustrates and describes the methods available for this work. 2500 w. Cassier's Mag—March, 1908. No. 90824 B.

A Sub-Aqueous Rock-Cutter Dredger. Benjamin Taylor. Illustrated description of a rock-cutter just completed for operation on the river Blyth, Northumberland. 1500 w. Int Marine Engng—April, 1908. No. 91107 C.

A Novel Dredge Director. Illustrates and describes a machine, recently designed, by means of which the operator can so control the movements of the dredge as to produce a cross-section of excavation of any desired shape. 1000 w. Int Marine Engng—April, 1908. No. 91108 C.

The Fruhling System of Suction Dredging. John Reid. Shows some of the causes for the low efficiency of the ordinary suction dredge and gives an illustrated description of the improved system developed by Otto Fruhling, of Germany. 3500 w. Eng News—March 5, 1908. No. 90690.

The Cost of Hydraulic Dredging on the Mississippi River. A memorandum by Lieut. Col. Clinton B. Sears for the Board of Engineers on the Improvement of the Ohio River. 1200 w. Eng Rec—March 21, 1908. No. 91086.

Georgian Bay Canal.

The Montreal, Ottawa and Georgian Bay Canal. On the inportance of this canal project, and the route selected. 3000 w. Marine Rev—March 12, 1908. No. 90836.

Harbors.

See Blyth, under WATERWAYS AND HARBORS; and Terminals, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Lighthouses.

See Foundations, under CONSTRUCTION.

Panama Canal.

The Strategical and Economical Effect of the Opening of the Panama Canal. Archibald R. Colquhoun. Outlines the present state of affairs in this great undertaking, and aims to show that the immediate result will be a great naval development of the United States. Considers briefly the strategic importance to Gt. Britain of retaining a stronghold in the Caribbean Sea. Also discussion. Maps. 12,000 w. Jour Roy U Serv Inst—Feb. 1908. No. 90685 E.

U. S. Waterways.

Preliminary Report of the Inland Waterways Commission. The message of the President and the commission's report are given in condensed form, with editorial comment. 6500 w. Eng News—March 5, 1908. No. 90694.

Some of the Engineering Problems Involved in the Construction of a Deep Waterway from the Great Lakes to the Gulf of Mexico. J. A. Ockerson. The problems of a deep waterway by the way of the Illinois and Mississippi rivers are discussed. Ills. 6000 w. Jour Assn of Engng Socs—Feb., 1908. No. 91049 C.

MISCELLANY.

Grubbing.

Methods of Grubbing Stumps and Trees. Illustrated description of methods used. 2500 w. Engng-Con—March 25, 1908. No. 91192.

Natural Resources.

Conservation of National Resources. H. M. Wilson. Brief account of the work being done by the U. S. Geol. Survey to reduce the waste of timber, fuel, mineral, lands and water. 1200 w. Cement Age—March, 1908. No. 91051.

Sand Damage.

Sand Waves and Their Work. Day Allen Willey. An illustrated article describing the ravage in desert regions, and some methods of fighting the sand. 2000 w. Sci Am Sup—Feb. 22, 1908. No. 90588.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-telegraphy.

Mr. Marconi on Wireless Telegraphy. Abstract of an address before the Chamber of Commerce, at Liverpool. Considers applications made and how it can be further utilized in the interests of commerce and industry. 2500 w. Electn, Lond—Feb. 28, 1908. No. 90766 A.

Wireless Telegraph Plant at the United States Naval Academy. W. H. G. Bullard. Illustrated description of this station at Annapolis, Md., and its equipment; also describing the instruction given midshipmen. 2000 w. Elec Wld—March 21, 1908. No. 91015.

Telegraphy.

See Telepost, under COMMUNICATION.

Telemechanic.

Dr. Branly's "Tele-Mechanic" Apparatus and Protecting Device. Louis Dubois. Describes this apparatus for controlling electrical apparatus at a distance by means of electric waves, and also a protecting apparatus to prevent accidental sparks from taking effect. Ills. 2500 w. Elect'n, Lond—March 6, 1908. No. 90895 A.

Telephone Cables.

Aerial and Underground Construction. C. H. Judson. Abstract of a paper read before the Int. Ind. Tel. Assn. Arguments, and comparisons, showing that underground conduits are in the end more economical. 2000 w. Elec Rev, N. Y.—March 7, 1908. No. 90726.

See also Cables, under TRANSMISSION.

Telephone Lines.

The Standard Specifications for Telephone Lines of the United States Reclamation Service. Outlines the proper construction. 3000 w. Eng News—March 12, 1908. No. 90793.

Telephony.

The Telephone System of the Transvaal. J. Grant. Gives the history of the development and present state of this industry, giving map and diagrams. 4000 w. Jour S African Assn of Engrs—Jan., 1908. No. 90756 F.

The Propagation of Telephonic Currents Through Underground Conductors. H. Abraham and Devaux-Charbonnel. Trans. from *Comptes Rendus*. Investigations to determine whether the actual propagation of telephonic currents is sufficiently represented by the well-known formulæ. 1200 w. Elect'n, Lond—Feb. 28, 1908. No. 90765 A.

See also Phase Differences, under MEASUREMENT.

Telephotography.

Telephotography (La Téléphotographie). G. Cerbelaud. A review of its development and the present systems. Ills. 4800 w. Génie Civil—Feb. 1, 1908. No. 90919 D.

Telepost.

"Electro-Magnetic" Automatic Telegraphy. ("The Telepost.") Patrick B. Delany. Illustrated explanation of a new method, its advantages and applications. 3500 w. Jour Fr Inst—March, 1908. No. 91064 D.

DISTRIBUTION.

Fuses.

Fuse Phenomena. Alfred Schwartz and W. H. N. James. Discusses points to be considered in choosing a suitable metal for a fuse. Also the rating of fuses. Ills. 10000 w. Inst of Elec Engrs—March 5, 1908. No. 90893 N.

Switchboards.

See same title, under GENERATING STATIONS.

Switches.

The Design of Battery Switch Connections (Bemessung von Zellenschalterleitungen). Franz Steindl. A mathematical discussion of single and double battery switches. Ills. 2000 w. Elektrotechnik u Maschinenbau—Feb. 16, 1908. No. 90965 D.

DYNAMOS AND MOTORS.

A. C. Motors.

A Method for Calculating the Short-Circuit Current in Three-Phase Motors. W. Oelschläger. Abstracted from the *Elektrotechnische Zeitschrift.* Shows a method whereby the short-circuit current can be calculated directly from the main dimensions of the machine. 1000 w. Elect'n, Lond—March 13, 1908. No. 90999 A.

See also Railway Motors, under DYNAMOS AND MOTORS.

Brushes.

Standardization Tests on Carbon Brushes for Dynamos and Motors. Abstracted from the *Bul. de la Soc. Int. des Electns.* Tests including determinations of density, porosity, tensile strength and compression as well as wear, resistivity and friction 2500 w. Elect'n, Lond—Feb. 28, 1908. No. 90763 A.

D. C. Dynamos.

A New Train-Lighting Dynamo. Explains the principle of the direct-current dynamo recently brought out by the Felten & Guilleaume-Lahmeyer Werke. Ills. 1000 w. Elec Rev, Lond—Feb. 21, 1908. No. 90660 A.

Flame-proof Motors.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE.

Insulation.

Coil Insulation in Electrical Apparatus. J. A. Jacobs. Read before the Ohio Soc. of Mech., Elec., & Steam Engrs. Considers the wire insulation, internal insulation, and external insulation. 2200 w. Engr, U. S. A.—March 16, 1908. No. 90860 C.

Insurance.

See same title, under GENERATING STATIONS.

Railway Motors.

The Alternating Current Railway Motor. S. M. Kintner. States the points in which alternating-current railways show improvement over direct-current; discusses motors suited to the two kinds of service, especially the single-phase motor and matters relating to it. Ills. 4500 w. Pro Engrs' Soc of W Penn—Feb., 1908. No. 90834 D.

Windings.

Square-Core and Round-Core Windings. Charles R. Underhill. Discusses the calculation of windings for electromagnets with cores of square or rectangular cross-section. 1200 w. Elec Wld—March 28, 1908. No. 91171.

ELECTRO-CHEMISTRY.

Diaphragms.

Diaphragms. J. R. Crocker. Gives a brief description of the attempts which have been made to meet the varied requirements when diaphragms are necessary. Ills. 2500 w. Elec-Chem & Met Ind—April, 1908. No. 91250 C.

Electro-Metallurgy.

Electric-Furnace Reactions Under High Gaseous Pressures. R. S. Hutton and J. E. Petavel. Abstract of paper communicated to the Royal Soc. Describes the large high pressure furnace used and the investigations carried out. 9000 w. Engng—Feb. 21 and 28, 1908. Serial. 2 parts. No. 90769 each A.

Electric-Furnace Reactions Under High Pressure. Dr. R. S. Hutton and J. E. Petavel. Extract from a paper before the Royal Soc. of London. Illustrates and describes interesting experiments with high pressures. 2500 w. Elec-Chem & Met Ind—March, 1908. No. 90642 C.

See also same title, under MINING AND METALLURGY, IRON AND STEEL; and Aluminium, under MINING AND METALLURGY, MINOR MINERALS.

Electro-plating.

The Rapid Deposition of Nickel. Illustrated description of Canning's method of agitating a nickel plating solution. 900 w. Brass Wld—March, 1908. No. 91060.

Electro-deposition of Copper and Tin Bronze. Observations and results of experience with deposits of this nature. 1300 w. Brass Wld—March, 1908. No. 91059.

Method for the Determination of the Free Cyanide in Silver and Copper Plating Solutions. Describes the process of testing the plating solution. 2000 w. Brass Wld—March, 1908. No. 91058.

Hydrogen.

The Electrolytic Production of Hydrogen and Its Application to Aeronautics and in Other Fields (Die Elektrolytische Gewinnung des Wasserstoffs und seine Verwendung für Luftschiffahrts und andere Zwecke). Describes the process and necessary plant. Ills. 1400 w. Serial. 1st part. Elektrochem Zeitschr—Feb., 1908. No. 90945 G.

ELECTRO-PHYSICS.

Induction.

A New Factor in Induction; the "Loop" vs. the "Cutting Lines of Force" Laws. Carl Hering. A discussion of the two working hypotheses for explaining quantitatively the induced electromotive force. Also editorial. 4800 w. Elec Wld—March 14, 1908. No. 90785.

An Imperfection in the Usual Statement of the Fundamental Law of Electromagnetic Induction. Carl Hering. Points out that it is not correct as a universal law, and requires to be modified; proof is given by a simple experiment. 3500 w. Pro Am Inst of Elec Engrs—March, 1908. No. 90833 D.

See Current Balance, under MEASUREMENT.

GENERATING STATIONS.

Accumulators.

The Care of Storage-Battery Cells. William Kavanagh. Considers how to maintain a battery in the most efficient condition. 1200 w. Power—March 17, 1908. No. 90876.

Central Stations.

Combined Central-Station and Water-Pumping Plant. A plant at Pine Bluff, Ark., a city of about 20,000 inhabitants, is illustrated and described. 1600 w. Elec Wld—Feb. 29, 1908. No. 90617.

Steam Turbine Power and Transmission Plant of the Moctezuma Copper Company, at Nacozari, Sonora, Mexico. John Langton and Charles Legrand. Illustrated description of the plant and its equipment. 5000 w. Can Soc of Civ Engrs—March 5, 1908. No. 91210 N.

See also Electric Power, under MINING AND METALLURGY, MINING.

Design.

Coupling Gas- and Steam-Engine Driven Generators (Couplage d'un Groupe Moteur à Gaz avec des Groupes Moteurs à Vapeur). C. Roche. Describes interesting work at the Biarritz station in arranging for the parallel operation of single-phase dynamos driven by gas and steam power. Ills. 2500 w. Génie Civil—Feb. 1, 1908. No. 90920 D.

Economics.

Publicity for Small Undertakings.-Remarks referring to towns of 30,000 inhabitants, or less. 2200 w. Elec Rev, Lond—Feb. 28, 1908. Serial. 1st part. No. 90762 A.

A Handy Curve Sheet. John B. Morgan. A brief description of a method of plotting central-station outputs and costs in the form of curves. 800 w. Elec Rev, Lond—Feb. 28, 1908. No. 90761 A.

Poor Light Complaints—A Central Station Problem. H. N. Muller. Briefly considers the causes of dissatisfaction with the lighting service, especially discussing the logic of free lamp renewals. 2500 w. Elec Jour—March, 1908. No. 90796.

The Electric Motor Load from the View Point of Central-Station Service. Charles K. Nichols. An illustrated article considering some of the applications that help to develop the power load. 3000 w. Elec Wld—March 7, 1908. No. 90730.

I. Electric Service of the Fitchburg Gas & Electric Company. William H. Stuart. Illustrated description of the plant and the business methods. II. Electric Power, Its Progress and Possibilities. A. H. Kimball. A detailed account of the building up of the Fitchburg power load and motor service. 3000 w. Elec Wld—March 7, 1908. No. 90729.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Hydro-Electric.

The Kashmir Hydroelectric Works. Cy. Whitwell. Illustrated description of a development in India. 2000 w. Elec Rev, N Y—March 28, 1908. No. 91187.

A Hydro-Electric Development in Utah. Illustrates and describes a development recently placed in operation by the Telluride Power Co., which supplies power for mining and smelting and for various other purposes. 4000 w. Eng Rec—March 14, 1908. No. 90844.

The Colliersville Hydro-Electric Plant. Illustrated description of a power-plant on the Susquehanna River, in Otsego Co., N. Y., to furnish power for a 65-mile line of railway and for power and lighting purposes. 2000 w. Eng Rec—March 7, 1908. No. 90698.

The Hydro-electric Plant of the Rockingham Power Company. Julian S. Miller. An illustrated account of a plant on the Pee Dee River, North Carolina, being constructed to supply 28,800 hydroelectrical horse-power. 3000 w. Elec Rev, N Y—March 14, 1908. No. 90846.

The Sioule Hydro-Electric Plant (Usine Hydraulico-Electrique de la Sioule). J. A. Montpellier. Illustrated description of a 1200 horse-power plant in France. 3200 w. Serial. 1st part. Elect'n—Feb. 22, 1908. No. 90914 D.

The Hydro-Electric Plant at Brillanne on the Durance (Usine Hydro-Electrique de la Brillanne sur la Durance). A. Bidault des Chaumes. Illustrated description of this 3500 horse-power plant. 3500 w. Génie Civil—Feb. 22, 1908. No. 90923 D.

The Lebring Electric Plant, Steiermark (Das Elektrizitätswerk Lebring in Steiermark). Illustrated detailed description of building and hydraulic and electrical installations. 2800 w. Serial. 1st part. Elektrotech u Maschinenbau—Feb. 9, 1908. No. 90964 D.

See also Turbines, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Insurance.

The Insurance of Electrical Plant Against Breakdown. William R. Bowker. An account of this business in Great Britain and the methods that have made it a profitable venture. 4500 w. Cassier's Mag—March, 1908. No. 90819 B.

London.

Bulk Supply in Greater London Area. J. Horace Bowden and Fred Tait. A critical discussion of the schemes put forward. 2200 w. Elec Rev, Lond—March 6, 1908. Serial. 1st part. No. 90892 A.

Porto Rico.

Electrical Developments in Porto Rico. An illustrated account of the construction of railways and electrical plants for power and light. 1500 w. Elec Wld—March 28, 1908. No. 91169.

Switchboards.

Some Notes on Switchboard Operation in Alternating-Current Stations. H. R. Mason. Calls attention to seemingly trifling things which are productive of disastrous results. 1800 w. Power—March 10, 1908. No. 90747.

LIGHTING.

Electric vs. Gas.

The Development and Present Position of Gas and Electricity for Lighting. Sydney F. Walker. A review of the early history of electric lighting and the effect on the gas industry, the competition, and future outlook. 2200 w. Cent Sta—March, 1908. No. 90744.

The Relative Hygienic Values of Gas and Electric Lighting. Samuel Rideal. Reports an inquiry made to determine and compare the hygienic effects of gas and electricity as used for ordinary domestic lighting. 28000 w. Jour Roy San Inst—March, 1908. No. 90829 B.

Illumination.

Influence of the height of Suspension Upon Uniform Illumination. Alfred A. Wohlauer. A study of illumination by means of a number of similar equidistant lamps at a uniform elevation. Also editorial. 2200 w. Elec Wld—March 21, 1908. No. 91016.

A New Graphic Method for Determining the Mean Spherical Intensity of a Lamp by the Length of a Straight Line When the Curve of Mean Meridional Intensity is Given. A. E. Kennelly. Analyzes examples of the use of the Rousseau diagram, and explains the new method. Editorial note. 3300 w. Elec Wld—March 28, 1908. No. 91170.

Incandescent Lamps.

The New Metal Flament Lamps: Their Qualities and Their Commercial Importance. H. Remané. Abstract of a paper read before the Elektrotechnische Verein, in Leipzig. Information relating to the manufacture of the filaments, and their efficiency. 2200 w. Elec Engr, Lond—Feb. 21, 1908. No. 90659 A.

Photometry.

Primary Standard of Light. Charles P. Steinmetz. Recommends mercury lamps as the sources of three monochromatic radiations, which combined give the primary standard of light. 12000 w. Pro Am Inst of Elec Engrs—March, 1908. No. 90831 D.

Working Standards of Light and Their Use in the Photometry of Gas. Charles O. Bond. Considers the qualities an ideal working standard would possess, and discusses the standards in general use in America. Ills. 5500 w. Jour Fr Inst—March, 1908. No. 91065 D.

MEASUREMENT.

Current Balance.

A New Current Weigher and a Determination of the E. M. F. of the Normal Weston Cadmium Cell. Prof. W. E. Ayrton, T. Mather, and F. E. Smith. Illustrates and describes an instrument designed and made by the authors, for the absolute determination of current. 3000 w. Elect'n, Lond—Feb. 28, 1908. No. 90764 A.

Meter Testing.

Testing Electric Meters at Their Place of Installation. Joseph B. Baker. The present article deals with the outfit needed in testing meters on the consumers' premises. Ills. 1200 w. Elec Wld—March 7, 1908. Serial. 1st part. No. 90728.

Phase Differences.

The Direct Measurement of Differences of Phase by the Abraham Galvanometer and Its Applications in Telephony (Emploi du Galvanomètre Abraham pour la Mesure Directe des Differences de Phase. Applications à la Téléphonie). M. Devaux-Charbonnel. Describes the instrument and gives a mathematical discussion of its use. Ills. 5300 w. Bul Soc Int des Elec'ns—Feb., 1908. No. 90904 F.

Resistance.

A Resistance Comparator. W. Clark Fisher. Discusses the advantages of the potentiometer method of comparing resistances, and describes the author's designs. Also refers to the plotting of results. Ills. 2000 w. Elect'n, Lond—March 6, 1908. Serial. 1st part. No. 90894 A.

TRANSMISSION.

Cables.

Electric Cables. Henry W. Fisher. Notes on the improvements made in this industry in the last twenty years. Ills. 2000 w. Sib Jour of Engng—March, 1908. No. 91067 C.

Condensers.

The Use of Condensers on High-Tension Circuits. From *Elektrische Kraftbetriebe und Bahnen.* Shows how they can be advantageously used, especially in connection with the protection of transmission lines against voltage rises. 1100 w. Elec Engr, Lond—March 6, 1908. No. 90890 A.

Conduits.

The Underground Conduit System for Electric Light and Power Wires. A. J. Quigley. Deals with the construction of an underground conduit system for the city of Davenport, Ia. Ills. 3500 w. Wis Engr—Feb., 1908. No. 91224 D.

Grounds.

Notes on Resistance of Gas-Pipe Grounds. J. L. R. Hayden. Gives results of an investigation made to get data in the resistance offered by gas-pipe grounds, their permanence and variation. Also discussion 1500 w. Pro Am Inst of Elec Engrs—March, 1908. No. 90830 D.

Line Construction.

See Telephone Lines, under COMMUNICATION.

Line Design.

A Transmission Line Considered as a Mechanical Structure. W. T. Ryan. Gives equations made use of in the mechanical design of the line. 2000 w. Elec Wld—Feb. 29, 1908. No. 90618.

Rotary Converters.

The Cascade Converter (Kaskadenumformer). August Bloch. An illustrated description of the design and construction of these machines. 3600 w. Elektrotech u Maschinenbau—Feb. 2, 1908. No. 90963 D.

The Cascade Converter. Abstract translation of an article by Herr A. Bloch in *Elektrotechnik und Maschinenbau.* Illustrated description of this machine and its operation. 1400 w. Elec Engr, Lond—March 6, 1908. No. 90889 A.

Substations.

See Berlin, under STREET AND ELECTRIC RAILWAYS.

Systems.

The Central Station Distributing System. H. B. Gear and P. F. Williams. Reviews critically the various general types of distributing systems which have come into use. 4000 w. Elec Age—Feb., 1908. No. 90725.

Transformers.

Current Rushes at Switching. J. S. Peck. An explanation of the phenomena. 1500 w. Elec Jour—March, 1908. No. 90797.

MISCELLANY.

Electric Fans.

Comparative Tests of Different Types of Electric Fans. Arthur C. Scott. An outline description and report of tests made of seven fans, three built to operate with direct current and four with alternating current. 2000 w. Elec Wld—March 7, 1908. No. 90727.

Farm Work.

Electric Power for Farm Work. Reprints an article by Jared Van Wagenen, published in the *Rural New-Yorker,* describing a method employed for utilizing a small water power to generate electricity for lighting and power purposes. Also editorial. 2500 w. Elec Rev, N Y —March 28, 1908. No. 91188.

Nomenclature.

Engineering Nomenclature. Robert H. Smith. Briefly considers algebraic symbolism, uniform technical names, and simple short names for the units, giving a list of such proposed names. 2000 w. Elec Engr, Lond—March 13, 1908. No. 91133 A.

INDUSTRIAL ECONOMY

Education.

The Influence of Technical Schools. John J. Stevenson. Discusses the aims of schools of applied science and the aims of classical studies. 2500 w. Pop Sci M—March, 1908. No. 90817 C.

A Comparison of University and Industrial Methods and Discipline. Frederick W. Taylor. Discusses the preparation of young men for success in commercial engineering and industrial enterprises. 3300 w. Wis Engr—Feb., 1908. No. 91225 D.

Notes on Four Years' Working of the Educational Committee's Recommendations. W. G. Spence. On the results of adopting a system of marking for recording the time keeping, industry, and evening study of apprentices. Discussion. 9000 w. Trans N-E Coast Inst of Engrs & Shpbldrs—Feb., 1908. No. 91244 N.

The Development of Higher Technical Education in Germany (Desarrollo de la Enseñanza Téchnica Superior en Alemania). Alvaro Llatas. A review of past and present conditions. Ills. 11500 w. Rivista Tech Indus—Jan., 1908. No. 90929 D.

The Practical Workshop Training of the Academic Mechanical Engineer (Die praktische Werkstattausbildung der akademischen Maschineningenieure). F. zur Nedden. A discussion of German and American methods in engineering apprenticeship courses. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 1908. No. 90980 D.

Eight-Hour Day.

Eight Hours' Day in Coal Mines. Comments on the first report of the Departmental Committee appointed to inquire into the probable economic effect of a limit of eight hours to the working day of coal miners, and on other works on this subject. 6500 w. Quarterly Rev—Jan., 1908. No. 91071 N.

Filing Systems.

Loose-Leaf Binders. J. H. Haertier. Explains methods of recording data in regard to the progress and cost of work, and of filing general information. 4800 w. Mines & Min—March, 1908. No. 90676 C.

Industrial Classification.

The Classification of Industrial Enterprises. William D. Ennis. An analytical study of various industries showing that the relation of costs to values of output gives the most satisfactory basis. 5400 w. Stevens Ind—Jan., 1908. No. 91194 D.

Labor.

American Industrial Conditions from a Workman's Viewpoint. A commentary by a New England machinist on Dr. Louis Bell's article "Wake Up America." 1300 w. Engineering Magazine—April, 1908. No. 91235 B.

Labor Insurance.

Workmen's Sick Funds and Insurance (Krankenkassen und Krankenfürsorge). Moritz Böker. A discussion of conditions in Germany. 4300 w. Stahl u Eisen—Feb. 26, 1908. No. 90935 D.

Management.

A Simple and Complete Draftingroom System. William F. Zimmermann. Illustrates and describes a system used in a Newark, N. J., plant. 4500 w. Am Mach—Vol. 31, No. 11. No. 90780.

The Rapid Handling of a Large Payroll. George Frederic Stratton. Describes method by which 11,000 employes are paid off in 20 minutes. 2200 w. Am Mach—Vol. 31, No. 10. No. 90689.

The General Shop Order (Die Generalstückliste). C. Redtmann. Illustrates and describes a shop-order form, explaining the importance of the system. 2000 w. Zeitschr f Werkzeug—Feb. 5, 1908. No. 90948 D.

Effective Machine-Shop Organization. Alexander Taylor. Describes the plan of reorganization of the Westinghouse Elec. & Mfg. Co. 1700 w. Am Mach—Vol. 31, No. 12. No. 91008.

Tracing the Work Through the Shop. Oscar E. Perrigo. Sixth of a series of articles on shop management and cost keeping. Gives the plan used in a shop making a variety of gears. 2500 w. Ir Trd Rev—March 5, 1908. No. 90711.

The Regeneration of the Old Shop. An illustrated article describing the abandonment of old methods and specializing in the manufacture of wood-working machinery. 2000 w. Am Mach—Vol. 31, No. 10 No. 90686.

Cost Reduction for Manufacturin Plants. Maurice Gesundheit. Read be fore the Metal Mfrs. Assn. of Phila. Dis cusses the various measures resorted t for reducing costs and their defects, sug gesting a remedy. 5000 w. Eng News— March 5, 1908. No. 90693.

Maximum Production Through Organ ization and Supervision. C. E. Knoeppe This first of a series of four articles dis cussing the adjustment of organization t secure the greatest efficiency. 3500 w. En gineering Magazine—April, 1908. Seria 1st part. No. 91234 B.

The Fundamental Principles of Work Organization and Management. P. J Darlington. This second article on thi subject deals with developing new prod uct and determining shop cost. 4500 w Engineering Magazine—April, 1908. No 91232 B.

See also Profit Sharing, Purchasing and Wages, under INDUSTRIAL ECONOMY.

Municipal Control.

The Municipality and the Public Utili ties. Hubert S. Wynkoop. Gives briefl the writer's views on the control and reg ulation of public utilities by municipali ties. 1200 w. Stevens Ind—Jan., 1908 No. 91195 D.

Patents.

The New British Patent Act. Georg Barker. An abstract of the more impor tant provisions of the new act. 1500 w Cassier's Mag—March, 1908. No. 90 826 B.

Does the Inventor Get a Square Dea at the Hands of the United States Gov ernment? H. Ward Leonard. A criticism of the working of the United States pat ent system, with editorial. Also article b Joseph B. Baker on "Salaries of Paten Office Examiners." 5000 w. Elec Wld— March 14, 1908. No. 90786.

Profit Sharing.

Profit Sharing. A Wilson. An expla nation of how such a system may be ap plied and its advantages. 2800 w. Cas sier's Mag—March, 1908. No. 90823 B.

Purchasing.

A Complete System for the Purchasin Department. J Cecil Nuckols. Deals wit methods and records necessary to intelli gent buying, giving forms. 1500 w. Engi neering Magazine—April, 1908. No. 91 230 B.

Wages.

The Payment of Wages. Forrest E Cordullo. Discusses the three systems i general use, their defects and virtues also the requirements of the best system and the system called the "Diminishin Premium System." 5000 w. Ir Trd Re —March 19, 1908. No. 91034.

MARINE AND NAVAL ENGINEERING

Battleships.

On the Size of Battleships. Sidney Graves Koon. A comparative analysis showing the great sacrifice in efficiency where the size is reduced. 2000 w. Engineering Magazine—April, 1908. No. 91-229 B.

A Review of All the Battleships Built During the Last Twenty Years and All the Armored Cruisers Built During the Last Fifteen Years, by the Eight Great Sea Powers (Uebersicht über alle in den letzten zwanzig Jahren abgelaufenen Linienschiffe und über alle in den letzten fünfzehn Jahren abgelaufenen Panzerkreuzer der acht grössten Seestaaten). Franz Eisenhardt. Gives statistics year by year. 3500 w. Schiffbau—Feb. 12, 1908. No. 90955 D.

Cruisers.

See Battleships, under MARINE AND NAVAL ENGINEERING.

Dredges.

See Dredging, under CIVIL ENGINEERING, Waterways and Harbors.

Dry Docks.

A New Method of Pumping Floating Dry Docks. William T. Donnelly. An illustrated explanation of the operation of the system and details of construction, stating the advantages claimed. Discussion. 10500 w. Pro Brooklyn Engrs' Club, No. 76—Vol. XI, 1907. No. 91-240 N.

American Docking Facilities on the Pacific Coast. H. A. Crafts. A review of the dry-dock facilities showing their inadequacy for keeping the vessels of Admiral Evans' fleet in first-class condition while in Pacific waters. 2500 w. Cassier's Mag—March, 1908. No. 90822 B.

Floating Docks (Zur Frage der Schwimmdocks). O. Flamm. Describes various types and discusses their design. Ills. 3000 w. Schiffbau—Feb. 26, 1908. No. 90952 D.

The Floating Dock of the Compagnie Générale de Navigation on Lake Léman at Ouchy (Dock Flottant de la Compagnie Générale de Navigation sur le Lac Léman à Ouchy). J. Michaud. Illustrated description of a dock for lifting 400-ton ships. 1800 w. Serial, 1st part. Bul Tech de la Suisse Romande—Feb. 25, 1908. No. 90915 D.

Ferryboats.

New Western River Car Transfer Paddle Ferryboat Albatross. Illustrated detailed description of a steel hull side-wheel boat for transferring cars between Vicksburg and the Delta on the Mississippi River. 1600 w. Naut Gaz—March 5, 1908. No. 90674.

Gyrostats.

The Use of Gyrostats. An explanation by Prof. Perry of what inventors using gyrostats have succeeded in doing, especially considering their application to reducing the rolling of ships and to the monorail railway. Ills. 3800 w. Nature—March 12, 1908. No. 91122 A.

Internal-Combustion Engines.

See Motor Boats, and Oil Engines, under MARINE AND NAVAL ENGINEERING.

Marine Transport.

Transportation on the Great Lakes. Walter Thayer. Describes the origin, character, and method of handling the tonnage of the Great Lakes. 5500 w. Naut Gaz—March 12, 1908. No. 90779.

Motor Boats.

Motor Boating for the Man of Small Means. Harry Wilkin Perry. An illustrated article giving information in regard to the application of motors to canoes and small boats. 3000 w. Sci Am—Feb. 29, 1908. No. 90599.

Inland Motor Boating. H. R. de Salis. Abstract of a paper on "Pleasure Cruises for Motor Boats on the Inland Navigations of England and Wales," read before the Motor Yacht Club. Concerning the conditions of travelling, and related matters. 3500 w. Auto Jour—Feb. 29, 1908. Serial, 1st part. No. 90757 A.

The Racing Motor-Launch "Siddeley-Wolseley." Illustrated detailed description of a boat to be entered at the Monte Carlo races. 1000 w. Engng—Feb. 21, 1908. No. 90668 A.

Motor-Pinnace for the Royal Navy. Illustrations and brief description of a boat originally equipped with steam machinery, showing the saving in space resulting from the change to internal-combustion engines. 500 w. Engng—March 13, 1908. No. 91141 A.

Oil Engines.

Thornycroft Paraffin Engines for the Italian Navy. Illustrates and describes these marine engines. 1800 w. Auto Jour—Feb. 22, 1908. Serial, 1st part. No. 90649 A.

Diesel Oil Engines for Ship Propulsion. Franz Erich Junge. Gives results of test of the latest type of high-speed Diesel engine, built especially for marine service. Ills. 2500 w. Power—March 24, 1908. No. 91113.

Shipbuilding.

Shipbuilding in 1907 (Der Schiffbau im Jahre 1907). F. Meyer and H. Dörwaldt. The first number of the serial gives detailed statistics for Germany. 4000 w. Serial, 1st part. Schiffbau—Feb. 26, 1908. No. 90954 D.

Steamboats.

The Fast Steamer Florida. George Jenkins and A. E. Woodruff. Illustrated description of a fine new vessel for service between Baltimore and Norfolk. 1200 w. Int Marine Engng—April, 1908. No. 91104 C.

Steam Boilers.

Some Remarks on the Design, Construction and Working of the Marine Boiler. Richard Hirst. Gives opinions on prevailing practice. 3500 w. Boiler Maker—April, 1908. No. 91245.

Steam Engines.

See Steam Turbines, under MARINE AND NAVAL ENGINEERING; and Lubricants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Steamships.

Steam Lumber Schooners for the Pacific Coast. Illustrated detailed description of two vessels of unique design for this service. 2000 w. Int Marine Engng—April, 1908. No. 91106 C.

Recent Freight Steamship Designs. Illustrations, with brief descriptions of two recent vessels—the "Echunga" and a freighter for the Norwegian trade. 1000 w. Sci Am Sup—March 28, 1908. No. 91180.

The Argo Liner "Schwan" (Der Argo-Dampfer "Schwan"). Franz Judaschke. Illustrated description of this vessel for service between Bremen and London. 1600 w. Schiffbau—Feb. 26, 1908. No. 90953 D.

Steam Turbines.

Turbines versus the Reciprocating Engine for Marine Purposes. Ferdinand La-Motte Gilpin, Jr. Calls attention to the advantages of turbines. 1800 w. Yale Sci M—March, 1908. No. 91040 C.

Submarines.

The Relation of the Government to the Development of Submarine Vessels. Letter from R. G. Skerrett, making statements relating to the United States government and its relation to the Holland Company experiments. 2500 w. Sci Am Sup—March 21, 1908. Serial. 1st part. No. 91024.

Warships.

The Relative Values of Warships. C. T. Brady, Jr. Derives a formula used by the writer for comparison of ships. Also editorial criticism. 1300 w. Int Marine Engng—April, 1908. No. 91105 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Commercial Vehicles.

See Electric, Omnibuses, and Road Trains, under AUTOMOBILES.

Construction.

The Bracing of Motor-Car Frames. Discusses prevailing practice in the bracing of pressed-steel frames, the stresses, etc. 2500 w. Engng—Feb. 21, 1908. No. 90665 A.

See also Ball Bearings, under MACHINE ELEMENTS AND DESIGN; and Alloy Steels, under MATERIALS OF CONSTRUCTION.

Crankshafts.

Design and Construction of Crankshafts. P. M. Heldt. Read before the Soc. of Auto. Engrs. at Boston. Illustrates and describes crankshafts of 1907 and 1908 models of American four-cylinder engines, showing a considerable variety in design, and discusses their requisites, design, materials, etc. 3300 w. Automobile—March 19, 1908. No. 91073.

Design.

The Design of the Automobile and Some Problems Peculiar to It. F. W. Lanchester. Read before the Inst. of Auto Engrs. Deals with suspension; dynamical effects in control mechanism; worm driving and screw propulsion; and gyroscopic effects. Ills. 7000 w. Autocar—March 14, 1908. Serial. 1st part. No. 91127 A.

Electric.

Electric Vans, 'Buses and Cabs. Discusses the prospects of electric commercial vehicles. 4000 w. Auto Jour—March 14, 1908. Serial. 1st part. No. 91126 A.

Electricity in the Transmissions of Petrol Vehicles (L'Electricité dans les Transmissions des Voitures à Pétrole). M. Gasnier. Describes various types of electric clutches and speed-changing devices. Ills. 11000 w. Bul Soc Int des Elec'ns—Feb., 1908. No. 90905 F.

Electric Automobiles at the Berlin Exhibition, 1907 (Die Elektromobile auf der Berliner Ausstellung, 1907). K. Schirmbeck. Describes the exhibits briefly and discusses the tendencies in design manifested. 4000 w. Serial, 1st part. Zeitschr d Mit Motorwagen Ver—Feb. 15, 1908. No. 90962 D.

See also Road Trains, under AUTOMOBILES.

Farm Motors.

The Gasoline Motor in Farm Development. George Ethelbert Walsh. An account of the extensive use being made of the gasoline motor in farming, and the saving effected. 2500 w. Cassier's Mag—March, 1908. No. 90820 B.

Fuels.

See Producer Gas, under AUTOMOBILES.

Ignition.

The Perfection of Automobile Ignition. J. O. Heinze. Read before the Soc. of Auto. Engrs. at N. Y. Considers present-day electrical ignition and the systems employed, their construction and efficiency. Ills. 3000 w. Automobile—March 12, 1908. No. 90812.

Light Cars.

The Development of the "Light Car" (Die Entwicklung des "Kleinen Wagens"). A. Bursch and J. Küster. Discusses the growing use of light, low-powered cars and describes many types. Ills. 1800 w. Serial. 1st part. Zeitschr d Mit Motorwagen Ver—Feb. 15, 1908. No. 90961 D.

Lubrication.

The Rationale of Lubrication. J. W. Frings. The present number discusses mainly the quality and quantity of the oil used. Ills. 2000 w. Motor Car Jour—Feb. 22, 1908. Serial. 1st part. No. 90646 A.

Omnibuses.

New York and Philadelphia Motor Buses. Harry W. Perry. An illustrated description of the gasoline and electric automobiles used in these cities. 2200 w. Sci Am Sup—March 28, 1908. No. 91179.

Producer Gas.

A Producer Gas Motor Car. Gives particulars concerning the adaptation of this source of power to motor car work. Ills. 1500 w. Prac Engr—March 6, 1908. No. 90883 A.

Renault.

Features of Renault Six-Cylinder Chassis. Illustrated description of the ignition system, self-starter, and other features. 1500 w. Automobile—March 12, 1908. No. 90813.

Road Trains.

The Sampson Gas-Electric Road Train. Harry W. Perry. Illustrated description of this novel tractor and trailers for transportation. 2000 w. Sci Am Sup—Feb. 22, 1908. No. 90590.

Multiple Unit Systems of Transportation. Joseph A. Anglada. Read before the Soc of Auto. Engrs, at Boston. An illustrated article discussing briefly the objections to large trucks, and the various systems of road trains. 2300 w. Automobile—March 26, 1908. No. 91184.

Steering.

Gyrostatic Action—Its Effect on Steering. William W. Watson. Read before the Royal Auto. Club, London. Brief explanation of the action and a study of its effects on the automobile. 1200 w. Automobile—March 26, 1908. No. 91185.

Testing.

Automobile Club of America's Motor Car Testing Plant. Harold Whiting Slauson. Describes briefly the equipment and the method of testing. 1500 w. Sib Jour of Engng—March, 1908. No. 91070 C.

Troubles.

Motor Troubles and How to Overcome Them. Arthur H. Denison. Discusses some common troubles and their causes, giving accounts of some troubles that cannot be traced. 2000 w. Automobile—March 19, 1908. No. 91074.

Vauxhall.

The 12-16-H.P. Vauxhall Car. Illustrated detailed description. 1600 w. Auto Jour—Feb. 22, 1908. Serial. 1st part. No. 90647 A.

Vulcan.

The 14-H.P. Vulcan Car. Drawings and description. 1600 w. Autocar—Feb. 22, 1908. No. 90650 A.

COMBUSTION MOTORS.

Fuels.

Acetylene, Alcohol, and Power. T. L. White. Read before the Int. Acetylene Assn. Considers the possibilities of acetylene as a motor fuel. 1500 w. Sci Am Sup—Feb. 15, 1908. No. 90583.

Tests of Gasoline and Kerosene Engines with Alcohol Fuel. S. M. Woodward. Description, condensed from Bul. 191 of the Office of Experiment Stations, of investigations carried out by the U. S. Dept. of Agriculture, upon the availability of alcohol as an engine fuel. Ills. 5500 w. Eng News—March 12, 1908. No. 90788.

Gas Engines.

Some Possible Developments of the Gas-Engine. Editorial review of recent paper by Prof. S. A. Reeve. 1200 w. Engng—Feb. 21, 1908. No. 90669 A.

Standard Designs and Construction of Large Gas Engines. F. E. Junge. A discussion limited to types that have given continuous service under severe conditions. Ills. 3500 w. Ir Trd Rev—March 26, 1908. Serial. 1st part. No. 91197.

Gas Engine Installations at Buenos Ayres. Two interesting installations of producers and gas engines are illustrated and described. 2500 w. Eng Rec—March 7, 1908. No. 90707.

See also Ignition, under COMBUSTION MOTORS; Engine Design, under STEAM ENGINEERING; and Water Works, under CIVIL ENGINEERING, WATER SUPPLY.

Gasoline Engines.

An Odorless Gasoline Motor. From the *Engineering Times.* Describes a new three-cycle engine. 3500 w. Sci Am Sup—Feb. 8, 1908. No. 90581.

See also Farm Motors, under AUTOMOBILES; and Fuels, under COMBUSTION MOTORS.

Gas Power Plants.

A Modern Power Plant for Railway

Shop Service. A producer gas plant to furnish power for the main car repair shops at Minneapolis is illustrated and described. 2000 w. Engr, U S A—March 2, 1908. No. 90622 C.

Ignition.

Ignition for Large Gas Engines. Illustrated description of the system of ignition invented by Sir Oliver Lodge, the characteristic feature being the use of a spark from a Leyden jar. 1000 w. Engr, Lond—Feb. 28, 1908. No. 90777 A.

The Speed of Ignition of Explosive Gas Mixtures (Versuche über die Zündgeschwindigkeit explosibler Gasgemische). A. Nägel. Describes and gives results of tests on various mixtures. Ills. 6600 w. Zeitschr d Ver Deutscher Ing—Feb. 15, 1908. No. 90977 D.

Light Motors.

The Extra-Light Internal-Combustion Motor (Moteur Extra-Léger à Explosion). M. R. Esnault-Pelterie. A theoretical discussion of the principles on which very light motors must be designed, materials, cylinders, etc. Ills. 10000 w. Mem Soc Ing Civ de France—Dec., 1907. No. 90902 G.

Oil Engines.

Tests of a High-Speed Diesel Motor (Versuche an einem raschlaufenden Dieselmotor). Chr. Eberle. Illustrated description of methods and results of tests on a 300 horse-power motor. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—Feb. 1, 1908. No. 90981 D.

Test of the 200 Horse-Power Diesel Motor in the electric plant of the L. v. Rollschen Ironworks (Untersuchung des 200 PS Dieselmotors mit Schwungraddynamo in der elektrischen Zentrale der L. v. Rollschen Eisenwerke, Giesserei Bern). Gustav Weber. Describes and gives results of tests of this engine which is direct connected to a direct-current dynamo. Ills. 2000 w. Schweiz Bau—Feb. 1, 1908. No. 90946 D.

See also Fuels, under COMBUSTION MOTORS; and Oil Engines, under MARINE AND NAVAL ENGINEERING.

Producer Gas.

See same title, under AUTOMOBILES.

HEATING AND COOLING.

Air Liquefaction.

Place's Air-Liquefying Expansion Engine. J. F. Place. An illustrated description of the engine installed at Norwich, Conn., and of its air liquefying apparatus, giving indicator cards taken at the time of testing. 3500 w. Compressed Air—March, 1908. No. 90794.

Central Plants.

The Calculation of Central Heating Plants (Ueber die Kalkulation von Zentralheizanlagen). Fritz Janeck. Refers especially to the cost of repairs and alterations. 8800 w. Gesundheits-Ing—Feb. 1, 1908. No. 90970 D.

Electric Heating.

Electric Heating at Biltmore, N. C. Illustrated description of arrangements for heating water and laundry equipment by electricity. 1600 w. Met Work—March 7, 1908. No. 90720.

Fans.

The Operation of Screw Disc Ventilators (Ueber die Wirkungsweise von Schraubenventilatoren). Leopold Nowotny. A mathematical discussion of their efficiency and output when electrically driven. Ills. 2000 w. Oest Zeitschr f d Oeffent Baudienst—Feb. 22, 1908. No. 90974 D.

Hot-Air Heating.

Air Velocity in Furnace Heating. Konrad Konrad. Diagram and explanation of the fundamental principles of a furnace system of heating. 2500 w. Met Work—Feb. 29, 1908. No. 90580.

Some Comments on Heating. A. K. Campbell. Inspired through an historical account of heating from Roman times, read by Hermann Vetter, at Vienna. 3000 w. Met Work—March 7, 1908. No. 90721.

Refrigeration.

Mechanical Refrigeration in a Horticultural Establishment. Illustrated description of a cold storage plant for cut flowers and bulbs at Morton Grove, Ill. 2000 w. Engr, U S A—March 16, 1908. No. 90858 C.

See also Electric Driving, under POWER AND TRANSMISSION.

Regulation.

Distant Measuring and Regulating Devices in Heating and Ventilating Plants (Fernmess- und Fernstellvorrichtungen im Dienste der Heizungs- und Lüftungsanlagen). H. Recknagel. Illustrated description of various instruments for the distant measurement and control of temperature. 4400 w. Gesundheits-Ing—Feb. 8, 1908. No. 90971 D.

Steam Heating.

Modern Steam Heating Illustrated. B. F. Raber. The first of a series of illustrated articles discussing the various systems of steam heating. 1800 w. Dom Engng—March 7, 1908. No. 90738.

Heating and Ventilation of the Madison Square Presbyterian Church, New York. Illustrated detailed descriptions of independent systems. The heating is by direct radiation on the two-pipe system with the Webster vacuum system of returns. Ventilation is applied on the downward plenum system. 4500 w. Eng Rec—March 14, 1908. No. 90840.

Ventilation.

Amount of Air Needed for Ventilation.

F. H. Bryant. Abstracted from the *Architect and Engineer.* Gives a few practical hints. 1200 w. Sci Am Sup—Feb. 22, 1908. No. 90587.

The Operation of a Modern Heating and Ventilating System. Information and instructions on the heating and ventilation of the New York City public schools. Ills. 5600 w. Heat & Vent Mag—March, 1908. No. 91062.

Warming and Ventilation. W. H. Casmey. From a second prize paper read before the British Inst. of Heat. & Vent. Engrs. Deals especially with the importance of ventilation and the features of mechanical systems. 1500 w. Heat & Vent Mag—March, 1908. No. 91063.

See also Steam Heating, under HEATING AND COOLING; and Subway Ventilation, under STREET AND ELECTRIC RAILWAYS.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Centrifugal Pumps. E. F. Doty. Describes pumps adapted for irrigation, mine service and hydraulic dredging. 1800 w. Engr, U S A—March 2, 1908. No. 90-624 C.

High-Pressure Centrifugal Pumps (Ueber Hochdruck-Zentrifugalpumpen). Donat Banki. A mathematical discussion, illustrating several types. 2000 w. Serial, 1st part. Zeitschr d Oest Ing u Arch Ver—Feb. 21, 1908. No. 90967 D.

Electric Pumping.

See Pumping Plants, under HYDRAULIC MACHINERY; and Fire Protection, under CIVIL ENGINEERING, WATER SUPPLY.

Pumping.

See Dry Docks, under MARINE AND NAVAL ENGINEERING.

Pumping Plants.

Electrically Operated Automatic Sewage Pumping Station at Waltham, Mass. Illustrated description of an isolated plant. 1000 w. Eng Rec—March, 1908. No. 90706.

See also Water Works, under CIVIL ENGINEERING, WATER SUPPLY; Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Pumping, under MINING AND METALLURGY, MINING.

Turbines.

A High-Head Reaction Turbine Installation. Illustrated description of an installation recently put in service at Centerville, Cal. 2500 w. Eng Rec—March 21, 1908. No. 91078.

The Highest Head Francis Turbine: Centerville Hydro-Electric Power Installation of the California Gas and Electric Corporation. James H. Wise. Read before the San Francisco Assn. of the Am. Soc. of Civ. Engrs. An illustrated description of the plant. 4000 w. Eng News—March 19, 1908. No. 91021.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Automobile Hub Ball Bearings. Henry Hess. Read before the Soc. of Auto. Engrs. An account of experiments to determine the behavior of ball bearings as used in an automobile hub under proper and improper conditions. 1700 w. Automobile—March 5, 1908. No. 90712.

Curved Parts.

The Design of Curved Rods (Berechnung von gekrümmten Stäben). A. Baumann. A mathematical paper on the design of curved machine parts. Ills. 7000 w. Serial, 1st part. Zeitschr d Ver Deutscher Ing—Feb. 29, 1908. No. 90979 D.

Drafting.

See Management, under INDUSTRIAL ECONOMY.

Gears.

The Design of Gears (Calcul des Engrenages). Clément Renders-Parent. A discussion of the calculation of bevel and spur gears. Ills. 2500 w. All Indus—Feb., 1908. No. 90918 D.

Kinematics.

The Mutual Relations of Geometry and Mechanics and Prof. Reuleaux's Mechanical Movements. Dr. Alfred Gradenwitz. An illustrated article explaining the principle of Reuleaux's theoretical kinematics, demonstrating the laws of guided motion. 2200 w. Sci Am—March 21, 1908. No. 91023.

Speed Changing.

The Theory and Design of the Ruppert Speed Changing Gear (Theorie und Berechnung der Ruppertschen Wechselräder-Getriebe). Victor Fischer. An illustrated mathematical discussion. 3000 w. Zeitschr f Werkzeug—Feb. 15, 1908. No. 90949 D.

Stresses.

Maximum Stresses. John S. Myers. Presents cases of variable and of combined stresses, showing the manner of obtaining the maximum stress for which the part should be designed. 3000 w. Mach, N Y—March, 1908. No. 90638 C.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing Tubes and Gas-Bottles. Walter J. May. Brief suggestions for annealing effectively. 800 w. Prac Engr—March 13, 1908. No. 91137 A.

Boiler Making.

Estimating the Cost of Repair Work. James Crombie. Gives method of estimating for several repair jobs on boilers. 2500 w. Boiler Maker—March, 1908. No. 90634.

Estimating the Cost of a Small Scotch Boiler. James Crombie. Gives the dimensions and working pressure of the boiler considered, with an estimate of the cost. 2000 w. Boiler Maker—April, 1908. No. 91246.

Boring.

Boring Bars for Turbine Castings. T. M. Lowthian. Illustrates and describes a tool used in building Parsons turbines. 1000 w. Am Mach—Vol. 31, No. 13. No. 91167.

Castings.

Malleable Iron Castings. P. I. Giron. Calls attention to errors with regard to this material in the present number. 1000 w. Prac Engr—Feb. 21, 1908. Serial, 1st part. No. 90658 A.

Cupola Charging.

Charging Machines for Cupolas. G. R. Brandon. Read before the Pittsburg Found. Assn. Illustrates and describes successful and practical machines. 1500 w. Ir Trd Rev—March 12, 1908. No. 90809.

Dies.

See Screw Machines, under MACHINE WORKS AND FOUNDRIES.

Drilling Machines.

A Multiple-Spindle Sub-Drill. F. H. Stead. Illustrates and describes a sub-drill used in connection with a single-spindle Davis drill. 800 w. Am Mach—Vol. 31, No. 12. No. 91009.

Foundries.

See Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Foundry Practice.

Making Low-Priced Machines. Walter J. May. Abstracted from the *English Mechanic*. Suggestions for turning out work well and cheaply in the foundry. Ills. 2000 w. Sci Am Sup—Feb. 15, 1908. No. 90584.

Foundry Waste. Dr. Richard Moldenke. Read before the Chicago Found. Foremen's Assn. Points out needless waste in castings, iron, molding sand, etc. 2200 w. Ir Age—March 12, 1908. No. 90783.

See also Annealing, Castings, and Moldings, under MACHINE WORKS AND FOUNDRIES.

Gear Cutting.

Hobbing Bevel Gears with a Taper Hob. E. Gregory. Illustrates and describes a new principle in gear hobbing. 1000 w. Am Mach—Vol. 31, No. 10. No. 90688.

Machine-Cut Double Helical Wheels. Illustrated description of wheels that are practically noiseless and satisfactory in every way. 1700 w. Engng—Feb. 21, 1908. No. 90667 A.

Grinding.

The Time Required for Machine Work. Fred H. Colvin. Gives examples of automatic screw-machine work that help in estimating. 1000 w. Am Mach—Vol. 31, No. 12. Serial, 1st part. No. 91011.

Grinding vs. Cutting by Emery Wheels. C. H. Norton. A comparison of conditions, power speeds and time necessary to remove metal by grinding under normal and abnormal conditions. 1800 w. Am Mach—Vol. 31, No. 13. No. 91163.

Grinding Machines.

Notes on the Use of Grinding-Machines. J. E. Livermore. Discusses this machine and its uses. 5000 w. Engng—March 6, 1908. No. 91000 A.

Jigs.

See Shop Appliances, under MACHINE WORKS AND FOUNDRIES.

Lathes.

The Automatic vs. the Hand Lathe. W. Conrad. Gives evidence in proof of the money-saving qualities of the automatic. Ills. 1800 w. Am Mach—Vol. 31, No. 12. No. 91012.

Special Lathe and Tool Equipment for Turning Cone Pulleys. Line engravings and illustrations, with description of the construction and operation of this machine and the tools used with it. 1300 w. Mach, N Y—March, 1908. No. 90664 C.

Milling Machines.

Purchasing Milling Machines by Power. P. V. Vernon. An argument for making horse-power the determining factor, rather than mere weight. 2000 w. Engr, Lond—March 13, 1908. No. 91144 A.

Molding.

Molding Drums for Hoisting Engines. Joseph F. Hart. Illustrates and describes types of drums and the rigging for molding them. 800 w. Am Mach—Vol. 31, No. 12. No. 91013.

Planing Machines.

Some Planing Machine History. T. R. Shaw. Reviews the history and development of the metal planing machine. 3000 w. Mech Engr—March 6, 1908. Serial, 1st part. No. 90887 A.

Pneumatic Tools.

M. Baril's Pneumatic Hammer (Sur un Frappeur Pneumatique de M. Baril). M. E. Sauvage. Illustrated detailed description. 1750 w. Bul Soc d'Encour—Jan., 1908. No. 90908 G.

Safety Appliances.

See Textile Machinery, under MISCELLANY.

Saws.

The Action of Toothless Circular Saws. F. W. Harbord. Micro-photographs and explanation of what they show. 900 w. Engr, Lond—Feb. 21, 1908. No. 90671 A.

Screw Machines.

Dies and Taps for Automatic Screw Machines. C. L. Goodrich and F. A. Stanley. An illustrated article dealing with spring and button dies, and various kinds of taps. 4000 w. Am Mach—Vol. 31, No. 11. No. 90781.

See also Grinding, under MACHINE WORKS AND FOUNDRIES.

Shop Appliances.

Cat Head for Connecting-rod Ends. L. E. Salmon. Illustrated description. 800 w. Am Mach—Vol. 31, No. 13. No. 91166.

A Slotting Attachment for Small Holes. George Bilham. Brief illustrated description. 600 w. Am Mach—Vol. 31, No. 13. No. 91165.

Jigs and Fixtures in the Pratt & Whitney Co.'s Shops. Illustrated descriptions of special tools. 3000 w. Mach, N Y—March, 1908. No. 90639 C.

Shop Practice.

Machining a Street-Car Motor Frame. P. Fenaux. Describes the operations performed and the tools and fixtures used. Ills. 2500 w. Am Mach—Vol. 31, No. 11. No. 90782.

Making a Novel Gun-Barrel Mandrel. Eugene C. Peck. Describes the method used for very accurate work. Ills. 1000 w. Am Mach—Vol. 31, No. 12. No. 91014.

Shops.

The Ball Engine Works at Erie, Pa. Illustrated detailed description. 2500 w. Ir Trd Rev—March 5, 1908. No. 90710.

Stockport Gas Engine Works. Brief review of the history, describing the works and methods. Ills. 3500 w. Engr, Lond—March 13, 1908. No. 91145 A.

Spittlegate Iron Works, Grantham. Illustrated description of works for the manufacture of agricultural implements, with brief review of their history. 4800 w. Engr, Lond—March 6, 1908. No. 91-005 A.

The New Works of Hans Renold, Limited. J. W. Carrel. Line engraving and half-tones, with description of this electrically driven plant. 1200 w. Am Mach —Vol. 31, No. 12. No. 91010.

The Boiler Shop of the Harlan & Hollingsworth Corporation. Charles S. Linch. Illustrated description of a modern shop at Wilmington, Del., and its equipment. 1800 w. Boiler Maker—March, 1908. No. 90633.

The Skoda Works, Pilsen. Historical review of the development and illustrated detailed description of the works in Austria. They combine the manufacture of steel with the construction of ordnance and artillery, and with engineering in all its branches. Plates. 5000 w. Engng—March 6, 1908. No. 91001 A.

The Arrangement and Construction of a Modern Manufacturing Plant. Thomas C. Flinn. Illustrated detailed description of the construction of the new plant of the Kennedy Valve Mfg. Co., at Elmira, N. Y. Discussion. 4000 w. Pro Brooklyn Engrs' Club, No. 77—Vol. XI, 1907. No. 91241 N.

Taps.

Taper Taps. Erik Oberg. Considers points of importance in making taper taps. Ills. 2800 w. Mach, N. Y.—March, 1908. Serial. 1st part. No. 90640 C.

See also Screw Machines, under MACHINE WORKS AND FOUNDRIES.

MATERIALS OF CONSTRUCTION.

Alloys.

Alloys Resisting the Action of Acids, Dilute or Concentrated, Hot, Cold or in the State of Vapor (Les Métillures, Alliages Resistant aux Acides Etendus ou Concentrés, Froids, Chauds ou à l'Etat de Vapeurs). M. Ad. Jouve. Discusses investigations of iron-silicon alloys for use in the chemical industries. 3000 w. Mem Soc Ing Civ de France—Dec., 1907. No. 90903 G.

Alloy Steels.

Manganese Steel (L'Acier au Manganèse). A discussion of its properties and applications. Ills. 2000 w. Génie Civil—Feb. 22, 1908. No. 90925 D.

The Special Steels at the Salon de l'Automobile (Les Aciers Spéciaux au Salon de l'Automobile). M. Louis Révillon. A review of recent advances in steels for automobile construction giving details in curves and tables. Ills. 5000 w. Rev de Metal—Feb., 1908. No. 90906 E + F.

Bearing Metals.

A New Bearing Metal. Lothar Sempell. Information on a new bearing alloy from investigations published by G. Renine. 1800 w. Power—March 24, 1908. No. 91110.

Metallography.

Researches on the Gas Contained in Metals (Recherches sur les Gaz Contenu dans les Métaux). M. O. Boudouard. The results of researches on the conditions of extraction of occluded gases. 2500 w. Rev de Métal—Feb., 1908. No. 90907 E + F.

Steel

Steel Differences. J. Kent Smith. Considers some of the causes of difference. 1200 w. Ir Age—March 26, 1908. No. 91162.

Steel and Its Uses. Edmund F. Lake. Illustrates and describes furnaces for converting iron into steel and discusses ingredients and materials used; heat treatment, hardening, tempering, carbonizing: properties; working, forging, welding and machining. 41500 w. Am Mach—Vol. 31, No. 13. No. 91168.

Notes on the Effect of Work and Time on the Properties of Mild Steel and Iron. John H. Heck. Gives results of tests made on material for the construction of vessels and machinery, and also tests of old steel which had been used for a number of years, discussing the quality. Disdiscussion. Ills. 13000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—Feb., 1908. Parts I & II. No. 91243 N.

MEASUREMENT.

Anemometers.

An Indicating Anemometer and Wind Direction Gauge. Describes an ingenious device, invented by J. C. Jurgensen, for indicating in the basement of a building the direction and force of the winds outside. Ills. 1600 w. Met Work—March 21, 1908. No. 91072.

Calorimetry.

Radiation Correction for the Coal Calorimeter. Ernest H. Peabody. Explains methods of making the "radiation correction," giving a new formula. 1800 w. Stevens Ind—Jan., 1908. No. 91193 D.

Gages.

A Gage for Use in Producing Accurate Tapers. C. C. Stutz. Describes establishing the proportions of tapers by a gage with adjustable jaws set by a pair of disks. Gives formulae of service. 1000 w. Am Mach—Vol. 31, No. 13. No. 91164.

Testing Machines.

A Large Testing Machine for the Wisconsin Laboratory. H. F. Moore. Illustrated description. 2500 w. Wis Engr—Feb., 1908. No. 91226 D.

POWER AND TRANSMISSION.

Air Compressors.

The Efficiency of Dry Air Compressors (Beitrag zur Kenntnis des Wirkungsgrad trockener Luftkompressoren). W. Heilemann. A mathematical paper giving the results of very extensive tests. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Feb. 8, 1908. No. 90976 D.

Compressed Air.

Compressed Air in Modern Engineering. William Andrews. Describes a few of the large plants in the vicinity of New York City, using compressed air giving an idea of its extensive application. Discussion. 4500 w. Pro Brooklyn Engrs Club, No. 74—Vol. XI, 1907. No. 91238 N.

See also Compressed Air, and Hoisting Engines, under MINING AND METALLURGY, Mining.

Electric Driving.

Central-Stations and Electric-Motor Applications. Gives data and figures of motor applications in various industries compiled in the interest of the principal Edison companies. 3000 w. Elec Wld—March 7, 1908. No. 90731.

The Application of Motors to Machine Tools. Dexter S. Kimball. Considers points of importance in deciding whether to use the group or individual motor system; the motors and methods of constructing them; speed control, and matters relating to electric driving. 4500 w. Sib Jour of Engng—March, 1908. No. 91068 C.

The Sawmills of Messrs. J. & W. Bellhouse. Brief illustrated description of an installation of alternating-current machines at Manchester, England. 1000 w. Elec Rev, N Y—March 21, 1908. No. 91035.

Electric Power and Lighting in a Dynamite Plant. Warren Aikens. Describes a refrigerating system showing the advantage of using electricity. Ills. 1800 w. Elec Rev, N Y—March 28, 1908. No. 91190.

See also Shops, under MACHINE WORKS AND FOUNDRIES; and Insurance, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Lubricants.

Marine Engine Lubrication. A series of papers prepared by advocates of several kinds of lubricant, with the reprint of paper by H. C. Dinger. 6800 w. Int Marine Engng—April, 1908. No. 91109 C.

Lubrication.

See same title, under AUTOMOBILES; and Engine Lubrication, under STEAM ENGINEERING.

Power Plants.

Graphical Presentation of Power-Plant Costs. W. G. Way. Gives curves showing average capital and operating costs for several types of plants. 900 w. Power—March 17, 1908. No. 90878.

See also Plants, under MINING AND METALLURGY, Mining.

Shafting.

Alining Shafting by a Steel Wire. A. H. Nourse. Explains the method, giving table. 800 w. Am Mach—Vol. 31. No. 10. No. 90687.

STEAM ENGINEERING.

Boiler Efficiency.

See Flue-Gas Analysis, under STEAM ENGINEERING.

Boiler Fittings.

Blow-Off Valves for Steam Boilers. R. T. Strohm. Illustrates and describes types of these valves, and matters related. 2500 w. Elec Wld—March 7, 1908. No. 90732.

See also Engine Lubrication, under STEAM ENGINEERING.

Boiler Flues.

Advantages of Corrugated Flues. Vernon Smith. Aims to show their superiority. Ills. 1500 w. Prac Engr—Feb. 21, 1908. No. 90657 A.

Boiler Furnaces.

See Smoke Prevention, under STEAM ENGINEERING.

Boiler Management.

Foaming and Priming in Boilers of Ice Plants. John C. Sparks. Discusses the causes, and their prevention. 2500 w. Ice & Refrig—March, 1908. No. 90715 C.

See also Plant Management, and Smoke Prevention, under STEAM ENGINEERING.

Boilers.

See Steam Boilers, under MARINE AND NAVAL ENGINEERING.

Boiler Settings.

Comparative Tests of Tabular Boiler Settings for Chicago Public Schools. Reports a series of tests to determine the relative evaporation and combustion efficiency of two types of boilers. Ills. 1200 w. Heat & Vent Mag—March, 1908. No. 91061.

Boiler Tests.

See Boiler Settings, under STEAM ENGINEERING.

Boiler Waters.

Boiler-feed Purification. H. Spurrier. Gives diagram and description of a feed-water purifying and softening plant. 1500 w. Power—March 3, 1908. No. 90632.

See also Economizers, and Feed-Water Heaters, under STEAM ENGINEERING.

Condenser Corrosion.

The Corrosion of Condenser Tubes. E. C. Sickles. Considers some factors involved in the selection of condenser equipment, especially for plants using salt circulating water. Ills. 4500 w. Power—March 10, 1908. No. 90746.

The Destruction of Condenser Tubes (Die Zerstörung von Kondensatorrohren). W. Heym. A discussion of materials and alloys for the construction of condensers. 1800 w. Serial. 1st part. Die Turbine—Feb. 20, 1908. No. 90960 D.

Condensers.

Air Pumps and Condensers. R. M. Ferguson. Read before the Manchester Assn. of Engrs. Deals with the effect upon the vacuum of certain features commonly met with in condensing systems. 4400 w. Mech Engr—Feb. 28, 1908. No. 90759 A.

See also Turbines, under STEAM ENGINEERING.

Economizers.

Economisers. W. W. Melville. Considers the advantages of heating feed water, the methods, etc. 4500 w. Pub Works—March, 1908. No. 90653 B.

Engine Design.

Gas and Steam-engine Proportions. W. H. Booth. A comparison. 1200 w. Power—March 3, 1908. No. 90631.

Engine Lubrication.

Worth-While Hints for Engineers and Steamfitters. William Kavanagh. Calls attention to details in boiler fittings and oiling systems. Ills. 1200 w. Power—March 10, 1908. No. 90752.

Engines.

A New Type of High Speed Engine. Illustrated description of a 160-h.p. angle-compound, with vertical-horizontal arrangement, recently put in operation at the plant of the American Engine Co. 1000 w. Engr, U S A—March 2, 1908. No. 90625 C.

Feed-Water Heaters.

Live Steam Feed-Water Heaters. Editorial criticism of paper by John Goodman and D. R. Maclachlan, before the Inst. of Mech. Engrs. 2800 w. Engr, Lond—Feb. 28, 1908. No. 90776 A.

Test of a Live-Steam Feed-Water Heater. John Goodman, and D. R. Maclachlan. Describes the plant and method of testing. The results lead to the conclusion that the heater has no material effect on the economy of the boiler. 2000 w. Inst of Mech Engrs—Feb. 21, 1908. No. 90758 N.

Flue-Gas Analysis.

Flue-gas Analysis and Boiler Efficiency. William D. Ennis. On the application of flue-gas analysis to the determination of the air supply and furnace losses and estimation of efficiency. 4000 w. Power—March 3, 1908. No. 90630.

Fuels.

Crude Oil as Fuel. William Chaddick Remarks on oil testing, its combustion, and points in installing this system. Ills. 1800 w. Engr, U S A—March 2, 1908. No. 90623 C.

Fuel Testing.

The Selection of Coal. From a paper by E. G. Bailey, recently read before the New England St. Ry. Club, giving conclusions from extensive experience in coal testing. 2500 w. Eng Rec—March 21, 1908. No. 91080.

See also Calorimetry, under MEASUREMENT.

Plant Management.

Sources of Economy in Power Production. W. H. Patchell. Especially with reference to colliery engineering. Describes uneconomical conditions often found, and changes needed. 12000 w. Ir & Coal Trds Rev—March 6, 1908. No. 90899 A.

Smoke Prevention.

How to Burn Bituminous Coal in Boiler Furnaces Without Smoke. L. P. Breckenridge. A discussion of the fundamental principles that apply to smokeless furnace construction and operation. General discussion follows. Ills. 12500 w. Pro St Louis Ry Club—Feb. 14, 1908. No. 90803.

Steam Pipes.

Vibration in Steam Pipes. William F. Fischer. Briefly discusses the causes and prevention. Ills. 1100 w. Power—March 10, 1908. No. 90750.

Steam Piping for Industrial Plants. W. E. Housman. An illustrated discussion of the design and construction for moderate sized installations. 3000 w. Engineering Magazine—April, 1908. No. 91233 B.

Superheating.

The Specific Heat of Superheated Steam. Prof. Sidney A. Reeve. Gives results of the experiments by Peake and Thomas, with the author's conclusions as to methods to employ in future investigations. 3800 w. Power—March 10, 1908. No. 90749.

Turbine Auxiliaries.

Auxiliaries for Steam Turbines. Thomas Franklin. Explains their adaptation to the service, with especial reference to the points to be noted in their preparation for testing. 4000 w. Power—March 17, 1908. No. 90877.

Turbine Governing.

The Question of Steam Turbine Safety Governors. A discussion of the general conditions under which a turbine operates, and their bearing on safety governor design. 2200 w. Prac Engr—March 6, 1908. Serial. 1st part. No. 90884 A.

Hodgkinson's Turbine Governing Device. Illustrated description of a mechanically-actuated governing mechanism which operates in conjunction with the primary and secondary valves of a turbine. 2000 w. Mech Engr—March 13, 1908. No. 91131 A.

Turbines.

Exhaust Steam Turbines. Summarized translation of paper read by Prof. Auguste Rateau before the Soc. of Belgian Engrs. On the results of combining reciprocating engines and turbines. 2000 w. Engr, Lond—March 13, 1908. Serial. 1st part. No. 91146 A.

The Steam Path of the Turbine. Charles P. Steinmetz. A mathematical discussion of energy conversions, losses, etc. 3500 w. Pro Am Soc of Mech Engrs—March, 1908. No. 90801 C.

Steam Tables (Wasserdampftafel). Donat Bánki. Gives a diagram of temperature drop in adiabatic expansion for both saturated and superheated steam, with explanation of its use. Ills. 2800 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 10, 1908. No. 90958 D.

The Principles of Steam-Turbine Buckets. William E. Snow. Gives a comparison of the different types of bucket, with a graphical explanation of their various forms and functions. 2500 w. Power—March 17, 1908. No. 90875.

The Belluzzo Two-Speed Steam Turbine. Illustrated description of a design aiming to be nearly as economical at half-speed as at full speed. 500 w. Engng—Feb. 28, 1908. No. 90771 A.

The Curtis Steam Turbine in Practice. Fred L. Johnson. How to determine if clearance between buckets and intermediates is right; the safety-stop, valve-gear, governor and stage valves. Ills. 1200 w. Power—March 10, 1908. No. 90748.

The Maschinenfabrik Augsburg-Nürnberg Steam Turbine (Die M. A.-N.-Dampfturbine). W. Koeniger. Illustrated detailed description of the Zoelly turbine built by this firm. 2800 w. Serial. 1st part. Zeitschr f d Gesamte. Turbinenwesen—Feb. 10, 1908. No. 90957 D.

The Kolb Elektra Steam Turbine and Rotary Condenser (Die Elektra-Dampfturbine und der Rotationskondensator von Kolb). H. Meuth. Illustrated description with details of efficiency tests, etc. 4300 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Feb. 1, 1908. No. 90982 D.

Tests of an Eyermann Steam Turbine (Untersuchungen an der Eyermann-Dampfturbine). E. Josse. The first part of the serial describes the construction and operation of this type of turbine. Ills. 3200 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Feb. 20, 1908. No. 90959 D.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Steam Turbines, under MARINE AND NAVAL ENGINEERING.

Turbine Testing.

Testing a Steam Turbine. Thomas Franklin. Considers special auxiliary plant for consumption test, test loads, and preparing the turbine for testing. 4000 w. Power—March 24, 1908. No. 91111.

Proper Method of Testing a Steam Turbine. Thomas Franklin. Special features to be examined before testing, importance of oiling system and water service, etc. Ills. 5000 w. Power—March 10. 1908. No. 90751.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Some German Overhead Tramways. Alfred Gradenwitz. Illustrates and describes new types in use in Germany, giving details of their operation. 3000 w. Eng & Min Jour—Feb. 29, 1908. No. 90612.

Cableways.

A South American Aerial Rope Railroad. An illustrated description of the construction of a line about 21 miles long, with a difference between levels of 11,600 feet. 2500 w. Sci Am Sup—March 28, 1908. No. 91178.

See also Aerial Tramways, and Material Handling, under TRANSPORTING AND CONVEYING.

Coal Handling.

See Dock Machinery, under TRANSPORTING AND CONVEYING.

Conveyors.

The Power Absorbed by a Bucket Elevator (Calcul de la Force Absorbée par une Chaîne à Godets). A Hacardiaux. A mathematical discussion of a method of estimation. Ills. 1500 w. All Indus—Feb., 1908. No. 90917 D.

See also Dock Machinery and Material Handling, under TRANSPORTING AND CONVEYING.

Cranes.

Electrical Power in Railway Goods Warehouses. H. Henderson. Deals with the advantages to be gained, especially considering the crane and car hoist equipment of the new warehouse, at Newcastle-on-Tyne. Ills. 3000 w. Inst of Elec Engrs—Feb. 20, 1908. No. 90891 N.

See also Dock Machinery and Material Handling, under TRANSPORTING AND CONVEYING.

Dock Machinery.

Electric Power in Docks. C. E. Taylor. Describes uses to which electrical machinery has been put in connection with coal conveyors, cranes, capstans, etc. Ills. 3000 w. Inst of Elec Engrs—Feb., 1908. No. 90661 N.

Electric Power in Docks. C. E. Taylor. Read before the Inst. of Elec. Engrs. Illustrates and describes the principal uses to which electricity has been applied in docks, the driving of coal conveyors, cranes, capstans, etc. Discussion. 4000 w. Elec Engr, Lond—March 13, 1908. No. 91132 A.

Elevators.

The High-Pressure Hydraulic Elevator. William Baxter, Jr. Illustrates and describes the construction and operation of the Otis vertical machine. 1800 w. Power—March 24, 1908. No. 91112.

Hoists.

A Hoist for Feeding Material to the Concrete Mixer. Illustrates and describes an automatic feeding and delivering elevator for concrete. 1000 w. Eng News—March 5, 1908. No. 90695.

See also Cranes, under TRANSPORTING AND CONVEYING.

Material Handling.

Handling Heavy Armor-Plates for a Bank Vault. Illustrates and describes a difficult job of hoisting and handling in the construction of a bank vault in New York City. 700 w. Eng News—March 5, 1908. No. 90692.

Hoisting Machinery for the Handling of Materials. T. Kennard Thomson. Illustrated descriptions of cranes, cableways and transporting conveyors adapted to this work. 4500 w. Engineering Magazine—April, 1908. 2d part. No. 91231 B.

MISCELLANY.

Aeronautics.

How to Construct and Operate a One-Man Airship. Thomas S. Baldwin. Suggestions for the construction, operation and care. 2000 w. Sci Am—Feb. 29, 1908. No. 90600.

How to Construct a Balloon.—The Making, Inflating and Sailing of Gas Balloons. B. Courtright. An illustrated treatise explaining the elementary principles of aeronautics. 4500 w. Sci Am—March 28, 1908. No. 91177.

The First Successful Trial of a New American Aeroplane. Illustrated description of an aeroplane constructed by the Aerial Experiment Association, which was able to fly at the first attempt. 1200 w. Sci Am—March 21, 1908. No. 91022.

Textile Machinery.

Ring Spinning-Frames and Their Safety Appliances. Illustrated description of some of the protective appliances used on ring-spindles. 2000 w. Engng—Feb. 28, 1908. No. 90770 A.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

See Fuel Testing, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Briquetting.

Lignite Briquetting in Germany. Robert Schorr. Explains the methods, describing apparatus used. 2500 w. Eng & Min Jour—Feb. 29, 1908. No. 90615.

Classification.

Classification of Coal. D. B. Dowling. Considers schemes of classification proposed, and suggests a scheme of names for Canadian coals. 1800 w. Qr Bul Can Min Inst—Feb., 1908. No. 91221 N.

Coke-Oven Gas.

See Blast-Furnace Gas, under IRON AND STEEL.

Coke Ovens.

The Von Bauer Coke-Oven System. Illustrated description of the by-product coke-oven system devised by one of the most experienced coke-oven engineers in

Germany. 2800 w. Elec-Chem & Met Ind—March, 1908. No. 90645 C.

The By-Product Coke Oven. William Hutton Blauvelt. An illustrated discussion of the types of by-product oven used in the United States, and the problems in connection. 7500 w. Pro Am Soc of Mech Engrs—March, 1908. No. 90800 C.

Modern Coke Ovens (Les Fours à Coke Modernes). F. Fieschi. A general review and a description of a new oven for operation either with or without recovery of by-products. Ills. 3500 w. Serial. 1st part. Génie Civil—Feb. 22, 1908. No. 90924 D.

Coking Plants.

The Phillips Plant of the H. C. Frick Coke Co. Plan and illustrated description of a coke plant embodying the latest practice. 2000 w. Mines & Min—March, 1908. No. 90680 C.

Notes on Canadian Retort Coke and Its Manufacture. Randolph Bolling. Illustrated detailed description of the coke plant, on Cape Breton Island. It consists of 120 Bernard ovens, grouped in three batteries of 40 ovens each, and 30 Bauer ovens. 3500 w. Eng News—March 5, 1908. No. 90691.

Placing the By-Product Coking Plant in Operation (Die Inbetriebsetzung von Teerkokereien). A. Thau. A practical discussion of the method of starting coke ovens. Ills. 3500 w. Glückauf—Feb. 22, 1908. No. 90943 D.

Colorado.

The Coals and Coal Fields of Colorado. Arthur Lakes. Map and description of deposits which include all varieties of coal. 1700 w. Min Wld—March 28, 1908. No. 91253.

Electric Power.

The Development of the Flameproof Motor. Illustrates and describes a type of motor-casing, on the lines of the Davis safety lamp. 1200 w. Elect'n, Lond—March 13, 1908. No. 91136 A.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnie en Belgique). Alfred Lambotte. The first part of the serial discusses electric power in mining with particular reference to the equipment and operation of the Elisabeth collieries at Auvelais. Ills. 8000 w. Serial. 1st part. Soc Belge des Elec'ns—Feb., 1908. No. 90901 E.

Explosions.

Darr Mine Disaster. An illustrated account of the disaster near Pittsburg, with the opinions of inspectors and experts, and editorial. 7500 w. Mines & Min—March, 1908. No. 90678 C.

Recent Explosions in Coal Mines. H. M. Chance. Reviews the conditions under which the coal-mining industry in the United States has been developed, showing that safety measures have not kept pace with increasing dangers. 3000 w. Eng & Min Jour—March 14, 1908. No. 90850.

Mexico.

Coal in Coahuila. Ezequiel Ordoñez. Discusses the coal industry in Mexico, and describes the Coahuila coalfields. 1500 w. Min & Sci Pr—March 14, 1908. No. 91032.

Mine Records.

See Filing Systems, under INDUSTRIAL ECONOMY.

Mining.

Plans for Mining a Flat Coal Seam. Audley H. Stow. Considers details of economical development. Ills. 3000 w. Eng & Min Jour—March 7, 1908. No. 90737.

See also Eight-Hour Day, under INDUSTRIAL ECONOMY.

Mining Plants.

See Plant Management, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

New Brunswick.

The Carbonaceous and Bituminous Minerals of New Brunswick. R. W. Ells. Describes the deposits and their development. 3800 w. Qr Bul Can Min Inst—Feb., 1908. No. 91220 N.

Oklahoma.

The Rock Island Coal Co.'s Mines, Oklahoma. R. S. Moss. An illustrated account of the mines operated by this company. 1100 w. Min Wld—March 7, 1908. No. 90742.

Pennsylvania.

The Sagamore Bituminous Coal Mines. Edward K. Judd. Illustrated description of these mines in the Clearfield district of Pennsylvania. 1200 w. Eng & Min Jour—March 21, 1908. No. 91089.

The Southern Anthracite Coalfield. John Haertter. An illustrated account of important development work in the Pottsville coalfields, with review of its early history. 2000 w. Eng & Min Jour—March 28, 1908. No. 91209.

Rescue Appliances.

Rescue Appliances in the Mines of France. Jacques Boyer. An illustrated article devoted principally to descriptions of respiratory appliances. 5800 w. Engineering Magazine—April, 1908. No 91228 B.

Modern Life Saving Apparatus for Mines. Frank C. Perkins. The Draeger apparatus is illustrated and described and information relating to its efficiency is given. 2500 w. Min Wld—Feb. 29, 1908. No. 90619.

Sampling.

See Weathering, under COAL AND COKE.

Storage.

The Storage of Anthracite Coal. Explains the conditions that have made necessary the construction of storage plants for both anthracite and bituminous coal, and describes the main features of some of the plants. 2500 w. Eng Rec—March 28, 1908. No. 91205.

Washing.

The Bituminous Washery at Tyler, Penn. Edward K. Judd. Illustrated description of a plant run by independent motors. The sulphur and ash contents are reduced about one-half. 1200 w. Eng & Min Jour—Feb. 29, 1908. No. 90614.

See also Magnetic Separation, under ORE DRESSING AND CONCENTRATION.

Weathering.

The Weathering of Coal. S. W. Parr and N. D. Hamilton. Gives a résumé of the statements by various writers, showing the present knowledge available, and an outline of experimental work. Also a report on the deterioration of samples in storage, by S. W. Parr and W. F. Wheeler. 8500 w. Univ of Ill, Bul. No. 17—Aug., 1907. No. 90874 N.

Yukon.

Yukon Territory, Between White-Horse and Tantalus. Official report of D. D. Cairnes, describing the topography and flora, the geology, coal and copper properties examined, etc. Ills. 3500 w. B C Min Rec—Feb., 1908. No. 91118 B.

COPPER.

Assaying.

Notes on the Practice of Assaying in British Columbia. C. S. Baker. Gives a few of the methods of treating the silver-lead-zinc and the copper-gold-silver ores. 2000 w. Qr Bul Can Min Inst—Feb., 1908. No. 91217 N.

British Columbia.

The Bulkley Valley District, in Skeena Mining Division. Information from the official report by W. W. Leach. Ills. 2500 w. B C Min Rec—Feb., 1908. No. 91117 B.

The Geology and Ore Deposits of Franklin Camp, B. C. R. W. Brock. Describes the somewhat complicated geology and deposits of various types. Ills. 3300 w. Jour Can Min Inst—Vol. X, 1907. No. 91152 N.

Mineral Locations on Moresby Island, Queen Charlotte Group. Report by William Fleet Robinson, reviewing the history of early voyages of discovery to these islands, geological observations made, prospecting, etc. 9000 w. B C Min Rec —Feb., 1908. No. 91119 B.

California.

Foothill Copper Belt of the Sierra Nevada. John A. Reid. Presents facts necessary to a proper understanding and development of the copper belt, and which may be readily used by the miner or prospector. Ills. 4000 w. Min & Sci Pr—March 21, 1908. No. 91182.

Chile.

The Poderosa Copper Mines, Collahuasi, Chile. Robert Hawxhurst, Jr. Describes this mine in the Andes, the geology, deposits, labor conditions, etc. 180c w. Eng & Min Jour—March 7, 1908. No. 90734.

Colorado.

See same title, under GOLD AND SILVER.

Converters.

Apparatus for Converting Mattes and Speisses. Herbert Haas. Illustrated description of the writer's invention, which is an improved process for converting copper and other mattes, also speisses and other metallic compounds. 1600 w. Min Wld—March 21, 1908. No. 91093.

East Indies.

Gold and Copper Mining in the Dutch East Indies. Information in regard to results during 1907. 1300 w. Min Jour—Feb. 29, 1908. No. 90767 A.

Lake Superior.

Underground Mining Methods at the Quincy Copper Mine, Michigan. G. R. McLaren. Student's prize paper. Briefly considers the geology, the deposits and their origin, and the mining methods. Ills. 4000 w. Jour Can Min Inst—Vol. X, 1907. No. 91157 N.

Refining.

The Electrolytic Copper-Refining Industry. John B. C. Kershaw. Considers the growth of this industry, recent changes, and gives brief descriptions of American and English plants. 3000 w. Elec Rev N Y—March 28, 1908. No. 91189.

Reverberatory Furnaces.

Coal-Dust Firing for Reverberatory Furnaces. Charles F. Shelby. Gives results of observations made at Cananea. The powdered ash introduces complications, and possibly waste heat boilers would not be of value. 4000 w. Eng & Min Jour—March 14, 1908. No. 90847.

Roasting.

The Dwight and Lloyd Sintering Process. Arthur S. Dwight. Illustrated description of a new blast-roasting process in which the material is sintered continuously in thin layers. 3000 w. Eng & Min Jour—March 28, 1908. No. 91208.

Smelting.

Matte Smelting at Ingot, California. W. B. Bretherton. An illustrated description of the smelting operations. 1500 w. Eng & Min Jour—Feb. 29, 1908. No. 90611.

Copper Smelting at Mammoth Plant. A. S. Haskell. Illustrated description of the enlarged plant of the U. S. Smelting, Refining and Mining Co., at Kennett, Cal.

2000 w. Mines & Min—March, 1908. No. 90681 C.

See also Converters, and Reverberatory Furnaces, under COPPER; and Refractory Materials, under MISCELLANY.

Tasmania.

The Mt. Lyell Copper Field, Tasmania. Ralph Stokes. Describes this district, its climate, geology, deposits, and the mining properties. Ills. 2500 w. Min Wld—March 21, 1908. Serial. 1st part. No. 91094.

Yukon.

See same title, under COAL AND COKE.

GOLD AND SILVER.

Assaying.

See same title, under COPPER.

British Columbia.

Camp Hedley, Similkameen District. Charles Camsell. An official report describing the topographic features, the general geology, etc. Ills. 4500 w. B C Min Rec—Jan., 1908. No. 90854 B.

Observations on the Geology and Ore Deposits of Camp Hedley, British Columbia. Charles Camsell. Describes the deposits of auriferous arsenopyrite and discusses their origin. 3500 w. Qr Bul Can Min Inst—Feb., 1908. No. 91219 N.

See also Hydraulic Mining, under GOLD AND SILVER.

Cerargyrite.

See Ore Deposits, under MISCELLANY.

Cobalt.

A Visit to the Cobalt District in Ontario. Alex. Gray. Gives results being obtained at some of the mines, and reformations in progress. Ills. 900 w. Min Wld—March 7, 1908. No. 90741.

A Review of Cobalt Results to Date. Alex. Gray. Discusses the methods of the Cobalt camp, its development and ore output. 1800 w. Min Wld—Feb. 29, 1908. No. 90621.

Mining at Cobalt. Frank C. Loring Considers the Cobalt silver mining district from the standpoint of the miner and mine operator. 1700 w. Qr Bul Can Min Inst—Feb., 1908. No. 91222 N.

The Cobalt Mining District. Dr. Robert Bell. Deals with points in connection with the geology of the Cobalt district and the nature of the metalliferous deposits. 3500 w. Jour Can Min Inst—Vol. X, 1907. No. 91149 N.

See also Sampling, under ORE DRESSING AND CONCENTRATION.

Colorado.

Re-birth of a Colorado Mine. Thomas Tonge. An account of the gold-copper Donaldson mine, and the favorable conditions due to the construction of the Rockford tunnel. 2200 w. Min Jour—March 7, 1908. No. 90898 A.

The General Geology of Summit County, Colorado. A. Lakes. Special reference to Breckenridge and vicinity, the topography of the region, the ore deposits, the origin of gold in the placers, etc. Ills. 1000 w. Min Sci—March 5, 1908. Serial. 1st part. No. 90739.

Cyaniding.

Hendryx Cyaniding. L. D. Bishop. Deals with the physical or mechanical treatment of ore, rather than the chemical, with special reference to the Hendryx methods of agitation and filtration. 2500 w. Aust Min Stand—Feb. 5, and 12, 1908. Serial. 2 parts. No. 91025 each B.

Notes on Preliminary Cyanidation Work. H. F. A. Riebling. On the tests advisable to determine whether or not a mine can be made to pay a profit by installing the cyanide process of ore treatment. 2000 w. Min Wld—March 7, 1908. No. 90743.

See also Silver Milling, under ORE DRESSING AND CONCENTRATION.

East Indies.

See same title, under COPPER.

Honduras.

Properties of the New York & Honduras Rosario Mining Co. Francis C. Nicholas. Gives the history of these mines, which yield gold, silver and other metals of value. Ills. 2000 w. Min Wld—Feb. 29, 1908. No. 90620.

Hydraulic Mining.

The Cariboo Consolidated Hydraulic Plant, Bullion, B. C. W. J. Dick. Student's prize paper. Describes this property and its development. 2500 w. Jour Can Min Inst—Vol. X, 1907. No. 91158 N.

Mexico.

See Silver Milling, under ORE DRESSING AND CONCENTRATION.

Nevada.

The Gold Camp of Rawhide, Esmeralda, Co., Nevada. Dr. Charles A. Gehrmann. An account of the discovery and progress of a new camp in the desert, the deposits found, etc. 1600 w. Min Sci—March 16, 1908. No. 91116.

See also Gold Milling, under ORE DRESSING AND CONCENTRATION.

Nova Scotia.

The Oldham Sterling Gold Mine, Nova Scotia. C. V. Brennan. Student's prize paper. Describes the mine and methods of working. Ills. 3500 w. Jour Can Min Inst—Vol. X, 1907. No. 91159 N.

Placers.

See Colorado, and Hydraulic Mining, under GOLD AND SILVER.

Rand.

The Origin of the Gold in Banket. J. S. Curtis. Combats views advanced in paper by Prof. J. W. Gregory. 3500 w.

Jour Chem, Met, & Min Soc of S Africa —Jan., 1908. No. 90880 E.

Refining.

Proof Gold and Silver. John W. Pack. Detailed description of the method used in the preparation. 900 w. Min & Sci Pr—March 7, 1908. No. 90810.

Utah.

See same title, under Lead and Zinc.

IRON AND STEEL.

Alabama.

Brown Ore Mining in the Russellville District, Alabama. F. Wm. Hausmann. Describes the ore and the plants and methods of mining. Ills. 1200 w. Stevens Ind—Jan., 1908. No. 91196 D.

Assaying.

A Canadian Method for the Technical Determination of Silicon in Pig Iron. Randolph Bolling. An explanation of the method used in the Nova Scotia Steel & Coal Company's laboratory. Ills. 1500 w. Can Min Jour—March 15, 1908. No. 91026.

The Determination of Phosphorus in Steel (Ueber die Phosphorbestimmung im Stahl). M. Frank and F. Willy Hinrichsen. Results of investigations at the Imperial Testing Laboratory. 2500 w. Stahl u Eisen—Feb. 26, 1908. No. 90936 D.

The Determination of Sulphur in Iron and Steel (Schwefelbestimmung in Eisen und Stahl). H. Kinder. The results of researches by the Commission on Chemistry of the German Ironmaker's Association. Ills. 3500 w. Stahl u Eisen—Feb. 19, 1908. No. 90934 D.

See also Blast Furnace Practice, under Iron and Steel.

Australia.

Iron Making in Australia. A. Selwyn-Brown. Brief account of the industry, the financial difficulties, etc. 1200 w. Eng & Min Jour—March 21, 1908. No. 91088.

Blast-Furnace Fuels.

Charcoal:—The Blast Furnace Fuel for Ontario. R. H. Sweetzer. Presents the advantages of this fuel. Ills. 1500 w. Qr Bul Can Min Inst—Feb., 1908. No. 91223 N.

Blast-Furnace Gas.

Furnace-Gas Diagrams. Reproduces the circular diagram of M. Leon Greiner, and gives another form of diagram prepared by him showing the same quantities, but disposed in a more effective manner. 1700 w. Cassier's Mag—March, 1908. No. 90827 B.

The Utilization of Blast-Furnace and Coke-Oven Gases in Metallurgical Works (Utilisation du Gaz des Hauts-Fourneaux et des Fours à Coke dans les Usines Metallurgiques). Léon Greiner. A general discussion and a description of the results obtained by the Cockerill Company at Seraing. Ills. 900 w. All Indus—Feb., 1908. No. 90916 D.

Blast-Furnace Practice.

Making Basic Iron with High Sulphur Coke. Randolph Bolling. A report of the experience of the Dominion Iron & Steel Co. 1500 w. Ir Age—March 5, 1908. No. 90682.

Preparation of Materials for the Blast Furnace. David Baker. Describes the nodulizing process which reduces the sulphur and prepares the ore for smelting. 2500 w. Eng & Min Jour—March 21, 1908. No. 91090.

The Uses of Chemical Analysis in Iron Blast Furnace Practice and Some Notes on Laboratory Methods. George D. Drummond. Student's prize paper. Treats chiefly of the methods at the Midland Blast Furnace, Ontario. Describes the plant which smelts Lake Superior ores with Connellsville coke. 7000 w. Jour Can Min Inst—Vol. X, 1907. No. 91160 N.

Blast Furnaces.

See Refractory Materials, under Miscellany.

Blast-Furnace Slag.

See Cement, under Minor Minerals.

Electro-Metallurgy.

Steel Making by Electricity. An illustrated review of modern processes. Sci Am Sup—Feb. 22, 1908. No. 90586.

The Electrical Smelting of Pig Iron. Horace Allen. Gives figures showing to some extent the variation in the curren expended by the different systems and on different qualities of ore, and related information. 700 w. Mech Engr—Feb. 28, 1908. No. 90760 A.

The Electrothermic Production of Steel from Iron Ore. Alfred Stansfield. A brief account of experiments made to determine whether, in smelting iron ores for the direct production of steel, phosphorus and sulphur would be eliminated. 1500 w. Jour Can Min Inst—Vol. X, 1907. No. 91151 N.

The Induction Furnace and Its Use in the Steel Industry. Abstract translation of a recent paper by Viktor Engehardt in *Elektrotechnische Zeitschrift* discussing the application of the electric induction furnace in the steel industry. Ills. 1200 w. Elec-Chem & Met Ind—April, 1907. No. 91247 C.

Germany.

The Ahaus and Koesfeld Clay Ironstone Deposits and Their Economic Value (Das Toneisensteinvorkommen von Ahaus und Koesfeld und seine wirtschaftliche Bedeutung). Herr Willert. A description of the deposits and the ores and a discussion of their utilization. 3200 w. Glückauf—Feb. 29, 1908. No. 90944 D.

Metallography.

The Separation of Graphite in the Smelting of Iron-Carbon Alloys of High Carbon Content (Zur Kenntnis der Graphitausscheidung in Eisenkohlenstoffschmelzen hohen Kohlenstoffgehalts). W. Gahl. A review of various theories. Ills. 2100 w. Stahl u Eisen—Feb. 12, 1908. No. 90933 D.

New York.

On the Associations and Origin of the Non-titaniferous Magnetites in the Adirondack Region. David Hale Newland. Describes the geology of the region, the ore deposits and their occurrence, discussing their origin. 3500 w. Ec Geol—Dec., 1907. No. 91043 D.

Ontario.

The Iron Ores of Ontario. A. B. Willmott. A statement of opportunities open for the iron-ore miner, describing the character of the ores. Map. 5500 w. Can. Min Jour—March 15, 1908. No. 91030.

The Moose Mountain Iron Range, with Special Reference to the Properties of Moose Mountain, Limited. Norman L. Leach. A report of the development work and deposits of this Canadian property. 800 w. Can Min Jour—March 15, 1908. No. 91029.

Open-Hearth.

Basic Open-Hearth Steel Manufacture, as Carried Out by the Dominion Iron and Steel Company at Sydney, C. B. Frank E. Lathe. Student's prize paper. Detailed description. Ills. 7000 w. Jour Can Min Inst—Vol. X, 1907. No. 91156 N.

Pyrites.

See Ore Deposits, under MISCELLANY.

Roasting.

The Wilfley Furnace. J. M. McClave. Illustrates and describes a furnace of the tower type for roasting iron sulphides in preparation for magnetic separation. 800 w. Eng & Min Jour—Feb. 29, 1908. No. 90613.

Steel Making.

The Thomas Process (Etude sur le Procédé Thomas). J. Dangel. A description of the theory and practice of the process, the influence of impurities, conduct of the operation, etc. 4000 w. Bul Sci de l'Assn des Elèves—Jan., 1908. Serial. 1st part. No. 90900 D.

Steel Works.

The Manufacture of Concrete Reinforcing. Illustrates and describes the process of making Kahn bars by the Trussed Concrete Steel Co. 1500 w. Ir Trd Rev—March 12, 1908. No. 90808.

See also Open Hearth, under IRON AND STEEL; Steel Buildings, under CIVIL ENGINEERING, CONSTRUCTION; and Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Trade.

See Royalties, under MINING.

U. S. Steel Corporation.

The United States Steel Corporation's Annual Report. Abstracts and general review of the sixth annual report. 6000 w. Ir Age—March 26, 1908. No. 91161.

LEAD AND ZINC.

Assaying.

See same title, under COPPER.

Great Britain.

Lead-Mining in Great Britain. Editorial review of the various lead-mining districts, discussing their possibilities. 1800 w. Engng—March 6, 1908. No. 91003 A.

Joplin District.

Zinc and Lead Deposits of South Western Missouri. F. Lynwood Garrison. Describes the deposits of the Joplin district, discussing their origin and comparing theories of a number of geologists. Ills. 2000 w. Min & Sci Pr—Feb. 29, 1908. Serial. 1st part. No. 90708.

Lead.

Lead: Its History and Economic Development. Evans W. Buskett. A review of its development in the United States, describing its properties, occurrence, mineralogy, etc. 1200 w. Min Wld—March 14, 1908. Serial. 1st part. No. 90853.

Roasting.

See same title, under COPPER.

Utah.

Mining and Milling at Stockton, Utah. Robert B. Brinsmade. Describes the methods used at the Honerine silver-lead mine and mill. Ills. 2000 w. Eng & Min Jour—March 21, 1908. No. 91091.

Daly-West Mine and Mill. Robert B. Brinsmade. Describes this silver-lead mine and its development, methods of working, surface equipment, etc. Ills. 5000 w. Mines & Min—March, 1908. No. 90675 C.

Zinc.

Notes on Zinc. The present article considers its physical and chemical properties, compounds, impurities, ores and localities, and production. 3500 w. Mech Engr—March 6, 1908. Serial. 1st part. No. 90886 A.

Zinc Industry.

A Review of the Zinc Industry. H. M. Burkey. Reviews the present state of the industry. 3000 w. Elec-Chem & Met Ind—March, 1908. No. 90643 C.

Zinc Smelting.

Recent Advances in the Metallurgy of Zinc. Woolsey McA. Johnson. A review of progress in the treatment of zinc ores, both in the concentration methods, and in the spelter plant. 4000 w. Jour Fr Inst—March, 1908. No. 91066 D.

See also Converters, under COPPER.

MINOR MINERALS.

Aluminium.

On the Direct Reduction of Alumina by Carbon. R. S. Hutton and J. E. Petavel. Part of a paper read before the Royal Soc. of London. Discusses the possibilities of direct reduction. 2500 w. Elec-Chem & Met Ind—March, 1908. No. 90644 C.

Antimony.

Antimony Mining in Peru and Bolivia. G. Preumont. An examination of the possibilities of antimony mining in these two countries. 1800 w. Min Jour—March 7, 1908. No. 90896 A.

Cement.

A New Rotary Kiln Cement Plant. Illustrated description of a new rotary kiln plant at Greenhithe, and of the process of manufacture. 4500 w. Engr, Lond—Feb. 28, 1908. No. 90775 A.

The New Mill of the California Portland Cement Company. Illustrated description of a new cement mill, with a capacity of 2500 barrels a day, recently placed in operation at Colton, Cal. 3500 w. Eng Rec—March 7, 1908. No. 90705.

Portland Cement and Slag Cement (Portlandzement und Eisen-Portlandzement). H. Wedding. A comparison, and a discussion of the production of slag cement as a steel-works by-product. 4500 w. Stahl u Eisen—Feb. 12, 1908. No. 90932 D.

Diamonds.

The Kimberlite Rock and the Origin of Diamonds. F. W. Voit. Gives a description of the rocks and the eluvial diamond deposits, the eclogite nodules, etc. 4000 w. Min Jour—Feb. 22, 1908. No. 90662 A

Graphite.

Modes of Occurrence of Canadian Graphite. H. P. H. Brunnell. Considers only the ore found in the Archaen rocks, from which the crystalline or flake variety is obtained. 2000 w. Can Min Jour—March 15, 1908. No. 91027.

See also Graphite Crucibles, under MISCELLANY.

Lime.

The Schmatolla System of Gas-Fired Lime-Kilns. Illustrates and describes a form of gas-fired kiln which seems satisfactory. 900 w. Engng—Feb. 28, 1908. No. 90772 A.

Calculating the Heat Balance of Lime Kilns. Robert Schorr. Gives facts relating to the combustion of coal, wood, oil, and producer-gas in calculating the efficiency of direct and gas-fired lime kilns. 2500 w. Eng & Min Jour—March 21, 1908. No. 91092.

Manganese.

On the Original Type of the Manganese Ore Deposits of the Queluz District, Minas Geraes, Brazil. Orville A. Derby. Some information of importance in determining the genesis of this type of manganese ore deposits. 1200 w. Am Jour of Sci—March, 1908. No. 90802 D.

Nickel.

Recovery of Nickel from Oxide and Silicate Ores. Wm. Koehler. Describes a process for handling ores which are not readily amenable to smelting methods. 1800 w. Elec-Chem & Met Ind—April, 1908. No. 91248 C.

Potash.

Potash Mining in Germany (Deutschlands Kalibergbau). A general review. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—Feb 29, 1908. No. 90939 D.

Salt.

The Saline Deposits of Carmen Islands. Edward H. Cook. Illustrates and describes these deposits in the Gulf of California. 800 w. Eng & Min Jour—March 14, 1908. No. 90848.

Sulphur.

A Historic Sulphur Mine in Durango, Mexico. Douglas Muir. Describes the deposits and methods of mining and refining. 700 w. Min Sci—Feb. 27, 1908. No. 90592.

Sulphuric Acid.

The Suitability of Sicilian Sulphur Ore for the Manufacture of Sulphuric Acid. Guiseppe Oddo. Gives results of experiments, and a statement of important advantages resulting from the treatment of sulphur ores. 1500 w. Min Jour—March 14, 1908. No. 91138 A.

Tin.

Tin Mining in Tasmania. James B. Lewis. Describes the extent and nature of the tin-bearing deposits and the condition of the mines. Ills. 3000 w. Eng & Min Jour—March 7, 1908. No. 90733.

MINING.

Borehole Surveying.

A New Borehole Surveying Instrument (Ein neuer Lotapparat für Bohrlöcher). Karl Haussmann. Illustrated description of the author's photographic device. 2800 w. Glückauf—Feb. 15, 1908. No. 90942 D.

Compressed Air.

Simple Problems in Air-Compression. Edward A. Rix. An address before the Min. Assn. of the Univ. of California. An explanation of the principles involved in the use of compressed air for various purposes in mining. 3500 w. Min & Sci Pr—March 21, 1908. No. 91183.

Diamond Drilling.

Notes on Cost of Diamond Drilling in the Boundary District. Frederick Keffer. Gives tabulated results of this work, with explanatory notes. 1000 w. Can Min Jour—March 15, 1908. No. 91028.

Drainage.

Drainage in Cripple Creek, Colorado, Gold Camp. T. R. Countryman. Considers the sources of the water, and gives the history of the Cripple Creek drainage tunnel. 1500 w. Min Sci—March 19, 1908. Serial. 1st part. No. 91115.

Drilling.

See Shaft Sinking, under MINING.

Drills.

Notes on Small Stope Drills. Discussion of paper by E. M. Weston. 800 w. Jour Chem, Met, & Min Soc of S Africa —Jan, 1908. Serial. 1st part. No. 90882 E.

The South African Stope-Drill Competition. Eustace M. Weston. The results proved the superiority of air-hammer drills as a one-man drill. Ills. 2200 w. Eng & Min Jour—March 7, 1908. No. 90735.

Electric Hoisting.

Losses in Ilgner Hoisting Plants and the Determination of the Most Economical Slip for Their Starting Motors (Verluste bei Ilgner-Förderanlagen und Bestimmung der wirtschaftlichsten Schlüpfung iher Anlassmotoren). L. Becker. A mathematical discussion illustrated with curves. 1800 w. Glükauf—Feb. 8, 1908. No. 90941 D.

Electric Power.

Electric Power Installation at Belgian Mines. F. C. Perkins. Special reference to Peronnes and St. Albert plants supplying power to large coal mines. Ills. 1500 w. Min Sci—Feb. 27, 1908. No. 90591.

The Central Power Plant of the Berwind-White Coal Mining Company at No. 40 Mine, Windber, Pa. William L. Affelder. Illustrates and describes a plant that will furnish power for six large mines. 1500 w. Mines & Min—March, 1908. No. 90677 C.

Engineering Ethics.

The Status of the Mining Profession. J. C. Gwillim. Describes the gambling element in mining and steps to correct the evil. Discussion. 7000 w. Jour Can Min Inst—Vol. X, 1907. No. 91154 N.

Explosives.

Method of Thawing Explosives. Abstract of a paper by P. N. Dennison, read before the Ohio State Stone Club. Discusses the dangers, describing safe methods of thawing and handling. 2000 w. Engng-Con—March 11, 1908. No. 90807.

Finance.

Value of Mining Stock. M. L. Requa. An argument for the making of San Francisco a financial center for the mining industry. 2000 w. Min & Sci Pr—March 7, 1908. No. 90811.

Hoisting.

Accidents in Winding, with Special Reference to Ropes, Safety Cages, and Controlling Devices for Colliery Winding Engines. G. H. Winstanley. Abstract of lecture before the Manchester Geol. & Min. Soc. 5500 w. Col Guard—March 13, 1908. No. 91139 A.

Hoisting Engines.

Dense-Air Winding-Engine for the Consolidated Gold-Fields of South Africa. Explains this system, and illustrates and describes an engine designed by H. C. Behr, for its application. 3000 w. Engng —March 13, 1908. No. 91142 A.

Locomotives.

Mine Locomotives, with Special Reference to Benzine Locomotives (Die Grubenlokomotiven mit besonderer Berücksichtigung der Benzinlokomotive). A. Kás. The operation and efficiency of compressed air, electric and benzine locomotives. 2000 w. Serial, 1st part. Oest Zeitschr f Berg- u Hüttenwesen—Feb. 8, 1908. No. 90937 D.

Plants.

The Installation of the Steam Power Mine Plant. Otto Ruhl. Notes relating to the boiler house, setting of and foundations for boiler, etc. 1700 w. Min Sci —March 5, 1908. No. 90740.

Pumping.

New Unwatering Plants with Sulzer High-Pressure Centrifugal Pumps in the Ruhr Coal District (Neuere Wasserhaltungen mit Sulzer-Hochdruck-Zentrifugalpumpen im Ruhrkohlenrevier). A. Thimm. Illustrated description of several plants. 2000 w. Glñckauf—Feb. 8, 1908. No. 90-940 D.

Royalties.

The Mining Royalty Burden on British Iron and Steel. T. Good. Discusses this tax in Great Britain, considering it highly burdensome on production. 1700 w. Cassier's Mag—March, 1908. No. 90825 B.

Shafts.

See Timbering, under MINING.

Shaft Sinking.

Improvements in Crossheads for Shaft Sinking. Eustace M. Weston. Illustrates and describes devices for preventing accidents. 1000 w. Eng & Min Jour—March 7, 1908. No. 90736.

Machine vs. Hand Drilling in Sinking on the Rand. Eustace M. Weston. Hand sinking is at present more popular, but future development and labor shortage will probably cause machine-sinking to become preferable. Ills. 3500 w. Eng & Min Jour—Feb. 29, 1908. No. 90610.

Stoping.

See Drills, under MINING.

Timbering.

Shaft Timbering, Brakpan, Transvaal, S. A. Eustace M. Weston. Describes the method of framing. 1000 w. Eng & Min Jour—March 14, 1908. No. 90849.

Unwatering.

Tapping Mine Water Under Great Pressure. Robert Sibley. Reviews the history of the Iron Mountain Tunnel Co. and this silver-lead mine at Superior, Mont., and describes the proposed method of tapping the water. Ills. 2000 w. Eng & Min Jour—March 14, 1908. No. 90851.

ORE DRESSING AND CONCENTRATION.

Crushing.

Crushing Ore. M. P. Boss. Aims to make clear the fundamental principles of ore crushing. 4000 w. Min & Sci Pr—March 14, 1908. No. 91031.

Drying.

Drying Appliances. Oskar Nagel. Illustrates and describes methods of artificial drying and apparatus used. 2000 w. Elec-Chem & Met Ind—April, 1908. No. 91249 C.

Gold Milling.

The Montgomery-Shoshone Mill of the Bullfrog Reduction and Water Co., Rhyolite, Nevada. P. E. Van Saun. Illustrated description of the equipment and methods of milling. 2500 w. Mines & Min—March, 1908. No. 90679 C.

Experimental Studies on the Work of Water Jigs. Abstract translation of a paper by Gust. G. Bring, *Jernkontorets Annaler*. Considers the fall in narrow channels, influence of currents, behavior under suction, etc. 2000 w. Eng & Min Jour—March 28, 1908. No. 91207.

Lead Milling.

See Utah, under LEAD AND ZINC.

Magnetic Separation.

The Possibility of Reducing the Ash-Content of Coal by Electro-Magnetic Means. E. Prost, *Bul. Soc. Chimique de Belgique*. A report of experiments showing the percentage of ash may be lowered, but the method is too costly to supersede washing. 1000 w. Col Guard—Feb. 21, 1908. No. 90663 A.

See also Roasting, under IRON AND STEEL.

Ore Dressing.

The Present Status of the Art of Ore Dressing. W. G. Swart. Presidential address discussing the general problems of concentration and separation in hydraulic, pneumatic, magnetic and static fields. 1700 w. Min Sci—March 26, 1908. Serial, 1st part. No. 91251.

Sampling.

The Sampling of Silver-Cobalt Ores at Copper Cliff, Ontario. Arthur A. Cole. Describes the methods used. Ills. 1200 w. Qr Bul Can Min Inst—Feb., 1908. No. 91218 N.

Silver Milling.

Some Features of Silver Ore Treatment in Mexico. W. A. Caldecott. Notes on works practice and present day cyanide treatment. 2500 w. Jour Chem, Met & Min Soc of S Africa—Jan., 1908. No. 90881 E.

A Small Lixiviation Plant in Mexico. H. A. Horsfall. Illustrates and describes the reconstruction of the old Ocampo silver mill in Chihuahua, the ores treated, the manner of operating, giving tabulated statements of ore worked and the cost. 2500 w. Min Wld—March 28, 1908. No. 91252.

Zinc Milling.

See Zinc Smelting, under LEAD AND ZINC.

MISCELLANY.

British Columbia.

Review of Progress in the Mineral Production of British Columbia. E. Jacobs. 1500 w. Jour Can Min Inst—Vol. X, 1907. No. 91153 N.

Canada.

The Mineral Production of Canada in 1907. John McLeish. A preliminary report. 2500 w. Min Wld—March 14, 1908. No. 90852.

Sir William E. Logan and the Geological Survey of Canada. Dr. Robert Bell. Gives incidents illustrating Sir Wm. Logan's important services to the Survey. 10700 w. Jour Can Min Inst—Vol. X, 1907. No. 91155 N.

Colorado.

The Historical Development of Colorado Viewed from a Geological Standpoint. T. A. Rickard. Ills. 2000 w. Min & Sci Pr—Feb. 29, 1908. No. 90709.

Earth Stresses.

The Earth a Failing Structure. John F. Hayford. Read before the Phil. Soc. of Washington. A study of the earth stresses, discussing whether it is an elastic or failing structure. 5500 w. Sci Am Sup—Feb. 22, 1908. No. 90589.

Graphite Crucibles.

Some Observations Upon the "Life" of Graphite Crucibles. Erwin S. Sperry. Gives an illustrated description of the appearance of a crucible after various heats when handled with care, and some of the causes of short life. 3800 w. Brass Wld—March, 1908. No. 91057.

Macedonia.

The Mineral Wealth of Macedonia. Extracts from an official report, which shows the country to be richly endowed with a large variety of minerals. 1200 w. Min Jour—Feb. 29, 1908. No. 90768 A.

Metallurgy.

Practical Metallurgy. Horace Allen. Gives a table showing the principal properties of various metals, discusses metallurgical processes, etc. 1000 w. Prac Engr—Feb. 21, 1908. Serial, 1st part. No. 90656 A.

Metal Oxidation.

The Action of Oxygen on Metals. Edward Jordis and W. Rosenhaupt. Trans. from *Zeit. fuer Angewandte Chemie.* Gives results of experimental investigations. 2000 w. Sci Am Sup—March 7, 1908. No. 90718.

New Zealand.

The Mineral Wealth of New Zealand. Dr. J. Mackintosh Bell. Abstract of a paper read in London, Nov. 19, 1907, dealing with the economic geology of the Dominion. 4000 w. N Z Mines Rec—Jan. 16, 1908. No. 91007 B.

Ore Deposits.

Cerargyritic Ores: Their Genesis and Geology. Charles R. Keyes. Gives suggestive hypotheses accounting for the formation of these silver chloride ores in arid America. 2200 w. Ec Geol—Dec., 1907. No. 91044 D.

The Origin of Deposits of Pyrites. A. B. Willmott. Deals with occurrences in Ontario, reviewing the opinions of many writers and the important theories advanced. 4000 w. Jour Can Min Inst—Vol. X, 1907. No. 91150 N.

Present Tendencies in the Study of Ore Deposits. Waldemar Lindgren. Presidential address before the Geol. Soc. of Washington. Shows the tendencies of the studies of ore deposits during the last seven years. Also list of literature on this subject. 7000 w. Ec Geol—Dec., 1907. No. 91042 D.

A Theory of Ore-Deposition. J. E. Spurr. Gives a theory that proposes that metalliferous fluids are extreme differentiation phases of rock magmas; that most ore deposits represent extreme products of magmatic differentiation, and the differences are due to successive precipitations. 5000 w. Ec Geol—Dec., 1907. No. 91045 D.

A Theory of Ore-Deposition. Horace N. Winchell. An editorial letter discussing critically the theory recently advanced by J. E. Spurr. 2000 w. Min & Sci Pr—March 21, 1908. No. 91181.

The Paragenesis of Minerals, Particularly of the Zeolites (Ueber die Paragenese der Minerale, namentlich die der Zeolithe). F. Cornu. A discussion of the development and present form of the theory of paragenesis. 3200 w. Oest Zeitschr f Berg- u Hüttenwesen—Feb. 22, 1908. No. 90938 D.

See also New York, under IRON AND STEEL.

Peru.

The Mining Possibilities of the Department of Cuzco, Peru. Enrique J. Dueñas. Abstract translation. Describes this region and its mineral resources. 1800 w. Min Jour—March 7, 1908. Serial, 1st part. No. 90897 A.

Transportation, Costs and Labor in Central Peru. J. C. Pickering. Information concerning the railroads, labor conditions, etc. Ills. 2500 w. Eng & Min Jour —March 21, 1908. No. 91087.

Refractory Materials.

Refractory Materials. Thomas Holgate. A study of the nature of materials in their refractoriness to heat. 2500 w. Engng—Feb. 21, 1908. No. 90666 A.

United States.

Mineral Production of Western States, 1906-1907. A general review. 1907 shows an increase over 1906 of nearly $82,000,000. 15800 w. Min Sci—March 12, 1908. No. 90873.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Crossing Bells.

Large Installation of Crossing Bells, C., C., C. & St. L. Ry. Illustrated description of an extensive installation in Ohio, embodying new features in this branch of signal service. 2500 w. Ry & Engng Rev—March 14, 1908. No. 90857.

Headlights.

See same title, under MOTIVE POWER AND EQUIPMENT.

Signalling.

Railway Accidents and the Color Sense. George M. Stratton. On the danger from the use of white as a signal code at night; also discussing the green and red signals, and suggests the use of luminous lines in various positions. 3500 w. Pop Sci M—March, 1908. No. 90816 C.

See Subway Signalling, under STREET AND ELECTRIC RAILWAYS.

Signals.

Signals, Locking and Safety Devices on the Railways of the United States (Note sur les Signaux, Enclenchements et Appareils de Sécurité des Chemins de Fer des Etats-Unis). Ch. Jullien. A description of the various signalling methods and devices in use. Ils. 10000 w. Rev Gen des Chemins de Fer—Feb., 1908. No. 90911 G.

Interlocking Devices Installed at Valenciennes Station (Appareils d'Enclenchement Installés à la Gare de Valenciennes). A description of the Bianchi and Servettas hydraulic system for the working of switches and signals. Ills. 3000 w. Génie Civil—Feb. 8, 1908. No. 90921 D.

See also Crossing Bells, under CONDUCTING TRANSPORTATION.

MOTIVE POWER AND EQUIPMENT.

Car Ferries.

See Ferryboats, under MARINE AND NAVAL ENGINEERING.

Car Heating.

Ventilation and Heating of Coaches and Sleeping Cars. Samuel G. Thompson. Describes the indirect system as used on the Pennsylvania R. R., outlining earlier types. Discussion follows. Ills. 13600 w. Pro W Ry Club—Feb. 18, 1908. No. 91041 C.

Car Lighting.

An Instantaneous Ignition Device for Gas Lamps under Test by the Eastern Railway of France (Note sur un Dispositif d'Allumage Instantané des Lanternes à Gaz à Incandescence Expérimenté à la Compagnie des Chemins de Fer de l'Est). E. Biard. Reviews previous attempts to solve the problem and illustrates and describes a new device. 5000 w. Rev Gen des Chemins de Fer—Feb., 1908. No. 90912 G.

Car Ventilation.

See Car Heating, under MOTIVE POWER AND EQUIPMENT.

Derrick Cars.

Derrick Cars for the Chicago, Milwaukee, & St. Paul. An illustrated detailed description of the heavy steel derrick car recently completed. 1500 w. Ry Age—March 13, 1908. No. 90855.

Dynamometer Cars.

A New Railway Dynamometer Car. Illustrated description of a car for testing the N.-E. Ry. Co.'s rolling stock, in England. 1000 w. Sci Am Sup—Feb. 8, 1908. No. 90582.

Electrification.

New York Central Electric Traction. C. H. Querean. Information in relation to the Initial Electric Zone, within the limits of Greater New York. 2000 w. Sib Jour of Engng—March, 1908. No. 91-069 C.

The Value of Electrification as a Steam Railroad Improvement. Clarence P. Fowler. A plea for the single-phase system on the ground of economy. Editorial. 5000 w. Elec Wld—March 21, 1908. No. 91017.

Headlights.

Green Shade for Headlight. Describes the device, its working, and objects. 1200 w. Ry & Loc Engng—March, 1908. No. 90628 C.

Locomotive Performance.

Results Obtained in Service with the New, 4-Cylinder Compound Articulated Freight Locomotive of the Northern Railway of France (Résultats Obtenus en Service par les Nouvelles Locomotives Compound à Marchandises à 4 Cylindres et à 2 Bogies Moteurs de la Compagnie du Chemin de Fer du Nord). M. du Bousquet. Ills. 2200 w. Rev Gen des Chemins de Fer—Feb., 1908. No. 90910 G.

Locomotive Rating.

Tonnage Rating of Locomotives. B. A. Worthington. Outlines a simple and inexpensive system of engine rating that will give excellent results, and describes a more complete system that has been in use nine years on the Southern Pacific. General discussion. 13500 w. Pro Ry Club of Pittsburgh—Jan. 24, 1908. No. 91056 C.

Locomotive Repairing.

A Method of Repairing Cracked Piston Valve Cylinders. B. P. Flory. Describes a method lately adopted by the Central of New Jersey. Ills. 700 w. R R Gaz—Feb. 28, 1908. No. 90596.

Locomotives.

Four-Coupled Ten-Wheel Side-Tank Locomotive; L., B., and S. C. Railway. Plate, illustration and detailed description. 1500 w. Engng—Feb. 28, 1908. No. 90773 A.

Missouri & North Arkansas 2-8-0. Simple consolidation engines of this type, for freight service, are illustrated and described. 1000 w. Ry & Loc Engng—March, 1908. No. 90627 C.

L. and S. W. Locomotive No. 335. Elevation and sections, with description of details. 300 w. Engr, Lond—Feb. 21, 1908. No. 90673 A.

Ten-Wheel Passenger Locomotives for the St. Louis and San Francisco. Illustrated detailed description of these heavy engines. 500 w. Ry Age—March 6, 1908. No. 90754.

New Locomotives for the Atchison, Topeka & Santa Fe. Illustrated descriptions of Pacific engines for passenger service, and consolidation engines for freight service. 900 w. R R Gaz—March 27, 1908. No. 91256.

Locomotives with Low Boiler Pressure and Smokebox Superheaters. Illustrates and describes engines for the A., T. & S. F. Ry. 1000 w. Am Engr & R R Jour—March, 1908. No. 90637 C.

Express Locomotives—State Railroads of Sweden. Illustrated description of a recently built engine designed to meet the increased requirements. Also report of tests. 2500 w. R R Gaz—Feb. 28, 1908. No. 90595.

Balanced Compound Locomotive with Superheater for the Pfaelz Railways. Illustrated detailed description of an engine of recent construction, used in Germany. 1500 w. Ry Age—Feb. 28, 1908. No. 90594.

Some Examples from Recent Italian Locomotive Practice. Illustrated descriptions of recent designs of locomotives of the 6-wheeled coupled type. 2200 w. Mech Engr—March 6, 1908. No. 90885 A.

The First Superheating Locomotive of the Italian State Railways (Le Prime Locomotive a Vapore Surriscaldato delle Ferrovie di Stato Italiane). Illustrated description. 2590 w. Serial, 1st part. Ing Ferroviaria—Feb. 16, 1908. No. 90928 D.

Locomotive Stacks.

Locomotive Smoke Stacks. W. E. Johnston. Presents the development of new formulæ for stack diameters, using the data obtained in the tests of 1896, 1903 and 1906 as a basis. 800 w. Am Engr & R R Jour—March, 1908. No. 90635 C.

Speed Indicators.

The Flaman Speed Indicator and Recorder for Locomotives. Illustrates and describes this device and its application to locomotives on the Eastern Railway of France. 2000 w. Mech Engr—March 13, 1908. No. 91130 A.

Train Heating.

Train Heating on Electric Divisions of Steam Railroads. Charles M. Ripley. Describes the two methods adapted to the rolling stock of the New York Central and of the New Haven R. R. Ills. 1200 w. R R Gaz—March 13, 1908. No. 90871.

Train Lighting.

See D. C. Dynamos, under ELECTRICAL ENGINEERING, Dynamos and Motors.

Train Resistance.

The Resistance of Railway Trains, and the Formulæ Used for Calculating It. Albert Frank. Compares the principal formulæ now used, considering the experiments which led to their determination. 6700 w. Bul Int Ry Cong—Feb., 1908. No. 91214 G.

Valve Gears.

Walschaert Valve Gear for Pacific Type Locomotive. Illustrates and describes the method of applying this gear on engines for the Florida East Coast R. R., commending the arrangements. 1000 w. Am Engr & R R Jour—March, 1908. No. 90636 C.

NEW PROJECTS.

Illinois Central.

The Illinois Central's Birmingham Line. Map and illustrated description of this new line. 2500 w. R R Gaz—March 13, 1908. No. 90869.

Memphis and State Line Railroad. Illustrated detailed description of a new line for handling heavy through traffic, avoiding grade crossings and heavy gradients which are serious hindrances on the main line. 1400 w. Ry Age—Feb. 28, 1908. No. 90593.

Lake Shore.

Vanderbilt Operations in Pennsylvania. Map and description of a new cut-off line from Franklin to Clearfield, in the bituminous coal regions. 1500 w. Ry Age —March 20, 1908. No. 91098.

PERMANENT WAY AND BUILDINGS.

Bridge Deflection.

The Osske-Kühne Deflection Recorder and the Utilization of Railway Bridge Records Obtained with It. Mr. Jaehn. Ills. 2000 w. Bul Int Ry Cong—Feb., 1908. No. 91212 G.

Coaling Plants.

Coaling Stations on the Belen Cut-Off. Illustrated description of stations in New Mexico. 800 w. R R Gaz—March 13, 1908. No. 90864.

Construction.

Building a Railway Embankment by the Hydraulic Method. George H. Moore. Describes the construction of what is said to be the largest railway embankment in the world, being built in the State of Washington. Ills. 1000 w. Eng News—March 12, 1908. No. 90791.

See also Gauge Conversion, under Permanent Way and Buildings.

Crossings.

The Proposed Elimination of Grade Crossings at Worcester, Mass. Charles B. Breed. An explanation of the difficult problem in this city and the method of solving it. Ills. 3500 w. R R Gaz—March 13, 1908. No. 90868.

See also Crossing Bells, under Conducting Transportation.

Curves.

Curve Superelevation. M. L. Byers. A mathematical study of proper speeds and elevations. 2200 w. R R Gaz—March 13, 1908. No. 90870.

See also Track Maintenance, under Permanent Way and Buildings.

Drop Pits.

Southern Pacific Drop Pit. Illustrated detailed description of this roundhouse appliance. 1000 w. Ry & Loc Engng—March, 1908. No. 90626 C.

Freight Sheds.

See Reinforced Concrete, under CIVIL ENGINEERING, Construction; and Cranes, under MECHANICAL ENGINEERING, Transporting and Conveying.

Gauge Conversion.

Railway Gauge Conversion in Manchuria. Illustrates and describes the work of gauge widening without serious interruption of traffic. 1000 w. Engr, Lond —March 6, 1908. No. 91004 A.

Maintenance of Way.

Reports and Discussions, Maintenance of Way Association. 25000 w. Ry Age —March 20, 1908. No. 91148.

Rails.

Strength and Endurance of Steel Rails. James E. Howard. Read before the Am. Ry. Engng. & Main. of Way Assn. Remarks on the conditions and influences which contribute toward fracture as shown by tests. Discussion. Ills. 5000 w. Ry Age—March 20, 1908. No. 91103.

Reconstruction.

Rebuilding the Northern Pacific in Minnesota. H. Cole Estep. Illustrates and describes interesting work including double-tracking, reballasting, grade reductions and modifications of alinement. 2000 w. R R Gaz—March 13, 1908. No. 90867.

Roundhouses.

Engine Houses of North American Railways (Lokomotivstationen nordamerikanischer Eisenbahnen). Herrn Blum and E. Giese. The first part of the serial discusses shops and coaling plants. Ills. 3300 w. Serial, 1st part. Zeitschr d Ver Deutscher Ing—Feb. 8, 1908. No. 90975 D.

See also Terminals, under PERMANENT WAY AND STRUCTURES.

Shops.

See Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Stations.

Station Standards; Virginian Railway. Illustrated detailed description of the standardized designs adopted for the States of Virginia and West Virginia on this line. 4000 w. R R Gaz—March 13, 1908. No. 90865.

Terminals.

Union Terminal at Washington, D. C. —Locomotive Terminal. Plan and illustrated description of the locomotive terminal, which provides storage for a large number of locomotives and complete facilities for cleaning and coaling. 1500 w. Ry Age—March 20, 1908. No. 91097.

Union Terminal at Washington, D. C.—Coach Terminal. Illustrates and describes the principal features of the coach terminal yards. 700 w. Ry Age—March 27, 1908. No. 91254.

Terminal Improvements at Ashtabula Harbor for the Pennsylvania Lines. Illustrates and describes improved facilities for handling coal and ore at this Lake Erie port. 600 w. Ry & Engng Rev—March 14, 1908. No. 90856.

Ties.

Australian Timbers for Cross Ties. C. O. Burge. Information concerning the quantity, quality and cost of the timber available. 2200 w. Eng Rec—March 21, 1908. No. 91085.

The Steel Tie (Die Eisenschwelle). A. Haarmann. A discussion of the development of permanent way construction with the increase in traffic and the efficiency of the steel tie, illustrating and describing various types. 9000 w. Stahl u Eisen —Feb. 5, 1908. No. 90931 D.

Track Maintenance.

Maintenance of Tracks at Curves. H. Saller. On the use of the sagitta method for determining whether rails are right. 1700 w. 2 tables. Bul Int Ry Cong—Feb., 1908. No. 91213 G.

Water Tanks.

Railroad Track Tanks. H. H. Ross. Illustrates and describes the details of tank systems, giving results of tests, and discussing matters relating to their efficiency. 3000 w. R R Gaz—March 13, 1908. No. 90862.

Yards.

The Sunnyside Yard of the Pennsylvania. F. H. Shakespeare: An illustrated detailed description of this new terminal yard on Long Island, and its facilities. 4500 w. R R Gaz—March 13, 1908. No. 90863.

Hump Yards and Terminals. From a committee report to the Am. Ry. Engng. & Main. of Way Assn. on the design of hump yards and giving illustrated descriptions of several yards and their operation. 9000 w. Ry & Engng Rev—March 21, 1908. No. 91095.

TRAFFIC.

Freight.

The Reform of the Goods Traffic on the Prussian State Railways. Mr. Schwabe. On increasing the capacity of the wagons, and accelerating their circulation. Ills. 4000 w. Bul Int Ry Cong—Feb., 1908. No. 91215 G.

Passenger Tariffs.

The Results of the Reform in the Passenger Tariff in Germany. Discusses the results since the new rates went into effect. 4400 w. Bul Int Ry Cong—Feb., 1908. No. 91216 C.

MISCELLANY.

Accounting.

Notes on the Application of a Depreciation Charge in Railway Accounting. Frederic A. Delano. A careful consideration of methods of dealing with this subject which have developed in the United States and Great Britain, with criticism of the proposed rules. 3300 w. Ry Age—March 27, 1908. No. 91255.

Africa.

Lessons of the Daressalam-Morogoro Railway (Was können wir aus dem Bahn-bau Darcssalam-Morogoro lernen). Herr Schubert. A description of the construction of this line in German East Africa. Ills. 9000 w. Glasers Ann—Feb. 1, 1908. No. 90956 D.

The Otavi Narrow-Gauge Railway in German South-West Africa (Die Otavi Schmalspurbahn im Deutschen Schutzgebiete Deutsch-Südwestafrika). E. A. Ziffer. A description of the line, its construction, operation, etc. Ills. 7000 w. Mit d Ver f d Förd d Lokal u Strassenbahnwesens—Jan., 1908. No. 90930 F.

Forestry.

I. Review of Forestry Experiments by American Railways. R. C. Bryant. An interesting account of these undertakings. II. Forest Work of the Pennsylvania Railroad. E. A. Sterling. An account of the commercial project, aiming to supply crossties and fence posts by the planting of forest trees on the company's lands. 4000 w. Ry Age—March 20, 1908. No. 91100.

History.

Some Early American Railroad Engineers. O. F. Nichols. An interesting review of the engineers who built the first railroads in America, the early engines, the canals, and other works. Photographs. 10500 w. Pro Brooklyn Engrs Club, No. 72—Vol. XI, 1907. No. 91236 N.

Newfoundland.

The Railroad System of Newfoundland. Illustrated account of railroad system and its equipment. 1600 w. R R Gaz—March 6, 1908. No. 90724.

Norfolk & Southern.

Growth of the Norfolk & Southern System. Describes the region served by this road, and the present lines of the system, and new construction. Maps. 2500 w. Ry Age—March 20, 1908. No. 91096.

Purchasing.

The Purchasing Department of a Railway System and the Importance of Cooperation Among Different Departments of the Service in Intelligently Standardizing Many of the Articles to be Purchased. W. V. S. Thorne. Describes the present practice and policy of the Union Pacific and Southern Pacific Systems. Discussion. 16800 w. Pro N Y R R Club—Feb. 21, 1908. No. 91055.

STREET AND ELECTRIC RAILWAYS

Accounting.

The Small Company and the New Classification of Accounts. W. B. Brockway. Concerning the classification proposed by the Interstate Commerce Commission, criticising points affecting electric railways. 3800 w. St Ry Jour—March 14, 1908. No. 90815.

Berlin.

Recent Extensions on the Berlin Hoch- und Untergrundbahn. Illustrates and describes the equipment of a large sub-station, and also the cars used. 3000 w. Elect'n, Lond—March 13, 1908. No. 91135 A.

Brooklyn.

Improvement of the Brighton Beach Line—Brooklyn Heights Railroad Company. Harry B. Snell. An illustrated detailed description of the methods used in the extensive work of depressing and elevating tracks, and construction work generally. Discussion. 6500 w. Pro Brooklyn Engrs Club, No. 75—Vol. XI, 1907. No. 91239 N.

Canal Traction.

See Canal Haulage, under CIVIL ENGINEERING, Waterways and Harbors.

Car Department.

The Car Equipment Department of the Interborough Rapid Transit Company—General Considerations and Analysis of Inspection Reports. 4500 w. St Ry Jour—March 28, 1908. No. 91186.

Cars.

See Berlin, Trucks, and Subway Cars, under STREET AND ELECTRIC RAILWAYS.

Controllers.

The Contractor and Reverser. W. B. Kouwenhoven. Illustrates and describes these devices as used on the Manhattan Elevated Ry., and their operation. 1200 w. Ry & Loc Engng—March, 1908. No. 90629 C.

Electrification.

See same title, under RAILWAY ENGINEERING, Motive Power and Equipment.

Elevated Railways.

The Kemwood and Stock Yards Extension of the Chicago South Side Elevated Railroad. An illustrated detailed description of these new lines. 3000 w. St Ry Jour—March 7, 1908. No. 90717.

Great Britain.

Electrical Installations in Great Britain (Les Installations Electriques en Grande-Bretagne). Discusses the present status of electric traction. 3300 w. Serial. 1st part. Génie Civil—Feb. 29, 1908. No. 90927 D.

Interurban.

The Boise & Interurban Railway. Illustrated description of a line recently put in operation in Idaho. 1500 w. Elec Ry Rev—March 14, 1908. No. 90872.

The Northern Electric Street Railway Company of Scranton, Pa. Illustrated detailed description of a line now operated between Scranton and Factoryville, and the proposed extensions. 3000 w St Ry Jour—March 21, 1908. No. 91033.

See also Single Phase, under STREET AND ELECTRIC RAILWAYS.

London.

See Subways and Surface Contact, under STREET AND ELECTRIC RAILWAYS.

Motors.

See Railway Motors, under ELECTRICAL ENGINEERING, Dynamos and Motors.

Single Phase.

Richmond & Chesapeake Bay Single-Phase Railway. Illustrated detailed description of the line and its equipment. 5000 w. St Ry Jour—March 7, 1908. No. 90716.

The Hanover & York Single-Phase Railway. An illustrated description of a new 20-mile single-track line in Pennsylvania, and its operation. 1500 w. Elec Ry Rev—March 7, 1908. No. 90745.

Pittsburg & Butler Single-Phase Railway. L. H. Kidder. Illustrated detailed description of a heavy interurban line of first-class construction. 5500 w. Elec Jour—March, 1908. No. 90795.

The Rome-Civita Castellana Electric Railway. Illustrated detailed description of the first single-phase line built in Italy. 3000 w. Tram & Ry Wld—March 5, 1908. No. 91128 B.

The Maggia Valley Railway (Die Valle Maggia-Bahn). Illustrated description of the line and equipment of this railway between Locarno and Bignasco, Switzerland. 1000 w. Serial. 1st part. Schweiz Bau—Feb. 1, 1908. No. 90947 D.

The Finzi System of Single-Phase Alternating-Current Electric Traction on European Railways (La Traction Electrique par Courant Alternatif Simple sur les Chemins de Fer en Europe). M. Henry. Describes the system and the lines on which it is in use. Ills. 2000 w. Elec'n—Feb. 8, 1908. No. 90913 D.

See also Electrification, under RAILWAY ENGINEERING, Motive Power and Equipment.

Subway Cars.

Improved Steel Cars for the New York Subway. Illustrated description of new features introduced. 1200 w. St Ry Jour—March 14, 1908. No. 90814.

The Subway Car. Part of the report of Bion J. Arnold discussing the various types of cars which can be used in rapid transit work and the arrangements of seats. Diagrams. 8000 w. R R Gaz—March 6, 1908. No. 90723.

Types of Rapid-Transit Car for Maximum Service. A summary of the arguments of Bion J. Arnold in regard to suggested types, presenting various designs. 2500 w. Eng News—March 5, 1908. No. 90697.

Subways.

The Strand to Embankment Subway. A criticism of this undertaking, with a description of its engineering features. Plate & Ills. 4000 w. Engr, Lond—March 13, 1908. No. 91143 A.

The Aldwych-Embankment L. C. C. Tramway Subway. Illustrated description of this connection of the northern and southern portion of the tramway system of London. 1500 w. Elec Engng—March 5, 1908. No. 90888 A.

Underground and Tube Railways of London, England. S. A. Ionides. Explains the conditions which led to their adoption, and briefly describes the methods of construction. Ills. 1800 w. Min Sci—March 19, 1908. No. 91114.

The United States Capital Subways. W. J. Knight. Illustrated detailed description of the reinforced concrete subways conecting the Capitol with the Senate and House office buildings. 2000 w. Eng Rec—March 21, 1908. No. 91081.

Subway Signalling.

The Signal System of the Interborough Subway. Gives improvements recommended by Bion J. Arnold. 1500 w. R R Gaz—March 20, 1908. No. 91076.

Subway Ventilation.

The Relation Between the Iron Superstructure of Tunnels and Their Artificial Ventilation (Zum Verhalten des eisernen Oberbaues in Tunnelanlagen und deren Künstliche Entlüftung). G. Steuer and M. Jäger. A discussion of the effects of tunnel air on iron construction and the necessity of efficient ventilation. Ills. 2500 w. Serial. 1st part. Elektrotech Rundschau—Feb. 5, 1908. No. 90950 D.

Surface Contact.

The Griffiths-Bedell Surface-Contact System in London. Illustrates and describes the line from Aldgate to Bow. Ills. 3000 w. Tram & Ry Wld—March 5, 1908. No. 91129 B.

Track Maintenance.

See Trucks, under STREET AND ELECTRIC RAILWAYS.

Trucks.

Trucks and Permanent Way Maintenance. F. W. Leevers. A brief discussion of the relationship a good truck bears to the economical maintenance of permanent way. 1200 w. Elec Rev, Lond—March 13, 1908. No. 91134 A.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Decoration.

Decoration of Metal, Wood, Glass, Etc. Edited by H. C. Standage. Size, 7½ by 5 in.; pp. 228. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall, Ltd.

Described as "a Book for Manufacturers, Mechanics, Painters, Decorators, and all Workmen in the Fancy Trades." It is a collection of recipes, assembled apparently without discrimination from all kinds of sources, intelligent and otherwise. Some, indeed, might have been gathered from the flotsam which drifts about the sea of the "exchanges" until it is battered out of all semblance of meaning. A few are addressed to the intelligence of the schoolboy; many would need to be supplemenetd by such knowledge of the art that the recipe would be superfluous. The best that can be said, perhaps, is that in spite of its incoherence the book does contain matter of usefulness and value.

Dictionary.

Illustrated Technical Dictionary in Six Languages, English, German, French, Russian, Italian and Spanish. Edited by K. Deinhardt and A. Schlomann. Vol. II. Electrical Engineering. Size, 7 by 4 in.; pp., 2100. Ills. Price, $7. New York: McGraw Publishing Company; London: Archibald Constable & Co.

Mention was made in these columns some months ago of the appearance of Volume I of this dictionary, covering machine details and tools. Our experience with the first volume leads us heartily to welcome the appearance of the second and to await with a considerable degree of impatience the remaining eight volumes which are projected for the completed work. The editing of the two volumes at present available has been most carefully done and such errors as might be expected to creep into a work of this magnitude are remarkably infrequent. The unique arrangement of the dictionary, the placing, wherever possible, of the equivalent terms in the six languages side by side with a small illustration of the device to which they refer, is a most commendable feature. The sixteen parts into which the present volume is divided deal with cells and batteries; boilers and prime movers; electrical machinery; switch apparatus; measuring instruments; electric supply stations; mains; wiring; lighting; various applications of electricity; telegraphy; telephony; electro-chemistry; electro-medical apparatus; electrical units; and an appendix. Electric traction is reserved for a subsequent volume on railway engineering.

Electrical Engineering.

An Introduction to the Study of Electrical Engineering. By Henry H. Norris. Size, 9 by 6 in.; pp., 404. Ills., 179. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman and Hall, Limited.

Prof. Norris defines electrical engineering as the industrial application of magnetic and electrical principles. He believes that the student in approaching the subject should have personal knowledge of the things and phenomena involved before any reasons can be assigned to them. The plan of the present work is, therefore, to take the every-day experience of the student as the basis of a general survey of electrical applications and, by combining with this experience the lessons taught by scientific research, to give a clear conception of electrical laws which may then be used to explain the operation of the numerous devices used in electrical practice. The work is mainly descriptive and, as its title implies, it is intended to serve only as an introduction to the more advanced knowledge required by the specialist in electrical engineering.

An Introductory Course of Continuous Current Engineering. By Alfred Hay. Size, 8½ by 5½ in.; pp., 327. Ills. Price, $2.50. New York: D. Van Nostrand Company.

Within the limits which the author has set for himself, this work is a very clear and useful exposition of the principles of direct-current engineering. It is introductory in the sense that, while the treatment presupposes an elementary knowledge of magnetism and electricity, the scope of the work is restricted to a simple account of the construction and operation of the component parts of a continuous-current lighting and power plant, without reference to their selection and arrangement to form a connected system. The author does not claim to have exhausted even this part of the subject but no information which could properly be included in an elementary treatise of this kind has been slighted. The material is very logically arranged and the many illustrations in the text assist materially in the clearness of its presentation. The book can confidently be recommended as a reliable and useful handbook.

Standard Handbook for Electrical Engineers. Written and Compiled by a Staff of Specialists. Size, 7 by 4 in.; pp., xx, 1283. Ills., 1260. Price, $4. New York: McGraw Publishing Company.

In the preparation of this latest addition to the list of electrical-engineering handbooks, the whole field of electrical engineering was divided into twenty sections and each section is treated separately by a specialist in the particular subjects covered by its title. The arrangement of the book follows the following general order: Fundamental theory, materials, apparatus, generation plants, transmission and distribution plants, utilization of electrical energy, standard practice and miscellaneous electrical information. In reality there are twenty books bound in one volume, each intended to be a complete and separate treatise on one particular section of electrical engineering but carefully edited according to a uniform style and thoroughly interconnected by cross references through a single index. The editing has apparently been very carefully done and the confusion and unnecessary repetition which might have been expected to result from this system of compilation seem to have been succesfully avoided. The most commendable feature of the book is that it is thoroughly up-to-date and contains much information on the later developments and applications of electrical science not usually found in similar handbooks.

Experimental Electrical Engineering and Manual for Electric Testing. By V. Karapetoff. Size, 9 by 6 in.; pp., xxxiv, 790. Ills., 538. Price, $6, 25/6. New York: John Wiley & Sons; London: Chapman and Hall, Limited.

A thorough and complete manual for electrical testing, covering in its 35 chapters the whole series of tests usually made by electrical engineering students during the last two years of their college course, as well as many others connected with the commercial applications of electricity, which are not usually found in manuals of this kind. In addition to the usual tests of generators, motors and transformers, complete and accurate outlines are given of tests of measuring instruments, transmission circuits, accumulators, electric heaters and welders, arc and incandescent lamps, railway controllers and telephone instruments. In still another feature has the author departed from the usual practice in laboratory manuals, in devoting considerable space to the description of the various types of machines and appliances. This descriptive matter will increase the value of the manual for laboratory use, for, while it in no way relieves the student of responsibility, it assists him to a clear understanding of the theory of the machine under test and ensures the most effective performance of the actual experimental work. In the preface, Prof. Karapetoff advocates the "concentric" method of teaching electrical engineering, but his book is so arranged as to satisfy the requirements of any schedule or any distribution of equipment.

Electric Lighting.

A Compilation of the Records of the Colorado Springs Lighting Controversy with an Introduction and Epitome. By Henry Floy. Size, 9 by 6 in.; pp., 327. Ills. Price, $4. New York: Illuminating Engineering Publishing Company.

The litigation in this case between the City of Colorado Springs and the Pike's Peak Hydro-Electric Company centred principally about three points, namely, the meaning of the phrase "an arc light of standard 2,000 candle power"; the monetary damage accruing by the substitution of a 6.6 ampere series alternating-current arc lamp for "an arc lamp of standard 2,000 candle power"; and the financial damage resulting from the failure to maintain the substituted lamps at their normal operating conditions. The judicial settlement of these points for the first time makes the case one of the most interesting and important that has arisen in connection with electric-lighting contracts. The records of the case, which occupy the greater part of the present volume, are a remarkably valuable contribution to the literature of arc lighting, since they present the opinions of a number of experts and authorities of the highest standing on a large variety of subjects of technical and commercial importance. Mr. Floy's introduction and his analysis of the testimony and award contain a great deal of excellent advice on the form of agreements for municipal electric lighting contracts, which central station managers would do well to follow. The book should be welcomed by electric-lighting engineers as ensuring the availability and permanence of a large amount of useful information on the legal, technical and commercial aspects of their work.

Electro-Metallurgy.

The Electric Furnace, its Evolution, Theory and Practice. By Alfred Stansfield. Size, 9 by 6 in.; pp., 211. Ills.

Price, $2. Toronto: The Canadian Engineer; New York and London: Hill Publishing Company.

A clear presentation of the theory and development of electric smelting has been needed for some time and Dr. Stansfield's present work fulfils its purpose admirably. It does not pretend to be an exhaustive treatise or to describe all the electric furnaces that have been invented. Its purpose is "to set forth clearly the fundamental principles of this form of furnace; to show its various uses; to indicate its limitations; and, if possible to be of some assistance to those who wish to design electric furnaces, or to judge of the feasibility of schemes involving their use." The book is divided into seven chapters, dealing, respectively, with the history of the electric furnace; a description and classification of the various types; the efficiency of electric and other furnaces and the relative cost of electrical and fuel heat; electric furnace design, construction and operation; the production of iron and steel in the electric furnace; the use of the electric furnace for the production of ferro-alloys, graphite and other carbides, for zinc smelting, and for other miscellaneous uses; and an estimate of the future possibilities in the development of the electric furnace and electro-thermic processes. Within its scope the work is admirably conceived and executed and has the additional merit of being thoroughly up-to-date.

Hydraulics.

A Treatise on Hydraulics. By William Cawthorne Unwin. Size, 8½ by 5½ in.; pp., 327. Ills. Price, $4.25. New York: The Macmillan Company; London: Adam and Charles Black.

This treatise on hydraulics is marked by the clearness and conciseness which engineers have come to expect in works from Prof. Unwin's pen, and his long connection with the subject, as a teacher and as an original investigator, gives the work a distinction rarely met with during the present period of over-production of technical books. Prof. Unwin recognizes that strictly rational hydrodynamics gives very little assistance to the engineer, since its theoretical results are flagrantly at variance with the behavior of actual fluids. In dealing with practical problems the engineer has to resort to empirical formulae, the data for which have been accumulating over a period of two centuries. These data are of very varying trustworthiness and importance and their uncertainties seem to Prof. Unwin to constitute the great difficulty in the solution of hydraulic problems. His treatment of the subject, therefore, aims to give a sufficient account of experimental investigations to enable the student to realize the limitations of formulae and the degree of confidence which can be placed in calculations without getting involved in a cumbrous and confusing amount of empirical details. Such a treatment in Prof. Unwin's well-known style will be heartily welcomed by engineers.

Index.

The Engineering Index Annual for 1907. Compiled from The Engineering Index published monthly in The Engineering Magazine. Size, 9½ by 6¾ in.; pp., 435. Price, $2.00, 10/. New York: London: The Engineering Magazine.

With this volume—the sixth since the work was first undertaken and the second since it assumed annual in place of triennial or quinquennial form—a continuous index to the engineering and technical literature of the past twenty-four years is made available to the reader. Like the 1906 Annual, this book retains the classification of all entries under the recognized great divisions of Engineering—Civil, Mechanical, Mining, Electrical, etc.—as preliminary to alphabetic arrangement by subject catchwords; but it shows the result of great additional editorial care in generous cross-referencing, in the standardization of catchwords, and in the close assembling of like entries under the more comprehensive catchwords, as (for example) "Locomotive". The classification also is in many respects amplified and clarafied. And appearance early in the year, while the literature indexed is still timely and easily accessible, is no slight addition to the value of a reference work of this sort.

Gas Power.

Gas Power. By F. E. Junge. Size, 9 by 6 in.; pp., 548. Ills. Price, $5, 21/. New York and London: Hill Publishing Company.

This is unquestionably one of the most important contributions to the literature of gas power that has appeared in English in some time. In its economic treatment of the subject it may fairly be said to be the most important. Other works have for the most part been devoted to one of three aims: the abstract study of the internal thermodynamic relations of gas producing and converting apparatus; the quantitative design of their mechanism; or the historical or inventive evolution of the problem. Mr. Junge combines with a survey of present developments in these important and interesting aspects of the problem, a discussion of the application of gas power, which places his book in a class by itself for which it is likely to set the standard for some time to come. The book is divided into three parts. The first, on the evolution of gas power, devotes two chapters to the general aspects of the problem and a historical and analytical study of the development, and criticism of the present mode of application, of gas power. The second part deals with the design and construction of large gas engines, a discussion of many standard types being introduced by a chapter on the general principles of design. The concluding section of the book discusses the application of gas power in the iron and steel industries and in the coal mining and coke making industries, and the rational utilization of low-grade fuels. As a condensed record of the experiences and achievements of European engineers in this important field the book should prove of inestimable service in England and America where the economic conditions which made necessary the rapid development of gas power on the Continent, especially in Germany, are beginning to make themselves felt.

Metallurgy.

The Metallurgy of Iron and Steel. By Bradley Stoughton. Size, 9 by 6 in.; pp., 509. Ills. Price, $3. New York and London: Hill Publishing Company.

As a descriptive treatise on the various processes in modern American iron and steel manufacture this book will unquestionably take a foremost place. Nothing of importance has been omitted and the processes and principles are described and explained with clearness and conciseness and with fair accuracy. In explaining general chemical, physical and mechanical principles, however, the author is less happy. Some of the faults seem to be due to carelessness, but in some few cases the explanations given are fundamentally inaccurate. These minor defects do not, however, seriously impair the value of the work as a text book for the beginner and as a general reference book for the specialist in other branches of engineering. It will not displace any of the older, established treatises on the subject, but it will fulfil, most acceptably, an important supplementary function.

Physics.

Practical Physics, a Laboratory Manual for Colleges and Technical Schools. By W. S. Franklin, C. M. Crawford and Barry MacNutt. In 3 volumes: Vol. I, Precise Measurements in Mechanics and Heat; Vol. II, Elementary and Advanced Measurements in Electricity and Magnetism; Vol. III, Photometry and Experiments in Light and Sound. Size, 8½ by 5½ in.; pp., Vol. I, 176; Vol. II, 160; Vol. III, 80. Ills. Price, Vols. I and II, $1.25 each; Vol. III, 90 cents. New York: The Macmillan Company; London: Macmillan & Co., Limited.

The authors believe that a laboratory manual for the teaching of physical science should set forth a series of definite exercises. Hence the volumes in hand are a collection of more or less theoretical problems which the student is required to solve by means of experimental data which he himself obtains. The ground covered is about that of the first year's work in physics in an engineering school. The explanations and instructions are very clear and, so far as it goes, the work would no doubt be found a useful guide in laboratory teaching.

Plans.

How to Read Plans. By Charles G. Peker. Size, 7½ by 5 in.; pp., 46. Ills. Price, 50 cents. New York: Industrial Publication Co.

A book for the building mechanic. The author admits that the best way to learn to read plans is to learn to draw, but this book is offered as a manual of self help for such as have not the necessary time to devote to the study of drawing. The meaning of the various parts of a building drawing, plans, elevations, sections, etc., and the conventional symbols used in drafting are explained in simple language and with the use of many illustrations. A full set of working plans for a small frame house is given at the end of the volume, so that the student is enabled to study the subject with reference to conditions he is likely to meet in his daily work. The book would no doubt be of great value to men in the building trades and it would also form a useful part of the equipment of the beginner in architectural drafting.

Works Management.

Profit Making in Shop and Factory Management. Charles U. Carpenter. Size, 8½ by 6 in.; pp., 146. Price, $2, 10/6. New York: London: The Engineering Magazine.

Perhaps the most significant of all professional literature is that in which men of action, who have been successful in carrying out work large in possibilities and extremely useful as precedent, put their own personality into the description of the way it was done. This is substantially what the author accomplishes in this instance. Mr. Carpenter for years has been constantly in the very heat of the struggle for economy and efficiency, and ever better economy and efficiency, in mechanical production. As superintendent, manager, director, president, of large manufacturing concerns, he is living daily amid the operation of the methods, the processes, the policies with which his book is concerned. Every chapter is vibrant with the daily life of the shop, and with triumphant progress toward conditions of greater profit to the manufacturer and greater contentment for the workman. The book is thoroughly practical in every part, and its suggestions as useful to the small shop employing ten men as to the great works employing thousands.

BOOKS RECEIVED.

Report of the Committee on Education, January, 1908. Size, 9 by 6 in.; pp., 72. Syracuse, N. Y.: Syracuse Chamber of Commerce.

Le Perou d'Aujourd'hui et le Perou de Demain. By Emile Guarini. Size, 9½ by 6½ in.; pp., 16. Price, 1 franc. Paris: Dunod & Pinat.

Les Merveilles de l'Electrochimie. By Emile Guarini. Size, 9½ by 6½ in.; pp., 168. Ills., 99. Price, 5 francs. Paris: Dunod & Pinat.

The Copper Handbook, Vol. VII, 1907. By Horace J. Stevens. Size, 9 by 6 in.; pp., 1228. Price, $5. Houghton, Mich.: Horace J. Stevens.

Steam-Electric Power Plants. By Frank Koester. Size, 10½ by 7½ in.; pp., xviii, 455. Ills. Price, $5. New York: D. Van Nostrand Company.

Safe Building Construction. By Louis de Coppet Bergh. Size, 8 by 5 in.; pp., xvi, 436. Ills. Price, $5. New York: The Macmillan Company.

Simple Mine Accounting. By David Wallace. Size 9 by 6 in.; pp., 63. Ills. Price, $1. New York and London: Hill Publishing Company.

Hydraulic Engineering. By Gardner D. Hiscox. Size, 9 by 6 in.; pp., 315. Ills. Price, $4. New York: The Norman W. Henley Publishing Company.

Engineering Reminiscences. By Charles T. Porter. Size, 9 by 6 in.; pp., 335. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Practical Steam and Hot Water Heating. By Alfred G. King. Size, 9 by 6 in.; pp., 402. Ills. Price, $3. New York: The Norman W. Henley Publishing Company.

Modern Pigments and Their Vehicles. By Frederick Maire. Size, 8 by 5 in.; pp., xi, 266. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

Arithmetic of Electrical Engineering. Size, 7½ by 5 in.; pp., 159. Ills. Price, 50 cents, 1/. New York: The Macmillan Company; London: Whittaker & Company.

Le Catalogue International des Principales Publications Périodiques du Monde. By Emile Guarini. Size, 9½ by 6½ in.; pp., 75. Price, 3 francs. Paris: Dunod & Pinat.

The Gas Engine. By Frederick Remsen Hutton. Third Edition. Size, 9 by 6 in.; pp., xx, 562. Ills. Price, $5, 21/. New York: John Wiley & Sons; London: Chapman & Hall.

Power and Power Transmission. By E. W. Kerr. Second Edition. Size, 9 by 6 in.; pp., xiv, 366. Ills. Price, $2, 8/6. New York: John Wiley & Sons; London: Chapman & Hall.

Development and Electrical Distribution of Water Power. By Lamar Lyndon. Size, 9 by 6 in.; pp., 317. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

The Elements of Railroad Engineering. By William G. Raymond. Size, 9 by 6 in.; pp., xvi, 405. Ills. Price, $3.50, 15/. New York: John Wiley & Sons; London: Chapman & Hall.

Handbook for the Care and Operation of Naval Machinery. By Lieut. H. C. Dinger, U. S. Navy. Size, 6½ by 4½ in.; pp., 302. Ills. Price, $2. New York: D. Van Nostrand Company.

Seventh Annual Report of the Commissioner of Labor for the Twelve Months Ended September 30, 1907. Size, 9 by 6 in.; pp., 272. Albany, N. Y.: New York State Department of Labor.

Steel Works Analysis. By John Oliver Arnold and F. Ibbotson. Size, 7½ by 5 in.; pp., xiv, 468. Ills. Price, $3.50, 10/6. New York: The Macmillan Company; London: Whittaker & Company.

Twenty-Fourth Annual Report of the Bureau of Labor Statistics for the Year Ended September 30, 1906. Size, 9 by 6 in.; pp., clii, 894. Albany, N. Y.: New York State Department of Labor.

Nineteenth Annual Report on the Statistics of Railways in the United States for the Year Ending June 30, 1906. Size, 9 by 6 in.; pp., 766. Washington, D. C.: Interstate Commerce Commission.

Preliminary Report on the Income Account of Railways in the United States for the Year Ending June 30, 1907. Size, 9 by 6 in.; pp., 77. Washington, D. C.: Interstate Commerce Commission.

Results of Magnetic Observations Made by the Coast and Geodetic Survey Between July 1, 1906, and June 30, 1907. By R. L Faris. Size, 11½ by 8 in.; pp., 74. Washington, D. C.: Department of Commerce and Labor.

Analysis of Mixed Paints, Color Pigments and Varnishes. By Clifford Dyer Holley and E. F. Ladd. Size, 8 by 5 in.; pp., xi, 238. Ills. Price, $2.50, 10/6. New York: John Wiley & Sons; London: Chapman & Hall.

Tolhausen's Technological Dictionary. Three volumes, French-German-English, English-German-French, German-English-French. Size, 6½ by 5 in.; pp., 1006, 1026, 1025. Price, each volume, $2.75. New York: The Macmillan Company.

Twenty-First Annual Report on Factory Inspection and Twentieth Annual Report of the Board of Mediation and Arbitration for the Twelve Months Ended September 30, 1906. Size, 9 by 6 in.; pp., 762. Albany, N. Y.: New York State Department of Labor.

THE ENGINEERING MAGAZINE
"THE WORLD IS ITS FIELD"

VOL. XXXV. JUNE, 1908. No. 3.

THE AMERICAN MUSEUM OF SAFETY DEVICES.

By Herbert T. Wade.

It is a great satisfaction to be able to follow our recent publications descriptive of Continental institutions by this account of the first American museum of safety devices. The economic arguments for the support of the undertaking are so well advanced by Mr. Wade, that we need not add here to our preceding pleas in advocacy of the cause.—THE EDITORS.

AN interesting exhibition designed to show the best methods of safeguarding workmen and protecting the general public has been held in New York during the present spring by the American Museum of Safety Devices and Industrial Hygiene. This exhibition was of great importance in demonstrating that much of the loss of life incident to industrial operations in the United States is preventable, and that there are already developed methods and appliances that accomplish much in this direction. The subject already is attracting much attention from practical men such as the directors of large corporations and manufacturers as well as students of social science and men and women earnestly and practically interested in social betterment. It was the hope of those by whom the exhibition was organized that such further interest would be aroused as might lead to a much needed permanent museum of safety devices, which European experience has shown is a most powerful agency for increasing measures and methods to secure protection from injury and to safeguard the health of the industrial population.

In fact on the Continent of Europe the museum of safety and life-saving devices is now a recognized institution, usually conducted by the government or at least under government auspices. It has been found most valuable in instilling among wage earners an appreciation of safety devices that not only prevent accidents, but often improve the operation of machine or plant from a mechanical standpoint. The museum was found the most practical way of educating the people to appreciate the gravity of the situation, and, just as in natural history, its influence was found to be as great with the children and the every-day workingman as it was with the manufacturer and student of social conditions.

This movement in Europe, where government supervision of industrial conditions, especially so far as dangerous trades and occupations are concerned, is far more strict than in the United States, attracted the attention of social workers and manufacturers interested in the protection of their employees. The subject of safeguarding industrial workers presented so many aspects, ranging from the financial interest involved in the greater or less liability of the employer for injuries to his workmen, to the altruistic point of view of the humanitarian, that the museum of safety devices soon came to be recognized as a distinct force for industrial betterment and one which on the practical side distinctly was workable. This was brought about in much the following way: Here is a dangerous occupation, and the conditions under which it is carried on are clearly shown in the museum. An inventor or manufacturer realizing that he has something that may cut down the risk in one or more respects, submits his device to the museum, where it is passed on by a technical commission, so that before it is accepted it is pronounced practical and workable. Once in the museum it is shown for the benefit of all, employer and employee, engineer and student, government inspector and legislator. Now if the device will diminish the liability of accident for which an employer may be held liable, and which if not involving a direct indemnity payment yet may mean the loss of a skilled workman, he is led to consider whether from an economic standpoint its introduction may not prove a good investment. The workman on the other hand seeing such a device and realizing its applicability to his particular work may try to secure its use. The government, moreover, has the opportunity of knowing and testing just what devices are available, what opinion of their value is held by those interested, and thus when regulations are promulgated can adopt those that, being practicable and workable, can be carried out firmly and intelligently. Such a museum stimulates inventors either directly as by prizes and medals, or by affording them an opportunity to exploit their inventions.

The deaths in the United States from railway accidents and fire, to mention but two causes, are a national disgrace, while the conditions in various industrial occupations in which injury or accidental death is all too frequent, or which are carried on under unsanitary

A CONTINENTAL EXAMPLE FOR COMPARISON. THE MUSEUM OF SECURITY AT BERLIN.

By courtesy of *American Industries*.

conditions, are hardly less serious. It is of course possible to assign reasons for this apparent disregard of human life that are satisfactory as explanations, but not as excuses. The national temperament with its haste and impetuosity, the sudden recklessness developed by the immigrant free from the firm restraint of his native land, the rapid growth of individual manufacturing plants as well as great industries where immediate returns rather than permanence and stability are the prime essentials, the carrying on of business with inadequate machinery often involving overloading, the laxity or absence of State inspection, the lack of a proper spirit of concern for the welfare of the employed, the ignorance and carelessness of the working classes, and finally the national vice of taking chances rather than observing proper precautions in providing and operating machinery, are equally characteristic of superintendent and workman. These reasons and many more are given for the condition of affairs mentioned, and it would appear that the whole matter could be summed up in the word *indifference*. Now to remove this indifference, education is necessary, and as the museum has been found the simplest and most direct way, such an exhibition was arranged early in 1907 and was held under the di-

A GENERAL VIEW ACROSS THE GALLERY OF THE MUSEUM.

The fire-extinguishing and fireproofing exhibits are in the foreground. Next to the right is the safety door and the railway signalling apparatus. The boat launching device is in the middle distance.

rection of Dr. Tolman at the American Museum of Natural History, a number of manufacturers contributing exhibits of safety appliances. The interest evolved was sufficient to induce the committee of direction of the American Museum of Safety Devices and Industrial Hygiene to arrange for a more permanent exhibition in quarters of its own with the hope of arousing sufficient public interest to put the enterprise on a firm basis with some guarantee of its permanency. Whether this end has been attained or not it is impossible to say before the close of the exhibition, but that the work otherwise has been successful is evidenced by the intelligent appreciation of the visiting public.

In its general character the exhibition was a collection of devices, models, photographs and charts, obtained from manufacturers, inventors, foreign museums of safety devices, boards of health, casualty companies, and students of industrial conditions, the whole possessing a reasonably comprehensive character and showing what is being done in various countries to improve industrial and sanitary conditions. Like every exhibition including miscellaneous mechanical devices, there naturally was a great difference in the value of the exhibits ranging from new inventions, many of which obviously were of rather doubtful value, to those of such recognized commercial success as the air-brake and wire-glass, to mention but two devices now so commonplace and essential. In this way was made apparent the great commercial importance and value of successful safety devices, while an interesting collection of photographs from the best American machine shops indicated the use made of such protective devices under conditions where the best practice was observed, showing how profitable and reasonable the use of such machinery was considered. A collection of clippings from newspapers reporting various accidents was prominently displayed, but it was only the collection and the bringing together of so many similar items from all over the United States—not the individual articles—that impressed the average visitor, so commonplace was this sort of information. Perhaps more impressive were the photographs of the scenes of various accidents, which plainly showed that many of them could be prevented by the use of the simplest precautions. Then there were the silent witnesses in the form of plates from defective boilers, portions of failed gear or fly-wheels, broken blocks and hooks, each with the sad story of death and accident which suitable forethought and inspection would have obviated.

Many of the various safety devices and protected machines were in operation during the exhibition, and where full-size machines were

ANOTHER NOTEWORTHY CONTINENTAL EXAMPLE. THE ROYAL BAVARIAN INDUSTRIAL MUSEUM.

Machinery hall, and collections illustrative of accidents and their causes.

not available or feasible, numerous models or photographs were shown. Perhaps the most striking feature of the exhibition was its diversity, extending as it did from automatic launching lifeboats to protected elevator shafts and circular saws. Indeed some of the simpler devices really aroused more enthusiasm than the complicated models, as their application was so simple and obvious. Thus in place of the usual square-headed set-screw used to hold a belt pulley on a shaft there was shown a screw without a head which by using a key wrench fitting in a square hole could be screwed in tight without leaving any projections to catch the workman's hand, as frequently happens with disastrous consequences. As loose nuts are the cause of so many accidents it was natural that several forms of safety bolts and nut-locking devices should be shown and their advantages demonstrated. A guard for the handles of wheelbarrows to protect the hands of the workman in passing through a passageway or past a post or pillar was so simple as to suggest surprise that it was not more used.

The deleterious effects of various dusts and vapors on the respiratory organs were shown by a series of anatomical models and preparations and specimens of the dusts themselves sent by Dr. Sommerfield of Berlin, the collection giving a complete and realistic representation of the effects of inhaling fine dusts, such as those of iron, emery, and stone, and poisonous vapors incident to various industrial occupations, as well as the results of other unsanitary occupations, such as match making, where the "phossy jaw" of the matchmaker or the poisoning of the leadworker was seen. In particular, the models showing the condition of the lungs of workmen forced to breathe such air were most impressive, especially when seen near the representation of the normal lung. But adjoining this collection were shown various respirators which could be worn as a protection by those forced to work amid dust, ammonia fumes, or smoke. With respirators must be considered smoke goggles for the eyes and smoke and ammonia helmets, various types of which were shown.

While typhoid fever is largely preventable in most communities by intelligent care for the water supply, yet a simple distilling apparatus, shown by the Forbes Company, is a most effective means of destroying pathogenic bacteria. Such an apparatus was exhibited which simply required connection with the gas and water supply and would thoroughly sterilize drinking-water, the device being particularly economical in its utilization of heat.

Just what form of elevator is the safest the exhibition committee in all probability would not pass on, but the Travellers' Insurance

Co. showed a collection of broken cables whose failure had resulted in fatal accidents. The remedy for this obviously is sufficient, expert, and regular inspection. Another frequent element of danger in connection with elevators is the door or hatchway which the carelessness of an operator may leave unprotected. This has afforded wide range for inventive skill and a number of such devices are shown, including those in which fireproofing is added.

If it is necessary to have elevator doors that shut, it is equally important to have for theatres and school houses doors that will open in an emergency, yet ordinarily will be locked. Samples were shown of such doors by the Standard Safety Window Guard and Exit Lock Door Co. Pressure on a broad plate or handle, either involuntary as by a pushing crowd or by a single person, draws the bolts and opens the door instantly.

Outside of transportation it is quite probable that fire claims the largest number of victims of any single cause of accidental death in the United States, and in an exhibition of safety devices the various means of saving life in case of fire naturally appear prominently, varying from the life net to the fire extinguisher carried on the automobile. The various portable fire escapes once made of manilla rope now appear with chains or wire rope and broad metal treads for the special advantage of women. The usefulness of portable fire apparatus is emphasized at the exhibition, as a convenient local extinguisher is often sufficient to quench what might prove a blaze of large dimensions. Thus a nest of buckets supplied by the Safety Fire Extinguisher Co. is contained within a tank of chemical extinguishing fluid which neither evaporates nor freezes. If placed at convenient points about a factory or a steamship this is a satisfactory means of putting out an incipient fire that easily might prove troublesome. Still more effective is the portable chemical fire engine with its hose reel for country places and factories, which is shown by S. F. Hayward and Co., and for isolated places where a water supply under pressure is not available immediately, it is a valuable means of protection. Next on the list of fire-prevention apparatus comes the automatic sprinkler, a number of which made by the International Sprinkler Co. of Philadelphia were shown. With these are shown various forms of thermostats that immediately give an alarm of a dangerous temperature, as 175 degrees F. Of these a most simple form is the double conductor of the Montauk Fire Detecting Wire Co., where any undue increase in temperature causes a fusible metal coating of the inner conductor to break down the insulation, and thus forms a short circuit and communicates the alarm

THE ROYAL BAVARIAN INDUSTRIAL MUSEUM, MUNICH.
Halls of general hygiene and of safety building appliances.

FIRE-PROOFING AND FIRE-EXTINGUISHING DEVICES.

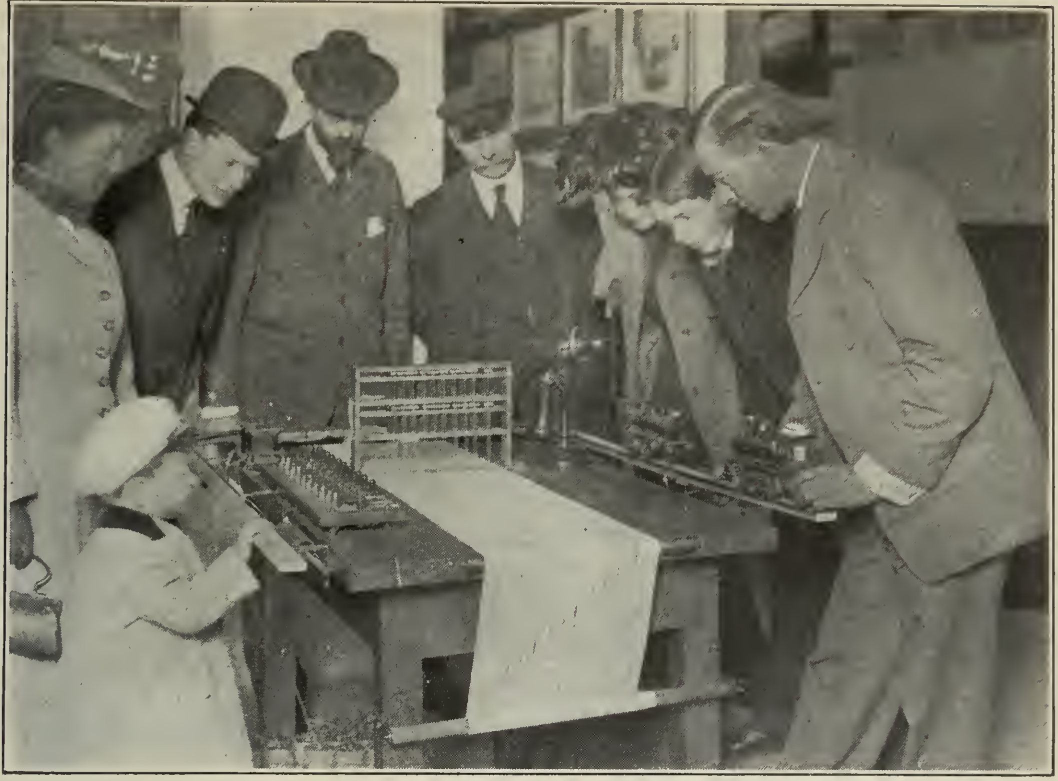
to the annunciator and gong. This device, like others shown, can be installed in any ordinary bell circuit. Or one can examine a new form of fire detector put out by the Rich Marine Fire Indicator for use on steamships, in which pipes from each compartment or hold are led to the pilot house, where a bell ringing every quarter of an hour warns the captain or watch officer to examine the outlet of each tube for smoke. These tubes all terminate in a compartment containing an electric exhaust fan which is constantly drawing the air from each hold through the tubes. Consequently, if there is fire in any compartment, it will be at once detected and connection can be made with the steam or water mains, and steam or water can be forced through the pipe directly to the particular compartment, while the alarm is being sounded. The great lesson for the American public to learn is that fires are preventable, but that the only emancipation can come by fireproof construction. Indeed, the loss of life and property involved in great conflagrations can be obviated by the more general use of concrete and fire brick, which with the increasing prices of wood is now available even for the simplest buildings and dwellings. In order to illustrate the desirability of such fireproof construction for buildings designed for workingmen, several apartments thus built were shown at the exhibition, made of hollow fire-brick, reinforced with T bars laid between the courses, and it was explained that they possessed the advantage of being much cooler in summer and warmer in winter than the usual type of dwelling. The fire-proof door has for many years been deemed essential in warehouses and mercantile buildings. Now we learn from the Museum of Safety Devices that there are on the market fire-proof doors finished to represent wood and available for dwellings. Furthermore, these doors with their enamel finish are absolutely sanitary and offer no change for dirt or germs to lodge. Safety containing vessels for gasoline or naphtha are exhibited in which by means of gauze and suitable valves in the various containers the danger of explosion is reduced to a minimum. The Stillman Safety Lamp consists of a metal bowl or font with a false bottom and a vertical perforated wick chamber into which the oil passes from an intermediate space packed with wool and holding the oil in suspension.

DEMONSTRATIONS OF THE SAFETY GASOLINE TANK AND KEROSENE LAMP.

With fire, as has been suggested, the American railway and the electric street car contribute most effectively to the needless mortality of the nation. If at this stage of American civilization and development we must consider the deadly grade crossing a necessity in well settled communities, then its proper and adequate protection should be demanded and sufficient notice of a train's approach should be given to all crossing the tracks. At the exhibition is shown a model of track gates from the Automatic Gate and Crossing Co., which without any operator protect the crossing in addition to giving warning by bell and danger lights of the approach of a train within two miles. Next to grade crossings there is a large element of danger from collision in working a single-track high-speed trolley line. This can be prevented by various automatic signal devices, one of the most recent of which, the Nachod Automatic Signal, manufactured by the United States Engineering Co., figures in the exhibition. It automatically indicates the presence and direction of a car on a single track by lights and semaphores. The Simmen automatic railway signal is designed to protect automatically against accidents resulting from the errors of the engineer or dispatcher, and to eliminate the telegraph operator for reporting trains and delivery of train orders. It also provides for the automatic recording of the location of trains (in the dispatchers' office) as they advance along the track, and permits the dispatchers to signal direct to the engineers of the various trains in their cabs while the trains are in motion. If the engineer fails to obey the signal to stop, the air brake is automatically applied, the train is brought to a standstill, and direct telephone communication is established between the dispatcher and the engineer on his engine. The system is already installed on 18 miles of the Santa Fe in Southern California. The connection between efficiency of operation and safety is strikingly illustrated in the air brake shown by model, and it is indeed rare that the application of safety devices has any other effect than to improve the mechanical conditions of the machine or plant.

Previous to the adoption of automatic couplings there was a great number of accidents to men engaged in coupling railway cars. This the compulsory use of the automatic coupler has reduced, but still it is necessary for a man to crawl between the cars to join the air-brake hose, and there is a certain number of accidents due to this cause. The Cary Automatic Car and Train Pipe Coupler combines both operations by a simple device and as soon as the cars are joined both the cars themselves and the air-brake hose connection are instantly coupled.

The Dube railway spike has one side barbed or serrated in order to hold more firmly; this spike is driven with a companion key which forces the projecting points firmly into the wood, but which on being withdrawn permits the spike itself to be removed without damage either to it or to the tie.



THE SIMMEN AUTOMATIC RAILWAY SIGNAL EXHIBIT.

Rapid transit in cities as carried on to-day is fraught with many dangers, and to obviate these the American Suspension Railway Co. is prepared to install a system where the car is suspended from a double track on an elevated structure. For several years a suspended railway in Germany between Elberfeld and Barmen has been successfully operated without accident, and the new system, plans of which were exhibited at the exhibition, is claimed to have many improvements, chief of which is the suspension from a double instead of single track.

But transportation wherever it may be has its dangers, and in navigation there is a vast opportunity for safety devices, which become the more essential the more they are developed. Thus for the life gun, there is the Meyer and Rogers projectile, recently approved by the United States Government, consisting of a projectile terminating in a grapnel anchor, to which is made fast the end of a substantial rope, instead of the shot line to which a stout rope must be subsequently attached as in the ordinary life gun. This device, which with a pound charge of gunpowder will send a rope a distance of 1600 feet, is useful both in sending a line from ship to ship and from ship to shore, or vice versa, as the arms of the grapnel catch either in the rigging or sand and give a firm hold to the rope which is heavy so that a breeches buoy may be operated over it. The Welin quadrant davit, whereby two men can swing the heaviest lifeboat clear in twenty seconds, is an example of a much needed device to launch a lifeboat in the shortest possible time and thus save life when time is the most important factor in effecting rescues. Furthermore, this lifeboat, after the disengaging gear is tripped, may shove off with all the crew in place and with far less danger of capsizing than in the older form of launching apparatus. The Engelhardt lifeboats which are collapsible, unsinkable, and self-bailing are approved and recommended by the U. S. Government, and three of the boats nested together occupy no more room than a single ordinary lifeboat. With this equipment every passenger steamer can carry, and should be made to carry, lifeboats for every person on board, and the U. S. Government regulations permit three of these boats to be carried under a single set of davits. A log indicator of the National Instrument Co. of Stockholm is a device of great assistance to the navigators as well as a provision of safety, for it records on a tape the number of miles logged, and if the course is to be changed at any time notifies the watch officer by ringing a bell after a given course has been sailed. Of different nature are the marine night and danger percussion and friction igniting signals of the Coston Signal Company for use either at sea or on railways, and their rockets both for signals and for carrying a line. Among these most interesting devices is the life buoy with signal attached, which when thrown overboard at night ignites automatically and burns in the water with a bright light, thus marking the buoy both for the swimmer and for the rescue party.

A very interesting exhibit is a model mine, shown by the Carnegie Steel Company, where the wood timbering has been replaced by steel as is now demanded by the best modern practice, on the score of safety on account of its greater strength, for its ease of application, and for the increased economy with the present high prices of wood. Likewise the miners' lamps, dating back to Humphry Davy, but to-day none the less essential not only for illumination but for the detection of mine gases are seen in improved form. One of the most readily prevented classes of accidents are those supplied by such machine tools as presses, punches, jointers, shapers and circular saws, where even skilled workmen are not exempt from danger of losing fingers or hands. But safety devices covering or protecting the saws and knives can be applied to these machines without impairing their efficiency, and there are shown in operation at the exhibition guards of the Jones Safety Device Company which most effectively protect the woodworker. Then there is a die punch where not only is the hand of the operator protected, but the work is automatically removed from under the die. Likewise a circular saw where the blade is guarded and the wood is secured against striking back at the operator, while a protected jointer is shown with a jointed handle which is an important element of safety. A series of electrical and mechanical hoists as shown by the Yale and Towne Manufacturing Company appeared as safety devices.

It was also interesting to note from a collection of photographs that particular attention is being devoted to the subject of eliminating danger to employees in all of the new plants under construction for the United States Steel Corporation. For several years a commission has been investigating the question of preventable accidents in its various works, and as a result of their examinations, numerous safety devices have been installed in a number of the plants.

Cleaning the windows of a high office building involves considerable danger unless the cleaner has a suitable safety belt to protect him in case of his falling. These belts must be fastened to bolts so secured in the walls or window casing as to be absolutely firm. Several forms of such bolts to which the belt is fastened were shown, available for either brick walls or wooden window frames. The safety clothes line which prevents another form of window danger also figured in the exhibition.

One of the most effective safeguards of the health of a community is the protection of the milk supply, and the work now being done in this field by the Board of Health of New York City has been so favorably criticized that an important collection of photographs showing the range and methods of milk inspection was a notable feature of the exhibition. With typhoid fever and small pox as preventable or reducible diseases must be considered tuberculosis, and a tuberculosis camp for the treatment of those in the early stages of this disease was shown by models and photographs by the New York Branch of the National Red Cross Association. While the elimination of accidents is the object sought in the museum, yet this does not prevent the consideration of methods and apparatus for first aid to the injured. As an example of what should be done on a railway, an exhibit of the Pennsylvania Railroad includes the standard outfit of litter and first-aid packets with which every baggage car is equipped, together with the various instruction books issued to employees and photographs showing actual applications of the first aid. This company maintains for its employees regular courses of instruction given by its surgeons. It also assists a benefit association of employees providing for cases of injury or illness.

A COLLECTION OF PHOTOGRAPHS ILLUSTRATING THE CONTINENTAL MUSEUMS.

In connection with the exhibition there were awards of gold medals for the best safety devices in the field of transportation, mining, and motor vehicles and motor boats. These have been provided respectively by the *Scientific American*, the Travellers Insurance Company, and F. H. Richards, while prizes of $100 each have also been provided by Dr. L. L. Seaman for the best essay on "The Economic Waste Due to Occupational Disease," and by Richard Watson Gilder, F. R. Low, and William H. Tolman, on "The Economic Waste Due to Accidents."

Both for the actual character and merit of the exhibits and for its suggestive lessons this beginning of an American Museum of Safety Devices has had a most positive value, and it would seem desirable that further and more ample resources should be forthcoming to enable it to continue its work adequately. As at least seventy-five per cent. of all accidents are preventable, and those that do occur can be relieved by proper first aid treatment, anything accomplished in this direction must be of great and lasting value.

OBTAINING ACTUAL KNOWLEDGE OF THE COSTS OF PRODUCTION.

By F. E. Webner.

II. WHEN AND WHERE A CLOSE KNOWLEDGE IS NEEDED.

BROADLY speaking, it may be truthfully said that every concern which pays dividends on its more or less narrow margin of profit from manufacture needs a close knowledge of production cost if the desire exists to maintain the dividend-paying basis, or perchance to increase the dividends or the surplus.

There are managers who are not in the least interested in costs and from their point of view one can quite agree with them. In the manufacture of new specialties which have proved to be winners to the extent of taxing the capacity of the management to its utmost to fill orders and take care of remittances, there is no pressing need for a close knowledge of detail costs; later on, when the inevitable "just as good as" appears and competition cuts into revenues, the subject of retrenching becomes live and factory costs are important.

When the buffalo roamed the plains in countless numbers they were often slaughtered merely for their tongues, to be used as counters to prove prowess. In similar manner have vast tracts of timber been frightfully abused and shamefully wasted that some slight need might be supplied, as for instance, the cutting of shakes in the early pioneer days. A shake formerly was a rude form of clapboard for building purposes, but has developed into a split shingle for making durable and artistic roofs. In early days shake-makers made camps in the sugar-pine belt and cut as they pleased, felling tree after tree in total ignorance of scientific principles underlying the proper choice. Only one tree in from six to ten sugar pines will split into shakes. The old pioneer way was to cut a tree down, saw a piece off, and try it; if it was useless for the purpose it was left to rot. The modern shake-maker chooses a mature sugar pine with thin homogeneous bark and "chips" it high up; he studies the "twist" and fiber until he is satisfied it will "work," and then he fells it; thus the resources of the timber tract are husbanded for use along other lines. The wastefulness of the past is being paid for in the present and will undoubtedly be more highly paid for in the future. The cost is there, to be absorbed somehow—and it must be absorbed; there is no alternative.

The parallel is drawn between the cases illustrated and the conditions surrounding the production of many public utilities and products, where a large degree of monopoly exists and the margin is sufficiently large in the mind of the management to preclude the necessity of finer distinctions and discriminations in the way of prime-cost lessening; so the public pays the freight and continues to smile and look as pleasant as possible.

There are cases where the consumer pays for existing evils over which the management can exert no possible influence. An instance in point is the making of fire-brick; the general run of labor is paid by piece work, and throughout the Southern Ohio fire-clay district there exists an unwritten law that certain quantities constitute a day's work, depending on the operation; even though such allotment of work may be finished at 2 P. M., no amount of coaxing, bribing, or driving will suffice to induce the laborers to perform more work, either of the same operation or a subsequent one; hence the volume of product of the individual works hinges on the whims and caprices of the labor element, and the selling price must be so fixed as to absorb the higher rate of expense burden imposed by the curtailed product.

It is a prevalent impression that where labor is on a piece-work basis or on what is known as the contract system, costs are known definitely. That is a serious mistake, which should be corrected as soon as possible in the minds of those who seek the truth. The case of the fire-brick manufacturer is a very good example. The piece workers may dally along all day with a small output and the consumption of an increased rate of burden of overhead expense, or again they may, and often do, take spurts and clean up in a short space of time, thus making it possible to save in power and other costs which are not fixed in amount but which accrue as used. It is a well-known fact that piece workers work spasmodically, and very often produce much less than their maximum capacity in order that the rate per unit be not reduced on them. Time consumed on piece work is, and should be, a part of the records of any well organized cost system. The premium system, whereby premiums and penalties are affixed for operations of various character, does more to stimulate the workmen to increased activity and energy than any other plan of payment under the ordinary run of conditions obtaining in modern shop practice. The secret is that the men share more liberally in the benefits derived than under the ordinary piece-work system, and when they come to a full realization of what it means are more keen to take advantage of it. The great saving in costs is made through the decreased burden of overhead expense, and through the increased volume of output, which means ultimately one and the same thing. The single item of saving through the labor costs would not make the plan an attractive one, for the reason that the labor costs as such are increased rather than decreased.

The factory which produces but one article or one line of articles in different sizes needs to know its cost of production just as accurately as that factory which produces a hundred different articles; however, the costs of the former are naturally more simple to evolve than those of the latter, though that does not always follow.

There are scarcely any two lines of production which are precisely alike in so far as cost finding is concerned; a difficult cost proposition is that of the manufacturing of optical goods, where in the grinding of lenses flaws are not discernible until after the lens has been practically completed and polished; it frequently happens that an eye-glass lens priced at one dollar will cost four dollars to grind, by reason of the several lenses that may have to be ground before a perfect one is produced. Possibly there may be a second- or third-grade outlet for the lenses condemned as first-class, and again possibly they may be absolutely worthless. This waste constitutes the larger percentage of burden in this particular work, and a cost system is needed in a plant of this character just as much as it is needed in a machine shop; but most emphatically the plans evolved for the machine shop will not fit the lens-grinding proposition.

Without question the greatest need for a well equipped cost department exists in plants where staple articles are produced, where to a more or less large extent the selling price is fixed by competition.

Hog-packing industries are good examples of this class, and are also good examples of what can be accomplished by counting the cost and making the best of little items that to the casual observer would be thought of as waste. It has been well said that nothing about the hog except the squeal, escapes a profit-making use. To the reader's mind may come the question as to what relationship that bears to a cost system. It bears a close relationship. The bookkeeper records receipts and disbursements of cash, also purchases of material and sales of product; periodically a statement is laid before the manager, and with an accurate reflection of his affairs he is enabled to direct his interests intelligently and know where gains are made and losses sustained. A cost system presents but another phase of the same business, and incidentally to its operation it discloses many leaks and drips which sap profits; it gives an accurate reflection of conditions, and if the management does not embrace all the opportunity afforded, then it is not getting full benefit. The cost system does not operate physically to cut down the cost of product—it presents apparent needs just as soap floats and makes a mute appeal for assistance. The general books present certain possible needs of retrenchment as between the factory and the outside world; the cost books present certain needs of retrenchment within its own confines.

A cost system is not a fad any more than astronomy is, but a serious proposition representing an original outlay of money and the retention of someone who knows his business in order to make the investment pay. The manufacturer may come to a point where he makes up his mind to indulge in a cost system. His probable needs are greater than he realizes, yet like buying needed life insurance, if he has not a strong influence brought to bear upon him constantly urging him on, he will invariably weaken in his determination through the machinations of disgruntled employees who cite many fancied wrongs as bugaboos against any change in plan. In the installation of a cost system it is a foregone conclusion that some points in the plan are bound to need revision according to developments, and if the manager be one who is easily discouraged he would better delegate to a strong-willed and enthusiastic subordinate the authority to proceed with the work, and then himself keep hands off and look only for results. As a broad rule, the greatest need exists for a cost system in plants where the labor element is diametrically opposed to it, as it means a curtailment of privileges formerly enjoyed and usually costly to the concern both directly and indirectly.

Under some conditions the refusal of foremen or workmen to do certain things required of them will seem to make it impossible to proceed with an installation; such conditions will have to be specifically treated, but in a number of cases which have come under my personal notice the dismissal of otherwise seemingly good foremen has had a salutary effect upon those concerned. A foreman is not what might be called "good" if he persistently works at cross purposes with the management.

Where a factory plant has grown from a small beginning to a large and distorted array of lean-tos and additions, and the route of the product in its course of process through the factory is physically cumbersome, then a cost system will be just as cumbersome and will show results which the management will refute. In cases of this kind the manager usually confesses to a knowledge of high costs but is not in position to know exact results, and he doubts the real truth.

In conclusion, the modern factory and the ancient one both need a knowledge of costs; but no cure-all remedy can be applied to each in the same manner—careful and specific treatment is needed.

A FOUR-YEARS COURSE IN INDUSTRIAL ENGINEERING.

By Hugo Diemer.

The Engineering Magazine has long urged that modern conditions of engineering employment demanded modifications in the scheme of engineering education. In the words of a writer reviewed in our March issue, many of the subjects included in the standard courses have not been taught as they must be practiced, and the entire scheme needs to be brought closer to life. Especially has provision been lacking for the large proportion of engineering graduates whose future work lies in the intelligent, efficient direction of manufacturing operations.

It is most gratifying to find that two of the great American Universities—Columbia and Harvard—are undertaking to solve the problem, one from the engineering and the other from the economic side. This notable movement, and the present season of special interest in the college year, make this article by Professor Diemer, of the Pennsylvania State College, peculiarly timely. It is a concrete presentation of a proposal for a course preparing the student for industrial work, and merits the attention due to pioneer effort. Next month Professor Rautenstrauch, of Columbia, will discuss the plan here outlined and will give the added interest of another advanced viewpoint.—The Editors.

SINCE the introduction of manual training into public schools there has been considerable argument whether a school education is to prepare the student to make a living, or whether it is to prepare him for life. Evidently he must be prepared for both.

It is becoming more and more generally recognized that manual training may well be given a place for its cultural value and that for this reason it may with advantage be given to all classes of pupils in the elementary schools. It is also becoming just as generally recognized that manual training as taught in the general cultural school cannot take the place of vocational industrial education.

The low efficiency of the craftsmen in various trades in America is becoming a cause of concern not only to employers and owners of industries, but to the leaders of organized labor as well. The tendency toward specialization makes it well-nigh impossible for apprentices to get a good general knowledge of their trade such as was in former years quite possible. In his striving for variety of experience, the young tradesman is perforce compelled to adopt a nomadic life, changing jobs and places of residence,—a process that not many can follow advantageously.

It has been noted and commented on that tradesmen coming to the United States from Germany are better all-around workers in their craft than the average of Americans in the same occupation. The German "continuation" schools, or trades schools, are largely responsible for this superiority. The Germans compel all children to attend the general-culture schools until they reach the age of fourteen years. In the general-culture schools they also receive manual-training exercises intended for general education. In the "continuation" schools the instruction is by skilled tradesmen, and in them one may learn to be a brick-layer, a plasterer, a carpenter, a lock-smith, a painter, a motor-man, and so on, receiving a thorough two-years trade-school training by experts in the trade.

We need a similar system of vocational schools in America in which we may prepare our young workingmen to be better workers, to be more skilful and less wasteful. The protestations of Mr. Crane of Chicago are not without reason, in that he like many others sees disadvantages in too great expenditure on higher technical education with no corresponding outlay in trade training for those who cannot attend the public schools longer than their fourteenth year.

Hand-in-hand with the secondary school system we need a further more advanced class of vocational schools for such students as have completed their general-culture high-school course at the age of eighteen and wish to spend not over two years in becoming proficient in one of the more advanced trades. In this second class of trade schools there could be taught such occupations as lithography, printing and other crafts of higher order. Such vocational training would not need to interfere with the sort of manual training which is now given in high schools and which should be continued as general cultural education. Such manual training should be given students in all courses so that they may have trained eyes and hands and may know the elements of wood and metal working, of domestic science, and of the arts and crafts in general.

Having thus provided for those students who cannot go to school beyond the periods of primary or secondary education respectively, by giving them an opportunity in separate schools, to gain vocational training also, we can keep our general primary and secondary school curricula free from vocational studies and can devote them wholly to the work that will best prepare for citizenship and for life in its broadest sense, and can retain still a section in our secondary schools for such preparatory studies as are needed by those students proposing to take a college course.

At first sight it would appear that we might continue this simple system into the realm of higher education, offering a four-years course in arts to those who could continue their general cultural education to the age of twenty-two, and then offering a vocational technical course to the graduate from the school of arts, or "college."

There are relatively few students who take first a course in arts and then follow it by a technical course, and the larger proportion of these few are those who take up the study of law or medicine. In engineering it is important that a continuous line of training be unbroken, and the consequence has been that we have tried to establish in our engineering courses a certain degree of general cultural training. Yet the more specialized technical portions of the engineering courses demand practically all the student's time, so that he cannot spend much effort on general culture, and the result is that after four-years time almost all the emphasis has been on technical specialization, and little if any time has been devoted towards training for life and citizenship.

To be sure, the greatest demand made on engineering schools thus far by students, their parents, and their employers, has been for technical specialists, and the need will always exist for four-year courses which are extremely specialized technically and which prepare the graduates to become chief chemists, head electricians, chief draftsmen, and designers. But there is also a need for men so trained that they can be developed to fill positions in industrial management in such a manner that they are serving the interests of all concerned, namely the purchasers, the men employed in the industry, and the small as well as the large stockholders. America was never more in need of men trained for industrial leadership than she is today. Her industries are suffering on account of the lack of such men—men who are not only thoroughly familar with productive processes, but who have broad human interests and are at the same time thorough business men.

Hitherto courses for educating mechanical engineers have concerned themselves primarily with the processes of designing and testing. The existing courses are admirably adapted to fit men for these processes. The manufacturing industries, however, are in need of men who know how to produce more economically. As America's natural resources diminish and approach more nearly those of foreign competitors, she is compelled to be less wasteful in manufacturing processes. Moreover, she must look for foreign trade to a much greater extent than hitherto.

In the past so large a proportion of the technical graduates have found employment in the large electrical and engineering corporations that the smaller industries of America have not availed themselves of the services of technically trained men to any considerable extent. Yet the most wasteful power plants, the most inefficient manufacturing processes, the most uneconomical building arrangements, and poorest organization methods, are found in the smaller industries. The opportunity for much greater profit and greater comfort to employees as well as greater peace of mind to the owners exists here. The owners of the smaller industries should appreciate the fact that technically trained men can be employed in many cases at not much higher wages than must be paid for men without such special training, who cannot develop with a growing business as well as the technically trained young man can.

A young graduate, no matter what his course of study has been, will of course not be able to revolutionize matters shortly after his employment in such an industry. Yet he should be able to save his wages many times over from the very beginning if he has been properly educated. On the other hand, the young technical graduates should be more willing to put up with the greater disadvantages they would at first encounter in entering the employ of smaller industries instead of the larger corporations. Life during the first few years of one's experience as an employee of the large corporation is apt to be more pleasant on account of social contact with other young college graduates, than would be his experience as an employee of a small industrial establishment, but in the long run his chances for independence and leadership are greater in the smaller establishment. Yet the possibility of leadership has been overlooked in the strictly technical curricula. The true function of the technical school of college grade should be to develop not only technical specialists, but superintendents, managers, and leaders in general.

The relative proportion of technical-college graduates to the number of graduates from secondary and primary schools is so small that we can legitimately adapt our technical-college courses to prepare their graduates to fill the higher places. If we adopt this policy for the higher schools, then we must provide for vocational technical schools for the graduates from primary and secondary general-culture schools. When we have once provided these vocational schools, the place and aim of the college technical school will be unquestioned. It must train for leadership.

Now that all America is pausing and trying to find the causes of the sudden financial and industrial depression, we are beginning to realize that we have been wasteful and inefficient in our manufacturing and construction processes, and that too often endeavor has been made to conceal this wastefulness by skilfully complex business statements, and to cover it up by sales of new stock, bonds, and other securities. We are beginning to realize that we must become more economical and more efficient in our manufacturing processes and business methods, and that we must know enough about accountants' and auditors' statements to know exactly what they do mean. One of the natural results of this present depression will be a demand for men who can make industrial enterprises really pay—not only on paper, but actually and permanently. We need to educate men to meet this demand.

The men we must provide must be trained in three distinct lines. They must be thoroughly grounded in engineering. They must have creative ability in applying good statistical, accounting, and "system" methods to production; and, finally, they must know something about men, so that they may develop in themselves the ability to stimulate ambition, and know how to exercise discipline with firmness and at the same time with sufficient kindness to insure the good-will and co-operation of all. The more thoroughly the graduate of a course intended for leadership is versed in questions of practical economics and sociology, the better prepared will he be to meet the problems that will daily confront him.

In such a course, education in commerce, statistics, and economics and sociology should go hand-in-hand with engineering education. As at present constituted, our college courses permit such training only for the students taking a college course in arts first and an engineering course afterwards, or *vice versa*—a procedure which very few follow. It is possible, however, to co-ordinate the essentials, as above enumerated, in a special four-years course.

By comparing the courses in mechanical engineering as now given in a number of representative American engineering schools, it will be seen that the amount of time devoted to any one branch and to groups of allied branches differs widely, so that if one will take the average time devoted to engineering fundamentals in these schools, and then note the minimum time devoted to these same fundamentals by certain successful institutions, it appears that without even confining one's self to the minimum times, a schedule of fundamentals in engineering could be laid out that would still leave available a considerable part of the four-years course for those branches which would train the graduate for industrial management.

The chart on pages 354-355 shows the relative times devoted to

COMPARISON OF MECHANICAL-ENGINEERING COURSES.

	Lang.		Hist. & Econ.		General Elective	Mathematics					Physics				Chemistry		Drawing			Shops						Mach. Des.				
	English	Mod. Languages	History	Political Science	General Elective	Trigonometry	Algebra	Analysis	Calculus	Diff. Equations	Elec. & Magnetism	Heat	Light & Sound	Phys. Laboratory	Gen. Chem.	Analysis	Free Hand	Geom. & Projections	Des. Geom.	Shop Methods	Forging	Carp. & Wood. Turn.	Pattern Making	Foundry	Machine & Bench	Mech. of Mach.	Mach. Draw. & Des.	Steam Eng. Des. (R)	Pneu. Mach.	Photography
Penn. State	10	11¾	6	8		5	3	5	7		4	2		1	4½	5¼	1	2½	3		2½	3¼	1¾	1	3½	8	12	2	2	
Percentage	12.7		8.2			11.7					4.1				5.7		3.8			7						14				
Cornell					2			5	5		6	6			6	5		3	2	1	2		4	2	4.	8	15	6	2	
Percentage					1.4	7.1					8.5				7.8		3.6			9.2						22				
M.I.T. †	170	710	100	90	120	90	90	180	270	90	135	35	135	100	195	165	45	90	135		110	60	30	30	220	330	368			
Percentage	12.3		3.3		2.1	12.5					7.				6.2		4.7			7.8						12.1				
Purdue	10	10	3	3		5	5	4	10			12			4	2		6	6			18				7	10	2		
Percentage	11.8		3.5			14.2					7.1				3.6		7.1			13.6						11.2				
Michigan	4	16					4	4	8		5		5	3	4	4			4		4		4		4	4	15			
Percentage	14.3					11.4					9.3				5.7		2.9			8.6						13.6				
Illinois	14			4		2	3	5	8		5			4	4			4	4			6			5	8	11			
Percentage	10.2		2.9			13.2					6.6				2.9		5.8			8.						13.9				
Iowa State	10	6	8	5		5	5	5	5		6	2	2	5	11	5		2	2			14				3	11	3		
Percentage	9.1		7.4			11.4					8.5				9.1		2.3			8						9.7				
Wisconsin	6	11				5	5	5	5			10			6			6	3		4	2			6	4	14	6		
Percentage	10.6					12.5					6.3				3.8		5.6			7.5						15.				
Ohio State	12	12				5	5	5	15	1	3	3	3	5	10	4	4	6	6		3	3	3	2	7	7	18			2
Percentage	10.8					14.					6.3				6.3		7.2			8.1						12.2				
Cincinnati	6					4		4	8			4	4	4	6	4	2		3		3	6			6	4	15	5	2	
Percentage	4.2					11.1					8.3				7.		3.5			10.4						18.				
Worcester †	18	39		18		9	12	15	15		12	15		10	16	8	6	4	9		6½		8	6½	24	9	29			
Percentage	13.2		4.2		0	11.8					8.6				5.6		4.4			10.4						8.8				
Columbia				6		2		6	5			8		3	14	11½		8	3	2			10½			6	18	10	2	
Percentage			3			6.5					5.5				12.7		5.5			6.2						17.9				
Average Percentage	9.2		2.7		.3	11.5					7.2				6.4		4.7			8.7						14.				
Highest Percentage	14.3		8.2		2.1	14.2					9.3				12.9		7.2			13.6						22.				
Lowest Percentage	0		0		0	6.6					4.1				2.9		2.3			6.3						8.8				
Proposed Percentage	13		30		0	12					4				7		4			4						2				

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† These institutions use a system of values different from the others, as explained in the text.

COMPARISON OF MECHANICAL=ENGINEERING COURSES.

Mechanics: Elem. or Anal. Mechanics	Mechanics: App'd Mech.	Mechanics: Eng. Materials	Metallurgy	El.Eng.: Dynamos	El.Eng.: Electr. Trans.	El.Eng.: Electr. Lab.	El.Eng.: A. C. Machinery	Civil Eng.: Hydraulics	Civil Eng.: Hydr. Machinery	Civil Eng.: Masonry	Civil Eng.: Graphic Statics	Civil Eng.: Surveying	Civil Eng.: Structures	Architecture	Mechanical Engineering: Steam Eng. & Boilers	Mechanical Engineering: Thermodynamics & Heat Engines	Mechanical Engineering: Heat & Ventilation	Mechanical Engineering: Locomotives	Mechanical Engineering: Contracts	Mechanical Engineering: Shop Economy	Mechanical Engineering: Thesis	Mechanical Engineering: Seminary	Mechanical Engineering: Other Work	Mechanical Engineering: Steam Lab.	Mechanical Engineering: Mfg. Plant Power Plant	Eng'g. Elective	Gymnasium	Milit-ary: Tactics	Milit-ary: Drill	Rel. Value: Recitation Practicum	Total "Semester Hours"
3	5	2½	1	2	2	3		2	2	1⅓					3	10	2	2	1	1	6½			6				1		½	171½
	6.1		**0.6**		**4.1**					**3.2**										**18.2**								**0.6**			
5	5	2		4		4		2							4	7				2	8			10		3		1	12 Act.Hrs.	⅓	141
	8.5				**5.7**					**1.4**									**22**							**2.1**		**.7**			
90	135	135	30	45	60	45		45	90	45		15	135		135	135	15		30	30	120			202		225		90		⅓?	5785
	6.2		**.5**		**2.6**					**5.7**										**11.5**						**3.9**		**1.6**			
4	3	1.	2	3				3			3				4	5	2	4			4			8				1	12 Act.Hrs.	½	169
	4.7		**1.2**		**1.8**					**3.6**										**16.**								**.6**			
5	5		2	3				4					1	3	4	3			3					5		10					140
	7.2		**1.4**		**2.1**					**3.6**				**2.1**						**10.7**						**7.2**					
5½	3½	1		2		2		3			5	2			4	5			1		3	4		6			2	1	12 Act.Hrs.	⅓	137
	7.3				**2.9**					**7.3**										**16.8**							**1.5**	**.7**			
3	8	3		2	2			4	3							3		2	1	2	6	4	4	6				8		⅓	176
	8.				**2.3**					**4.**										**15.9**								**4.5**			
3	8	3		3		4	3	3	3						5	5			1		14			4		3				½	160
	8.7				**6.3**					**3.7**										**18.1**						**1.9**					
5	5	2	5	4		4		5	3	3	5				10	5				3	5			14						½	222 (x⅔)
	5.4		**2.2**		**3.6**					**7.2**										**16.7**											
2	7		6	3	6	1	2	3	3						4	10					3			4						½&⅓	144
	6.2		**4.2**		**8.3**					**4.2**										**14.6**											
12	18	3	0	6		8	6	9				4			9	18			3	8	12	3		23		0	0	0		¾	431
	7.7				**4.6**					**3.0**										**17.6**											
5	8		2		12	3		4½				2	1⅓		6	13				2		1	5	10	9½		2			⅓	201½
	6.5		**1.**		**7.5**					**4.**										**23.1**							**1**				

Mechanics	Metallurgy	El.Eng.	Civil Eng.	Architecture	Mechanical Engineering	Eng'g. Elective	Gymnasium	Milit-ary	Rel. Value	Total
6.9	**.9**	**4.3**	**4.2**	**0.2**	**16.8**	**1.3**	**.2**			**154.***
8.7	**4.2**	**8·3**	**7.3**	**2.1**	**23.1**	**7.2**	**1.5**			**197.5**
4.7	**0**	**1.8**	**1.4**	**0**	**10.7**	**0**	**0**			**137.**
7	**–**	**1**	**5**	**3**	**8**	**0**	**0**			**169**

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* All totals were reduced to a "semester-hour" basis before the averages were computed.

various branches by twelve representative American schools in their course in mechanical engineering.

The unit of time devoted to any one subject or group of subjects is the "semester-hour" or "semester-period," being the equivalent of one hour of recitation work per week for one semester or half-year. Thus, in a class which meets three times a week for recitations in a branch which continues for one semester, the credit would be three periods. The column headed Recitation—Practicum, Relative Value, refers to the relative value assigned by the different schools to one hour of recitation as compared to one hour of practicum—viz., laboratory or drafting room or shop. Thus 1/3 would indicate that three hours of practicum work are required for a unit credit.

In the case of Worcester Polytechnic Institute the upper series of figures express the units as used at that institution, which differ from the notation just indicated in that they give the unit of value to one hour per week for one semester of practicum work, and each hour of recitation or lecture attendance is considered as requiring two additional hours of outside work, and the latter are thus given a credit of three units. The lower set of figures opposite Worcester are however reduced to percentage of total credit.

The system at the Massachusetts Institute of Technology is similar, but there the total hours which a man spends in class, shop, and preparation are counted. Thus a recitation coming one hour per week for a semester of, say, sixteen weeks, would receive a credit of the recitation hours plus the preparation hours multiplied by the number of weeks, or one hour recitation plus two hours preparation (viz., three hours) multiplied by sixteen, or forty-eight units credit. The upper figures opposite "M. I. T." are expressed in the units used at that institution. The lower figures are reduced to percentage of total credit.

As the Ohio State University has three semesters or terms per annum, the credits must be multiplied by 2/3 to give their equivalent value.

There is room for some difference of opinion as to the title of the group heading under which certain branches are listed in the classification. Thus under "Civil Engineering" are listed the branches of Hydraulics, Hydraulic Machinery, Masonry, Graphical Statics, Surveying, and Structures. This group is intended to cover the branches taught students in a mechanical-engineering course by instructors generally designated as instructors in "Civil Engineering." Continuing this particular group as an illustration, it will be noticed that the average number of semester hours of these various branches in the civil-engineering group taught to students taking a mechanical-engineering course is 4.2; the highest is 7.3 and the lowest 1.4.

The writer is indebted to Mr. E. B. Norris, secretary of the schedule committee at Pennsylvania State College, for assistance in preparing this tabulation.

From time to time speakers at educational conventions have advocated the giving of instruction in branches that would train a technical graduate for management. These speakers have always been met by the argument that the engineering courses are already overcrowded. An investigation of the subjects taught at these ten representative institutions reveals the fact however that there is wide variation in the time devoted to any one subject. Evidently, a course in which the minimum time given by any representative school to a given purely engineering essential was used as the basis would be too light. However, a course can be prepared in which the essentials, such as mathematics, mechanics, and other fundamentals, are fully as strong in time as the average, and in which are omitted such courses as are not common to all. This would leave opportunity for insertion of the cultural studies. Such a four-years course is presented below.

It will be noted that at the very beginning branches are inserted which awaken the student's realization of the fact that human affairs constitute a most important part of life's work. Beginning with history in the freshman year, elements of political economy follow in the sophomore year, and more advanced courses in modern economics follow in each semester throughout the course. Accounting and business law and allied courses begin in the sophomore year, and accompany the work in economics in each semester following.

The regular mathematics of the engineering courses predominate, and are followed by kinematics, mechanics, and theory of structures. The fundamentals in judging materials are furnished in chemistry, qualitative and quantitative, engineering materials, metallurgy, and physics. Thus the student gets the really fundamental studies in engineering, omitting the descriptive and specialized technical branches.

In order that well-designed, safe, livable and attractive buildings shall appeal to the graduate, and that he may realize the effects of good buildings on economical production, he is taught graphics of structures, heating and ventilating, architectural drawing, and history of architecture.

The regular shop-work of the engineering courses is given, not quite so much time being devoted to this as in the mechanical-engineering courses. Sufficient steam- and electrical-laboratory work is given to familiarize the graduate with the elements of power-plant work. Such a course is believed to be far superior to the so-called business or commercial courses offered by a few of our larger universities at present, since the latter courses are deficient in omitting mathematics and engineering, thus only partially equipping the graduate and being themselves open to the same criticism as to one-sidedness that can be made of purely engineering courses.

COURSE IN INDUSTRIAL ENGINEERING.

Freshman Year. First Semester.

	Actual Hours.	Credit Hours.
English	5	5
Mathematics (Trigonometry)	5	5
Modern Languages	5	5
History	4	4
Drawing, Freehand and Geometric	4	2
Forensics	1	½
	24	21½

Second Semester.

	Actual Hours.	Credit Hours.
Mathematics (Analytical)	5	5
Modern Languages	5	5
English	2	2
History	4	4
Drawing, Projection	4	2
Shop Work	4	2
Forensics	1	½
	25	20½

Sophomore Year. First Semester.

	Actual Hours.	Credit Hours.
Elements of Political Economy	4	4
Elements of Accounting	3	3
Commercial Law	2	2
Mechanics (Elementary)	3	3
Mathematics { Algebra 3, Calculus 2 }	5	5
Descriptive Geometry	6	3
French or German Conversation	2	1
English	1	½
	26	21½

Second Semester.

	Actual Hours.	Credit Hours.
Political Economy	4	4
Mathematics (Calculus)	5	5
Commercial Law	2	2
Statistics	3	3
Physics	3	3
Physics Lab.	2	1
Shops	4	2
French or German Conversation	2	1
English	1	½
	26	21½

Junior Year. First Semester.

	Actual Hours.	Credit Hours.
Commercial Geography	3	3
Theory and History of Money	2	2
Physics (Heat)	2	2
Steam Engines and Boilers	3	3
Mechanics (Analytics)	5	5
Shop Work	4	2
Shop Methods	1	1
Electrical Measurements	4	2
Steam Laboratory	2	1
English	1	½
	27	21½

Second Semester.

Banking	2	2
History of Development of Industrial Society	3	3
Manufactures of United States	3	3
Machine Drawing	4	2
Theory of Structures	2	2
Graphics of Structures	2	1
Chemistry	5	4
Chemistry, Qualitative Analysis	6	3
English	1	½
	28	20½

Senior Year. First Semester.

	Actual Hours.	Credit Hours.
Industrial and Social History of the United States	3	3
Transportation	2	2
Corporations	2	2
Gas Engines, Refrigeration and Turbines	5	5
Kinematics	2	2
Qualitative Chemical Analysis	4	2
Bridges and Roofs (Str. 3)	3	3
Structural Design (Str. 4)	4	2
	25	21

Second Semester.

Factory Organization and Administration	3	3
Engineering Specifications	2	1
Heating and Ventilating	2	2
History of Architecture	3	3
Architectural Drawing	4	2
Quantitative Chemical Analysis	6	3
Engineering Materials (1-3) / Metallurgy of Engineering Materials (2-0)	3	3
Thesis	6	3
	29	20

Summarizing the proposed course by groups of studies, we have:

Group of Subjects.	Actual Semester Hours.	Credit Hours.
English	13	10
Modern-Language	14	12
History	8	8
Economics, Accounting, and Jurisprudence	43	43
Mathematics	20	20
Physics	7	6
Chemistry	21	12
Drawing	14	7
Shops	13	7
Mechanics	11	11
Structures	11	8
Architecture	7	5
Machine Drawing and Kinematics	6	4
Mechanical Engineering, including Steam and Electrical Laboratory	22	16
	210	169

Expressing this in the nearest even percentage, omitting fractions, for comparison with the courses already established, we find the following results:

Group of Subjects.	12 Representative Courses.	Proposed Course.
English and Modern Languages	9	13
History, Political Science, Jurisprudence, and Accounting	3	30
Mathematics	12	12
Physics	7	4
Chemistry	6	7
Drawing	5	4
Shops	9	4
Mechanics	7	7
Civil Engineering	4	5
Architecture	Negligible.	3
Machine Design	14	2
Electrical Engineering	4	1
Mechanical Engineering	17	8
Miscellaneous, including General Elective, Engineering Electives, Metallurgy, and Gymnasium	3	0
Total	100	100

The foregoing comparison of the proposed course in industrial engineering with the average of twelve representative courses in mechanical engineering, brings out the following contrasts:

1.—In English and modern languages the proposed course provides for 13 per cent of credits against an average of 9 per cent. Most observers will admit that the engineer who is to become a manager must have a better command of language than has hitherto been the rule with technical graduates.

2.—The group of History, Political Science, Jurisprudence and Accounting, is raised to 30 per cent in the proposed course from an average of 3 per cent in present mechanical-engineering courses. It is believed this heavy increase is justifiable and necessary in order to produce men who can become practical, successful business men, and to reduce the number of business failures, without any weakening of the fundamentals in engineering.

3.—The Mathematics of the proposed course aggregate 12 per cent, identical with the existing average.

4.—The Physics of the proposed course has been reduced to 4 per cent from an average of 7 per cent in existing courses. It is believed that the higher mathematical physics of wave-motion may be omitted in this course.

5.—The Chemistry percentage in the proposed course is 7, as against an average of 6 per cent. The coming business man needs to know more about the composition of the materials with which he is dealing than has hitherto been the case, and chemistry stopping short of quantitative analysis is not sufficient.

6.—Drawing, including projection, mechanical drawing and descriptive geometry, has been reduced from 5 to 4 per cent. The student, however, has occasion to use his drawing instruments in his subsequent courses in structures and architectural drawing and in kinematics.

7.—The percentage of shop work is reduced to 4 per cent in the proposed course, from an average of 9 per cent. The reason for this is that the institution undertaking to teach engineering should not be a manual-training school. The kind of instruction in shop work that will be of real value to the industrial engineer is of a totally different character from that which has been heretofore given, and it will not require so much time. I wish to quote briefly from the outline of the course in Principles of Machine Manufacture as scheduled by Columbia University for the coming year.

"The Economic Elements of Shop Processes. Time and power per unit of surface finished or cut, and per unit of metal removed, with the conditions for most economic production. Processes in the shop. Functional operation of engine lathes, turret lathes, and automatic machinery, and limits of economic production by each process. Times of setting, handling, forming and finishing of parts for job and repetitive work in quantity. Limits of time, power, and cost for finishing surfaces per square inch and removing per cubic inch and per pound by hand and machine operations. Machines for performing specific operations, their functional operation, capacities, adaptability and rate of production. * * * * Value of limit gauges, standard and special; measuring devices and methods of inspection. Selection of economic cutting conditions, and analysis of recent experiments on relations between rate of feed, depth of cut, heat treatment, form of tool, quality of the metal being cut, diameter of work, elasticity of work and tool; time of cut and cooling during cutting on the maximum allowable cutting speed. Adaptation of economic cutting speeds to machine tools as affected by the pulley and feeding power of the machine. Labor saving devices in the pattern shop. Tools and appliances used, capacity and adaptability, * * * * etc."

8.—Mechanics in the proposed course occupies 7 per cent, the same as the average.

9.—Civil-Engineering branches in the proposed course occupy 5 per cent, as against an average of 4 per cent, the increase being due to emphasis being laid on the graphics of structures in the proposed course.

10.—Architecture occupies 3 per cent in the proposed course, as against an imperceptible percentage in the average. The industrial engineer needs to use better judgment in erecting new plants and plant extensions than has been the rule in the past, and elementary architecture is desirable among the branches to be taught him.

11.—Machine Design in the proposed course has been reduced to 2 per cent from an average of 14 per cent. This is the heaviest cut, and is made for the reason that almost all competent machine designers unite in stating that if a technical graduate is thoroughly grounded in mechanics, kinematics, and strength of materials, and knows how to handle his instruments, his training is sufficient. When the technical graduate goes to work in a drafting room he must learn the special conditions there existing, and a thorough knowledge of the above fundamentals is more essential than much time spent in detailing in his educational course.

12.—Electrical Engineering has 1 per cent in the proposed course, as against an average of 4 per cent. The industrial engineer needs more to know about the selection of the right kind of apparatus and the essentials of direct-current and three-phase alternating-current installations than about the mathematics of alternating currents.

13.—"Mechanical Engineering" in the proposed course fills 8 per cent as against an average of 17 per cent, due to the omission of technical thermodynamics and analytical heat-engine tests.

THE PRODUCT AND METHODS OF EUROPEAN LOCOMOTIVE WORKS.

By Charles R. King.

Mr. King's review is devoted to the most actively interesting phases of European locomotive work, as shown in mechanical design, steam practice, and shop methods and devices. In this number he deals with German works and their product. A following section will cover French, British, Italian, and north European types, and will also give very interesting data concerning the oxy-hydrogen and other new processes of welding.—THE EDITORS.

WRITING in these pages upon European locomotive construction, in the year 1902, I commented upon the rapid increase ever progressing in the power of locomotive engines. During the last five years the development of the power per unit has been unceasing, and despite the prophesies made then, as now, to the effect that the locomotive engine is destined to be superseded before long by another form of power for railways, there appears every probability that it will respond to all requirements for long-distance traffic for a great number of years to come, and survive at least the present generation. Very frequent has been the fear expressed that it was already outgrowing the constructive gauges of the railways for which it is built; but the difficulty appears to vanish before the resources of actual practice. England with its smallest constructive gauge in Europe was to be, by all appearances, the first country to be faced with the impossibility of building larger locomotives; yet here, in the beginning of 1908, we have the English Great Western introducing the most powerful locomotives for express trains ever built on this side of the Atlantic. The fact is a remarkable one, and edifying for Continental locomotive builders. The locomotive with a boiler of over 3,400 square feet of heating surface, producing steam with a tension of 225 pounds and a temperature of 130 degrees F. above saturation, produced by coal evaporating 12 pounds of water per pound of coal, and utilising this steam in four cylinders at full pressure and with 60 tons available for driving-wheel adhesions, is a railway engine with a potential exceeding that of the largest engines built to the ample constructive gauges of central Europe. This by no means represents finality in power even for the English Great Western.

Continental locomotives approaching in power the new English engine are more interesting constructively, having regard to the fact that the ruling condition of wheel-load there calls for greater ingenuity in the design, and the introduction of all available forms which allow the power to be increased without a corresponding increase in weight. In Austria with the maximum wheel load of 14.5 tons per pair, as many as eight large driving wheels would be required to utilise the power of the Great Western engine; in Italy the maximum permissible load is 14.7 tons; in Germany 16 tons; in France close on 18 tons; in Belgium 18 tons, and likely to be increased; while in England 20 and 21 tons give a free scope to the designer. Again, Continental coal evaporating only 6 pounds of water requires much larger fireboxes, consuming nearly twice as much coal in evaporating only the same quantity of water in the same time as the best English steam coal. In Austria the average evaporative power of the locomotive coal is only 5 pounds or, with lignite, 4 pounds. With larger fireboxes capable of evaporating as much water in the same time as English coal, the weight of the boiler must of necessity be much heavier. In sum, poor fuel and light rails and track are two opposing conditions requiring the greatest skill on the part of the locomotive designers in planning high-power, high-speed locomotives, and for this reason it appeared to me that examples of the most recent Continental practice would be the most instructive in this review.

Before entering into the details of construction or recent methods and practices of construction, it is desirable to refer to the locomotive types now prevailing in Europe. When writing here in 1902, the principal locomotive types mentioned were two-cylinder compounds or else four-cylinder compounds nearly all due to or imitated from forms originated by Mr. Alfred G. de Glehn, late Director of the Société Alsacienne de Construction Mécaniques of Mulhausen and Belfort; exceptions thereto were the tandem compounds—since abandoned as modern practice—and the "Adriatic" four-cylinder compounds. Since that period, however, a four-cylinder balanced compound engine that was not there mentioned as a distinct type has become, in the space of five years, the standard practice of almost every country in Europe except Prussia, France and England. It was represented at Paris in 1900 by three examples: that is, the four-cylinder balanced compound of the London & North-Western Railway, due to the ideas of the late Mr. F. W. Webb, the balanced compound of the Prussian State Railways due to the late Professor Von Borries, and the "Adriatic" balanced compound due to M. Plancher of the *ex* Meridionali Railways of Italy. In these three types all cylinders are bolted together in one block, all drive on one balanced axle and have one set of valve mechanism for four cylinders. The origin of the various "systems" of multiple-cylinder locomotive engines now in extended use in Europe and America may be given here in order to facilitate future references to the subject of engine arrangements:

Central-European System.

Cylinder castings bolted together.

Balanced drive.

1884. Four-cylinder balanced compound locomotive, "Vulcan," converted by Charles Sandiford, Scinde, Punjaub & Delhi Ry.

1892. First regular series of balanced compound locomotives. Nos. 4521-4530. Messrs. Henry & Vallancien. Paris-Lyon Ry.

1897. Four-cylinder balanced compound locomotives. "Black Prince" series. F. W. Webb. London & North Western Ry.

1897. Four-cylinder balanced compound locomotives. "3408" series. Professor von Borries, Prussian State Railways.

1905. Adoption by Belgian State Railways:
+ Compounds, Type 19, and non-compound, Nos. 3302-3303.—Fig. 53.

1906. Four-cylinder balanced compound. English North-Eastern.

1905. Four-cylinder balanced compound for coal trains. Lancashire & Yorkshire Ry.

Mixed Systems.

Cylinder castings bolted together.

Divided engines.

1889. (Beginning of) Regular series of four-cylinder divided compounds, the first having side rods. Messrs. Henry & Baudry. Paris-Lyon Ry.
Types:
C. 1 & C. 2—express.
3201-3202—freight.
4301-4302—mountain.
Modern derivative.—Fig. 55.

1902. Freight locomotives for French "Midi" Ry. De Glehn design.

1905. Type 19 bis.—Fig. 54.
+ Belgian State.

1906. Great Northern. Compound. Mr. Ivatt.

Webb-de Glehn Systems.

Separated cylinders.

Divided engines.

1881. Three-cylinder divided compound locomotive, "Experiment." F. W. Webb. London & North-Western Ry., without side rods.

1886. (Beginning.) Four-cylinder divided compound locomotive, "No. 701," without side rods. A. G. de Glehn. French "Nord" Ry.

1891. Aug.-Sep. Divided compound locomotives, Nos. 2121-2122, built for side rods. Messrs. du Bousquet & de Glehn. French "Nord" Ry.

1900. Adopted for Saxon State Railways and since abandoned.

1901. Adopted for Bavarian State Railways and since abandoned. — Fig. 13.

1906. Great Northern "Vulcan" Co. Compound. No. 1300.
London & South West. Non-compounds.

1907. Great West. Ry.

1908. + Non-compounds. —Fig. 27.

Examples marked thus + have only one set of valve mechanisms and a rocker transmission for the second set of valves similar in arrangement to that introduced by Mr. Webb for his four-cylinder balanced engines.

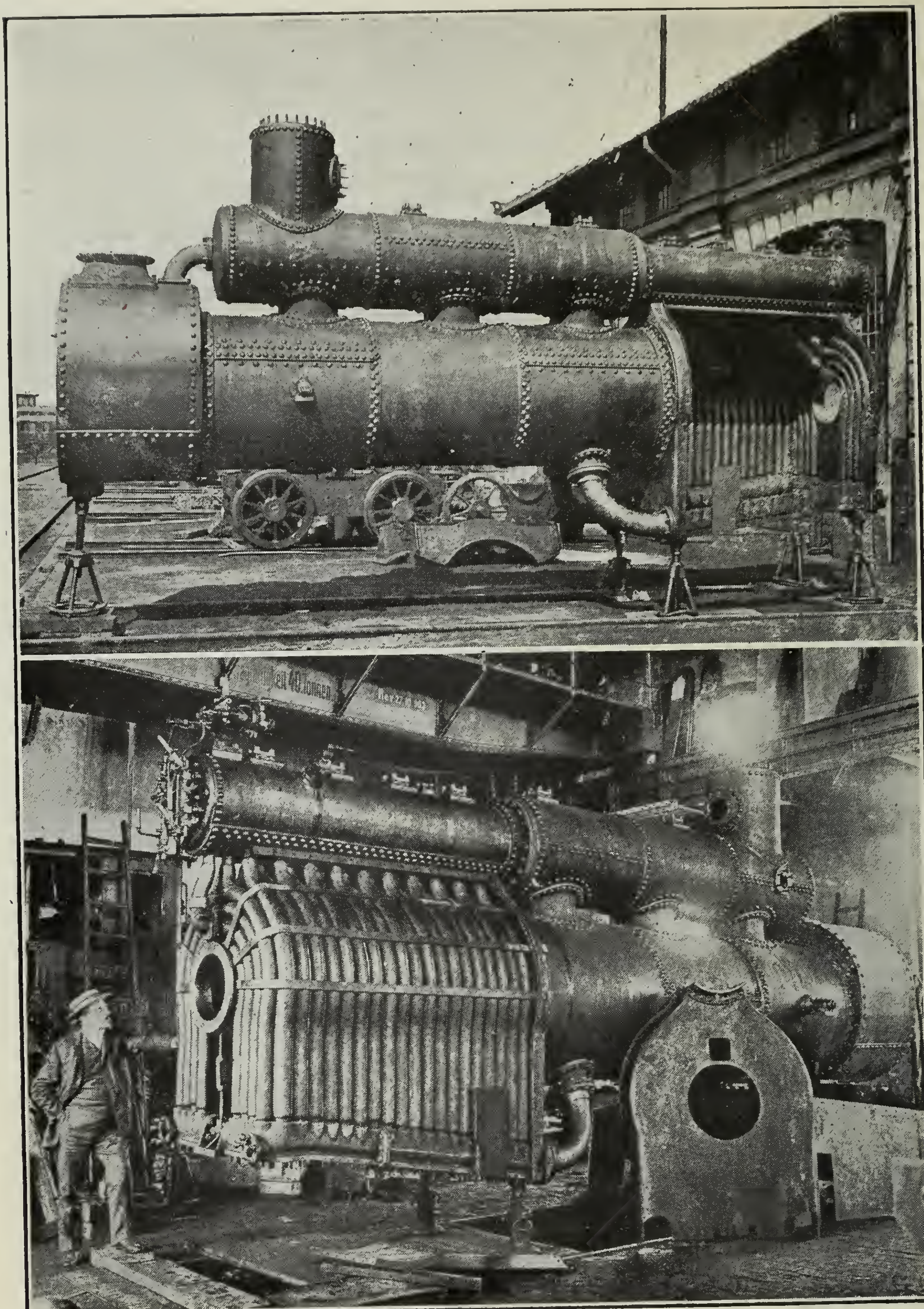

FIG. I. BROTAN WATER-TUBE FIREBOX.

Since 1902 the most notable change has been the general adoption of the simple four-cylinder arrangement now common in Central Europe and in America—as indicated in the first column. The mixed system indicated in the second column has been revived upon the

French Paris-Lyons Railways and adopted for certain types on the Belgian State Railways. The du Bousquet arrangement of the de Glehn compound is adhered to at present by the larger number of French railways, Swiss Railways, and a certain number of de Glehn locomotives continue work in Prussia and Belgium. As shown in the third column a compromise of the Webb and de Glehn arrangements for single-expansion four-cylinder locomotives is being adopted by at least two English railways.

The three different cylinder arrangements now being followed are therefore derived from models long existing—that is, the Sandiford, the Henry and the Webb. The chief improvements of the last few years have been, first the simplification in construction of the first and second models, the reduction in the number of valve mechanisms practicable in all four-cylinder types of any model, and the wide and growing use of piston valves. The application of poppet and Corliss type valves is, thus far, too rare to be considered as locomotive practice.

The changes introduced in the boilers are more notable than in the machinery. The water-tube boiler of Brotan, of which some illustrations accompany this article, has been much more successful than was generally anticipated. More locomotives in Austria are to have this form of boiler, which is also being tried in Switzerland. See Figure 1.

On the French "Nord" railway the water-tube firebox on the du Temple system is composed of small water tubes openly spaced out and running between the lower water-legs and upper collector drum, the rest of the boiler—the barrel—being of the ordinary type, thus differing from the Robert entirely water-tube boiler of the Paris-Lyons Company and also from the entire water-tube boiler of William R. Macklind. Locomotive engineers are aware of the greater efficiency of the water-tube boiler, but are loth to undertake the arduous task of experimenting, preferring to leave the anxiety and expense of evolving a practical locomotive-type water-tube generator to the more restless. A recent visit to the "Nord" works showed that if the water-tube firebox of that line is made a success for locomotives, the "Nord" Company will merit considerable praise for its venture. The locomotive is of the four-connected type,* *oo OO o,* but a four-wheeled truck, *oo OO oo,* has since been introduced to carry the weight beneath the trailing end. The boiler pressure is 228 pounds and in the running department the engine is said to start away with extraordinary speed.

* The method of wheel notation employed in this article is brief, concise and instantly

Another change in boilers is the introduction of steam pipes for reheating the steam. The reintroduction of superheaters for locomotives now appears as an added element of fuel economy, which would perhaps prove more practical were it combined with water-tube rather than fire-tube boilers. So far, the superheaters consisting of steam pipes lodged in the smoke flues and conveying the steam twice backwards and twice forwards throughout the length of the boiler barrel, have proved to be the more successful. This superheater system in a practical form, but contrived without complicated arrangements such have been introduced into recent modifications, was invented and patented in 1850 by Jean de Montcheuil, the chief mechanical engineer of a French railway. It appears quite possible that this original multitubular superheater will eventually prove to be the most efficient of its type. Whatever measure of economy its use may realise the results will be free from the conflicting figures of rival commercial enterprises. It is perhaps but a small honor to the forgotten inventor to record his remarkable and important invention here. See Figure 2.

In the details of construction the practice of Europe follows later, but surely, the results of experience obtained in the United States—which are the pioneers in the production of forms suited to large units. In the adoption of the pilot truck, outside cylinders, large boilers, flanged smokebox tube plates, wide fireboxes, sloped front water legs, sloped boiler heads, vertical gussets and diagonal rods for staying the latter, American wheel arrangements and the reintroduction of bar frames, Europe has learnt the fitness of American arrangements. But not until faced with urgent necessity have the transatlantic forms been adopted, for—and it would be foolish to conceal the fact—European experience of American materials, American workmanship and American design of cylinders, and all that belongs to the motion, has been such as to prejudice the mind greatly against American types. The most progressive designers and makers have reasoned that the American system was good, but that the construc-

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legible to all readers in all countries. The other systems require a mental effort to translate where yet other systems are in vogue.

The graphic method is largely employed in drawing offices where visual effect saves useless mental effort.

	English method.	Continental.		Universal.	
Brevity.	0—6—0	0—3—0	(5 signs)	OOO	(3 signs)
	4—4—0	2—2—0	(5 signs)	oo OO	(4 signs)
	4—6—0	2—3—0	(5 signs)	oo OOO	(5 signs)
Precision.	2—8—0 Duplex engine =			o OO + OO	
	2—10—0 Mallet engine =			o OO + OOO	
	2—4—0 Webb engine =			o O + O	

For accuracy, brevity and intelligibility in all countries the graphic method is preferable for all whose time is precious.

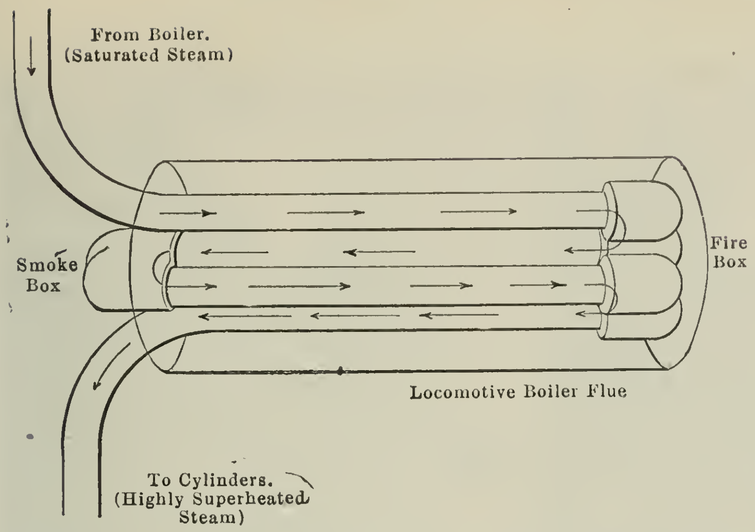
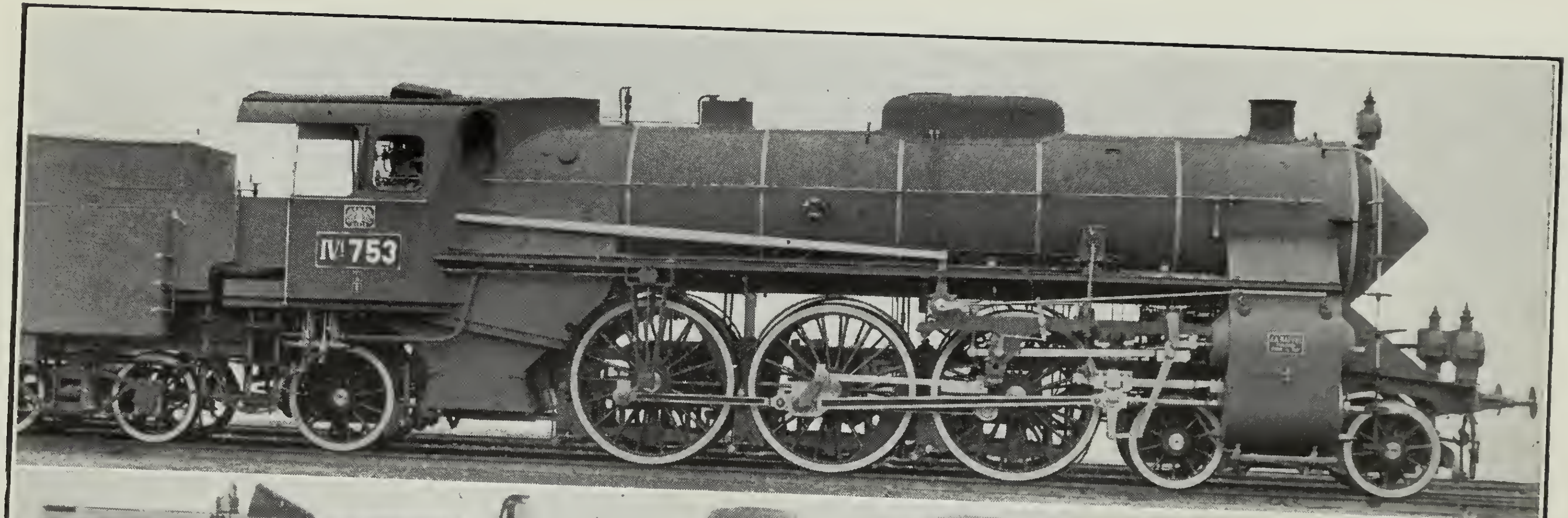


FIG. 2. THE EARLIEST PRACTICAL TUBE SUPERHEATER.
Montcheuil patented system, 1850, fire-flue multitubular superheater for locomotives.

tion materials or details in the form were susceptible of improvement.

The first firm in Europe to adopt the American models largely, in an improved form, is J. A. Maffei, whose works, situated in the sylvan recesses of the "English Garden" on the banks of the milky Isar, at Muenchen in Bavaria, are a familiar objective point for the American engineer when in Europe. This firm has combined the American boiler, frame, and wheel arrangements with the most approved type of Continental balanced compound engine, under a general form of superior elegance, as will be observed from the accompanying examples of different types designed by the firm. For the purpose of comparison the first three European locomotives of the "Pacific" type—French, Bavarian and English builds—are illustrated in these pages. The English type is perhaps the most pleasing, principally because the mere accessories as sand-box pipes, oil pump, speed-indicator bracket, rods to live-steam inlet valves, are invisible or absent as compared with the Bavarian-built engine. The valve motion is inside in the first and entirely outside in the second. In the latter the whole of the inside and outside motions are most readily accessible at all times and places—and this is an important practical advantage not to be ignored for the sake of avoiding a display of the mechanism—which is not one whit more simple, rod for rod and pin for pin, in the one machine than in the other. The French engine differs from the preceding types in that it has two complete sets of reversing gears and four valve mechanisms. It has, in common with the English machine, special frame bracings for the support of the outside cylinders—which are dispensed with, with notable advantage, in the Bavarian-built machine. But the new French engine has no outside main steam pipe as usual in most French locomotives. Each engine is interesting for new features which will be described in due course.



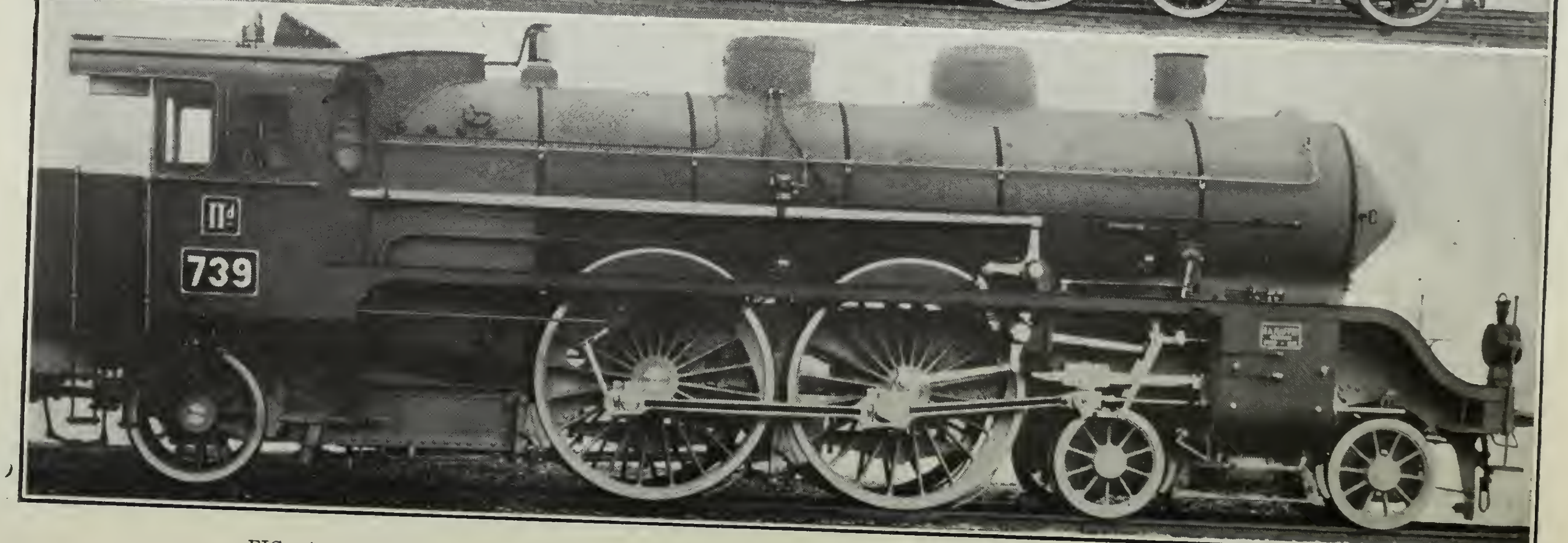


FIG. 4. BALANCED COMPOUND, UTILISING SUPERHEATED STEAM, BADEN STATE RAILWAYS.

FIG. 3. BALANCED COMPOUND, PROTOTYPE OF BAVARIAN HIGH-SPEED LOCOMOTIVES. RAN 90 MILES AN HOUR ON RISING GRADIENT.

Locomotives Built by J. A. Maffei of Munich.

Baden State Railway. The *oo OO o* type locomotive shown in Figure 3 was Maffei's first design of the Central European balanced compound engine, which, in the year 1904, ran at higher speeds than were ever before attained under equal conditions, by a European steam locomotive—that is, an average start-to-stop speed of 72 miles per hour for a distance of 39¼ miles on a continuous rising gradient, the difference between levels at either end being 359 feet, the car load 138 metric tons and the maximum speed, on a short level, 90 miles per hour. The full-way speeds for the whole journey varied between 75 and 84 miles per hour on the ascending grade. This locomotive was designed for trains running up to 56 miles per hour, average, or up to 62 miles per hour in making up time. It was built before experience had given full confidence in the use of piston valves and at a time when it was deemed advisable to provide at least the low-pressure cylinders with flat valves. The locomotive has also flat rolled frames; in all other respects it is typical of the most recent practice.

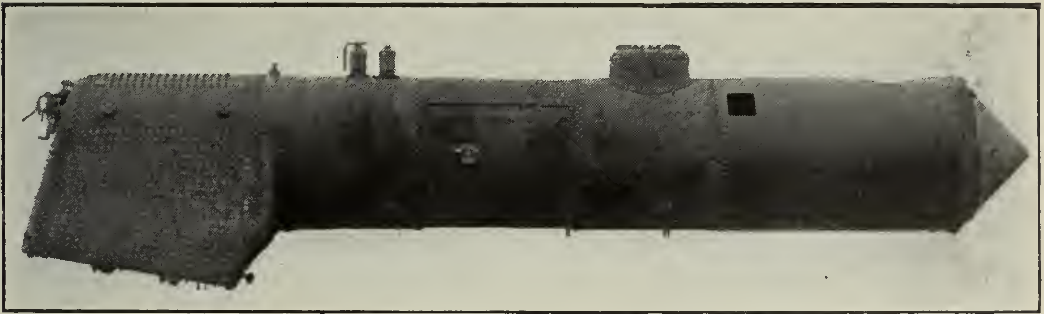


FIG. 5. BOILER FOR PACIFIC-TYPE LOCOMOTIVE, BADEN STATE RAILWAYS.

The *oo OOO o,* or "Pacific"-type locomotive, Figure 4, for the same Baden State Railways, combines all the most recent improvements of the firm Maffei. It has piston valves to all cylinders, bar frames, latest-pattern boiler fitted with superheating pipes according to the Schmidt arrangement. The boiler is of the wide firebox type with round crown to the firebox wrapper, according to the most generally approved practice of Europe, and as shown in the view Figure 5. The plates are rolled from best quality mild steel—*flusseisen*—by the Martin open-hearth basic process. The plates employed in Bavarian practice have, for flanged work, a tensile strength of 32 to 38 kilogrammes per square millimetre with a minimum elongation of 25 per cent, the sum of the two values being 62 minimum. The rest of the shell plates have a tensile strength of 36 to 42 kilogrammes per square millimetre with a minimum elongation of 22 per cent, the sum of the two being, in minmum, 61. Tests include bending the plates through an angle of 180 degrees, hot and cold, and bending, after hardening, around a mandrel to a diameter equal to twice the thickness of the plate. Test strips 10 centimetres wide, and red-hot, must enlarge 1½ times their breadth under the hammer without showing crack or other flaw. The rivets of mild steel have a tensile strength of 34 kilogrammes per square millimetre with 20 per cent elongation, the minimum sum of the two values to be 54. The bending tests are the same as for the boiler plates.

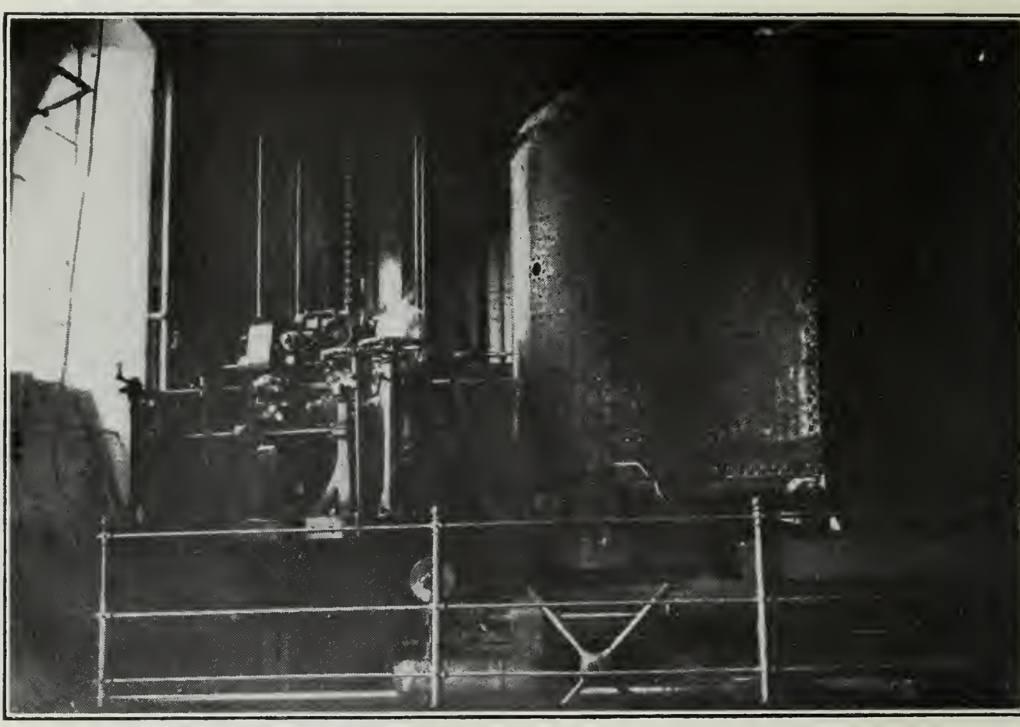


FIG. 6. MAFFEI-BUILT SPECIAL BOILER-DRILLING PLANT.

The plate-working shop at Maffei's is a fine building replete with bending rolls, planers and drills; but it is in a small annex to the old boiler-makers' shop that we find an interesting machine tool specially designed by Maffei for drilling the stay holes of very large modern fireboxes. A snap-shot view of this in Figure 6 shows that the firebox is clamped down by the throat sheet to a revolvable platform. The drilling machine is permanently fixed to the side of the boiler pit. The multiple drilling heads, with the operator's platform, move up or down the vertical slides, the controlling gear enabling rapid setting of the cutting tools to the punch marks on any part around the whole contour and height of the box. The inner box is of copper of the purest quality—99.5 per cent minimum—and of 21 kilogrammes per square millimetre tensile strength; 42 to 45 kilogrammes sectional contraction in minimum, and 38 per cent minimum elongation. The metal must bend at an angle of 180 degrees; and on a mandrel bend to

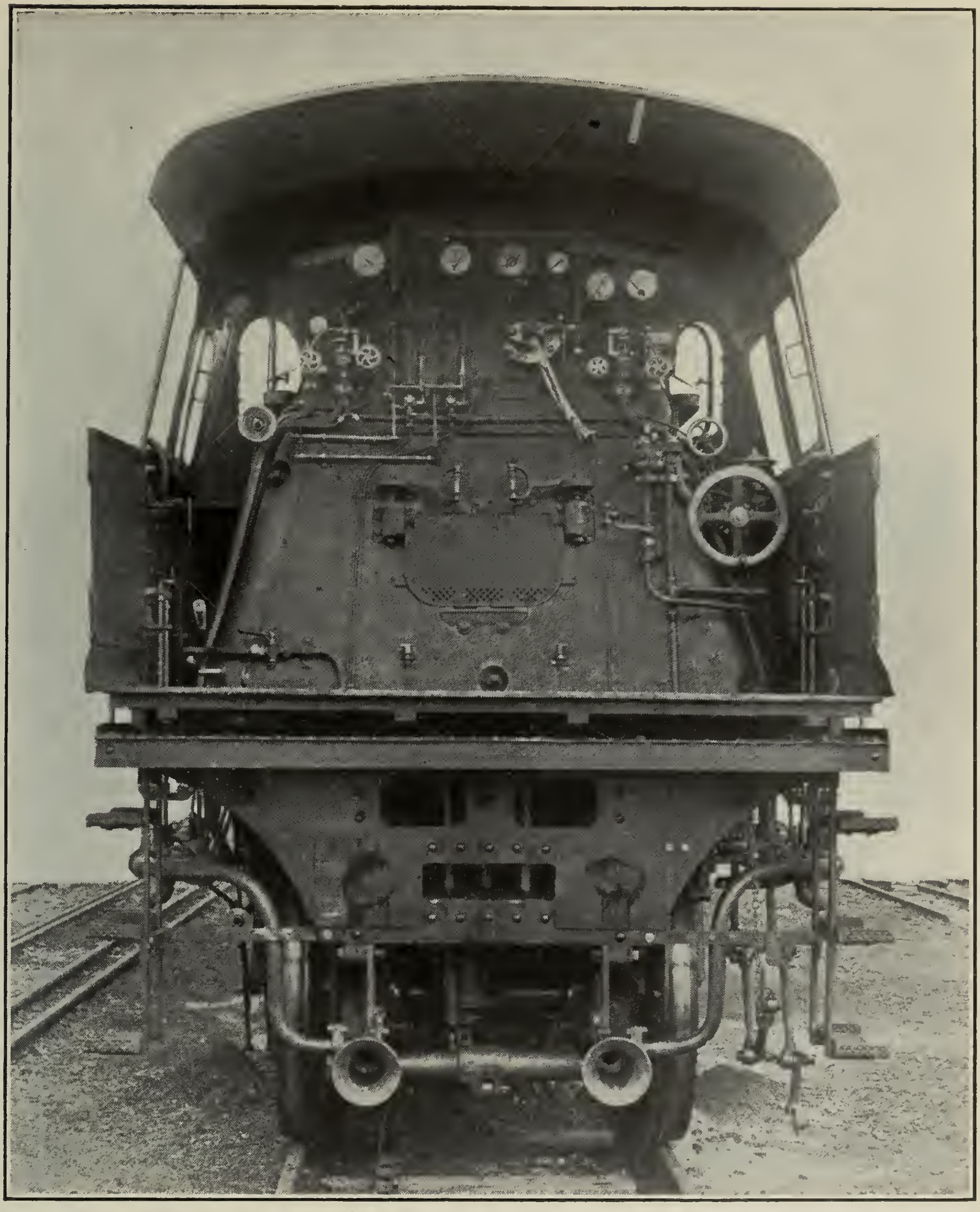


FIG. 7. BOILER HEAD, PACIFIC-TYPE BADEN LOCOMOTIVE.

a diameter equal to the thickness of the plate without sign of flaw. Copper tubes and ferrules are of the same quality. Copper stays have a tensile strength of 22 kilogrammes with minima of 45 per cent sectional contraction and 38 per cent elongation. The copper-stay rivet heads are left solid—that is the central hole is not opened out on the outside of the box. The inner and outer boxes are usually assembled at the fire-hole by means of forged iron space rings; and to this the new safety inside-opening firedoor is fitted—see back view, Figure 7. The cylinders for the Baden locomotive are shown in the view Figure 8. Here the inside group of two cylinders, two valve chests, the saddle, and the legs forming a box brace, is in one piece; the two outside cylinders, with their valve chests, being each cast separately. This makes three pieces instead of only two as in the American plan. For facility in erection and for ease in removing the outside cylinders for reboring, etc., this three-piece arrangement is preferred. The receivers between high- and low-pressure cylinders are simple U castings as shown in Figure 8, and the steam is not carried around in a pipe to absorb the heat of the smokebox as is often practiced with receiv-

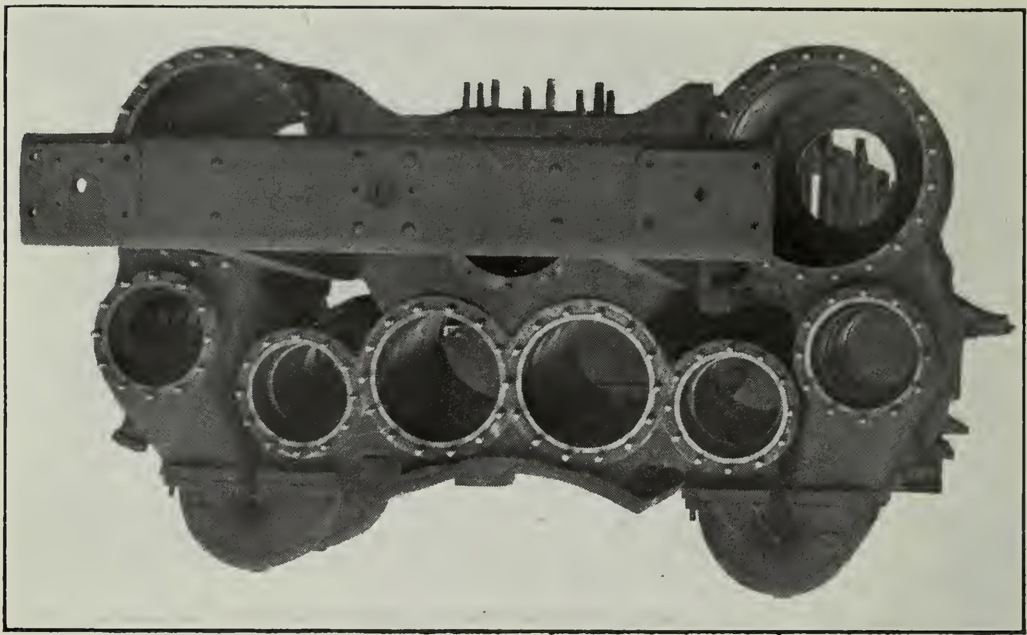


FIG. 8. CYLINDER CASTINGS ATTACHED TO FRAMES OF PACIFIC-TYPE BADEN LOCOMOTIVE.

ers. The whole group of cylinders has the appearance of being somewhat complicated, but in reality the disposition is of the simplest; and while there are no more parts here than in the four-cylinder engines now built for single-expansion, the arrangement is practically more simple than in any class of engine having the same number of cylinders, where those cylinders are bolted to different parts of the frames and so require, in addition, a heavy box bracing or caisson between the two outside cylinders; while the losses by heat radiation are greater in divided cylinders than where the whole mass of the cylinders is concentrated together; further important advantages are realised where the efforts of all four pistons are opposed, one against the other, in the same transverse plane. A side view of the cylinders is given in Figure 9. The four receivers connect the ends of the four valve-chests, the middle passage being for the admission of the steam. The outside valves are double-headed and triple-ported; the inside valves are single-headed. All valves give central, or inside, admission.

FIG. 9. BAR FRAMES, COMPLETE WITH ALL ATTACHMENTS, PACIFIC-TYPE BADEN LOCOMOTIVES.

There are only two valve mechanisms, precisely as in any two-cylinder engine, and the rocking shafts for actuating the inside high-pressure cylinders have simple equal-length arms. Comparatively, two-cylinder engines are really more complex than this simple type of four-cylinder engines, in that they require one valve gear for each cylinder, whereas the simplest of four-cylinder engines have only one mechanism for two cylinders.

The bar frames are also illustrated in the view Figure 9. An important advantage arising from the use of four cylinders is not only the preservation of the track but also the reduction, by half, of the maximum working stresses on the frames and all parts in connection. The bar frames as made by Maffei for balanced engines appear to have given most satisfactory results in practice, and their use is extending rapidly. This result is to be attributed to the high quality of the work in their production. They are forged from slabs of best-best iron of selected scrap, double-fagoted, welded, and hammered, the welds being well removed from the neighborhood of motor efforts. After the frames are forged they are annealed and then placed on the machine depicted in the view Figure 9 A, which was made specially for this class of locomotive work by the celebrated firm Collet & Englehardt. The frames shown on the machine are for the *oo OOO o* type Baden balanced compounds. The notable feature of this machining is that the material is milled away to a depth often of ⅜ inch, which entirely removes the outside hide even in the thinnest parts of the forging, and thus the structure of the metal is liberated from unequal tensions tending to buckle a plate

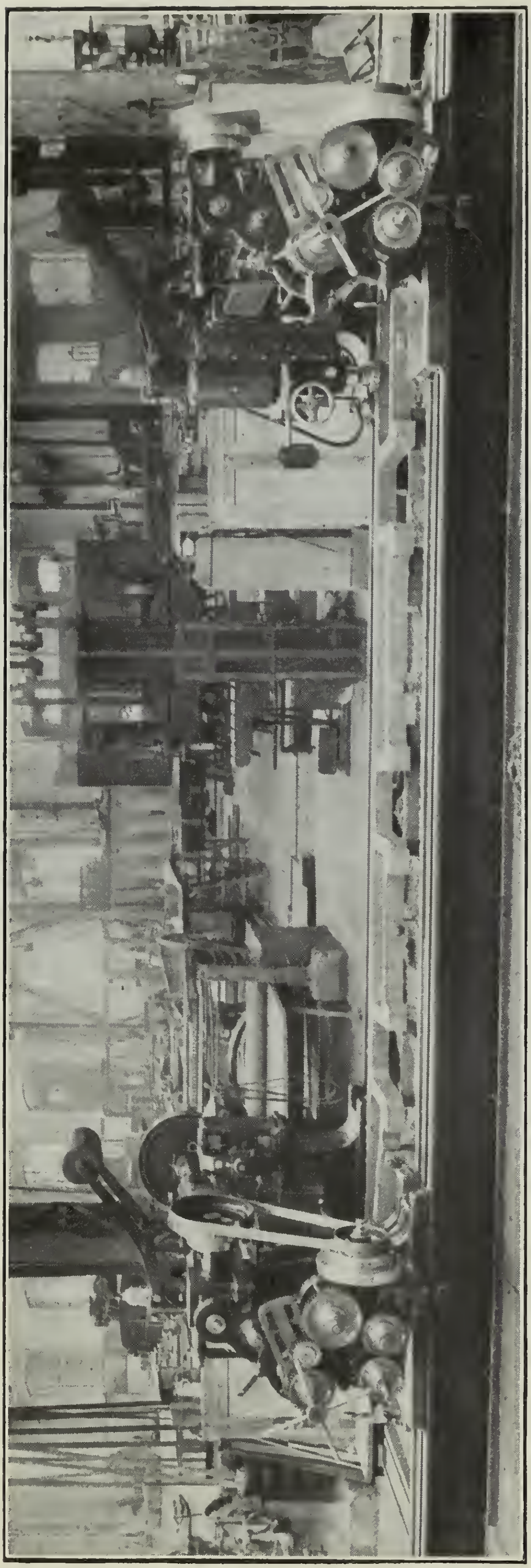


FIG. 9A. SPECIAL MILLING MACHINE AT WORK ON PACIFIC-TYPE ENGINE FRAMES.

having different grades of homogeneity. The machine leaves the frames with a fine surface finish on both sides. The traversing motion of the milling tools—for milling the pedestals or axle-box guides—is better understood from the snap-shot picture, Figure 10, made of the machine whilst working. The frames are then removed to the adjoining slotting machines, which are of the universally employed type of the Saxon Engine Works of Chemnitz—see Figure 11. Generally not more than two frames are slotted together at the one time. The frames are thus finely machined over every inch of their surface and the work of tracing proceeds upon perfectly true bases, the subsequent erection and fitting up of front and back extensions and of the various parts for the running gear being greatly simplified and facilitated.

The advantages experienced in Europe with bar frames are: saving of weight, less number of bolts and rivets, interchangeability of pieces by which reserve parts may be kept in store and replace broken parts at all

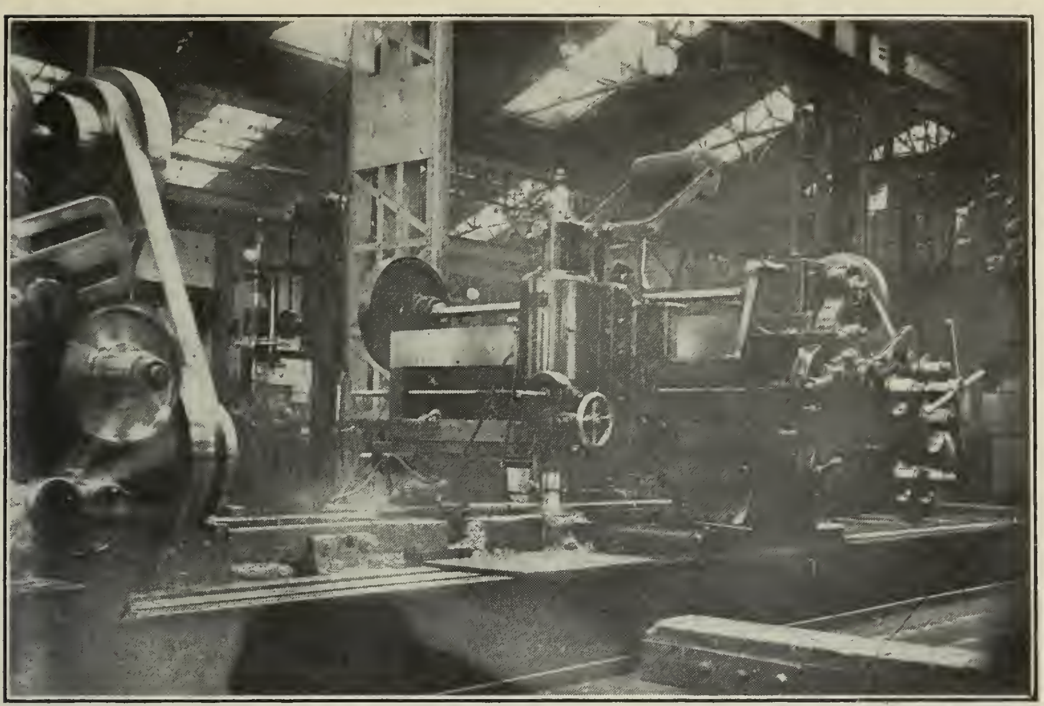


FIG. 10. MILLING BAR FRAMES FOR NEW BAR-FRAME LOCOMOTIVES.

times certain of a good fit, and finally greater ease in erecting all parts that have to be attached to the frames, and much greater convenience to the enginemen who can inspect all inside parts of the motion without half the effort entailed with plate frames.

The running gear, axles, wheel centres and tires are, as usual in most European locomotive works, procured from large steel works. It is, indeed, rare to find engine builders rolling their own tires, etc., as practiced by the English Lancashire & Yorkshire Railway Co. The

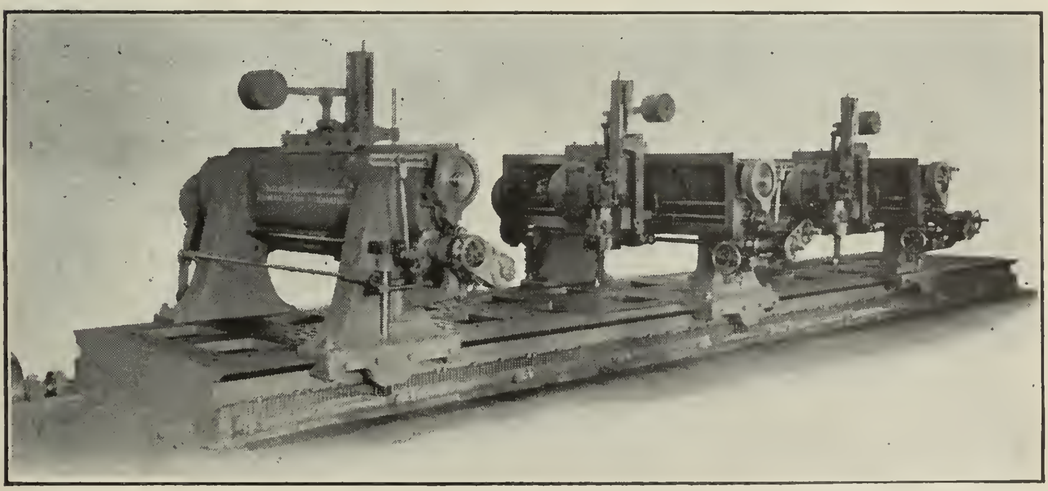


FIG. 11. TRIPLE SLOTTING MACHINE FOR LOCOMOTIVE FRAME PLATES.

Mattei works, Munich. For automatically machining straight edges or circular holes, in longitudinal or transverse direction. 300-millimetres stroke.

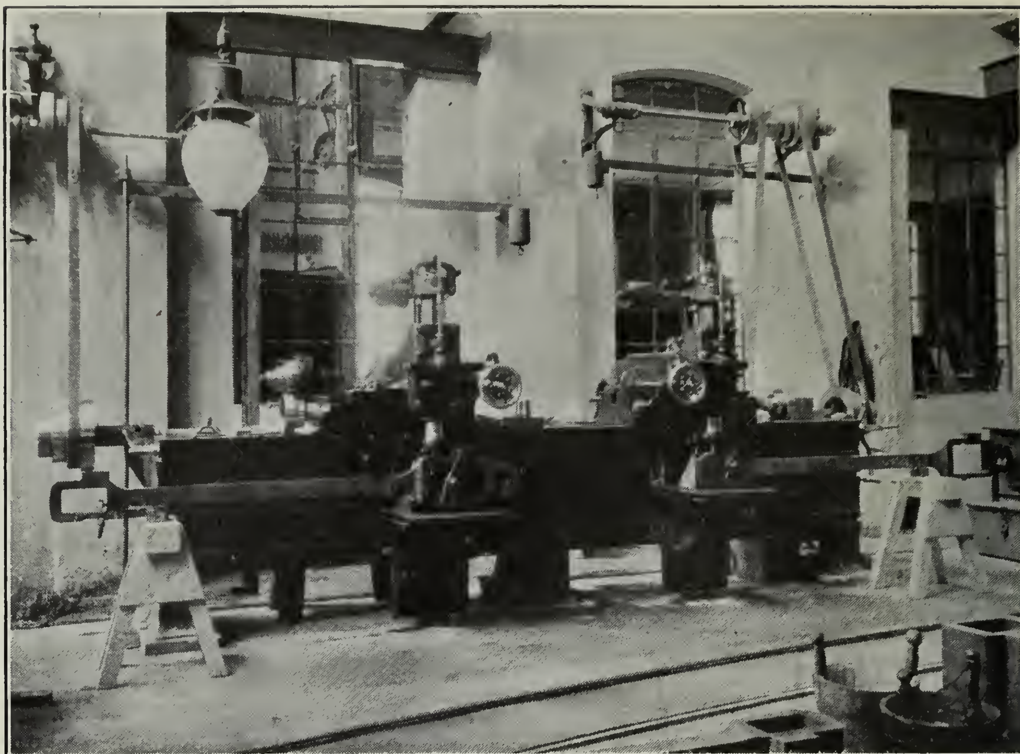


FIG. 12. DOUBLE-SPINDLE LOCOMOTIVE MAIN-ROD OIL-CUP MILLING MACHINE.

engine motion, rods, etc., are forged at the works. In design they are always characterised by most carefully studied proportions, and of marked elegance. Weight having to be cut down in every part, lightness is of great consideration—hence the reduction in the bulk of the pieces, and in their number wherever one piece can be made to do the work of two. The single guide-bar of the crossheads in Figure 4 may, for example, be compared with the guide bars of the smaller cylinders in Figure 27. In the latter case weight is of small import and durability can be increased by greater strength in proportions. The Maffei engine work is also fine in its finish. The rods are always channeled—Kendall & Gent milling tools being employed for this work. The oil boxes are fashioned in the forgings by means of a special double-headed milling tool by Zimmerman which is shown in Figure 12, at work on a pair of rods. The milling cutter has an eccentric movement and automatically finishes a deep oblong cavity to the required dimensions.

The axles of the driving wheels are cranked in Z form according to the now almost general practice of the Continent. The straight parts of the axle—journals and cranks—are hollow. This form of cranked axle (Figure 12 A)—derived from the old Martin type—is said to be very satisfactory. In countries where it is only adopted at present to a relatively small extent, it is conceded to be so good as never to have failed during a number of years since its adoption; yet it is said to be unable to command entire adoption because its form does not allow of such complete consolidation under the hammer as the ordinary right-angle form, and also because of its higher price.

The cranked axles are usually of nickel steel. The other axles are of cast steel and crucible cast steel. The nickel steel has a tensile strength of 55-65 kilogrammes, cast steel 50-55 kilogrammes, crucible cast steel 55-60 kilogrammes, the sectional contraction of cast-steel and nickel steel being in minimum 40 per cent, the sum of the two values not to be less than 95. The tires are of crucible cast steel having a tensile strength of 65 to 73 kilogrammes per square millimetre, 30 per cent minimum sectional contraction, the sum of the two values being 95. For turning tires, etc., several Niles' lathes are in use.

The foregoing description applies generally also to the locomotives of the Bavarian State Railways. This latter administration adopted the Central European engine type only two years later than the very progressive Baden State Railways:—1902:1904. Both commenced with the French four-cylinder types. The Bavarian 1901 model of the de Glehn engine is illustrated in Figure 13. It has four valve gears as usual. These are excellent engines for light express trains but the complicated arrangement of the outside cylinders, fixed at a

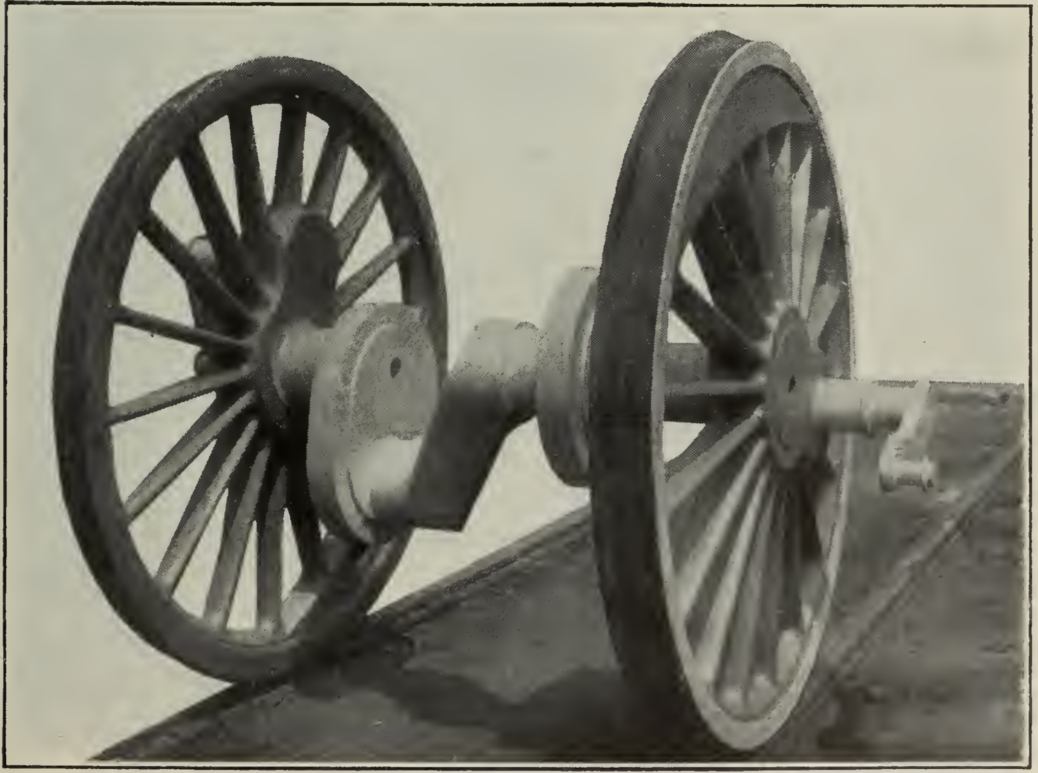


FIG. 12A. Z-TYPE NICKEL-STEEL CRANK AXLE, BORED OUT HOLLOW.

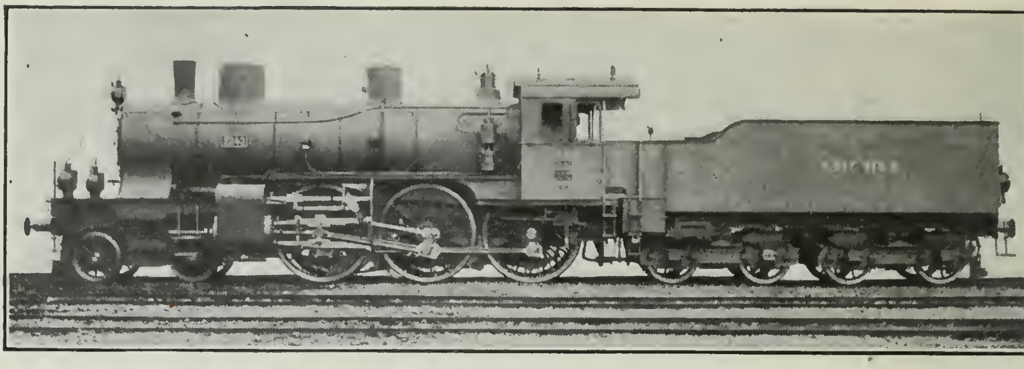


FIG. 13. FIRST DE GLEHN LOCOMOTIVE FOR BAVARIAN STATE RAILWAYS.
High-speed four-cylinder compound.

different position to the inside cylinders, their liability to slacken the bolts after hard working, the trouble with the pipes that run along between the two pairs of cylinders, the complication of two valve sets, and the difficulty of inspecting the inside motion whilst on the road where no track pits are available, have resulted in this type being replaced by the simple arrangement seen in the *oo OOO* and *oo OO o* Bavarian locomotives illustrated in Figure 14 and Figure 15. With a wheel load of 16 tons per pair the class of service required of each of these types will be fairly understood. The "Atlantic" type is able to run at speeds much in excess of the maximum velocities allowable in ordinary service. Pulling the Brenner Pass express between Ber-

FIG. 14. BALANCED COMPOUND WITH SUPERHEAT FOR HEAVY TRAINS ON HILLY LINES, BAVARIAN STATE RAILWAYS.

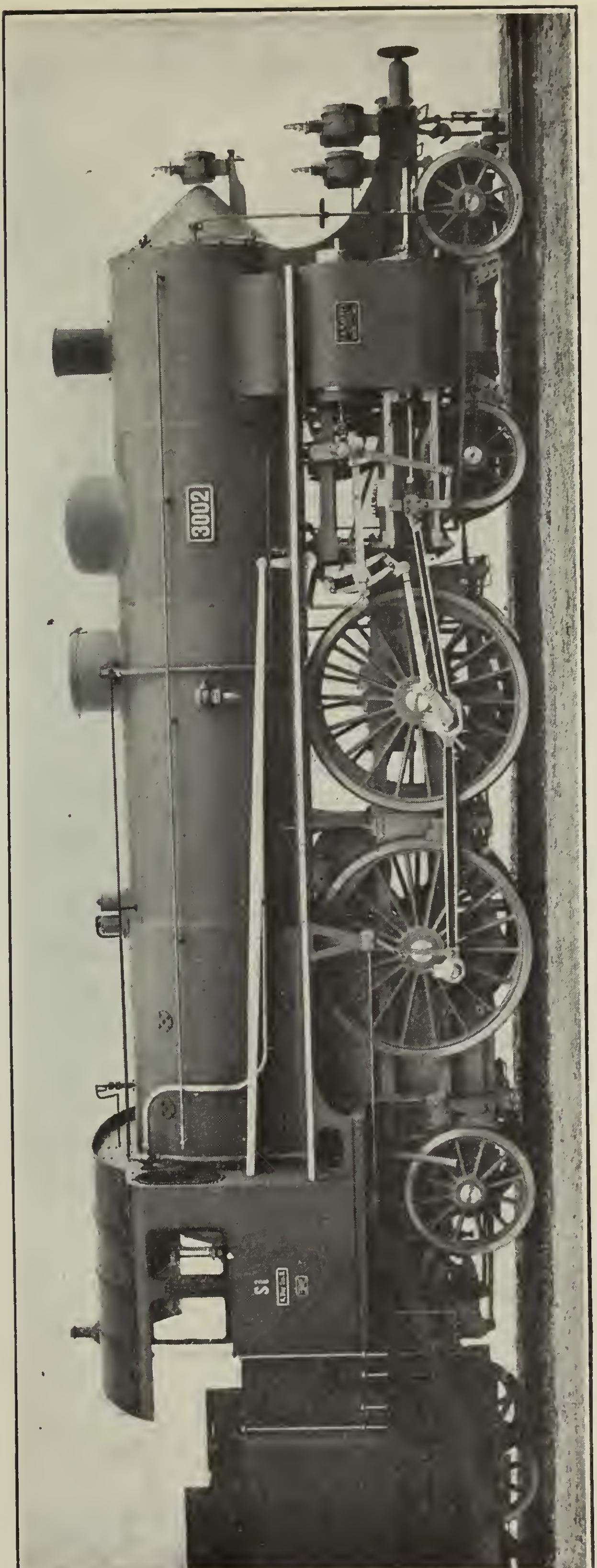


FIG. 15. FOUR-CYLINDER COMPOUND, BAVARIAN STATE RAILWAYS. BAR FRAMES MILLED AND SLOTTED ON ALL SIDES.

lin and Venice, via the Austrian Tyrol, with a load of 255 metric tons behind the tender, the speed of 60 miles per hour can be maintained for miles together on continuous grades rising 1 in 300, 1 in 350; and 70 miles per hour is the pace in descending the same gradients. This occurs with the special express on the stretch between Muenchen and Rosenheim near the Austrian frontier. The *oo OO oo* locomotive, Figure 16, was built for speeds of 94 miles per hour on the Bavarian State Railways, and between Muenchen and Augsburg it has run a considerable distance with a train of 150 tons at 96 miles per hour, the average start-to-stop speed for the 37½ miles being 81 miles per hour—the record for the steam locomotive in Europe. The locomotive is similar in construction to all the balanced compounds designed by Maffei except that a grate area of 50 square feet is provided for the rate of evaporation required by

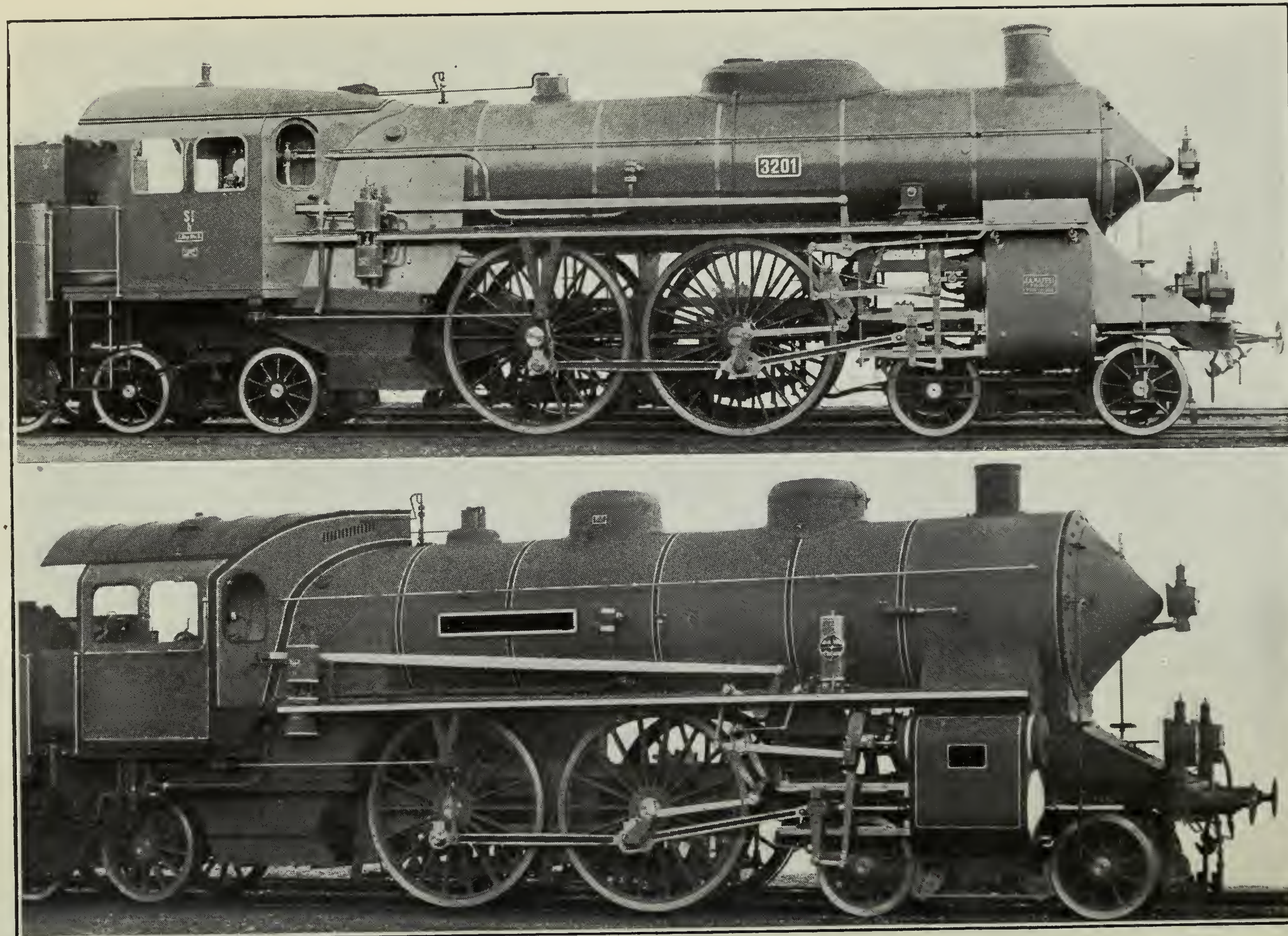


FIG. 16. HIGH-SUPERHEAT BALANCED COMPOUND, BAVARIAN STATE RAILWAYS. AVERAGE START-TO-STOP SPEED OVER 80 MILES AN HOUR.

FIG. 17. FOUR-CYLINDER BALANCED COMPOUND, PFAELZ RAILWAYS. PIELOCK SUPERHEATER, AUTOMATIC FIRE-BLOWING AND

FIG. 18. WIDE-TYPE FIREBOX AND PARALLEL BOILER, APPROVED IN RECENT CONTINENTAL PRACTICE.

mediocre coal, averaging about 1:6 only, and to supply the volume required at 205-pounds pressure and at 300 degrees C. temperature. This large firebox accounts for the special wheel arrangement; and the great diameter of the driving wheels—7 feet 2 inches—is responsible for the height of the boiler—9 feet 10 inches to center.

The Pfaelz Railways of the Bavarian Palatinate, connecting the Baden Railways with the Prussian railways of the Rhineland and of the Reichland—Alsace-Lorraine—have their own type of balanced compound as illustrated in Figure 17. It is always of the Maffei engine type and with bar frames; but in this case the Schmidt superheater arrangement is replaced with the Pielock apparatus located in the boiler barrel, and the locomotive has a special fire-blowing apparatus of the Staby-Koerting system—steam-operated air jets blowing at will on the surface of the fire—by which the dense black smoke of Saarbrucken coal is suppressed, the fuel economised, and the rate of combustion increased when required—a device which should be of value in Italian railway tunnels where, even with viscid naphtha fed on a coal fire with Holden burners, the air, where the ventilation is deficient, is not at present supplied in volume sufficient for the very large locomotives in service.

THE YOUNG AMERICAN WORKMAN AS SEEN BY A SHOP SUPERINTENDENT.

By C. R. McGahey.

Mr. McGahey's experience in his subject is as large, direct, and practical as that of our New England correspondent in the April issue to whom he replies. He also is a graduate from the moulding floor and the bench. His interpretation of modern American conditions is interestingly different. From his point of view the inferior quality and the poor spirit of the American apprentice are not due to the indifference of employers, but to lax home training and to the false standards suggested by the unions. He finds a hopeful and elevating influence in the trade school, and makes some interesting recommendations to superintendents and employers for the treatment of the boy or the young workman in the shop.—The Editors.

A VERY interesting article on American industrial conditions from a workman's viewpoint, which appeared in The Engineering Magazine for April, prompts me to reply, or at least to express an opinion upon conditions as they appear from another point of view.

My experience has been perhaps that of a smaller number of men, because opportunities in the South twenty-five years back were not what they were in the New England States. The young man who sought to become a thorough mechanic there found his school at his door. The conditions here were much different. But I will venture to say that the materials for making the man were the same. Allowing to the New England States all the advantage of the shops and schools for the boy who wished to learn, I yet contend from actual experience and observation that the boy of today is not the same. The deterioration is due, in my opinion, entirely to the new training he receives from his parents. The boy of today is often—even usually—the "boss" when he is about ten years of age. Such conditions at home will follow largely into the shop or the industrial establishment; this, combined with the get-there-quick idea running in his head, and the union atmosphere of many of our shops, is actually ruining the country.

The boy's desire today (though many times it proves his sorrow) —his one object—is to get a "card." "I have my card"—this foolish and unsound expression is heard everywhere. The young man's wish to advance may be genuine, but his real welfare has not been shown to him. The author of the article referred to above was a man of many years' experience. I, also, have worked through several branches, and for some years have been general superintendent of large plants with active experience. I have had many young men come to me for a position, having served their time, and they will promptly tell me that they have their card. To my mind this is of no value and, indeed, serves to put false ideas into the young workman's head. These young "card men," tried on simple jobs, could not chuck a plain, ordinary piece of work—proof enough that the card does not make a mechanic.

I have often said that I do not care how many cards a man has if he is a mechanic and can do the work; but there is one teaching among the Southern branch of the "card gang" which is very apparent. You may take a young workman and show him the proper speed at which to run his tool; when you come by again soon you may find that the speed has been set back; some card man has told him it was too fast for a union man. Here is where I have always clashed with the union. They have their rights outside the shop, but not within it.

I wish to express belief that there is a fair solution to the problem of the technical-school course. The boys from these schools are somewhat different from others. A young man who has ambition and persistence enough to go through one of these schools is worth more than the ordinary "scrub" and is more capable; but in justice we must recognize that our shops have many youngsters made of just as good timber. The whole thing lies just here: How can we pay a uniform scale of wages until all men are born equal and alike? We must be satisfied at this stage of the world to accept differences; we can not all be President of the United States or superintendent of the works; but more of us than now seem to admit it could do better than we are doing, and could improve our position in the world by studying and attending to our own business. Knowledge is power—a greater power than the card; the young man who will devote his spare moments as the New England writer did, to work out of time in the shop, practicing a hard job, will come out all right. The boy who wants to do right will get proper instructions; he can get them if he really desires.

Returning to the trade-school boys; I want to point out an important point. They will try to run their tools and produce the work as directed by the foreman. You will notice that they have learned the lesson to obey at school, while the other boys have not learned this either in school or at home. This defect of home training is being felt throughout the whole country, in all departments of work, and what we shall do in the future for good all-around mechanics is a mystery to me. Many of our shops are willing to teach boys, but what do they get in return? When the apprentice has been in the shop about two years, he becomes dissatisfied with his pay and leaves to enter another shop as a journeyman. I believe that manufacturing concerns should require a written certificate as to the past whereabouts of men applying for positions; it would tend to correct this evil.

The unions in practice tend to lower the standard of the mechanics of the country; they condemn the handy man; in times of strikes they will take in laborers or anybody to try to win their point. They may be good in principle, but not as managed in present practice. Our shop managers should wake up to the true valuation of young men of merit, and pay according to their ability and their worth to the concern. This would tend to check their movement away—to secure selected material—to make real mechanics; then we should teach them system, etc.

All men are not alike, nor can all accomplish the same in life. Where a vast difference exists in young men it should be recognized and the abler should be compensated for their efforts in behalf of the employer. Often a young man is turned down by the manager of the concern with which he is employed and this cuts his ambition and turns him against his own shop. Superintendents and managers, therefore, should be careful in their attitude toward their young men, listening to their wants, and granting those that are right. Fairness and justness in early training will make good workmen—men who can not be led off easily by the trouble-maker.

Experience has taught me that it is best to keep in touch with the young mechanic. If you do, you will have a man who can be much more depended upon.

MAXIMUM PRODUCTION THROUGH ORGANIZATION AND SUPERVISION.

By C. E. Knoeppel.

III. ECONOMY IN THE USE OF MATERIALS AND TIME.

Mr. Knoeppel's initial article, in our April issue, reviewed the conditions under which the internal factory organization will work at its highest efficiency. The second of the series showed the results obtainable by proper system in processing, machining, assembly, and erection. A fourth and concluding article in July will deal with the means for assuring better deliveries—more satisfied customers.—THE EDITORS.

IF it were possible by a simple turn of the hand to transform the energy which is wasted in a number of manufacturing establishments into the same amount of efficiency, the results would be such as would lead a manufacturer to turn his hand without any delay. The great trouble is that many business men get so accustomed to seeing energy lost that they do not give the matter much intelligent consideration until quite a little live steam has escaped. They either forget or neglect to lock the door *before* the horse is stolen.

How much time are you paying for which is producing you nothing? Time is an important element in production, and it naturally follows that any lost or wasted time means a certain decrease in the amount of an output. The following illustration will serve to show what lost time may mean to a manufacturer. If we assume that 200 producers lose only 2 minutes each hour, we have 66.6 lost hours at the end of a 10-hour day, which in 300 days to the year would amount to *19,980* hours. Figuring each hour on the basis of 20 cents would mean that lost time, in labor alone, would amount to *$3,996*, not counting the fact that considerable money is lost in the way of an output, which would not be the case could these 19,980 hours have been utilized to advantage. Consider the number of machines which could be built in this lost time alone!

Doubtless every reader of this article can call to mind a plant where the production could be materially increased if wasted time could be used to advantage—where men have to wait around after finishing one job before receiving another—where the stock clerk is obliged to spend considerable time in looking over his stock before knowing whether a certain part is in stock or not—where machines are often idle until work can be found for them—where the assemblers are kept waiting for parts being machined before they are able to complete a unit—where it is often necessary for the shipping clerk to be on the jump a good share of the time to find a part here and a piece there before shipment of a machine can be made—where it is necessary for someone to be constantly interviewing various persons in an endeavor to find the status of an order—where more than a reasonable amount of time is consumed by men in taking work out of their machines, in order to finish a *rush* or *forgotten* order, then putting back the work they had taken out on the start—where machines are about ready to ship only to find that some part has been neglected or forgotten—where it is necessary to spend considerable time running to the office and drawing room for certain information before a part can be machined or a unit assembled. Add to these the harmful effects of friction between those in authority, the turmoil, confusion, etc., and we have a condition of affairs for which there is no excuse and which is responsible, to a large degree, for lack of maximum results. Efficiency in production can be brought about only after we have either eliminated these conditions altogether or reduced the wasted time to a minimum. I will admit that it is impossible to have everything go right all of the time, but everything can be so handled as to make things go right most of the time.

The first article in this series dwelt at some length on the necessity for a carefully worked out organization that the various forces might be harmoniously united; the second briefly analyzed the industrial body, providing a means for taking care of the information necessary to facilitate production; this article will go a step further and outline such methods as have for their ultimate purpose the handling of the greatest amount of work in the shortest space of time consistent with good workmanship. In order to do so, we will assume that a business has been organized to manufacture certain machines, all raw materials to be purchased outside, labor being paid by the day, the shop manufacturing departments being:—

Assembly Department.
Lathe and Planer Department. }
Milling Department. } Machining Department.
Drilling Department. }
Forging Department.

The connecting link between the factory or engineering branch of the business and those who consume its output is the office or commercial branch; much therefore depends upon how it is managed, and too much importance cannot be attached to the necessity of having

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31

OFFICE COPY

		Buffalo, N. Y.,	June 23 1907.
Sold To	William Jenkins and Company	Date Sold	June 21 1907
Address	Utica, New York	Sold By	Johnson
Destination	,, ,,	Our Order #	3445
Ship Via	Fast freight	Their Order #	A 25589

One cylinder head	X 442	3441
One cylinder	B 20	2811
One piston	X 440	3441

This is a rush order.

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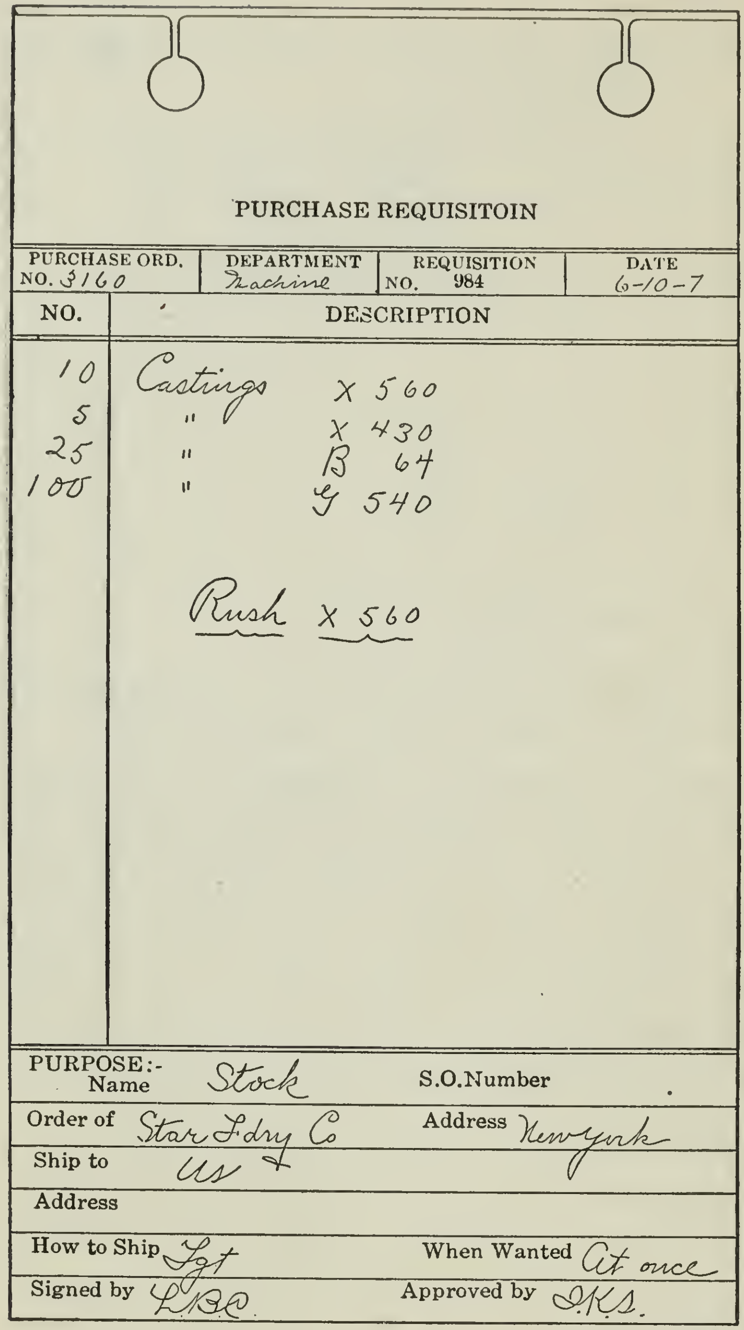
FORM I. INITIAL RECORD OF ORDER. MADE IN QUADRUPLICATE.

some definite understanding, on the start, as regards the way details shall be handled; otherwise costly blunders are bound to occur. To illustrate. If orders are given by more than one person, or if they can be given by more than one department, it is only natural to expect that some orders will be entered twice, or some not at all, each person or department thinking that the matter has been looked after by the other. Delegate certain lines of work to those most competent, make the supervision such as will take care of the detail properly, and it will be found that there will be less confusion and mistakes.

All orders and letters pertaining to orders should therefore be sent to the order department before anything else is done with them. This is our starting point; and that the office may have a record of each order, that the works manager may know what the shop is expected to build, that the shipping and stock departments may also have this information, and that the customer may be advised that the order has been received and entered, four copies of the order should be made, Form I being the office record, the one sent to the customer bearing the regulation acknowledgement advice and the possible date of shipment.

The drawing room, having been made responsible for the accuracy of all orders entered, should state what is necessary to furnish, giving the commercial as well as the shop classifications. In order to do this, they naturally need the original order to know what the customer


PURCHASE REQUISITOIN

PURCHASE ORD. NO. 3160	DEPARTMENT Machine	REQUISITION NO. 984	DATE 6-10-7

NO.	DESCRIPTION
10	Castings X 560
5	" X 430
25	" B 64
100	" G 540
	Rush X 560

PURPOSE:- Name Stock S.O.Number
Order of Star Fdry Co Address New York
Ship to Us
Address
How to Ship Fgt When Wanted At once
Signed by L.B.C. Approved by J.K.S.

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FORM 2. REQUISITION FOR MATERIAL.

really ordered; but the order department, in turn, must have some means of knowing where the order is before it is entered and finally filed away. The order department therefore takes the four copies above mentioned, fills in the headings only, and sends the office copy, with the original order from the customer, to the drawing room, leaving the three remaining copies of the order on the desk of the chief order clerk, which will show, at all times, the orders received but not as yet entered. The drawing room takes the order, looks up the necessary information, makes a "list of material," (Form 1, pp. 232-233, The Engineering Magazine, May, 1908), if the order calls for a number of parts or if for a machine, but if the parts necessary be few, the information is simply recorded on the original order and returned with the office copy, to the order department. The four copies of the order are then taken, the information filled in the body of the order, the possible date of shipment ascertained (the clip showing the date is indicated on Form 1) the acknowledgement is mailed to the customer, the works manager's and shipping clerk's copies are sent to the proper persons, while the office copy is filed alphabetically in the order department, in a place which we can call the "live-order" file. In connection it might be said that the possible date of shipment should not be decided upon until after the matter has received the attention of those competent to know regarding the time the materials can be shipped. This is of the utmost importance, and the proper handling of shipments will be the subject of the next and last article of this series.

As the orders are being made, a number of copies of the "list of material" should be typewritten—one for the works manager, one for the assembly department, one for the foreman in charge of the machining department, one for the benefit of the stock and shipping clerks, one for the order department—to be used by the cost department in entering cost data during process of construction and finally filed away by this department—the original from which the copies were made being filed in the drawing room as their record.

So far we have given notification regarding work to be made as well as the necessary information to complete the work, but no direct authority has been given to process or assemble, which cannot be done until it is known in what condition the stock of materials is in. What must be known is:

1.—What is in stock finished ready for assembly.

2.—What is in stock in the rough.

3.—What must be ordered which when received will be ready for assembly.

4.—What must be ordered which when received will have to be processed.

The stock clerk therefore takes the office list which accompanies his list, checks through his stock, and in the check columns uses the following symbols to designate the condition the order is in.

✓✓ Covering parts under classification 1.

✓ Covering parts under classification 2.

(✓✓) Covering parts under classification 3.

(✓) Covering parts under classification 4.

The office list is then returned to the order department along with requisitions for material needed, Form 2, and here the information concerning the condition of the stock is transferred to the list for the assembly department, the requisitions being turned over to the purchasing department where the necessary material is ordered.

The order department then takes Form 3 and makes an order in duplicate for the assembly department to cover the assembly work,

PRODUCTION ORDER				FINISHED / ROUGH
PRODUCTION ORDER No. 1160.57	PIECE No. X 450	DRAWING No. 3345	MATERIAL Steel	TO BE COMPLETED
DATE OF ORDER. 5-10-7	FOR ASSEMBLY ORDER No. 1160 Abbott			COMPLETED 6-10-6
QUANTITY	DESCRIPTION			
50	Guide Heads			
NOTE: Execute this order, returning same to factory office upon completion of the work. Charge all labor and material to the above Production Order Number. When this Production Order covers the assembly of a machine, charge "labor" only to the Production Order Number.				Burke FOREMAN

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FORM 3. PRODUCTION ORDER; FACE.

sending the original to the foreman, duplicates being filed in the office, after which orders are made for all parts marked as in stock in the rough, or as needing to be processed upon receipt, sending the originals of the former class to the foreman of the machining department, the duplicates being filed in the office; on the reverse side are posted the cost data secured from the daily reports turned in by the workmen, these duplicates being filed either by consecutive numbers of

Assembly				Boring				Turning				Forging				Milling				Planing				Drilling			
Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.
Threading				Grinding				Babbitting				Laying Out				Cutting Off											
Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.	Date	Man No.	Hrs.	Amt.

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FORM 3. PRODUCTION ORDER; BACK.

orders or by part symbols as best suits the conditions, for we have the "list of material" showing the order number and the name of the customer or the purpose for which the work is being done, and we have the official notification, Form 1, which is filed alphabetically, so that any reference or cross reference is facilitated. The original and duplicate orders covering the material which must be ordered and processed upon receipt are held in the order department, in a place by themselves, pending the receipt of the materials, so that the machining department receives orders to process only such parts as are in stock. This file we will call the "reserve-order" file. Form 4 is made out at the same time as Form 3, and being sent to the stock clerk for attaching to the parts when they are issued will show the workmen what is wanted; in no case should these tags be removed until the work is safely on the assembly floor, after processing.

WORKMAN'S ORDER TICKET.			
PRODUCTION ORDER NO. 560.301	PIECE NO. BB680	DRAWING NO. 3340	MATERIAL C.I.
DATE OF ORDER 10-20-6	FOR ASSEMBLY ORDER NO. 560		
MATERIAL TO GO TO { WORKMAN / ~~MACHINE~~ } NO. 31 NO. 20 NO. 101 NO.			
100 Bracket Boxes			
WHEN MACHINE WORK IS FINISHED, DELIVER TO Stock Room			

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FORM 4. WORKMAN'S ORDER TICKET. MADE IN TAG FORM FOR ATTACHMENT TO WORK.

As yet however, no material has moved, although we have provided for handling it as fast as it may be issued. In the first place, the assembly department knows from the list what parts are necessary to complete the order; it is also known from the checking what parts are available as finished stock for immediate assembly and what parts must be machined before they can be assembled. The assembly foreman knows, if he is familiar with the product, in order that assembly may be facilitated:

The finished parts needed first.

The rough parts that need machining first.

In order to start the work, and that his department may operate to the best of advantage, he fills out Form 5, for the important finished parts he needs in order to begin the assembly, making other lists as fast as he needs other finished materials, these lists being sent to the stock room. To get the parts needing machining, he uses Form 6, sending to the machining department the slips covering those parts he is most in need of, the balance being sent to the stock room. It is therefore evident that the stock and machining departments know what the assembly department is most in need of at all times and can be governed accordingly, and while the stock clerk is delivering the finished parts called for, the machining department is making out requisitions for the rough parts, using Form 3 as the authority for so doing, taking into consideration the requirements of the assembly department as evidenced by their requisitions for finished parts. The stock clerk also sees to it that the requisitions from the machining department marked with the cross in the circle, which cover the parts wanted first by the assembly department, are promptly attended to.

FINISHED PARTS

Deliver to ________ floor ,for Assembly Order # ____ the following finished parts which are needed by my department at once.

#	Piece	Drawing	Mat'l	Name	Order	Date Del.

Date Foreman Date Stock Clerk

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FORM 5. ASSEMBLY DEPARTMENT'S ORDER FOR FINISHED PARTS.

After the stock clerk has delivered the parts wanted first by the machining and assembly departments—after the machining department has begun work on the parts the assembly department is most in need of —the balance of the orders can be worked in as convenient; at any rate, we have prevented, by some such method, giving to the assembly and machining departments, on the start, materials which are not necessary until toward the end of the work while material that is urgently needed is not sent in or processed until the assembly department finds that it cannot go any further until the parts are in hand that should and could have been ready on the start. As fast as the stock clerk delivers material to the assembly department, requisitioned by Forms 5 and 6, and to the machining department by Form 6, he sends the slips to the order department. This is also done by the machining department when material covered by requisitions from the assembly department is delivered to the assembly floor.

MATERIAL CARD.			
PRODUCTION ORDER NO. 125.43	PIECE NO. X 4320	DRAWING NO. 2640	MATERIAL Steel
DATE OF ORDER 5-30-6	FOR ASSEMBLY ORDER NO. 125- McKinney		
DELIVER MATERIAL TO {WORKMAN / ~~MACHINE~~} NO. 30			
10 Armbrackets- to be finished standard. ⊗	Drill 6/3/6 L. & P 6/8/6 Finished Stk 6/10/6 Assembly 6/12/6		
When properly dated and signed by Foreman, this card becomes a Requisition for Material. It becomes a Material "Delivered" card when dated and signed by the Stockkeeper, who, after signing, will place weight on back and return it to office.			
DATE 6/2/6	FOREMAN Jenkins	DATE 6/3/6	STOCKKEEPER Smith

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FORM 6. MACHINING DEPARTMENT'S ORDER FOR PARTS SPECIALLY NEEDED.

If the assembly department could use the output of the machining department as fast as parts are finished by it, the proper course would be to send all work to the former department; but this cannot be done in the majority of cases for the reason that the assembly floor would soon be so littered up as to make it almost impossible for the workmen to turn around, and as we have a place for the storage of parts (the stock room) the most logical plan is for the machining department to send all completed work to the stock room with the exception of the few parts that are of importance in the eyes of the assembly department. If we made it a rule to send *every* part to the stock room, we would perhaps be treated to the spectacle of seeing a trucker take a piece of finished work to the proper location in the stock room, unload it, be informed that the assembly department wanted it immediately, load it, and take the part to the assembly floor —considerable unnecessary work. The better and more efficient way is as above outlined, for the order department will know from the signatures to Form 6 whether the part that went to the assembly department came from the stock clerk or the machining department; but before this latter department can deliver a finished part it must know *where* to deliver it, and no trucker must take a part unless the ticket attached shows where it is to be taken. The rule is simply this: all parts go to the stock room except those covered by the requisitions from the assembly department, so that it is an easy matter for someone delegated to look after this particular part of the work to check assembly-department requisitions against the work, marking at the bottom of the workmen's ticket where the parts are finally to go.

It is the duty of the order department each day to check over the receiving clerk's list of receipts, so that if any material has been received against which there are orders in the "reserve-order" file, they can be released and the machinery started so as to get the parts through the machining department and to the stock room or assembly floor. The stock clerk has the requisitions from the assembly department covering parts which, while not needing processing, were not in stock, so that as fast as material arrives, it will be issued by him without delay.

The most important consideration now is: *where are all the parts after an order has been started and under way, and what shape is an order in at any one time?* Any manufacturer who is in a position to answer this question intelligently is on the road to getting everything out of his business that is possible to get. Reference to Form 6 will show that after signing by the foreman and previous to delivery, it is a "requisition" for material; but as soon as the material is delivered and the stock clerk affixes his signature, the slip indicates that the material has been "delivered" to the machine or workman specified. From this slip we know that on June 3, Smith the stock clerk delivered ten arm brackets to workman 30—drill department, as requested by Jenkins the foreman, and as the order department receives this slip right after the stock clerk signs it, the department has a means of knowing *when* these ten parts were issued as well as *where* they were delivered. If we file this slip against the drill department, we really charge it and credit the stock room for the

MATERIAL RECEIPTS

We have just received from the Drill Department, the list of parts below described

#	Piece	Drawing	Name	Order
10	X4320	2640	Arm Brackets	125.43
3	B60	2120	Posts	160.82
5	X342	1080	Cylinders	130.45
20	Y 20	4080	Caps	420.5

Date 6/8/6 By Wilson Department L & P.

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FORM 7. RECEIPT FOR MATERIAL PASSING BETWEEN DEPARTMENTS.

parts, for these slips are used as authority for posting to the stock cards (Form 4, page 236, THE ENGINEERING MAGAZINE, May, 1908). When the order department has done this with all of the "material cards," it has in its possession a means of advising anyone who wants to know just where any part is—*providing the part is followed from place to place in some way.* This can be done by using certain information and having in the Order department a file of drawers where these slips, Form 6, can be filed.

This information comes from different sources. In the order file, we have the "reserve orders" for which there is no material—we have the lists of finished parts, Form 5, which the stock clerk has delivered to the assembly department, and we have the requisition, Form 6, which comes from either the stock clerk or machining department as the case may be. A form of receipt is used to cover the materials passing *between* the departments of the machining department, Form 7, these being sent to the office when one of these departments receives material from another. The importance of this cannot be over-estimated as it places each department on its own feet, each one checking the work of the other as well as fixing responsibility. The machining department and the stock room require no receipt from the assembly department for the reason that the requisitions for material are "delivered" slips after materials have been delivered, and are virtually equivalent to receipts. This is our fourth source of information, the fifth and final one being a daily list of receipts from the stock clerk covering finished parts received from the machining department. This knowledge is valuable and on tap so that manipulation is the only thing necessary to be able to furnish information concerning the work under way.

Take, for instance, Form 6. Upon receipt of this slip from the stock room, the clerk, who knows that Jenkins is in charge of the drill department, marks in one corner—"Drill, 6/3/6," as shown, and files in the drawers above mentioned back of the guide marked 125, the arrangement being numerical. On the 8th, a receipt, Form 7, comes from the Lathe and Planer Department, the first item being the ten arm brackets, order 125.43. The clerk then removes the slip, Form 6, from its numerical place and marks "L. and P., 6/8/6," placing it back in its position again. On the 10th, a list of receipts comes to the order department which contain this item of ten arm brackets, and the clerk then marks on the slip as is shown in the illustration. It is again filed where it remains until the assembly department requisition for these ten parts is received from the stock clerk, dated the 12th. The slip is marked to correspond, and filed with the assembly-department slip, for future reference.

It is therefore evident that any reference to 125.43, ten arm brackets, will show the condition of the order at any time after the material was delivered. Applied to all orders, it follows that the drawers, the "reserve-order" file, and the lists sent to the office by the assembly department through the stock clerk, will show at all times the condition of any order; the value of this cannot be everestimated, and while a casual reading would seem to indicate that the method is too complex to be practical, consideration will show that this is not the case. It needs or should need no argument to convince a manufacturer that material should not be delivered anywhere without a record being made of the transaction, either in the form of a receipt or requisition, and that the stock clerk should make a list of all the materials he receives from the machining department, as the receiving clerk does for all materials received from outside. The information serves a purpose in itself, but why not go further with it? What would do more good than an arrangement whereby this information can be used to inform anyone regarding the condition of orders, especially when one considers that a few hours each day will do the work, and that in a plant of any size, where a number of machines are being built—the parts numbering into the thousands—if regular and stock orders are considered, it is out of the question to expect any one man or group of men to *know all about every part of every order at all times.* Provide some means of informing them regarding the progress of the orders and the location of the parts, and they are then in a position to take advantage of the information for they will know how to proceed to a desired end, as the following will show.

If the works manager wishes to "get after" an order, he gives his "list of material" to the order department, with instructions to advise him regarding the condition of the various parts. These parts are either on the assembly floor, in the lathe and planer, drilling, or milling departments, in the stock room as finished parts received from the machining department and awaiting requisitions from the assembly department, not as yet withdrawn from stock, while some of the material necessary to finish the order may not have been received by the stock department. The order department adopts the following symbols as indicating the condition of the parts:

W.—Orders waiting for material.
A.—In Assembly Department.
M.—In Milling Department.
D.—In Drilling Department.
L.—In Lathe and Planing Department.
F.—Finished parts in Stock Room ready for assembly.
N.—Parts not as yet withdrawn.

The clerk can turn to his file or orders waiting for materials and place a letter W in the √ column of the "list of material" for parts whose numbers correspond to the numbers of the parts on the list. He then takes the list from the assembly department, Form 5, prefixes the letter A for parts in the assembly department, after which he refers to the drawers where the slips, Form 6, are filed, and checks each one covered by the order number in question against the list of material. After he has done this he will have a number of parts against which there are no check marks which must be the parts that have not been withdrawn from stock up to time the list is checked, these parts being marked with a letter N. When the works manager again gets the list—and this process can be repeated as many times as desired—he knows the exact condition the order was in up to within a short time previous to the checking, and even if the list shows a piece as being in the drilling department that has gone on to the milling department no harm has been done, for he knows *where to start* his investigation, which is far better than to have no definite point from which to begin. If on the other hand the works manager or any of the foremen desire to know concerning any part, the file in the office will supply the information. As before stated, the necessary data are at hand as soon as material is delivered or transferred, and a little work will put the information in shape for use whenever needed. There is a difference between having information in every conceivable shape and having it properly classified and on tap for immediate reference.

Further information is at the disposal of the shop management in the shape of the daily time cards turned in by the workmen, all time being posted to the reverse side of the production order each day. Reference to the orders covering parts or to the orders covering assembling work will therefore show how much time has been consumed on an order up to the day previous to the reference. The clerk furnishing the works manager with information regarding the condition of an order, by turning to the file of live production orders, when checking through the various parts that are in the machining department, can mark opposite these parts:

T.—Time recorded.

N.—No time recorded.

This will show him not only where the parts are but whether they have been worked on or not, and through the information furnished him he can plan for maximum production under the best conditions, for once he knows the shape an order is in, personal effort will do the rest. He will want to make certain demands on certain departments after he knows what work is to be given preference over other work, using Form 8 for this purpose.

The scheme of numbering here shown will facilitate investigation. A large number of concerns have a series of numbers to cover the various orders for machines and another series of numbers covering the parts of a machine. For instance an order for a certain machine might be No. 3,140 while the first part might be No. 11,908, the second part No. 11,909, etc. It is evident that in looking up an order there is no such connection between the two series of numbers as in the case of the method advocated above. An order for a machine may have 250 as its number, while the first part would be 250.1, the second part 250.2, the third 250.3, etc. As soon as the order gets under way, the workmen know that the parts are for order 250 and the assemblers will soon fix 250 in their minds, so that when it is desired to follow

WORK WANTED AT ONCE

To the Foreman of the ______________ Department. The following orders are urgently needed. Give them preference over all other orders ______________ W.M.

Order	#	Piece	Drawing	Order	#	Piece	Drawing

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FORM 8. REQUISITION FOR URGENT WORK.

up an order, any person looking for the parts that go to make up 250 will have no great difficulty in finding them.

A workman should always have at his floor the material that he can commence upon as soon as he finishes the job on which he is working. For a man to finish a job, go to his foreman for another, and then wait for the material, certainly does not assist in making dividends for the manufacturer. In a large number of plants the work is such as will admit of a "job ahead" plan, which is in successful operation in a number of enterprises. The system can be used

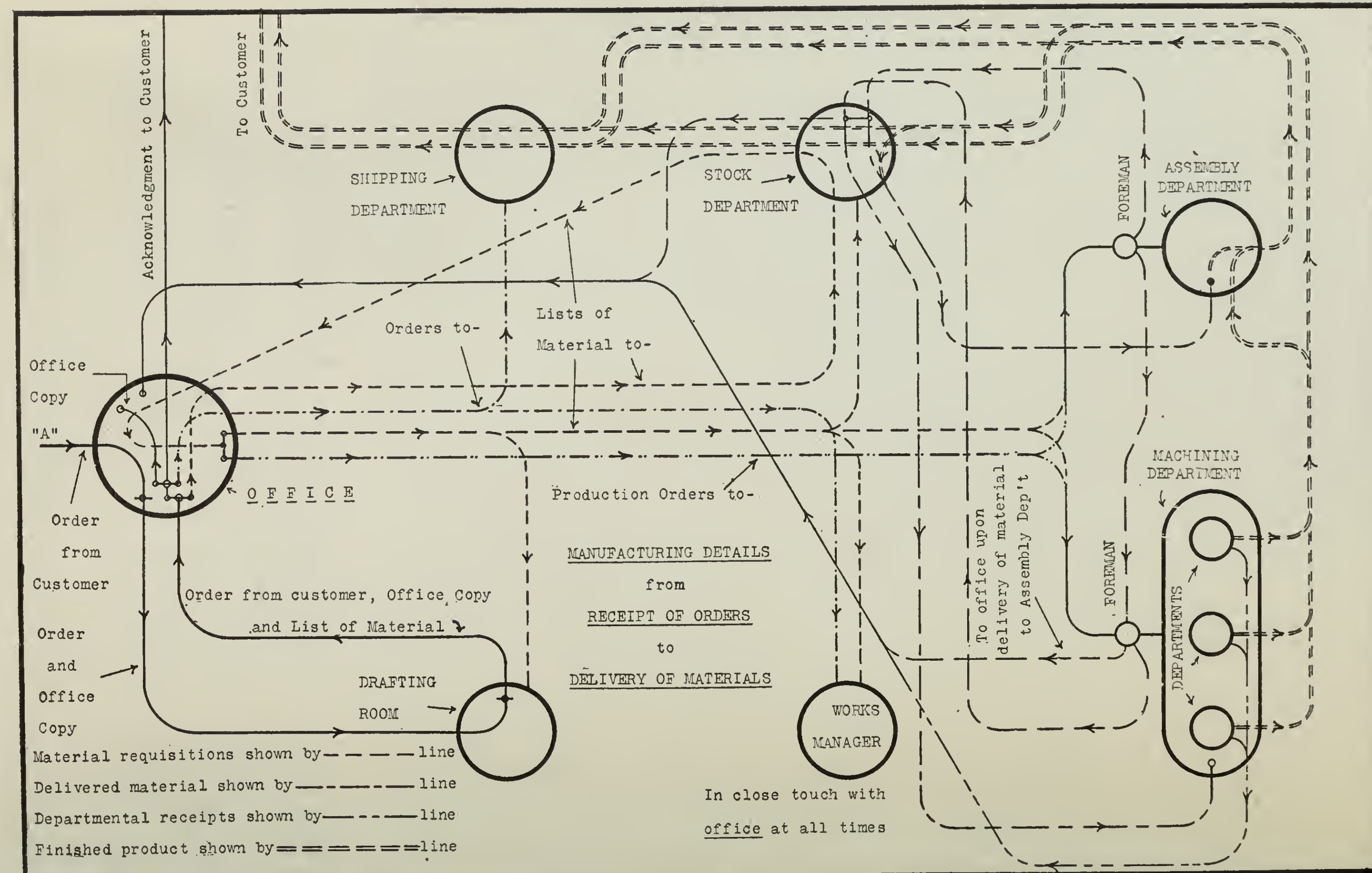


DIAGRAM SHOWING THE COURSE OF ORDERS, MATERIALS, AND WORK UNDER THE SYSTEM DESCRIBED.
To read the Diagram, start at A.

in conjunction with a time clock, by the introduction of an additional card rack which is to hold the "job ahead" tickets. When a foreman gets the production order, he knows the operations necessary to complete the work as well as the men who will do the work, so that it is an easy matter to make out the time cards for the necessary operations and place them in the proper pockets in the "job ahead" rack, at the same time sending the material requisitions covering the work to the stock room. When a man finishes the work he has in his machine, he takes his card from the "jobs in operation" rack, stamps it properly and then takes the top card from his pocket in the "job ahead" rack, stamps it, sees what work it calls for, places it in the "jobs in operation" rack; goes to his machine, finds the material ready for him, and goes to work without losing much time unless he *creeps* to the clock and back, as is often done.

To prevent this creeping, and in order to see to it that a workman accomplishes what is expected of him, some method for comparing operation time and cost should be introduced, which would enable the cost department to call to the notice of the foremen any costs that are higher than they should be. The total time and cost of each operation on each part, with the number of the workman, should be posted in such a way as to facilitate comparison with all previous work of the same kind. When a high cost is recorded it will be noticed at once and a form such as that shown on page 81 of THE ENGINEERING MAGAZINE for April, 1907, can be used as the notice to the foremen, who will naturally speak of the workmen responsible in order to give some reason for the increase in the time, the result of which will be that the workmen will soon realize that they cannot do something that their foremen will not know of, and loafing will decrease.

The assembling of certain parts into groups, to be carried in stock for final assembly, should be given careful consideration by progressive manufacturers. In the second article it was shown that even special machines may have some standard parts, and a study of the product would show where grouping could be done to such advantage as would greatly facilitate final assembly. If we have thirty separate parts to assemble, time required to assemble being fifty hours, and by grouping certain parts it is found that only ten pieces are necessary to assemble, five pieces being groups composed of two or more parts each, as the case may be, the final assembly time will be considerable lessened; any saving in assembly time is always an object, especially when delivery is the important consideration as it often is. The work of grouping can be done in odd moments or when there is a slackening in orders, and the results of this would certainly justify the efforts.

PERSONALISM IN RAILROADING.

By H. W. Jacobs.

THE INDIVIDUAL ELEMENT IN RAILWAY ORGANIZATION.

A leading authority on industrial administration said recently that there are two great schools apparent in American works organization—the monarchical, typified by the Taylor system, in which the management does all the thinking, and orders every act of every individual producer by code; and the democratic, represented by the Carpenter system, in which individual initiative is encouraged and co-ordinated.

As a study in the science of management, Mr. Jacobs' paper is a striking contribution to the propaganda of co-operation, advanced also elsewhere in this issue by Mr. Knoeppel. On the mechanical side it suggests an interesting contrast between American locomotive practice and the Continental ideas depicted in preceding pages by Mr. King.—The Editors.

AMERICA offers unprecedented opportunities for individual development—for the individual to develop the natural resources of a productive land, for the individual to reap an enormous percentage of profit by the intelligent combination and direction of collective labor.

The fundamental cause for this opportunity has lain in the American idea of government, which stands for giving each man the largest individual freedom possible. The man has not been held in check by an array of governmental restrictions, of landed and vested interests, rights and privileges, of barriers by which avenues are closed to the rise of even exceptional individuals into the "upper" and controlling strata. The "exceptional" man in America has been able to rise to positions of great power both in the political and in the industrial or commercial world. Such men are exceptional chiefly in the fact that they *use to advantage* the resources embodied in their own selves, and much less because of any special aptitude or genius—for America is relatively poor in the artists and masters of art and craft who are distinguished by such singular attributes in their special fields.

The ordinary individual possesses within himself capabilities which may be turned to great profit, if properly used; but he lacks the spring for liberating these capabilities and making them of use.

It is worth remembering in this connection that the material wealth extracted from the earth's natural resources is as old as the hills themselves, and is given value only by the form produced upon it by men's efforts and minds.

> "But the mines of wealth to be found in every brain will, if worked, supply treasures such as have never been dreamed of. The iron and steel that make the locomotive came out of the ground, where the iron has always lain. But the idea of the locomotive itself, like all ideas that have brought humanity up through the stone age to our very imperfect civilization, came out of a man's mind.
>
> "If the men who have done the thinking for the race—and pitifully few of them there are—had been content to draw a bare living from their brains, the rest of us would now be getting our breakfast with clubs and sleeping in caves, or in the tree tops."

The very growth of the institutions which the extraordinary man has founded, however, now demands that the latent or partly inert abilities of the army of ordinary individuals shall be used to the utmost. So far as practicable, his own super-ordinary genius must be embodied in principles and systems which will endure, and may expand, while his individual mind extends its work elsewhere—or even after it has ceased to live and work at all. This is the meaning of industrial organization at its best—not the substitution of method and motive for human genius, but the expression of genius in the form of principles which ordinary men may follow, and following bring out more of their own capacity perhaps than they previously knew how to make effective.

Any movement which thus tends to impersonalize (so to speak) the individual, inevitably causes individual disapproval. Leadership is less strongly commanding, as staff or bureau organization becomes more prominent and even the rank and file rise to a certain sense of participation in result. All along the scale of authority more or less jealousy will be manifest—apprehension that individual prestige and profit may be lessened, and the autocracy of the individual hand and brain may be endangered, if others are admitted into deliberative counsel—still more, if others are admitted into co-operation in the development of any proposition.

So it is that a narrow and selfish egotism, prey to prejudice, prevents many a person from arriving at correct conclusions. Thus people are envious of the success of others, especially if that success is attained through the practical application of ideas which they themselves have entertained in a vague but unconstructive way. These people may not have the initiative, the imagination, or the practical ability and judgment to execute their ideas; but such ideas occurring to other men having the qualities of conception and execution, endow the latter with the large rewards. The lesser return is always the portion of the man who cannot make use of his ideas.

Two practical examples of this state of affairs come to mind, one taken from the history of the locomotive, and the other from a general modern business condition. Walschaert invented a valve gear of undoubted excellence when applied to locomotives. Although designed and constructed many years ago, it has remained almost unknown and unproductive until men of push and business ability, realizing the advantages of the gear, took hold of it and made it a part of modern locomotive practice. As a result the gear was given an impetus that is rapidly forcing it ahead as the principal gear for locomotive use. However, if Walschaert should return to earth today and see his gear in operation on the many large locomotives running up and down the railways of the United States, he would probably feel that he had a just grievance because he was not reaping the benefit from this development of his original idea by other progressive men, and in fact he might criticize the present designs.

The general example of this tendency is found in modern advertisement. Articles such as cigars or oatmeal in packages are sold on the open market, where there is no exclusive claim to a particular idea. These articles are widely advertised and the public practically hypnotized on a large scale into making them standards of use and believing in the merits claimed. For the privilege of using these, the public pays a sum that covers the cost of advertisement many times over. The reason for the success of these advertised articles over ordinary articles is that energy and push is used in disposing of them, and not at all that the idea of selling cigars in boxes, or of putting oatmeal up in paper packages with gay colored labels, is a new one.

Some have the quality of idealization or imagination *(einbildung)*, without the creative or practically constructive force; their ideas are still-born and fail to survive from want of ever receiving living expression; others have qualities of patience and slow persistence, bringing into real being ideas or purposes which are set before them; but few combine these qualities in successful degree, and the few that do are the leaders and masters. Most men in charge of modern enterprises, however, are not true leaders or commanders; as in our political scheme, so also in our industrial organization, the men are executives—they approve or veto, they select, they give form to and execute the ideas of the staff, of others. And so it must be; the manager must hold the welfare of the business entrusted to his supervision—as it may be advanced by any policy, whatever its source—above a personal egoistic valuation of his own originality; and the lesser man of the staff, who is employed for his good ideas, but who perhaps has not the other qualities essential to an executive (since he has not earned the managerial position), should welcome and be glad in the opportunity afforded of having his ideas elaborated into concrete, living, useful daily realities, rather than stand one side and think "I, I contrived this thing, but others, because they have money to employ me, get the credit and the benefit."

The value of ideas lies in the ability to use them constructively and to execute them. Day-dreams are generally of less value than the time spent in building them.

In industrial enterprises—manufactories, shops, transportation companies—the sympathy and co-operation of the foremen and others most immediately directing the actually productive labor, is most essential for the successful introduction and application of progressive and useful ideas and methods.

I have known foremen and engineers, who, when it was first sought to introduce improved methods and devices or advanced types of locomotives, *thought* it was their duty to try to defeat the object of these devices and new designs by failing to run the jig or to operate the tool and engine to their best advantage. This is destructive criticism of the worst type, because it cheats those who employed these men, as well as because it is dishonorable to those engaged in putting these tools and ideas into effect.

In the motive-power operation of a railroad, a road foreman of engines, more than any other man, should be the evangelist among engineers and expound the new methods of progress, and like other reformers, should be able to paint with a broom the object to be attained.

An engineer on the road should be as supreme on his engine as a captain on his ship; undoubtedly it is true that many "engine failures" are due to the fact that in some cases enginemen are directly opposed to the shopmen and their work, even being encouraged in such an attitude by some of the officials, such as road foremen of engines, to report engines for unnecessary work, in order to burden the shop men needlessly, or to show a disposition not to assist in keeping an engine going when some defect develops, so as to throw the blame for this condition upon the shop men.

It is a road foreman's duty to criticize and to have corrected any improper work done in the shop. No one who is not supersensitive objects to criticism that brings out weak spots in any method or plan, as criticism of this kind is far more helpful than undue praise which makes a man feel that he could not make a mistake if he tried. There is also a kind of criticism which helps neither the giver nor the recipient; the kind that is destructive, and not constructive in the least. True, it may set the originator thinking that perhaps a certain point may be improved, but there is no hint of the critic's ideas on the subject, nor indeed whether he has any. It is one thing to look over an innovation, such as a method, or tool, or practice, and to give out the uncalled for statement that it is "not as it should be," or that "one would not have done it in that way"; and it is a very different thing to be presented with a problem and to be asked to devise a method of putting it into effect and practical operation. In many cases, the critic has offered no suggestions in the beginning and only condemned the work that has been put into practice to show that he knows that it might have been made or done differently. The conception and putting into effect of tools, methods, or practices requires a certain amount of imagination, which is a quality that is lacking in a critic of the destructive type. He can see a method after it has been thought out and put it into effect, and he gets the idea that a difference here or there might be better; but when it comes to creative criticism, making a suggestion of value, the destructive critic is all at sea. The constructive critic, on the other hand has suggestions for improvement that are real, points out ways and means of making desired changes, and is a real helper rather than an irritating fault-finder.

Then there are those who oppose new policies, but who do not openly object to them. These men in referring to some advocate of an improved method will admit the man's brilliance, or ingenuity, or peculiar ability, and will follow up this apparently friendly attitude with an apology (indulgent perhaps and a little patronizing) for some supposed weakness of character, bad habit, incapacity, religious belief, of the person under discussion, couching the expression in such terms and selecting the particular defect that is to be enlarged upon in such a way as most to appeal to the prejudices of the hearer.

Equally restrictive to the introduction of any new device or system on a railway is the extreme element of conservatism that has such a stronghold in the minds of the average railway official, from the heads of departments down to the foremen, and even to the men in the shops; a conservatism fostered by years of unbroken habitude, and firmly established by following devoutly the recurrent routine of daily duties. From this conservatism itself, coupled with a fear of disapprobation should a mistake be made in the adoption of some method or device differing from the old and established *régime,* springs a destructive criticism which, though it may be given with the object of self-protection, often results in an irreparable loss, both to the object of criticism and to the criticiser.

Most railroads are continuing to use almost exclusively the simple engine of half a century ago, modified only in its size and power, but employing the same essential design; and American railroads have been behind other engineering progress in questions relating to the mechanism of their locomotives. The marine engine had its real development during almost the identical period in which the steam locomotive has so potently changed the face of the land and the destinies of its denizens. "Fulton's Folly" was a simple slide-valve engine operating upon a transverse shaft—and the locomotive of today is little more. But the marine engine soon turned to the screw propeller, soon adopted the economical compound cylinder type (largely stimulated by experiments in the United States navy), further extended this principle to the use of triple and quadruple expansions, of twin, and quadruple screws, and has lately adopted the still more efficient and facile steam turbine. And the art of marine motive power will not stop here. Already plans are seriously discussed looking to the application of some form of gas or oil internal-combustion motor on shipboard; indeed these motors already propel the swifter, cheaper, and more convenient power boats of smaller size.

What parallel to this can the railroads show? True, in fifty years our locomotives have increased from thirty tons to two-hundred and ninety tons, total weight, but in the same period steamships have increased from eight-hundred to forty thousand tons displacement, and marine engines from three hundred to seventy-thousand horse power. But where the compound engine was early adopted on shipboard from reasons of economy of operation and space occupied per power unit developed, those reasons, still more important in the narrow confines of rail traffic, have not until recently been effective in railroad circles in America in making a success of the compound locomotive.

There is nothing the matter with the compound locomotive; the only trouble with the use of these engines in the United States is that they require a greater attention, a greater detailed supervision of their finer mechanism, than is the case with simple engines which are cheaper to build, perhaps cheaper to maintain (though not on a performance-unit basis) and certainly less efficient in the use of power and in the haulage of loads.

As proposed by one engineer, we should have today, instead of simple engines and boilers whose greatest efficiency is demonstrated to be at about 180-pounds pressure, boilers of the automobile or sectional type operating at from 400 to 1,000-pounds pressure, superheated, and turbo-generators transmitting power to all wheels of the locomotive unit through electric motors; possible even we should have gas engines, driving through a similar electric arrangement or through a mechanical transmission.

Taking their cue from the remarkably successful street-railway installations, some steam railroads are making a fair show of adopting electricity direct as the tractive force, but it is very evident that this will prove economical, as compared even with crude steam-locomotive traction, only where the very densest traffic produces such continuous use of facilities and resultant revenue as to return a sufficiently large figure on the very costly improvement. Probably an internal-combustion motor using producer gas or fuel oil would, if worked out, prove more efficient.

Since the advent of the common spike years ago no important steps have been taken to replace a device admittedly wanting in qualities most to be desired in a spike—holding power and preservation of the tie; yet the common nail spike has such a firm place in the minds of the conservatives that it is only recently that the screw spike has received any attention, though admittedly the screw spike is far superior to its competitor in every respect, as its extensive use in Europe, where lumber is dear and labor cheap, had demonstrated conclusively.

There are many other examples easily called to mind which only serve to bring out more strongly this element of conservatism. The old adage of "Let well enough alone" has long been a slogan on the American railway, but is fast losing its convincing power. One can almost distinguish with clearness a dividing line springing up among the employees of American railroads—the old and new blood, the man whose convictions are not to be modified and the man who is "willing to be shown."

An analyst of railroad conditions while speaking of the application of intelligence and methodical system to the problems met in the course of ordinary and extraordinary experience, and the influence they may have in improving the workaday opportunities, has aptly said:

"A better and more expensive engineer was needed to stop the flow into the Salton Sea when the break had been made than is needed to keep the Colorado River where it belongs now that the break is closed. Sensational work, such as damming the Colorado River, putting a ship off the rocks, or keeping engines going after they are in such shape that every one is looking on, is more exciting and pleasing than plodding along the systematic, detail daily work. Systematic detail work keeps everything going properly, but cuts out the chance of having the lime light thrown upon the performer.

"This element of pride and self-glory makes the ordinary man of authority plant his feet and balk when system is proposed. He wants to do everything himself and get all the glory. If record and system are applied he feels that a set of clerks will do his work. He knows that if system is applied rigidly enough the proper course will be as plain as the channel into a harbor marked with lighthouses and buoys. Columbus is more of a hero than the sea captain of today who courses the ocean with charts, lighthouses, and buoys which mark the channels through which the man in authority should sail his affairs. This man, however, realizes that his personal glory dwindles when he sails in charted seas. Hence he says: 'No system for me.'"

Of course it is apparent that the thing for such a man to do is to seize the opportunity and make charts where there are none, so that not only will he more certainly and swiftly arrive at his objective port, and avoid treacherous shoals and reefs by the way, but also achieve the distinction of providing charts where there was only wind and water before, and of piloting the way for the more timid who follow.

PIPE-LINE REFRIGERATION.

By Jos. H. Hart.

PIPE-LINE refrigeration on a large scale was confidently predicted as a development of the near future, by the majority of the engineering profession, soon after the advent of mechanical refrigeration as a commercial process and the recognition of its status as a commercial convenience. Time has passed, however, and to the great majority of engineers pipe-line refrigeration still looms very remote in engineering progress, at least as a general and universal service. It is the object of this paper to consider more especially what progress has been made, to enumerate the difficulties encountered and the possibilities of their removal, and to give a brief *résumé* of the entire situation.

Pipe-line systems producing efficient refrigeration are in actual operation today in a fairly great number of the larger cities, and in some cases have been in use for over a score of years with very satisfactory results. In order to understand the limitations in this practice and the reasons for lack of further progress, a complete understanding of refrigerating engineering would be necessary; but a few of the main features and difficulties will be at once perceptible in the majority of cases, and will lead rather to surprise that the development has extended as far as it has. Pipe-line refrigeration exists in the following American cities:—Boston, New York, St. Louis, Atlantic City, Baltimore, Norfolk, Los Angeles, Denver and Kansas City. The length of mains installed varies from one mile to seventeen miles, and the commercial status of the systems varies from a very lucrative one in several of the plants to the direct opposite in Denver where the operation has been discontinued. The refrigeration in every case is used to cool cold-storage plants, chambers in hotels and apartment houses, restaurants, and the shops of a few small dealers whose consumption is yet several times larger than that of the average dwelling It has been found very inefficient to attempt to produce refrigeration in smaller units than about 500 pounds per day—that is, refrigeration equivalent to the melting of 500 pounds of ice per 24 hours.

The refrigerating plants in such installations have invariably been of the ammonia type, and in the selection of the latter the absorption system has been invariably used on account of mechanical considerations purely. Only two methods have been employed for distribution—brine-circulation and direct-expansion. The brine-circulation is much the older of the two methods, but is generally considered the more inefficient, and the direct-expansion has been installed in all the recent systems.

Pipe-line refrigeration is a very attractive proposition to the average cold-storage or ice manufacturer, since he invariably increases his refrigeration output and consumption, with diminution in fixed charges due to the utilization of the refrigeration outside of his own building; but even so, the progress has not been rapid. Brine circulation requires the laying of two mains, an outgoing and ingoing pipe for the cold and warm brine respectively. Direct expansion, on the other hand, requires the installation of three pipes, one of these (the liquid-ammonia pipe), being invariably a heavy-pressure pipe constructed to withstand severe usage In the brine system the brine is cooled by the evaporating ammonia in a system of coils or shell cooler, and is then piped through the circuits. This process is simply an hydraulic one and no serious difficulties from a theoretical viewpoint are encountered. However, the loss in refrigeration due to radiation and the difficulty of regulating the flow of brine through units of various sizes arranged in parallel, is considerable and ultimately limits the expansion of the system.

The direct-expansion system, on the other hand, sends the liquid ammonia through the piping, under pressure, to the expansion valve situated at the point requiring refrigeration. Here the evaporation occurs and the refrigeration is produced, and the vapor is there drawn back through the return vapor pipe into the cylinder, where it is, in turn, compressed. Owing to the presence of air in the circuit to a greater or less extent, it is necessary to have a third pipe connected with each unit immediately beyond the expansion valve in order to remove the air. This pipe in turn serves the further purpose of supplying in sections an alternate channel for the return or outgo of ammonia in case any part of the circuit or any refrigerative unit requires special attention on account of breakdown or leakage. The great stresses to which both of these systems are subjected on account of temperature variations, requires that they shall be laid with great care, in hollow conduits with expansion joints and on account of the heavy pressure in the supply pipe, connections are made only at stated intervals through man holes, generally at the intersection of cross streets. The direct-expansion system, while eliminating to a certain extent the loss of radiation in transit of the cooling material, involves a number of mechanical difficulties extremely hard to overcome. The liquid ammonia must always be kept under sufficient pressure to remain liquid. On this account it cannot be raised any great distance in high buildings, on account of hydraulic pressure acting against the machine, and considerable grades cannot be negotiated. In addition there is a distinct friction loss in the pipes, and this has been sufficient in some cases to allow of gasefication of the ammonia in the supply pipe. On the other hand, in the vapor pipe the friction loss is very great; and a sufficient head can be maintained at the terminal to withdraw the vapor from the cooling coils with sufficient rapidity to produce satisfactory refrigeration there, only by lowering the suction pressure to an extent which renders the operation of a compression system absolutely impracticable.

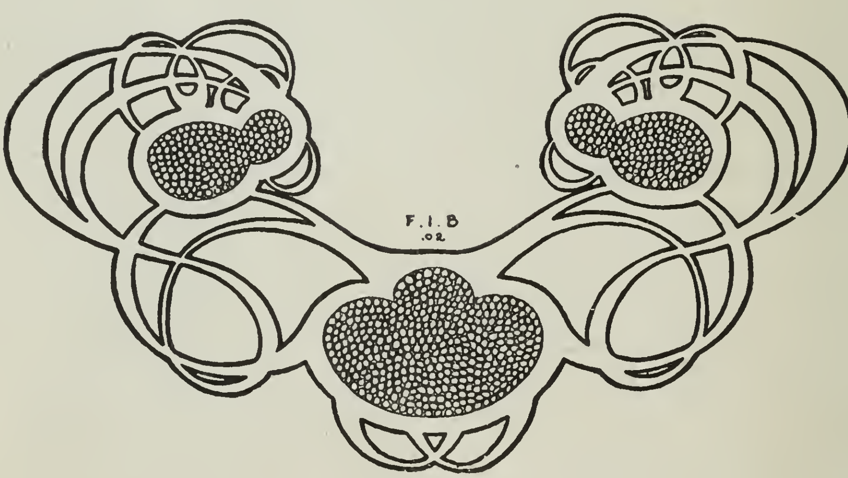
The absorption system, utilizing the absorptive power of water for ammonia gas and the loss of this power with rise in temperature to produce the liquid ammonia and remove the vapor, operates efficiently at a much lower suction pressure than is possible with the compression type. Hence the absorption system only has been installed in such developments. Under these circumstances it can be readily seen that the difficulties met with in the direct-expansion systems are very great. The direct-expansion system has superseded to a very great extent the brine circulation as in practice it has proved more efficient. Certain problems have been met and solved, however, in the installation of these systems which will permit of their more rapid development in the future. Thus a pipe-line system, in order to be a commercial success and operate efficiently, can never handle freezing business. It is limited exclusively to the production of mild refrigeration, owing to the weak back-pressure available with low temperatures and the unequal distribution of the ammonia evaporation when it must be maintained at different pressures in the several refrigeration boxes. Again, it has been found that pipe lines must be above suspicion as far as leakage between manholes is concerned, since the loss of ammonia and its re-supply will make a big difference between profit and loss in the operation of the plant.

In the brine system moisture is an ever-present difficulty, and in the Atlantic City plant the presence of moisture in the form of salt water and electrolysis due to stray currents all present difficulties in the maintenance. The joints between manholes are made fairly tight today in the direct-expansion system by the use of thermit for direct welding; but the cost of installation is still great. The cost of construction of the city mains will be about $4 per lineal foot with the vapor line 4 inches, and laterals will cost 75 per cent. of this. Hollow tile with concrete base must be used and allowance made for expansion and contraction without undue strains. Outside of a congested district in the city of Boston, and one or two isolated lines where the length of mains is abnormal, the average gross income is about $12,000 a mile. Boston and New York have both the brine-circulation and direct-expansion systems installed in two separate operating units. One of the Boston plants cools approximately 600 refrigerating boxes with a total space of 1,500,000 feet. This is one of the largest systems and one of the most complicated.

This constitutes the situation in regard to pipe-line refrigeration in the United States as it exists today. Undoubtedly progress will be comparatively slow and the dream of the average refrigerating engineer, that central-station plants will supply refrigeration to all the inhabitants of the city at reasonable rates, will not be solved in the near future (if ever) by the expansion of either of these systems. Engineers are beginning to realize this latter fact, and one or two possible changes or new developments are promised for the near future. Cold-air refrigeration by utilizing balanced expansion and obtaining cold air by the performance of work is not an efficient refrigerating process. It is used, however, to a very great extent in England, even in large units, and has been reasonably satisfactory. It is also used on shipboard and is in use in some special refrigeration systems in transportation for the conveyance of perishable products. Thus the method while not as efficient in individual units as a corresponding ammonia system, still is not so inadequate that it cannot compete under special local conditions. A compressed-air plant produces refrigeration when the air is used to do work, and in many cases the exhaust from an air-driven engine will clog up with ice formed from the moisture present in the atmosphere. The compressed-air plant of Norwich, Conn., which supplies compressed air produced by hydraulic air compressor to the entire town through a system of mains, has recently developed a machine for the production of liquid air from the exhaust of the average air-driven engine. Such a refrigerating system for pipe-line service would consist simply of a single line of pipe supplying compressed air at normal temperature. A small machine utilizing this air for work in the production of electric light for the dwelling or building could then turn its exhaust into a refrigerating chamber, and after that could allow it to escape into the atmosphere. Thus, such a system constructed on the above lines would be simplicity itself as far as the details of pipe-line construction and operation were concerned. The air pressure need not be great for mild refrigeration, and its advent is probably dependent only upon the development of a more efficient and satisfactory air compressor than the modern reciprocating type. The rotary air compressor will probably find a new field waiting as soon as it becomes an efficient practical machine.

Again, absorption-machine manufacturers and designers are considering the separation of the absorption machine into two separate units, the liquid-ammonia producer existing in the central power plant, the absorber and the cooling coil being placed at the point where the refrigeration is required. Under these circumstances liquid only would go through the pipes—liquid ammonia, weak and strong liquor respectively—and the difficulties met with in diminution in pressure of the vapor through friction loss and variable supply from different points would not be as severe.

Sufficient has been said to show the main inherent difficulties of the present installation of pipe-line refrigeration, and to show further that probably some new movement is necessary for any great extension of this engineering process. That such developments will undoubtedly come along lines herein mentioned is also a foregone conclusion, but the rapidity with which these will occur will depend largely upon the external influencing conditions.



STEEL-RAIL BREAKAGES. QUESTIONS OF DESIGN AND SPECIFICATIONS.

By Harold V. Coes.

In the following pages Mr. Coes treats of a subject which is attracting international attention—the frequency of rail breakages on the railroads of the United States and the increasing number of disastrous derailments due to this cause. While his point of view is primarily that of the consumer, his summary of, and comments on, the questions at issue between manufacturers and consumers are entirely non-partisan in spirit. The discussion will be continued in a subsequent issue by Dr. G. B. Waterhouse who will present the view of the situation taken by the manufacturers.—The Editors.

THERE has been a great deal of discussion of late as to the causes of the increasing number of rail breakages, particularly apparent since the advent of the heavier-section rails. It is the aim of this paper to compare impartially the arguments pro and con and the facts as presented by both manufacturer and consumer.

Neither party can controvert the facts as presented by the Report of the New York State Railroad Commissioners. The Commission's figures show that during the three winter months January, February, and March 1905, there occurred 1,331 breakages, 826 for the same period in 1906 and 3,014 for the same period in 1907. When reduced to breakage per mile of main track (including all trackage except sidings, yards, and turnouts) the figures show that there was on an average, one breakage for every 7 miles of the 9,474 miles of main line in 1905, but that in 1907 the figures had more than doubled, showing one breakage for each 3 miles.

Chart I gives the graphic relations of age to frequency of fracture. This curve shows that by far the largest majority of rail breakages develop during the first year of service. In fact, for nearly 500 breakages per year of rails one-year old there are but about 50 breakages of rails ten-years old. The curve has an upward tendency after the fifteenth-year point is reached, which checks very well with the known facts as to the average life of steel rails.

Chart II shows the relations between the weights of rail in pounds per yard and the total number of breakages. It is seen at a glance that the heaviest sections commonly used produced the largest number of breaks. Thus the 80-pound rail shows 719 breakages in 1905, the 90-pound 324 in 1906, and the 100-pound 1,295 in 1907.

Chart III is plotted with the above data, omitting all sections from Chart II excepting the 80, 90 and 100-pound section.

Chart IV gives the relations between the dates of manufacture and the total breakages for the periods of January, February, and March, 1905, 1906, and 1907.

Drawing 1 shows the general types of breakages that are liable to occur. This does not mean that these are the only kinds of breakages that ever occur, but that as a rule they may be classified according to one of these types.

Bearing these facts in mind we may now compare the arguments presented by the manufacturer and the consumer and see what force there is in them.

Bessemer Rails.

RAIL CONSUMER.

The acid Bessemer process leaves in the steel practically the whole of the phosphorus which the ore contains, and it cannot be so altered under conditions of American manufacture at present as to remove the phosphorus.

Dr. Dudley of the N. Y. C. & H. R. R. and Mr. J. W. Kendricks of the Santa Fe R. R. state that more time should be given to the process of manufacture.

The consumers or the railroads say that the Bessemer process is essentially a hit-or-miss process and that the phosphorus content and other injurious elements cannot be regulated with nearly the same degree of certainty as in the open-hearth process.

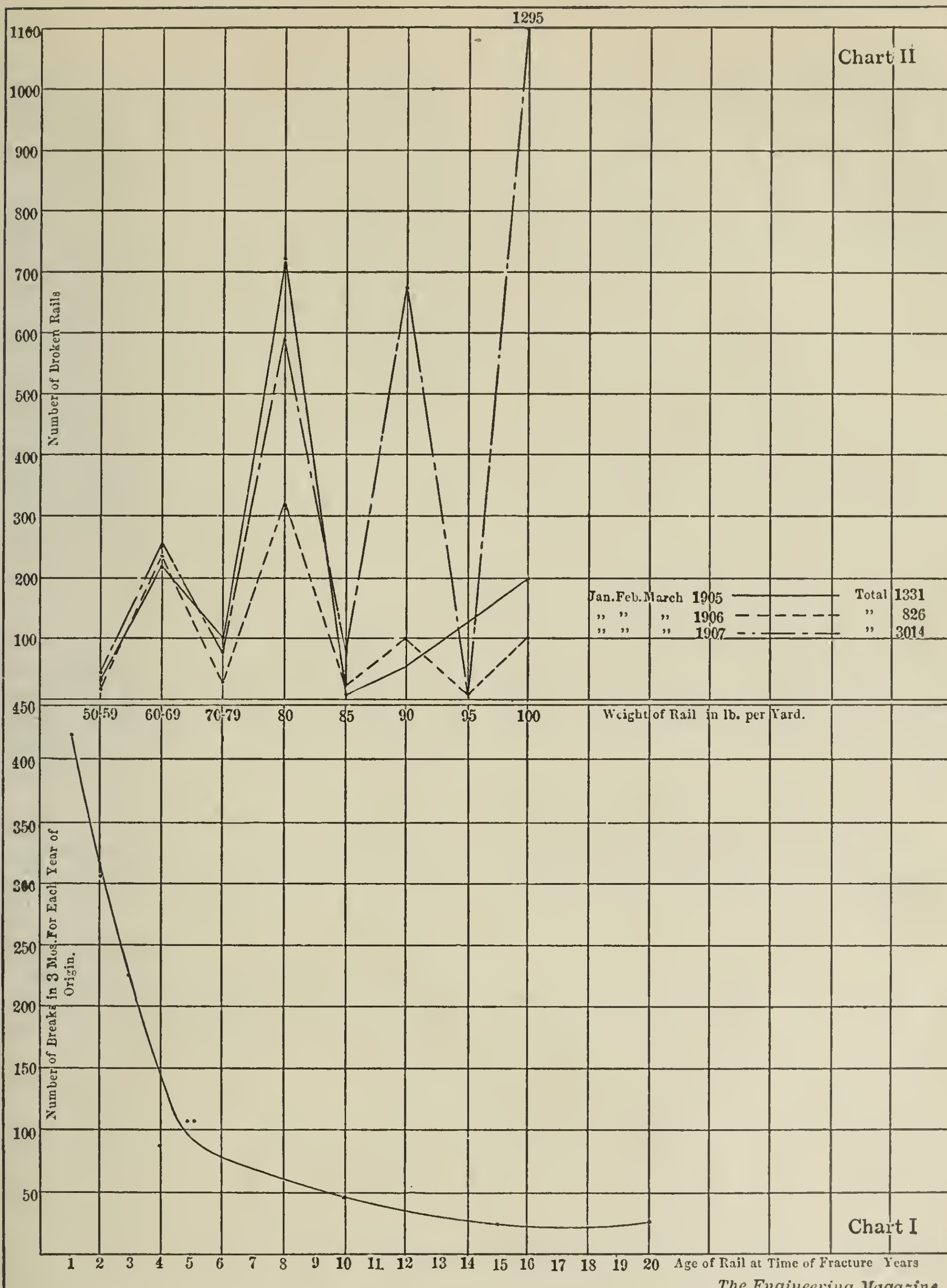
RAIL MANUFACTURER.

Mr. W. R. Webster, chairman of the Committee on "A Standard Specification for Iron and Steel," for the Society for Testing Materials, says: "It must be admitted that the best rails are produced from steel low in phosphorus, rolled with light reductions and finished at proper low temperatures."

Mr. P. E. Carhart, of the Illinois Steel Co., states that "the rail mills are using the same engines and the same speed that they did seventeen years ago, and that the time was saved in other ways, such as changing rolls, rather than in the passes."

The rail manufacturer states that he is producing the best possible rails under the present conditions and at the present demand, and that to change over to the open-hearth process would involve the expenditure of millions of dollars, and that in the meantime he could not keep up with the demand.

Prof. H. M. Howe states that the acid Bessemer process can be improved: (1), by the liberal use of aluminum or its equivalent which will lessen segregation materially, but will lengthen the pipe, or where no pipe exists will increase the tendency to pipe. This tendency in turn will have to be met by cropping off and discarding a larger part of the top of the ingot; (2), by slow casting, which should shorten the pipe and raise the segregate toward the top of the ingot, in both ways less-



CHARTS I AND II.

ening the proportion of discard needed in order to get trustworthy steel; (3) by increasing the discard which should cut out the segregate and pipes. The richest of the segregate lies near the top of the ingot, usually in the upper 20 per cent, often in the upper 10 per cent of its length.

Section.

Rail Consumer.

Mr. C. S. Churchill of the Norfolk and Western R. R., states that an improvement in section is necessary, but does not believe it is necessary to enlarge the heads of rails. That recent experiments with rails have not proved that the present sizes of rails have not sufficient strength if properly made.

Rail Manufacturer.

Prof. Howe says: "Another and expensive way of getting around the trouble would be to change the section in the direction of making the web and flange more nearly of the same thickness as the head."

Mr. Webster states: "In a recent discussion it was claimed that the old committee of the American Society of Civil Engineers kept in mind the importance of low finishing temperature in designing their rails and gave sections best suited for that purpose. As a matter of fact, the heat treatment of steel was not properly understood at the time that committee made its report in 1892, and the sections do not permit of low finishing temperatures in rolling, owing to the width of the flange."

Axle Loads.

Rail Consumer.

Dr. P. H. Dudley says:

"The axle loads have doubled in the past fifteen years, and the requirements for sound and safe rails exceed what some producers consider ample."

Mr. H. B. Wille, of Baldwin Locomotive Works, states that the strength of rails has increased in greater proportion than the loads put upon them.

Rail Manufacturer.

Mr. W. R. Webster:

"In all justice it must be admitted that a fair percentage of breakages is caused by the great increase of wheel loads since 1892, the increase in speed of trains and use of large capacity cars."

Mr. Carhart believes that a large proportion of the rail breakages are due to the impact of the blow from badly counterbalanced engines.

Mr. Thackray, of the Cambria Steel Co., contends that the axle loads have increased much more rapidly than the strength of the rail section.

Specifications.

American Society for Testing Materials.

(a) Discard:—There shall be sheared from the end of the blooms formed from the top of the ingot not less than * per cent, and if from any cause the steel does not then appear to be solid, the shearing shall continue until it does.

(b) No bled ingots shall be used.

Chemical Properties.

Size of rail	50-59 lb.	60-69 lb.	70-79 lb.	80-89 lb.	90-100 lb.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Carbon	0.35-0.45	0.38-0.40	0.40-0.50	0.43-0.53	0.45-0.55
Phosphorus	0.10	0.10	0.10	0.10	0.10
Silicon	0.20	0.20	0.20	0.20	0.20
Manganese	0.70-1.00	0.70-1.00	0.75-1.05	0.8 -1.10	0.8 -1.10

* Percentage not yet settled upon by the Society.

Drop Test.

Weight of Rail. Lb. per Yard.	Height of Drop in Feet.
More than 45 to and including 55	15
More than 55 to and including 65	16
More than 65 to and including 75	17
More than 75 to and including 85	18
More than 85 to and including 100	19

The following is the result of nine tests of rails made by the Talbot continuous open-hearth process.

Carbon	0.477 per cent.
Silicon	0.372 per cent.
Sulphur	0.049 per cent.
Phosphorus	.0426 per cent.
Manganese	0.818 per cent.
Tensile strength	91,740 lb. per sq. in.
Elongation in 3 in.	13.9 per cent.
Reduction of area	14.4 per cent.
Deflection on drop test of 1 ton, 30 feet on 3 ft. 6 in. span.	3⅝ in.

Specifications for the Union and Southern Pacific Railways.

	75 lb. Per cent.	50 lb. Per cent.
Carbon	0.51-0.61	0.58-0.72
Phosphorus	0.06 max.	0.06 max.
Silicon	0.20 max.	0.20 max.
Manganese	0.75-100 max.	0.80-1.03 max.
Sulphur	0.06 max.	0.06 max.

British Standard Chemical Specifications for Steel Rails.

Carbon	0.35-0.50 per cent.
Phosphorus	0.075 per cent. maximum
Silicon	0.10 per cent. maximum
Manganese	0.70-1.00 per cent.
Sulphur	0.08 per cent. maximum

The Pennsylvania Railroad have recently issued an order for 55,000 tons of rails under their new specifications, which allows the manufacturer considerable latitude as regards the percentage of crop end to be removed or discarded. These specifications drawn up for a new section state that the rail is to be free from all injurious mechanical defects. A history of the rail is to be kept during manufacture and in service. In order to test the rails to see if they come up to specification, the company has arranged for an elaborate series of tests. Bids are to be accepted on both open-hearth and Bessemer rails.

In 1905 nearly 12,500,000 tons of Bessemer and low-phosphorus pig were produced in the United States, compared with about 4,000,000 tons of basic pig. The total production of rails in 1905 amounted to 3,375,929 tons, of which all but 183,264 tons were by the Bessemer process. About sixty-three converters produced the supply of Bessemer rails during the year 1906. To produce the same tonnage by the open-hearth process would require about 535 furnaces, costing approximately $20,000 apiece. Open-hearth rails are produced at present by the Tennessee Coal and Iron Company and by the Pueblo plant of the Colorado Fuel & Iron Co. In the immediate future open-hearth rails will be produced by the Bethlehem Steel Co., the Jones and Laughlin Co., and the Pennsylvania Steel Co. Hence it can be readily seen that when the steel maker says that the railroad man is unreasonable in asking him to change to the open-hearth process there is a good deal of truth in the statement.

A process which will undoubtedly help to solve the problem is the Talbot continuous open-hearth process. In this method, the molten pig iron from the blast furnace or an intermediate mixer, is added to a bath of metal and slag contained in a basic open-hearth furnace of about 200 tons capacity. The metal and slag are highly oxidized, and a violent reaction takes place, greatly reducing the metalloids of the added pig iron. The charge is then worked down in the usual way, and when of the desired composition, a fraction is poured off, which fraction is replaced at the proper time by a further addition of molten pig iron. The furnace has an output of about 150 tons in 24 hours.

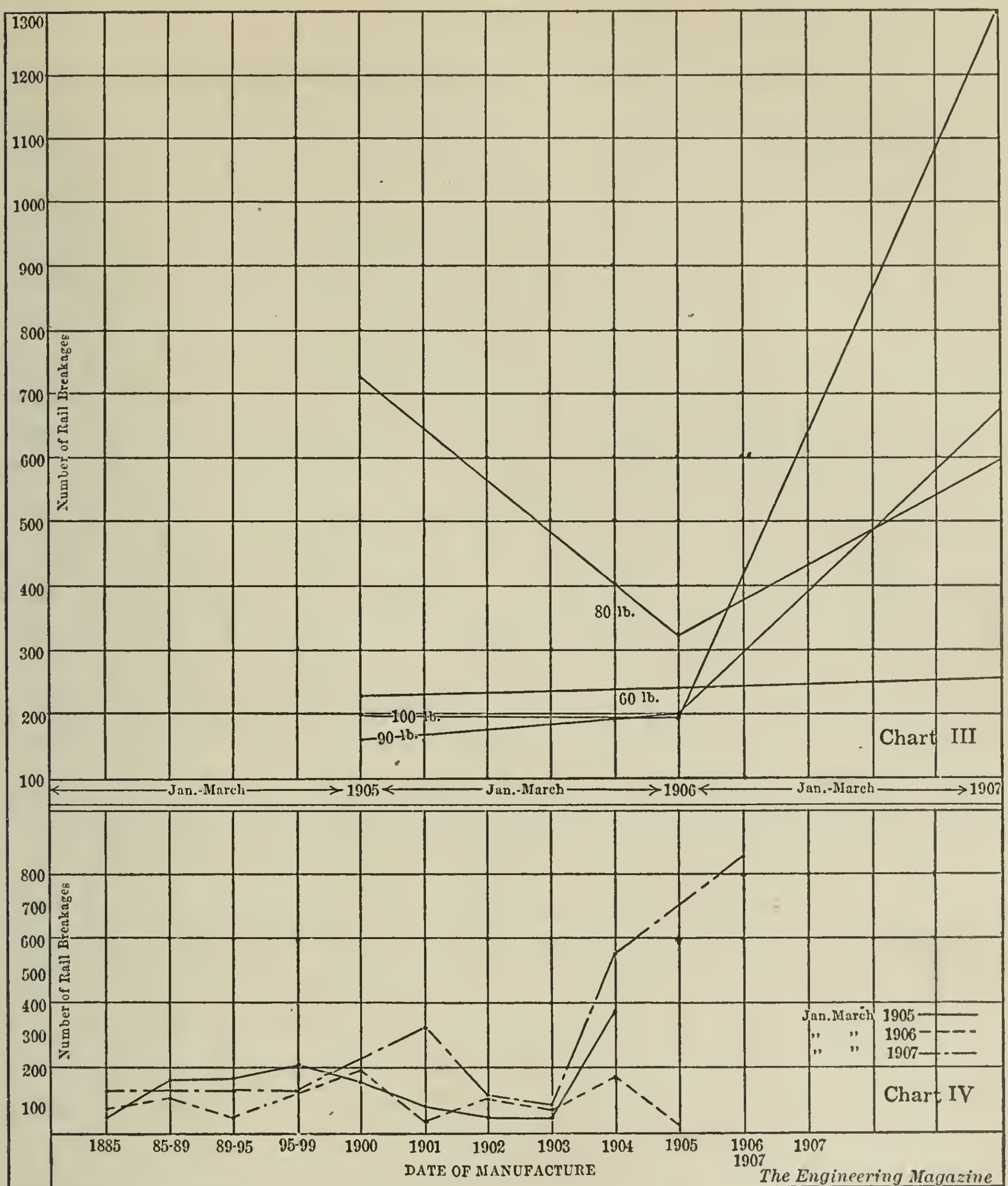
Another process which has been successfully tried to some extent in

1906.

Road.	Length of Road Operated.	Length of Line in New York.	Car Miles.	Car Miles per Mile of Line (Approximately).	Life of Rail in Yrs.	Size of Rail in lb. per yd. Max.	Min.	Number of Fractures.	Fractures per Mile of Line.
Boston & Maine	2,241	146	117,500,000	52,500	12	100	56	7	.05
*Buffalo, Rochester & Pittsburg	568	203	43,340,000	76,500	6	100	60	4	.02
Delaware & Hudson	857	857	65,780,000	78,000	12	90	62	60	.07
Delaware, Lackawanna & Western	.....	630	51,730,000	125,000	10	90	55	142	.11
Erie	1,884	1,301	212,300,000	112,000	10	90	56	22	.03
Lehigh Valley	1,429	807	165,690,000	109,000	10	100	56	50	.06
N. Y. C. & H. R. R.	3,580	4,183	462,400,000	129,000	17†	100	56	288	.07
N. Y., N. H. & H.	2,062	160	139,300,000	67,500	12	100	56	2	.01
Western New York & Penna.	600	332	40,400,000	67,300	12	85	56	186	.56

* This is an ore road; has exceedingly heavy wheel loads.

† The rails were rolled under Dr. P. H. Dudley's specifications and supervision, which probably accounts for their long life.



CHARTS III AND IV.

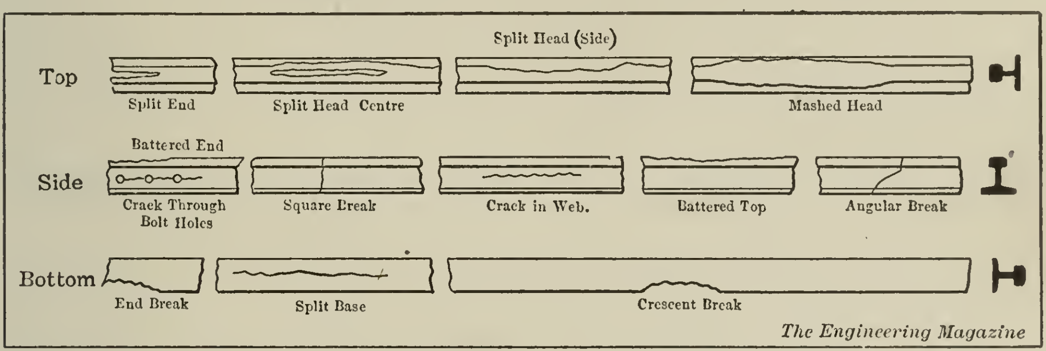
the United States is the Duplex process. In this method, the pig iron is first de-siliconised; and, at least partially, decarbonised in an acid Bessemer converter. The partially blown metal is then poured into a basic open hearth furnace and the succeeding operations carried on there. Here the phosphorus and to some extent the sulphur are removed, and the carbon brought to the desired percentage. The combined costs of the operations are high, and the losses of iron in the slag are also excessive.

The two contentions, therefore, seem to be as to the phosphorus and the kind or shape of section. By what process or method the phosphorus will be eliminated will be decided in the future, but there is no doubt that the phosphorus content must be decreased as the carbon increases, in order to prevent brittleness in the rails. That it can be eliminated in one process or another seems to be openly conceded and the choice hinges merely on expense.

As to the section question, the railroads must also be reasonable. From the standpoint of the metallurgist it is very difficult and almost impossible to roll the present section at the proper finishing temperature. To change the rail section so as to make the areas of the web and flange more nearly approach the area of the head would be expensive and would increase the weight of the rail to 115 or 120 pounds per yard, yet this would help the present situation immensely. The present section is designed on dynamic principles only. The web being so near the neutral axis does not, from a purely civil-engineering standpoint, need to be very thick. The flange is made broad so as to prevent the rail from cutting into the ties and from being over turned by lateral pressure from the flanges of the wheels, and therefore, does not need to be very thick. But the head is made thick in order to endure the concentrated wheel load applied to its upper surface, and to withstand the dynamic blows due to flat spots in tires or poor counterbalancing of reciprocating parts. Consequently the head cannot be made wide and thin like the flange; it must be relatively thick and narrow. These conditions compel the rolling to cease at a time when the metal in the head is too hot and is considerably above a proper finishing temperature. Almost every engineer knows that most of his troubles with steel can be directly traced to the heat treatment, and yet here the rail maker is compelled to roll a section to which it is manifestly impossible for him to give proper heat treatment. Furthermore, there is no reason except that of expense why the web and flange should be made thin. If they were made as above suggested, the cooling would not outrun the head, and the rolling would continue until not only the web and flange, but also the head, had cooled to a proper finishing temperature.

Hence the ideal rail is one which embodies all good points mentioned. The phosphorus content must be low, much lower than in the present Bessemer process, if this process is to hold its own. The phosphorus must decrease as the carbon increases so as to avoid brittleness. The section must be so designed as to take care of the dynamic and static stresses and also to allow the rail maker to roll it properly, working it to the proper crystalline structure and finishing at the proper temperature. The rolling should of course be so planned as to put sufficient work into the head, the part subjected to wear.

The question of high axle loads as argued by the rail manufacturer also deserves some consideration. The 20,000-pound freight cars formerly used have been replaced by those of 60,000, 80,000, 100,000, and even 200,000-pound capacity, the 60,000-pound being the light car of to-day, while the 100,000-pound is the standard for mineral traffic. The freight-train load has increased from 500 to 600 tons to 3,000 and 4,000 tons, and the volume of traffic in like ratio, as shown by the plates in THE ENGINEERING MAGAZINE for February. The axle loads under the freight locomotives have risen from 25,000 to 50,000 pounds, with four pairs coupled instead of two, and in the passenger service 55,000 to 57,000 pounds are common axle loads for some recent locomotives.



DRAWING I. DIAGRAMMATIC REPRESENTATION OF COMMON FORMS OF RAIL BREAKS. The crack through the bolt holes may extend through the head or web. The split base may extend at each end to the side of the flange.

In order to finish the investigation the problem of track design should be considered, and the loads and forces acting on the rails with the present system of rail support discussed. There is probably nothing in railroad construction so devoid of the principles of design as the track. There has been an evolution from the old strap rail up to those used at present. The rail has been designed and carefully tested, the tie spacing, the kind of tie, the method of holding the rail, and the bonding have all been carefully gone into; the road bed has been graded, filled, drained and ballasted, and yet there has been no co-ordination of all the component parts which make up the complete structure upon which the locomotive travels. The rail is subjected to bending moments, due to its acting as a continuous girder, amounting in some cases to 600,000 inch-pounds. The tendency of the rail to take the position of the elastic curve, also breaks out crescent-shaped pieces from the flange (see Drawing 1). Trolley roads design a rail of girder section so as to take care of these bending moments. Would it not be more rational simply to use the rail for its original purpose, and to design a homogeneous structure doing away with the cross-tie system, capable of acting as a continuous girder, with wide enough base or bases to take care of the ground reactions,

DAMAGE DUE TO DERAILMENTS.

Date.	Number.*	Kind of Train.	Killed.	Injured.	Damage to engines, cars and roadway.	Cause.
Oct.	4	Passenger	0	49	$7,700	Broken rail.—Speed 60 m. p. h. Rail had excess of manganese and phosphorus.
Nov.	..					
Dec.	..					
1906.						
Jan.	2	Passenger	2	15	......	Broken rail.
Feb.	4	"	0	2	6,500	Broken rail. — One passenger car destroyed by fire.
March	8	"	1	5	11,260	Broken rail.
1907.						
July	1	Passenger	5	13	1,125	Failure of 100-lb. rail nine yrs. old. Cracked between ball and web.
Aug.	..					
Sept. ..... 1907.	18	Passenger	0	..	63,000	Broken rail. — Train running 50 m. p. h. on straight line. Rail 12 yrs. old, bad interior defect.

* Refers to numbers in Bulletins of Interstate Commerce Commission.

of sufficient depth to sustain the continuous-girder bending moments, and of such cross section as would allow for the elastic action produced by our present rail and cross tie system, with a proper method of fastening the rail to the girder, and with properly designed and connected tension bars to take up the tension produced by the lateral wheel pressure of the flanges? In other words our section would be an inverted "U" with wide bases. The direct wheel loads would make this section act like an arch, the thrust of one leg being taken up by the tension member, the other thrust being taken up simply by the friction of the base, and the ground gives us the elastic action that we desire. Such a homogeneous structure seems worthy of careful consideration. It would stop some of the dangerous rail breakages and give some relief from the perplexing problem of replenishing cross ties, and at the same time relieve the rail from some duties for which it was not originally designed and which it cannot therefore meet. The first cost of such a system per mile of line, would be higher than the present, but with the price of ties ranging from $0.60 to $0.90 apiece and continually soaring the cost per mile of line gradually decreases as a mean. The life of the outlined structure would be approximately that of the rail, and when the life of the tie is compared with that of this structure and the cost of replenishing it, the differential cost of the two systems per mile of line is considerably reduced.

EDITORIAL COMMENT

Engineering Ethics.

IN an address on the topic of "Engineering Honor" recently delivered before the Engineering Society of Columbia University, Dr. Schuyler S. Wheeler developed, and adapted to his special audience, certain ideas and recommendations for an established code of engineering ethics which had already found expression in his former argument of the same question in other circumstances. The distinguished past-president of the American Institute of Electrical Engineers recognizes clearly the objection that an effort to codify the ethics of the profession might have the effect, on some minds, of substituting the dry and necessarily partial letter of formulated law for the lively and complete spirit of engineering honor. He would keep constantly in mind the fact that the rules to be adopted could represent only the application of accepted principles to a certain number of cases, and that the principles themselves were greater than the rules and must be looked to for guidance where the rule was silent.

The perplexities, as Dr. Wheeler pointed out, appear chiefly in cases where duties to separate interests seem to conflict. A very interesting part of Dr. Wheeler's address was that in which he fixed the relative order of the three important duties of the engineer —"first, to his client; second, to the public; third, to his engineering society." The duty to the society was placed last, he explained, because it was a sort of extension of his duty to himself and therefore subordinate to his duty to others.

It has been charged against the old codes of other professions that they ranked the duty to the "society" or its equivalent above the duty to the client or the public. Few, probably, would dissent now from Dr. Wheeler's arrangement of the order. None could well object to the spirit defined for his code in language chosen from the preface written by Francis Bacon for his "Maxims of the Law:"—

"I hold every man a debtor to his profession; from the which as men of course do seek to receive countenance and profit, so ought they of duty to endeavor themselves to be a help and ornament thereunto."

The Prevention of Accidents.

THE fact has been often emphasized, especially of late, that the proportion of accidents to workers in manufacturing, mining, or transportation industries in Europe is but a fraction of that existing in this country, and that the intelligent and careful study given abroad to determining the causes of accidents, and preventive measures against them, appears to be largely creditable for the better situation there. Our workmen, even more than our manufacturers, might profit by study of the differing conditions and of remedies suited to our own case. Carelessness on the part of employees is no doubt a larger factor than indifference of employers in the American problem; and while the suffering falls first on the laborer, the financial burden of supporting the crippled, the incapacitated, the pauperized, falls inevitably at last largely on the manufacturer. We believe that at home, as abroad, it will be the manufacturers who will first and most effectively promote the campaign of education for safer conditions of industrial employment. We shall not long be left with only the one Safety Exposition—and that temporary, and the product of individual initiative and energy—to compare with the ten or more permanent museums of Europe.

As further evidence of the lead taken by the Continent in this direction comes the announcement of the "Eighth International Congress for the Prevention of Accidents" to be held in Rome this summer. The sessions of this body are held triennially, and draw together influential government officials, publicists, economists, and specialists. The reports are made by the most eminent technicians, and the published proceedings represent the record of the world's best advances in the prevention of accident. Membership in the congress is only $2.00, and intending subscribers may send the fee to Dr. W. H. Tolman, 231 West 39th Street, New York, by whom it will be acknowledged and forwarded to Rome. This subscription entitles the sender to all the reports and the complete proceedings.

Educating Industrial Engineers.

A LITTLE more than seven years ago, Mr. James Newton Gunn concluded an article in the Works Management Number of THE ENGINEERING MAGAZINE with these words:

"I believe so thoroughly in the fundamental importance of cost keeping and factory organization as to proffer this suggestion: that while engineering today has, as its recognized representatives, civil, mechanical, mining, and electrical engineers—those who deal rather with processes and mechanical methods—yet there exists a science which only awaits the creation of a literature to have its own existence recognized as a new department of engineering."

The prediction is now being realized. The steady upholding of this ideal by such leaders as Mr. Gunn; the growth and development of the literature—a very large proportion of it through the initiative or under the auspices of THE ENGINEERING MAGAZINE; and the constantly increasing and insistently evident demand for men with a new sort of specialized knowledge, expert in directing great manufacturing operations—these have at last proved to the world at large that a new professional field has opened for engineers, and that new means must be employed for preparing workers to enter it.

The most striking phenomenon of the coming era is the great awakening of the Universities to the call for a change in their long-established courses—a change which will bring the education of the student nearer to the conditions of professional employment as he must meet them after graduation.

The most notable movement is that at Columbia University, which will be adequately set forth by Professor Rautenstrauch in this magazine next month. The most important features in its peculiar effectiveness are, first, the thoroughness with which the elements of works management and of economical and efficient manufacturing are recognized and proportioned; second, the system by which the active participation of practical manufacturers, consulting engineers, and specialists is enlisted and co-ordinated, thus bringing the students into direct contact with master workers in the profession, and the newest thought and the latest practice in the field; third, the incorporation of this work as part of the essential preparation of all students in the department of mechanical engineering, instead of making it optional or special. It can no longer be said, as we said last September, that no scientific school makes "adequate provision for the student whose life work is to be superintendence of a manufacturing plant." The Columbia Schools of Applied Science now provide such training, and further give to every student in the mechanical engineering course those fundamental ideas of the elements of economy and efficiency in construction, operation, or production, which are vital to the success of engineering undertakings.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

IRRIGATION IN EGYPT UNDER BRITISH DIRECTION.

A REVIEW OF THE WORKS CARRIED OUT AND THEIR ECONOMIC EFFECTS.

Sir Hanbury Brown—Royal Society of Arts.

TWENTY-FIVE years ago last month the Irrigation Department of Egypt was placed under British direction by the appointment, as its head, of Sir Colin Scott-Moncrieff. In this comparatively short space of time, the nation has been brought from the verge of bankruptcy to a condition of such solid and rapidly increasing prosperity as to give assurance of the fulfilment of the prophecy made in 1898, that, "for its size, the province of Egypt would become the most valuable domain on the face of the globe." Lord Cromer, than whom no one is better qualified to judge, presiding at a meeting of the Royal Society of Arts on February 25, attributed this remarkable regeneration to the work of the Irrigation Department, which, more than all other influences combined, contributed to the financial rehabilitation of the country and laid the foundation for the vast moral and material improvement of recent years. A brief survey of the irrigation works carried out since 1883 and their economic effects is contained in the following abstract of a paper by Sir Hanbury Brown, read at the meeting referred to above. The paper dealt only with the results of the work of the Irrigation Department in Lower Egypt, without reference to the basin tracts of Upper Egypt or to the Sudan, where the problems of irrigation are only in the preliminary stages of study.

In the latter half of 1883 Sir Colin Scott-Moncrieff made a personal investigation of conditions throughout the country and when his staff of four engineers of the Indian Irrigation Service joined him the following year, they were assigned as Inspectors of Irrigation to separate sections of the country, with instructions to do what they could to put things right and to spend as little money as possible. The difficulties under which these Inspectors labored during the first few years were enormous. They were unable to obtain money for works of any magnitude and they had to contend against the open or hidden opposition of the native governors, who bitterly resented the interference of foreigners with their vested rights. The Inspectors, however, were able to accomplish a great deal, especially in the just distribution of water to rich and poor alike. Formerly the distribution of water had been under the control of the governors of provinces or the larger land owners, and the poorer cultivator was entirely at the mercy of his richer neighbor. The abuses which had grown up under this system were extremely difficult to eradicate but they were finally removed and a just and scientific system of distribution established.

The distribution systems, however, could not be established and maintained without the expenditure of considerable labor on the channels and banks of the canals. The funds at the disposal of the Irrigation Department were insufficient to provide for the payment of the necessary labor and, much against their will, the Inspectors had to resort to the Corvée, or system of unpaid labor, which was of long standing in Egypt. Under the native governors this system had been one of extreme barbarity, involving the free use of the lash and subjecting both the impressed laborers and those dependent on them to the utmost rigor of cruelty and hardship. After the British occupation, the Corvée, so long as it existed, was reformed as far as possible and applied only to duly authorized works of public usefulness; but even under the most favorable circumstances it was but a poor and inefficient instrument. In 1884 the amount of unpaid labor used was equivalent to that of 165,000 men working for 100 days, but even this large army of laborers was insufficient for the amount of work which had to be done. The greater part of the labor was expended on clearing the channels of the deep canals of the cotton fields of Lower Egypt, which silted up badly during every flood and could not be cleared properly, under the Corvée, before water had to be admitted for the cultivation of the cotton crop. Relief had to be sought in some other direction.

"An attempt had been made to avoid the necessity of maintaining deep canals by raising the river water-level artificially at the head of the Delta. With this object a barrage, or river regulator, had been built across each of the Damietta and Rosetta branches of the Nile close below the point of bifurcation, some 15 miles north of Cairo. The work was designed to raise the natural water-level of the river at that point by 15 feet. Its construction was begun in 1843 by Mougel Bey, a Frenchman, and was supposed to have been complete in 1861. But the foundations had been so carelessly laid, and were so defective in consequence, that, when the work was subjected to a head of water in 1867, it showed such unmistakeable signs of failing that all attempts to use it for its original purpose were abandoned."

In 1883 the Barrage was declared incapable of raising the river levels in summer and valueless except as a bridge over the Nile, and a project was put forward to irrigate the whole of Lower Egypt by means of pumps. The arrival of Sir Colin Scott-Moncrieff and an examination of the Barrage by Sir William (then Mr.) Willcocks caused the abandonment of this project in favor of the restoration and strengthening of the original Barrage. This work was begun in 1885, a loan of a million pounds having been raised for the purpose. Each of the two regulators which together constitute the Delta Barrage consists of 61 openings of 5 metres width, fitted with a pair of iron gates sliding in vertical grooves, by which the water can be dammed to the height necessary for forcing the river discharge into the canals. Before the restoration work was begun, the regulating apparatus was entirely wanting on one section of the Barrage and on the other was incomplete and defective. Further, the foundation work was full of faults and before the regulating apparatus could be restored or repaired a new skin of masonry had to be laid over the old floor, with apron extensions up and down stream, and the foundations had to be consolidated by forcing cement grout into deep holes in the foundation material. The work of restoration was carried out with complete success and by June, 1890, the Barrage was made strong enough to hold up 13 feet head of water.

"Lastly, weirs have been constructed down-stream of the barrage on either branch, with the object of relieving the original structure of some of its work and, at the same time, of increasing its powers of control over the river, so that it has now been made possible to head up the river in summer to an artificial height af 20 feet, instead of 13 feet only. Consequently every drop of the summer Nile which reaches the head of the Delta is forced into the canals which carry it to the crops to be irrigated. Absolutely no water is allowed to flow past the Barrage along the natural channels of the river below it until such time as the rising flood has caused the canals to run with liberal discharges."

The great reduction in the labor of

clearing the Delta canals which resulted from the restoration of the Barrage made possible the abolition of the Corvée and the substitution for it of contract labor. "But the removal of this burden was not the only result of the full development of the working powers of the Barrage. In consequence of the better water supply obtained in summer by its action, the cotton crop, on which the wealth of Egypt depends, had been doubled, having increased from 3,000,000 to 6,000,000 cwt., or in value from £7,-500,000 to £15,000,000. As the result also of the greater control obtained over the levels of the rising flood, the timely sowing of the peasants' food crop of maize had been ensured. Further, the cost of raising crops had been lowered in consequence of the reduction of the height to which the water had to be lifted for irrigation. Meantime the cultivated area of Egypt had increased from 5,000,000 to 6,000,000 acres. and the value of land had been doubled; while, at the same time that these benefits were accruing, the land tax had been reduced from £5,000,000 to £4,500,000.

"If these results are represented by figures giving their money value, it will be found that the return for the special expenditure of under £4,000,000, incurred in bringing these results about, was not a hundred per cent. only, but several hundred per cent."

Notwithstanding the enormous improvement made by the restoration of the Delta Barrage and the building of the subsidiary weirs, the continuous expansion of the cotton area soon reached a point when the total amount of water impounded by these large works was utilized in irrigation, and it was foreseen that, if the development of Egypt was not to be arrested, means must be found for supplementing the summer discharge of the river. Following the very low floods of 1899, conditions became acute in the summer of 1900, and it was only by the most strenuous efforts at conservation and the strictest regulation of distribution that the supply of the latter year was made to serve. The question of reservoirs for storing the surplus water of the flood and winter discharges of the Nile for use during the summer was placed in the hands of Sir William Willcocks for study and as a result of his investigations the construction of the Assuan dam was decided upon. It is estimated that the storage of water necessary for Egypt's fullest development amounts to 6,000 million cubic metres. The first project provided for the construction of a dam on the crest of the first cataract above Assuan, of a height sufficient to store 2,500 million cubic metres of water. Owing to the protests of archæologists against the submersion of the buildings on the Island of Philae, the height of the dam as first decided upon was reduced by 26 feet, and the capacity of the reservoir is, therefore, at present only 1,000 million cubic metres. The dam as it now exists is 1¼ miles long, has a maximum height of 127 feet and supports a head of water of 67 feet. Recently it was decided to raise the height of the dam by 5 metres and the high water level of the reservoir by 7 metres, so that in the near future the capacity of the reservoir will be increased to 2,300 million cubic metres.

"The further expansion of Egypt's prosperity which has followed as a consequence of the construction of the Assuan Dam, and the works subsidiary to it, has not yet reached its full development, and that is probably the reason why the annual official reports of the Irrigation Service have not as yet attempted a statement of results. However, here is one item mentioned in the report for 1906. 'The actual benefit which has, up to the end of 1906, resulted to the country (that is, Middle Egypt) from these works is estimated to be a rise of rental value of £E.1,770,000, and of sale value of £E.23,569,000.' There were then about 300,000 acres converted from basin to perennial irrigation out of a total of 400,000 acres to be eventually converted.

"Basin land is land that is inundated during the flood season and grows one crop of cereals or clover in a year. When it is converted from basin to perennially irrigated land—that is, when floods are excluded and irrigation is provided all the year round—two crops a year are grown in place of one, and the rental and selling values of the land are more than doubled. The converted basin lands of Middle Egypt absorb the lion's share of the reservoir water; but the reservoir has also a high importance as providing insurance for the cotton crop of Egypt, valued at about £28,000,000. Land also in the Fayum Province has risen in value, and the area of cultivation there has extended in consequence of the improved conditions of water supply created by the construction of the Assuan reservoir."

The works mentioned above as subsidiary to the Assuam dam, themselves works of the first magnitude, include the Assiout and Zifta Barrages, the function of which is similar to that of the Delta Barrage. The former, consisting of 111 bays of 4 metres width, controls the distribution of water between Lower and Middle Egypt. The Zifta Barrage, on the Damietta branch of the Nile, distributes the waters of that branch to the canals on either side. Another barrage of 120 bays is now being constructed at Isna, about 100 miles below Assuan, to raise artificially the levels of low flood for the benefit of those basin lands of Kena which would otherwise not be reached by the inundation.

The binding of the Nile can never be made complete within the limits of Egypt proper. The future development of Egypt as well as the Sudan depends upon the solution of the problems presented by the Upper Nile, beyond the Southern boundary of Egypt. These problems are now being studied and it may be expected that eventually irrigation will work a transformation in the Sudan, similar to that which it has accomplished in Egypt under the British Protectorate.

THE CONSERVATION OF NATURAL RESOURCES.

A SYMPOSIUM ON THE CONSERVATION OF THE FORESTS, FUEL SUPPLIES, WATER POWERS AND WATERWAYS OF THE UNITED STATES.

American Society of Mechanical Engineers.

IN response to the invitation of the President of the United States to the engineering societies, to cooperate for securing the conservation of the natural resources of the country, the American Society of Mechanical Engineers devoted their April meeting to a consideration of this subject which just now is occupying so prominent a position in the public mind. The purpose of the meeting was announced as the discussion of the nature and extent of the resources of the country, the past and future demands upon them, the economy or wastefulness of methods of use, and the public policies best suited to their more efficient utilization and wise conservation. The four addresses delivered are published in abstract in the May *Proceedings,* from which the following summary has been prepared.

In introducing the subject of the conservation of waters and woods, Dr. W. J. McGee, Secretary of the Inland Waterways Commission, said that the future prosperity of the nation is bound up with this problem of the conservation of natural resources. What is most needed is an awakening of individuals to a sense of obligation for the preservation of the gifts of nature not only for the present, but for future, generations. Water is one of the most important resources to be conserved. The average rainfall over the mainland of the United States is about 30 inches, or 200,000,000,000,000 cubic feet, per year. As soon as the population and industries have increased to such an extent as to consume this annual rainfall, the limit of development will have been reached. About three-fifths of the rainfall is evaporated from the surface of the earth, another one-fifth passes deep down into the soil or is consumed in various chemical combinations on the surface, while the remaining one-fifth flows down to the sea. Too much of this last portion of the rainfall flows away on the surface and it is with its conservation that the people of the United States should be most concerned. Owing to the deforestation of the mountains and foothills at the headwaters of streams, the soil no longer acts as a great sponge, drinking in the water and giving it out slowly, but it sheds the water with a rapidity which gathers it in torrents. The rapid variation in the levels of streams due to the very rapid run-off is having a great influence on navigation, but by far the most important and deplorable result of deforestation is the loss of the millions of tons of the best soil which are annually carried into the streams by the torrential surface waters, to the detriment at once of agriculture and navigation. This soil erosion amounts to between one and two billion tons annually.

The conservation of the fuel supply was discussed by Prof. W. F. M. Goss of the University of Illinois under the four heads of value, methods of production, wastefulness in utilization, and possible sources of economy. In 1850 there were mined in the United States 6,000,000 tons of coal. Since that date the production has more than doubled every ten years and in 1906 the production amounted to 414,000,000 tons. If we add to this amount of anthracite and bituminous coal the natural gas and oil drawn to the surface in the same year, the total fuel production reaches the enormous total of 440,000,000 tons. The methods of coal mining are very wasteful. Powder is used in many cases in which the coal should be cut by hand or by machine and excessive charges are common. In mining it is generally the practice to extract only the coal which can be easily mined and requires the least preparation for market. Thin layers, seamy coal, and coal high in sulphur are totally neglected and in most cases their value is destroyed by the methods employed in mining the high-grade coal. It is estimated that only about one-half the coal in the mines ever reaches the surface. In the case of oil the waste has not been so great, but the supplies of natural gas which should have lasted for generations have been exhausted in the space of twenty years.

In every movement of fuel from the point of production to the stack of the furnace there is waste which might be reduced or entirely eliminated by proper attention. The necessary steps to secure economy in the use of fuel are: scientific research for the establishment of facts; practical development of the facts thus established, on a scale which will convince men that there is a profit, direct or indirect, in a better practice; restrictive legislation which will protect the public from the competition of unscrupulous men; and effective inspection which will secure enforcement of laws. Economies can be secured at the mines by a more rational use of explosives, and washing and briquetting processes must be developed so that every ounce of available fuel may be utilized. The conservation of the fuel resources is an engineering problem and will yield only to engineering treatment.

In his address on the conservation of stream flow, water power and navigation, Prof. George F. Swain of the Massachusetts Institute of Technology said that streams may be preserved and regulated in two ways, by the preservation of forests and by constructing reservoirs. Many facts were cited to show the importance of forests as regulators of flow and examples were given of the effect of removing forests. It must be remembered that the value of a stream depends not on its total flow but on the regularity of that flow. Variations in streams greatly affect the economical utilization of water power which is one of the most important resources of the country. It is therefore of the greatest importance that the deforestation of the country should be arrested, both for the conservation of the timber supply and for the preservation of streams. The control of streams by storage reservoirs has not been undertaken to any great extent but it is a method which will naturally increase in importance. The reservoirs will be located near the headwaters of the streams, where the floods have their origin. Here also the effects of the destruction of the forests will be most injurious, owing to the erosion of the soil by the storm waters and melting snows, and the consequent silting up of the reservoirs. The problem is one in which engineers should take an active and enthusiastic interest, for the formulation of a wise and broad public policy can be attained only by the assistance of the knowledge of the engineer.

This point was emphasized in the concluding address by Dr. Henry S. Pritchett, on the relation of the engineer to the body politic. A profession is distinguished from a business in that it is a vocation in which expert service is applied not only for the benefit of him who uses it but for the interests of the state and the public as well. The engineering works of antiquity were probably no larger than those of today but in many cases they were undertaken only for the personal glorification of some monarch and were of little moment for civilization or improvement. Today the engineer works always in the service of mankind and the engineering profession has entered into the company of those great callings whose members are recognized as not only the servants of those who employ them, but as the guardians, also, of the public interest and the public honor. The engineer is in a unique position to exercise by his advice, suggestion, and his consciousness of the public interest, a great influence in the encouragement of justice and wisdom. It will be a part of the honor due to his profession to look always at the larger than at the smaller view of development; to undertake the consideration of great enterprises rather from the standpoint of the great and unlimited future than from the standpoint of the small and limited present. In a word he will, if he be a true member of a profession, while serving loyally his employer, keep ever before the eye not only of himself, but of those whom he serves, the honor of his own profession, the debt which he owes to it, and the service of those larger interests of humanity which these considerations require.

THE NECESSITY FOR CORPORATION FORESTRY.

A DISCUSSION OF THE PROBLEMS OF FUTURE TIMBER SUPPLY IN THE EASTERN UNITED STATES.

E. A. Sterling—Engineers' Club of Philadelphia.

IN the present national movement for the conservation of the natural resources of the United States, the question of the timber supply is unquestionably of the most pressing and immediate importance. The forests of the country have been so depleted by wasteful methods of production and utilization of timber that their absolute exhaustion within a very few years can be prevented only by the practice of forestry on a large scale. The activity of the Forest Service of the Federal Government during the past few years has placed the immense forest lands of the public domain, lying for the most part west of the Mississippi, under a wise system of control, and, though a large part of the Western timber lands are still privately owned, the position of the Western States with regard to timber supply is more or less secure. In the East, however, no such conditions prevail. The timber lands are almost wholly in the hands of private owners and there is no guarantee of a rational conservation in the public interest, such as exists in the West, which will prevent the timber scarcity, already serious, from becoming more and more acute. In a paper read before the Engineers' Club of Philadelphia and printed in the January number of the *Proceedings*, Mr. E. A. Sterling, Forester for the Pennsylvania Railroad, asserts that the only possible solution of the problem for the large wood-using corporations of the East lies in the practice of private forestry on a large scale. His data and argument are most interesting and we present the main points of his paper in the following brief abstract.

"There are today many indications of timber scarcity which are all too evident to the business man, and it requires only a glance at statistics to show that conditions will rapidly become worse unless prompt action is taken. The rise in lumber prices should in itself be sufficient to point out the need for economy and for the more conservative use of our forest resources, especially when we consider that certain grades of timber are hardly obtainable even now, at any price. Taking our more common kinds of lumber, we find that in the decade ending 1906 the wholesale price per thousand board feet for white pine, rough uppers, jumped from $52 a thousand to $92, while in the same period yellow poplar went from $32 to $53.50 per thousand, southern yellow pine from $14 to $29.50, and hemlock from $12 to $23 per thousand. Manipulation of the market may have accounted to some slight extent for this marked increase, but it is very certain that the main reason for the advance was the scarcity of the raw material. Taking white pine, for instance, which has long been one of our standard woods, we find that the total cut in 1905 was only 4,862,000,000 feet, and much of this was obtained by cutting over the original pine lands the second or even the third time. Since the maximum cut of some 8,000,000,000 feet of white pine back in the eighties there has been a steady falling off despite all efforts of the millmen to maintain higher outputs. The decline in white pine has thrown other woods into the lead, and in 1906 we find that yellow pine and Douglas fir, with 31.1 per cent. and 13.2 per cent., respectively, have increased rapidly in proportion to the total cut. In 1899, 22.5 per cent. of the lumber cut in the United States was white pine, in 1905 16 per cent., and in 1906 only 12.2 per cent., whereas Douglas fir in 1899 produced only 5 per cent. as against the 13.2 per cent. for 1906. Comparing the output of hard woods and soft woods, we find that in 1905, 81.3 per cent. of the total consisted of soft woods such as pine and spruce, whereas in 1899 the soft woods showed about 75 per cent. This change in ratio is due mainly to the increased cut of yellow pine and Douglas fir and the falling off in oak and yellow poplar."

The scarcity of certain kinds of timber is very seriously felt in a number of industries. The case of the vehicle manufacturers may be cited as a prominent instance. Hickory is used almost exclusively in the construction of the better grades of vehicles and as yet no satisfactory substitute has been found for it. Nevertheless, it is estimated that the present supply of hickory will last only twelve years, at the present rate of consumption of about 150,000,000 feet annually. To take another case, in railroad work the scarcity of suitable tie timber has become a serious problem. White oak has long been the standard timber for ties on the Eastern lines but the supply has fallen off to such an extent that many inferior species are now used at prices formerly paid for the best white oak. The average value of the 102,834,000 ties used in 1906 was 47 cents each but with the constant recession of the timber supplies from the lines of the railroads, the price is certain rapidly to increase.

Hickory and white oak are not the only hard woods of which the supply is waning rapidly. The production of all the more desirable classes of hard wood is decreasing notwithstanding the constantly increasing demand. During the period 1899 to 1906, in which the expansion of all branches of industry gave rise to an unparalleled demand for raw materials of all kinds, the decrease in the output of hard wood amounted to 15 per cent. and the corresponding increase in price varied from 25 to 65 per cent. The most desirable and widely used woods, oak, yellow poplar, elm, became increasingly more scarce and, to supply the deficiency in the better grades, resort was had to inferior woods, maple and red gum, the production of which continually increased. At the present time the consumption of hardwood timber of all grades, as lumber, ties, piling, poles, etc., amounts to over 25,000,000,000 feet annually, a consumption which the standing hard wood timber on even the highest estimate will be able to supply for only sixteen years.

Taking the whole timber supply of the country the prospect is not less discouraging. According to the most reliable statistics the annual consumption of wood in all forms, in lumber, mine timbers, cooperage, packing boxes, pulp wood, fuel, etc., reaches a total of 100,000,000,000 feet, a per capita consumption of 440 feet as compared with Europe's 60. According to the most reliable estimates of the standing timber, an annual consumption of 100 billion feet will exhaust the available supplies in twenty years.

The problem of the future timber supply in the East will have to be solved mainly by the wood-using corporations. In the Western States, Federal and State control of the timber on the lands of the public domain will accomplish much but in the East a definite supply of timber at a reasonable price can be assured only by the individual action of the corporations. The lumberman, whom one would naturally expect to be most concerned about the future supply, can be depended on for but little assistance. He is concerned only with immediate profits and has no interest in ensuring the permanence of a timber supply such as the long-lived corporate concerns must have. The solution which the corporations, and particularly the railroads must adopt eventually will be the purchase of large timber tracts, their management on a long-time basis, and the preservative treatment of the timber so far as is consistent with the use to which it is to be put. Any other policy would be most short sighted. Mining companies which are paying in the neighborhood of one million dollars a month for mine timbers in the open market are endeavoring to increase the life of timbers by treatment with preservatives. The railroads are working along the same lines and are attempting to economize by getting the maximum life out of inferior timbers. But in view of the rapid exhaustion of the forests such expedients can be of but temporary relief. The only true economy, the only possible solution of the pressing problem of timber supply, lies in buying timber lands and placing them under competent forest management.

"Assuming that a large eastern corporation was in control of a timber reserve sufficient to fill its wood requirements wholly or in part, the next question would be how to operate to the best advantage. Naturally, the first step would be to place the property in charge of a forester who would make a plan of management in accordance with the local conditions of the tract and of his company's requirements. On typical forest land his first step would be the inauguration of a scheme of fire protection. This would be followed by such improvements in the line of mills, logging railroads, etc., as were necessary to the exploitation of the timber. With these facilities he could handle the orders placed by his company and deliver the material in any form desired. In cutting, his aim would be to utilize only the mature timber, provide as far as possible for natural reproduction by leaving seed trees and disposing of the slash, and, wherever it could be done with profit or without undue expense, thin out and improve his second-growth timber. He would at the same time replant open areas where there was no prospect for natural regeneration and, in short, would gradually bring every acre of the tract up to its maxamum production. The normal forest, with an annual cutting area and an annual budget equal to the increment of the whole stand, he could not expect to approach for many years, but conservative logging methods, fire protection, improvement cuttings, planting, etc., would gradually lead to this end. It is not unreasonable to anticipate that the day will come in this country when our economic conditions will permit the more intensive forest practice of our European neighbors. . . . .

"Although the idea that wood-using corporations should be wood producers as well is comparatively new in this country, several firms have already adopted policies of this kind. Of the Eastern railroads, the Pennsylvania and the Delaware and Hudson have appointed foresters and may be expected to work out their wood problems according to their own needs. In the West, the Santa Fe is the most active, and in addition to operating the largest and best creosoting plant in the country at Somerville, Texas, have purchased some

,000 acres of land in southern Califor- ia, where they will grow eucalyptus for ies. Since eucalyptus in that climate vill grow into tie size in eight to ten 'ears, and each tree produce two to hree ties, an area of this size when lanted will go a long way toward fur- ishing a continuous supply of tie tim- er. This same company has over 25,- 00,000 treated ties in track, and by this ne process alone they will probably ut their annual consumption in half. he Southern Pacific, Union Pacific, urlington, Rock Island, Illinois Cen- ral, and other of the large western oads are erecting or operating large vood-treating plants, and within a few ears untreated ties will be the excep- ion, west of the Mississippi at least. Of hé coal and iron companies, the Lehigh oal and Navigation Company is prac- ising forestry on a large tract in the ocono region of Pennsylvania; the hiladelphia and Reading Coal and Iron ompany is treating mine timbers; the ackawanna Railroad, with its affiliated oal interests, is taking up the question f timber protection and timber treat- ng, while the Cleveland-Cliff Iron Com- any in Michigan owns very large areas f forest lands, which are under the nanagement of trained foresters. Paper and pulp companies in New York and Maine have acquired large holdings of spruce and balsam and are practising primitive forestry, while the International Harvester Company owns and husbands its own supply of hard-wood.

"In conclusion, it can safely be said that most of our large corporations, as a matter of self-protection and economy, must sooner or later take up the practice of forestry. It will pay in most cases because eventually there will be no other solution, and the sooner the start is made the more profitable will be the outcome. From the broader patriotic standpoint of the nation and the State, the corporations and the lumbermen have it in their power to solve the great questions of stream flow, inland navigation, and water power, and to decide whether our lands which are unsuited for agriculture shall be barren wastes or productive of successive crops of timber for the nation's use. From the commercial and economical standpoint the attitude of these same industrial interests will largely determine whether the approaching timber famine shall be postponed indefinitely, or whether we shall soon be made to face a scarcity of one of our most useful products, which will paralyze many of our industries."

COMMERCIAL RESEARCH.

A DISCUSSION OF ITS FIELD AND METHODS OF INVESTIGATION.

C. E. Skinner—The Electric Journal.

THE following brief abstract of Mr. C. E. Skinner's address on the field and methods of commercial esearch, delivered before the Electric lub of Pittsburgh on January 27 and rinted in *The Electric Journal* for pril, can give but an inadequate idea f its interest. To Mr. Skinner, as head f the research department of the West- ghouse Electric and Manufacturing ompany, are given opportunities to ppreciate the importance of research ork in manufacturing operations, not pen to the engineer in other lines of ork or even to the engineer connected ith smaller manufacturing concerns. ut no one in reading his address can fail to be struck by the breadth and variety of the problems connected with modern industry, for which the laboratory is required to furnish solutions, or to gain a clearer realization of the interdependence of, and the close connection between, science and industry. The bare outline given below can do no more than indicate the main points with which Mr. Skinner deals, without reference to the wealth of practical illustration to which his paper owes a large part of its interest.

Probably the most important branch of commercial research is that which deals with the investigation of the properties of materials. The variety of raw materials used by a large manufacturing company is very great. In the case of the Westinghouse Electric and Manufacturing Company the number of classes exceeds five hundred, and the tests to which the materials must be subjected cover practically the whole range of physical and chemical science. In some cases the investigations follow well-established lines but frequently new tests must be devised to give the intimate knowledge of the properties of materials necessary for their economical purchase on specifications and for their efficient utilization. In many cases the research laboratory is required to develop new materials or new combinations of old materials to meet new and special conditions. Metallic filament lamps and alloy steels are striking examples of the manner in which the research laboratory responds to the demands of industry.

Closely allied to the determination of the properties of materials are the development and investigation of the processes by which they are treated to meet the conditions of manufacture and the methods of manufacture or of making combinations to fit the particular work in hand. This branch of commercial research is of large importance and the necessity for careful and thorough work is nowhere more apparent. For the development of a successful process the investigator needs to know very intimately the properties of the materials involved, the various methods by which they may be handled, and the results which must be obtained in the finished product. Investigations of this kind may develop into researches of the highest complexity and of far-reaching results.

All rational design is based on the disposition of material in such a manner as to take advantage of phenomena, usually related to the law of the conservation of energy. Among these phenomena the properties of materials are of great importance but design can by no means be limited alone to the consideration of the characteristics of materials. Hence an important branch of commercial research, and one which will probably never be exhausted, is the determination of the physical laws and the absolute values of those phenomena affecting design which lie outside the properties of materials. In all progressive work new phenomena of this kind and new phases of well known phenomena are constantly being observed and require investigation. It is impossible, of course, entirely to separate the phenomena which lie outside the properties of materials from those which depend on these properties. The investigation of the former class must recognize the results of investigation of the latter.

No less important than the design itself is the determination of its results. All design is more or less of a compromise. The phenomena which affect it are imperfectly understood and may be mutually opposed to one another. Hence the best designs are those which contain the most that is satisfactory and the least that is unsatisfactory. The examination of the results of design consists of making tests on the various features involved and determining whether or not the best compromise has been effected between the conflicting elements entering into it. Ordinary testing to determine whether a machine meets the specifications of a customer or designer is not to be considered research work but many cases arise in which totally unforeseen features or partial or total failure require careful and elaborate investigation. The investigation of the causes of failure of a machine is often of a most difficult and exacting character, for failure may arise from any one of a large number of causes, from faulty design, material, or workmanship, or from causes altogether outside ordinary experience and knowledge.

The development of new classes of apparatus, the critical study of existing designs, and the investigation of reputed inventions and discoveries of a doubtful nature are other important branches of commercial research. The first two require most careful and painstaking work, for the development of new, and the improvement of old, devices can be accomplished only by a systematic and broad-minded study of every possible factor.

The last usually requires nothing more than common sense and a firm grasp of fundamental physical laws.

As to the methods by which the various problems are to be attacked no general rule can be laid down. In some cases a solution may be reached by a cut and try method or by a process of trying everything possible. In the development of costly processes or large machines, however, the only commercially satisfactory method is that of advancing step by step from one definite, partial solution to another, and in general it may be said that this method is the best for any problem, even though it may take a longer time than others. Before attacking any problem, however, a process of elimination, based upon known facts regarding the properties of materials and the theoretical requirements of the results, should be carried out. It will usually be found that a careful preliminary consideration of all possible materials and processes, with the rejection of all obviously unsuited or doubtful, will reduce a problem to very simple proportions.

SERVICE PERFORMANCE OF THE LUSITANIA.

DATA ON THE STEAM AND COAL CONSUMPTION ON HER THIRD VOYAGE WEST.

Thomas Bell—Institution of Naval Architects.

THE paper from which the following extracts are taken was undoubtedly the most important and interesting presented at the recent meeting of the Institution of Naval Architects. Very full reports of the trials of the Lusitania have been published in the technical press but the subject was by no means exhausted and Mr. Bell's paper gave a great deal of detailed information in the form in which its importance can be appreciated most readily. With this part of the paper we shall not deal, since the main results of the trial trips were given in these columns in the October, 1907, number of THE ENGINEERING MAGAZINE. We present below, however, that part of the paper dealing with the results obtained under service conditions, which contains, we believe, the first authoritative statement of the performance of either of the great turbiners. The data given by Mr. Bell have reference to the Lusitania's third voyage west.

"With reference to the third voyage west, from November 2 to November 8 of last year, thanks to the courteous permission of the chairman of the Cunard Company, the leading particulars of the official engine-room log are summarised in the table below. Regarding the mean draught of the vessel at sea, it may be remarked that, after the second

ABSTRACT OF ENGINE-ROOM LOG FOR THIRD VOYAGE WEST: QUEENSTOWN TO NEW YORK.

Date when last Dry Docked, July 22, 1907. Mean Draught, leaving Queenstown, 33 feet 7 inches. Mean Draught, arriving New York, 30 feet 10 inches.

Date, 1907.	Steam Pressures. Boilers.	H. P. Receivers.	L. P. Receivers.	Temperatures. Hot-well.	Feed-Water.	Vacuum.	Barometer.	Length of Day.	Distance by Observation.	Mean Speed.	Mean Revolutions.	Mean Slip.	Coal Consumed for Main and Auxiliary Engines per Day.
	lb.	lb.	lb.	deg.	deg.	in.	in.	hr. min.	naut. m.	knots	per min.	p. c.	tons
Noon Nov. 3....	170	140.0	2.3	68	200	28	30.4	0 52	21	24.24	182.5	16.5	40
" " 4....	169.1	142.2	2.2	78	197	28	29.7	24 57	606	24.28	182.6	16.4	1090
" " 5....	167.3	140.6	2.3	78	198	28.2	30	25 2	616	24.6	182.8	15.4	1090
" " 6....	168.3	140.4	2.5	70	196	28.2	30.1	24 55	618	24.8	183.5	15.1	1090
" " 7....	168.3	138.3	2.2	72	195	28	29.6	24 52	610	24.52	181.4	15	1090
1.14 A. M., Nov. 8	165	132.5	1.5	75	200	27.8	29.3	14 2	310	22.09	174	20.2	576*
Total	....	....	..	...	...	...	...	114 40	2781				4976
Means	168	139.3	2.2	74.5	197	28.1	29.8	.... ..	....	24.25	181.1	15.9	....

* This includes all coal used till 10 A. M. on the 8th.

Summary of total coal consumed on voyage:—Liverpool to Queenstown, 408 tons; Queenstown to New York, 4976 tons; galleys, etc., 18 tons: Total coal taken from bunker from leaving landing stage, Liverpool, till moored at wharf, New York, 5402 tons. Passage—Queenstown to Sandy Hook—4 days 18 hours 40 minutes.

day out, certain of the forward tanks were gradually filled for the purpose of avoiding excessive trim, so that the mean draught on November 5, 6 and 7 was approximately 32 feet, or very little more than the mean of the first pair of runs from Corsewall Point to the Longships and back. The conditions, however, were otherwise very different, for, with the exception of the twelve hours of fine weather and smooth sea from noon till shortly after midnight on November 6, it was, throughout, the average mid-Atlantic winter weather—namely, strong winds and resulting boisterous sea. Up till midnight on the 6th—*i. e.*, for 2176 nautical miles out of a total of 2781 nautical miles—the mean speed works out at 24.65 knots; but, unfortunately, early on the 7th the wind freshened, gradually increasing to a furious southwesterly gale, which reached its height about 4 P. M., and reduced the average speed for the last 24 hours below 23 knots, and thus brought down the mean average for the completed voyage to 24.25 knots. A table giving the mean average speeds at the different stages of the voyage, shows very clearly the effect of this gale, unfortunately so far as preventing the vessel from complying with the contract conditions, but giving those connected with the ship an opportunity of thoroughly satisfying themselves as to her behaviour when driving through huge waves at about 22½ knots, without any racing of engines or signs of labouring, and dispelling the idea current in some minds, that turbine-propelled ships do not show to advantage in heavy weather.

"The following particulars of the steam consumption are given in conjunction with the figures of coal consumption set forth in the table. Throughout the voyage a careful record of the feed-pump counters gave an average of 998,000 pounds of water pumped into the boilers per hour. Of this, about 114,000 pounds were used by auxiliary machinery exhausting into the feed-heaters, 26,000 pounds by the evaporating plant supplying feed make-up and washing water, and about 6500 pounds for steam to the thermo-tanks, galleys, and pantries, both of which latter figures are based on data obtained from tests carried out before the vessel left the Clyde. Hence, taking the average shaft horse-power as 65,000, the steam consumption per shaft horse-power-hour works out as follows:—

			Per Shaft Horse-Power Hour.
	lb.		lb.
Main turbines	851,500	=	13.1
Auxiliary machinery	114,000	=	1.75
Evaporating plant and heating	32,500	=	0.5
	998,000		15.35
Average amount of coal burnt per hour for all purposes	43½ tons		
Water evaporated per pound of coal.........	10.9 lb. from and at 212 deg.		
Water evaporated per pound of coal.........	10.2 lb. from a feed temperature of 196 deg.		
Coal for all purposes per shaft horse-power per hour	1.5 lb.		
Coal per square foot of grate per hour.........	24.1 "		

Taking a mean displacement of 36,000 tons, this represents at 24½ knots per hour a consumption of almost exactly 11 pounds of coal per 100 nautical miles per ton of displacement. Half of the coal used was South Wales and half Yorkshire—practically the same as on the official trials."

THE QUESTION OF SPEED IN BATTLESHIPS.

A DISCUSSION OF THE RELATIVE VALUES OF SPEED, GUNS AND ARMOR.

Ensign R. R. Riggs—United States Naval Institute.

As was pointed out very clearly in Mr. Sidney G. Koon's discussion of the size of battleships in THE ENGINEERING MAGAZINE for April, a satisfactory compromise between the conflicting military interests in battleship design can be arrived at much more easily in a large than in a small ship, and the general tendency in all navies is toward ships of larger and larger displacement. But though large ships are generally accepted as the standard, there is no settled agreement as to the relative values of the military elements of speed, armor and armament in ships of a given displacement. It would seem, however, that naval architects are prone to exaggerate the importance of speed and to make excessive sacrifices of armor and guns to attain it. A vigorous and very interesting protest against this tendency is made by Ensign R. R. Riggs in a recent number of the *Proceedings of the United States Naval Institute,* from which the following extracts are taken.

"Speed is the most unreliable of these three elements: foul bottoms, poor coal, green firemen, accidents to boilers or steam line, minor accidents to engines, hot bearings, damage to stacks in battle, damage to hull by shells or torpedoes, or any one of a thousand things may neutralize a superiority in speed when the crucial time arrives. In some of the late British maneuvers, over half the battleships had to return to port on account of accidents to machinery, in a period of only two weeks, and this took no account of the hazards of battle. It may be argued that the slower fleet is just as liable to these accidents as the faster; true, but the slower fleet, if equally numerous and of the same displacements, must still retain its superiority in guns and armor, while if the faster fleet lose the advantage of speed, it is outclassed at all points and must be defeated. And this risk increases in proportion to the number of ships engaged, for there is just so much more chance of one ship being winged, and the speed of the fleet must be the speed of the slowest ship. This is one place where concentration of fire, aside from any technical considerations, is advantageous. If two ships are engaged with two others, and one pair concentrates its fire on one of the opposing ships, the total damage to each side in a given time will be equal, but the ship on which the fire of one side is concentrated will receive *all* the damage on her side and so will lose speed twice as rapidly as her opponents. Her faster consort must either slow to her speed, with no compensating gain, or else abandon her, and expose herself to a similar concentration. If ten ships are engaged on each side, this must take place five times as soon, and if they are of equal size, the slower will be consequently stronger in guns and armor, and so receive less damage than they inflict. Any damage to the battery and armor of the slower fleet is not open to the same objection, for it is local, and the damage to one gun or ship in no way effects the other guns or ships.

"It is frequently stated that the Russo-Japanese war illustrates the need of great speed for battleships, and this at the first glance appears to be true; but if the underlying principles are carefully studied, the fallacy of this is discovered. For example, at the battle of Tsushima, the Japanese fleet made about 15 knots to the Russians' 9 knots, and the Japanese won. But how much of the victory was due to speed, and how much to gun-fire? Had the fleets been equally well handled, and had the Japanese obtained their superiority in speed *at the expense of superiority in guns and armor,* would they still have won? That is the real point at issue. I think that no one will doubt that the result would have been the same had the Japanese not had the advantage of speed; it was this advantage *together with* superiority of gun-fire that made the victory so complete. As stated above, superiority in speed for a fleet in other respects equal to the enemy is of undoubted advantage, but should superiority in guns and armor be sacrificed for it? Another point shown by this battle. The Russian fleet was able to steam at 15 knots on leaving the Baltic, but it could make but 9 knots when the time arrived to use it, and Rozhestvensky's division of new 18-knot battleships could make but 11 knots on a spurt. Does not this illustrate the unreliability of speed when operating at long distances from a base? Do we find any similar deterioration in the battery or armor? These last were at least as good as when they left Russia. Furthermore, the Japanese armored cruisers were used in the line of battle, and had to reduce their speed to that of the battleships. Would not this extra weight given to speed which could not be used have been better utilized in guns and armor? To be sure, Rozhestvensky attributed the Japanese victory to their superior speed, but he would be likely to assign any but the real cause to his defeat. If the crews could have been exchanged, which would have won, Japanese ships or Japanese personnel? Admiral Nebogatoff says that he surrendered because the superiority of the Japanese in speed enabled them to keep outside the range of his guns, and bombard him. Does not this show above all other things that the Russians were inferior in gun-fire as well as in speed? It should have been impossible for the Japanese to keep without the range of his guns and still do him any damage. . . . .

"If naval wars are, as history teaches, not to be decided by skirmishing or cross-raiding, but by one or more pitched battles, then every nerve should be strained, both in peace and war, to prepare for these *battles*. As armored cruisers have been shown not to be as valuable for this purpose as are battleships of the same size, they are a mistake. If this mistake has been made in the past then there is all the more reason for avoiding it in the future and this will not be done by repeating the error —the sacrifice of strength for great speed—in another form or under another name. I don't mean to say that very high speed is not valuable in its place, but putting it in large, imperfectly armed vessels is 'like putting all the eggs in one basket and putting the basket out to be kicked.' Contrary to strength, speed must be distributed through as many units as is practicable. . . . .

"There are positive disadvantages to high speed. Either the coal capacity of the ship must be increased, out of all proportion to the gain in speed, or else the radius of action must be correspondingly reduced. The disadvantage of the first is that on a given displacement the guns and armor must be reduced, and the disadvantage of the alternative is self-evident. Also, if it be such a problem to coal our fleet in time of peace, what would it be with greatly increased consumption and in war? The increased cost of maintenance might better be spent in other ways. When the armored cruiser squadron was out in the East it was the customary thing to see at least one of the ships coaling; so much so that they became known as 'Colliers' Weekly.' It was also a well known fact that, even with the coal bought at other ports, they were burning it faster than it was being sent out—and there were but four ships of moderate displacement—and in time of peace. . . . .

"While guns and armor have been racing for supremacy, the highest speeds have remained nearly constant. The reason for this is that the horse power increases as the cube or even as the four power of the speed after a certain point is reached, and soon becomes prohibitive. The improvements in engineering have not changed this point to any great extent, and there is no immediate prospect that it will be changed. The calculations of a French officer, and one who is an advocate of high speed, show that to give an 18-knot battleship of 18,000 tons a speed of 21 knots, one-sixth of the battery or one-fifth of the armor must be sacrificed. This is a very large sacrifice, equivalent to five ships against six in offensive power, but for an increase of another three knots nearly twice as much of the remaining battery or armor would have to go. There may easily be a division of opinion as to the advisability of an increase from 18 to 21 knots, but I think that very few will think it advisable to sacrifice between 30 per cent and 40 per cent of power for an increase from 21 to 24 knots speed, and practically none will say that any decrease in speed below 18 knots would be compensated for (except in such cases as the *Idaho,* where the displacement was limited by law to an abnormal figure). Therefore the proper speed must be somewhere between 18 and 21 knots, and 19 knots may be taken as a good mean, above which the gain in speed would not justify the sacrifice in power, and below which the gain in power would be too small to justify a reduction in speed. The engines should be designed for a very high cruising speed, such as those in merchant vessels, for the real value of speed lies not in the ability to make spurts, but in the wide field of strategy. Give the ships coal capacity enough to enable them to run from one base to another, with a good allowance for emergencies, and do this on the least displacement. In case improvements in machinery, such as turbines or internal-combustion engines, result in a saving of weight for a given horse-power, this weight may be better utilized in better protection than in speed."

RECENT DEVELOPMENTS IN THE GAS TURBINE.

THE CONTINUATION OF M. ARMENGAUD'S RESEARCHES AND THE APPLICATION OF THE GAS TURBINE TO SUBMARINE TORPEDOES.

Alfred Barbezat—Cassier's Magazine.

THE researches of M. René Armengaud on the gas turbine, culminating in the construction of a 300 horse-power unit, have probably constituted the most important individual contribution to its development. The experimental work on which M. Armengaud was engaged at the time of his death, in the summer of last year, has been continued by some of his former associates, and in *Cassier's Magazine* for April, M. Alfred Barbezat gives an interesting account of the more recent advances. Especially important in the extracts from this article, which are given below, are the data on the practical application of the gas turbine to submarine torpedoes.

"The early experiments were made with a small turbine of the De Laval type, capable of developing about 30 horse-power, and after studying the performances of this machine, when driven by compressed air alone, arrangements were made to test it in connection with a combustion chamber, delivering the products of the combustion of liquid hydrocarbon fuel at constant pressure through a nozzle upon the blades of the turbine. In these experiments the compressed air was furnished from an independent source, the object being to ascertain the action of the combustion in the chamber and the behaviour of the working parts under the conditions involved. The results obtained with this experimental machine were sufficiently encouraging to warrant the construction of the large 300 horse-power turbine.

"The general principle of this machine involves the delivery of air under pressure into a pear-shaped chamber lined with refractory material and provided with an expanding nozzle through which a uniform flow of gases can be delivered upon the blades of the wheel. In the center of the air nozzle there is arranged an axial tube, with a pulverizer at the inner end, through which the fuel in the form of gasoline, or similar liquid hydrocarbon, is forced into the chamber. The electric sparking device enables the fuel to be ignited on starting, after which the high temperature of the chamber maintains the combustion indefinitely. The high temperature produced by the combustion greatly increases the volume of the air, and this, together with the gaseous products of the combustion of the fuel, flows at a high velocity through the expanding nozzle upon the blades of the wheel.

"In dealing with such high temperatures, the temperature of the combustion being about 1,800 degrees C., the best refractory lining for the combustion chamber has been found to be carborundum, this being a product of the electric furnace, and thus having already sustained even higher temperature than those in the turbine combustion chamber. An elastic backing of asbestos provides for the expansion of the carborundum lining, and the nozzle through which the gases are discharged upon the wheel is also made of carborundum.

"In addition to the provision of a refractory lining, it has been found necessary to surround the combustion chamber with a water jacket in the form of a coil of pipe imbedded in the metal of the chamber walls, much in the same manner as such coils are used in the tuyeres of blast furnaces, and the circulation of the water in the coil aids in keeping the temperature of the chamber walls within practicable limits.

"After the water has circulated in the jacket tube it is delivered, through small holes, into the gases just before they enter the nozzle, and is there converted into steam, this acting both to lower the temperature of the issuing gases to a point where they will not injure the blades of the turbine, and also itself being discharged upon the wheel with the gases and forming a part of the jet, which is thus composed of mingled gas, steam and highly heated air.

"In order to obtain the desired result of a machine involving only rotary motion, it is necessary that the compressed air by which the combustion chamber is fed should be produced, not by a reciprocating piston compressor, but by some form of rotary machine, preferably so arranged that it can be coupled directly to the turbine itself. This means that the rotary gas turbine must also include a rotary air compressor, and that such a compressor must have a high efficiency in itself, otherwise it will produce such a large proportion of negative work as to detract materially from the efficiency of the combined machine, even though the actual thermal efficiency of the turbine be high.

"After a number of experiments upon single-impeller turbine air compressors, driven at high rotative speeds by De Laval steam turbines, the services of Professor Rateau were enlisted in the work, and a multiple turbine compressor, designed by him especially for this work, was constructed at the works of Brown, Boveri & Co., at Baden, Switzerland. This machine is arranged in three sections and provided with continuous cooling circulation, and, being thoroughly tested, was found to be capable of delivering one cubic meter of air per second at a pressure of 6 to 7 atmospheres, with an efficiency ranging between 60 and 70 per cent.

"In this arrangement the compressor was found to absorb about one-half the total power developed by the turbine, the machine, when running at about 4,000 revolutions per minute, developing about 300 horse power over and above the negative work absorbed by the compressor. At the present time experiments are being made upon the thermal efficiency of the machine, which is, as yet, not as high as that of the reciprocating gas engine; but these tests are not yet completed, and the results not available for publication.

"During the past few months a practical application of this turbine has been made in connection with the operation of submarine torpedoes. It is well known that in certain types of such machines the motive power for the brief period which elapses between the discharge and the contact with the target is derived from a store of compressed air, and in some such torpedoes the compressed air acts upon a turbine wheel similar to the steam turbine. This principle has now been extended to the use of the gas turbine, the compressed air from the reservoir passing through a combustion chamber, and the total products of combustion, together with the vapour of water, acting on the turbine, largely increase its capacity.

"The turbines made for this purpose develop 120 horse power at a speed of 1,000 revolutions per minute, the expansion ratio being 8.4. The weight of the turbine alone is 73.16 kilogrammes, or about 1.3 pounds per horse power. Including the weight of the reservoir of compressed air, together with the petrol and water for a discharge lasting 80 seconds, the total weight of the whole apparatus is about 295 kilogrammes, or a little less than 2.5 kilogrammes, or 5.5 pounds, per horse power.

"Although the gas turbine is, therefore, still in the experimental stage, it has made material advances during the past year, the 300 horse-power combined compressor and turbine being an accomplished fact, and a number of 120 horse-power machines of a special type being actually installed in submarine torpedoes completed for active service. When this rate of progress is compared with the time required to bring the reciprocating gas engine to its present state of perfection, there appears to be reason for encouragement and interest."

TECHNICAL EDUCATION IN THE UNITED STATES.

A COMMENTARY ON VARIOUS FEATURES BY AN EMINENT BRITISH ENGINEER.

Sir William H. Preece—Royal Society of Arts.

TECHNICAL education in the United States is at a stage of more than ordinary interest. At least two important movements are clearly discernible — one toward standardization of requirements and courses, and the other (as yet localized and individualistic) toward bold and sweeping changes in curriculum and in modes of teaching applied science. While these tendencies are not necessarily opposed, at present they are pointing in opposite directions; one (probably unintended) is to give such force and authority to established, crystallized "standard" courses that change becomes more difficult; the other is to keep the entire scheme fluid and to run it into channels closely parallel to the engineering life of the day. This latter idea is apparent in Prof. Diemer's article, which we publish this month, and it will be presented again with clearness and vigor in Prof. Rautenstrauch's discussion following in our next issue.

The announcement of Sir William H. Preece's paper before the Royal Society of Arts therefore wakens expectancy of something peculiarly significant. The contact of a distinguished man with a great subject under auspices so high should yield a notable result. It is however a disturbing surprise to find that beyond his enthusiasm over the technical schools of the Carnegie Institute, the opening of which he attended, the eminent author has little to say that tends to enlightenment upon American technical education, and that much that he says tends in the contrary direction. Possibly the foundations he laid were too slight for an important structure to rest upon. He says:

"The old universities of America do not differ very widely from their ancestral type in the old country. The oldest of this class are Harvard, Yale, Princeton, Cornell, Johns Hopkins (Baltimore), and Columbia (New York), etc. I had on previous occasions visited Harvard and Johns Hopkins, and on my recent visit was prevented from going to Cornell. Cornell was founded by Ezra Cornell in 1807. Its centenary was celebrated last year."

Perhaps if Sir William had not been prevented from going to Cornell he would have learned that the centennial was of the birth of the founder, not of the University. Cornell was chartered in 1867; instead of being one of the oldest, it is one of the youngest of the American universities, while Johns Hopkins dates only from 1876. If the line of historic development be followed, with the great colleges might well be grouped the University of Pennsylvania, founded as a college in 1755 and recipient of the first university charter in America in 1779; or we might be told of some of the smaller colleges—William and Mary (1693); Brown (1764); Dartmouth (1769); Washington and Lee (1782); Williams (1793); Union (1795); the University of Virginia (1819). These, and others equally worthy to be noticed in their class, have all been intimately associated with the Colonial history of the country, or with the early days of the Republic, and with the education of men who have made American history.

Continuing his outline of the institutions to be considered, Sir William says:

"The best known State universities are those of Michigan, Minnesota and Illinois. The leading technical colleges are: Massachusetts Institute of Technology (Boston), the Stevens Institute (Hoboken), the Armour and Lewis Institutes, Chicago, the Pratt Institute, Brooklyn, and the Worcester Institute of Technology (sic). There is also a very fine trade school in New York."

The determination of the three "best known" State universities perhaps must be decided to some extent by one's own knowledge of the many institutions in this class meriting consideration. We may admire without imitating the confidence shown in this definitive choice. But the list of the "leading technical colleges" (we say it without the least disrespect to the excellent institutions included in it) could scarcely be more curious. Are examples so pre-eminent as the Columbia Schools of Applied Science (formerly the School of Mines) or the Colleges of Engineering at Cornell University, omitted because the parent institutions have been mentioned before in another and a wholly different connection? Then what remains yet to be said of a selection catholic enough to range from the Massachusetts "Tech" to the New York Trade School, yet silent as to Rensselaer, the first college of civil engineering ever established and Alma Mater of some of America's best railroad men; ignorant of Purdue University, famous for its work in railroad technology; of Lehigh, unique in its instruction in coal mining; of Cincinnati, with its novel project for mechanical training; of Pennsylvania, ignored now in its technical as well as its classical schools; of Washington, Clarkson, Vanderbilt? But space fails for the mention of institutions which should be included if the scale suggested by Sir William's list is applied throughout; and yet no place has been made in his classification for examples so distinctive and interesting as the University of Chicago, or Leland Stanford Junior.

These exceptions are not taken in any spirit of captiousness, but pursuant to careful inquiry into the extent of the author's acquaintance with technical education in America, and therefore the validity of his deductions. There is no question as to Sir William's conscientiousness in recording the observations which he thinks he has made. He is almost painfully careful to explain that he is not certain whether it was at the Keighley or the Halifax Institute that Mr. Carnegie quoted his grandfather in 1900. He gives a pictorial typographic rendering of the Carnegie Institute yell. The difficulty probably is that the white lime-light which follows Andrew Carnegie wherever he goes is perhaps not the best for a clear vision or an accurate perspective of broad ranges. The tendency of this influence is shown by Sir William's enthusiastic statement in his first paragraph that by Mr. Carnegie's gifts "the enjoyment of literature, art, music and science has thus been placed within the free reach of every citizen in Pittsburg . . . . which has a municipal population of 750,000 people . . . . and is surrounded by a district of 2,000,000 souls." It appears two pages later that the entire plan contemplates tuition for but 4,000, that less than 1,400 are enrolled, and that the "reach" is not "free," but costs up to a maximum of $30 a year. It seems, in short, that the observations which Sir William was able to make during his trip, modified by former visits to Harvard and Johns Hopkins and by a disappointment in the direction of Cornell, are not many enough to admit of safe generalization. Take, for example, the paragraph toward the close of the paper in which a number of general propositions are advanced concerning educational conditions in the United States:

"A smart boy in America can get his education practically given free up to twenty-two years of age. There is everywhere co-education. There is no residential system at the universities. Accredited pupils can pass from the high schools to the university without an entrance examination. There is a close and almost organic connection between academic and industrial life. Culture is not neglected as with us. Teachers are actively engaged in the practice of their professions."

Scarcely one of these propositions is true of a mapority of cases, and many of them are true only of exceptional instances.

Again, Sir William has this to say of a certain class of material which he seems to think represents the student body of the American technical college:

"The American boy, the training of whose mind we are considering, possesses the energy and smartness of a new race. The European boy is mentally two years behind him. His precocity is assisted by his keenness and by his vivacity. He works with an object and a determination to succeed. . . . This imbibed energy is not a question of race, but one of climate, for it affects all those who go there, whatever their nationality."

It is not difficult to believe that under the inspiration of Mr. Hammerschlag's unusual genius, many of these qualities were shown by the boys in the trade schools that Sir William visited. That they are not widely distributed is perhaps best proved by the comments of a New England Machinist in the April issue of THE ENGINEERING MAGAZINE, and those of a Southern shop superintendent printed elsewhere in this number. It is very doubtful indeed whether, among the classes making up the vast majority of students in American technical colleges, the American lad is at all ahead of the English lad of the same age. In fact, the English school system seems rather to cultivate a superior self-reliance which puts the English youth in the lead. But it would be interesting to know just what climate Sir William has in mind—Maine or California, Minnesota or Louisiana, Ohio or Colorado. The range of climate of the United States is as great as that between Sweden and Italy or between Switzerland and Japan. Are all these varieties so "champagne-like"?

Apart, however, from all these points of exception is the fundamental question as to what Sir William is talking about. He passes from manual training to technical education—from the New York Trade School to Johns Hopkins or Harvard—with such speed and suddenness that it is hard to disentangle the two ideas. He says that he has "always defined technical education to be that form of teaching which trains the brain to assist the hands." This scarcely seems to be an accurate description of the concept usually held in the United States. It is at once too broad and too narrow—too broad because it would cover equally well the training of a sculptor, a cigar-maker, or even a "professor of legerdemain"—too narrow because it omits most of the training of the technical man as exemplified, for instance, by the late Lord Kelvin, or Sir Benjamin Baker, or by Mr. John Hays Hammond. Except for some manipulative skill with instruments, usually needed only in junior positions, the technical man does not work with his hands.

The trade school and the college of engineering in the United States are wholly different in scope and purpose, working upon different material by different methods. The hopeless entanglement of the two ideas, and the attempt to make a composite picture with features from two radically different types, mingled at random, makes Sir William's image of technical education in the United States almost unrecognizable to those who know the original and quaintly misleading to those who do not. It is fashioned with evident enthusiasm and kindliness of purpose—but the likeness is not there.

THE STUDY OF ORE DEPOSITS.

A REVIEW OF PRESENT TENDENCIES AND THE PREVAILING THEORIES.

Waldemar Lindgren—Economic Geology.

THE advance in scientific knowledge during the nineteenth century is nowhere better illustrated than in that branch of the science of geology which is concerned with the study of the nature and formation of ore deposits. From insignificant beginnings, a series of notable achievements advanced it to a position of the utmost practical utility, based upon well fortified theories. As Mr. Waldemar Lindgren pointed out in his recent Presidential address before the Geological Society of Washington, the year 1900 may be taken as a year of equilibrium, in which the adherents of the various prevailing theories were somewhat evenly divided, but since that date the rapid development of the science has led to a number of changes in general opinion as to the manner of ore deposition. It was the purpose of Mr. Lindgren's address to trace the general tendencies of thought during the first seven years of the present century, and a brief summary of his interesting review of present activities and theories is contained in the following abstract of his paper, as published in *Economic Geology* for December, 1907.

While the study of ore deposits was first put on a scientific basis in Germany, the variety and extent of the ore deposits of the United States and the generous aid given to their study by the federal and state Governments have placed the latter country at the head of the nations in extent of practical and theoretical investigations. In general activity, Germany undoubtedly occupies the second place, though here the advance is due mainly to individual effort unaided by state grants. Sweden and Norway are prominent, and in Austria-Hungary, France and Italy the work of investigation is being carried on by able and earnest students. In England, little attention is given to the subject but in many of the British colonies, notably Canada and Australia, a great deal of valuable and successful work is being done. In Latin America, Mexico has assumed the leading place but a great deal of activity is manifested in all the South American states. In the United States geological researches are, for the most part, published in monographic form, in which the results of thorough investigations in particular fields are recorded in great detail. Canada and Mexico have taken up monographic work on a considerable scale, and other countries to a greater or less extent, but a good part of recent literature, though valuable in many respects, is decidedly superficial in character.

A great part of the progress of recent years may be attributed to the universal appreciation of the necessity of microscopic study of rocks and ores. While microscopic investigations have been numerous, only one new method of importance has been developed, that of Campbell's application of metallographic methods to the study of opaque minerals. On the other hand, a field which has been too much neglected, as shown by the small amount of recent literature on the subject, is that of chemical geology. Early in his work the geologist is forced to recognize chemical work as absolutely essential but in most cases his own knowledge of analytical chemistry is insufficient and he has to resort to the services of a professional chemist in performing the experimental work necessary to support his deductions. Chemical geology has failed to advance as rapidly as it should because it is only rarely that chemists are interested in geology or have means or opportunity to pursue geological studies. As the most notable of recent contributions to this subject may be mentioned the work of Arrhenius and Vogt on differentiation in magmas, and of Kohler on absorption, but the vast number of questions which can be elucidated only by chemical research demands a large and systematic expansion of investigation in this field.

The general methods of the study of ore deposits may be classed as the monographic, as exemplified in United States practice, and the geographic. The latter neglects to a certain extent the minor features of deposits but studies a great number of adjacent localities in their geographic relations. To quote DeLaunay, who had been chiefly responsible for the development of the geographic method, it "desires to show the distribution of the various regional types of mineral deposits, and the accord of these types with the geological structure, with the age of the rocks and with the eruptive districts." The monographic method leads to a minute knowledge of a limited number of districts but without the application of the geographic method, knowledge of the distribution of metals and their connection with geological structure is insufficient. The study of hot springs, an important field in which but little advance has been made in recent years, is a case in which both these methods should be employed.

"Attempts have been made to perfect a genetic classification of ore deposits, but it must be confessed that we are still far from the goal, and many editors of text-books candidly throw consistent genetic classification to the winds and describe ore deposits geographically, or by metals, or by the old terms of bedded, massive, or tabular deposits. Two genetic terms have, however, found general acceptance after their recent introduction by Stelzner and Beck. The terms are *syngenetic* and *epigenetic*. The former comprise those deposits which originate simultaneously with the surrounding rocks either through the differentiation of magmas, through mechanical deposition, or through chemical precipitation in seas or lakes. In the epigenetic deposits, on the other hand, the ores formed by filling or metasomatic action are later than the encasing rocks. During the last years many deposits have, by prevailing opinion, shifted their position in relation to these two distinctions."

In general the syngenetic class of igneous origin has grown considerably. Prominent examples of additions to it are the North Swedish apatitic iron ores and the Sudbury pyritic deposits, which are now regarded as products of magmatic differentiation on a large scale. On the other hand there is a strong tendency to transfer many occurrences formerly held to be of syngenetic-sedimentary origin to the epigenetic class. A great deal of discussion now centres about such deposits as the copper and lead-bearing sandstones, shales and conglomerates, the magnetite ores of Central Sweden, and pyritic occurrences. The prevailing theories, based upon recent investigations which disclose undoubted evidence of metasomatic action, tend to assign many of these deposits to the epigenetic class.

Contact metamorphic deposits have ceased to be considered oddities and exceptions and have taken their rightful place as a distinct and important class of occurrences. It is only within recent years that the study of metamorphic processes has been put on a thoroughly scientific basis but few advances have been more fruitful of results. Another subject of much importance has claimed attention recently, which may be called the counterpart in the study of ore deposits of historical geology in the larger field. This is the study of the various epochs of the formation of mineral deposits. To the geologist the processes of first deposition are perhaps the most interesting, but economically, to the mining industry, the study of secondary rearrangement and concentration has been attended by results of great importance and value. Another important feature of the study of ore deposits in which the mining industry is deeply concerned is the determination of form and structure, a field in which much progress has been made within the period under review.

"But after we are done with the description of our deposit and with the explanation, if attainable, of its manner of mineral formation, the question of its ultimate origin always remains, that most difficult and unsatisfactory chapter to write, since it is in part based on hypotheses and suppositions. Whence came these solutions, these carriers of the rarer metals? Aqueous deposition is universally accepted for the epigenetic deposition. We are all familiar with the theory of circulating and depositing or surface waters whose ablest exponent is Van Hise, and which found almost universal approval in the last years of the nineteenth century. The metals contained in the reascending surface waters were held by Stelzner to come from 'indefinite depths,' by Posepny to be extracted from the 'barysphere,' by Sandberger from the wall rocks of the deposits, by Van Hise finally by gradual solution of minute traces in the rocks during the descent of the waters. . . . .

"In the study of genesis, the most remarkable tendency during the last few years has consisted in the rapid and widespread, though not unanimous acceptance of the magmatic theory, according to which all igneous magmas contain water and dissolved metals which upon the ascent of the magma into a zone of lessening pressure are given off, penetrate the surrounding rocks, and ascend to the surface as thermal springs. The results would in consecutive order consist of: (1) Product of igneous differentiation in the magmas, (2) contact deposits at the point where the volatile substances left the magma, (3) deposits by magmatic waters on their way to the surface at greater or less distance from their point of origin and more or less mixed with surface waters. The theory that many hot ascending waters and much of their dissolved substances are of magmatic origin has been supported by some of the ablest men in geology. . . . .

"Perhaps the adherents of the magmatic theory go too far in some cases, as always happens in a new swing of opinion toward fresh and attractive views, but I believe it is safe to say that this theory has come to stay and that this and no other satisfactorily explains many ore deposits. Far be it from me to deny the power of surface waters, especially when somewhat heated by long underground passages, to dissolve and deposit material, and their work of concentrating metallic values is surely most efficacious in porous sedimentary rocks. Furthermore, it must be remembered that the magmatic waters constantly mix with those from the surface and that, as pointed out by many observers, this is one of the most potent causes for precipitation. . . . .

"The prevailing theoretical tendencies of the present day may be summed up as follows: We unanimously agree in seeking the ultimate source of the metals in the igneous rocks. We say that the rarer metals and other substances in aqueous solution emanate from the ma mas during and after their irruption i to higher levels of the lithosphere, ar that minerals containing these meta are deposited along the pathway of t waters. We assert that heated atmo pheric waters may search the congeal rocks, abstract from them a part of t small residues of the valuable metals a deposit them along their channels. W say further that metamorphism, aid by moisture, when acting upon the igneous rocks, is a potent factor in fav of further concentration.

"We say finally that as erosion d grades the volcanic mountains and the ore deposits, and the fragments are ca ried down to form sedimentary beds, t heavy native metals such as gold an platinum, are concentrated into placer and the baser metals are distributed salts of various kinds throughout t beds. Atmospheric waters take up the particles into solution, and, aided by t influence of sulphur compounds and o ganic matter, concentrate the deposits i congenial places. Ore deposits of valu resulting from chemical precipitates i sea or lake water, form only in case c abundant metals like iron. It is possib that in this summing up is reflected to much of my own individual opinion, b I believe that it represents fairly th general trend of modern thought."

THE CONSTITUENTS OF STEEL.

A DEFINITIVE SUMMARY OF THE CONSTITUENTS RECOGNIZED IN METALLOGRAPHY.

Henry Le Chatelier—Revue de Métallurgie.

IN a paper published in the *Revue de Métallurgie* for March, M. Henry Le Chatelier attempts to give a simple and precise definition of the various constituents of steels. In introducing his subject he recognizes that perfect simplicity and precision of definition are unattainable, simplicity, because of the inherently complex nature of the problems involved, and precision, because of the incompleteness of metallographic knowledge. The slow progress of this study, notwithstanding the large number of researches already made, has been due to the experimental difficulties in dealing with minute particles of sub stances, which cannot easily be isolate from the complex mixtures in whic they occur, but much unnecessary confu sion has been introduced by certain in vestigators who have modified the appli cation of the nomenclature originall adopted. It is possible, however, to out line the problems underlying the stud of the constituents of steels, to give th facts already established, and to indicat the points still in doubt. The followin abstract translation of M. Le Chatelier' article will indicate the unusually clea manner in which he reviews the prese state of the study of this branch of metallography.

Among the constituents of steel, at least four different species have to be distinguished: simple elementary substances; definite chemical combinations; solid solutions, also called compound crystals or isomorphous compounds, which are homogeneous mixtures, though in constantly varying proportions, of two or more different substances; and aggregates, heterogeneous matter formed by the mixture of homogeneous substances, elements, compounds or solid solutions. Regarding the latter, certain chemists have adopted the hypothesis that as aggregates become more and more fine in grain, they pass gradually into true solution and hence they introduce a special category of a state intermediary between the two extreme terms, which they designate under the name of emulsion or collodial solution.

The elementary substances found in steels are graphite, or pure carbon, and ferrite, or pure iron. Carbon exists in steel as an element only in the form of graphite, although different names are often employed to distinguish the free carbon of cast iron and steels, according to the conditions of its formation. Recent researches have shown, however, that the chemical properties of the carbon are always constant, the only difference lying in the size of the particles. Ferrite means primarily pure iron but the same name is retained for the solid solutions which iron forms with other elements, at least so long as the proportion of the latter is not too great. The ferrite of commercial steels always includes in solid solution in varying proportions some phosphorus, silicon, manganese, and doubtless other impurities. A combination of pure iron and pure carbon, Fe_3C, known as cementite, is the only definite chemical compound recognized in steels. The carbide of manganese, Mn_3C, can mix with cementite in solid solution but it is not known whether other elements can be introduced in this manner.

Before considering the nature of the different solid solutions occurring in steels, it is necessary to recall the allotrophic forms of iron, the existence of which was demonstrated by Osmond. There are at least two: alpha iron, normally stable at ordinary temperatures and characterized particularly by its magnetic properties; and gamma iron, stable only at temperatures above 900 degrees, and characterized by the absence of magnetic properties and by an electrical resistance at least ten times as great as that of alpha iron, measured at ordinary temperatures. The transformation of gamma iron into alpha iron is accompanied by a sudden change in linear dimensions, amounting to one or two thousandths, and by the production of considerable heat. A third form, beta iron, has been mentioned, stable between 750 and 900 degrees and differing from alpha iron only by the absence of magnetic properties but the effect of this form is not yet recognized.

The study of solid solutions in steel is rendered very difficult by the fact that none of them is stable at ordinary temperatures but at least two are recognized, austenite and martensite. Austenite is a solution in gamma iron of carbon, but whether in the form of pure carbon or of carbide of iron is not known. The solution, however, cannot contain more than 2 per cent. of carbon. It is stable between the point of solidification of the metal and a lower point of transformation, varying between 700 and 1200 degrees, according to the carbon content. Austenite can be preserved in steel at ordinary temperatures with great difficulty by very sudden cooling but it is never obtained pure. It is always mixed with martensite, troostite, cementite, etc. In the presence of sufficient quantities of nickel or manganese, in ferro-nickel with 25 per cent. nickel or in 13 per cent. manganese steel, it is stable at ordinary temperatures. Austenite is not magnetic and has a very high electrical resistance. Martensite also is a solution of carbon in iron. It is distinguished from austenite by the fact that it is very magnetic and it may be considered as a solution of carbon in alpha iron. It is the normal product when steels are quenched at or above 800 degrees. The sudden cooling hinders the breaking down of the austenitic solution, but it does not succeed, except in exceptional cases in preventing the gamma iron from returning in that solution to the state of alpha iron.

In addition to these known solid solutions there is a certain constituent which M. Le Chatelier calls the constituent X, which may be a solid solution or a very fine-grained aggregate of indistinguishable elements. It is recognized by its property of taking an intense black coloration when the polished surface of a specimen of steel is etched by even the weakest acids. This constituent has been given various names, troostite, osmondite, troosto-sorbite, and even sorbite (Stead), the different names referring to the different conditions in which the constituent is obtained. Troostite is the name generally applied to the black substance obtained when steel with 1 per cent. carbon is quenched at the recalescence point, about 750 degrees. Osmondite is obtained by reheating an originally martensitic steel to 300 degrees. Troosto-sorbite is the name given to the black substance often observed in connection with martensite and austenite when steels containing over 1 per cent. carbon are quenched at temperatures above 1000 degrees. According to Stead's definition, sorbite is the black substance obtained by slow tempering of steel, as in the oil tempering process. Recent researches would seem to indicate that the constituent X is a very fine aggregate of ferrite and cementite, on account of the uniformity of some of its electrical properties with those of annealed steels.

In slowly cooled steels an extremely clean aggregate, pearlite, is formed, consisting of alternating particles of ferrite and cementite and with a structure corresponding to that of most eutectic mixtures. It is produced by the breaking down by slow cooling of the austenitic solution, which allows ferrite and cementite to crystallize out. Sorbite, according to Osmond, is a badly formed or granular pearlite, or one of structure so fine that its two constituent elements cannot be recognized under the microscope. It is normally produced by reheating martensitic steel above 300 d grees. The black matter becomes clear and takes on an appearance more a more clean as the temperature of r heating approaches 700 degrees. Wh the point of recalescence is passed, no mal pearlite is obtained on sufficient slow cooling. There is no differen between pearlite and sorbite except difference of structure. The elementa aggregates pearlite and sorbite may found associated in the same specim of steel with masses of ferrite and c mentite or with some of the solid sol tions, and aggregates of great comple ity may result. Names have be adopted, after Howe, for three of thes eutectoid steel, exclusively of pearli with 0.8 to 0.9 per cent, carbon; hyp eutectoid steel, an aggregate of ferr and pearlite, with less than 0.8 per ce carbon; and hyper-eutectoid steel, aggregate of pearlite and cementi with more than 0.9 per cent. carbo Similar terms are employed for ca iron, the eutectic in this case containi about 4 per cent. carbon.

The most important points for elu dation are the nature of the constitue X; the rôle of beta iron in the sol solutions of certain steels; and the cau of the progressive increase in the ele trical resistance of martensite with t temperature at which it is obtained. T nature of the constituent X is perha the most pressing problem and it is he also that the most trouble has be caused by certain investigators by t inexact application of certain term The constituent X has been called ma tensite, a distortion of the meaning this term as applied by Osmond, its ori inator. The application of the ter sorbite indifferently to imperfect pear ite and the constituent X is anoth source of confusion. Finally, almo every author has his own special si nification for the new term hardenit which is applied to martensite of a ce tain composition, to martensite in ge eral, and to the constituent X. Since r usage has given a preponderating im portance to any one of these significa tions, it would be as well if the use the term were suppressed altogether.

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of -manent value published currently in about two hundred of the leading en- ieering journals of the world—in English, French, German, Dutch, Italian, 1 Spanish, together with the published transactions of important engineering :ieties in the principal countries. It will be observed that each index note 'es the following essential information about every publication:

(1) The title of each article,	(4) Its length in words,
(3) A descriptive abstract,	(5) Where published,
(2) The name of its author,	(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineer- ; science, to the end that the busy engineer, superintendent or works man- er may quickly turn to what concerns himself and his special branches of rk. By this means it is possible within a few minutes' time each month to rn promptly of every important article, published anywhere in the world, on the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illus- tions, can usually be supplied by us. See the "Explanatory Note" at the end, ere also the full title of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

hes.

The Semicircular Masonry Arch. A. E. indau. Extends the method of para- lic-arch analysis, proposed by E. E. reene, to the analysis of the semicircu- r arch with fixed ends. 2500 w. Pro m Soc of Civ Engrs—April, 1908. No. 921 E.

See also Demolition, under BRIDGES.

:kwell's Island.

The Channel Spans of the Blackwell's Island Bridge. Illustrated detailed description of these spans and the method of erection. 4000 w. Eng Rec—April 11, 1908. No. 91645.

Cantilever.

Cantilever Bridge Erection on the Guatemala Northern Railway. On a 60-mile section through a high mountainous country there are 57 single-track bridges. Describes erection methods. Ills. 1500 w. Eng Rec—Apr. 4, 1908. No. 91408.

See also Blackwell's Island, Quebec and Viaducts, under BRIDGES.

Columns.

A Summary of Tests of Large Columns: Appendix 13 to the Quebec Bridge Commission's Report. A study of large-size column tests. 2000 w. Eng News—April 9, 1908. No. 91605.

Safe Stresses in Steel Columns. Discussion of J. R. Worcester's paper on this subject. 9500 w. Pro Am Soc of Civ Engrs—March, 1908. Serial. 1st part. No. 91311 E.

Concrete.

See Piers, and Viaducts, under BRIDGES.

Demolition.

The Destruction of Arch Bridges, Etc. H. C. D. Scott. Deals principally with the methods adopted for destroying old arch bridges carrying public roads over a main line of railway. Ills. 3000 w. Soc of Engrs—April 6, 1908. No. 91774 N.

Drawbridges.

Swing-Bridge Over the River Avon, at Bristol. William Henry Bourchier Savile. Illustrated description of a bridge with a carriage road and a double line of railway. Plate. 6000 w. Inst of Civ Engrs, No. 3666—April 16, 1907. No. 91847 N.

The Pyrmont Bridge, Sidney, N. S. W. Percy Allan. Illustrated detailed description of the methods of construction used for this swing-bridge, and information relating to it. Plate. 7000 w. Inst of Civ Engrs, No. 3483—April 16, 1907. No. 91846 N.

Discussion and Correspondence. Combined discussion of papers by Percy Allan, and by William Henry Bourchier Savile on large swing-bridges. 16000 w. Inst of Civ Engrs—April 16, 1907. No. 91848 N.

A Drawbridge Wreck, and Temporary Construction to Restore Traffic. Mason R. Strong. Illustrates and describes this wreck at Cleveland, O., and the difficulties to overcome in restoring traffic; the methods adopted and time consumed are given. Ills. 2500 w. Eng News—April 2, 1908. No. 91333.

Failures.

The Failure of an Old Railway Bridge in France. Jean Phizey, in *Gènie Civil.* An illustrated description of an accident occurring Aug. 8, 1907, at a bridge over the Loire near Angers. 1500 w. Eng News—April 9, 1908. No. 91602.

See also Drawbridges, under BRIDGES.

Floors.

Flooring vs. Stringers. Louis Ross. Discusses the problem of finding the distribution of loads, offering a solution. 3500 w. Eng News—April 23, 1908. No. 91878.

Manhattan.

The Towers on the Manhattan Bridge Over the East River at New York City. Illustrated account of the progress in the construction of the third suspension bridge between Manhattan and Long Island. 2000 w. Eng News—April 16, 1908. No. 91738.

The Erection of the Manhattan Bridge Towers. Illustrates and describes interesting details in the construction of the massive towers of this bridge across the East River, at New York. 3000 w. Eng Rec—April 4, 1908. No. 91402.

Masonry.

A Three-Hinged Arch Bridge of Freestone with Zinc-Filled Joints (Pont à Arcs de Pierre de Taille articulé à la Clef et aux Naissances avec Joints coulés en Zinc). Henri Tavernier. Illustrated description of this highway bridge of 25 metres span, near Lyons, France. 20000 w. Ann de Ponts et Chaussées—1907-V. No. 91508 E + F.

See also Arches, under BRIDGES.

Piers.

Substructure of Piscataquis Bridge, and Analysis of Concrete Work. G. A. Hersey, Jr. A general illustrated description of the construction of this railroad bridge, and also reports results attained with the different classes of concrete used. 1600 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91309 E.

Quebec.

Appendix 12, Report of Quebec Bridge Commission. A description of the fallen structure. Also Appendix 13, giving an examination of the various full-size column tests; and Appendix 14, giving a comparison of stresses. 9000 w. Eng Rec—April 11, 1908. No. 91652.

Appendix 15, Report of Royal Commission on Quebec Bridge. A description of researches made. Also Appendix 16, giving a discussion of the theories of built-up compression members, and editorial 14000 w. Eng Rec—April 18, 1908. No. 91783.

Appendix 17, Report of Royal Commission on Quebec Bridge Failure. Gives a comparison of certain chords with similar members of other large bridges. Appendix 18, gives a critical discussion of certain parts of the specifications. Appendix 19, on deflections under heavy winds. 6500 w. Eng Rec—April 25, 1908. No. 91934.

See Columns, under BRIDGES.

Reinforced Concrete.

Reinforced Concrete in Electric Railway Construction. N. M. Stark. Read before the Iowa St. & Int. Ry. Assn. On the value of concrete bridges, their design and erection. 1500 w. Elec Ry Rev—April 25, 1908. No. 91965.

Reinforced Concrete in the Construction of Highway Bridges and Culverts. James Mortland. Read before the Nebraska Cement Users' Assn. Considers briefly the materials in use for bridges and culverts, and discusses the adaptability of concrete for this purpose. 3000 w. Engng-Con—April 1, 1908. No. 91361.

A New Ferro-Concrete Bridge. Illustrated detailed description of a structure in Crewe Park. 2500 w. Engr, Lond—April 3, 1908. No. 91674 A.

The Henry Hudson Memorial Bridge. Illustrates and describes the reinforced-concrete arch bridge soon to be erected at New York. 1700 w. Sci Am—April 11, 1908. No. 91608.

The Reinforced-Concrete Bridge Across the Rhone at Pyrimont, France. An illustrated description, translated and abstracted from *Schweiz. Bau.* 1500 w. Eng News—April 2, 1908. No. 91329.

The Pyrimont Bridge (Note sur le Pont de Pyrimont). M. Schoendoerffer. Illustrated description of the design and construction of this bridge of concrete reinfôrced on the Hennebique system. 10000 w. Ann d Ponts et Chaussées—1907-V. No. 91509 E + F.

The Depression of Prince Regent Street in Wilmersdorf (Unterführung der Prinz-Regenten-Strasse in Wilmersdorf). Herr Hart. Illustrated description of a reinforced-concrete railway over-bridge. 2000 w. Beton u Eisen—March 12, 1908. No. 91575 F.

See also Trestles, under Bridges.

Steel.

Modern Simple Bridge Trusses of Long Span. C. R. Young. A discussion of spans over 300 feet, briefly considering the designs most used. 3500 w. Can Engr—April 3, 1908. No. 91376.

The Victoria Falls Bridge. George Andrew Hobson. Illustrated detailed description of the design and erection of this two-hinged spandrel-braced arch. Discussion and correspondence. Plates. 17000 w. Inst of Civ Engrs, No. 3675—March 19, 1907. No. 91852 N.

Strengthening a Double Line Railway Bridge. Aims to show how a girder may be designed to reduce just sufficiently the stresses in the existing girders. 2500 w. Engr, Lond—March 20, 1908. No. 91279 A.

Erecting the Springfield Bridge on Semi-Suspended Falsework. Illustrates and describes the methods used in replacing a bridge on the Boston & Albany R. R. across the Connecticut River. 1800 w. Eng Rec—April 4, 1908. No. 91385.

Erection of the Bellows Falls Arch Bridge. L. D. Rights. Illustrated detailed description of a highway bridge across the Connecticut River, an example of a through arch with a suspended floor. 3000 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91307 E.

Erection of French River Bridge—Canadian Pacific Railway. C. N. Monsarrat. Illustrated description of the erection of a long and heavy single-track span by the end launching method. 3000 w. Can Soc of Civ Engrs—April 16, 1908. No. 91895 N.

Changing the Steel Superstructure of the Bridge Over the Elbe on the Berlin-Magdeburg Line (Auswechslung der eisernen Ueberbauten der Bahnbrücke über die Elbe, Strecke Berlin-Magdeburg). W. Dietz. Illustrates and describes the methods used in replacing this bridge, span by span, the new trusses being completely built on shore and floated into position on pontoons after the old trusses had been removed bodily in a similar manner. 5000 w. Zeitschr d Ver Deutscher Ing—March 14, 1908. No. 91590 D.

See also Blackwell's Island, Cantilever, Columns, Drawbridges, Failures, Manhattan, Quebec, Transporter, Trestles, Viaducts, and Williamsburgh, under Bridges.

Suspension.

See Williamsburgh, under Bridges.

Terminals.

See same title, under STREET AND ELECTRIC RAILWAYS.

Transporter.

A New Transporter Bridge at Warrington. Illustrates and describes the methods of construction for this English bridge. 3000 w. Engr, Lond—March 27, 1908. Serial. 1st part. No. 91467 A.

Trestles.

Reinforced Concrete Trestle on the Burlington. Illustrates and describes method of renewing a timber trestle with a reinforced concrete structure. The work had to be put up under traffic. 500 w. R R Gaz—April 17, 1908. No. 91764.

A Large Wooden Trestle at McGill, Nevada. J. L. Dobbins. An illustrated detailed description of the timber and steel trestle approach to a smelter. 1200 w. Eng News—April 16, 1908. No. 91734.

Viaduct at the Steptoe Valley Smelting & Mining Company's Plant. Illustrated description of the wood and steel trestles forming a part of this plant in Nevada. 1200 w. Ry Age—April 10, 1908. No. 91689.

Viaducts.

Some Concrete Viaducts on the West Highland Railway. Walter Stuart Wilson. Brief illustrated description of two viaducts on this railway. 500 w. Inst of Civ Engrs, No. 3595—1907. No. 91856 N.

A German Railway Viaduct of Cantilever Construction with Novel Hinge Detail. Illustrated description of a structure at Westerburg, Germany. 700 w. Eng News—April 23, 1908. No. 91877.

Williamsburgh.

Additional Supports for the Stiffening Trusses of the Williamsburgh Bridge, New York City. In order to develop maximum carrying capacity, it was decided to strengthen the supports of the stiffening trusses of this large suspension bridge crossing the East River. An illustrated explanation of the work is given. 1200 w. Eng News—April 2, 1908. No. 91336.

CONSTRUCTION.

Barracks.

New Sanitary Detention Barracks at the U. S. Naval Training Station, Newport, R. I. R. E. Bakenhus. Describes barracks of interest on account of special features, and because of the great speed in planning and construction. 2500 w. Eng News—April 2, 1908. No. 91331.

Brickwork.

Reinforced Brickwork. Brief illustrated description of strengthening brickwork by binding it with wire mesh. 1200 w. Mech Engr—March 20, 1908. No. 91268 A.

Concrete.

See Foundations, under CONSTRUCTION; and Dams, and Sea Walls, under WATERWAYS AND HARBORS.

Concrete Blocks.

A Fireproof Garage. George E. Walsh. Illustrated description of a cement block structure. 2200 w. Sci Am Sup—April 11, 1908. No. 91609.

Earth Work.

See Dams, under WATER SUPPLY.

Factories.

Methods and Cost of Constructing a Brick and Steel Wire Glass Plant at Greensburg, Pa. A. E. Duckham. Details of cost and explanation of methods. 1800 w. Engng-Con—April 15, 1908. No. 91756.

The Fort Wayne Lamp Works of the Electric Company. A four-story reinforced-concrete factory building is described and the methods of construction used. Ills. 1800 w. Eng Rec—April 4, 1908. No. 91400.

Foundations.

Foundations. A. B. Clark. Describes some recent phases of development on the Manhattan Island, especially the use of high capacity piles of steel and concrete. Ills. Discussion. 6000 w. Pro Engrs' Club of Phila—Jan., 1908. No. 91629 D.

The Development of Building Foundations. Frank W. Skinner. An illustrated article describing the changes and difficulties in the preparing of foundations for the tall buildings now built in cities. 14000 w. Eng Rec—April 4, 1908. No. 91389.

Recent Developments in Pneumatic Foundations for Buildings. D. A. Usina. Reviews recent developments in foundations of the class used for high buildings in lower New York City. Ills. 3000 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91308 E.

Special Foundations for a New Edison Sub-Station. Describes piles of heavy steel tubes filled with concrete, and the methods used. Ills. 1200 w. Eng Rec—April 4, 1908. No. 91391.

A Stupendous Application of Concrete. Walter Mueller. Deals with its extensive use in the construction of the terminal buildings of the Hudson tunnels, more particularly in the foundations and approaches. Map and Ills. 2200 w. Cement Age—April, 1908. No. 91771.

Foundation Construction for the New Steel Capitol of South Dakota. Samuel H. Lea. Describes the character of the soil, the methods of determining the bearing capacity, and precautions taken to prevent unequal settlement. Ills. 2000 w. Eng Rec—April 4, 1908. No. 91395.

See also Piers, under WATERWAYS AND HARBORS.

Masonry.

See Dams, under WATER SUPPLY.

Piling.

See Foundations, under CONSTRUCTION.

Regulations.

Foreign Building Regulations. The present number considers the regulations in force in New York City. 2000 w. Builder—March 21, 1908. Serial. 1st part. No. 91257 A.

The Limitation of Height and Area of Buildings in New York. Ernest Flagg. Discusses the problem of limiting the height and area of buildings in the congested parts of cities, especially New York, giving suggestions believed to be effective. 2500 w. Am Archt—April 15, 1908. No. 91726.

The Regulations of the Austrian Department of the Interior, Relating to Construction in Rammed Concrete or Reinforced Concrete (Die Vorschriften des k. k. Ministeriums des Innern, betreffend die Bauweisen in Stampfbeton oder Betoneisen). 5000 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—March 6, 1908. No. 91581 D.

Reinforced Concrete.

Architectural Expression in a New Material. H. Toler Booraem. A discussion of practical and aesthetic problems of design in reinforced concrete. Ills. 7500 w. Archt Rec—April, 1908. No. 91303 C.

The Use of Reinforced Concrete in Engineering Structures. An informal discussion. Ills. 3300 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91312 E.

Graphical Determination of the Actual Stresses in Reinforced Concrete Beams

(Détermination graphique des Efforts réels dans les Poutres et Hourdis en Beton armé). J. Rieger. A mathematical discussion taking into account tensile stresses and the strength of concrete in tension. Ills. 5000 w. Génie Civil—March 7, 1908. No. 91528 D.

Reinforced-Concrete Cantilever Girders in the Boyertown Building, Philadelphia. A brief description of the main features of the design of this 10-story reinforced-concrete building, discussing details of interest. Ills. 1100 w. Eng News—April 23, 1908. No. 91879.

Reinforced-Concrete Building for Oil-Tank. C. F. Leonard. Read before the New England Assn. of Gas Engrs. Illustrates and describes a structure built to enclose an oil-tank in a thickly settled district, as a protection from fire. 4500 w. Pro Age—April 15, 1908. No. 91692.

A Ten-Story Building in Forty-seven Working Days. Describes the construction of a reinforced concrete building at 34 Fletcher St., New York City. Ills. 2000 w. Eng Rec—April 4, 1908. No. 91382.

The Construction of the Thirty-ninth Street Building, New York. An illustrated detailed description of the building of the McGraw Publishing Co. and its construction. 5000 w. Eng Rec—April 4, 1908. No. 91380.

The New Building of the Phelps Publishing Company. Brief illustrated description of a reinforced-concrete building for office and publishing business. 1800 w. Eng Rec—April 4, 1908. No. 91403.

Reinforced Concrete Power Station. Illustrated description of the construction of the Georgetown power station of the Seattle Electric Co., Seattle, Washington, which furnishes power for railways, lighting, etc. 2500 w. Cal Jour of Tech—Feb., 1908. No. 91302.

The Erection of the Westport Power House, Baltimore, Md. Illustrated description of the construction of a reinforced-concrete building. 1200 w. Eng Rec—April 25, 1908. No. 91932.

Extraordinary Public Works in Course of Construction in the Province of Ravenna, with Special Reference to Those of Reinforced Concrete (Lavori pubblici straordinari in Corso di Costruzione nella Provincia di Ravenna con speciale Riguardo a quelli in Cemento armato). Medeerico Perilli. The works include sewers, locks, dams, bridges, breakwaters, etc. Ills. 7000 w. Ann d Soc d Ing e d Arch Ital—Feb.-Mar., 1908. No. 91532 F.

See also Factories, Foundations, Regulations, and Tunnels, under CONSTRUCTION; Reinforced Concrete, under BRIDGES; Sewers, under MUNICIPAL; Dams, and Purification, under WATER SUPPLY; Coast Protection, under WATERWAYS AND HARBORS; Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS; Poles, under ELECTRICAL ENGINEERING, TRANSMISSION; Dry Docks, under MARINE AND NAVAL ENGINEERING; Reinforced Concrete, under MINING AND METALLURGY, MINING; and Shops, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Steel Buildings.

Erecting Columns in Occupied Offices. Describes work on the old Singer building in raising it from 11 to 14 stories. 1200 w. Eng Rec—April 4, 1908. No. 91392.

The Erection of the Metropolitan Life Building Tower, New York. An illustrated article giving information concerning methods of erecting this 48-story structure. 3500 w. Eng Rec—April 4, 1908. No. 91396.

The Construction of the City Investment Building, New York. Illustrated detailed description of methods of erection used for this immense fireproof structure. 6000 w. Eng Rec—April 4, 1908. No. 91398.

The Construction of the Hudson Companies' Buildings, New York. Illustrated description of this important terminal and office building. 3000 w. Eng Rec—April 4, 1908. No. 91410.

Hippodrome Building at Cleveland, Ohio. James A. Joyce. Plans and description of difficult foundation work and details of a steel-frame building. 1700 w. Eng News—April 9, 1908. No. 91603.

Trusses.

Displacement Diagrams of Framed Structures by Deflection Angles. Myron S. Falk. Explains a graphical method which overcomes difficulties occurring when using the Williott diagram. 2200 w. Sch of Mines Qr—April, 1908. No. 91-913 D.

Tunnels.

The Second Raton Hill Tunnel of the Atchison, Topeka & Santa Fe Railway. Illustrated description of a tunnel under construction at Raton Pass, New Mexico. 2500 w. Eng Rec—April 4, 1908. No. 91404.

The East River Tunnels of the Pennsylvania Railroad. A general summary of the work, with illustrations. 2000 w. R R Gaz—April 3, 1908. No. 91435.

The Meeting of the Four East River Tunnels of the Pennsylvania Railroad. Particulars of this most difficult of subaqueous tunneling projects, with illustrations. 3000 w. Eng Rec—April 4, 1908. No. 91407.

The Manhattan Cross-Town Tunnels of the Pennsylvania Railroad. Brief illustrated description of the main features of the engineering work. 1500 w. Bul Am Inst of Min Engrs—March, 1908. No. 91717 C.

The "Subway," New York City. Sections 13 and 14. Stephen U. Hopkins. An illustrated description of the construction and methods on these sections. 4500 w. Harvard Engng Jour—April, 1908. No. 91837 D.

Tunnels Under the Chicago River for Electric Cables. George B. Springer. Describes the methods of construction and some of the interesting features. Ills. Discussion. 7000 w. Jour W Soc of Engrs—Feb., 1908. No. 91632 D.

The Construction of the Market Street Subway, Philadelphia, Pa. Illustrated description of the methods on the difficult City Hall section, and other sections of this reinforced-concrete subway. 3000 w. Eng Rec—April 25, 1908. No. 91929.

See also Sewers, uder MUNICIPAL; Tunneling and Tunnels, under MINING AND METALLURGY, MINING; and Subways, under STREET AND ELECTRIC RAILWAYS.

MATERIALS OF CONSTRUCTION.

Cement.

See Mortars, under MATERIALS OF CONSTRUCTION.

Masonry.

The Effect of Temperature Changes on Masonry. Charles S. Gowen. Gives a report of observations of various cracks occurring in the masonry sections of the new Croton Dam. 3000 w. Pro Am Soc of Civ Engrs—April, 1908. No. 91920 E.

Mortars.

Portland Cement Mortars and Their Constituent Materials. Richard L. Humphrey and William Jordan, Jr. Reports results of tests made at the structural-materials testing laboratories, Forest Park, St. Louis, Mo., 1905-1907. Ills. 30000 w. U S Geol Survey—Bul. 331. No. 91705 N.

Steel.

The Work of the Testing Department of the Watertown Arsenal, in Its Relation to the Metallurgy of Steel. James E. Howard. Remarks on the tests of steel ingot metal and derivative shapes. 2200 w. Bul Am Inst of Min Engrs—March, 1908. No. 91709 C.

Timber.

A Graphical Comparison of Various Log Rules. Arthur H. Morse. A comparison of rules for ascertaining the number of board feet of 1-inch lumber which can be sawn from a log of given diameter and length. 1800 w. Eng News—April 9, 1908. No. 91604.

Structural Timber. W. K. Hatt. Discusses the physical character of wood fabrics, indicating the effect on its strength of various elements arising during the growth of the tree, and some of the operations necessary in preparing the material for market. Discussion. Ills. 8500 w. Pro W Ry Club—March 17, 1908. No. 91835 C.

Timber Preservation.

The Analysis and Grading of Creosotes. Arthur L. Dean and Ernest Bateman. Gives experimental data and conclusions. 7000 w. U S Dept of Agri, Circ 112—Feb. 26, 1908. No. 91959 N.

Kansas City Plant of the American Creosoting Company. Illustrated detailed description of a plant designed for treating ties by the Lowry patented process. 2500 w. Ry Age—April 3, 1908. No. 91412.

MEASUREMENT.

Surveying.

Survey of Inaccessible Places by Tacheometry. Otway Fortescue Luke Wheeler Cuffe. A description of instruments used and work done, to obtain data for the construction of a lighthouse on a rocky coast. Ills. 2000 w. Inst. of Civ Engrs, No. 3644—1907. No. 91854 N.

Results of Base Line Measurements through the Simplon Tunnel, March 18 to 23, 1906 (Die Ergebnisse des Basismessung durch den Simplontunnel vom 18 bis 23 März, 1906). M. Rosenmund. Describes the methods of measurement and gives the results. Ills. 2000 w. Schweiz Bau—March 14, 1908. No. 91551 D.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

MUNICIPAL.

Garbage Disposal.

City Wastes Disposal and Street Cleaning. Paul Hansen. Abstract of a paper before the Ohio Engng. Soc. A study being made by the State Board of Health concerning the disposal of city refuse. 1500 w. Eng News—April 23, 1908. No. 91880.

Report on Street Cleaning and Waste Disposal, New York City. Extracts and general review of a report recently made by a committee appointed by the Mayor. Also editorial. 7500 w. Eng News—April 23, 1908. No. 91881.

Parks.

The Construction of Small Parks in Chicago. Linn White. An illustrated article on the construction and maintenance of these parks and the problems connected with them. Discussion. 7000 w. Jour W Soc of Engrs—Feb., 1908. No. 91634 D.

Pavements.

Street Paving in London. A summary of the report of the Metropolitan Paving Committee. 2800 w. Surveyor—April 17, 1908. Serial. 1st part. No. 91963 A.

The Cost of Brick Pavements and Cement-Mortar Curbs at Centerville, Iowa. M. G. Hall. Records of labor, material, and cost accounts. 1000 w. Eng News—April 2, 1908. No. 91334.

Detailed Cost of Jobs of Laying Asphalt Pavement in a Southern California City. Gives details of costs for two pieces of work. 2500 w. Engng-Con—April 1, 1908. No. 91362.

Comparative Strength of Brick and Concrete Foundations for Brick Pavements. Extracts from a report of Prof. I. O. Baker, concerning results of tests made, showing that a brick foundation is more than equal to a concrete. 1500 w. Munic Engng—April, 1908. No. 91474 C.

Public Baths.

The Municipal Public Baths at St. Gallen (Das städtische Volksbad in St. Gallen). A. Pfeiffer. A description of the building and the mechanical equipment. Ills. 3000 w. Serial. 1st part. Schweiz Bau—March 7, 1908. No. 91550 D.

Roads.

Progress Reports of Experiments with Dust Preventives. Experiments made by the Office of Public Roads during 1907. 9500 w. U. S Dept of Agri, Circ. 89—April 20, 1908. No. 91958 N.

Sanitation.

The Sanitary Campaign in California. An account of work to prevent the reappearance of the bubonic plague. 4000 w. Eng Rec—April 11, 1908. No. 91651.

Sewage Disposal.

See Purification, under Water Supply.

Sewers.

The New Main Intercepting Sewer at Waterbury, Conn. William Gravin Taylor. Illustrated description of the construction of this reinforced-concrete sewer. 1500 w. Eng Rec—April 4, 1908. No. 91406.

A Large Double-Barrel Sewer Built Across a Salt Marsh. Describes work on a reinforced-concrete sewer in progress in the borough of the Bronx, New York City. 3000 w. Ills. Eng Rec—April 4, 1908. No. 91388.

A Private Sewer Tunnel in Rock Excavation. Illustrates and describes the private sewer that serves the depressed yard of the N. Y. C. & H. R. R. R. Co. 3000 w. Eng Rec—April 11, 1908. No. 91650.

Some Construction Methods on Metropolitan Works. Howard S. Knowlton. Describes methods adopted in the handling of the field work in the construction of the sewerage system in the Boston Metropolitan District. Ills. 2000 w. Eng Rec—April 4, 1908. No. 91399.

The Canal Street Tunnel Sewer, New York City. Illustrated description of the rearrangements of the sewer system in the district traversed by the new subway loop to connect the Manhattan terminals of the Brooklyn and Williamsburgh bridges with the present subway lines. 2800 w. Eng Rec—April 18, 1908. No. 91780.

Stone Crushing.

A Commercial Stone-Crushing Plant at North LeRoy, N. Y. John Rice. Description of this plant. 2000 w. Eng Rec—April 4, 1908. No. 91284.

Street Cleaning.

See Garbage Disposal, under Municipal.

WATER SUPPLY.

Aqueducts.

See Ashokan, under Water Supply.

Ashokan.

Subsurface Investigations on the Catskill Aqueduct, Board of Water Supply. Robert Ridgway. A general description of this great engineering structure, with special description of the methods of exploration necessary to locate the aqueduct. Ills. 4500 w. Eng Rec—April 18, 1908. Serial. 1st part. No. 91779.

Explorations for Hudson River Crossing of the Catskill Aqueduct, New York City. Alfred D. Flinn. Explains the character of the problem as given by expert geologists, and describes the results of borings made, especially the sub-aqueous drilling. Ills. 4000 w. Eng News—April 2, 1908. No. 91332.

California.

Rain and Run-Off Near San Francisco, California. C. E. Grunsky. An analysis of rainfall and run-off conditions. 5500 w. Pro Am Soc of Civ Engrs—April, 1908. No. 91922 E.

Dams.

The Design of Buttressed Dams of Reinforced Concrete. R. C. Beardsley. Explains the calculations necessary in designing a dam of this type. 2000 w. Eng News—April 23, 1908. No. 91882.

Masonry Dam Formulas. Orrin L. Brodie. Presents a series of formulæ deduced by the writer in connection with studies made for the Board of Water Supply of the City of New York. Ills. 7000 w. Sch of Mines Qr—April, 1908. No. 91912 D.

A Few Words About Hollow Concrete-Steel Dams. Charles H. Eglee. Describes the construction, for reservoir purposes, of a dam of the open-front storage type.

Ills. Discussion. 5000 w. Jour N Eng W-Wks Assn—March, 1908. No. 91720 F.

Cost of Earth Work on the Belle Fourche Dam, South Dakota. Describes this construction work in S. Dakota, giving tables of costs. 1000 w. Eng News—April 2, 1908. No. 91330.

An Earth Dam with a Reinforced Concrete Core Wall at Dixville, N. H. Arthur W. Dudley. Describes the construction. 1200 w. Eng Rec—April 25, 1908. No. 91931.

The Marseilles Concrete Dam. Dr. J. H. Goodell. Illustrated description of difficult engineering work in Illinois. 1600 w. Sci Am Sup—April 18, 1908. No. 91748.

A Combination Dam and Bridge. Brief illustrated description of a reinforced-concrete structure at Horse Shoe, N. Y. 400 w. Eng News—April 9, 1908. No. 91600.

The Cataract-Dam. Illustrated detailed description of the construction of a rubber masonry dam for water conservation in New South Wales. 1800 w. Sci Am Sup—April 4, 1908. No. 91375.

A Drained Cement Revetment with Galleries, on the Upstream Side of the Masonry Dam of the Mouche Reservoir (Revêtement drainé en Mortier de Ciment avec Galeries visitables sur le Paremont amont du Barrage en Maçonnerie du Réservoir de la Mouche). A description of large works carried out to protect the masonry of the dam. Plate. 18500 w. Ann d Ponts de Chaussées—1907-V. No. 91511 E + F.

See also Masonry, under MATERIALS OF CONSTRUCTION; and Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Fire Protection.

See Fire Boats, under MARINE AND NAVAL ENGINEERING.

Irrigation.

Irrigation in Egypt. Brief illustrated descriptions of plants for the works at Fadlab and Atbara. 1000 w. Engr, Lond—April 17, 1908. No. 91983 A.

Home-Making by the Government. C. J. Blanchard. An illustrated account of the eleven immense irrigating projects to be opened in 1908. 9500 w. Nat Geog Mag—April, 1908. No. 91902 C.

A Large Irrigation and Power Project in Southern California. Illustrated description of an extensive project under construction in San Bernardino Mountains. 4000 w. Eng Rec—April 4, 1908. No. 91386.

Pipe Corrosion.

The Action of Water on Pipes. Freeland Howe, Jr. Treats of the causes, extent, and results of water action, and the remedies. 4500 w. Jour N Eng W-Wks Assn—March, 1908. No. 91721 F.

Pipe Laying.

Laying a 20-Inch Water Main Under Sidewalks. Describes work recently carried out at Utica, N. Y. 1200 w. Eng Rec—April 4, 1908. No. 91387.

Pueblo, Col.

A Notable Ground-Water Development at Pueblo, Colo. Explains the conditions and the development made 14 miles north of Pueblo, in the underground flow in the valley of the Fountain River. Ills. 5500 w. Eng Rec—April 4, 1908. No. 91383.

Purification.

Purification of Water Supply at Lawrence, Mass. J. Rodney Ball. Reviews the history of filtration in this city since 1893, showing the increase in healthfulness. Ills. 2200 w. Munic Engng—April, 1908. No. 91475 C.

Construction Methods at the Water Purification Plant at Toledo, Ohio. H. McKechnie. Illustrates and describes the construction of the reinforced-concrete mechanical filtration plant. 2500 w. Eng Rec—April 4, 1908. No. 91394.

Water and Sewage Purification Legislation in Ohio. A bill turning the control of stream pollution, sewage and water purification over to the State Board of Health. Also editorial. 2800 w. Eng Rec—April 11, 1908. No. 91646.

Reservoirs.

Some Construction Methods at the Croton Falls Reservoir. Illustrates and describes methods and appliances. 3500 w. Eng Rec—April 11, 1908. No. 91648.

Small Communities.

The Collection and Storage of Water for Domestic Purposes in Connection with Farmhouses and Villages. Harold G. Turner. Prize essay. The sources of supply, their palatability and wholesomeness, are considered. 3000 w. Plumb & Dec—April, 1908. Serial. 1st part. No. 91655 A.

Softening.

Water Softening at Oberlin, Ohio. W. B. Gerrish. Reports the success of softening with lime and soda ash. 1200 w. Eng Rec—April 18, 1908. No. 91782.

Tanks.

The Use of Steel in the Construction of Large Water Service-Tanks. Charles Walter Smith. Describes tanks used by the Board of Water Supply, Sydney, N. S. W. Ills. 2500 w. Inst of Civ Engrs, No. 3677—1907. No. 91843 N.

Water Works.

The Indian Creek Water Supply System of the Pennsylvania Railroad. J. W. Ledoux. Describes an elaborate system to supply the lines between Philadelphia and Pittsburg. Map. 3000 w. Eng News —April 9, 1908. No. 91606.

WATERWAYS AND HARBORS.

Barge Canal.

Progress on Section 11, New York State Barge Canal. Recent work between Pendleton and Tonawanda is illustrated and described. 1500 w. Eng Rec—April 4, 1908. No. 91397.

Construction Work on the Erie Barge Canal. James Cooke Mills. An illustrated article explaining the magnitude of this work and describing methods of excavating, the machinery used, etc. 2200 w. Cassier's Mag—April, 1908. No. 91454 B.

Canal Haulage.

Notes on Electric Haulage of Canal Boats. Lewis B. Stillwell and H. St. Clair Putnam. Appendix to paper (No. 90832) on tests on the Lehigh Canal. 600 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91704 D.

Canals.

Mountain Canals, a New, Natural System of Water Transport (Gebirgskanäle, neues, natürliches Wasserstrassen-Transportsystem). An illustrated description and discussion of the Caminada system. 3300 w. Serial. 1st part. Oest Wochenschr f d Oeff Baudienst—March 7, 1908. No. 91584 D.

See also Barge Canal, and Panama Canal, under Waterways and Harbors.

Coast Protection.

Method of Constructing Reinforced-Concrete Slope Paving for Holland Dikes. H. Huisman. (Condensed.) Illustrates and describes the DeMuralt system. 1400 w. Engng-Con—April 8, 1908. No. 91613.

Groynes of Reinforced Concrete to Check Coast Erosion. J. B. Van Brussel. Illustrates and describes this system of protection to be used at Brighton, England. 800 w. Sci Am Sup—April 25, 1908. No. 91892.

Colorado River.

The Lower Colorado River During and After the Freshet Stage of 1907. C. E. Grunsky. Describes the results of returning the river to its old channel, after the flood of the Salton Basin. 1500 w. Eng News—April 16, 1908. No. 91735.

Diving.

See same title, under MINING AND METALLURGY, Mining.

Dredging.

Dredging Equipment on the Panama Canal. F. B. Maltby. A brief description of the dredging machinery in use. 4000 w. Pro Engrs' Club of Phila—Jan., 1908. No. 91630 D.

Removal of Subaqueous Rock at Blyth. Georg Duncan McGlashan. An account of the use of a Lobnitz Patent Rock-breaker, stating its advantages. Ills. 4000 w. Inst of Civ Engrs, No. 3723—1907. No. 91845 N.

Floods.

The Flood of March, 1907, in the Sacramento and San Joaquin River Basins, California. Discussion of paper by W. B. Clapp, E. C. Murphy, and W. F. Martin. 7500 w. Pro Am Soc of Civ Engrs —April, 1908. No. 91923 E.

Great Lakes.

The Right-of-Way of the Great Lakes. F. C. Shenehon. Discusses the right-of way of the transportation system on the Great Lakes, and the importance of maintaining the lake levels. 6000 w. Jour Assn of Engng Socs—March, 1908. No. 91724 C.

Panama Canal.

The Panama Canal and the Middle West. Robert Isham Randolph. Argument for the improvement of inland waterways, especially the Mississippi and its branches, that the products of the middle west may find a shorter route to the Panama Canal. Map and Ills. 4000 w. Marine Rev—April 9, 1908. No. 91639.

Piers.

Concrete-Cylinder Sinking at Haulbowline. Harry Ekermans Oakley. Brief illustrated description of foundation work for a berthing jetty at Cork. 1500 w. Inst of Civ Engrs, No. 3707—1907. No. 91853 N.

Pollution.

New York Laws Relating to the Pollution of Streams. A. H. Seymour. From the Report of the seventh annual conference of Sanitary Officers of New York, giving information concerning these laws. 2000 w. Munic Engng—April, 1908. No. 91473 C.

Sanitary Investigation of the Mohawk River Drainage Area. Information from the Bulletin of the New York State Board of Health, concerning the river pollution, with recommendations. 700 w. Eng News—April 2, 1908. No. 91335.

River Regulation.

River Regulation, with Special Reference to the Ontario Peninsula and to the Grand River. W. H. Breithaupt. Read at Engrs' Club, Toronto. Map, and outline of possible development. 2000 w. Can Engr—April 10, 1908. No. 91681.

The Regulation of Streams with Shifting Beds, such as the Loire (De la Correction des Rivières à Fond mobile telles que la Loire). M. Audouin. A description of conditions and the works carried out to improve navigation on the Loire. Ills. 4200 w. Bul Soc d'Encour—March, 1908. No. 91526 G.

Sea Walls.

The Concrete Sea-Wall at Cebu, Philippine Islands. H. F. Cameron. Illustrated description of this sea-wall and the methods of construction. 2500 w. Eng Rec—April 25, 1908. No. 91928.

U. S. Waterways.

Our Inland Waterways. W. J. McGee. Reviews the history of waterway development in the United States and the recent work of the Inland Waterways Commission. 7000 w. Pop Sci M—April, 1908. No. 91300 C.

The Further Improvement of Our Inland Waterways. Major C. S. Riché. Read before the Contemporary Club of Davenport, Iowa. General suggestions for waterway connections, urging their need and advantages. 3500 w. Eng Rec—April 25, 1908. No. 91930.

See also Panama Canal, under WATERWAYS AND HARBORS.

Water Powers.

The Great Water Powers of the Provençal Alps (Etude des grandes Forces hydrauliques de la Région des Alpes Provençales). René Tavernier. A general report, and a report of the special investigations carried out in 1904-5. 18000 w. Ann d Ponts et Chaussées—1907-V. No. 91510 E + F.

MISCELLANY.

Forestry.

The Practical Work of the United States Bureau of Forestry. Day Allen Willey. Brief account of the work. 1800 w. Sci Am—April 25, 1908. No. 91890.

What Forestry Has Done. Treadwell Cleveland, Jr. Gives facts showing what forestry has done in other countries. 10000 w. U S Dept of Agri, Circ 140—Jan. 28, 1908. No. 91957 N.

Grubbing.

Methods of Grubbing Stumps and Trees with Machines. Illustrated description. 900 w. Engng-Con—April 8, 1908. No. 91614.

Natural Resources.

Conservation of the Natural Resources of the United States: the Work of the U. S. Geological Survey. Herbert M. Wilson. A summary of recent work by the U. S. Geol. Survey. 7000 w. Eng News—April 9, 1908. No. 91601.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

Wireless Telegraph and Telephone. Thomas E. Clark. A general explanation of the method of sending wireless messages, and the special advantages of the Clark system. 5000 w. Jour Assn of Engng Socs—March, 1908. No. 91722 C.

A Study of the Propagation and Interception of Energy in Wireless Telegraphy. C. A. Culver. Deals with the relative efficiency of several different types of receiving systems. 2500 w. Elect'n, Lond—April 10, 1908. Serial. 1st part. No. 91815 A.

Radio-Telephony.

See Radio-Telegraphy, under COMMUNICATION.

Submarine Telegraphy.

Submarine Telegraphy. Charles Bright. Gives a general idea of the theory and practice of transmitting electric signals, and experiences connected with the development of submarine telegraphy. Ills. 11000 w. Jour Roy U Serv Inst—March, 1908. No. 91499 N.

Telegraph Lines.

The Source of Current for Telegraph Lines (Stromquellen für Telegraphenleitungen). Wenzel Bubenik. A mathematical paper discussing methods of adjusting for variations in insulation resistance. Ills. 2000 w. Elektrotech u Maschinenbau—March 15, 1908. No. 91565 D.

Telegraph Offices.

The New Imperial Central Telegraph Office in Vienna (Die neue k. k. Telegraphen-zentrale in Wien). Illustrated description of the building and equipment. 2500 w. Serial. 1st part. Elektrotech u Maschinenbau—March 22, 1908. No. 91567 D.

Telegraphy.

See Submarine Telegraphy, under COMMUNICATION.

Telephone Exchange.

The New Gerard Exchange of the National Telephone Company. Illustrated detailed description of a London exchange. 2000 w. Elec Engr, Lond—April 10, 1908. Serial. 1st part. No. 91812 A.

Telephone Lines.

Private Telephone Installations (Les Installations de Téléphonie Privée). J. A. Montpellier. A discussion of the design of small local lines and of the appliances available. Ills. 3000 w. Serial. 1st part. L'Elecn—March 14, 1908. No. 91523 D.

Telephony.

The Effects of Leakance and the Use of Heaviside's Distortionless Condition in Telephone Transmission. B. S. Cohen. Shows that all lines should be kept at the highest practical insulation point consistent with due economy. 1000 w. Elect'n Lond—April 10, 1908. No. 91813 A.

DISTRIBUTION.

Choking Coils.

Choking Coils. Explains their use to reduce voltage where alternating current is used. 1500 w. Prac Engr—April 3, 1908. No. 91661 A.

Wiring.

Looping. Donald S. Munro. Discusses modern practice in wiring. 2500 w. Elec Rev, Lond—April 17, 1908. No. 91876 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Discussion on "The Non-Synchronous Generator in Central Station and Other Work." "Some Developments in Synchronous Converters." "Some Features of Railway Converter Design and Operation," at New York, February 14, 1908. Three papers by W. L. Waters, Charles W. Stone, and J. E. Woodbridge, are discussed together. 7500 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91703 D.

See also High Speed, under Dynamos and Motors.

A. C. Motors.

The Sandycroft Foundry Company, Limited, Chester. Illustrates and describes the products of this English works manufacturing electrical machinery. 2500 w. Elec Engr, Lond—April 3, 1908. No. 91666 A.

Some Points in the Connecting and Repairing of Alternating-Current Motors. M. O. Buckley. Explains the grouping and winding of the coils, giving diagrams, and briefly considers the chief troubles of these motors. 2000 w. Elec Age—March, 1908. No. 91287.

Brush Holders.

New Carbon Brush Gear for Turbo-Dynamos. Illustrated description of pneumatic brush-holders and "Morganite" brushes, with report of tests. 800 w. Elec Rev, Lond—March 27, 1908. No. 91459 A.

Commutators.

Truing Up Rotary Commutators. C. L. Greer. Briefly describes two methods. Ills. 500 w. St Ry Jour—April 4, 1908. No. 91349.

D. C. Dynamos.

See High Speed, under Dynamos and Motors.

D. C. Motors.

Systematic Designs of Direct Current Stationary Motors. H. O. Eurich and F. P. Whitaker. Read before the Rugby Engng. Soc. Considers the market requirements, general construction, electrical and mechanical design. 2500 w. Mech Engr—April 10, 1908. Serial. 1st part. No. 91810 A.

Frequency Transformers.

Frequency Transformers (Periodenumformer). A. Heyland. Outlines a system of control for induction motors involving the use of a cascade connection and a frequency changer, and enabling the current drawn from the line to be maintained constant. Ills. 2700 w. Serial. 1st part. Elek Kraft u Bahnen—Jan. 4, 1908. No. 91553 D.

Frequency Transformers. A. Heyland. Abstract from *Elek. Kraft, und Bahnen.* Describes a system of control for a. c. induction motors. 1500 w. Elect'n, Lond—April 10, 1908. No. 91814 A.

High Speed.

High-Speed Electrical Machinery. Gerald Stoney and A. H. Law. Traces the progress of the high-speed dynamo from its first inception, also describes some of the important features of modern types. Ills. 5000 w. Inst of Elec Engrs—March, 1908. No. 91664 N.

Railway Motors.

Discussion on "A Single-Phase Railway Motor," at New York, January 10, 1908. Discusses the paper by E. F. Alexanderson. 10500 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91701 D.

Windings.

A New System of Former Winding for Semi-Closed Slots. Briefly outlines methods that have been used, and describes the new system, stating its advantages. 3800 w. Elec Rev, Lond—March 20, 1908. No. 91272 A.

The Magnetomotive Force of Polyphase Windings. B. C. Dennison. Explains a simplified method of calculating the magnetizing effect, and shows its conformity with the results of other methods. 1700 w. Sib Jour of Engng—April, 1908. No. 91909 C.

ELECTRO-CHEMISTRY.

Electro-Plating.

A Method of Electroplating Lace. Illustrated description. 1500 w. Brass Wld—April, 1908. No. 91769.

ELECTRO-PHYSICS.

Alternating Currents.

On the Representation of Alternating Current Phenomena. D. W. Rennie. Explains two methods. 2000 w. Elect'n, Lond—April 3, 1908. No. 91669 A.

Electromagnetic Force.

Electromagnetic Force. A. S. McAllister. Points out that the usual explanation of this phenomenon is misleading. 800 w. Elec Wld—April 11, 1908. No. 91495.

GENERATING STATIONS.

Accumulators.

See Boosters, under GENERATING STATIONS.

Boosters.

The Pirani Reversible Battery Booster of the Siemens-Schuckert Company (Die umkehrbare Batteriezusatzmachine, Bauart Pirani, der Siemens-Schuckertwerke G. m. b. h.). W. Weissbach. Illustrated description of the construction and operation of this machine which is intended to increase the balancing power of storage batteries. 3000 w. Elek Kraft u Bahnen—March 24, 1908. No. 91562 D.

Central Stations.

New Generating Station of the Merchants Power Co., Memphis, Tenn. Brief illustrated description. 2000 w. Eng Rec —April 11, 1908. No. 91649.

A Small Power Plant. Charles L. Hays. Illustrated description of a small plant at Cassville, Wis., for supplying light and pumping water. 1000 w. Engr, U S A—April 1, 1908. No. 91297 C.

Extensions of Generating Plant at Wolverhampton. Detailed description of new plant made necessary by the growth of the power-load. Ills. 3500 w. Elec Engng—March 19, 1908. No. 91269 A.

Power Station Improvements, Original Devices and Ideas in the West Penn Station at Connellsville, Pa. Illustrates and describes improvements introduced at a station operating an interurban system of more than 150 miles. 3000 w. St Ry Jour—April 4, 1908. No. 91345.

The Central Power-Station of the De Beers Consolidated Mines, Ltd., Kimberley, South Africa. Percy A. Robbins. Illustrated description of the plant and its equipment, and information related. 8700 w. Bul Am Inst of Min Engrs—March, 1908. No. 91708 D.

Construction.

See Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

Design.

The Choice of Prime Movers for the Central Station (Sur le Choix du Matérial moteur pour les Stations centrales). J. Izart. A discussion of the advantages of steam power for stations operating under variable load. Ills. 3000 w. L'Elecn —March 21, 1908. No. 91522 D.

Economics.

Electric Supply Prospects and Charges as Affected by Metallic Filament Lamps and Electric Heating. H. W. Handcock and A. H. Dykes. Thinks the universal adoption of high-efficiency lamps would be disastrous for current-supply authorities and suggests a modified system of charging. 7000 w. Inst of Elec Engrs—April, 1908. No. 91811 N.

The Relation Between the Cost of Current and the Duration of Service (Ueber den Zusammenhang zwischen Stromkosten und Benutzungsdauer). G. Dettmar. Gives curves showing the variation in the cost of electrical energy for light and power with the amount consumed. Ills. 2200 w. Elek Kraft u Bahnen—March 14, 1908. No. 91559 D.

Great Britain.

Electric Installations in Great Britain (Les Installations électriques en Grande-Bretagne). Describes six of the leading electricity supply concerns, with especial reference to their financial arrangements, the cost of power, profits, etc. 5600 w. Génie Civil—March 7, 1908. No. 91529 D.

Hydro-Electric.

Construction Features of the Hydro-Electric Plant of the Rockingham Power Co. J. S. Viehe. Illustrated detailed description of the reinforced-concrete dam, power house, etc., of this water-power development in North Carolina. 3000 w. Eng Rec—April 4, 1908. No. 91390.

Power Development at Priest Rapids on the Columbia River. C. L. Creelman. Illustrated description of work including a canal, a two-mile embankment, a power house, a wing dam, and a system of gates. 1000 w. Eng Rec—April 4, 1908. No. 91409.

Penstock with Reinforced-Concrete Lining at the Northern Aluminum Works, Shawinigan Falls. Illustrated description of the tunneling and concreting work, executed during a severe northern winter. 4000 w. Eng Rec—April 4, 1908. No. 91401.

Some Considerations on the Recent Project for a Large Hydraulic Development on the Rhone for the Supply of Electricity to Paris (Einige Betrachtungen über das neue Projekt einer grossen Wasserkraftanlage an der Rhone für die Versorgung von Paris mit Elektrizität). Theodor Roehn. A review of the project in the light of experiences in other parts of the world. Ills. 1600 w. Zeitschr f d Gesamte Turbinenwesen—March 10, 1908. No. 91572 D.

See also Accumulators, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Isolated Stations.

See Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Operation.

Trouble in Paralleling Generators at a Railway Plant. C. W. Clark. Explains the trouble and its cause. 1200 w. Power —April 14, 1908. No. 91697.

Switchboards.

High-Tension Continuous-Current

Switch Gear at Hull. Illustrated description of a large switchboard designed especially for this system. 1200 w. Elect'n, Lond—April 3, 1908. Serial. 1st part. No. 91668 A.

Testing.

Test of Medium Capacity Central Station. Howard S. Knowlton. Gives results of a test made on a central station of about 2500 kilowatts normal capacity. 3000 w. Elec Wld—April 4, 1908. No. 91368.

LIGHTING.

Arc Lamps.

The Magnetite Arc. G. M. Dyott. Considers some of the peculiarities of the magnetite arcs and their performance. Also editorial. 3000 w. Elec Wld—April 25, 1908. No. 91886.

Illumination.

Economical and Efficient Plans for Lighting Small Houses. J. R. Cravath and V. R. Lansingh. Suggestions for the lighting of all the common rooms of a small house. Ills. 2500 w. Elec Wld—April 4, 1908. No. 91366.

See also Terminals, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Incandescent Lamps.

"Over Shooting": A New Observation on Tungsten Incandescent Lamps. John B. Taylor. Offers an explanation of this phenomenon. 700 w. Elec Wld—April 25, 1908. No. 91888.

Comparative Tests of Carbon, Metallized Carbon and Tantalum Filament Lamps. T. H. Amrine. Gives results of tests. Ills. 6000 w. Univ of Ill, Bul. 19—Sept. 9, 1907. No. 91707 N.

See also Economics, under GENERATING STATIONS.

Terminology.

Inconsistencies in the Present International Terminology Relating to Illumination. Dr. B. Monasch. Abstract from the *Jour. für Gasbeleuchtung.* A criticism and suggestion. 1800 w. Elect'n, Lond—April 17, 1908. No. 91975 A.

MEASUREMENT.

Capacity.

See Cables, under TRANSMISSION.

Dynamo Testing.

Testing Electric Machinery. W. M. Hollis. Gives tests of very general application that do not require many measuring instruments or intricate calculations. 1800 w. Elec Wld—April 4, 1908. No. 91369.

Inductance.

See Cables, under TRANSMISSION.

Instruments.

New Alternate-Current Instruments. W. E. Sumpner, and J. W. Record. Describes instruments in which iron-cored electromagnets are utilized. Ills. 7500 w. Inst of Elec Engrs—March 19, 1908. No. 91338 N.

Laboratories.

The National Physical Laboratory in 1907. A summary of the past year's work in electrical research. 4000 w. Engng—March 27, 1908. Serial. 1st part. No. 91460 A.

Standardizing Laboratory of the Georgia Railway Electric Company. E. P. Peck. Illustrates and describes the equipment and work. 2000 w. Elec Wld—April 11, 1908. No. 91497.

The National Bureau of Standards; the Service That It May Render to Electrical Engineers and Central-Station Companies. Joseph B. Baker. Explains the valuable service that may be rendered at small cost, describes the resources of the bureau, the building and its equipment. Ills. 3500 w. Elec Wld—April 4, 1908. No. 91367.

Metres.

The Meter and Testing Department of the Hartford Electric Light Company. F. W. Prince. Deals with the adjustment, calibration, installation, maintenance, and reading of recording or integrating wattmeters. Ills. 2000 w. Elec Jour—April 1908. No. 91476.

Motor Testing.

See Dynamo Testing, under MEASUREMENT.

Oscillograph.

The Oscillograph and Its Application. J. A. Johnson. Read before the employees of the Ontario Power Co. Describes the instrument, explaining its work, and the ways it can be used. Ills. 4000 w. Jour Worcester Poly Inst—March, 1908. No. 91626 C.

Power-Factor Meter.

Physical Theory of Power Factor Meter and Synchroscope. A. R. Dennington. An analysis of the field relations which produce the deflections of the pointers, considered from the standpoint of directional tendencies. Also editorial note. 2000 w. Elec Wld—April 11, 1908. No. 91498.

Resistance.

The Measurement of Dielectric Resistances by Means of the Barretter (Die Messung dielektrischer Widerstände mittels des Barretters). Béla Gali. Illustrated description of method, referring principally to tests of telephone cables. 1500 w. Elektrotech u Maschinenbau—March 29, 1908. No. 91568 D.

See also Cables, under TRANSMISSION.

Synchroscope.

See Power-Factor Meter, under MEASUREMENT.

TRANSMISSION.

Cables.

Splicing Lead-Armored Cables. H. H. Brown. A brief description of the methods followed by the San Francisco Gas & Elec. Co. 1500 w. Cal Jour of Tech —April, 1908. No. 91967.

Economical Pressures for Power Transmission by Underground Cables. J. B. Sparks. Shows how the cost of cables is affected by raising or lowering the working pressure. 2000 w. Elec Engng —April 2, 1908. No. 91663 A.

Capacity Cables. F. J. O. Howe. Shows the errors arising in the measurement of capacity by the methods in general use and gives results of an investigation which led to the design of a combined bridge for resistance, inductance and capacity tests, the operation being simple and the results accurate. 2500 w. Elect'n, Lond—March 20, 1908. Serial. 1st part. No. 91273 A.

See also Resistance, under MEASUREMENT.

Conduits.

The Cost of Building Electrical Conduits in Baltimore, Md. Gives details of the work and a report of costs. Ills. 3500 w. Engng-Con—April 1, 1908. No. 91363.

Insulators.

Porcelain Insulators for High-Voltage Lines. J. A. Sandford, Jr. Considers the requirements of a good insulator, how they are made and tested, and the present tendency. 3500 w. Jour Worcester Poly Inst—March, 1908. No. 91627 C.

Some Notes on High-Tension Insulators for Overhead Transmission Lines. C. J. Greene. Gives results of a series of tests recently made at 100,000 volts on some porcelain insulators of British make. Also statistics of insulators of other countries. 1000 w. Elec Rev, Lond —April 17, 1908. Serial. 1st part. No. 91875 A.

The Electrical Behavior of Insulators for Aerial Transmission Lines and Their Testing (Das elektrische Verhalten der Freileitungsisolatoren und ihre Beurteilung). Gustav Benischke. Describes dangerous conditions which may arise. Ills. 2000 w. Elek Kraft u Bahnen—Jan. 24, 1908. No. 91554 D.

Line Construction.

Overhead Construction for High-Tension Electric Traction or Transmission. Discussion of R. D. Coomb's paper on this subject. Ills. 7800 w. Pro Am Soc of Civ Engrs—March, 1908. No. 91310 E.

Line Design.

The Effect of a Broken Wire on Transmission Line Poles (Ueber das Verhalten von Freileitungsgestängen bei Drahtbruch). Ludwig Kallir. A mathematical paper on the design of transmission lines. Ills. 3200 w. Serial. 1st part. Elektrotech u Maschinenbau—March 22, 1908. No. 91566 D.

Lines.

The Installations of the *Sud Electrique* (Les Installations du Sud Electrique). M. Dusaugey. Describes the organization, substations, and lines of a company for the transmission and distribution of electricity, not its generation, over four departments of Southern France. Ills. 1000 w. Bul Soc Int des Elecns—March, 1908. No. 91506 F.

Poles.

Tests and Calculation of Reinforced Concrete Poles of Annular Section (Versuche und Berechnung von Eisenbetonmasten mit ringförmigem Querschnitt). F. Schüle. Gives the results of tests and conclusions drawn from them. Ills. 2600 w. Beton u Eisen—March 12, 1908. No. 91574 F.

Protective Devices

Protective Devices for High-Tension Transmission Circuits. J. S. Peck. Explains some of the disturbances, and describes protective devices now in use. Ills. 4500 w. Inst of Elec Engrs—March, 1908. No. 91860 N.

Rotary Converters.

See A. C. Dynamos, under DYNAMOS AND MOTORS.

Transformers.

The Relation Between Iron and Copper in Transformers. M. Kawara. Gives a graphical synopsis of the costs of material in constructing a particular type of transformer. 300 w. Elec Wld—April 11, 1908. No. 91496.

Vector Algebra for Alternate-Current Problems. William Cramp and C. F. Smith. An explanation of a system that is considered an improvement on that introduced by C. P. Steinmetz. 2500 w. Elec Eng'r, Lond—March 20, 1908. No. 91270 A.

MISCELLANY.

Aluminium.

Is Copper Essential to the Electrical Industry? H. M. Hobart. Gives the writer's views on the possibilities of the use of aluminium. 2000 w. Cassier's Mag—April, 1908. No. 91455 B.

America.

America Revisited, 1907. Sir William Henry Preece. Describes the writer's impressions of developments since a previous visit, especially in electrical fields. 12800 w. Inst of Elec Engrs—March 12, 1908. No. 91337 N.

Copper.

See Aluminum, under MISCELLANY.

Electromagnetic Brakes.

The Design of Electromagnetic Brakes.

J. Nikonow. Discusses the design of electromagnetic brakes with reference to particular types in practical use. Ills. 3000 w. Elec Wld—April 18, 1908. No. 91732.

France.

The Electrical Industry in France. Georges Dary. Remarks on the peculiarities of temperament that affect industrial enterprise, and gives a general review of the French industrial situation. 3500 w. Elec Rev, Lond—March 20, 1908. Serial. 1st part. No. 91271 A.

INDUSTRIAL ECONOMY

Accounting.

The Development of Bookkeeping on a Mathematical Basis (Die Entwicklung der Buchführung auf mathematischer Grundlage). Paul Beck. Special reference to accounting methods in manufacturing establishments. Ills. 2500 w. Serial. 1st part. Technik u Wirtschaft—March, 1908. No. 91534 D.

See also Civil Engineering, under MARINE AND NAVAL ENGINEERING.

Apprenticeship.

The London 'Prentice, His contemporaries and Successors. George Frederic Stratton. A discussion of the old and new methods of training mechanics. 4000 w. Cassier's Mag—April, 1908. No. 91451 B.

The Crisis of Apprenticeship in France (La Crise de l'Apprentissage dans l'Industrie Française). Georges Courtois. Discusses the cause of its decadence and the remedies proposed. 4000 w. Génie Civil—March 14, 1908. No. 91530 D.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. The first of a series of six articles, considering what constitutes a knowledge of costs. 2500 w. Engineering Magazine—May, 1908. No. 91956 B.

Education.

Technical Education in America. Sir William H. Preece. Describes the Carnegie Institute of Pittsburgh, and other technical colleges, commenting on the American practice. General discussion. 7500 w. Jour Soc of Arts—April 10, 1908. No. 91803 A.

The Importance of English in the Work of the Engineer. William D. Ennis. On the need of practice and training in the use of language. 2000 w. Engineering Magazine—May, 1908. No. 91951 B.

College Training of Electrical Engineers. Prof. Arthur C. Scott. An examination of criticisms of the present system, with discussion and suggestions for changes that the author considers desirable. 4000 w. Elec Wld—April 18, 1908. No. 91733.

Hydraulic Engineering at the University of Wisconsin. Daniel W. Mead. Describes the methods of instruction and the laboratory equipment, research work, etc. General discussion. Ills. 11000 w. Jour W Soc of Engrs—Feb., 1908. No. 91631 D.

Resumed Discussion on Mr. W. G. Spence's Paper on "Notes from Four Years' Working of the Educational Committee's Recommendations." 10500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1908. No. 91750 N.

Progressive Shop Education—A Suggestion. Frederick A. Waldron. Outlines a systematic course to train shop men for the responsibilities of foremen, superintendents or managers. 3000 w. Am Mach—Vol. 31. No. 14. No. 91327.

Methods of Instruction and Examination in the Mechanical Engineering Department of the Danzig Technical High School (Die Ausgestaltung des Unterrichtes und der Prüfungsvorschriften für das Maschineningenieurwesen an der Technischen Hochschule). A Wagener. 5500 w. Zeitschr d Ver Deutscher. Ing—March 7, 1908. No. 91589 D.

Eight-Hour Day.

The Eight-Hour Bill as Related to English Coal Mining. George Raylton Dixon. Describes the conditions which this act proposes to amend, the difficulties, and the writer's solution. 2200 w. Eng & Min Jour—April 25, 1908. No. 91939.

Engineering Ethics.

Concerning Engineers as Members of Commissions. Editorial discussion of the reasons why the policy of appointing engineers on public commissions has led to criticism. 1200 w. Eng News—April 16, 1908. No. 91740.

The Engineer's Activity in Public Affairs—Public Utility Commissions and Franchise Valuations. Henry Floy. Discusses the importance of verifying his conclusions and opinions and determining his line of action that his work may be of value in these fields. 7000 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91699 D.

Engineering Literature.

The Making of Literature for Engineers. Charles Whiting Baker. Address before the engineering students of the University of Michigan. 6000 w. Eng News—April 16, 1908. No. 91742.

Management.

General Instructions for Machine-Shop Methods. Holden A. Evans. Describes a system aiming to promote efficiency. 4000 w. Am Mach—Vol. 31. No. 16. No. 91731.

Additional Methods of Tracing the Progress of the Work. Oscar E. Perrigo. Discussion on methods of accurately locating component parts of work in progress. 3000 w. Ir Trd Rev—April 2, 1908. No. 91343.

An Analysis of Machine-Shop Methods. Holden A. Evans. A discussion of causes tending to inefficiency in government shops. 5500 w. Am Mach—Vol. 31. No. 15. Serial. 1st part. No. 91493.

Mechanical Engineering as Practiced on the Atlantic and Pacific Coasts. George W. Dickie. Compares the conditions from an engineering standpoint. 2500 w. Jour Assn of Engng Socs—March, 1908. No. 91725 C.

Maximum Production Through Organization and Supervision. C. E. Knoeppel. This second article of a series considers systematic processing, machining, assembly and erection. 3500 w. Engineering Magazine—May, 1908. No. 91954 B.

See also Drafting, under MECHANICAL ENGINEERING, Machine Elements and Design; and Pattern Shops, under MECHANICAL ENGINEERING, Machine Works and Foundries.

Patents.

Notes on Patent Procedure. F. W. Blair. Gives information of assistance to inventors. 3000 w. Elec Rev, N Y—April 11, 1908. No. 91616.

Safety Devices.

The New Museum of Safety Devices at Paris. Jacques Boyer. Illustrated description of the collection of the Conservatoire des Arts et Métiers. 3500 w. Engineering Magazine—May, 1908. No. 91953 B.

South America.

The Wealth and Prospective Development of the West Coast of South America. Francis W. Blackford. A descriptive account of the conditions, and problems in developing this region. 3500 w. Jour Assn of Engng Socs—March, 1908. No. 91723 C.

Trusts.

The Proposed Anti-Trust Law Amendment. An analysis by Henry R. Towne of the Hepburn amendment of the Sherman Anti-Trust Act. 2000 w. Ir Age—April 16, 1908. No. 91744.

Waste Products.

The Utilization of Waste Products. F. F. Gairns. Brief discussion of conditions under which economies may be effected. 1500 w. Cassier's Mag—April, 1908. No. 91453 B.

MARINE AND NAVAL ENGINEERING

Armor.

Modern Armor and Its Attack. T. J. Tresidder. Read before the Inst. of Naval Architects. A discussion from the theoretical and analytical point of view. 8000 w. Engng—April 10, 1908. No. 91819 A.

Battleships.

The United States Battleships "Delaware" and "North Dakota." Illustrates and describes these battleships. 1500 w. Sci Am—April 18, 1908. No. 91747.

U. S. Battleships "Mississippi" and "Idaho." Illustrations, with description of machinery and official trials. 2500 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91637 H.

Japanese Battleship "Iwami" as She Was and Is.—A Lesson in "Freeboard." Illustrates and describes the transformation of the Russian "Orel," in which a high-freeboard is changed to a moderate-freeboard, also other changes. 1200 w. Sci Am—April 4, 1908. No. 91372.

Trials of French Battleships. A report of the trials of the four newest battleships of France, with remarks on their special features. 1500 w. Engr, Lond—March 20, 1908. No. 91280 A.

Features of a Battleship Design. H. C. Dinger. Presents new possibilities with the aim of creating discussion and criticism of the various features of the best possible fighting vessel that can be built with a displacement of less than 20000 tons. 7500 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91638 H.

The Question of Speed in Battleships. R. R. Riggs. Considers the military elements of a battleship to be guns, armor and speed, and gives the writer's views of how far the first two should be sacrificed to attain the last. 4000 w. Pro U S Nav Inst—March, 1908. No. 91444 F.

Another Argument for Speed in Battleship Design. Yates Stirling, Jr. Gives an illustration to show the substantial advantage possessed by the faster fleet. 700 w. Pro U S Nav Inst—March, 1908. No. 91445 F.

Civil Engineering.

The Duties of the Navy Civil Engineers, and Their System of Keeping Cost Accounts. L. F. Bellinger. Describes some of the duties and work, and methods of determining detailed cost. Ills. 5000 w. Cornell Civ Engr—April, 1908. No. 91838 C.

Davits.

Appliances for Manipulating Lifeboats on Sea-Going Vessels. Axel Welin. Considers the principal requirements of an ideal system of davits, and the advantages of the Welin Quadrant type. Ills. 2500 w. Jour Fr Inst—April, 1908. No. 91941 D.

Destroyers.

Torpedo-Boat Destroyer for the Greek Navy. Illustrated description. 600 w. Engng—April 3, 1908. No. 91673 A.

Dry-Docks.

Floating Docks. Harry R. Jarvis. Describes various types of dock, and the class of work performed on them, their advantages and cost. Discussion. 6500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1908. No. 91751 N.

The Contractor's Plant and Methods on Mare Island Dry Dock No. 2. Illustrates difficult work in California, giving details of methods employed on this reinforced-concrete dock. 10500 w. Eng Rec —April 4, 1908. No. 91393.

Fire Boats.

Chicago Fire Boats. Sectional plans with descriptions of two fire boats now being built. 2300 w. Marine Rev—April 2, 1908. No. 91379.

Fleet Steaming.

Fleet Steaming and Economy. H. C. Dinger. Discusses the conditions for obtaining the greatest economy in steaming. 2500 w. Pro U S Nav Inst—March, 1908. No. 91446 F.

Fulton.

Fulton in England. H. N. Dickinson. An illustrated article giving correspondence and unpublished details of early work in England. 4500 w. Cassier's Mag—April, 1908. No. 91448 B.

Gyrostats.

Dr. Schlick's Gyroscopic Apparatus for Preventing Ships from Rolling. M. Wurl. Explains the principles underlying the rolling of ships, and the steadying effect of this system of gyroscopes. Discussion. 6500 w. Jour Soc of Arts—April 3, 1908. No. 91654 A.

Launches.

Two New Steam Launches. Illustrations and particulars of the "Constructor" and the "Sirius." 700 w. Engr, Lond—March 27, 1908. No. 91468 A.

Lifeboats.

The Lifeboats of the United Kingdom. Information concerning the types in service, and recent changes aiming at greater efficiency. 1600 w. Engr, Lond—April 17, 1908. No. 91982 A.

Lightships.

Trials of Lightship Number 88. Brief report of trials for the U. S. Government vessel. 500 w. Int Marine Engng—May, 1908. No. 91831 C.

Lusitania.

The Speed of the Cunard Turbine-Steamer "Lusitania." Thomas Bell. Read Before the Inst. of Naval Archts. A brief record of the trials and running in service of this Cunard turbine-steamer. 4500 w. Engng—April 10, 1908. No. 91821 A.

Marine Transport.

Improvement of the American Merchant Marine. William P. Munger. Briefly discusses the various plans proposed to strengthen the service. 1600 w. Sci Am —April 25, 1908. No. 91889.

Mauretania.

The Electrical Equipment of the SS. "Mauretania." Illustrated description of the electrical installation. 2000 w. Elec Rev, Lond—April 3, 1908. Serial. 1st part. No. 91667 A.

Motor Boats.

Motor Yacht Club's Efficiency Trial—A New System. A summary of the rules and regulations for the Fifth Annual Trial. 2200 w. Auto Jour—April 11, 1908. No. 91805 A.

See also Exhibitions, under MECHANICAL ENGINEERING, AUTOMOBILES.

Propellers.

Model Propeller Experiments. An account of the experiments by Prof. Flamm, of the Technisch Hochschule of Berlin. 3500 w. Engr, Lond—April 3, 1908. No. 91675 A.

Repairs.

Practical Hints on Foundry Work. A. E. Roskilly. Suggestions for ordinary replacements by the engineering staff on board a man-of-war while the vessel is away from a naval port. 2000 w. Prac Engr—March 20, 1908. No. 91266 A.

Resistance.

A Contribution to Experimental Research on the Resistance of Water to Moving Bodies (Ein Beitrag zur experimentellen Ermittlung des Wasserwiderstandes gegen bewegte Körper). Fr. Gebers. Gives the results of elaborate experiments with flat plates. Ills. 8000 w. Serial. 1st part. Schiffbau—March 25, 1908. No. 91549 D.

Sails.

Sail Making. Adrian Wilson. Much information in regard to sails and sailing. Ills. 5000 w. Int Marine Engng—May, 1908. Serial. 1st art. No. 91833 C.

Shipbuilding.

Shipbulding on the Great Lakes. Illustrates and describes the building of modern steel freight steamships of the Great Lakes. 3000 w. Naut Gaz—April 2, 1908. No. 91340.

See also Yachts, under MARINE AND NAVAL ENGINEERING.

Ship Design.

A Few Constructive Details. Details of rudders and frames are given in the present number. Ills. 800 w. Int Marine Engng—May, 1908. Serial. 1st part. No. 91832 C.

Unsolved Problems in the Design and Propulsion of Ships. Francis Elgar. The discussion is limited to the mercantile marine, and considers problems relating to loading, stability, strength, speed, propulsion, vibration, etc. 13,000 w. Inst of Civ Engrs—June 18, 1907. No. 91858 N.

Steam Engines.

The Combination System of Reciprocating Engines and Steam Turbines. C. A. Parsons and R. J. Walker. Read before the Inst. of Naval Archts. Considers the general arrangement and estimated economy, and the applications of this system. Ills. 2500 w. Engng—April 17, 1908. No. 91978 A.

See Lusitania, and Mauretania, under MARINE AND NAVAL ENGINEERING.

American Turbines for the Japanese Armored Cruiser "Ibuki." Illustrated description of 27000-h.p. turbines. 1500 w. Sci Am—April 25, 1908. No. 91891.

Steam Turbines.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING; and Torsion Meters, under MECHANICAL ENGINEERING, MEASUREMENT.

Submarines.

New Submersibles for Russia. Illustrated descriptions. 400 w. Engr, Lond—April 17, 1908. No. 91984 A.

Torpedo Boats.

Modern Torpedo Boats and Destroyers. J. E. Thornycroft. Read before the Inst. of Naval Archts. A review of the developments. Ills. 4500 w. Engng—April 10, 1908. No. 91820 A.

U. S. Navy.

The Engineering Situation in the United States Navy. Henry Charles Dinger. A general description of conditions, explaining remedies that appear necessary, and calling attention to proposed plans of remedy which are not based on sound principles. 32500 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91636 H.

Warships.

Unsinkable and Uncapsizable Ships of the Goulaeff Form and System of Construction. E. E. Goulaeff. Read before the Inst. of Naval Archts. An illustrated description of the proposed form, with special reference to warships. 5000 w. Engng—April 10, 1908. No. 91818 A.

Yachts.

New Royal Yacht Alexandra. Illustration and description of this new turbine yacht. 1400 w. Engr, Lond—March 27, 1908. No. 91466 A.

Elongation and Rebuilding of the Royal Danish Steam Yacht Dannebrog. Axel Holm. Illustrated detailed description of alterations, and report of trials. 2200 w. Int Marine Engng—May, 1908. No. 91830 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Arctic Regions.

Motors in the Arctic Regions. H. O. Duncan. Information in regard to climatic conditions and other difficulties to be encountered. 1800 w. Autocar—April 4, 1908. No. 91656 A.

Brooke.

The 40-H.P. 6-Cyl. Brooke Car. Illustrated description of an interesting British car. 1200 w. Auto Jour—March 21, 1908. Serial. 1st part. No. 91262 A.

Carbureters.

The New Sthenos Carbureter. Sectional drawing, with description. 700 w. Autocar—March 21, 1908. No. 91264 A.

Commercial Vehicles.

The Use of Motor Trucks for the Delivery of Coal in Paris (Note sur l'Emploi des Camions automobiles à la Livraison de la Houille, à Domicile, dans Paris). M. Chambelin. Illustrates and describes the side dumping truck used, and gives details of their cost of operation. 1700 w. Rev. Gen d Chemins de Fer—March, 1908. No. 91519 G.

See also Exhibitions, under AUTOMOBILES.

Construction.

Some Observations on Frames and Their Suspension. Illustrated discussion of the construction and suspension of chassis frames. 2800 w. Auto Jour—March 21, 1908. Serial. 1st part. No. 91261 A.

See also Forging, under MACHINE WORKS AND FOUNDRIES.

Design.

Some Commoner Faults of Auto Design. A. H. Denison. Calls attention to instances of faulty design. 2200 w. Automobile—April 23, 1908. No. 91927.

Electric.

Petrol-Electric Systems. Frost Smith and W. A. Stevens. Abstract of a paper read before the Soc. of Road Trac. Engrs. Brief consideration of the principal systems. 1800 w. Auto Jour—April 4, 1908. No. 91658 A.

Exhibitions.

Commercial Vehicles and Motor-Boats at Olympia. Begins an illustrated description of the interesting exhibits. 3000 w. Engng—April 3, 1908. Serial. 1st part. No. 91672 A.

Fuels.

Benzine or Benzol (Benzin oder Benzol). Karl Dieterich-Helfenberg. A discussion of their relative value as motor fuels. 2500 w. Zeitschr d Mit Motorwagen Ver—Mar. 15, 1908. No. 91579 D.

Garages.

See Concrete Blocks, under CIVIL ENGINEERING, Construction.

Gears.

Epicyclic Gearing for Automobiles. T. A. Borthwick. An illustrated explanation of sun and planet trains for speed-changing. 1500 w. Cassier's Mag—April, 1908. No. 91452 B.

Ignition.

Some E. I. C. Ignition Specialities. Brief illustrated descriptions of interesting devices. 1700 w. Autocar—April 18, 1908. No. 91970 A.

Motors.

Comparison of Four and Six-Cylinder Motors. Arthur H. Denison. Shows that the six-cylinder overcomes many disadvantages of the four-cylinder, though both give excellent service. 1600 w. Automobile—April 2, 1908. No. 91356.

Producer Gas.

A Producer-Gas-Driven Automobile. Describes a vehicle recently subjected to trials in Scotland. 1200 w. Sci Am—April 11, 1908. No. 91607.

Sheffield-Simplex.

The 45 H. P. Sheffield-Simplex Chassis. Illustrated description. 2000 w. Autocar—March 21, 1908. Serial. 1st part. No. 91263 A.

Stanley.

The Stanley Steam Car. Illustrated detailed description. 1200 w. Auto Jour—April 4, 1908. Serial. 1st part. No. 91657 A.

Testing.

Rules for Making Ordinary Tests of Motor Vehicles (Ueber Normen zur typenmässigen Prüfung von Kraftfahrzeugen). Herr Weiss. A general discussion of the tests necessary and methods of conducting them. 2500 w. Zeitschr d Mit Motorwagen Ver—Mar. 15, 1908. No. 91578 D.

Tires.

Non-Skids. An illustrated review of many now on the market. 2000 w. Autocar—April 11, 1908. No. 91806 A.

Wheels.

The British Divisible Rim. Illustrated description of a device aiming to save time and labor in repairing a puncture. 1000 w. Auto Jour—March 28, 1908. No. 91457 A.

COMBUSTION MOTORS.

Crankshafts.

Gas-Engine Shafts. W. H. Booth. Considers gas-engine crank-shaft design and manufacture. 1500 w. Am Mach—Vol. 31, No. 15. No. 91494.

Gas Cleaning.

See Blast-Furnace Gas, under MINING AND METALLURGY, Iron and Steel.

Gas Engine Governing.

The Governing and the Regularity of Gas-Engines. James Atkinson. Discusses what is commonly called the quality method of governing gas-engines, and also the quantity method, and when each is desirable. Ills. 7000 w. Inst of Mech Engrs—April 10, 1908. No. 91969 N.

Gas-Engine Guarantees.

Gas Engine and Producer Guarantees. Prof. C. E. Lucke. Presents forms of guarantees, with critical remarks, showing the need of action on this question. Also discussion. 4000 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91478.

Gas Engines.

Gas Engines in a Carnegie Steel Plant. Cecil P. Poole. Illustrates and describes three large double-acting Westinghouse units at Bessemer which are being successfully operated under trying conditions. 1800 w. Power—April 28, 1908. No. 91987.

Why the Tandem Double-Acting Gas Engine is Standard. L. B. Lent. Explains the advantages of this type. 1600 w. Power—March 31, 1908. No. 91284.

Gas-Engine Failures and Their Remedies. A. H. Burnand. Gives a number of cases, explaining the troubles and remedies. 2000 w. Mech Wld—April 17, 1908. No. 91870 A.

The Gas Engine's Probable Future. Sumner B. Ely. Considers a satisfactory bituminous gas producer necessary to secure general use. Discussion. 5000 w. Pro Engrs' Soc of W Penn—March, 1908. No. 91625 D.

The Effect of Mixture Strength and Scavenging Upon Thermal Efficiency.

Bertram Hopkinson. Gives results of investigations regarding the efficiency of a 40 h.p. Crossley gas engine. 9500 w. Inst of Mech Engrs—April 10, 1908. No. 91968 N.

Improvements in Large Gas Engines (Perfectionnements aux gros Moteurs à Gaz). Dr. Handorff. From the *Zeitschrift des Vereines Deutscher Ingenieure.* Discusses recent advances. Ills. 6000 w. All Indus—Mar., 1908. No. 91-525 D.

See also Crankshafts, under COMBUSTION MOTORS; and Power Plants, under POWER AND TRANSMISSION.

Gasoline Engines.

The Dufaux Aerial Petrol Motor. Illustrated description of an extremely light and powerful engine for aerial work. 700 w. Auto Jour—April 11, 1908. No. 91-804 A.

Gas Power Plants.

South American Gas-Power Plants. Illustrated account of the producer installations at Banfield and at Liniers, successfully operated on bituminous slack coal. 1000 w. Power—March 31, 1908. No. 91283.

A Satisfactory Producer-Gas Plant. F. C. Tryon. An account of a plant in Brooklyn, N. Y. 2200 w. Power—April 21, 1908. No. 91828.

See also Pumping Plants, under HYDRAULIC MACHINERY; and Power Plants, under POWER AND TRANSMISSION.

Gas Producer By-Products.

Ammonia Recovery in Connection with Producer Gas. F. J. Rowan. Reviews the practice and investigations in gas works, and the application to gas producers. 5500 w. Jour W of Scotland. Ir & St Inst—Jan., 1908. No. 91919 N.

Gas Producers.

The Rational Utilization of Low Grade Fuels in Gas Producers. F. E. Junge's paper is discussed. 4500 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91480.

Poor-Gas Producers (Les Gazogènes à Gaz Pauvre). L. Letombe. An elaborate paper, discussing their design, determination of calorific power of gas, the historical development of the gas producer, the latest types, gas cleaning, etc. Ills. 23000 w. Mem Soc Ing Civ de France —Jan., 1908. No. 91504 G.

The Production of Power Gas and the Construction of Producer Plants (Die Kraftgaserzeugung und die Construction von Kraftgas-Generatoranlagen). J. Schmidt. A general discussion of producer plant construction and practice. Ills. 4000 w. Serial. 1st part. Elektrotech u Polytech Rundschau—Mar. 4, 1908. No. 91569 D.

Gas Tables.

Gases: Tables and Constants. George C. Stone. Gives tables calculated by the writer on the weight, thermal capacities, etc., of gases. 1200 w. Sch of Mines Qr —April, 1908. No. 91915 D.

Gas Testing.

A Simple Continuous Gas Calorimeter. C. E. Lucke. Discusses this problem, presenting a method of solving it. Also discussion. Ills. 3000 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91479.

Gas Turbines.

Recent Developments in the Gas Turbine. Alfred Barbezat. An illustrated article giving records of actual experience with operative machines. 1500 w. Cassier's Mag—April, 1908. No. 91450 B.

Oil Engines.

See Air Compressors, under POWER AND TRANSMISSION.

HEATING AND COOLING.

Air Washers.

The Development of the Air Washer. Thomas Barwick and Sam. Kauffman. A discussion, illustrating and describing types. 2000 w. Heat & Vent Mag—April, 1908. No. 91772.

Cooling Towers.

The Capacity of Cooling Towers. C. O. Schmitt. Reply to the discussion of the writer's paper on this subject. Ills. 3500 w. Jour S African Assn of Engrs —Feb., 1908. No. 91260 F.

Electric Heating.

Cooking and Heating by Electricity (Das Kochen und Heizen mit Elektricität). A general review of advances and results in this field. Ills. 2500 w. Serial. 1st part. Elektrotech u Polytech Rundschau—Mar. 26, 1908. No. 91570 D.

Hot-Air Heating.

Heating and Ventilating a Bank. Illustrates and describes an upward system installed in the First National Bank in Boston. 1000 w. Heat & Vent Mag—April, 1908. No. 91773.

Furnace Heating of a 32-Room Residence. Detailed description of case of two separate furnaces for a single building. Ills. 3000 w. Met Work—April 25, 1908. No. 91925.

Hot-Water Heating.

The Calculation of Pipe Lines for Hot-Water Heating Plants (Die Berechnung der Rohrleitungen von Warmwasserheizanlagen). M. Haller. A practical discussion. Ills. 3300 w. Gesundheits-Ing—Mar. 14, 1908. No. 91586 D.

See also Shop Heating, under MACHINE WORKS AND FOUNDRIES.

Refrigeration.

Mechanical Refrigeration. M. G. Anderson. Read before the Manchester Assn. of Engrs. Discusses the principles of refrigeration, the plant and testing arrangements, and results. 5000 w. Mech Engr—April 10, 1908. No. 91809 A.

Minor Details in an Absorption Plant. William S. Luckenbach. Suggestions for care that will lessen cost and increase efficiency. 1800 w. Power—April 28, 1908. No. 91989.

Advantages of Absorption Refrigerating Machines. Heywood Cochran. An explanation of this system, with a statement of the advantages claimed. Discussion. Ills. 6500 w. Ice & Refrig—April, 1908. No. 91488 C.

The Ammonia Compression System. George Norden. Arguments in favor of this system. 2000 w. Ice & Refrig—April, 1908. No. 91487 C.

Test of Compressor. Charles E. Lucke. Gives details of tests on a 50-ton De La Vergne oil compressor to determine the horse-power per ton refrigeration. Ills. 3500 w. Ice & Refrig—April, 1908. No. 91489 C.

Steam Heating.

Progressive Heating. Jno K. Allen. First of a series of elementary papers on the best applications of steam and water for producing artificial heat. 2000 w. Dom Engng—April 11, 1908. Serial. 1st part. No. 91680.

Heating and Ventilation of the New Forrest Theater, Philadelphia, Pa. Heated by steam on the low-pressure system, using both indirect and direct radiation. Ventilation by upward flow. 3000 w. Eng Rec—April 25, 1908. No. 91935.

Back Pressures in a Factory Heating Plant. John C. White. Increasing the back pressure is found to add little to the heating capacity, while it reduces the efficiency. 3000 w. Power—April 14, 1908. No. 91696.

Summer Care of Heating Plants. Directions for putting steam and hot-water plants into such condition as will prevent their being harmed by months of disuse. 1000 w. Dom Engng—April 4, 1908. No. 91411.

Ventilation.

See Hot-Air Heating and Steam Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Accumulators.

Hydraulic Accumulators in Power Plants (Ueber hydraulische Akkumulierungsanlagen bei Kraftwerken). Artur Budau. A discussion of their utility in plants operating under variable load. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver —Mar. 13, 1908. No. 91582 D.

Centrifugal Pumps.

Centrifugal Pumps. G. F. Blessing. The present article gives a classification; and subsequent articles will deal with characteristics and constructive features, operation, etc. Ills. 2500 w. Sib Jour of Engng—April, 1908. Serial. 1st part. No. 91907 C.

Tests of a Centrifugal Pump (Versuche an einer Zentrifugalpumpe). Ernst Reichel. Illustrated description of pump, tests, and results. Tables. 4000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Mar. 10, 1908. No. 91571 D.

The Operation of Centrifugal Pumps and Fans (Die Wirkungsweise der Kreiselpumpen und Ventilatoren). R. Biel. Gives a mathematical discussion of their theory and describes and analyses the results of elaborate tests. Ills. 4800 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—Mar. 21, 1907. No. 91-500 D.

Electric Pumping.

See Electric Power, under MINING AND METALLURGY, COAL AND COKE; and Pumping, under MINING AND METALLURGY, MINING.

Laboratories.

See Education, under INDUSTRIAL ECONOMY.

Pumping Plants.

Experience with a Producer Gas Plant. Harry L. Thomas. An account of experience in pumping water with a gas-producer plant. Ills. Discussion. 6500 w. Jour N Eng W-Wks Assn—March, 1908. No. 91719 F.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS; and Pumping, under MINING AND METALLURGY, MINING.

Pumps.

Proper Thickness of a Valve Deck in a Pump. F. F. Nickel. A criticism of a proposed plan, with suggestions. Ills. 900 w. Power—April 21, 1908. No. 91826.

A Test of the Screw Pump for Flushing the Kinnickinnic River at Milwaukee, Wis. Report of tests made of a river-flushing plant. 900 w. Eng News—April 23, 1908. No. 91883.

Turbine Governing.

The Governing Action of Modern Indirect Hydraulic Turbine Governors (Der Reguliervorgang bei modernen indirekt wirkenden hydraulischen Turbinenregulatoren). R. Löwy. A discussion of the action of a number of types of indirect-acting governors. Ills. 4000 w. Serial. 1st part. Elektrotech u Maschinenbau—Mar. 1, 1908. No. 91564 D.

Turbines.

Water Flow in the Runner of a Francis Turbine (Die Strömung im Laufrad einer Francisturbine). R. Löwy. A mathematical and theoretical discussion. Ills. 2000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—Mar. 30, 1908. No. 91573 D.

MACHINE ELEMENTS AND DESIGNS.

Bearing Caps.

Proportions of Connecting-Rods and Bearing Caps. Charles H. F. Lubcke. Shows the application of the bending formula to bearing caps. 1000 w. Power—April 28, 1908. No. 91988.

Chains.

The Strength of Chain Links. G. A. Goodenough and L. E. Moore. A report of experimental work, deriving formulæ for the loading of chains. Ills. 11000 w. Univ of Ill, Bul 18—Sept., 1907. No. 91-834 N.

Crankshafts.

See same title, under COMBUSTION MOTORS.

Drafting.

Efficiency in Drawing-Room Practice. H. S. Knowlton. Suggests methods of increasing output and reducing costs. 2000 w. Cassier's Mag—April, 1908. No. 91449 B.

Flywheels.

Effect of Speed Variation on Flywheel Spokes. E. Wagner. Shows a way to demonstrate the bending strain caused by acceleration and retardation. 900 w. Power—April 28, 1908. No. 91991.

Stresses.

Similar Structures with Corresponding Loads. A. Inokuty. Discusses structures where stresses due to their own weights must be considered. Mathematical. 2000 w. Prac Engr—April 3, 1908. No. 91-660 A.

MACHINE WORKS AND FOUNDRIES.

Brass Founding.

Producing High Grade Brass Goods. Joseph H. Glauber. Read before the Metal Workers' Club, at Buffalo. The care and personal attention needed in the manufacture. 2500 w. Met Work—April 25, 1908. No. 91926.

Case Hardening.

Making Case-Hardening Carbon from Waste Leather. Walter J. May. Describes the method of preparation. 1400 w. Prac Engr—April 3, 1908. No. 91-659 A.

Case-Hardening. G. Shaw-Scott. Abstract of a paper read before the Iron and Steel Inst. at Vienna, with additional notes. Ills. 2000 w. Autocar—April 18, 1908. No. 91971 A.

Castings.

Steam. H. Sayers. Discusses the effects of steam in the mold, and the remedy. 1500 w. Foundry—April, 1908. No. 91288.

Ornamental Gray Iron Castings. H. Cole Estep. Illustrated description of the practice followed in a new plant in Minneapolis. 2500 w. Foundry—April, 1908. No. 91291.

Malleable Iron Castings. C. H. Gale. Read before the Pittsburgh Found. Assn. A comparison of furnaces used and methods of annealing. 2200 w. Ir Age—April 23, 1908. No. 91885.

The Production of Malleable Castings, by the Fusion of Wrought Iron in Crucibles. E. C. Ongley. Describes this process, giving its cost, reporting tests, and the applications of this material. Appendices and discussion. 9500 w. Jour W of Scotland Ir & St Inst—Nov., 1907. No. 91917 N.

See also Alloy Steels, and Malleable Iron, under MATERIALS OF CONSTRUCTION.

Construction.

Engineering Organization in the Building of Industrial Plants. Frederic W. Bailey. Discusses the advantages and shows the higher economy secured by designing engineers and constructors. 5000 w. Engineering Magazine—May, 1908. No. 91955 B.

Core Ovens.

Core Ovens for Light and Heavy Work. B. F. Fuller. Read before the Pittsburg Found. Assn. Considers ovens for light and heavy work. 1200 w. Foundry—April, 1908. No. 91290.

Cupola Charging.

Charging Machine for Cupolas. G. R. Brandon. Read at meeting of the Pittsburg Found. Assn. Illustrates and describes machines in successful operation. 1500 w. Foundry—April, 1908. No. 91292.

Dies.

Compound Dies for Sheet-Metal Punchings. K. S. Allen. Explains details of construction. Ills. 700 w. Am Mach—Vol. 31, No. 15. No. 91491.

Drilling Machines.

A New 16-Spindle Drill. Illustrated description. 500 w. Sci Am Sup—April 25, 1908. No. 91893.

Forging.

About Forgings for Automobile Work. Richard W. Funk. Read before the Soc. of Auto. Engrs., Boston. Gives facts showing the effects of certain forging methods on nickel chrome steel as compared with the processes known as hydraulic and drop-forging. 800 w. Automobile—April 2, 1908. No. 91357.

Forging Presses.

The Davy Combined Steam and Hydraulic Forging Press. Illustrates and describes improvements made in this press with the object of expediting the action. 2500 w. Prac Engr—March 20, 1908. No. 91265 A.

Foundry Furnaces.

Electric Furnaces for the Iron and

Brass Foundry. John B. C. Kershaw. Points out some of the advantages resulting from the use of electricity, and illustrates and describes forms of furnace which might be employed. 2500 w. Elec Wld—April 25, 1908. No. 91887.

Foundry Practice.

Jobbing Steel Foundry Practice. Methods pursued in the new plant of the Bucyrus Steel Casting Co. are illustrated and described. 2500 w. Foundry—April, 1908. No. 91294.

The Development of Ornamental Iron Founding (Zur Entwicklungsgeschichte des Eisenkunstgusses). Julius Lasius. A historical review of methods and achievements in this field. Ills. 3500 w. Stahl u Eisen—Mar. 18, 1908. No. 91540 D.

See also Brass Founding, Castings, and Molding, under MACHINE WORKS AND FOUNDRIES; and Repairs, under MARINE AND NAVAL ENGINEERING.

Galvanizing.

The Protection of Iron and Steel Surfaces by Means of Zinc. Sherard Cowper-Coles. Gives details and comparisons between four different methods of coating iron with zinc. Ills. 3500 w. Elec-Chem & Met Ind—May, 1908. No. 91962 C.

Gear Cutting.

Bevel-Gear Planing Attachment for the Shaper. Illustrated detailed description of an attachment for planing bevel gears. 700 w. Am Mach—Vol. 31, No. 17. No. 91872.

A Study in Spirals. Walter Gribben. Considers the table setting when cutting a spiral gear in a milling machine. Ills. 1200 w. Mach, N Y—April, 1908. No. 91353 C.

Grinding.

Grinding and Grinding Machines. Carl Olson. Considers the influence of vibrations, speed, depth of cut, the grinding wheel, external and internal grinding, etc. Ills. 4500 w. Mach, N Y—April, 1908. No. 91325 C.

Grinding Machines.

Some Grinding Machine Troubles and What Causes Them. Jas. N. Heald. Describes various experiences. 2000 w. Am Mach—Vol. 31, No. 15. No. 91490.

Jigs.

Jigs and Fixtures. Einar Morin. Explains the object and use of these devices, their fundamental principles of design, etc. Ills. 4500 w. Mach, N Y—April, 1908. No. 91324 C.

Machine Tools.

See Time Recorder, under MEASUREMENT.

Management.

See same title, under MACHINE WORKS AND FOUNDRIES.

Milling Cutters.

The Manufacture and Upkeep of Milling Cutters. W. H. Booth. Describes the annealing process and the finishing. 800 w. Am Mach—Vol. 31, No. 16. No. 91729.

Molding.

Gravity Molding. James Cooke Mills. Illustrates and describes the method. 1200 w. Brass Wld—April, 1908. No. 91770.

Molding a Three-Parted Job in a Two-Parted Flask. W. W. McCarter. Illustrated description of method. 600 w. Am Mach—Vol. 31, No. 17. No. 91873

Molding a Cast-Steel Clam-Shell. H. J. McCaslin. Illustrates and describes a method of molding skeleton pattern work. 2500 w. Foundry—April, 1908. No. 91289.

Molding Sands.

Notes on Molding Sands and Their Employment in the Foundry (Notes sur les Sables à Mouler et sur leur Emploi en Fonderie). M. Vinsonneau. The second part of a paper published in April, 1906, dealing with the mixing of sands and their regeneration. Ills. 4800 w. Rev de Métal—Mar., 1908. No. 91515 E + F.

Pattern Making.

Patterns for Special Pipe Flanges. F. W. Barrows. Considers the standards in use, making a plunge, method of laying out, and combination patterns. Ills. 1600 w. Am Mach—Vol. 31, No. 16. No. 91730.

Pattern Shops.

A Practical Pattern Shop System. Oscar E. Perrigo. Explains a simple method of recording patterns. 3000 w. Foundry—April, 1908. No. 91293.

Pipe Founding.

Casting Pipes in Permanent Molds. Edgar A. Custer. Illustrated detailed description of a process and apparatus used by the Tacony Iron Co. 5000 w. Ir Age—April 16, 1908. No. 91743.

See also Pattern Making, under MACHINE WORKS AND FOUNDRIES.

Planing Machines.

Electrically-Driven 14-ft. Planing-Machine. Illustrated description of a machine-tool built by the Niles-Bement-Pond Co. Plates. 2000 w. Engng—April 17, 1908. No. 91979 A.

Safety Devices.

See Textile Machinery, under MISCELLANY; and Safety Devices, under INDUSTRIAL ECONOMY.

Shop Heating.

Hot-Water Heating for a Machine Shop. Illustrated description of an independent heating plant at a shop in Jersey City. 2500 w. Met Work—April 4, 1908. No. 91378.

The Heating and Ventilation of Industrial Buildings (Chauffage et Ventilation des Etablissements industriels). L. Gérard. Describes a recent installation in a Berlin establishment. Ills. 2000 w. L'Elecn—Mar. 28, 1908. No. 91524 D.

Shop Hygiene.

The Hygiene of the Pottery Trade. William Burton. Explains the difficulties and dangers in connection with the manufacture of pottery, and the present position of this industry in its influence on the health of the workers. Ills. 8000 w. Jour Soc of Arts—March 27, 1908. No. 91472 A.

Improvements in Sand-Blast Machines (Les Améliorations réalisées dans les Machines à Jet de Sable). E. Barbet. Discusses methods of removing the dust from the air breathed by the workman. Ills. 1600 w. Rev d'Econ Indus—Mar. 16, 1908. No. 91505 D.

Methods of Quantitative Determination of Dust (Zur Methodik der quantitativen Staub- und Russbestimmung). Dr. Martin Hahn. Describes the methods and devices used in Germany for determining dust in air. Ills. 4000 w. Gesundheits-Ing—Mar. 14, 1908. No. 91587 D.

Shop Practice.

Building Automobiles in New York City. Illustrates and describes some of the tools, fixtures and methods used in building motor cars. 3000 w. Am Mach—Vol. 31, No. 16. No. 91728.

Shops.

The Hungarian State Engineering Works. Gives a résumé of the origin of these works at Buda Pesth, with plan and illustrated description. 4500 w. Engr, Lond—March 27, 1908. Serial. 1st part. No. 91462 A.

Developments in Austrian Steel Works (Neues in Oesterreichischen Eisenhüttenwerken). Th. Naske. Describes the Skoda Works, Pilsen. Ills. 1400 w. Serial. 1st part. Stahl u Eisen—Mar. 4, 1908. No. 91537 D.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT, and under STREET AND ELECTRIC RAILWAYS.

Tempering.

Chloride of Barium for Hardening. O. M. Becker. Considers the style of furnace to use, how barium chloride should be handled and its effect when hardening steel tools. Ills. 3000 w. Am Mach—Vol. 31, No. 14. No. 91326.

Tool Making.

Tool Making in a Large Manufacturing Plant. H. C. Barnes. Describes methods for the economical productions of jigs, dies, and other appliances made in large quantities. 3500 w. Am Mach—Vol. 31, No. 15. No. 91492.

Woodworking Machines.

A Machine That Saws 240,000 Wooden Paving Blocks in a Day. Jacques Boyer. Illustrated description of the invention by M. Josse. 1200 w. Sci Am—April 18, 1908. No. 91746.

MATERIALS OF CONSTRUCTION.

Alloy Steels.

The Practical Application of Vanadium to Steel and Iron. J. Kent Smith. Considers the best methods of incorporating this metal. 2000 w. Ir Trd Rev—April 2, 1908. No. 91342.

Vanadium in Steel Castings. E. F. Lake. Explains the properties given to steel castings by addition of vanadium, with some of the tests made, and how it is added to the metal. Ills. 1500 w. Am Mach—Vol. 31, No. 14. No. 91328.

See also Forging, under MACHINE WORKS AND FOUNDRIES.

Cast Iron.

Some Uses of Chilled Castings. Walter J. May. Remarks on their utilization in other ways than those generally adopted. 700 w. Prac Engr—April 17, 1908. No. 91972 A.

See also Malleable Iron, under MATERIALS OF CONSTRUCTION.

Malleable Iron.

Malleable Cast Iron: Its Evolution and Present Position in the Metallurgical World. William Herbert Hatfield. Aims to raise the position of this material, showing its physical properties and general usefulness. Ills. 4000 w. Trans Inst of Engrs & Shipbldrs in Scotland—March 17, 1908. No. 91339 N.

Metallography.

Summary of a Lecture on the Crystallization of Metals. Prof. Thomas Turner. Explains the usual system of classification of crystals, considering different varieties and the circumstances under which they originate. Ills. 3000 w. Jour W of Scotland Ir & St Inst—Oct., 1907. No. 91916 N.

The Constituents of Steel (Les Constituants des Aciers). Henry Le Chatelier. An attempt to give a simple definition of the various constituents recognized in the metallographic study of steel. 2500 w. Rev de Métal—Mar., 1908. No. 91517 E + F.

Steel.

See same title, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Wastes.

Metal Wastes. Dr. Theodor Koller. Trans, from *Verwertung von Abfallstoffen aller Art.* Describes methods of separating mixed chips, and uses made of alloy wastes. 1500 w. Sci Am Sup—April 4, 1908. No. 91374.

MEASUREMENT.

Dovetails.

Measuring Dovetail Slides, Gibs and V's. Frank H. Scheu. Application of wires of known diameters in the accurate measurement of male and female dovetails and V's of various angles. 1000 w. Am Mach—Vol. 31, No. 17. No. 91874.

Hardness.

The Schuchardt & Schutte Steel Hardness Tester. Illustrated description of an electro-magnetic instrument for determining certain properties of iron and steel. 1800 w. Ir Age—April 9, 1908. No. 91485.

Laboratories.

See same title, under ELECTRICAL ENGINEERING, MEASUREMENT.

Pyrometry.

Modern Methods of Temperature Measurement. Illustrated descriptions of types of instruments at present in use. 2000 w. Prac Engr—March 27, 1908. Serial. 1st part. No. 91458 A.

Time Recorder.

A Time Recorder for Machine Tools. N. D. Chard. An illustrated description of an instrument for recording the actual cutting and idle time of machine tools and other machines. 1000 w. Am Mach—Vol. 31, No. 16. No. 91727.

Torsion Meters.

Torsion-Meters, as Applied to the Measurement of the Horse-Power of Marine Steam Turbines. J. Hamilton Gibson. Briefly examines and describes some of these instruments and their application. Plates. 5000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—March, 1908. No. 91752 N.

POWER AND TRANSMISSION.

Air Compressors.

The Problem in Air Compression. Prof. Joseph H. Hart. A general discussion of important features, such as inadequate efficiency, and lack of isothermal compression, and the advantages of mechanical refrigeration of the air. 2800 w. Power—April 28, 1908. No. 91990.

Corliss Inlet Valves on Air Compressors. H. V. Conrad. Directions for setting them with diagrams illustrating the two principal forms of Corliss air-valve drive. 1000 w. Power—April 14, 1908. No. 91695.

Test of a Mietz & Weiss Oil Engine Air Compressor. Describes the oil engine and a test of the oil consumption, and the special features and tests of the air compressor. Ills. 3000 w. Ir Age—April 9, 1908. No. 91486.

Air Compressor Plant for East River Tunnels of the Pennsylvania Railway. A. D. Williams, Jr. Illustrates and describes the large Manhattan plant. 1800 w. Engr, U S A—April 1, 1908. No. 91295 C.

The Hydraulic Air Compressing Plant in the Clausthal District (Die hydraulische Luftkompressionsanlage der Kgl. Berginspektion Clausthal). P. Bernstein. Illustrated description with details of costs. 2000 w. Glückauf—Mar. 14, 1908. No. 91547 D.

Compressed Air.

See same title, under MINING AND METALLURGY, MINING.

Costs.

The Cost of Power in Small Units. William E. Snow. Gives data of actual cost of installation and operation compiled from the results of about thirty steam plants. 1000 w. Engineering Magazine—May, 1908. No. 91948 B.

See also Power Plants, under POWER AND TRANSMISSION.

Electric Driving.

An English Electrically-Driven Cement Works. An illustrated description of works at Haverton Hill, Eng., driven by three-phase induction motors. 2000 w. Eng Rec—April 11, 1908. No. 91647.

Economy and Cleanliness in Packingtown—Electricity an Important Factor. C. A. Tupper. Illustrates and describes some of the many applications of electricity in the stockyards and industrial plants. 2200 w. Elec Rev, N Y—April 25, 1908. No. 91901.

Notes on Individual Electric Driving (Notizen über elektrische Einzelantriebe). Wilhelm Kübler. A general discussion of its economic aspects. 2700 w. Elek Kraft u Bahnen—Mar. 4, 1908. No. 91558 D.

The Driving of Machines of Periodically Varying Power by Three-Phase Motors (Antrieb einer Arbeitsmaschine mit periodisch schwankendem Kraftbedarf durch einen Drehstrommotor). Philipp Ehrlich. Discusses the dynamic phenomena in the driving of pumps, compressors, etc. Ills. 2200 w. Elektrotech u Maschinenbau—Mar. 1, 1908. No. 91563 D.

Gas Power.

The Dependability of Gas Power. F. C. Tryon. Gives results from two plants, showing their reliability. 2300 w. Power—April 28, 1908. No. 91992.

The Approximate Cost of Gas Power. M. P. Cleghorn. Gives curves showing cost of installing and operating suction and producer gas-power plants, as compared with steam plants. 1200 w. Power—March 31, 1908. Serial. 1st part. No. 91285.

See also Gas Power Plants, under COMBUSTION MOTORS; and Power Plants, under POWER AND TRANSMISSION.

Hydraulic Power.

Modern Hydraulic Machinery. Carl Wigtel. Deals mainly with the production and distribution of the pressure fluid, including pumps, accumulators, and pressure-generating machinery. Ills. 2000 w. Cassier's Mag—April, 1908. Serial. 1st part. No. 91456 B.

Lubricants.

The Chemical and Physical Testing of Lubricants. J. J. Morgan. Explains chemical and physical tests that should be applied to determine the suitability of a lubricant. 2200 w. Prac Engr—March 20, 1908. Serial. 1st part. No. 91267 A.

Power Plants.

Some Interesting Data on Steam and Gas. J. H. Alexander. A comparison of costs and efficiencies. 2700 w. Engr, U S A—April 1, 1908. No. 91299 C.

Isolated Station Records and Cost Accounting. G. F. Gebhardt. An interesting description of a system employed in a large plant at Chicago, with charts and diagrams. 2000 w. Power—April 28, 1908. No. 91993.

The Old and the New in Power-Plant Machinery. Sterling H. Bunnell. Brief discussion of the relative uses of steam turbines and reciprocating engines, and gas engines. 1500 w. Cassier's Mag—April, 1908. No. 91447 B.

Modern Power Plant. George Ness. Showing modern developments as contrasted with earlier ideas, considering boilers, economizers, superheaters, engines, electrical distribution, turbines, etc. Also discussion. 8500 w. Jour W of Scotland Ir & St Inst—Nov., 1907. No. 91918 N.

The Power Plant of the New Addition of the Raritan Copper Works. Frank D. Easterbrooks. Illustrated detailed description. 1600 w. Elec-Chem & Met Ind —May, 1908. No. 91960 C.

Union Terminal at Washington, D. C.—Main Power Plant. Illustrated description of the plant furnishing current for electric lighting in the station and yards, and the compressed air and hydraulic service. 1200 w. Ry Age—April 24, 1908. No. 91946.

The New Power Plant of the Harburg-Vienna United Rubber Company at Harburg (Das neue Kraftwerk der Vereinigten Gummiwarenfabriken Harburg-Wien in Harburg a. d. E.). H. Wille. Illustrated description of a plant supplying electrical energy for light and power in this large establishment. 2200 w. Elek Kraft u Bahnen—Mar. 4, 1908. No. 91557 D.

See also Construction, under Machine Works and Foundries.

Power-Plant Testing.

See Testing, under ELECTRICAL ENGINEERING, Generating Stations.

STEAM ENGINEERING.

Boiler Management.

Emergency Operations in Boiler Plant. Notes of value to engineers dealing with trying conditions. 1800 w. Elec Engr, Lond—April 17, 1908. No. 91974 A.

Regulation of the Draft of Steam-Boiler Furnaces. W. H. Wakeman. On the making of a simple but correct draft gage, and the value of an automatic damper regulator. Ills. 1500 w. Elec Wld—April 4, 1908. No. 91371.

Increasing the Rate of Heat Absorption by Steam Boilers. Walter T. Ray and Henry Kreisinger. Treats of the practical utilization of the principles governing the transmission of heat from hot gases through plates. 3500 w. Mines & Min—April, 1908. No. 91321 C.

See Flue-Gas Analysis, and Steam Generation, under Steam Engineering.

Boiler Waters.

Purification of Feed Water in the Management of Boilers (Entretien des Chaudières, Epuration des Eaux). M. Bidaine. Describes the various methods of purification and softening both within and without the boiler, with comments on their efficiency. Ills. 5000 w. Serial, 2 parts. Bul Sci de l'Assn des Elèves—Feb. and Mar., 1908. No. 91501, each D.

See also Power Plants, under Power Steam Engineering.

Condensers.

Running Condensing. P. E. Merriam. Considers the action of condensers and their operation. Ills. 2500 w. Engr, U S A—April 1, 1908. No. 91296 C.

The Influence of Air on Vacuum in Surface Condensers. D. B. Morrison. Read before the Inst. of Naval Archts. An account of research work and results. 4500 w. Engng—April 17, 1908. No. 91-980 A.

Engines.

A 25,000 Horse-Power Blooming-Mill Engine. James Tribe. Illustrates and describes features involved in the design and construction of a large reversible rolling-mill engine at the Carnegie Steel Works, South Sharon, Pa. 2500 w. Power—April 21, 1908. No. 91825.

See also Power Plants, under Power and Transmission.

Feed-Water Heaters.

Exhaust-Steam versus Live-Steam Heating. Charles A. Howard. A commentary on the method proposed by Prof. Reeve for heating the feed water in power plants. 1000 w. Engineering Magazine—May, 1908. No. 91949 B.

The Substantial Advantages of Steam-Hot Feed Water. Sydney A. Reeve. A rejoinder to the criticism of Charles A. Howard, with a reply by Mr. Howard. 700 w. Engineering Magazine—May, 1908. No. 91950 B.

Flue-Gas Analysis.

Does It Pay to Equip a Boiler Room with CO_2 Recorders? H. J. Westover. Describes the apparatus, explaining how to install it and the value of the records. 2000 w. Power—April 7, 1908. No. 91441.

Fuels.

Burning Sawdust, Tanbark and Mill Refuse. Gives views of a number of correspondents as to the best methods of handling the material, and the type of furnace required. Ills. 1700 w. Power—April 7, 1908. No. 91443.

Fuel Specifications and Contracts. William D. Ennis. On the value of laboratory tests, and the importance of correct sampling, testing, and analysis. 5500 w. Eng Rec—April 25, 1908. No. 91933.

The Purchase of Coal Under Government and Commercial Specifications, on the Basis of Its Heating Value, with Analyses of Coal Delivered Under Government Contracts. D. T. Randall. A summary of information obtained by the U. S. Geol. Survey. 9000 w. U S Geol Survey, Bul 339—1908. No. 91777 N.

Fuel Testing.

Government Fuel Testing Plant at Denver, Colorado. G. R. Delamater. An illustrated description of the methods employed in making tests and the apparatus used. 3500 w. Mines & Min—April, 1908. No. 91313 C.

Plant Design.

Discussion on "The Ratio of Heating Surface to Grate Surface as a Factor in Power Plant Design," at New York, December 13, 1907. Paper by Walter S. Finlay, Jr., is discussed. 5000 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91-700 D.

Plant Management.

Solving Some Power House Problems. George W. Martin. Suggests some "home-made" oil separators, method of preventing water-hammer in a pump, an expansion bolt, etc. 1000 w. Elec Wld—April 4, 1908. No. 91370.

Plants.

See Costs, and Power Plants, under Power and Transmission.

Smoke Prevention.

Smoke Prevention. John W. Krause. Brief review of action taken in various cities, considering the causes of smoke, its prevention, etc. Discussion. 12000 w. Pro Engrs' Soc of W Penn—March, 1908. No. 91624 D.

Steam Generation.

The Formation of Steam. R. H. Smith. An explanation of the method of steam formation and its most economic generation. 3000 w. Engr, Lond—March 27, 1908. No. 91463 A.

Steam Pipes.

See Valves, under Steam Engineering.

Steam Properties.

Energy from Expansion of Steam. Sidney A. Reeve. Gives charts with explanation of their use. 1100 w. Power—April 21, 1908. No. 91827.

Steam Transmission.

The Heat and Pressure Losses in the Transmission of Saturated and Superheated Steam (Versuche über den Wärme- und Spannungsverlust bei der Fortleitung gesättigten und überhitzten Wasserdampfes). Chr. Eberle. The first part describes the apparatus and methods used in elaborate researches. Ills. 4400 w. Zeitschr d Ver Deutscher Ing—Mar. 28, 1908. No. 91592 D.

Superheating.

The Superheating of Steam. Trans. of article by Aimé Witz. Reviews the history of superheating, explaining the theory, and giving results of experiments. 12000 w. Jour Am Soc of Nav Engrs—Feb., 1908. No. 91635 H.

Turbines.

The Steam Path of the Turbine. Discussion of Dr. C. P. Steinmetz's paper. 1600 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91482.

Design of a 400-Kilowatt Reaction Turbine. Henry F. Schmidt. Discusses forms of blades and spacers and methods of insertion. 2000 w. Engr, U S A—April, 1908. No. 91298 C.

Guide-Bearings, Oil Distribution, and Carbon Packing in Curtis Turbines. F. L. Johnson. Considers important points in securing a perfect running balance. 1000 w. Power. April 14, 1908. No. 91698.

The Steam Turbine (Les Turbines à Vapeur). V. Marmor. A mathematical discussion of the flow of steam and of the thermodynamics of the steam turbine. Ills. 6000 w. Serial. 1st part. Rev de Mécan —Mar. 31, 1908. No. 91527 E + F.

See also Power Plants, under Power and Transmission, and Steam Turbines, under MARINE AND NAVAL ENGINEERING.

Turbine Valves.

Setting the Valves of the Curtis Turbine. F. L. Johnson. Explains the purpose of the stage valve, discussing possible troubles with mechanical valve-gear, and the remedies, adjusting the governor, etc. Ills. 1600 w. Power—March 31, 1908. No. 91286.

Valve Gears.

A Handy Slide-Valve Diagram. H. J. Zeiper. Gives a convenient diagram with explanation of its use. 1800 w. Power—April 21, 1908. No. 91829.

Distributing Valve Reversing Gears (Sur les Distributions par Tiroirs à Changement de Marche). L. Detrez. A mathematical treatment of the general features of their design and descriptions of several types. 5200 w. Bul Sci de l'Assn des Elèves—Mar., 1908. No. 91-502 D.

Valves.

Automatic Steam Pipe Isolation Valves (Rohrbruchventile). Georg W. Koehler. Illustrates and describes a large number of types. 5500 w. Zeitschr d Ver Deutschr Ing—Mar. 14, 1908. No. 91591 D.

Valve Setting.

How to Set the Valves of a Putnam Engine. F. L. Johnson. Illustrated description of the valve-gear, with directions for setting the valves. 8000 w. Power—April 14, 1908. No. 91693.

Valve Setting for the Greene-Wheelock Engine. Hubert L. Collins. Illustrated description of the Wheelock valve-gear, with the Greene and Hill modifications, and detailed directions for adjusting. 2500 w. Power—April 7, 1908. No. 91440.

TRANSPORTING AND CONVEYING.

Cableways.

Formulas for the Design of Cableways. Edward B. Durham. Discussion of aerial tramways with a study of the derivation of formulae for cable curves. 3000 w. Eng News—April 16, 1908. No. 91736.

Characteristics of Wire Rope Tramways with Some Figures on Cost of Operation. W. S. Gemmert. A brief description of the leading systems. 2000 w. Engng-Con—April 29, 1908. No. 92043.

Wire Ropeway in the North Argentine Cordilleras. Gives a brief account of the valuable mines in the Cordilleras, and the difficulties of transportation, illustrating and describing the wire cableway which has been constructed to give communication to the shipping ports. It is chiefly intended for the conveyance of ores from the mines to the railway, but has been put to other uses. Ills. 3500 w. Engng—March 20, 1908. Serial. 1st part. No. 91275 A.

Car Dumping.

The Hulett Moving Car Dumper. Illustrates and describes this car dumper and its operation. 1700 w. Ir Age—April 30, 1908. No. 92010.

Conveyors.

The Problem of the Spiral Conveyor. F. Webster. Describes the method of laying out the flights. 1000 w. Mach, N Y—April, 1908. No. 91323 C.

Cranes.

5-Ton Electric Overhead Travelling Jib-Crane. Illustrated description of a crane of special design and its operation. 14 w. Engng—March 20, 1908. No. 91277 A.

The Storehouse of the South German Danube Navigation Company in Vienna (Lagerhaus der Süddeutschen Donau-Dampfschiffahrts-Gesellschaft in Wien). R. Dub. Illustrates and describes the crane equipment. 1600 w. Zeitschr d Ver Deutscher Ing—Mar. 7, 1908. No. 91588 D.

See also Ore Handling, under TRANSPORTING AND CONVEYING.

Derricks.

A Light, Long Steel Derrick Boom. Illustrated detailed description, of interest on account of its unusual reach and lightness. 900 w. Eng Rec—April 18, 1908. No. 91781.

Elevators.

The High-Pressure Hydraulic Elevator. William Baxter, Jr. Illustrated explanation of the operation of the main and pilot valves of the Otis vertical elevator, including the electrical control sometimes employed. 1200 w. Power—April 7, 1908. No. 91442.

Material Handling.

Hoisting Machinery for the Handling of Materials. T. Kennard Thomson. This third and concluding article illustrates and describes shovels, dredges, and special unloaders. 3500 w. Engineering Magazine—May, 1908. No. 91952 B.

Ore Handling.

Methods of Handling Ore on the Great Lakes. Charles H. Wright. Brief illustrated descriptions of locomotive cranes operating a 2-rope grab bucket, electric side dump cars, and other devices for economical handling. 900 w. Min Wld—April 4, 1908. No. 91415.

MISCELLANY.

Aeronauutics.

See Gasoline Engines, under COMBUSTION MOTORS.

Air Resistance.

The Resistance of the Air and Mr. Eiffel's experiments. Describes the methods and apparatus adopted in these investigations, outlining the results obtained. 4500 w. Engr, Lond—April 17, 1908. No. 91981 A.

Sugar Machinery.

A Large Formosan Sugar Factory. Illustrates and describes the modern machinery built for a large, fully-equipped factory on the island of Formosa, belonging to the Japanese. 3000 w. Engr, Lond—March 27, 1908. No. 91465 A.

Textile Machinery.

Safety Appliances on Looms in Cotton Mills. Illustrated descriptions of causes of accidents and means for preventing them. 2500 w. Engng—April 17, 1908. No. 91977 A.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Prevention of Accidents in and Around Mines. H. O. Prytherck. Read at Y. M. C. A. Mining Inst., Scranton, Pa. Precautions recommended for anthracite mines. 1800 w. Mines & Min—April, 1908. No. 91320 C.

Australia.

Coalfields and Collieries of Australia. F. Danvers Power. Information in regard to the deposits, the quantity, quality, fossils, etc. 2500 w. Aust Min Stand—Feb. 19, 1908. Serial. 1st part. No. 91258 A.

Briquetting.

See Washing, under Coal and Coke.

Classification.

A Practical Classification for Low-Grade Coals. Marius R. Campbell. Explains the essential points of a proposed classification. 2500 w. Ec-Geol—March, 1908. No. 91754 D.

Classification of Coals by the Split Volatile Ratio. D. B. Dowling. Brief discussion of methods of classification that have been used, with diagrams for comparison. 1500 w. Can Min Jour—April 15, 1908. No. 91794 C.

Coal Cutting.

An Electric Coal Puncher. Timothy W. Sprague. An illustrated description of the construction and method of operation of this coal-cutting machine. 2800 w. Mines & Min—April, 1908. No. 91319 C.

Coke Drawing.

The Hebb Coke Drawing Machines. Illustrated description. 900 w. Ir Age—April 23, 1908. No. 91884.

Coking.

The Manufacture of Metallurgical Coke. M. Hennebutte. Trans. from the French. Explains the principles and methods of manufacture. 1800 w. Queens Gov Min Jour—March 14, 1908. No. 91686 B.

See also Washing, under Coal and Coke.

Coking By-Products.

Disposal of Coal Tar—Carroll Miller. Read before the New England Assn. of Gas Engrs. On the value of tar as a by-product to both the gas and coke industries. Discussion. 5000 w. Pro Age—April 15, 1908. No. 91691.

Culm.

The Recovery of Anthracite from Culm Banks. Richard Lee. Illustrated account of recovery from culm by washing, the cost, methods, etc. 2000 w. Eng & Min Jour—April 4, 1908. No. 91433.

Electric Power.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnie en Belgique). Alfred Lambotte. The second part of the serial describes the installations of the Grand-Hornu collieries and the electric pumping plant at the Baudour colliery. Ills. 13000 w. Soc Belge d'Elecns—March, 1908. No. 91507 E.

England.

The Littleton Collieries. From the *Jour.* of the British Federated Soc. of Min. Students. Gives an outline of the interesting history of these collieries, with description of the mines and methods. 3500 w. Ir & Coal Trds Rev—March 27, 1908. No. 91469 A.

See also Eight-Hour Day, under INDUSTRIAL ECONOMY.

Explosions.

The Prevention of Coal Mine Explosions. W. B. Williams. Several methods are suggested. 1500 w. Eng & Min Jour—April 18, 1908. No. 91791.

Caught in a Coal Mine Explosion. R. M. Downie. An account of the experience. 1500 w. Eng & Min Jour—April 11, 1908. No. 91644.

Remarks on Some Recent Explosions in Coal Mines. C. J. Coll. Address before the Min. Soc. of Nova Scotia. Deals principally with methods of prevention. 4000 w. Can Min Jour—April 15, 1908. No. 91795 C

Explosives.

The Evolution of the Coal-Mine Explosive. E. J. Deason. Information concerning the permitted list in England. 1800 w. Ir & Coal Trds Rev—April 17, 1908. No. 91986 A.

Mine Fires.

The Causes of, and Protection against, Mine Fires in the North West Bohemian Lignite District (Ursachen und Bekämpfung von Grubenfeuern im nordwestböhmischen Braunkohlenrevier). Wolfgang Kummer. Illustrates and describes the arrangements for fire protection. 3000 w. Oest Wochenschr f d Oeff Baudienst—March 21, 1908. No. 91585 D.

Mining.

The Systematic Development of a Coal Mine. William Leckie. Illustrated description of work at Pocahontas, Va., and vicinity. 3500 w. Eng & Min Jour—April 25, 1908. No. 91940.

Submarine Coal Mining. John Johnston. Read before the Min. Soc. of Nova Scotia. Deals with the subject generally. 1200 w. Can Min Jour—April 15, 1908. No. 91792 C.

See also Coal Cutting, under COAL AND COKE; and Cages, and Car Loaders, under MINING.

Mining Plants.

The Plants of Pits Heinrich and Robert of the de Wendel Colliery, Herringen (Die Schachtanlage Heinrich & Robert des Steinkohlenbergwerks "de Wendel" in Herringen bei Hamm. i. Westf.). A. Hochstrate. Illustrated description of the electric installations and mining plants. 3000 w. Serial. 1st part. Elek Kraft u Bahnen—Jan. 4, 1908. No. 91552 D.

Mississippi.

The Lignite of Mississippi. Calvin S. Brown. Describes these deposits, giving information and analyses. 1200 w. Ec-Geol—April, 1908. No. 91842 D.

Montana.

The Coal and Lignite Deposits of Montana. Jesse Perry Howe. Describes the deposits and methods of working. Ills. 3500 w. Min Wld—April 25, 1908. Serial. 1st part. No. 91943.

Southern Extension of the Kootenai and Montana Coal-Bearing Formations in Northern Montana. Cassius A. Fisher. Gives results of recent investigations, describing the formations. 6000 w. Ec Geol—Jan., 1908. No. 91306 D.

Ohio.

The Pomeroy Coal in Ohio. J. A. Bownocker and D. D. Condit. Aims to show that this coal seam is the equivalent of the Redstone coal of Pennsylvania and West Virginia. 3000 w. Ec-Geol—April, 1908. No. 91841 D.

Pennsylvania.

Distribution of Phosphorus in the Pittsburg Coal Seam. J. R. Campbell. Gives a comparison of analyses of top, bottom and other parts of the seam in different mines. 2000 w. Mines & Min—April, 1908. No. 91315 C.

Phosphorus.

See Pennsylvania, under COAL AND COKE.

Rescue Appliances.

Rescue Work in Collieries. An illustrated account of the opening of the new station of the Lancashire and Cheshire coalowners, the training and apparatus. Editorial. 9500 w. Col Guard—April 10, 1908. No. 91816 A.

Liquid Air and Its Practical Applications (Ueber flüssige Luft und deren praktische Verwendung). Otto Suess. The first part of the serial deals with apparatus for the liquefaction of air, the second with its use in rescue apparatus. Ills. 2500 w. Serial. 2 parts. Oest Zeitschr f. Berg- u Huttenwesen—March 7 and 14, 1908. No 91543 each D.

Sampling.

Moisture in Coal. E. E. Somermeier, in *Jour. Am. Chem. Soc.* On the importance of proper care of samples for analysis to prevent moisture changes. 3000 w. Mines & Min—April, 1908. No. 91354 C.

Washing.

Coal Washing. C. C. Myers. Brief consideration of this process of separation and the defects of the washers now in use. 1200 w. Sib Jour of Engng—April, 1908. No. 91908 C.

Washing of Bituminous Coal for Coking Purposes. Randolph Bolling. Historical account of its introduction into the United States, and of the methods of testing coal to determine its adaptability to the process. Ills. 2200 w. Min Sci—April 16, 1908. No. 91798.

Coal Screening, Washing, and Briquette-Making Plant at the Alstaden Collieries, Germany. Illustrated description. 2000 w. Ir & Coal Trds Rev—April 3, 1908. No. 91679 A.

Coal Washing as Practiced by the Nova Scotia Steel and Coal Company, at Sydney Mines, Cape Breton, N. S. C. L. Cantley. Gives an outline of the process, with analyses of the washed coal. 3500 w. Can Soc of Civ Engrs—April 2, 1908. No. 91775 N.

Washing and Coking Tests of Coal and Cupola Tests of Coke Conducted by the United States Fuel-Testing Plant at St. Louis, Mo., Jan. 1, 1905, to June 30, 1907. Richard Moldenke, A. W. Belden, and G. R. Delamater. 15400 w. U S Geol Survey—Bul. 336. No. 91706 N.

See also Culm, under COAL AND COKE.

COPPER.

Blast Furnaces.

The Cananea Blast Furnace. Charles F. Shelby. Full details and drawings of a copper blast furnace. 3000 w. Eng & Min Jour—April 25, 1908. No. 91936.

The Corrosion of Water-Jackets of Copper Blast-Furnaces. George B. Lee. Brief note introducing a discussion. 3000 w. Bul Am Inst of Min Engrs—March, 1908. No. 91712 C.

California.

Primary Chalcocite in California. Oscar H. Hershey. An account of an unusual type of copper deposit containing chalcocite as a primary mineral. Not of economic importance, but interesting. 1200 w. Min & Sci Pr—March 28, 1908. No. 91359.

Chalcocite.

See California, under COPPER.

Congo.

The Copper and Tin Deposits of Katanga. John R. Farrell. An illustrated article giving information regarding deposits of iron, copper, and tin, which are being developed. The copper belt is the most important. 4000 w. Eng & Min Jour—April 11, 1908. No. 91640.

Costs.

Cost of Lake Superior and Montana Copper. James Ralph Finlay. A review of results and costs of mining and smelting, showing favorable conditions in Michigan and high costs at the Butte mines. 5000 w. Eng & Min Jour—April 25, 1908. No. 91938.

Mexico.

Cananea Consolidated Copper Company. Abstract from a recent report of the Greene Consolidated Copper Co., concerning developments in 1907. 2000 w. Eng & Min Jour—April 11, 1908. No. 91641.

Peru.

Recent Developments at Cerro de Pasco, Peru. J. C. Pickering. Reviews the history of this district, first mined for silver and later for copper, the character of the deposits and the development. Ills. 2500 w. Eng & Min Jour—April 11, 1908. No. 91642.

Queensland.

Great Fitzroy Copper and Gold Mine, Mount Chalmers. B. Dunsten. Maps, illustrations, with description, and account of mining developments. 7000 w. Queens Gov Min Jour—March 14, 1908. Serial. 1st part. No. 91687 B.

Refineries.

See Power Plants, under MECHANICAL ENGINEERING, Power and Transmission.

Rhodesia.

Kansanshi Mine and Mine Sampling. J. R. Farrell. Information concerning an ancient copper mine in northwestern Rhodesia. Ills. 2200 w. Min & Sci Pr—April 18, 1908. No. 91899.

Smelter Hygiene.

Welfare of Laborers in Reduction Works. L. S. Austen. Discusses what has, and can be done. 3800 w. Min & Sci Pr—April 11, 1908. No. 91758.

Smelters.

The New Balaklala Smelter of the Balaklala Consolidated Copper Co., at Coram, Cal. J. L. Mauch. Illustrates and describes the proposed sampling and smelting operations. Also editorial. 8000 w. Mines & Min—April, 1908. No. 91317 C.

Smelting.

See Costs, under Copper.

Utah.

See Copper, under Ore Dressing and Concentration.

GOLD AND SILVER.

Assaying.

Assay of Battery Chips and Screens. Leslie J. Wilmoth. Reports results of experiments made by the author. 2200 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1908. No. 91470 E.

The Indian Mint Assay of Silver Bullion. F. T. C. Hughes. Remarks on the bullion and method of sampling, with a detailed description of the method employed in assaying silver at the Indian Mints. Ills. 3000 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91864 N.

The Sulphuric Acid Process for Parting Gold and Silver. A description of the methods used at the U. S. Government Assay Office, in New York City, with information, relating to the business carried on. Ills. 3000 w. Brass Wld—April, 1908. No. 91768.

Australia.

"Mt. Morgan" Mine. A talk by G. M. Colvocoresses to the senior class of Met. & Min. Engrs. at Sheffield Scientific School, concerning this mine in Australia. 4500 w. Yale Sci M—April, 1908. No. 91623 C.

See also Gold Milling, under Ore Dressing and Concentration.

Chile.

The Silver-Bearing Veins of Huantajaya, Tarapaca, Chile. Jose Muro. Abstract translation describing these deposits. 1300 w. Min Jour—April 18, 1908. Serial. 1st part. No. 91976 A.

Cobalt.

See Silver Milling, under Ore Dressing and Concentration.

Columbia.

Gold Deposits of Sierra Nevada de Santa Marta. Francis C. Nicholas. Information in regard to the gold deposits of Colombia, S. A. 2200 w. Min Wld—April 18, 1908. No. 91801.

Cyaniding.

Electro-Cyanide Processes. Douglas Lay. A discussion of claims regarding these processes. 2000 w. Eng & Min Jour—April 11, 1908. No. 91643.

Development of the Cyanide Process for Silver Ores in Mexico. Bernard Macdonald. Explains why cyanidation has been adopted, and pan-amalgamation abandoned. 1700 w. Eng & Min Jour—April 18, 1908. No. 91785.

Present Cyanide Practice in Mexico. Mark R. Lamb. Fine grinding, filtering of the slime, and air agitation are in use in the treatment of silver ores. Ills. 5800 w. Eng & Min Jour—April 4, 1908. No. 91430.

Cyanidation of Silver Ores at Guanajuato. Bernard Macdonald. Only stamps are used for crushing, long treatment of pulp, percolation, decantation, and precipitation. 7000 w. Eng & Min Jour—April 4, 1908. No. 91431.

Cyaniding Cripple Creek Ores. F. L.

Barker. Discusses the cost of treatment in mills, rates of freight, analyses of ores; and describes the Isabella and the Wild Horse mills. 3000 w. Mines & Min—April, 1908. Serial. 1st part. No. 91318 C.

See also Silver Milling, and Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Germany.

See same title, under LEAD AND ZINC.

Hungary.

See Placers, under GOLD AND SILVER.

Mexico.

Stories of the Batopilas Mines, Chihuahua. Mark R. Lamb. An account of peculiar deposits where sampling was hardly an indication of value, with information of interest. Ills. 1200 w. Eng & Min Jour—April 4, 1908. No. 91426.

See also Silver Milling, under ORE DRESSING AND CONCENTRATION.

Nevada.

Rawhide, Nevada. Algernon Del Mar. An account of the discovery and development of this gold camp. Ills. 1000 w. Eng & Min Jour—April 25, 1908. No. 91937.

See also Placers, under GOLD AND SILVER.

North Carolina.

Ore-Deposits of the Eastern Gold-Belt of North Carolina. W. O. Crosby. Information in regard to the location, geology, deposits, and conditions of this district. 3000 w. Bul Am Inst of Min Engrs—March, 1908. No. 91711 C.

Nova Scotia.

A Practical Suggestion for the Testing of the Gold Mines of Nova Scotia. Fred. P. Ronnan. Read before the Min. Soc. of Nova Scotia. Outlines a plan for improving this industry in Nova Scotia. 2000 w. Can Min Jour—April 15, 1908. No. 91793 C.

Placers.

The Gold Alluvials of the River Drau in Hungary. A. von Gernet. Brief note concerning these gold-bearing gravels. 400 w. Inst of Min & Met, Bul. 43—April 2, 1908. No. 91869 N.

A Tertiary River Channel Near Carson City, Nevada. John A. Reid. Illustrated description of a large and well defined channel on the east slope of the Sierra Nevada Mts., giving such facts about it as appertain to the mining industry. 2500 w. Min & Sci Pr—April 18, 1908. No. 91898.

Rand.

See Electric Power, under MINING.

Rhodesia.

A Short Account of the Penhalonga Mine. H. P. Townsend. Describes the location, the geological, and mineralogical characteristics, and the methods of mining and milling at this gold and silver mine in Rhodesia. Discussion. 5000 w. Jour S African Assn of Engrs—Feb., 1908. No. 91259 F.

IRON AND STEEL.

Armor Plate.

Armor Plate Forging and Machining at the Bethlehem Steel Works. A non-technical illustrated description. 1600 w. Mach, N Y—April, 1908. No. 91322 C.

Assaying.

The Determination of Nickel in Nickel Steel (Die Bestimmung des Nickels in Nickelstahl). O. Brunck. A discussion of prevailing methods with conclusions drawn from investigations. 1600 w. Stahl u Eisen—March 4, 1908. No. 91538 D.

Blast Furnace Gas.

The Cleaning of Blast-Furnace Gas (Epuration des Gaz de Hauts-Fourneaux). V. Defays-Lanser. A discussion of the problem and of attempts to solve it, and a description of the Sépulchre system. Ills. 4000 w. Rev de Métal—March, 1908. No. 91514 E + F.

Blast Furnaces.

The New Blast Furnace of the Hamilton Steel and Iron Company, Ltd. Illustrated description of this Canadian plant. 1500 w. Ir Age—April 9, 1908. No. 91484.

The New Iron Works of the Staveley Company. Illustrated detailed description of new blast furnaces and accessories recently added to these works. Plate. 4000 w. Engng—March 27, 1908. Serial. 1st part. No. 91461 A.

The Blast Furnace Diagram (Das Hochofendiagramm). Carl Brisker. Gives a series of curves showing the theoretical operations and reactions in the blast furnace. 3500 w. Stahl u Eisen—March 18, 1908. No. 91541 D.

Blowing Engines.

A Blowing-Engine Repair. Alonzo G. Collins. Describes the conditions and the methods used. 1200 w. Power—April 14, 1908. No. 91694.

Briquetting.

The Briquetting of Iron Ores (Das Brikettieren von Eisenerzen). A summary of the findings of a commission of the German Steel Makers' Association on the present status and possibilities of the process. Ills. 3000 w. Stahl u Eisen—March 4, 1908. No. 91536 D.

Cuba.

Iron Mining in Cuba. An illustrated description of the old and new properties of the Spanish American Iron Company, the methods of mining, etc. 8000 w. Ir Age—April 9, 1908. No. 91483.

Electro-Metallurgy.

Possibilities in the Electric Smelting of Iron Ores. Alfred Stansfield. Read before the Can. Min. Inst. Discusses what can probably be accomplished, the manner of obtaining successful results, and the advantages and drawbacks of the electrical process. 3000 w. Can Min Jour—April 1, 1908. No. 91417.

The Electro-Metallurgy of Iron (L'Electrosidérurgie). Charles Le Chatelier. Discusses the production of steel in the electric furnace. Ills. 8000 w. Rev de Métal—March, 1908. No. 91512 E + F.

Ferro-Alloys.

A New Method of Producing Ferro-Alloys Free from Carbon (Neuer Weg zur Herstellung kohlenstoffarmer Ferrolegierungen). B. Neumann. Describes the results of a series of laboratory experiments. Ills. 2500 w. Stahl u Eisen—March 11, 1908. No. 91539 D.

Japan.

Japan's Manufacture and Importation of Iron Goods. M. Kawara. Gives a brief historical sketch of Japan's home manufacture and foreign importation, discussing the present situation and the outlook. 2500 w. Engineering Magazine—May, 1908. No. 91947 B.

New York.

The Magnetite Belts of Putnam County, N. Y. C. A. Stewart. Gives a description of the wall rocks of closely associated deposits, stating facts that may prove a value in the future. 3500 w. Sch of Mines Qr—April, 1908. No. 91914 D.

Nomenclature.

The Uniform Nomenclature of Iron and Steel. Republished report of Committee of the International Assn. for Testing Materials at the Brussels Congress, 1906. 3300 w. Bul Am Inst of Min Engrs—March, 1908. No. 91716 C.

Ontario.

The Moose Mountain Iron Range, Ontario. J. J. Bell. Illustration, with short description. 600 w. Eng & Min Jour—April 18, 1908. No. 91786.

Open Hearth.

See Steel Works, under Iron and Steel.

Rolling Mills.

See Steel Works, under Iron and Steel.

Russia.

The Bogoslovsk Mining Estate. William H. Shockley. Description of this property, its management, conditions, labor, transportation, etc. The chief industry of the estate is iron-making in charcoal blast-furnaces, and the manufacture of steel; gold, copper, and other minerals are found. Ills. 9500 w. Bul Am Inst of Min Engrs—March, 1908. No. 91715 C.

Segregation.

Segregation in Steel Ingots. Henry M. Howe. Brief notes on investigations made to determine the laws which govern segregation, and the influences that affect it. 1200 w. Sch of Mines Qr—April, 1908. No. 91911 D.

Steel Making.

Electrical Machinery in Steel Making. W. T. Dean. Read before the Schnectady Sec. of the A. I. E. E. An outline of the mechanical processes and means of transportation. Ills. 2500 w. Sci Am Sup—April 11, 1908. No. 91610.

See also Steel, under CIVIL ENGINEERING, Materials of Construction.

Steel Works.

The Works of Sir William Arrol and Co., Limited. Illustrated description of the Dalmarnock structural-steel works, at Glasgow, and the methods employed. Plates. 4500 w. Engng—March 20, 1908. No. 91274 A.

The Plant of the Andrews Steel Co., at Newport, Ky. Illustrated detailed description of the open-hearth and rolling-mill equipment of a recently completed plant which is well arranged. 3500 w. Ir Trd Rev—April 2, 1908. No. 91341.

See also Armor Plate, under Iron and Steel.

Sweden.

The History of Iron Making in Sweden (Zur Geschichte des schwedischen Hüttenwesens). Paul Martell. Reviews progress since 1770. 6000 w. Oest Zeitschr f Berg- u Hüttenwesen—March 28, 1908. No. 91544 D.

LEAD AND ZINC.

Germany.

The Ems Silver-Lead Mines with Special Reference to Recent Improvements (Das Emser Blei- und Silberwerk, unter besonderer Berüchsichtigung der in den letzen Jahren geschaffenen Neuanlagen). Hans Linkenbach. Describes the deposits, mining methods, ore dressing and smelting practice, etc. Ills. 3000 w. Serial. 1st part. Glückauf—March 14, 1908. No. 91546 D.

Roasting.

Wilfley Roasting Process. J. M. McClave. Describes a new method of roasting sulphide ores to prepare them for magnetic concentration. Ills. 1000 w. Mines & Min—April, 1908. No. 91314 C.

Zinc Assaying.

Sampling and Assaying Spelter. Evans W. Buskett. Gives methods of assaying for iron, lead, and cadmium. 1200 w. Eng & Min Jour—April 18, 1908. No. 91789.

MINOR MINERALS.

Arsenic.

A Rapid Method for the Estimation of

Arsenic in Ores. Harley E. Hooper. Explains a method suitable for sulphide or oxidized ores containing upwards of 1% of arsenic. 700 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91863 N.

Cement.

Geology of the Cement Belt, in Lehigh and Northampton Counties, Pa., with Brief History of the Origin and Growth of the Industry and a Description of the Methods of Manufacture. Frederick B. Peck. Map & Ills. 10500 w. Ec-Geol—Jan., 1908. No. 91305 D.

Inland Portland Cement Works. An illustrated description of the "Saxon" and the "Norman" works and the processes used. 4000 w. Engr, Lond—March 20, 1908. No. 91281 A.

The Revolving Furnace in the Cement Industry (Il Forno rotativo nell Industria del Cemento). From *Baumaterialienkunde.* An elaborate discussion, both theoretical and practical. 5500 w. Serial. 1st part. Il Cemento—Feb., 1908. No. 91533 D.

See also Electric Driving, under MECHANICAL ENGINEERING, Power and Tranmission.

Diamonds.

The Geology of Diamonds. Describes the deposits in alluvial gravels and in pipes, discussing theories in regard to the original formation in pipes. 2000 w. Mines & Min—April, 1908. No. 91316 C.

Diamonds in Arkansas. George F. Kunz, and Henry S. Washington. Information regarding the geology, general conditions, and occurrence. 3500 w. Bul Am Inst of Min Engrs—March, 1908. No. 91713 C.

The Conversion of Diamond Into Coke in High Vacuum by Cathode Rays. Charles A. Parsons, and Alan A. Campbell Swinton. Read before the Roy. Soc. Brief account of experimental investigations. 700 w. Elec Engr, Lond—April 3, 1908. No. 91665 A.

Kaolin.

The Kaolins of the Dry Branch Region, Georgia. Otto Veatch. The geology and structure of these clay deposits are described, giving a theory of their origin. 2500 w. Ec-Geol—March, 1908. No. 91753 D.

Oil.

Prospecting in the Oil Fields of Eastern Colorado. Arthur Lakes. Gives experiences in both surface and deep boring examinations, with conclusions and recommendations. 2000 w. Min Sci—April 23, 1908. No. 91944.

Potash.

The Economical Production and Utilization of Steam and Power in Potash Mining (Wirtschaftliche Erzeugung und Ausnutzung von Dampf und Kraft im Kalibergbau). R. Scharf. A general discussion of economy in power production in mining. Ills. 4900 w. Serial. 1st part. March 28, 1908. No. 91548 D.

Tar Sands.

The Tar Sands of the Athabasco River, Canada. Robert Bell. Describes these deposits, discussing the origin of the tar, and the value and usefulness of the material. 4500 w. Bul Am Inst of Min Engrs —March, 1908. No. 91710 C.

Tin.

See Congo, under Copper.

MINING.

Accidents.

The Shaft Accidents at Foggs, Barrow and Rawdon Collieries. From report by Prof. R. A. S. Redmayne on the causes of, and circumstances attending these accidents. Ills. 10000 w. Ir & Coal Trds Rev—April 10, 1908. No. 91817 A.

Cages.

The Design of Cages for Modern Collieries. J. S. Barnes. Considers some of the factors that determine the size of a cage, and gives sections, elevations and descriptions of designs. 2800 w. Ir & Coal Trds Rev—April 3, 1908. Serial. 1st part. No. 91678 A.

See also Hoisting, under Mining.

Car Loaders.

A Mechanical Substitute for the Shovel in Coal Mines. W. E. Hamilton. Illustrated description of the Hamilton loading machine and its operation. 2500 w. Eng & Min Jour—April 18, 1908. No. 91790.

Compressed Air.

Design of Compressed Air Plants. E. A. Rix. Read before the Mining Assn. Gives data used by the writer in making the necessary calculations, and presents a problem showing the application. 3500 w. Cal Jour of Tech—Feb., 1908. No. 91301.

Joints and Fittings for High-Pressure Air. H. V. Haight and B. C. Batcheller. Describes and illustrates fittings used in connection with pneumatic haulage plants and other applications in mining. 5800 w. Am Mach—Vol. 31, No. 17. No. 91871.

Costs.

The Cost of Mining—General Conditions. James Ralph Finlay. The present article discusses the factors that determine variations in cost. 7500 w. Eng & Min Jour—April 18, 1908. Serial. 1st part. No. 91784.

Variations in Mining Costs. John B. Hastings. Reviews an article by J. R. Finlay, published Jan. 4, 1908, and gives estimates made by the writer, and a discussion of the subject generally. 3000 w. Min & Sci Pr—March 28, 1908. No. 91358.

See also same title, under Copper.

Diving.

Diving: With Special Reference to Mines. J. S. Haldane. Abstract of a paper read at meeting of the N. Staffordshire Inst. of Min. & Mech. Engrs. Deals with the physiological side of the subject, with special reference to diving work in mines. Discussion. 6000 w. Ir & Coal Trds Rev —April 10, 1908. No. 91824 A.

Diving in Mining Operations (Ueber Taucherei im Bergwerksbetriebe). Herr Grahn. Discusses diving apparatus and the ways in which divers may be employed in mining. Ills. 3000 w. Glückauf—Mar. 7, 1908. No. 91545 D.

Drilling.

Air Drill Practice in the Joplin District. Otto Ruhl. Describes the practice and use of power drills. 1500 w. Min Sci—April 9, 1908. No. 91682.

Electric Hoisting.

Electrically-Driven Winding-Gear, and the Supply of Power to Mines. Arthur Henry Preece. Considers the cost and discusses certain aspects of the question. Ills. 6800 w. Inst of Civ Engrs, No. 3698 —March 26, 1907. No. 91850 N.

See also Electric Power, under MINING.

Electric Power.

The Application of Hydro-Electric Power to Slate-Mining. Moses Kellow. Illustrated detailed description of a plant installed in North Wales. 7000 w. Inst of Civ Engrs, No. 3650—March 26, 1907. No. 91849 N.

Discussion on Hydro-Electric Power and on Electrical Winding. Discusses papers Nos. 3650 and 3698, by Kellow, and Preece. 13500 w. Inst of Civ Engrs —March 26, 1907. No. 91851 N.

The Electrical Equipment of Gold Mines. H. J. S. Heather. General remarks on the choice of voltage and system and matters relating to cost, with suggestions as to choice of machinery and methods of transmission, distribution, etc. 5000 w. Inst of Min & Met, Bul 43—April 2, 1908. No. 91866 N.

On the Cost of Power at Mines of the Witwatersrand, with Reference to a Proposed Supply from a Central Source. Henry James Shedlock Heather, and Anthony Maurice Robeson. A report of an investigation carried out with reference to the cost of a proposed electrical supply. 8000 w. Inst of Civ Engrs, No. 3711—1907. No. 91844 N.

See also Electric Hoisting, under MINING; and Electric Power, and Mining Plants, under COAL AND COKE.

Geology.

Dip and Pitch. R. W. Raymond. Note on the meaning of these terms when applied to ore-deposits. 600 w. Bul Am Inst of Min Engrs—March, 1908. No. 91714 C.

Haulage.

Inclined Planes and Mine Tracks (Plans Inclinés et Voies Minières). A. Laran. Describes an arrangement for double-track slope haulage and switches for mine railways. Ills. 2000 w. Mem Soc Ing Civ de France—Jan., 1908. No. 91503 G.

A Simple Optical Signal Device for Rope and Chain Haulage Ways Driven by Three-Phase Motors (Eine einfache optische Signalvorichtung für Seil- und Kettenbahnen mit Drehstromantrieb). Hans Neubauer. Illustrates and describes an arrangement of signal lights by which the operation of the motor can be controlled. 3000 w. Oest Zeitschr f Berg u Hüttenwesen—Mar. 7, 1908. No. 91542 D.

Hoisting.

Skips and Cages. S. A. Worcester. A comparison of the important features of these two devices in practical operation for the hoisting of ores. 1500 w. Min & Sci Pr—April 11, 1908. No. 91757.

Locomotives.

Accumulator Locomotives for Mines. Illustrates and describes locomotives of special type, having a large capacity in proportion to their weight. 1000 w. Iron & Coal Trds Rev—March 20, 1908. No. 91282 A.

Plants.

See Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Pumping.

An Emergency Pumping Plant at Cannock Chase Colliery. S. F. Sopwith. Read before the S. Staffordshire & Warwickshire Inst. of Min. Engrs. Explains the conditions, describing the pumping arrangements and results with an electric pump. 3500 w. Ir & Coal Trds Rev—April 17, 1908. No. 91985 A.

Quarrying.

See Electric Power, under MINING.

Reinforced Concrete.

The Utilization of Concrete in Mining Work. Ernest McCullough. Considers the method of constructing reinforced-concrete beams, and formulae for calculating compression and tensile stresses. Ills. 5000 w. Min Wld—April 11, 1908. No. 91683.

Sampling.

Sampling of Mine Dumps. Henry S. Munroe. On the advantages of sinking a vertical shaft through the dump to obtain the samples. Ills. 1500 w. Sch of Mines Qr—April, 1908. No. 91910 D.

See also Rhodesia, under COPPER.

Shaft Sinking.

Record Shaft Sinking on the Rand Gold Field. Ralph Stokes. Describes the remarkable performances at the Brakpan

Mines, Ltd. Ills. 1500 w. Min Wld—April 18, 1908. No. 91802.

Stope Drawing.

A Method of Mining. C. Everard Arnold. Illustrated description of a method used at Smuggler, Colorado, for removing stope-filling. 9000 w. Min & Sci Pr—April 11, 1908. No. 91759.

Tunneling.

A Modern Type of Mine Tunneling Machine. Silas A. Knowles, and Walter E. Carr. Illustrated description of a reciprocating cutter head tunneling machine. 3000 w. Min Wld—April 18, 1908. No. 91800.

Tunnels.

Deep Mining Tunnels in Clear Creek County, Colorado. H. P. Dickinson. Brief illustrated account of some of the larger bores, their history and methods. 1000 w. Min Sci—April 16, 1908. No. 91797.

Valuation.

On Certain Errors in Computing Ore Values. Henry Abbott Knox. Errors due to the failure to take into account the more or less regular distribution of the ore in the plane of the vein to be estimated. 1000 w. Eng & Min Jour—April 18, 1908. No. 91787.

ORE DRESSING AND CONCENTRATION.

Centrifugal Classifiers.

The Centrifugal Classifier (Le Classeur Centrifuge). M. Baclé. A description of the Souchon dry concentrating device and its operation. Ills. 1700 w. Bul Soc d'Encour—Feb., 1908. No. 91518 G.

Copper.

The Utah Copper Mill Near Garfield, Utah. Robert B. Brinsmade. Illustrates and describes the mining of porphyry copper ores by steam-shovel, and concentration in a 6,000-ton mill. 3500 w. Min Wld—April 4, 1908. No. 91414.

The Boston Consolidated Concentrator, Utah. Robert B. Brinsmade. Illustrated detailed description of buildings and equipment for concentrating low-grade sulphide ore. The cost of refined copper is 8.5 cents per pound. 3500 w. Min Wld—April 18, 1908. No. 91799.

Crushing.

See Gold Milling, under Ore Dressing and Concentration.

Elmore Process.

See Ore Dressing, under Ore Dressing and Concentration.

Gold Milling.

Description of the Montana-Tonopah Company's Mill. Traces the ore from the mine through the crusher, and various processes of milling. 1500 w. Can Min Jour—April 1, 1908. No. 91418.

Westralian Wet-Crushing Plants, with Some Notes on Labor Efficiency. Gerard W. Williams. Describes the methods in use in West Australian goldfields, discussing the value of efficient labor. 6000 w. Jour Chem, Met & Min Soc of S Africa—Feb., 1908. No. 91471 E.

See also Cyaniding, under Gold and Silver.

Magnetic Separation.

Magnetic Separation of Ores in Joplin District. Doss Brittain. Describes the roasting kiln and magnetic separators. Ills. 800 w. Min Wld—April 25, 1908. No. 91942.

An Electro-Magnet for Testing the Suitability of an Ore for Magnetic Separation. L. H. L. Huddart. Illustrated description. 700 w. Inst of Min & Met, Bul. 43—April 2, 1908. No. 91868 N.

See also Roasting, under Lead and Zinc.

Mixed Sulphides.

Separation of Mixed Sulphides at Charcas, San Luis Potosi. R. C. Canby. Illustrated description of a plant for the treatment of highly zinkiferous copper-lead ores. Sutton-Steele concentrating tables are used. 1500 w. Eng & Min Jour—April 4, 1908. No. 91428.

Ore Dressing.

Ore Dressing with Special Reference to Oil Concentration. A review of the present status of the art of ore dressing given by W. G Swart in his presidential address before the W. Assn. of Tech, Chem. & Mets., with notes on acid flotation and the new Elmore oil vacuum process. Also description of a dry concentrating table and a new separator. 5000 w. Elec-Chem & Met Ind—May, 1908. No. 91961 C.

Silver Milling.

Concentrating Cobalt Ores. G. H. Gillespie. Suggests a method of milling and concentration for these complex argentiferous ores. 3000 w. Can Min Jour—April 1, 1908. No. 91416.

Milling and Cyaniding Methods in Mexican Camp. Mark R. Lamb. Illustrates and describes model mills, their equipment and methods. 2500 w. Min Wld—April 11, 1908. No. 91684.

See also Cyaniding, under Gold and Silver.

Slimes Treatment.

A Method of Settling Slimes as Applied to Their Separation from Solution in Cyanide Treatment. Horace G. Nichols. Describes a method which has given remarkable results both in the completeness of the separation effected and in the small proportion of liquid carried off. Ills. 2000 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91862 N.

Discussion on "A Method of Settling Slimes, as Applied to Their Separation from Solution in Cyanide Treatment." Horace G. Nichols' paper is discussed. 3500 w. Inst of Min & Met, Bul. 42—March 12, 1908. No. 91865 N.

MISCELLANY.

Alloys.

The Thermal Analysis of Alloys. C. L. A. Schmidt and W. K. Watkins. Shows how cooling curves may be used in determining the composition of alloys without chemical analysis. 3000 w. Cal Jour of Tech—April, 1908. No. 91966.

The Alloys of Gold and Tellurium. T. K. Rose. Describes examinations made and gives results and conclusions. 1200 w. Inst of Min & Met, Bul. 41—Feb. 13, 1908. No. 91861 N.

The Alloys of Silver (Les Alliages d' Argent). A. Portevin. Reviews recent literature on the alloys of silver with aluminium, bismuth, tin, antimony, etc., published in the *Zeitschrift für anorganische Chemie*. Ills. 5000 w. Rev de Métal—Mar., 1908. No. 91516 E + F.

The Alloys of Nickel and Bismuth (Les Alliages de Nickel et de Bismuth). A. Portevin. Gives the results of an investigation of their heat treatment and their metallography. Ills. 3500 w. Rev de Métal—Mar., 1908. No. 91513 E + F.

Australia.

The Mineral Resources of Western Australia. Hon. C. H. Rason. An interesting account of the development of the Australian goldfields, and other information. Discussion. 9000 w. Jour Soc of Arts—April 3, 1908. No. 91653 A.

Carat.

The Carat Weight. E. J. Vallentine. Information concerning the use of this measure, and the steps in progress to cause the adoption of a metric carat as a standard. 1200 w. Inst of Min & Met, Bul. 43—April 2, 1908. No. 91867 N.

China.

Mineral Resources of China. Bailey Willis. An interesting review of China, the development of its mineral resources, the deposits, the different fields, etc. 11700 w. Ec Geol—Jan., 1908. Serial. 1st part. No. 91304 D.

Mexico.

Empire Building in Western Mexico. Percy E. Barbour. An illustrated account of old mineral lands to be opened by new railroads. 3000 w. Eng & Min Jour—April 4, 1908. No. 91427.

Growth and Decay of the Mexican Plateau. Robert T. Hill. An illustrated article describing the geologic features and changes. 6000 w. Eng & Min Jour—April 4, 1908. No. 91425.

Character and Habits of the Mexican Miner. Allen H. Rogers. Describes the peculiarities of this class of laborers, and their value as miners. 3500 w. Eng & Min Jour—April 4, 1908. No. 91429.

Ore Deposits.

Artificial Vein Formation. R. C. Canby. Describes the occurrences of artificial vein formations in heap-roasted matte. 900 w. Eng & Min Jour—April 4, 1908. No. 91432.

The Localization of Values or Occurrence of Shoots in Metalliferous Deposits. J. D. Irving. Defines mining terms, and explains features of ore-deposits and their causes. 4500 w. Ec-Geol—March, 1908. No. 91755 D.

Queensland.

The Queensland Mining Industry. Report of the Under Secretary for Mines, reviewing the year 1907. 22000 w. Queens Gov Min Jour—March 14, 1908. No. 91-685 B.

Salvador, C. A.

Mineral Resources of the Republic of Salvador, C. A. Santiago Ignacio Barbarena. An account of the fine results of the mining industry in recent years. 1000 w. Eng & Min Jour—April 18, 1908. No. 91788.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Signals.

Block Signals on the Railroads of the United States, Jan. 1, 1908. Tables issued by the Interstate Commerce Commission. 3500 w. R R Gaz—April 17, 1908. No. 91765.

New Automatic Block Signals on the Erie Railroad. Illustrated account of the system installed. The signals are of the electric motor semaphore type. 1600 w. R. R. Gaz—April 24, 1908. No. 91904.

Bolt Locking. W. H. Arkenburgh. Explains the use of bolt locks in an interlocking system, describing weak points in present practice, and the method of electrical bolt locking. 1800 w. R R Gaz—April 3, 1908. No. 91438.

Train Service.

A Long Continuous Run of 1876, and the Engine That Made It. C. H. Caruthers. An account of a 10-hour run from Jersey City to Pittsburgh, and description of engine. 1000 w. R R Gaz—April 10, 1908. No. 91619.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Brake Valve Cleaning and Repairs. Discusses right and wrong methods. 2000 w. Ry & Loc Engng—April, 1908. No. 91422 C.

Trials of the Vacuum Brake (Hardy System) on the Arlberg Lines. An illustrated description of the improved brake and report of trials made by the Austrian State Railway. 1700 w. Bul Int Ry Cong—March, 1908. No. 91622 G.

Tests of the Automatic, Quick Acting, Vacuum Brake for Freight Trains (Versuche mit der automatischen Vacuum-Güterzug-Schnellbremse). The results of elaborate tests carried out under the direction of the Austrian Minister of Railways. Ills. 10000 w. Serial. 1st part. Glasers Ann—Mar. 1, 1908. No. 91577 D.

Tests of Continuous Automatic Brakes on Freight Trains (Versuche mit durchgehenden selbsttätigen Bremsen bei Güterzügen). Johann Rihosek. Deals principally with the tests of the Vacuum brake in Austria. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—Mar. 6, 1908. No. 91580 D.

Car Lighting.

Car Lighting. Discussion of R. M. Dixon's paper on this subject. Ills. 5500 w. Pro Am Soc of Mech Engrs—April, 1908. No. 91481.

Cars.

Passenger Rolling Stock; Natal Government Railways. Illustrated description of coaches built at the Durban workshops. 1500 w. Plate. Engng—March 20, 1908. Serial. 1st part. No. 91276 A.

Steel Car Construction and Maintenance. G. E. Carson. Calls attention to important points in their construction, with suggestions for repairs, and their cost. Discussion. Ills. 7500 w. Pro Ry Club of Pittsburgh—Feb. 28, 1908. No. 91859 C.

Electrification.

The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City. Discussion of William J. Wilgus' paper on this subject. 5000 w. Pro Am Soc of Civ Engrs—April, 1908. No. 91924 E.

Electrification of Steam Railroads and Terminals. Richard H. Phillips. Brief general discussion of the subject, especially in reference to St. Louis, with illustrated descriptions of types of motor cars, electric locomotives, etc., in use. 6500 w. Pro St Louis Ry Club—March 13, 1908. No. 91439.

The Preparation of the State Railways for the Introduction of Electric Operation on Trunk Lines (Die Vorbereitungen der Staatseisenbahnverwaltung für die Einführung des elektrischen Betriebes auf Hauptlinien). Wolfgang Heinrich von Ferstel. A discussion of applying electric traction on a large scale on the Austrian State Railways. Ills. 2500 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—Mar. 27, 1908. No. 91583 D.

Locomotive Fuel Consumption.

Combustion Processes in English Locomotive Fire-Boxes. Dr. F. J. Brislee. A report of investigations. Ills. 6000 w. Inst of Mech Engrs—March 27, 1908. No. 91670 N.

Combustion and Heat Balances in Locomotives. Lawford H. Fry. Discusses the results of certain trials of locomotive engines, in so far as they deal with the processes of combustion and evaporation. Ills. 11500 w. Inst of Mech Engrs—March 27, 1908. No. 91671 N.

Locomotive Fuels.

Locomotive Fuel Economy. A study of the fuel question, giving government investigations and tests, discussing the mining, distribution, coaling stations, weighing coal, wastes, education of firemen, mechanical stokers, briquetting, etc. Ills. 30000 w. Am Engr & R R Jour—April, 1908. No. 91364 C.

Locomotive Management.

Some Instructive and Methodical Ideas as to the Handling of High Pressure Power by Enginemen so as to Render Satisfactory Service to Both the Mechanical and Transportation Departments. John A. Talty. Paper and discussion. 12000 w. Pro Cent Ry Club—March 13, 1908. No. 91836 C.

Locomotive Performance.

The Performance of a Four-Cylinder Locomotive. Charts and diagrams which show results with the exceptionally large engine designed by Dugald Drummond for the L. & S. W. Ry. 2200 w. Engr, Lond—April 10, 1908. No. 91822 A.

An Italian Unit of Locomotive Performance. Lawford H. Fry. An explanation of the use of the "virtual ton-kilometer" for recording work done by locomotives 1200 w. R R Gaz—April 17, 1908. No. 91762.

Locomotives.

The 4-Cylinder Locomotive in America. An illustrated explanation of the 4-cylinder compound principle as applied on American railways. 1000 w. Mech Engr —April 17, 1908. No. 91973 A.

Tampa Northern Ten-Wheeler. Illustrated description of engines for either freight or passenger service. 9000 w. Ry & Loc Engng—April, 1908. No. 91421 C.

Heavy Pacific Type Locomotive, N. Y. C. & H. R. R. R. Illustrates and describes the heaviest passenger engines ever built

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for this road. 700 w. Ry & Engng Rev—April 4, 1908. No. 91413.

Ten-Wheel Locomotive for the Boston & Albany. Illustrated description of heavy engines of the 4-6-0 type. 500 w. Ry Age—April 10, 1908. No. 91688.

Shunting Locomotive, Great Central Railway. Illustrated description of this 8-wheel coupled 3-cylinder tank engine. 500 w. Engr, Lond—April 10, 1908. No. 91823 A.

New Tank Locomotives, North-Eastern Railway. Plate and description. 500 w. Engr, Lond—April 3, 1908. No. 91676 A.

The Last of a Famous Class. W. B. Paley. Information in regard to the "Lady of the Lake" class of express engines on the London & North Western. 2000 w. R R Gaz—April 17, 1908. No. 91766.

Recent Railway Developments. Illustrated description of 2-6-0 locomotives for working mixed and cargo trains on the Great Western Railway of Brazil. 1500 w. Prac Engr—April 10, 1908. No. 91-807 A.

Locomotive Development in Germany. Illustrated description of a locomotive of the "Pacific" type for the Baden State Railways. 7000 w. Mech Engr—April 10, 1908. No. 91808 A.

Freight Tank Engine of the Prussian State Railroads with Schmidt Smoke-Tube Superheater. Illustrated detailed de-Railways. 700 w. Mech Engr—April 10, 1908. No. 91620.

The New Rolling Stock of the Italian State Railways (Le Nouveau Matériel roulant des Chemins de Fer de l'Etat Italien). P. Raulin. Illustrated description of several of the latest types of locomotives. 6500 w. Génie Civil—Mar. 21, 1908. No. 91531 D.

See also Train Service, under CONDUCTING TRANSPORTATION.

Locomotive Steam Pressures.

High Steam Pressures in Locomotive Service. Editorial review of the results of experiments by Prof. W. F. M. Goss. 3500 w. R R Gaz—April 3, 1908. No. 91434.

Motor Cars.

Petrol Rail Motor Inspection Car, North-Eastern Railway. Illustrated description. 600 w. Engr, Lond—April 3, 1908. No. 91677 A.

Shops.

A Modern Locomotive Works in Germany. Charles S. Lake. Historical review and brief illustrated description of German Locomotive Works recently built at Wildau, near Berlin. 2000 w. Mech Engr—April 3, 1908. No. 91662 A.

New Shops of Intercolonial Railway of Canada, Moncton, B. C. C. F. Bristol. Illustrated detailed description of an extensive application of reinforced concrete. 4500 w. Can Soc of Civ Engrs—April 16, 1908. No. 91894 N.

Tires.

The Source of Internal Tire Defects. An illustrated article, describing the experimental investigations made to determine the cause of the defects found. 1800 w. R R Gaz—April 24, 1908. No. 91906.

Wheels.

The Reason for the Steel Wheel. Editorial review of the development of car wheels in America, discussing the changes made necessary by conditions and the need of a cheaper reliable wheel for freight service. 1500 w. R R Gaz—April 10, 1908. No. 91617.

NEW PROJECTS.

Erie.

The New Four-Track Entrance of the Erie Railroad into Jersey City. Illustrates and describes work in progress through Bergen Hill which will give the Erie four tracks. 3500 w. Eng Rec—April 18, 1908. No. 91778.

PERMANENT WAY AND BUILDINGS.

Coaling Plants.

Notes on the Design and Performance of Locomotive Coaling and Ash-Handling Plants. Wilbur G. Hudson. Illustrated description of types, giving operating costs and general information. 4000 w. Eng News—April 16, 1908. No. 91737.

The Handling of Locomotive Coal and Ashes. C. F. Whitton. Deals with present practice and designs for coaling and ash-handling plants. Plans of stations, representing five methods are given, with operating cost of each. 5000 w. Can Soc of Civ Engrs—March 19, 1908. No. 91776 N.

Curves.

Re-Lining Long Curves by Running Trial Curves. R. W. Willis. An explanation of this method. 800 w. R R Gaz—April 3, 1908. No. 91437.

Compensation of Grades on Curves. Gives existing practice on important railways, and rules of Prof. Walter L. Webb, with criticisms by W. D. Taylor. 2500 w. Eng News—April 16, 1908. No. 91739.

Rails.

Steel Rails. T. S. Griffiths. Read before the Engrs.' Club, Toronto. Briefly considers the failures in rails and their possible causes. Also part of discussion following. 3500 w. Can Engr—April 3, 1908. No. 91377.

The New Rail Specifications of the Pennsylvania R. R. Gives new specifications drafted by the company's officials which were made public on April 11. 1500 w. Eng News—April 16, 1908. No. 91741.

A Rail-Section Tracing-Machine. Horatio Edgar Dawson Walker. Explains the importance of renewals of worn and weakened rails, illustrating and describing a machine for ascertaining their condition. 2000 w. Inst of Civ Engrs, No. 3718—1907. No. 91855 N.

Reconstruction.

Some Recent Improvements on the Union Pacific Railroad. Illustrates and describes extensive reconstruction work, especially the Lane Cut-off. 4000 w. Eng Rec—April 4, 1908. No. 91381.

Reconstruction Work on Cincinnati, New Orleans, and Texas Pacific. Illustrates and describes numerous changes which will reduce the curvature and gradients, double-track a large part of the line, new viaducts, etc. 2500 w. Ry Age—April 24, 1908. Serial. 1st part. No. 91945.

Surveying.

Notes on the Natal-Cape Railway, Particularly with Regard to the Location and Setting-out. David Wilson. Describes the principal topographical features of the country, and the methods adopted in the final survey and setting-out of the line. Plate. 1800 w. Inst of Civ Engrs, No. 3662—1907. No. 91857 N.

Terminals.

Electrical Equipment of the Hoboken Terminal of the Lackawanna Railroad. Briefly describes the arrangement of this terminal and gives illustrated description of the very satisfactory illumination. 1600 w. Elec Wld—April 4, 1908. No. 91365.

Ties.

See Timber Preservation, under CIVIL ENGINEERING, Materials of Construction.

Tracks.

The Railway Track of the Past, and Its Possible Development in the Future. J. W. Schaub. An illustrated discussion of the defects of tracks and the remedies. General discussion. 13500 w. Jour W Soc of Engrs—Feb., 1908. No. 91633 D.

Water Supply.

See Water Works, under CIVIL ENGINEERING, Water Supply.

Yards.

The Baltimore & Ohio's New Eastbound Freight Yard at Brunswick, Maryland. Plan and illustrated description of a large classification yard. 1500 w. R R Gaz—April 10, 1908. No. 91621.

TRAFFIC.

Demurrage.

Reciprocal Demurrage and Car Supply. Arthur Hale. Abstract of an address recently delivered to a committee of the Massachusetts legislature opposing a reciprocal demurrage bill. 7000 w. R R Gaz—April 10, 1908. No. 91618.

Freight Rates.

How the States Make Interstate Rates. Robert Mather. Paper prepared for the Am. Acad. of Pol. & Soc. Science. Shows the interstate effect of state rates, giving charts. 5000 w. R R Gaz—April 17, 1908. No. 91763.

MISCELLANY.

Forestry.

The Necessity for Corporation Forestry. E. A. Sterling. Gives information in regard to timber scarcity, discussing the difficulties, and the need of the practice of forestry. Discussion. Ills. 7500 w. Pro Engrs' Club of Phila—Jan., 1908. No. 91628 D.

STREET AND ELECTRIC RAILWAYS

Accounting.

Depreciation in Electric Railway Accounting. Daniel Royse. Read before the Ohio St. & Int. Ry. Assn. Discusses the proposed classification of accounts of the Interstate Commerce Commission contained in Circular No. 20. 5000 w. St Ry Jour—April 25, 1908. No. 91897.

Adhesion System.

The Chamonix-Martigny Railway. Illustrated description of an electrically operated line between France and Switzerland, partly on the adhesion system and partly on the rack system. 1600 w. Engr, Lond—March 27, 1908. No. 91464 A.

Austria.

Electric Traction in Austria (Die elektrischen Bahnbetriebe in Oesterreich). Wolfgang Adolf Müller. A statistical article giving the development of electric traction in Austria and extensive physical and financial data regarding the construction and operation of the lines. Ills. 3200 w. Elek Kraft u Bahnen—Feb. 14, 1908. No. 91556 D.

See also Electrification, under RAILWAY ENGINEERING, Motive Power and Equipment.

Berlin.

The Increase in the Capacity of the Berlin City and Belt Line Railway (Studie über die Erhöhung der Leistungsfahigkeit der Berliner Stadt- und Ringbahn). J. W. van Heys. Discusses various aspects of the recent project for the electrification of this steam railway. Ills. 2200 w. Serial. 1st part. Elek Kraft u Bahnen—Mar. 14, 1908. No. 91560 D.

See also Subways, under STREET AND ELECTRIC RAILWAYS.

Car Barns.

Construction of Car Barns. New standard rules and requirements of the National Board of Fire Underwriters. 2400 w. Ins Engng—April, 1908. No. 91718 C.

New Car House and Shops of the Chattanooga Railways Company. Illustrated description of these buildings and their equipment. 1800 w. St Ry Jour—April 18, 1908. No. 91760.

The Broadway Car House of the International Railway Company. Thomas Pumfrey. Illustrated description of a structure in Buffalo, N. Y. 2500 w. Elec Ry Rev—April 18, 1908. No. 91796.

Car Cleaning.

See Car Inspection, under STREET AND ELECTRIC RAILWAYS.

Car Department.

The Car Equipment Department of the Interborough Rapid Transit Company—Methods of Car Inspection, Lubrication Practice, Car Cleaning and Labor Payment. Illustrates and describes the facilities for inspection and the records of the department; also the inspection and cleaning practices. 7000 w. St Ry Jour—April 4, 1908. Serial. 1st part. No. 91344.

Car Inspection.

Car Inspection Based on Mileage. Editorial explaining the system of inspection on the Interborough Rapid Transit Railway in New York. 1000 w. Ry & Loc Engng—April, 1908. No. 91420 C.

Maintaining Car Equipment on the Chicago City Railway. An illustrated description of the inspection and maintenance practice. 3000 w. St Ry Jour—April 11, 1908. No. 91612.

Car Cleaning and Inspection—Chicago City Railway. Describes the methods of inspection, making light repairs and car cleaning, illustrating the shops, and outlining the general idea upon which the work is based. 3800 w. Elec Ry Rev—April 4, 1908. No. 91419.

Car Repairing.

Maintenance of Rolling Stock by the Indiana Union Traction Company. Information in regard to the methods adopted at the repair shops. Ills. 3500 w. St Ry Jour—April 4, 1908. No. 91348.

The Car Depot Record System of the Boston Elevated Railway Company. Explains a very satisfactory system of reporting and investigating car defects. 3500 w. St Ry Jour—April 4, 1908. No. 91351.

See also Car Inspection, under STREET AND ELECTRIC RAILWAYS.

Cars.

Northwestern Elevated Railroad—New Trailer Cars, with Steel Underframes and Sliding Side Doors. Illustrated description. 1200 w. Elec Ry Rev—April 25, 1908. No. 91964.

Controllers.

Subway Electric Control. W. B. Kouwenhoven. Illustrated description of the automatically operated controller used in the New York Subway, and its operation. 1100 w. Ry & Loc Engng—April, 1908. No. 91423 C.

Electrification.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Fares.

Handling Fares on Interurban Railways. P. P. Crafts. Read before the Ohio St. Int. Ry. Assn. Gives the most universally used systems, and the various combinations of duplex checks, describing the system of fare collection and accounting on two lines. 3000 w. St Ry Jour—April 25, 1908. No. 91896.

Interurban.

Twelve-Hundred-Volt System of the Indianapolis & Louisville Traction Company. H. D. Murdock. Abstract of paper read before the Cent. Elec. Ry. Assn. Principally a description of the electrical apparatus used on the cars and in the power house, and the operation of the system. 2000 w. Elec Ry Rev—March 28, 1908. No. 91355.

Locomotive Performance.

Railway Calculations. Malcolm MacLaren. Gives illustrations from tests on the N. Y., N. H. & H. Ry., showing the close agreement between theory and practice. 1000 w. Elec Jour—April, 1908. No. 91477.

Locomotives.

See Electrification, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Maintenance.

Maintenance of Overhead Lines and Electrical Equipment by the Indiana Union Traction Company. An explanation of the interesting features of the system. 2000 w. St Ry Jour—April 18, 1908. No. 91761.

Memphis, Tenn.

Reconstruction of the Memphis Street Railway System. Illustrates and describes work including tracks, overhead construction, trolleys, feeders, power house improvements, etc., connected with the recent extensions. 1200 w. St Ry Jour—April 4, 1908. No. 91346.

Shops.

New Repair Shops of the York Railways Company. Brief illustrated description of shops at York, Pa. 900 w. Elec Ry Rev—April 11, 1908. No. 91690.

Changes in Shops and Shop Practice by the New York & Queens County Railway Company Due to the Adoption of All-Steel Cars. All-steel cars were adopted in preparation for the use of the 42nd St. tunnel under the East River, and the shop changes and equipment of the repair shops is illustrated and described. 3000 w. St Ry Jour—April 4, 1908. No. 91350.

See also Car Barns, under STREET AND ELECTRIC RAILWAYS.

Single Phase.

Discussion on "The New Haven System of Single-Phase Distribution, with Special Reference to Sectionalization," at New York, January 10, 1908. Discusses W. S. Murray's paper. 4000 w. Pro Am Inst of Elec Engrs—April, 1908. No. 91702 D.

Murnan-Oberammergau Single-Phase Railway. Cyril J. Hopkins. Gives an outline of the general conditions of the system, giving information in regard to first and annual costs. Ills. 3000 w. Elec Rev, N Y—April 4, 1908. No. 91360.

The Thomson-Houston System of Single Phase Electric Traction on European Railways (La Traction Electrique par Courant Alternatif Simple sur les Chemins de Fer en Europe, Système Thomson-Houston). M. Henry. A general description. Ills. 2500 w. L'Elecn—Mar. 7, 1908. No. 91521 D.

Subways.

Belmont, Interborough and Manhattan, and Hudson River Tunnels. A series of addresses by engineers describing their equipment for electric traction. 19600 w. Pro N Y R R Club—March 20, 1908. No. 91749.

The East River Tubes Connecting New York and Brooklyn. An illustrated description of the construction of the subaqueous tunnels and the electropneumatic block signaling and interlocking system. 5000 w. Elec Rev, N Y—April 11, 1908. No. 91615.

Progress on the Bridge Loop Subway. Explains the difficulties due to the interference with sewers, pipes, conduits, pneumatic postal tubes, gas and water mains, vaults and cellar walls, and illustrates and describes the work accomplished. 2800 w. Eng Rec—April 4, 1908. No. 91405.

The Completion of the First Tramway Subway in London. Illustrated description of the extension connecting the subway under Aldwych with the tramways on the Victoria Embankment. 1000 w. Tram & Ry Wld—April 2, 1908. No. 91-767 B.

The Tunnel Projects of Great Berlin Street Railway (Die Tunnelentwürfe der Grossen Berliner Strassenbahn). The first part discusses the project in the light of experiences with the Boston subway. Ills. 2000 w. Serial. 1st part. Elek Kraft u Bahnen—Mar. 24, 1908. No. 91561 D.

See also Tunnels, under CIVIL ENGINEERING, CONSTRUCTION.

Subway Signalling.

Tunnel Indicator. Illustrated description of the apparatus used to show the position of trains in either of the twin tubes under the East River at New York. 1000 w. Ry & Loc Engng—April, 1908. No. 91424 C.

See also Subways, under STREET AND ELECTRIC RAILWAYS.

Switzerland.

See Adhesion System, under STREET AND ELECTRIC RAILWAYS.

Terminals.

Underground Bridge Terminal in New York for Brooklyn Surface and "L" Lines. Illustrates and describes the large underground terminal at the Delancey St. end of the Williamsburg Bridge. 1500 w. St Ry Jour—April 11, 1908. No. 91611.

Track Construction.

The Proper Construction and Maintenance of Tracks in Electric Railway Service. H. L. Weber. Considers points that determine whether tracks should be permanent, or temporary; the requisites of good tracks, and their maintenance, and related matters. 2500 w. St. Ry Jour—April 4, 1908. No. 91347.

Special Methods Employed in Tearing Out Old Concrete Roadbed for Cable Railway and Rebuilding for Electric Railway. Illustrates and describes machines and methods used on recent work in San Francisco. 600 w. Engng-Con—March 11, 1908. No. 90806.

Trucks.

Electric Motor and Trailer Trucks. A. C. Vauclain. Abstract of paper read before the Cent. Elec. Ry. Assn. Discusses their design and construction, illustrating types. 4000 w. St Ry Jour—April 4, 1908. No. 91352.

Single-Axle Trucks for Street Cars (Einachsige Drehgestelle für Strassenbahnwagen). M. Schiff. A general discussion of their utility and a consideration of types in use. 2300 w. Elek Kraft u Bahnen—Feb. 4, 1908. No. 91555 D.

Trunk Lines.

The Organization of an Economical Operation of Trunk Lines with Light Traffic and of Branch Lines (Organisation eines ökonomischen Betriebes auf Hauptbahnlinien mit Schwachem Verkehr und auf Sekundärbahnen). A general discussion, reviewing the practice of various countries. 13000 w. Mit d Ver f d Förd d Lokal- u Strassenbahnwesens—Feb., 1908. No. 91535 F.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Science. *w.* Denver, U. S. A.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE ENGINEERING MAGAZINE

"THE WORLD IS ITS FIELD"

VOL. XXXV. JULY, 1908. No. 4.

MINING AND INDUSTRIAL PROGRESS IN SWEDEN.

By John Geo. Leigh.

The recent engineering and manufacturing development of Sweden has been rapid; with the opening of the railway through the rich ore fields north of the Arctic circle and the extension of hydro-electric installations, are now allied many important ship-canal and other projects and a general quickening of industrial activities. The possibilities are most interesting for all who are engaged in engineering, contracting, or machinery building. In the present article Mr. Leigh surveys the most significant undertakings or proposals now receiving consideration. In another to follow in a later issue he will take up the methods and characteristics of representative establishments. He writes at first hand, with the vigor and authority of a trained observer, and the broad viewpoint of one long familiar with the spirit and policy of some of the world's greatest pioneers in the exploitation of the resources of a rising industrial nation.—THE EDITORS.

IN no country is there larger excuse than in England for the reflection that much of the energy and capital devoted, not unfrequently with prodigal recklessness, to the opening-up of unknown or semi-civilised lands, or to the furtherance of great distances of magnificent and altruistic ideas, might often be employed to far greater advantage, to all concerned, at home or close at hand. Even in these comparatively prosaic days, when, as we are wont to believe, every project is weighed with cold calculation before its benediction by capital, imagination and the glamour of distance play by no means insignificant *rôles*. In the lives of the most matter-of-fact of business men, there are moments when the pulse is quickened by a craving for adventure, the ordinary routine is illumined by a flash of sentiment, poetry takes the place of sober prose. It is well for many reasons that this is so, for such lapses beget not merely wondrous pity for the aboriginal, self-satisfied without the resources of latter-day civilisation, not merely dreams of untold wealth, but engineering and other enterprises of more than ordinarily important character, which, under other conditions, might never be practically tested.

Yet in these things lurks a danger more serious than individual ruin, disillusion, and disappointment, with their inevitable consequence —exaggerated caution in the future. They tend, only too frequently, to divert attention from necessities and movements nearer home, less sensational perhaps, but offering as great and beneficent opportunity for safe and welcome co-operation. Thoughts such as these could not fail to obtrude themselves during a recent tour through Sweden, and, since then, when summing-up the lessons derived from it and the conclusions based upon observations. Already in the last decade signs were not wanting that this Scandinavian kingdom might readily emerge from the state of comparative isolation into which, since the aftermath of her once conspicuous position among the European nations, she had been thrust by political circumstances. The visit of the Iron and Steel Institute in 1898 revealed aspirations which had hitherto found scant or no expression, and not a few sympathetic and clear-sighted foreigners recognised that the day was approaching when Sweden would be esteemed not only as a store-house of timber and iron ore and because of the intellectual and inventive capacity of her sons, but also as the home of a people striving to take fitting place in the modern system of industrial life.

Many readers may remember that, following the meeting of the Iron and Steel Institute to which reference has been made, there appeared in THE ENGINEERING MAGAZINE two articles by Dr. David A. Louis.* The first described at length the iron-mining and iron- and steel-making industries of Central Sweden, while the second included mention of the railway between Gellivare and the Norwegian frontier and seaboard, projected with a view to opening to the world the rich ore deposits of that remarkable range of heights then known by little more than name as Kirunavara and Luossavara. Since these articles were published, much has happened in Sweden, as elsewhere. In the central provinces, aided by the best appliances and the adoption of the most up-to-date methods of modern practice, there has been an ever-increasing output of raw material and manufactured products, and new industries have been created with conspicuous success. The Gellivare-Narvik railway has been opened and is operating smoothly, thriving settlements have arisen in the neighbourhood of the "iron mountains," and ores from Arctic Norrland are available for export in larger quantities than are actually permitted. It will be the purpose of the present and following contributions to outline the economic conditions responsible for existing

* The Iron Industry of Sweden, June, 1899; The Great Magnetite Deposits of Swedish Lapland, July, 1899.

developments, to indicate the probable issues of the latter, and to suggest means whereby they may be advantageously assisted from without. Therefore, although necessarily less technical in character and scope than were those of Dr. Louis, the articles may be regarded as a natural sequel to their predecessors of nine years ago.

The ordinary laws of progress fail to supply adequate explanation of the phenomena that during the past few years the national wealth of Sweden, the assessed value of real property, the income derived from capital and labour, and the volume of international commerce all show ratios of increase largely in excess of previous periods, and —having regard for varying conditions—comparable with or superior to equivalent statistics of the most thriving of nations. The real explanation must be looked for in the fact—of which I hope in the following pages to offer convincing proof—that this so-called "poor" country of Sweden has of late years been the scene of a general economic expansion, which, if continued (and of this there appears every likelihood) should soon cause people to abandon the qualification as out of date, if, indeed, it ever was warranted. A new spirit of enterprise, based largely upon recognition of the riches which still lie fettered in the hearts of the mountains or run to waste in its abundant waterfalls, has taken hold of the nation. The ultimate goal, of course, is to transform the raw-product industries into manufacturing ones, and so bring about the invasion of modern industrialism into practically every department of the occupations of the people. Outward evidences of this are seen in the increased attention devoted to commercial and technical training, in the tendency of recent legislation, in the amalgamation of competing interests under a harmonious and common direction, and in the increasing number of company formations.

Though Sweden has been comparatively well-to-do during the preliminary years of the present period of transition, its capital cannot be regarded as in any degree adequate to meet existing, much less coming, requirements. To carry out even a few of the more ambitious enterprises projected with a view to utilising the natural resources of the country, the latter needs to increase from without its working capital. This the Swedes themselves are not reluctant to admit, though heretofore the idea of borrowing has been somewhat foreign to the national instinct, as evidenced by the facts (1), that the small public debt of £21,000,000—contracted almost exclusively for the purpose of railway construction and loans—mainly represents home investments; and (2), that the total external liabilities of the country do not greatly exceed £33,000,000.

INDUSTRIAL SWEDEN

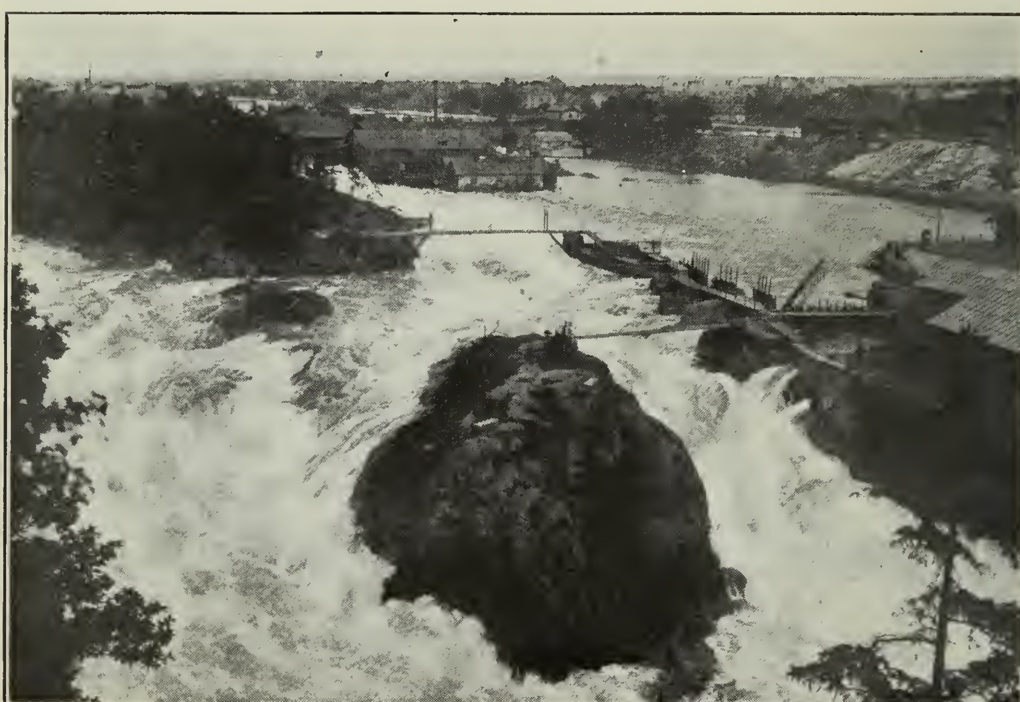
Sweden covers 4.57 per cent. of the area of Europe, and is, consequently, one of the larger countries of that continent. It is rather smaller than France or Germany, but nearly half as large again as Great Britain and Ireland. As an economic and industrial unit, it is convenient to consider it as made up of three main sections, viz., Central Sweden, or Svealand—the limits of which are indicated in the accompanying map by dotted lines and a portion of the Göta Canal; Southern Sweden, or Götaland; and Norrland, extending to the Arctic Ocean.

The extreme south, the peninsula of Scania, is extremely fertile, and its people, as a result, have always devoted themselves particularly to the profession of agriculture. Even here, however, thanks to the favourable geographical position of the province and the wealth

VIEWS ON THE INDAL RIVER, NORRLAND.

The upper one shows the Sillve Rapids and old sawmill.

of its inhabitants, marked changes have taken place during recent years, with the result that Scania to-day rivals other parts of the country in variety of industrial interests. Immediately to the north is the well-wooded and watered, but otherwise naturally poor, province of Smäland, beyond which, on either side of the old volcanic lake, Vettern, are the ancient seats of agriculture, Ostergöthland and Vestergöthland, the fertile plains of which are broken here and there by metalliferous hills, for the most part neglected of the prospector.



TROLLHATTE FALLS; THE SITE OF A PROPOSED HYDRO-ELECTRIC STATION.

Over a large portion of Svealand, on the other hand, the mining of ores, and particularly of iron, has long been a formidable rival to the claims of agriculture, and now, on all sides, in its various provinces, there are arising allied manufacturing industries, of great interest to Sweden, and not to be lightly esteemed by other nations. As an outlet for the products of this activity Nature has provided the wide-stretching, many-bayed Lake Malaren, near whose junction with the Baltic lies Stockholm, the nation's beautiful and busy capital; while adjacent to the western ore regions is Lake Venern, with the Gota Elf, its egress to the North Sea.

North of Svealand extends the immense territory, representing two-thirds of the kingdom, to which has been given the name of Norrland. Neglected until quite recent years, because of its extent, inaccessibility and climate, Norrland bids fair to become, in the near future, one of the best-prized of the nation's assets. Its forests, untouched for generations, are adding year by year to the value of Sweden's exports; the fine iron ores with which its mountains are enriched everywhere command a ready market, and the mighty waterfalls along the courses of its rivers are certain sources of a power calculated to expedite in no small degree the development of local and national industries.

The changes now in progress, and referred to in foregoing paragraphs, are indicated in the movements of population during recent years. Without going into details, it may be stated that Sweden's entry into the sphere of modern industrial concentration and international competition has been accompanied by conditions specially unfavourable to herself. The period of transition was consequently marked by serious economic difficulties, notably expressed by a volume of emigration which often almost neutralised the natural increase of population. Thus it happens that there are in the United States and Canada about 1,350,000 people of Swedish origin and that the Swedish population of Finland and other countries of northern Europe numbers at least 500,000. Since 1894, however, emigration has sunk to a relatively low point, and the growth of population has compared favourably with the whole of Europe.

Of late years, consequent upon the birth of new industries and the development of those of older date—and also, in a measure, the special administrative privileges and educational advantages enjoyed by urban communities—the town population has increased much more rapidly than that of the rural districts. Even now, however, over 50 per cent of the population is engaged in agriculture, as against about 30 per cent in industrial occupations, lumbering and mining included, and the town inhabitants represent but 23 per cent of the whole. There are three cities only with populations exceeding 50,000—the capital, which in 1850 had 93,000 inhabitants and has now 380,000; Gothenburg, the population of which has within the same period increased six-fold, to 152,000; and Malmo, the busy commercial port of Scania, which has grown in the same proportion and has now 71,000 inhabitants. The growth of Norrköping and Boräs, centres of the textile industry; of Jonköping and Orebro, celebrated for their matches; of Eskilstuna, a youthful and diminutive Birmingham, to which I shall have occasion to refer in my second article; of Sundsvall, Gefle, Söderhamm and Hernösand, centres of the saw-mill industry and ports for the export of timber; of Lulea, the port from which the Gellivare iron ore is shipped, and of the many nuclei of towns arising about the larger factories, is equally and often even more noteworthy.

Generally speaking, the towns are more extensive than might be expected from the number of inhabitants, are attractive by reason of their cleanliness and order, and retain, in larger degree than is usual in other countries, the better natural conditions of rural life. It is well that it is so and that the newer industrial development is widely diffused and not restricted to a few centres, for in the larger town the rise in value of real estate is truly remarkable. In Stockholm, for instance, the gross rateable value of property (the market price being about 10 per cent higher) was £60,869,000 in 1906, as compared with £40,000,000 in 1899 and £1,500,000 in 1859. As a result, the rent required for what may be described as a lower middle-class or artisan's dwelling is more than double that ruling in the larger cities of England and the United States.

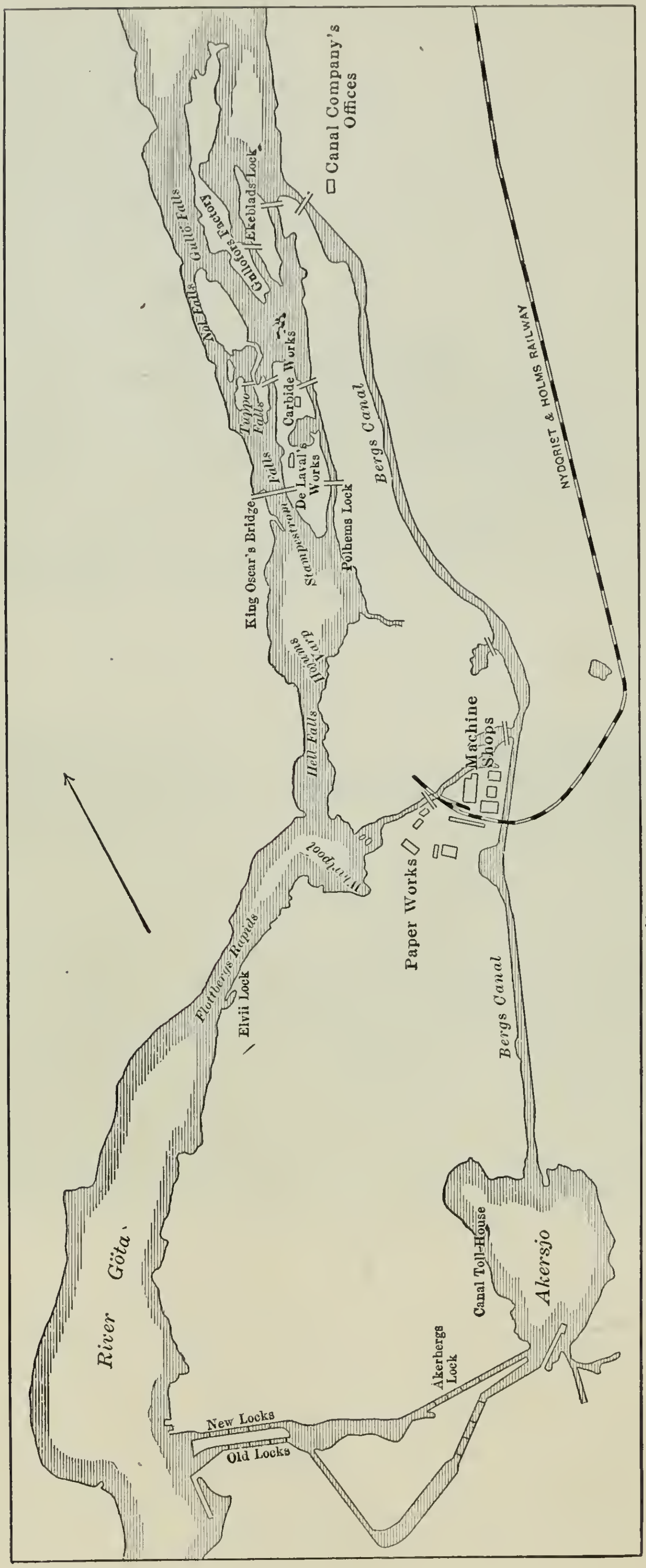
SUNDSVALL HARBOUR.

Mention may here be made of four important engineering projects —typical of the enterprises necessary to give full effect to the present industrial movement—which, it is hoped, may shortly take practical form. I refer to the propsed conversion of the Göta and Trollhatte Canals into highways for large-sized vessels and the erection at the Trollhatte Falls and on the river Dalelfven (Elfkarleo Falls) of works for the generation and transmission of electrical power to Gothenburg and Stockholm respectively.

ELFKARLEO FALLS, ON THE RIVER DALELFVEN.

The upper view shows the site of the proposed hydro-electric station.

Of the Swedish canals and water-ways and their influence upon the cultivation and colonisation of the country, a very interesting history might be written. In default, however, of space to this end, it must suffice to mention that attention was directed in Sweden earlier than in most European States to the value of artificial water-ways intended to link and make more serviceable those provided by nature, and that early in the sixteenth century the first king of the



TROLLHÄTTE CANAL AND WATERFALLS.

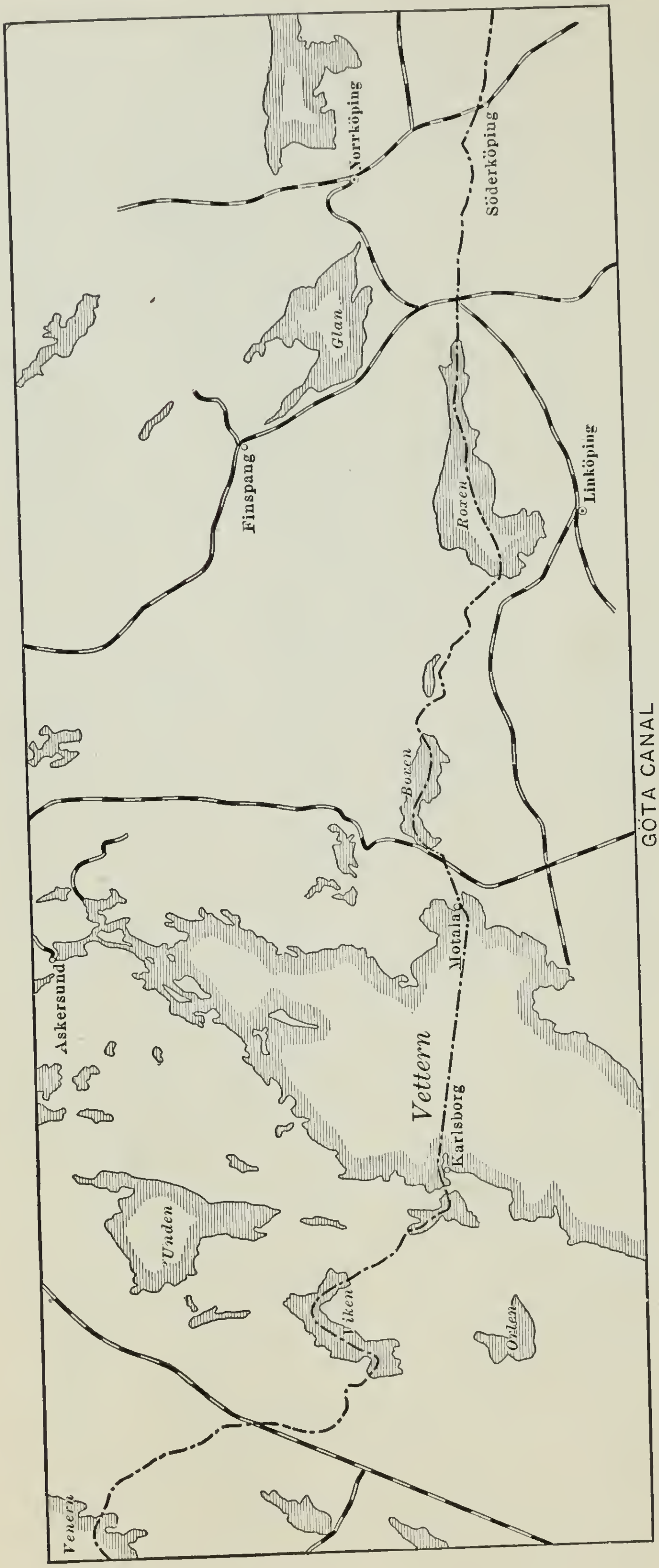
Vasa dynasty projected practically all the great canals now in existence or proposed. Unfortunately, in Sweden, as elsewhere, all canals built in other than quite recent years have failed to confirm the high hopes based upon them. They have been useful for purely local traffic, but, as a general rule, owing to their inferior dimensions and the revolutions effected, first, by the introduction of steam as a motive power and iron as a building material, and, secondly, by the competition of railways, they have proved comparative failures in facilitating commerce and international navigation. In no country is this felt more keenly than in Sweden, the inland ports of which are numerous and in close proximity to the great centres of industry.

Navigation through the existing Trollhatte Canal is restricted to vessels of less than 110 feet length, 28 feet beam, 9 2/3 feet draught and 250 tons displacement. To the enlarged canal, however, which is projected, vessels might be admitted 325 feet long, 47 feet wide, drawing 19 1/2 feet and having a displacement of 5,000 tons. The number of locks would be reduced from sixteen to six and the time of transit lessened from three hours to one. By means of canals from Lake Venern, via Lake Vettern, to the Baltic, and from Lake Venern, via Lake Hjëlmaren, to Lake Mälaren, in conjunction with auxiliary canals of shorter length, all constructed on the above-mentioned scale, there would be secured not only a much-needed traffic transit between the North and Baltic Seas, but also direct water communication between many important inland manufacturing centres and foreign countries, very helpful to international trade. Data concerning existing canals may be thus conveniently summarised:

Canals and Canalised Water-Systems.

	Year of construction.	Length, Miles. Total.	Artificial.	Depth, ft.	Bottom width, ft.	No. of locks.
Trollhatte	1838-44	51	5	9.8	39	16
Göta	1810-32	126	55	9.8	46	58
Sodertelge	1806-19	1.5	.7	12	39	1
Hjälmaren	1819-30	40	5	7	36	9
Orebro	1887-8	1.4	1.4	7	26	1
Eskilstuna (Upper and Lower)	1855-60	6.5	.7	8	26	3
Stromsholm	1842-60	62.5	1	5	32	31
Dalsland	1865-9	160	5	5	15	28
Snacke	1872-4	8.5	.06	7	14	1
Kinda	1865-71	50	16	5	16	15
Seffle	1866-70	56.5	7.5	7	25	1
Stockholm Lock	1845-50	.06	.06	12	32	1
Nine others	....	140	8	..	..	16

To the United Kingdom and Germany, which share more than 60 per cent of Sweden's external commerce, a ship-canal across Svealand could not fail to be particularly advantageous. Germany now pays toll to Denmark for much of her trade with the northern kingdom, but if goods could be transported across the peninsula at rates low enough to make Gothenburg the chief shipping port, exports might thence be carried direct to Hamburg by open sea. English interests are equally concerned, remembering that British shipping naturally frequents the western coast in preference to the often frozen and dangerous and always intricate Baltic Sea, with its high insurance rates. Touching the prospects of the enterprise, it is significant that even now, despite the limited accommodation, no fewer than 10,000 and 6,000 vessels annually pass through, respectively, the Trollhatte and Göta Canals.



GÖTA CANAL

The municipal authorities of Gothenburg have recently given practical proof that they share the cheerful optimism of the country generally and regard with extreme hopefulness the two enterprises at Trollhatte to which I have referred. They believe that much of the anticipated increased traffic through the enlarged canal must directly benefit the terminal city and port, and that such must be the result also of any larger employment of electrical power—that, thanks to both, there will be a marked industrial development along the canal route and on the banks of the Göta, taking its requirements from abroad and exporting its products via Gothenburg. Much energy has accordingly been displayed in extending and improving the harbour and in the endeavour to consolidate the corporation's authority over both banks of the Göta and its outlet so that the harbour plans as a whole shall be secured from outside influence. Not less important is the erection, now in progress, of powerful electrical works, which, with connections, will probably cost £350,000, or more. These will distribute current for lighting and power throughout the urban district, transform to suitable tension for different purposes the current from the station at Trollhatte, and serve as a reserve for the latter in cases of emergency. Already, there is a marked movement in the neighbourhood of the city in the establishment and extension of spinning and weaving mills and other works, in the operation of which electrical energy seems destined to play a very conspicuous part. In Stockholm, also, a new central station has been built, planned in view of a future transmission of power from Elfkarleo, a distance of 115 miles.

The building of railways was commenced late, but, once begun, was continued with remarkable energy. All the main lines have been constructed for and are owned by the State, which has also assisted, by loans or subventions, most of the other railways. At the end of 1905 Sweden possessed in actual use 7,865 miles of railway, of which 2,605 belonged to the State. Consequently, in proportion to population, Sweden has more railways than any other country in Europe. The rails are generally of British, German, or Belgian manufacture, but the rolling-stock, especially on the Government lines, is for the most part of local origin. A recent supply, however, was obtained from the United States. As fuel, English coal is chiefly used. With few exceptions, the railways are provided with but a single track, which has made it possible to reduce the cost of construction to a relatively low figure. The total capital expended on railway enterprise up to the present is about £50,550,000, on which average dividends have been paid exceeding by more than 1 per cent the corresponding figure for Europe generally. Some of the profits derived from the State railways are truly remarkable, as witness the following, quoted from a return for 1905, not only the gross and net income being considered, but also the cost of construction:—The Katrineholm-Nassjo line, through Ostergothland, 8.39 per cent; the Gellivare-Lulea line, practically for ore-transport only, 6.66 per cent, and the Stockholm-Gothenburg and Södertelje line 6.60 per cent. The gross earnings of the State railways in 1906 amounted to over £33,333,000, and those of the private lines to nearly an equivalent sum.

Great interest and hopes centre in schemes for a larger employment of electric traction. Already several electrically-driven railways, among them one between Helsingborg and Ramlösa, in the southernmost province, are operating with considerable success, and it may with certainty be asserted that the movement has passed the experimental stage. During 1906 and last year, extensive investigations were pursued with a view to testing the feasibility and economy of applying electric traction to all the trunk lines south of Bollnäs, a place some 150 miles north of the capital. As a result of these studies, there has been prepared, under the direction of the Government, a very elaborate report, including exact calculations of cost, etc., strongly favouring the entire project, with the exception, for sundry reasons, of three relatively short and unimportant sections. As the most interesting portions of this report have already appeared in The Engineering Magazine,* it is happily unnecessary for me to refer at greater length to the subject. It may, however, be pointed out that, inasmuch as the plans relate to no fewer than 1,700 miles of track, the project is, beyond question, the most important of its kind ever formulated. As such, it may be regarded as not inaptly illustrating the argument with which this article was opened.

There have been times when Sweden was foremost among the nations as regards iron and copper production. Although it long since lost this dominant position, the people have always maintained, both in mining and metallurgy, the highest of technical standards. Progress during recent years has been steady and phenomenal. In the decade ending 1900, the number of persons deriving their support from the mining industry and metal production increased by 50,000, and it is estimated that there are at present in the country at least 200,000 such persons. Whereas in the period 1871-5 the average annual production of ores and minerals (except stone) was 939,092 tons, the production in 1902 was 3,536,759 tons, in 1908 3,678,000 tons, and last year considerably exceeded 5,000,000 tons. Of this increased output some details will be found in the following table:—

Mining of Ores and Minerals.

Metric tons of 2,204 lb.

	Average, 1871-5.	Average, 1896-00.	In 1905.
Iron	795,263	2,294,760	4,365,967
Iron pyrites	......	450	20,762
Coal	50,396	235,626	332,384
Lead and silver	10,949	8,644	8,397
Copper	44,273	23,590	39,255
Zinc	30,539	57,701	56,885
Manganese	488	2,487	1,992

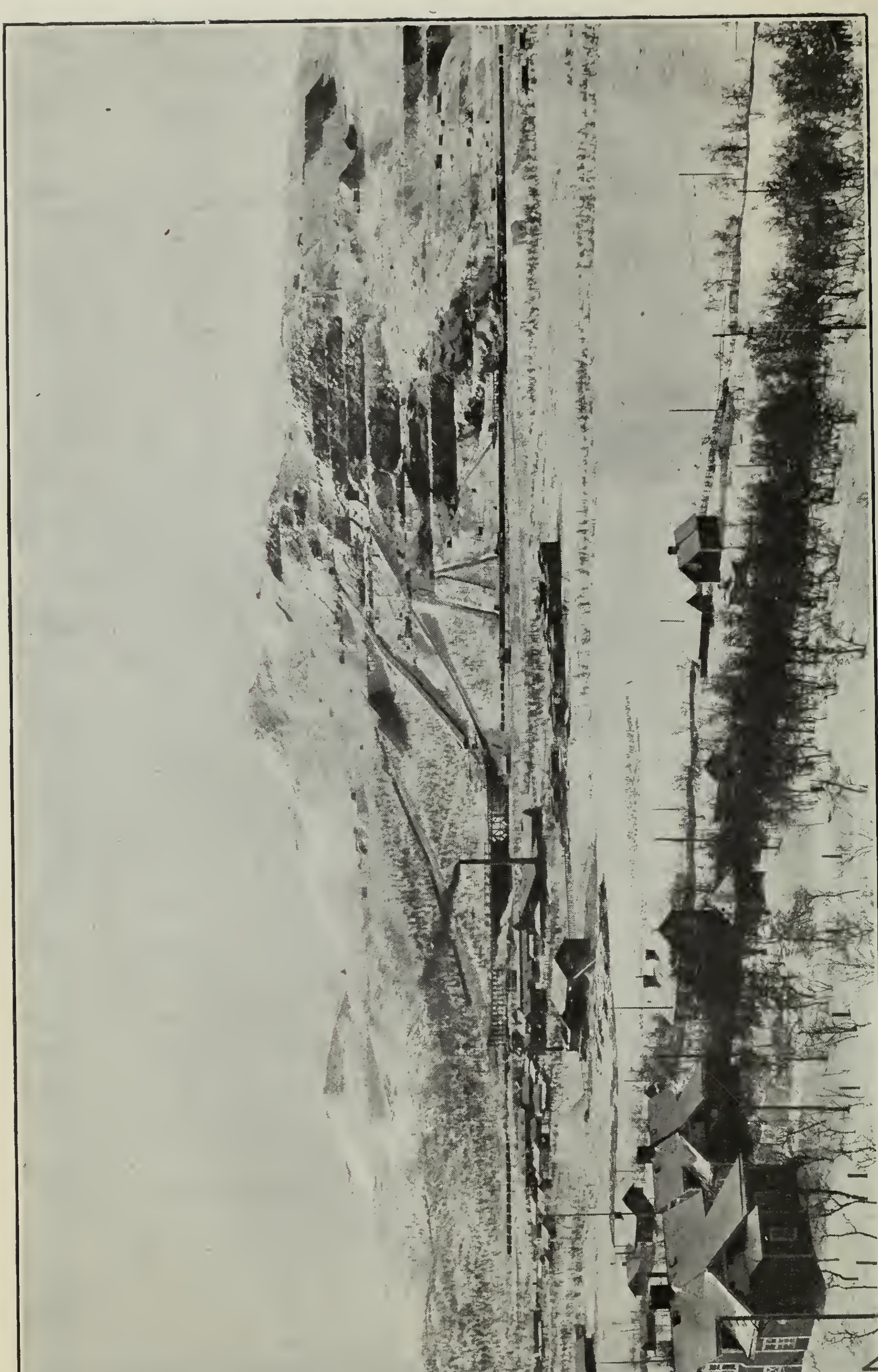
In central and southern Sweden the principal ore regions are concentrated within an area of some 5,800 square miles, stretching from

* The Electrification of the Swedish State Railways. February, 1908.

LULEA-NARVIK RAILWAY AND NORTHERN IRON-ORE REGIONS.

the southernmost part of the Gulf of Bothnia in the east to the north of Lake Venern in the west. North of this region, however, ores of different kinds occur, the most important being the deposits in Lapland, from one-half to one and a half degree above the Arctic circle —these being, in respect of length, thickness and percentage of iron, among the richest in the world. Until within the last four years, of the ore-fields in this region, one only, that of Gellivare, was worked on a large scale. Now, however, since the extension of the Lulea-Gellivare railway to the Norwegian port of Narvik, which is free from ice all the year, an active and increasing production of ore is recorded from the practically inexhaustible supplies of Kirunavara and Luossavara. During 1906 the quantity of ore from Gellivare shipped from Lulea was 1,216,780 tons, an increase of nearly 145,000 tons as compared with the preceding year, while from the more recently opened fields 1,558,635 tons were transported by rail into Norway and shipped from Narvik. The latter amount would, doubtless, have been exceeded but for the special rates payable to the railway for traffic beyond 1,200,000 tons yearly, a regulation which came into force in 1906 and the wisdom of which is open to question.

During last year the average number of workers engaged in actual mining operations on the properties of the Luossavara-Kirunavara Company was 1,217, the total amount of ore transported over the railway and shipped from Narvik being 1,407,298 tons. This exported



GENERAL VIEW OF KIRUNAVARA.
Photograph by Erland Groth, Kiruna.

PART OF THE KIRUNAVARA WORKINGS.
Photograph by Erland Groth, Kiruna.

ore included four standard qualities, analyses of which showed the following results:—

Quality A	0.028 per cent. phosphorus,	69.61	per cent. iron.
" C	0.255 " " "	68.19	" " "
" $	1.91 " " "	62.20	" " "
" G	2.90 " " "	56.07	" " "

VALUE OF EXPORTS AND IMPORTS—METALS AND MINERALS.

In Pounds Sterling.

Exports.

Iron and Steel:

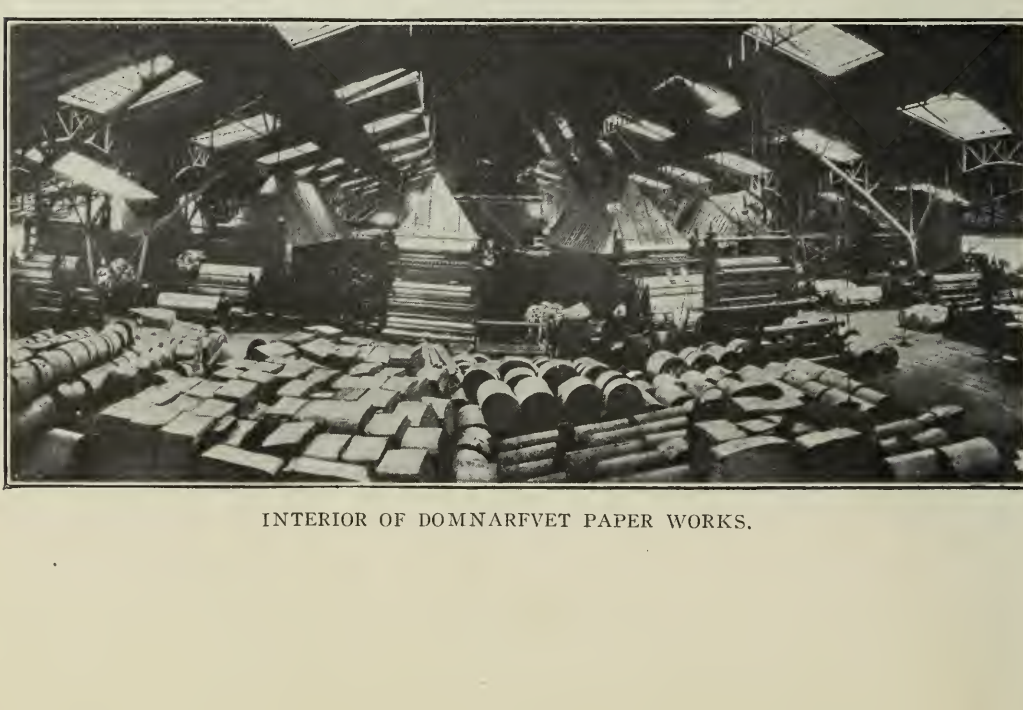
	1895.	1905.		1895.	1905.
Iron Ore	311,278	1,516,440	Coal and Coke	1,803,440	2,775,220
Pig Iron	199,890	489,830	Iron and Steel, unwrought and partly wrought	180,660	432,400
Bar, Bolt, Hoop, etc.	1,296,000	1,890,440	Manufactures of	524,500	1,194,110
Blooms	125,500	300,160	Machinery, including Locomotives	619,440	1,314,000
Plates	30,220	21,400			
Iron and Steel Wares	350,000	861,550			
Iron and Steel Wire	19,450	30,770			
Machinery	307,000	859,000			
Zinc Blende	64,330	194,110			

During the period 1871-85 the value of the imports greatly exceeded that of the exports, but since then the ratio of exports has

THE DOMNARFVET PAPER WORKS.

risen considerably, and this notwithstanding the ever and largely increasing imports of coal. The necessity of the latter is a dominant factor in the industrial development of the country and has been the cause of many ingenious expedients for augmenting the supply of inland fuel. On all sides, however, it is recognised that the problem must be solved by a larger utilisation of the vast amounts of water-power available in practically every section of the country.

Of the total land area of Sweden, not fewer than 52,000,000 acres, or rather more than 50 per cent, are estimated to be covered with timber. It is to this circumstance that we must look for a deciding influence on the development of the nation's iron industry, for the fuel used in the production of iron is principally charcoal and wood—often mixed, however, with fossil coal or coke, or peat or peat-coal, in the producers for open-hearth furnaces, in puddling furnaces, and in the making of blister steel. Moreover, of the value of Swedish ex-

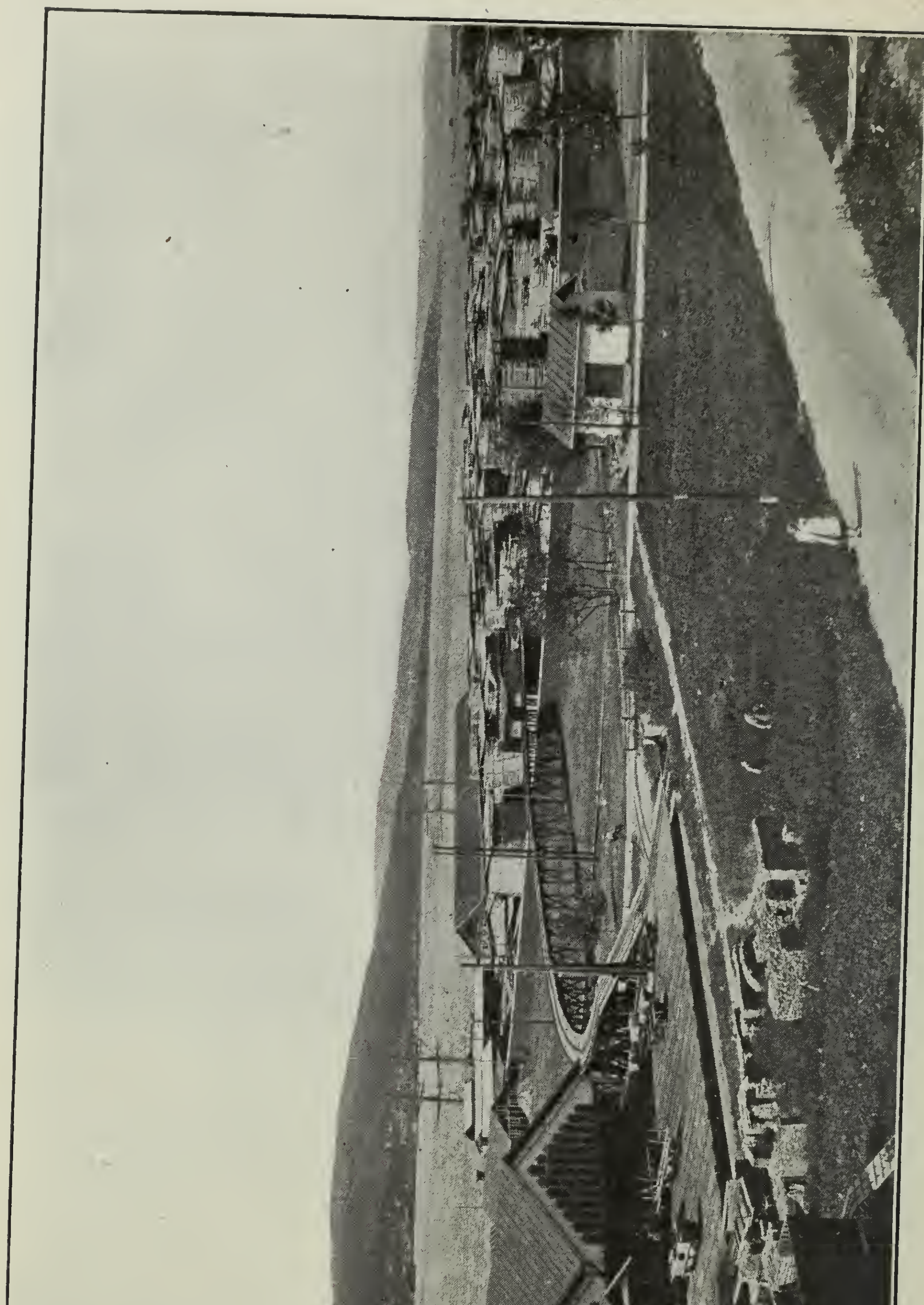


INTERIOR OF DOMNARFVET PAPER WORKS.

ports, more than one-half must be credited to forest products—unwrought and wrought timber, pulp and paper. From these facts it will be obvious that no inquiry touching the economic and industrial position of Sweden is possible without reference to its wealth-producing forests. These, during recent years, have been directly responsible for much engineering activity, and we may confidently anticipate that this relationship will continue and become increasingly close.

THE POWER STATION AT DOMNARFVET PAPER MILLS.

Notwithstanding Sweden's forest resources—superior in extent and value to those of any European country other than Finland—it is estimated that even now the annual consumption of timber exceeds the growth capable of being used by nearly 4,000,000 cubic yards. That the proportion is not more serious is due in large measure to the prescient legislation of recent years, which, in effect, decrees that no timber shall be exported or sawn up at saw-mills unless the trunk at a certain height is of specified diameter; that for every tree cut another shall take its place; and that, after lumbering, the ground shall be treated in such way that the regrowth of wood is not endangered. Something more, however, might yet be done in improving communication, whereby the wood-material in more or less inaccessi-



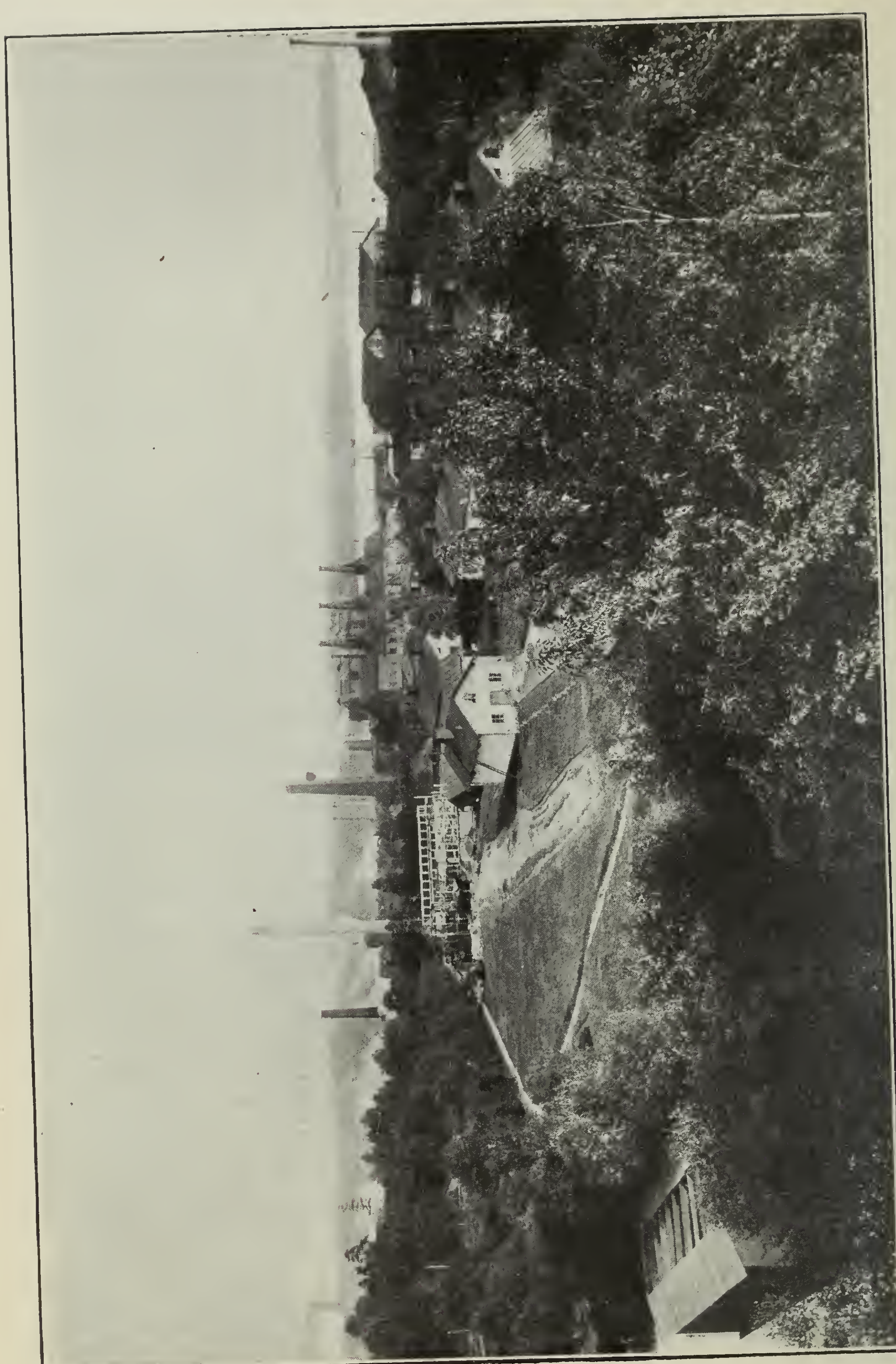
GUSTAFSBERG SAWMILLS, NEAR SUNDSVALL.

ble parts might be better utilised, and by putting into a wood-producing state heaths and other, at present, unproductive territory.

To illustrate the growth of the industry, a few figures may here be given. In 1821 (the year of the first reduction of custom duties in England) Sweden possessed 3,633 saw-mills, with an output of 267,000 dozen deals and boards, of which 200,000 were exported. Forty years later, she owned 59 steam and 4,933 water or wind saw-mills, and the export of deals and boards alone amounted to 1,478,000 dozen. In fifteen years more, this export was trebled, and the exports of rough timber rose to over £5,500,000. In 1903—a record year so far as regards unwrought, *i. e.*, sawn or hewn, timber—the exports classified under this head exceeded £9,600,000 in value; and in 1905 the value of exports associated with the country's forest resources approximated to £13,000,000, including wood pulp £2,566,000, paper £5,330,000, matches £480,000, and joiners' wares £590,000. There were in operation in 1900 1,148 saw-mills, ranking as factories and employing 43,312 workmen; 1,835 saw frames and 769 planing machines were in use, and, as motive power, 536 water wheels or turbines and 859 steam engines were employed in the mill-work proper and 10 water wheels and 109 steam engines for running electric motors. Since the last census there has been an almost continuous boom in erecting and enlarging mills, equipped with the most modern machinery; consequently all these figures are inadequate.

The principal saw-mills are situated north of the river Dal and adjacent to the Gulf of Bothnia, the most notable in regard to the export trade being those in the Sundsvall, Hernosand, Hudiksvall, and Gefle districts. The wood-pulp and paper mills and match and pasteboard factories are, on the other hand, mostly located in the southern provinces, a prominent exception being the Domnarfvet paper mill, of which illustrations appear in the present article. This mill is the property of the Stora Kopparbergs Bergslags Aktiebolaget, probably the oldest industrial corporation existing in any country, the owners, also, of the historic Falun copper mine, the great Domnarfvet iron works, 750,000 acres of forest, the largest saw-mill in the world, and an important wood-pulp factory at Skutskar, and a recently erected combined pulp factory and paper mill at Kvarnsveden.

It will be my duty, in a subsequent article, to refer in some detail to the more important features of the movement discussed in the preceding pages, to its international significance, to recent progress in hydro-electricity and other departments of engineering, and to the operations of typical industries and establishments in promoting and profiting by Sweden's new, progressive, and interesting departure.



GENERAL VIEW OF THE SANDVIKEN IRON WORKS.

THE PRODUCT AND METHODS OF EUROPEAN LOCOMOTIVE WORKS.

By Charles R. King.

Mr. King's review of Continental locomotive design, steam practice, shop methods, and mechanical devices began in our issue for June. The data since received concerning the new processes of welding, and especially the details and illustrations of machine operations in the Italian works, have made it necessary to divide the remainder into two portions, instead of finishing in this number as first intended. The August installment, concluding the study, will deal with the latest Italian work and some interesting examples of Roumanian, Russian, Belgian and other practice.—THE EDITORS.

SWISS railways have adhered for years to the de Glehn engine arrangement or its modifications. The view on page 520 shows the first of the Central European type introduced into Switzerland. It has bar frames and the Clench superheater in the boiler barrel. The engine is the Maffei standard compound arrangement with his new inlet valves on the low-pressure cylinders for automatic admission of steam when starting a train. The cylinders are shown in the view Figure 21. The receivers do not connect the cylinders direct as in the Bavarian and Baden engines, but are formed of pipes passing through the smoke-box. The inlet-valve chambers are visible projecting one from each of the two ends of the low-pressure cylinders. Figure 22 is a view of the boiler. It has sextuple-riveted longitudinal seams and double-riveted circumferential seams. The saturated steam collector is in the rear barrel and the superheated steam dome and manhole is placed on the forward barrel over the superheater. The superheater simply consists of the forward end of the barrel partitioned off as a reservoir of superheated steam traversed by the flues. The position of the intermediary tube plate in the forward barrel is easily distinguishable by the second row of rivet heads. The great antiquity of this invention, as also of the U bent smoke-tube superheater, will be understood from the fact that this form of superheater figures incidentally—as would a chimney or a firebox in a locomotive boiler—in the French patent of Emorine, No. 13246, April 2, 1853. In this old superheater and in this latest arrangement of the Clench, the throttles are placed between the superheater and the cylinders so that the same steam pressure is always maintained in the superheater drum as in the boiler

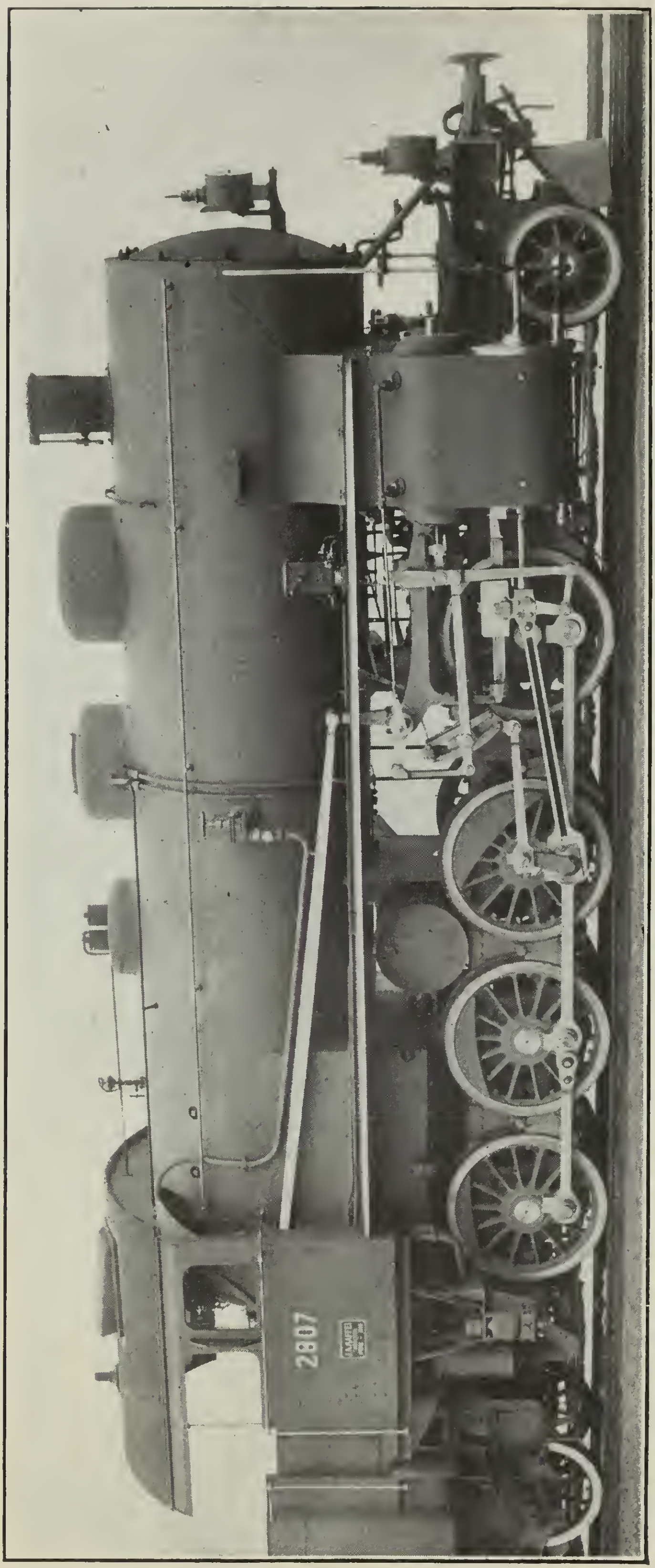


FIG. 20.* BALANCED COMPOUND WITH CLENCH SUPERHEATER, FOR PASSENGER AND FREIGHT, ST. GOTHARD RAILWAY.

proper a most important detail; if it be absent, much capital is made of the fact by advocates of rival systems. The Gotthard Railway is so highly satisfied with the results of this Clench modified apparatus that, until future notice, it will be a standard application for all Gotthardbahn locomotive boilers. The temperature of steam attained in service with these superheaters is 260 degrees C. and this is in part due to the action of the three vertical partitions within the drum; the holes in the partitions through which the steam passes from one compartment to the other; around the flues, are only slightly larger than the flues—52:61 millimetres—so that the steam is compelled

* The figure numbers are consecutive with those in Mr. King's first article.

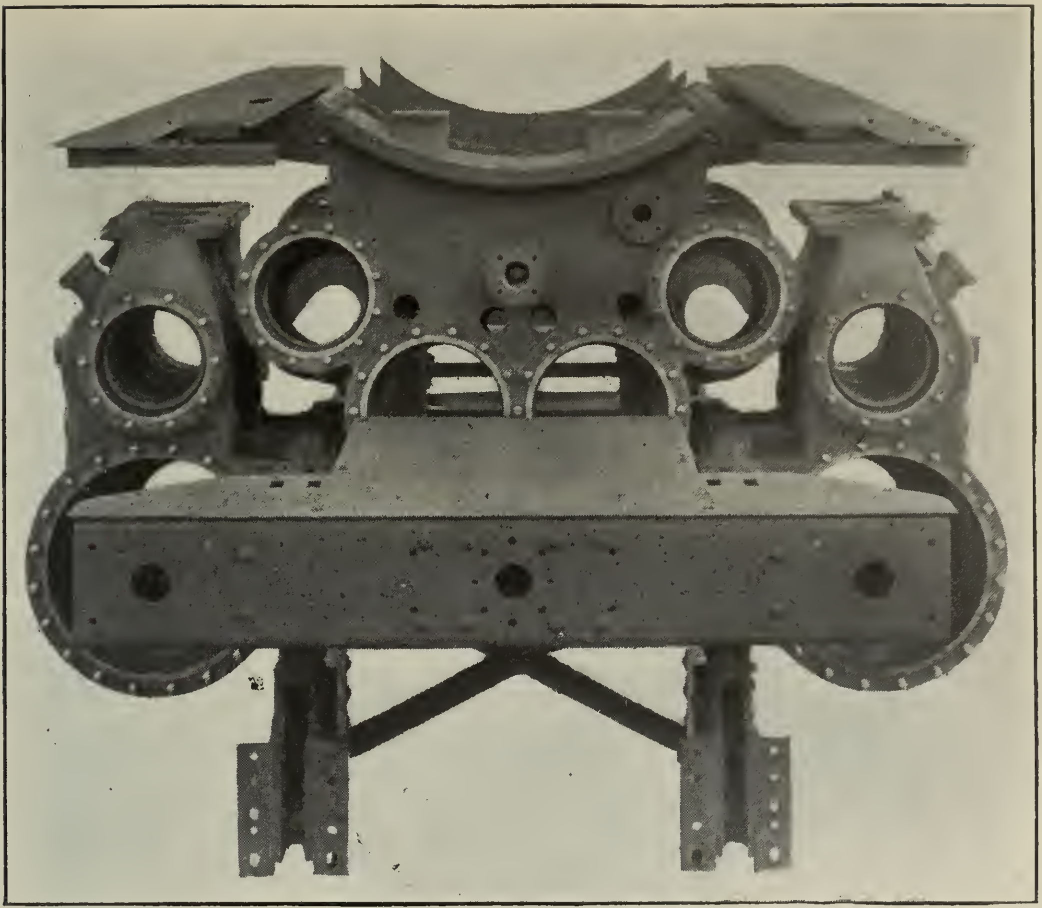


FIG. 21. CYLINDER CASTINGS FOR ST. GOTTHARD MOUNTAIN LOCOMOTIVE.

to circulate on the surface of the tubes. One of these new locomotives replaces two of the machines hitherto employed for hauling accommodation passenger trains on the slopes of the Alps. They are very powerful machines for their weight and are doing excellent service. Supplementing the first lot of eight machines a further lot of eight is on order from Maffei.

For light haulage work the motor-car engine has been carefully studied by many locomotive builders, including Maffei. This class

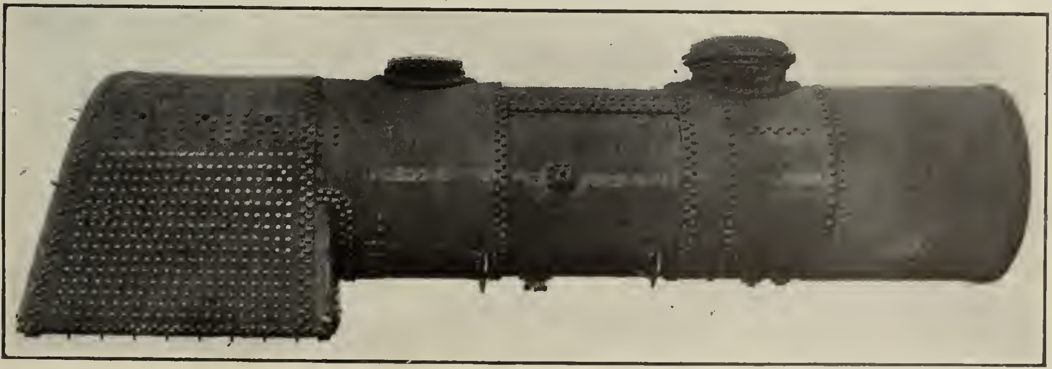


FIG. 22. BOILER WITH CLENCH SUPERHEATER, ST. GOTTHARD MOUNTAIN LOCOMOTIVES.

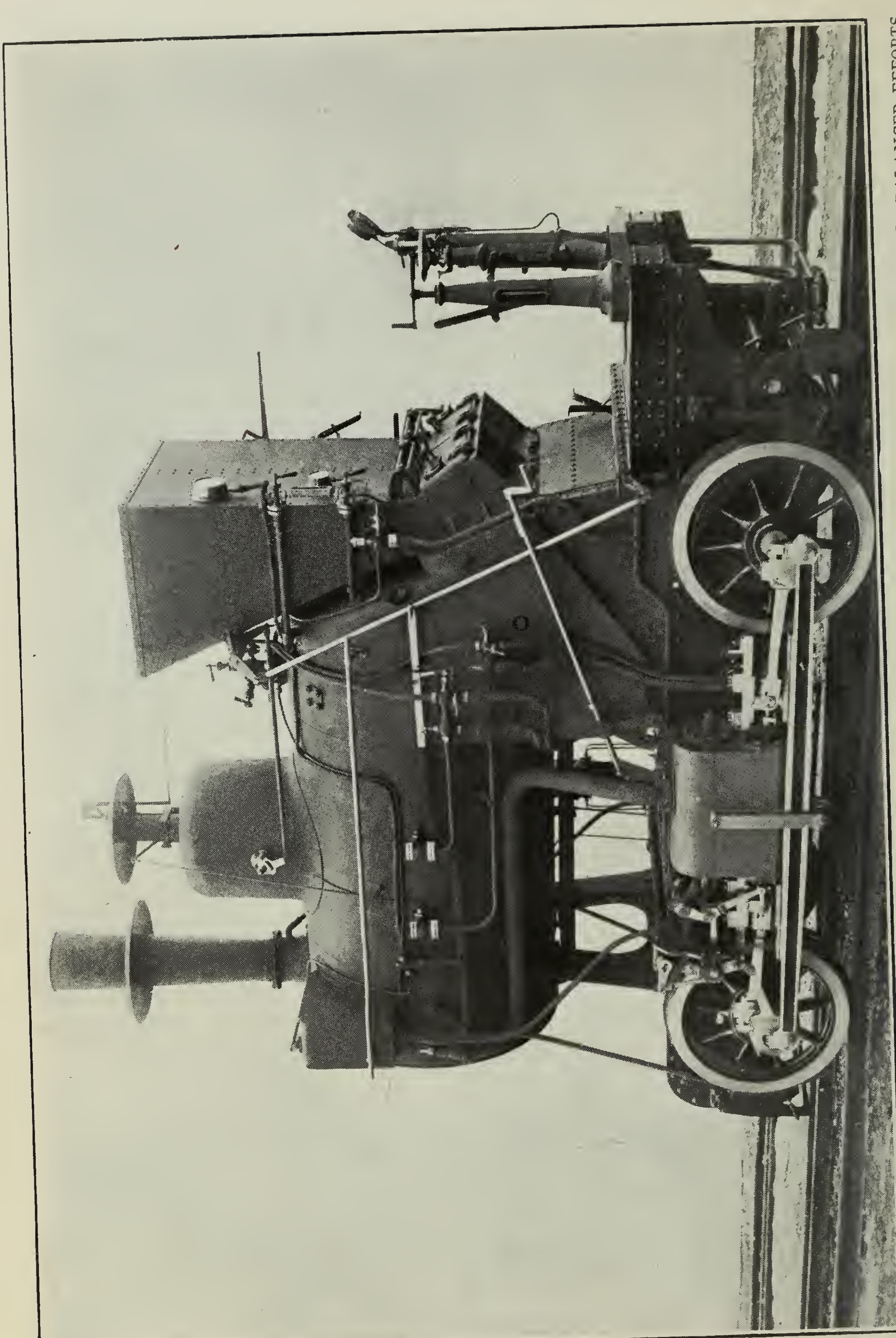


FIG. 23. CAR MOTOR FOR TRUNK LINE TRAINS; TWO CYLINDERS, TWO VALVES, FOUR PISTONS, FOUR CRANKS; BALANCED EFFORTS.
Schmidt superheater, automatic stoker.

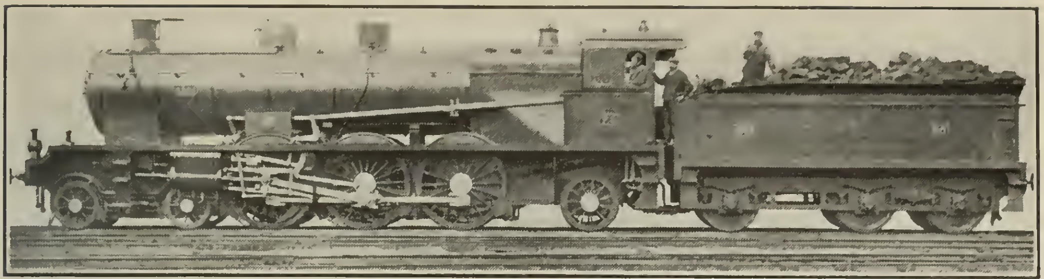


FIG. 24. NEW PACIFIC-TYPE LOCOMOTIVE, PARIS-ORLÉANS RAILWAY.
Four-cylinder compound; feature, tapering mud ring and firebox.

of engine is built at Munich to be both dependent and independent of the car body. The boilers are both of the water-tube type, Turgan's patent, and of the ordinary locomotive type—see Figure 23. They have hoppers for the fuel and automatic firing arrangements. Superheaters of the Schmidt type are also fitted. The engines are entirely novel, there being four pistons in two outside cylinders, which are practically, in effect, the same as four cylinders. Steam is admitted between the two pistons and drives them apart simultaneously, and then it is admitted against the outer faces of the two pistons, driving them towards each other again. The object is to secure complete equalisation of the forces, by opposing one effort to another that is exerted in the opposite direction and thus avoiding the thumping so well known to passengers riding over two-cylinder engines when the car is slowly mounting a grade. The engines of the independent locomotives for light services or branch lines are made in precisely the same way, the only difference being that the "side-rods" are placed inside the frames—a novelty in locomotive construction. In the motor-car engines the coupling rods are, as shown in Figure 23, fitted on the cranks outside of the driving rods and in such way as to rise and fall on the outside of the cylinder casing.

French Railways. Paris-Orléans. The *oo OOO o* type locomotive of the Paris-Orléans line, Figure 24, began service in 1907. It is remarkable for its cone-shaped firebox. The object of this unusual arrangement was to contrive a box of the wide type having its most important advantage, of facility in firing, and yet with the ordinary narrow firebox flue sheet in front. Against wide tube sheets much is said among railway men; much also is written against the wide firebox altogether, but very often such adverse criticism is traceable to some commercial interest in arrangements favored by narrow fireboxes—and of such it may be said that literature based upon interest in the commercial advancement of certain specialties has little scruple with regard to truthful foundation. Even in England, the North, the Brighton and Western Railways have commenced the practice of wide fireboxes—and the Brighton is very satisfied with them. The Orléans has sought an improvement on the type, and in service the fact that for six months no remark or complaint has been forwarded to headquarters relative to the new boilers is considered to be a very good augury—enginemen and locomotive dépôts abhorring changes. The plan of the firebox is very clear in Figure 25, and is all the more so if the reader will take the trouble to view the engraving the wrong way up. The arrangement was proposed by Mr. Guth, the new director of the engine department of the Société Alsacienne de Constructions Mécaniques, and accepted by the chief of motive power, Orléans Ry. The form is new, but the principle old. In 1899 Cockerills of Seraing, Belgium, built for the Belgian State lines, and showed at the Paris Exhibition, their remarkable *o OO o* type having the genuine wide Belpaire firebox, but with somewhat less than half its length at the forward end contracted, between the high driving wheels, to little more than half the full width. The forward end of the firebox is fitted between the frames near the rear driving wheels. The same effect is realised in the new conical-plan boxes of the Orléans line.

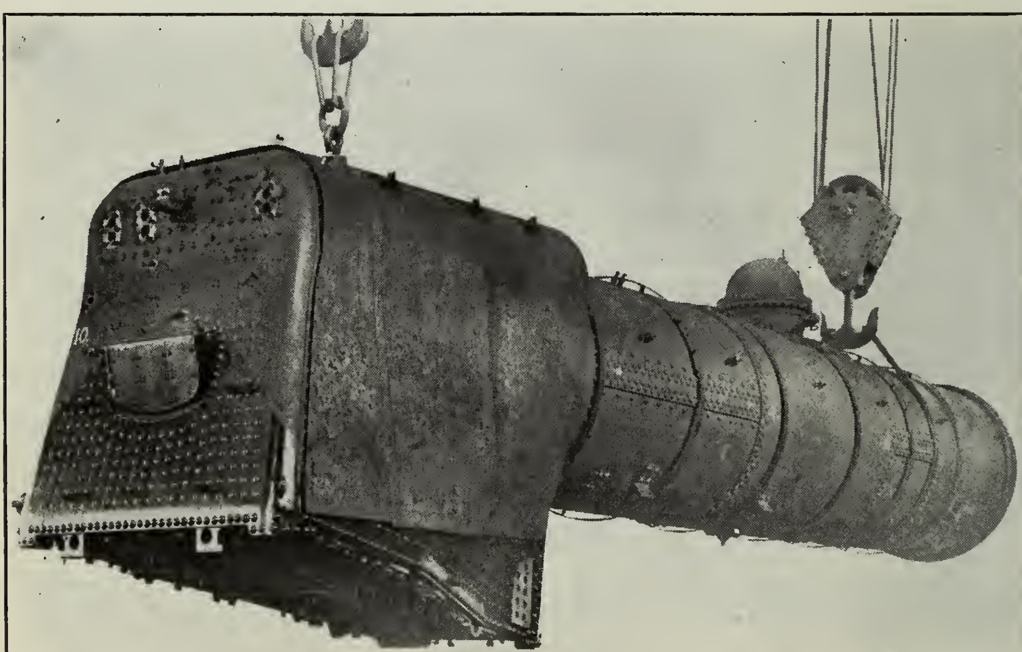


FIG. 25. PARIS-ORLÉANS LOCOMOTIVE BOILER SHOWING UNDER SIDE OF TAPERING FIREBOX.

The new boilers, with heating surfaces of 15.37 square metres in firebox and 241.88 square metres inside flues, and working pressure of 16 kilogrammes per square centimetre, weigh 24 tons complete with chimney and ash pan. The latest plan for riveting all the seams is best seen in the view of the boiler. The firedoor is of the inwardly-opening type, which will probably become obligatory in future, as it closes of itself when, as the result of accident, steam rushes into the firebox. The frames are illustrated in the Figure 26. It will be observed that they are strongly reinforced where cut out to clear the front end of the firebox. Complete, as shown, and with yokes or balance levers for the springs, but without draft beam or spring draft and buffing gear, the frame weighs 10 tons. In the engine proper are to be noted points of relative novelty for French practice, that is, the approaching nearness of the inside and outside cylinders, the construction of piston valves by a firm which, with Mr. de Glehn, had so long adhered to flat valves, and the removal of the characteristic steam pipe from the outside into the smokebox.

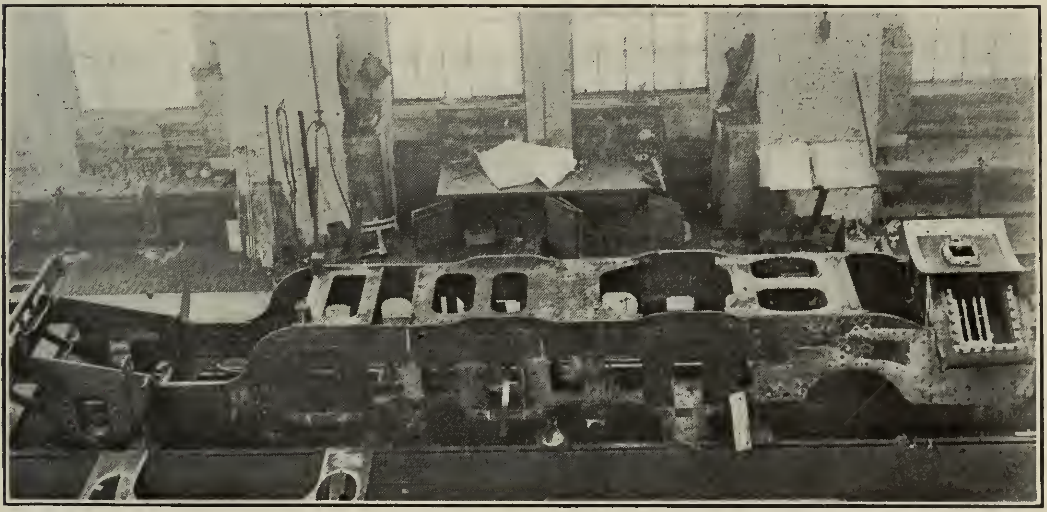


FIG. 26. PARIS-ORLÉANS LOCOMOTIVE FRAMES FOR PACIFIC TYPE.

Elsewhere in France no change in engine design is yet pronounced, but there are indications that one line—the Ouest—may in future experiment with the simple four-cylinder arrangement common elsewhere on the Continent and against which no substantial objection can be produced by French designers—other than that entailed by strong attachment to the now out-of-date but original divided system of the late Mr. Webb. The "Est" Railway is now drying the steam in its passage through the receiver from the outside high-pressure group, set back on the frames, to the forward low-pressure group between the frames. This defective Webb-de Glehn arrangement of the cylinders facilitates condensation. Consequently the "Est" passes the steam all around the inside contour of the smoke-box in four parallel pipes, instead of in one as usual. This dries the steam, which need not have become moist were all cylinders grouped in one block. A saving of about 4 per cent is credited to this arrangement; but those responsible for the "drier" do not consider the figures to be yet proved. Mr. Drummond, the veteran motive-power chief of the

English South-West Railway, delivers steam from boiler to cylinders through thirty small pipes instead of two, as in the conventional arrangement; and admits that while it is a favorable detail for the engine there is no claim to make for any distinct economy.

The new processes for welding have been of the greatest utility for the work of railway shops, for they permit of the metal being fused *in situ* without having to dismount the parts to be repaired. Even a broken bridge in the orifices of a valve-chest liner can be sometimes "touched" with the flame and the liner then rebored in place. In the work of new constructions these welding processes are largely employed. At the La Chapelle (Paris) shops of the Nord Railway the oxyhydric process is in use for welding all thin plates not subject to special working strains. Boiler flues are pieced together and frame plates are welded or soldered, after being fractured in service. For joining the clothing plates of boiler or cylinders —which require to be hermetic when no non-conductor is used for lagging the boiler—it is especially serviceable. A length of 1 metre of 1-millimetre thick plate is welded in 10 minutes, consuming 20 litres of oxygen and 100 litres of hydrogen and costing, together, 14 centimes = barely 3 cents; one metre of 2-millimetre plate is soldered in 15 minutes, consuming 60 litres oxygen and 280 litres hydrogen. The proportion of hydrogen is much above the theoretical value in order to avoid oxidation. Frame plates or parts attached, are repaired with a consumption of gas differing widely in proportion to the importance and difficulty of the operation. For instance, suppose a crack 5 inches long in the angle of horn-plates or axle-box guides ("pedestals"), the depth being 1¼ inches. The metal to be run into the cavities, that machined inside and outside to half-depth, calls for an expenditure of 1,500 litres of oxygen and 8,800 litres of hydrogen, costing 11.39 francs, say $2.28. The removal of the plant, its installation, the welding, and the return of the plant, takes the smith and his help 2 hours, costing 2.45 francs, so that the whole repair comes to 13.84 francs.

The process is also employed in the construction and repair of steel and iron pipes, of ash-pans, locomotive footplates, and for all kinds of repairs where the flaws are superficial and compromise neither strength nor safety.

The outsider, in watching the process, sees the operator wearing dark spectacles holding the burner against a 1¼-inch frame plate. The flame first blisters superficially; the iron then gradually becomes a blotchy red, losing color directly the flame is moved away, then reddening through the whole depth of the metal, and finally becomes white and attains the point of fusion, when the soft iron rod to fill the cavity is introduced and fuses with the neighboring metal of the plate being welded. With boiler flues the two coned and hollowed ends of the tubes are lightly butted together while resting on a X-trestle, and the operator touches the joint with the flame forming a series of little fused points, turning the tube slightly with each touch of the flame. Each operator welds 120 flues daily, or an average of 5 minutes per tube, the cost in gas for each 10 tubes being 100 litres oxygen and 650 litres hydrogen, costing, together, 81 centimes or 16 cents. The saving as compared with the old system of brazing amounts to 40 centimes (8 sous or 8 cents) per tube, or enough to pay for the gas required to weld 5 tubes.

An assistant removes the welded tubes and passes one extremity of the flue through a hole in a block, leaning on the other extremity, turning the tube slightly at each pressure. The tube, according to the foreman, never breaks at the joint but gives way at any other part if the tube is tested to destruction.

Summing up the price of shop work in connection with this form of welding, each tube costs 32 centimes, or 6½ cents, for labor; that is, cleaning and cutting down old tubes, sawing off and chamfering the new ends for the firebox extremities, welding, straightening; tests in the block and at the hydraulic press, and trials at the store reception. The gas costs 0.81 centimes per tube, consequently each tube thus welded costs, altogether, 40.1 centimes or 8 sous or cents.

The saving by this process for welding ribbed tubes of the Serve pattern is even greater—that is 13 sous or cents per tube. The ends of the tubes are hollowed and coned as usual, the lip on the hollowed end furnishing the metal for the fusion of the joint. Each tube-weld necessitates 60 litres oxygen and 243 litres hydrogen, together worth 37 centimes or 7½ cents. Each installation turns out 60 welded tubes per day or an average of 10 minutes for each ribbed tube, for which 4 sous or cents per tube is allowed. The entire cost per tube amounts to 25 sous or cents—one shilling—in including cleaning, selecting, and cutting down of tubes, removal of ribs at the extremities, sawing off the new end, chamfering the joints and, at the same time, removing the ribs near to the weld, welding, straightening and testing.

The two kinds of gases are delivered in steel cylinders of 47 litres capacity and at a pressure of 150 kilogrammes per square centimetre. Reduced to atmospheric pressure, each cylinder therefore contains about 7 cubic metres of gas, for which 16 sous or cents is paid to the "Société L'Oxhydrique Française" per cubic metre of hydrogen and 58 sous per cubic metre of oxygen. For thin metal up to 3 mili-

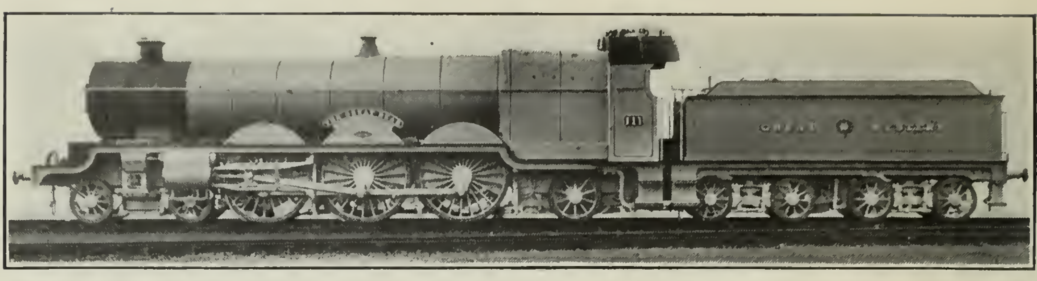


FIG. 27. GREAT WESTERN FOUR-CYLINDER NON-COMPOUND LOCOMOTIVE.

metres thickness this process is at quite as economical as the oxy-actelenic process of welding, but beyond that thickness the latter is the more economical. This latter process is largely employed at the Epernay works of the Eastern of France Railways. By reason of its less intense whiteness the glare of the oxyhydric flame is said to fatigue less the eyes of the operatives.

English Great Western. The new *oo OOO o* type Great Western locomotive, Figure 27, is a four-cylinder single-expansion engine of the divided arrangement of cylinders and driving axles. The boiler is notable for the authentic type Belpaire wide firebox, and the Cole superheater in the boiler combined with a Swindon arrangement of the collector reservoir for the superheated steam. The brick arch is supported upon water tubes as in American practice. The heating surface of the boiler is 2855.8 square feet, and of the superheater 545 square feet. The grate area of only 41.8 square feet is not disproportionate, with the immense calorific value of the coal used by engines between London, Bristol and Plymouth, and which, under best conditions, evaporates 12 pounds of water, while the average quality of coal for express locomotives varies between 10½ and 11 pounds evaporation. The laboratory test of the evaporative value gives 15 pounds per pound of Welsh steam coal, which is equal to a little over 15,000 B. t. u. per pound. Besides good coal, there are other conditions which tend to make this largest European express locomotive more powerful and efficient than Continental engines of the same dimensions, such for instance as softened water, first-class upkeep, and scrupulous attention to the trimming and cleaning of the machine. Under the very inferior conditions of ordinary routine care and attention so often prevailing on the Continent the best of coal-saving devices and systems often work at waste, except during the period of trials when men and machine are made to do their utmost according to the urgency of the issue—as where the figures thus realised are required for publication in proof of the superiority of any marketable article.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

I. TYPICAL INEFFICIENCIES AND THEIR SIGNIFICANCE.

The progress of developing and segregating a new field of engineering—that which is occupied with directing the great forces of *manufacturing* to the greatest advantage and economy—has been marked by several great productions in professional literature which have established new ideals and have themselves become classics. Such were Mr. H. F. L. Orcutt's papers on Machine-Shop Management, and Mr. C. U. Carpenter's two series on Profit-Making Management, all published in this Magazine. Such was Mr. F. W. Taylor's world-famed study of the Art of Cutting Metals.

We believe that this preaching of Mr. Emerson's new gospel of efficiency marks another such era, and that his articles will form another of the great volumes in the library of Industrial Engineering.—The Editors.

NATURE'S operations are characterized by marvelous efficiency and by lavish prodigality. Man is a child of Nature as to prodigality, but not as to efficiency. If it had happened the other way—if he had followed Nature's lead as to efficiency, but had taken up parsimony as a distinctly human virtue—the human race would have become wealthy beyond conception.

Most political economists have preached parsimony, not efficiency. As parsimony is not one of Nature's teachings and as efficiency is, it would be better to aim at efficiency first and leave parsimony to the generations to follow, who will be forced to make a virtue of necessity.

The efficiency of Nature's operations is seen on every side.

There is Nature's pump, which draws up the water from the surface of the ocean to a vast height, carries it thousands of miles and deposits it on mountain tops and over plains. No reciprocating parts, no valve slip, no lost motion, no frictional resistance, no pipe lines. Prodigal in the amount sucked up, prodigal in the height to which it is lifted, prodigal as to distance transported, but as a pump proposition a perfect heat cycle.

There is Nature's storage battery in muscular reserve. A salmon will enter the Rhine from the sea, cease feeding after entering fresh water; he will swim up stream 500 miles, in exceptional cases stay at the headwaters for 17 months, and then, not having lost much weight, will swim to sea again.

An oil engine may reach 30 per cent of thermal efficiency, but the salmon, assuming his whole weight to be pure oil, stores at least several hundred per cent more than thermal efficiency.

The salmon uses stored, not thermal, energy.

The fire-fly, the glow-worm, the phosphorescent jelly-fish, show a far higher light efficiency than has ever been reached even by vacuum lamps.

A heavier-than-air flight of 23 miles is the limit thus far attained by man; but most of Nature's visible creatures, from the midge to the heavy swan, revel in mechanical flight. From swans to humming birds, innumerable feathered creatures fly every spring from the tropics to the Arctic circle, every autumn from Arctic circle back to tropics, while some of them fly from Arctic to Antarctic.

To attain the high efficiency of stored energy of the fish, the high mechanical efficiency of the bird, the high lighting efficiency of the fire-fly, is not an ethical or financial or social problem, but an engineering problem, and to the engineering profession, rather than to any other, must we look for salvation from our distinctly human ills, so grievously and pathetically great.

Inefficiency, principally of administration, is alone responsible for the long bread line of able-bodied men, which during this winter, spring and summer honors Mr. Fleischman's generosity, but disgraces New York City. Inefficiency, principally of administration, is alone responsible for the 700 starving children, fed daily at the East side schools in New York.

For every mouth that comes into the world, there are two hands, two feet; and, if each set of hands and feet does not have an organizing brain to direct it, there are occasionally great creative and organizing minds, whose province, whether they know it or not, ought to be to enable the hands and feet to forestall bread lines and infant starvation.

When one considers such products of engineering knowledge and skill as a first-class ocean steamer, with its perfection of design, its perfection of machinery, its perfection of line and staff organization; or when one considers a modern New York office building, the Hudson Terminal for instance, where one finds without any futile or inept talk, discussion, or legislation, a harmonious and smooth-working combination and aggregation of intense individualism, intense socialism, intense communism—and even intense anarchy, since all the tenants come and go as they please—one realizes that it is to engineering knowledge and practice one must look for redemption from existing evils. Men, women and children starve, not because there is not abundance and plenty, not because the few have appropriated the portion of the many, but because there is such tremendous waste. The actual and potential wastes in each year amount to as much as the total accumulations of wealth, and if all the possessors of accumulations should be left in undisturbed possession, and the wastes of current production and use be eliminated and equitably apportioned according to meed and deed, no woman or child would have to do mill or factory, store or office work, no old man or woman would have to toil, no young man need delay his marriage, nor any head of a family be torn by anxiety as to the feeding, clothing, or housing of his dependents.

It is distinctly the business of the engineer to lessen waste—wastes of material, wastes of friction, wastes of design, wastes of effort, wastes due to crude organization and administration—in a word, wastes due to inefficiency. The field is the largest and richest into which any worker was ever turned.

Progress—absolute, not temporary time-serving—will be made slowly or rapidly as the ideals and standards are high.

The field is large and rich because so little is being done, because there is so much to do.

Very few, outside of those who have made special investigations, realize how very low the average efficiency of endeavor is, even in a highly civilized country like the United States. Everywhere we see brilliant results; rarely can anyone follow the losses between result and initial supply.

We are all familiar with the light from an electric incandescent film in a bulb. We know that usually the power revealed in the light comes from coal found in mines. The human endeavors, in producing light from coal in the mine, to worker's table, can be followed both absolutely and comparatively.

We can assume the fire-fly to have attained 100 per cent standard; not absolute, but a standard that engineers might expect ultimately to attain. That the fire-fly is 1,000 times as efficient in combined economy and production is scarcely believable, yet a rough analysis of fire-fly light and of bulb light from coal will show this to be the case.

A worker requires on his table, for least fatigue and detriment to the eyes, a certain amount of light. As the sun does not always shine, as winter days are short, as some rooms are at the bottom of air shafts, artificial light is needed. Electric light is most convenient and safest. What is the efficiency of production of electric light compared to the efficiency of the fire-fly, which will be called 100 per cent standard?

The fire-fly's source of light is the hydrocarbons contained in what it has eaten. Man's source of light is the hydrocarbons in coal.

The fire-fly finds its food with about the same facility that it finds the oxygen it breathes. Man finds oxygen without expense, but there are enormous wastes between coal in mine and coal entering furnace door. Of coal owned in ground, half the seams are not mined but ruined, and at best 75 per cent is recovered from the seams that are mined. This reduces the mined coal to 37.5 per cent of the total coal destroyed in mining. The workers and machines are inefficient all the way from coal seam, through mining and transportation, to furnace door. This adds unnecessarily to cost. The efficiency of purchase price is only 70 per cent. In furnace, boiler, engine and generator at best only 10 per cent of coal energy appears as electrical energy. The fire-fly's conversion of hydrocarbon into energy is on a basis of 40 per cent. Of the electrical energy only 5 per cent is recovered as luminous energy.

From supply to light emitted the fire-fly shows a continued use, transformation and luminous efficiency of 100 multiplied by 0.40 multiplied by 0.30, equals 30 per cent. Man shows 37.5 multiplied by 0.70 multiplied by 0.10 multiplied by 0.05, equals 0.013125 per cent, or a little over 1/8 of 1 per cent. The fire-fly is more than 200 times as efficient.

The fire-fly effects two further very great economies; it flashes its light only for the time actually needed and it also flashes it for the benefit of eyes made exceedingly sensitive by darkness. These economies we need not consider for ordinary working illumination, although both of them are very effectively used in the theatre and in biograph exhibitions.

Man usually produces ten times as much light as is needed and wastes 90 per cent of it. The fire-fly producing light with one two-hundredth part of the hydrocarbon used currently by man, gets along with one two-thousandth of the light used by man.

If any human activity is followed out from initial reservoirs to final attainments, a similar sequence of losses will be found—losses gauged not by any ideal or unattainable standard, but by what is being continuously accomplished all around us. Even if, as yet, some of the high efficiencies seen in Nature are beyond reach, it is a greater reason for eliminating those wastes which are avoidable and which are primarily responsible for the starvation of men, women and children.

Not only are occurring wastes more flagrant than is generally admitted, but it is also not realized that very hard and extremely exhausting work is not an evidence of efficiency.

The fire-fly works comfortably; the miner and furnace stoker do not. Recently on the first of the hot summer days, I stood on the charging floor of an iron foundry in the middle West. It was a foundry far-famed for its advanced methods. Three men weary, haggard, worn to the limit of human endurance, were throwing the pig, scrap, and coke into the cupola, yet in spite of their exertions they were working with only 33 per cent efficiency. Three days before we had observed two men, with less fatigue and effort, charge a cupola twice as large. What caused the 67 per cent inefficiency? The tracks for the cars bringing up the supplies of pig, scrap and coke, were so located as to the single cupola door, that three men were required to charge. One lifted a pig from the car, passed it to his companion who swung it to the third man who threw it into the cupola. This had been going on for twenty years. At the other foundry, there were two cupola doors, the car came up so that each man unloaded, with minimum of effort, directly from car into cupola.

That men should work very hard for 9 or 10 hours per day is not a hardship if they are interested in their work, or if, in the larger interest of the community, they work efficiently; but to work desperately hard for many hours at dirty, hot and rough work, yet waste 67 per cent of the time and effort, is unpardonable. What could not have resulted from an elimination of this waste?

1.—The product could have been cheapened.

2.—The men could have worked one-third the time and have accomplished as much.

3.—One man could have done all the work and have earned three times as much.

The benefits should however be distributed in all three directions. Fewer men should work less hard, receive higher wages, and deliver a cheaper product.

The inefficiency on the charging floor pervaded the whole of this foundry although it stands exceedingly high in its class. The proof of the general inefficiency in this foundry is evidenced by the fact that the other foundry turns out its finished castings for less than half as much per 100 pounds, labor, materials and overhead charges included.

It is not because men do not work hard but because they are poorly directed and work under adverse conditions that their efficiency is low.

Railroad repair shops throughout the country do not show 50 per cent efficiency on an average, as regards either materials or labor. When the particular jobs are picked out, similar or worse wastes to those of the charging floor, appear. An actual instance observed was as follows:

The foundry made, for a railroad shop, big cylinder bushings. These, after being machined in the railroad shop, weighed about 375 pounds, but the original casting weighed 1,780 pounds. It took three days to remove 1,405 pounds of cast iron. It should have taken less than one day if the rough bushing had weighed only 600 pounds.

Comparison of Costs.

	As made.	Standard.
Weight, rough	1,780	600
Cost per pound	$0.04	$0.04
Total cost	$71.20	$24.00
Labor	3 days	1 day
Cost of labor, $3.00 per day	$9.00	$3.00
Machine charge, $2.00 per day	$6.00	$2.00
Overhead charges, $2.00 per day	$6.00	$2.00
Total cost	$92.20	$31.00

In this same shop the most efficient men were checked up and found to average only 60 per cent of actual output, compared to realizable standards. At the end of two years of persistent effort many of the best men were brought up to 110 per cent efficiency, but there were still men as low as 10 per cent as to actual output compared to reasonable standard—the same standard on which others realized 110 per cent.

In another big locomotive shop, a careful study of the machines which had been in operation for 20 years showed that the location of 75 per cent of them would have to be changed, so as to facilitate the orderly, effective, and economical progress of work from one to the other. This and other eliminations of wastes doubled the output, with less labor costs.

In consequence of general shop inefficiency and operation inefficiency due to similar causes, locomotive repair costs, on western railroads, run from $0.08 to $0.12 a mile; yet a most efficient superintendent of motive power on a large transcontinental road succeeded in dropping to $0.05 and had only touched the high spots, his well considered opinion being that $0.04 was reasonably attainable. On another transcontinental road, repair costs per mile were dropped from $0.1374 to $0.08 by persistent effort, but when the efforts were relaxed expenses immediately rose to $0.17. They should have come down to $0.06. Eastern and southern roads, with their small engines, better coals, and better waters, are not to imagine that they show any higher efficiency. They are on the whole worse.

It was a leading eastern road that established piece rates in its car shops and then limited the earning power of the men. When there was a sudden demand for increased car repairs, the limit was taken off and the men doubled their earnings. Then the limit was put back. Other eastern roads have also signally failed in attempts to increase the efficiency of their repair shops.

In a leading southern shop many men were receiving 12-hours pay for 3-hours work.

Coal wastes on railroads are almost as bad as labor and material wastes. On a very large railroad system, fuel charged per 1,000 tons of train weight per mile averaged 260 pounds; yet actual tests where all coal used was weighed, showed a consumption between terminals of only 80 pounds. This actual consumption could be doubled, be made 160 pounds, yet this standard be only 60 per cent of the actual wasteful expenditure.

The total amount of preventable material and labor wastes and losses in American railroad operation and maintenance approximates $300,000,000 a year—not less real, but more easily preventable, than the $600,000,000 of fire losses and fire-department expenses, which actually occur in the United States. This inefficiency of effort pervades to a greater or less degree all American activities.

Mr. F. W. Taylor, who has given twenty-five years to the minute and scientific study of inefficiency, and who as an incidental consequence developed high-speed steels, thus speaks of it.

"That the first-class man can do in most cases from two to four times as much as is done on an average, is known to but few and is fully realized by those only who have made a thorough and scientific study of the possibilities of men.

"This enormous difference exists in all of the trades and branches of labor investigated, and this covers a large field, as the writer together with several of his friends have been engaged, with more than usual opportunities, for twenty years past, in carefully and systematically studying this subject. It must be distinctly understood that in referring to possibilities, the writer does not mean what a first-class man can do on a spurt or when overexerting himself, but what a good man can keep up for a long term of years without injury to his health, and become happier and thrive under."

Inefficiency similar to that in the manufacturing shops exists in all building operations to the same or even greater extent. Mr. Taylor found a labor efficiency of only 28 per cent in the rough labor employed in the Bethlehem Steel Company's yards. The writer, by time studies, determined an efficiency of only 18 per cent in a gang of laborers excavating a foundation, and even less on some construction work in the erection of the large office buildings in New York.

The United States and State agricultural bureaus have determined similar inefficiencies in farming operations. The land was there, the effort was there; but owing to poor preparation of soil, poor planting, poor cultivation, the net results in such great staples as cotton, wheat, and corn, have been less than half of what proper methods, with the same climatic conditions, land and men, have since realized.

The agricultural stations and Mr. Luther Burbank, combined, have been doing for agriculture what Mr. Taylor and his disciples have been doing for the machine shops.

In our whole educational system there is the same inefficiency. Years are given to study, yet better results have been attained in months. In American schools the two main objects of education, amenities and discipline, are largely neglected; and instead an immense amount of time is consumed acquiring quantities of information of very low absolute or ultimate value.

Inefficiency is not a local evil. It extends through the whole of American life—extends through the whole industrial life of the world. The Chinese coolie, who as a daily task carries 100 pounds 27 miles for $0.27, is industrious and hardworking, but not more inefficient than the American railroad which moves a freight car an average of 23 miles a day, the cars at best, averaging only half loads per mile.

By a very inefficient use of his brain and muscles, the coolie carries the maximum load a maximum distance for a minimum price. The American railroad by the most advanced engineering and industrial methods carries an absurdly small net load for an absurdly small distance at an unnecessarily high cost.

Prevailing inefficiency is not a lapse from former virtue. We cannot praise "the good old times" when everything was done better. The coolie in spite of his many virtues is not better than the railroad whose charges per ton mile average only one-thirtieth those of the coolie. The difference is, however, that elementary though his methods are, the coolie has high standards, evolved during many centuries, but in Europe and America the railroad and the modern shop, using methods of great promise, have as yet no standards.

In tabulating inefficiencies it is not assumed that it is a human ideal to work hard all the time and to spend nothing.

The unit is the man. If he elects and can manage it, he can live in a tub, bask in the sun, and curtail his efforts and wants to a minimum. If he elects, he can work hard for days, weeks or months, and in short and riotous extravagance spend all he has accumulated. The fire-fly probably is chargeable with both extremes, but what is expected is that the man shall emulate the fire-fly in working efficiently when he does work.

Each nation has its own ideals, and the readiness with which the new ideal of efficiency can be assimilated and made effective, will depend on psychological rather than physical and mental traits.

The Japanese can equip their mills with American machinery and work on American materials. If in addition Japanese men are more quick to assimilate or to develop best methods, then indeed will the European and American, in the long run, lose.

MAXIMUM PRODUCTION THROUGH ORGANIZATION AND SUPERVISION.

By C. E. Knoeppel.

IV. BETTER DELIVERIES—MORE SATISFIED CUSTOMERS.

Mr. Knoeppel's initial article, in our April issue, reviewed the conditions under which the internal factory organization will work at its highest efficiency. The second of the series showed the results obtainable by proper system in processing, machining, assembly, and erection. The third dealt with economy in the use of materials and time. The present paper completes this series.—THE EDITORS.

IT was a wise man who decided to incorporate as a part of his letter-head: "Agreements subject to strikes, accidents, fires and other causes beyond our control"; but little did he think how many times it was destined to be used, not only to cover such cases as fires, accidents, and excusable causes, but many inexcusable ones as well. Today the clause above quoted is either on all business stationery or is taken for granted, and it is safe to say that nearly every business house uses it many times during a year to explain their non-fulfilment of promises. While I will grant that a manufacturer is often in no way to blame because he has failed to forward his shipment according to schedule, there are a greater number of times when no real excuse exists—unless perhaps it is carelessness, which of course would not be offered.

Every manufacturer who reads this article is a receiver of materials in some form as well as a shipper, and while the argument is intended more for the shipper than for the receiver of materials, we will start the discussion from the viewpoint of the receiver.

Is it not a fact, that almost daily you are disappointed in not receiving the notice of shipment, covering materials your works manager is anxiously awaiting?

Is it not a fact, that almost daily you receive in your mails about such replies as the following, in answer to your letters asking why the materials you have ordered have not been shipped as promised?

> "Yours of the 10th received. We regret to advise that owing to causes over which we had no control, we have found it impossible to make shipment as promised, but we expect to forward them about the 25th."

Is it not a fact that almost daily you or your assistants call up the freight offices, regarding certain materials which have been shipped, only to be advised—"nothing as yet"?

These are conditions that exist almost everywhere, and while they would not be worthy of more than passing consideration if they only ruffled a man's temper, as they sometimes do, they are entitled to careful attention as they directly concern the success of any manufacturing enterprise. You no doubt feel at times like doing business with some other concern than the one you are now doing business with, thinking perhaps that you might get better deliveries by so doing, which brings me to this question:

Do you as a *receiver* of materials, feeling as you do over your disappointment in not receiving notices of shipment—the letters of excuses and the statement, "nothing as yet", ever stop to consider that the receiver of *your* materials may be in exactly the same position as you are often in?

I will grant that you often look to those from you purchase, in order to make proper deliveries to your customers. Your customers, in their turn, whether they have their trade looking to them for shipments when promised or whether they are direct users of what they purchase from you, look to you for as prompt deliveries as possible, so that your success (in their eyes at least) depends to a large degree upon your ability either to make prompt shipments, or to convince them that their interests are receiving your best attention. If you cannot do this, you may be running the risk of having some of your business go to your competitors.

You may ask how can the maximum results be obtained in the way of getting shipments off according to schedule? The best results along these lines can be obtained only when proper attention has been given to conditions, present and future, before making a promise, and then the work has been followed watchfully until you *know* that you will be able to ship as promised, or that you will not be able to do so.

A promise cannot keep itself any more than a shipment can make itself, yet this seems to be the principle that so many work upon. I have known cases where promises to ship have been made and nothing more has been thought about them until letters were received asking for information as to the shipments, and as business courtesy demanded replies, the letter heretofore quoted was the result. I am therefore of the opinion that a promise composed of about one-quarter discretion in making and about three-quarters energy in fulfilling, will go a longer way towards enabling the manufacturer to ship according to schedule than anything else. By "energy" I do not mean hustle and bustle, at the last minute, in an almost superhuman attempt to rush the work through the shops and onto the cars, in an effort to "make good," but an energy that is in evidence from the time the order is received and the promise made until the material is on the cars and finally at its destination. Any arrangement that will enable you to make deliveries as close to schedule as it is possible to make them should have your careful attention, for it will mean much in the way of more satisfied customers, better deliveries from those from whom you purchase, and lower costs through an increased production, all these being points which materially assist in making an enterprise successful.

It is very likely that almost every order you receive is accompanied by a request to state about when shipment will be made; is it not well to have some well defined method of procedure in filling your orders? It should need no argument to convince a manufacturer that the shipping of materials when promised is beneficial to the whole business structure. How this can be accomplished to a greater degree than is usually the case, it is the purpose of this article to indicate.

In any establishment of ordinary size, those concerned in the handling of an order from its receipt until shipment are:

Chief Order Clerk.
Works Manager.
Chief Stores Clerk.
Shipping Clerk.

Indirectly, the customer depends upon the shops for his shipment; but directly, he depends upon the shipper, who in turn cannot make shipment until the shops furnish him the finished product, the shops in their turn look to the stores department for the materials necessary to complete an order, and naturally nothing can be done until the order department has given the necessary orders for the work. At least, this should be the case; but there are places where verbal orders seem to receive as much consideration as written ones—a practice that is productive of no possible good. At any rate, the order department is looked to indirectly by all concerned in the manufacture of any article; so without further argument, we may assign to this department the important duty of keeping track of all orders from the time of their receipt until delivery is finally made to the customer.

If the four men heretofore mentioned are allowed to act as one body, with full power, the result is going to be better deliveries no matter under what conditions the company may be operating. Organize a committee, composed of these four men; make them responsible for promises and deliveries—and you can depend upon it that they will exercise care before they set a time when an order will be shipped; for in their discussions, they will (or should) ascertain how much of an order is ready to ship, how much must be built, what is in stock ready to assemble, what is in stock ready to process, what must be purchased outside and about when this material can be secured, how long it will take the shops to process and assemble, etc.; and if track is kept of the progress the order is making, from time to time, there is every reason to expect that the shipment will go forward about when promised.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 30 31

OFFICE COPY

		Buffalo, N. Y.,	June 23 1907
Sold To	William Jenkins and Company	Date Sold	June 21 1907
Address	Utica, New York	Sold By	Johnson
Destination	,, ,,	Our Order #	3445
Ship Via	Fast freight	Their Order #	A 25589

One cylinder head	X 442	3441
One cylinder	B 20	2811
One piston	X 440	3441

This is a rush order.

The Eng. Magazine

FORM I. INITIAL RECORD OF ORDER. MADE IN QUADRUPLICATE.

Let us take, for example, a plant manufacturing engines and boilers, and let us outline the arrangement that will enable the company to make more prompt deliveries. We will assume that the company has allowed a committee to be formed composed of the chief order clerk, works manager, chief stores clerk, and shipping clerk, the order clerk being responsible for the routine and clerical detail connected with the work. As the mails are opened and sorted, all orders are naturally turned over to the order department, and these orders can be written up; but before sending them to the various departments, they are referred to the committee before mentioned, to be acted upon daily, along the lines just suggested. Four copies of each order should be made, one for the office (Form 1), one for the shipper, one for the works manager, and one to be sent to the customer as an acknowledgement of the order (Form 2). It will be noticed that Form 2 bears the possible date of shipment while it is checked at the top under the same date as shown by the clip. The copies for the works manager and the shipper should be marked in the same way by using the metal markers. Upon filing these orders in an alphabetical file, we have each order filed by name of customer and cross indexed by possible date of shipment; and as the three individuals most concerned have copies of the orders before them, it can be readily seen that it is possible for each and every one of the three to keep track of the progress of an order until the shipment is made.

ACKNOWLEDGMENT

	Buffalo, N.Y., June 23 1907.
Sold To William Jenkins and Company	Date Sold June 21 1907.
Address Utica, New York	Sold By Johnson
Destination " "	Our Order # 3445
Ship Via Fast freight	Their Order # A 25589

One cylinder head	X 442	3441
One cylinder	B 20	2811
One piston	X 440	3441

This is a rush order

We herewith acknowledge receipt of your order, which has been properly entered as above, for which accept our thanks. We will endeaver to make Shipment on or before June 29 1907

THE ENTERPRISE COMPANY.

The Engineering Magazine

FORM 2. ACKNOWLEDGMENT OF ORDER.

In conjunction with this method of handling the orders, it would be well to use a recapitulation sheet, compiled each day by the order department, to be considered by the committee before mentioned at its daily conferences. A sample (Form 3) is here shown with entries. This will show the committee the total shipments promised for any one day, and by having each day's slip show the shipments arranged for the following day, it is an easy matter, in case it is absolutely impossible to make certain shipments as promised, to set new dates for shipment. It should be the duty of the order department to inform the customers of the changes; this will not only forestall com-

SHIPMENTS ARRANGED For June 29 1907								
According to our records, the following shipments have been arranged for the above date. If anything has occured in your department to change your plans, advise so a new date may be set and the customer notified of the change.								
Name	Material	Fgt.	Exp.	Order #	Can we ship on above date			New Date
					Yes	No	If not, why	
Smith and Sons	Engine base			3421			Error in shop	7-10
Wm. Jenkins and Co.	Cylinder with head and piston			3445				
Jones and Co.	Complete Engine			2660				
Johnson and Frank	Boiler Fronts			3010				
THE ENTERPRISE COMPANY, Order Department, Per F. A. James								

The Engineering Magazine

FORM 3. RECAPITULATION SHEET FOR SHIPMENTS ARRANGED.

plaints, but will create the impression in the minds of some customers, at least, that their interests have not been ignored altogether, for if you receive an *unsolicited* letter from a concern from whom you are purchasing, in which they state that they found it was going to be impossible to make the shipment as promised but that they would be able to on such and such a date, you certainly feel in a much better state of mind than if you should receive no notice of shipment and no letter explaining the reason.

After a shipment has been made, in cases where it is delayed, the manufacturer should keep after the railroad company until deliveries are shown. A "tracer" is such a common thing that it is not necessary to show one here, but Form 4 here shown should be used in conjunction with tracers so that the railroad company may be reminded of the fact that they have been asked to place a tracer after certain shipments. In many instances, upon receipt of these notices, the agent will take up the matter with those along the line and this will assist to a certain extent in bringing about better deliveries than would be

SHIPMENTS

July 5 1907

George Franklin Agent

New York Central Railroad

To the agent.- Let us know at once if you have received any advice regarding the delivery of the shipments listed below

Date of tracer June 20th

To The Howard Manufacturing Company

500 Franklin Street

New York N. Y.

Date shipped June 10th

Materials claimed short

Remarks None of this shipment has been delivered and these people are in need of the material

THE ENTERPRISE COMPANY,

Per F. A. James

The Engineering Magazine

FORM 4. SUGGESTED FORM FOR TRACER.

secured were the railroad company to receive no such reminders. If the agent has received no advice he will say so, and if you take up this point with your customers, they will be quick to see that your interest did not cease when shipments were made—a decided point in your favor, and it is such points as this that the success of your business depends.

The system is simple, and while it would require a little work each day in order to obtain maximum results, does not the end in view justify the means? Let us sum up briefly the advantages to be derived through some such system, devised to meet your own conditions. In the first place your works manager, order clerk, stores clerk, and shipping clerk all know and have collectively agreed upon the dates of shipment, the points peculiar to each order having received attention before this was done; the orders are constantly before them, the metal markers showing the dates of shipments to be made; and through co-operation, which should be insisted upon, they will be able practically to see the end at the start.

The works manager will be in a position to plan his work to better advantage, for he can notify his foremen what he wants and when he wants it, they in their turn giving their men the necessary orders and instructions that will start the desired work along and through the shops in the most systematic way, so that in reality we have the whole force doing their share in an effort to get the work through on time.

The stock clerk will know what stock is necessary to get ready for the shops, and he will also know what has to be purchased outside. He can make the necessary requisitions on the purchasing department, with notations as to *when* he wants the materials that are to be ordered.

The purchasing department can keep after the people with whom the orders were placed, which in itself will have an influence in obtaining better deliveries; for once you know *what* you want and *when* you want it, you can in the majority of cases, by keeping after the concerns from whom you ordered, get your materials in time to enable you to keep your promise to your customers.

Your order clerk each day will bring to the attention of the others the list of shipments arranged for the following day, and if new dates have to be set, it can be done and he can so notify the people to whom the materials were going. At the same time he can take up with the others the possibility of getting future shipments off as promised, and by keeping track of the details and looking after the clerical work, he is in a position to give valuable information as to the status of any order.

The shipping clerk, knowing after each day's conference what is to go forward within the two or three days following, is in a position to see to getting everything in readiness for shipment on the day set; and if anything happens to make it necessary to change any date set, he knows it the day previous and can be governed accordingly. The shipping clerk is therefore in a position to make his work count for something, as he is able to concentrate his attention upon the accomplishment of something definite and is not forced to do a lot of work that will count for nothing.

In brief, we have a combination of brains working together along the same lines and with the same end in view, and this will accomplish more than could be accomplished by individual effort along widely different lines. The result of such effort would be more prompt deliveries and therefore more satisfied customers—the desire of every manufacturer.

NEW PROCESSES FOR METAL CUTTING AND AUTOGENOUS WELDING.

By J. B. Van Brussel.

Mr. Van Brussel's description is concerned chiefly with the characteristic elements of the processes so far available, and with the use of the oxygen blowpipe for metal cutting. This phase of the subject is extremely interesting, not only as affording new economies but as suggesting means for doing work heretofore almost impracticable. If, for example, the wreck of the Quebec bridge is to be removed, some adaptation of the blowpipe process (providing it is shown to meet the claims of its friends) would seem to provide the solution of an otherwise most difficult problem. The employment of the method for welding or brazing is further authoritatively presented in Mr. King's article elsewhere in this issue.—THE EDITORS.

SOLDERING metals by fusion—or autogenous soldering—though but a few years in use, is expanding rapidly in the most diverse industrial applications because of the advantages it possesses. Already it is rendering immense service, exceeding, indeed, the best that was hoped for it. Limited at the outset to the soldering of lead, it is now applied to almost all metals; and almost all industries, from heavy metal working to jewelry, find it a valuable and in many cases an indispensable auxiliary.

Practical autogenous soldering may be performed by means of *aluminothermie,* of electricity, or of the blow-pipe.

Electricity furnishes often a practical and economical means for joining metals by fusion. Two modes of procedure are available. First, the electric arc may be made to act as an electric blow-pipe and so used. In this case the pieces to be joined are attached to the negative pole, and to their point of junction is presented a carbon attached to the positive pole. The heat of the arc causes local fusion of the metal. Disadvantages frequently met with are that the temperature is too high and difficult of control, and that the metal is burned. An alternative plan is to bring the two pieces which are to be joined into imperfect contact and to pass through them a heavy current (5,000 or 6,000 amperes for example) under a low tension. The resistance caused by the imperfect contact results in the heating and finally the fusion of the metal. It is readily understood that such an operation is not easy, but nevertheless excellent results are secured in special cases—for instance, in making chain links.

In the aluminothermic process the pieces to be joined are held in contact by any convenient device and the place which is to be brazed is surrounded by a clay mould. Above this is placed a crucible filled with a substance called by its inventor "thermite," which is a mixture of ferric oxide and powdered aluminium. By means of a special highly inflammable preparation the thermite is ignited and burns almost instantaneously, developing enormous heat. The temperature probably reaches 3,000 degrees C. The aluminium takes away oxygen from the iron oxide, the iron thus set free is melted, and flows into the mould between the pieces which are thus firmly brazed together. The process is particularly convenient for joining rails in place, for transmission shafting, and for the repair of broken parts.

The newest process for autogenous soldering, and without doubt the simplest and the most economical in practice, is that of the blow-pipe. In this operation the two parts which are to be joined are placed in contact and the operator directs upon the line of junction a blow-pipe flame capable of giving a temperature of at least 1,600 degrees C. Fusion of the metal takes place at the point where the flame strikes and the welding of the two parts is thus effected. The operator's skill when operating upon small pieces consists in stopping the action of the flame at the moment when fusion has proceeded so far that solidification is assured, and before it has advanced to a point where the piece might be destroyed or pierced. It is indispensable further that the flame of the blow-pipe should not be oxidizing but rather decidedly reducing.

Blow-pipes may be classed according to the combustible material which they employ—hydrogen, acetylene, ordinary gas, and naphtha. All these utilize the same supporter of combustion, oxygen, which is usually supplied in flasks or tanks compressed to 150 atmospheres. It may be obtained by the electrolysis of water, by the distillation of liquid air, or by chemical reactions. The earlier forms of blow-pipe were operated with hydrogen obtained by electrolysis of water and stored in receptacles if prepared in advance, or in other cases generated at the point of use. Acetylene, employed in the second type, is obtained by the action of water upon calcium-carbide, and also may be generated in place or stored under pressure by taking advantage of its solution in acetone. It is not practicable to compress acetylene in reservoirs as may be done with hydrogen, because of its explosive qualities when compressed, which might cause serious accidents. MM. Claude and Hesse devised the acetone-solution method. The solution is stored in a flask filled with porous material, which forms a capillary tubular structure and prevents the spread of explosion.

OXY-HYDROGEN BLOW-PIPE IN OPERATION.

In this review we are concerned solely with technical considerations, and no attempt will be made to advocate any one method more than any other; in my opinion the most important factor in the successful conduct of the process, at the present stage of perfection attained in the various methods, is the skill of the manipulator.

The great advantage of blow-pipe brazing is that it is quite as applicable to mild steel as to iron, and that it permits the brazing of thin steel plates which hitherto must be riveted or clinched together, neither of these latter methods being satisfactory for producing a thoroughly tight joint. The blow-pipe is further most valuable for use wherever it is necessary to work upon parts already in place, as, for example, in joining pipes and tubes, steam conduits, etc. It comes into play particularly in the manufacture of metal tanks, various vessels made of enamel ware, feed-water heaters, etc., permitting the manufacture of forms of apparatus requiring numerous and complicated joints impossible to manufacture by forging. It has the further advantage of being a light apparatus, easily manipulated and requiring no elaborate installation.

At first sight it might appear that the melted or cast metal produced would not have the qualities of strength, and particularly of elasticity, shown by rolled or hammered material. Surprising results, however, are secured when care is taken during the process to avoid

BRAZING PLATES BY MEANS OF THE OXY-ACETYLENE BLOW-PIPE.

overheating or oxidation of the metal, or its alteration by the introduction of impurities such as sulphur or phosphorus. If, for example, we braze thin sheets or tubes of a few millimetres thickness and subject the brazed part to a light hammering or even a mild tempering, the metal will be found perfectly ductile and the joint will exhibit a strength almost equal to the resistance of the original metal. Tubes thus welded may be crushed or twisted, and plates may be bent and refolded, following the weld, without showing any cracks.

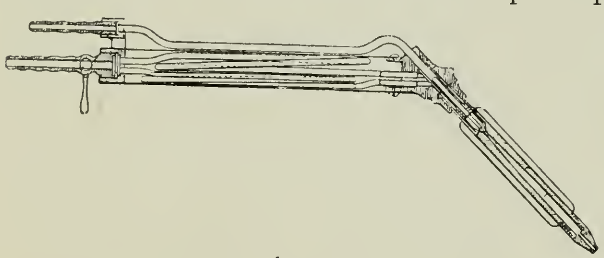
When it comes to the brazing of comparatively thick plates such as those of a boiler, the problem is more complicated because of the greater difficulty of producing uniform, thorough fusion to a thickness exceeding 6 or 8 millimetres. Under such conditions use is often made of an artifice which should be condemned, and which has to some extent discredited autogenous soldering of heavy plates. This artifice consists in chamfering both edges which are to be joined, and filling the space thus left by melting an iron wire in the blow-pipe flame. The procedure is not absolutely bad if it is very skilfully carried out, if the operator is careful to use a flame heating a large area and to let the drop of melted metal fall only on the part of the joint which has already been raised to the fusion temperature. It is easy to see what extreme attention is necessary to succeed in manipulation of this kind; if it is ill done, we get only poor adhesion; if it is well done, the relatively large quantity of melted metal introduced between the two edges lowers the strength and destroys the ductility. Test pieces submitted to tension break without elongation.

A process of autogenous soldering which is employed with much success and which is particularly applicable to plates from 6 to 25 millimetres thick is the following:

The two pieces to be joined are brought edge to edge without superposition, in perfect contact; if necessary to secure this they are first subjected to a light cut on the planer; they are then heated by means of two blow pipes, one above and one below, exactly opposite to one another, and producing as large a heated zone as possible. When fusion begins to appear on the surface it is safe to conclude that the interior of the sheet is at a white welding heat. The blow-pipes are then withdrawn and by a simple mechanical arrangement they are replaced by an anvil and a very light hammer not exceeding one or two kilogrammes weight. The blow of this hammer is sufficient to cause a consolidation of the metal along the two butting edges.

Perfect welding is secured and it is probable that the light hammering produces at the same time a certain orientation of the molecules favorable to the elastic properties of the metal. In fact, if test pieces of metal so welded are tested under tension to the breaking point it is found that the grain of the fracture is not that characteristic of cast specimens, but is perfectly homogeneous, and like that of the original plate. The strength is but a small percentage less than the original and the elongation is satisfactory. Metal of a tensile strength of 36 to 38 kilogrammes and elongation of 25 to 28 per cent shows after welding a tensile strength of 36 kilogrammes and elongation of 13 per cent. These results are completely satisfactory for the majority of cases in which it is desirable to substitute for riveting a process of soldering, secured rapidly and by simple appliances requiring no complicated or costly installation.

In all ordinary forms of blow-pipe there is of course one tube supplying combustible gas and another supplying the agent of combustion. The differences consist principally in the arrangement of these tubes and especially in their mode of connection. All present forms make use, under conditions which we shall examine further, of a mixture of gases effected in advance.



SECTION OF FOUCHÉ ACETYLENE BLOW-PIPE.

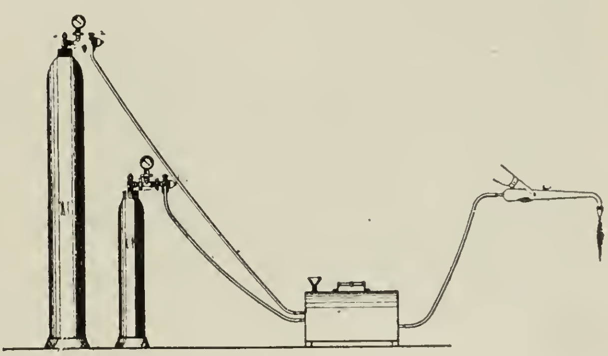
Acetylene Blow-pipe.

At first an ordinary form of blow-pipe was used for burning acetylene with oxygen. The two gases were kept separate up to the tip of the blow-pipe; that is to say, to the actual point of combustion. With acetylene, however, a serious inconvenience appeared; a heavy deposit of carbon took place, the flame was suppressed and indeed a sort of carbon mushroom resulted. It was therefore necessary to resort to some form of blow-pipe in which the mixture of gases might be made in the interior of the apparatus. But with acetylene a serious accident was to be feared, as the flame might flash back into the blow-pipe and cause an explosion. It is known, of course, that to prevent a back-draft of the flame the issuing gas must ordinarily have a velocity higher than that of the explosion wave, which for a mixture of oxygen and acetylene is extremely high. Practical experience showed that it was not necessary to attain this point because of the very small section of the blow-pipe tip. A velocity of flow equal to 150 metres a second is sufficient to prevent the flame from traveling back into the apparatus. In further prevention of this return of the flame the interior was filled with porous material, but this made it necessary to increase the pressure to the equivalent of 3 to 4 metres of water.

A problem still to be solved was that of utilizing acetylene not under pressure—that is, gas produced immediately in the works in calcium-carbide apparatus. M. Fouché found a very interesting solution by introducing the oxygen into the apparatus through an injector, which draws a flow of acetylene with it. The acetylene enters through extremely small tubes which do not permit the passage of flame.

Oxy-Hydrogen Blow-pipe.

In this apparatus the two gases are always used under pressure. The original form of hydrogen blow-pipe consists simply of a brazed sheet-steel receptacle terminating in a neck, upon which the blow-pipe tip is screwed. To the other end are brazed two attachments for the rubber tubing through which the gas flows from the reservoirs. Economy of combustion has been sought by preheating the gases. For this purpose they are made to pass through a coil surrounding the flame. This gives the regenerative blow-pipe. Lastly, in some important installations use has been made of a mixing blow-pipe. In this the blow-pipe itself is of the type already described, but it has a single attachment, for in this case the gases are mixed in advance.



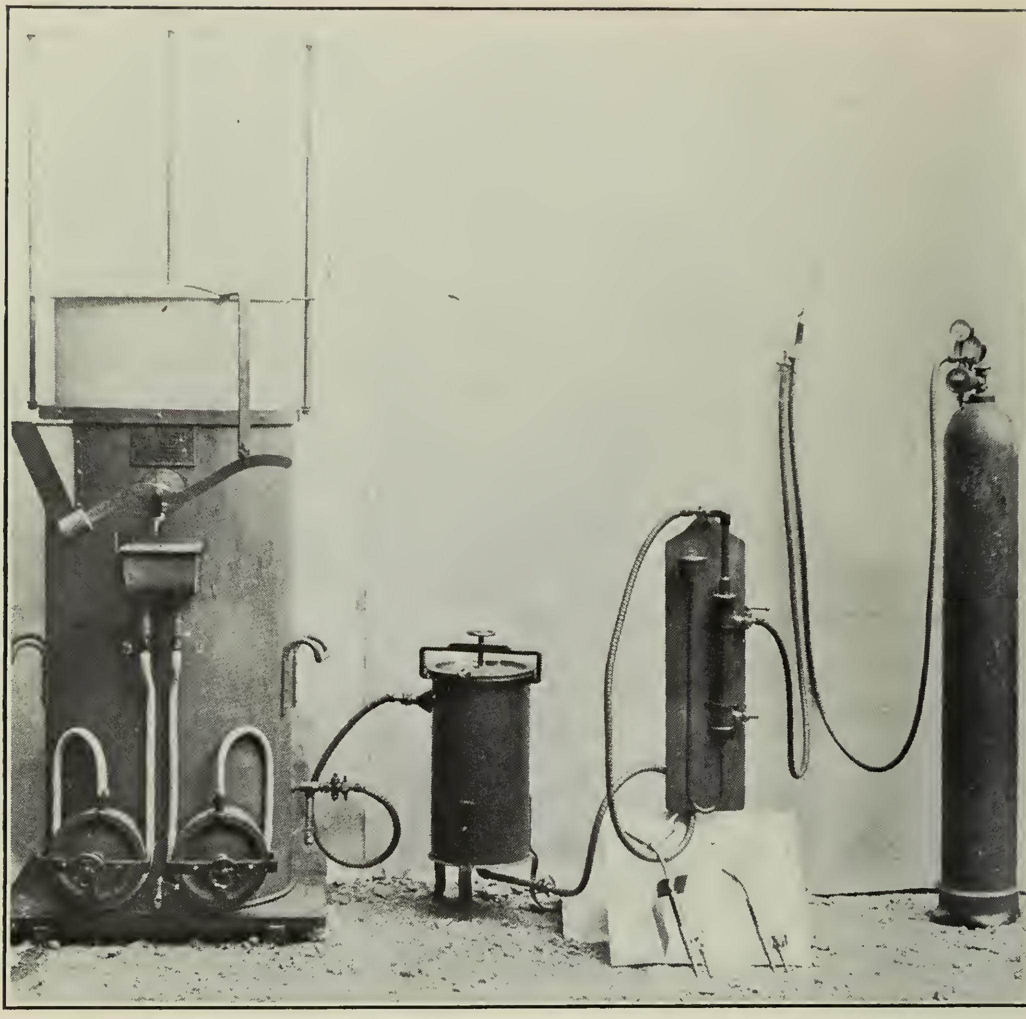
OXY-HYDROGEN BLOW-PIPE WITH MIXER.

It should be added that apparatus employing acetylene in solution and hydrogen in tanks is best suited for use in work requiring a portable installation and in establishments where continuous use of the process is not required; while it is more economical to use an installation with generators for acetylene and hydrogen where the work is to be continuous, or where the applications are many enough to allow continuous operation of the generating apparatus and are performed upon parts so light or so easily handled that they can readily be brought to the blow-pipe.

The Cutting of Metals.

We come now to the cutting of metals, or more exactly of iron and steel, by oxygen.

It is well-known that iron burns easily and rapidly in an atmosphere of oxygen gas. The experiment is familiar in every course in physics and chemistry. The same phenomenon occurs when a jet of oxygen is directed upon iron heated to a bright red—that is to



OXY-ACETYLENE BLOW-PIPE WITH ACETYLENE GENERATOR.

say, the metal burns and the heat evolved fuses the oxide. The process for cutting plates by oxygen is based on these phenomena; it can readily be seen that it is possible to divide a piece of metal by means of an oxygen jet, but it is not easy in practice to attain a regular and clean cut.

At first use was made of an oxy-hydrogen blow-pipe to bring a certain portion of the work to a bright red heat. Then the flow of hydrogen was cut off and the current of pure oxygen was increased. A good combustion was produced, but it did not proceed very long. The resultant iron oxide not being hot enough, lacked fluidity; it was with difficulty removed, became mixed with the partially melted iron, and thus obstructed the close contact of the metal with the oxygen; the combustion stopped and it was necessary to bring the blow-pipe into play again. The manipulator, even after long practice, could obtain only an irregular cut, dirty, and with edges incrusted with closely-adhering oxide.

One of the engineers of a company in Brussels therefore devised a double apparatus which entirely remedies these difficulties. This consists of two blow-pipes in one piece, which travel along the section to be cut. The first is an ordinary oxy-hydrogen blow-pipe which heats the metal to a bright red; the second directs a fine jet of pure oxygen upon the heated spot under a pressure varying with the thickness of the metal. The action of the two blow-pipes is continuous; the first prepares the way for the second, furnishing a volume of heat sufficient to permit instantaneous combination of the oxygen with the metal in the heated zone. The metal is not melted, and the adjoining parts remain unaltered, as the action proceeds too rapidly for the heat to spread into the mass and the oxidized portion is removed by the pressure of the oxygen; the section is cleaner than a saw-cut and its width never exceeds 4 millimetres. The speed of travel of the double blow-pipe is about 20 centimetres a minute; in other words, the operation is quite rapid and comparable to hot sawing.*

CUTTING A SHAFT BEARING LENGTHWISE.

The consumption of gas is relatively small, depending naturally upon the thickness of the piece which is to be cut. As the work is rapidly done the labor cost is not important.

* Interesting data of the use and cost of oxyhydric welding, etc., in locomotive work are given by Mr. King on pages 526-528 of this issue.

The double blow-pipe, which is easily handled and furthermore may be guided by any sort of mechanical device, is available for cutting not only thick plates, but also, and with equal ease, tubes, beams, shafts, and all sorts of rolled sections. The cutting may be made to follow any line, executing all sorts of curves and profiles; further, it is not necessarily normal to the surface, the cut being easily made on a bevel. It is evident further that the quality or the mechanical properties of the metal do not in any way modify the process; whether it be hard or soft, tempered or annealed, chrome or Harveyized, the steel burns just as fast. The problem of cutting armor plates is thus fully solved.

The essential qualities of the process may be thus summarized: Extreme simplicity of the installation and appliances, complete mobility, independence of any need of motive power, absence of any reaction upon the tool, extraordinary speed of operation, and so to speak unlimited adaptability.

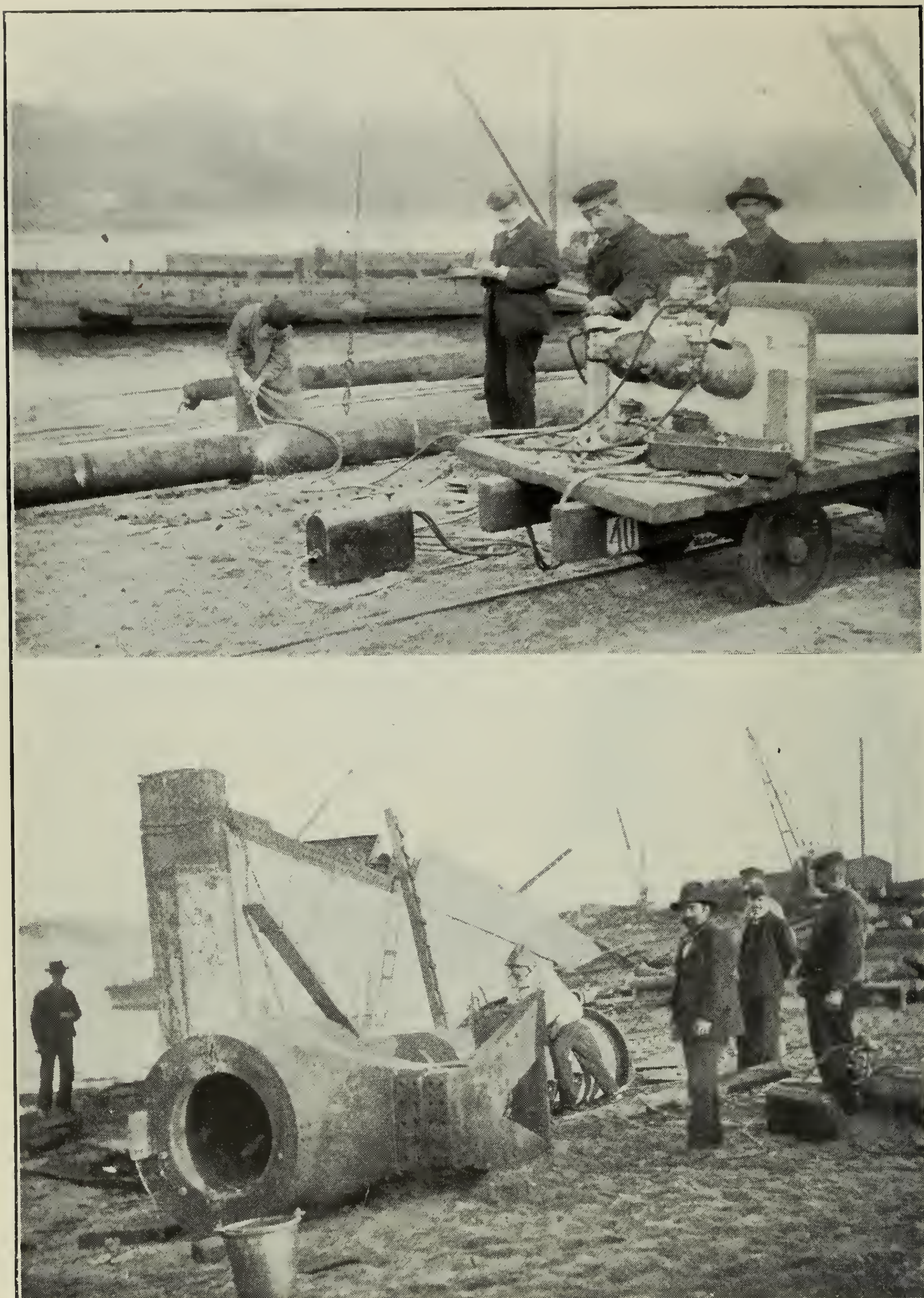
In illustration of the rapidity which above all characterizes oxy-hydrogen cutting some examples may be adduced: An armor plate 160 millimetres (6.3 inches thick) was cut to a length of 1 metre in 10 minutes. A cut of similar length in a plate 15 millimetres thick took less than 5 minutes, and the cost of the operation did not exceed 1 franc 50 centimes.

To cut a manhole 300 by 400 millimetres (12 by 16 inches) in a plate 20 to 30 millimetres (.8 to 1.2 inches thick) requires 4 to 5 minutes. An opening 150 by 150 millimetres (6 by 6 inches) in a tube 5 millimetres thick required 3 to 4 minutes, while the cutting of the same opening with tools would need from 35 to 40 minutes. The cost of this work by the oxygen method was from 12 to 15 centimes.

Another very striking example was furnished at the station of the Metropolitan Railway at the Place d'Italie in Paris. It was necessary to cut away an iron staircase 6 metres high whose width impeded the traffic. It was cut down to a width of 1 metre in four hour's time. At Bremen, Germany, also, the method has been used for breaking up ships and among other records the following time data are interesting; a plate 300 millimetres (12 inches) thick was cut for a length of 1 metre to a depth of 4 to 6 centimetres in 7 minutes. The same plate had been cut with a pneumatic chisel along the length of 1.15 metres and to a depth of 1.5 centimetres, but this work had required an hour. The oxygen method was used also for rivet cutting; in less than 12 seconds the head of a 22-millimetre rivet could be burned without any injury to the plates. The rivet

ABOVE, STRAIGHT-LINE CUTTING OF 50-MILLIMETRE PLATES. BELOW, SLOTTING ARMOR PLATE TO A DEPTH OF 6 OR 7 CENTIMETRES.

was then driven out with a punch. The maximum thickness which has yet been cut is 210 millimetres (8.27 inches) in armor plate, but 300 millimetres has been reached in round shafting.



ABOVE, CUTTING OFF A MAIN SHAFT. BELOW, CUTTING A BEARING LENGTHWISE.

It has seemed of interest to examine the influence of this oxygen cutting upon mechanical properties of the metal. Naturally, there was fear that a certain zone of metal would be superheated and that it might even be oxidized to some depth. To determine these points the double oxy-hydrogen and oxygen blow-pipe was used to cut a plate 15 millimetres thick, 500 millimetres long, and 250 millimetres wide. The practical tests were threefold; 1.—Micrography demonstrated that the material was a normal mild steel of about 0.15 per cent carbon. The examination of a metal section showed that there was no decarburization even on the extreme edge, and that at a very slight depth the pearlite showed the somewhat coarse structure of slightly overheated metal. Everywhere else the structure was strictly normal.

2.—Shock tests upon test pieces 10 by 10 by 60 millimetres notched to a depth of 2 millimetres, and taken at varying distances parallel and at right angles to the section made by the blow-pipe, gave the following results:

No. of Test.	Kilogrammes per square millimetre.	No. of Test.	Kilogrammes per square millimetre.
1	14	9	23
2	12	10	20
3	20	11	12
4	20	12	12
5	25	13	19
6	12	14	12
7	13	15	10
8	22	16	21

The concordance of these results is noticeable. In the average, it showed 20 kilogrammes lengthwise and 12 kilogrammes transverse, these results being very good. In order to examine particularly the part of the metal which showed an abnormal microscopic structure, this portion was cut into small test pieces so that by placing three of these side by side the equivalent of an ordinary test bar would be obtained. On this results of 18 kilogrammes longitudinally and 12 transversely were secured.

3.—Finally, on the plate, planed perpendicularly to the cut margin a series of Brinell tests were made with results which are closely concordant. Under a pressure of 3,000 kilogrammes the Brinell figures shown were:

On a first line 564, 555, 557, 563, 574, 576.

On a second line 542, 547, 557, 555, 558, 553.

From these various tests it may be concluded that the metal is not changed by oxygen cutting, at least so far as actual trial has yet demonstrated.

For convenience it may be recalled that kilogrammes per square millimetre multiplied by 1422.3 give pounds per square inch.

THE RAIL MAKER VERSUS THE RAIL CONSUMER.

By G. B. Waterhouse, Ph.D.

Mr. Coes' well written article on the above subject in the June issue of The Engineering Magazine has once more brought to the front the very important rail question. The following short paper may be considered as a discussion of some of the points brought out in that article.—G. B. W.

NOTWITHSTANDING all that has been written and said about rails in the last few years, and particularly in the last year, it is questionable whether the full importance of the subject has been realized. Probably the best way to illustrate its vital interest would be to trace rapidly the upbuilding of the United States, and to point out how this is in great part due to the pioneer and helpful work of the railroads. It is recognized that the country was able to take, and did take, the advanced methods of transportation of older countries, and used them as a ground work in building up her own methods. These became the great factor in aiding the phenomenal national growth and expansion. Chief among these methods is railroad transportation, and the arguments given above are merely another way of saying that from the start the country is greatly indebted to the railroads. It would then be easy to show how railroad facilities and efficiency depend on good roadbed, and it is self-evident that the first requisite for this is a suitable rail.

So that, working backwards, good and suitable rails are not only essential, but amongst the foremost essentials for adequate railroad facilities, which in turn contribute to the very life of the country.

Mr. Coes mentioned in some detail the Talbot and duplex processes and it will be instructive to consider briefly the methods by which rail steel is made.

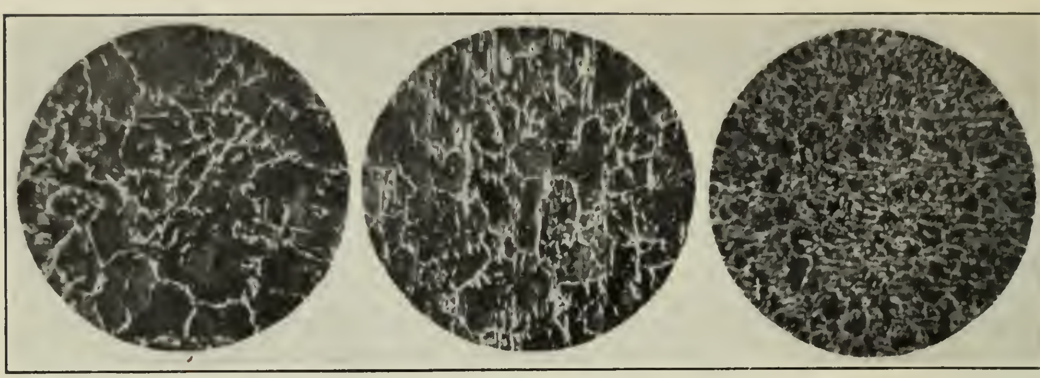
By far the greatest bulk is made by the acid Bessemer process which is so well-known that no description need be given. It must by no means be considered as a hit-and-miss process, as it is capable of very careful regulation—just as much so as the open-hearth process, if not more. The basic Bessemer process has attained great prominence, and produces a large part of the rail steel of Europe and Great Britain but none in the United States. It is similar in principle to the acid Bessemer but in this case the lining of the vessel is basic, and is usually composed of calcined dolomite. The distinctive feature is that at the end of what would be the blow in acid practice, comes the afterblow. During this afterblow, phosphorus is oxidized and enters the basic slag, where it is retained.

In the basic open-hearth process a hearth is used, made of a basic refractory material, usually calcinated magnesite. A considerable amount of scrap can be used in the charge up to 60 per cent., and the phosphorus can be slagged off. The Talbot process is a modification of the basic open-hearth.

Most interesting of all is the duplex process, combining as it does the Bessemer and open-hearth. It was the dictum of a famous metallurgist that the latter would attend the funeral of the former process, but this has been very happily changed, as many indications point to there being a wedding instead of a funeral. In the duplex or combined process, the molten pig iron is first desiliconized, and partly decarburised, in an acid-lined converter. The partially blown metal is then transferred to a basic-lined open-hearth furnace, where the succeeding operations are carried on. When of the desired composition it is tapped out, and the necessary additions of ferro-alloys are made to the ladle. Made by whatever process, the steel is cast into ingots, which are subsequently rolled to the desired section.

Considerable attention is now being devoted to the production of good ingots. It is coming to be felt more than ever that many of the faults of the rails can be traced back to the ingot, and that unless it possesses the desired qualities to give good rails, no subsequent treatment can remedy its defects. The chief desideratum is soundness, which means steel as free as possible from blow holes, pipe, and mechanically held impurities. Very frequent reference has been made by recent writers to the difference in the metal in the various parts of the rail. Mr. Coes has brought out the reason for this very well, namely, the difference in the finishing temperature of the head and other parts of the rail. An examination was recently made as to the composition, strength, and structure of the material in various parts of a rail, some of the results of which may be given. The material chosen was from a 100-pound rail, made according to the specification of the American Society of Civil Engineers. The average composition was:

Carbon	0.51 per cent.
Silicon	0.147 " "
Manganese	0.77 " "
Sulphur	0.078 " "
Phosphorus	0.089 " "



HEAD. WEB. FLANGE.

The structure of the steel in the centre of the right half of the head, the centre of the web, and the centre of the right half of the flange is given in the accompanying micro-photographs which are magnified forty-seven diameters.

These are all transverse views, looking at the cross section of the rail. The constituents in each case are dark-etching pearlite, and yellowish-white ferrite. It is readily seen how profoundly the structure of the steel is influenced by the difference in the finishing temperature. The head, finished the hottest, has the greatest range of temperature to pass through before crystallization stops, and so gives the largest structure. The web is intermediate, and the flange is finished so near the recalescence point that the structure is very small. Tensile tests from the same places gave the following results:

Position.	Elastic Limit.	Ultimate Stress.	Elongation, Per cent. in 8 in.	Reduction of Area, Per cent.
Head	54,460	110,750	18.50	33.2
Web	53,100	110,300	18.25	29.4
Flange	53,340	111,300	17.00	36.4

The analysis from the head, web and flange were as follows:

Position.	Carbon.	Silicon.	Manganese.	Sulphur.	Phosphorus.
Head	.52	.152	.77	.079	.090
Web	.52	.150	.78	.077	.090
Flange ...	.52	.147	.77	.080	.090

From the analysis it may be seen how uniform the rail was in composition, and the results of the mechanical tests show that notwithstanding the difference in structure, the steel is also very uniform.

The flange shows itself to be unmistakably the best material, being slightly higher in tenacity and decidedly better in ductility than the metal in the web and head.

The above examination was made on a sample representing the heavy rails of the present day. The growth of the section from the smaller sizes of a few decades ago has been very marked and rapid. It is impossible in this paper to trace this growth, or its causes and results, in detail. It is intimately bound up with the duties of the rail, a subject which is very complex and but little understood. No great and concerted efforts have been made by the rail consumers up to the present time, to investigate these duties. This means that the manufacturers have only been notified what quantity of material was required, and not particularly as to its quality.

The rail certainly has to perform three important functions. In the first place, it acts, as a whole, as a continuous girder, to support the passing trains, distribute the loads, and transfer them to the ties and ballast of the track. The second function is to resist the wear caused by the friction of the wheels and the loads, which occurs principally on the bearing surface. The third is to act as a guide to the passing trains. It would seem then that two of these principal functions are fulfilled by the head of the rail, and the chief property that is needed here is that of abrasive hardness, to resist the severe action on the side and upper surface.

Mr. Coes very early in his article brings out the fact that heavy rails do not give such good service as the lighter rails of earlier days. The metal apparently wears and flows more rapidly in the head than with the smaller sections. This is often, without thought, attributed to these newer rails being made of inferior metal.

The great increase in wheel loads, both of locomotives and trains, has been so repeatedly emphasized that it need only be mentioned here. Another reason why these larger rails apparently fail is that they absorb and carry in themselves a great portion of the wheel effects, which were previously transmitted to the ties and ballast. This has been emphasized many times by Dr. P. H. Dudley, the well known consulting engineer of the New York Central Lines. Especial reference may be made to his reports to the International Railway Congress, June 1904 and 1905, and to his paper "Rail Sections as Engineering Structures." The latter was read before the American Society for Testing Materials and published in Volume 5 of their Proceedings. He points out that the fact of the rails absorbing so much more of the load is the chief influence in the production of the smooth-running tracks we enjoy today. Without them it would be impossible to keep the roadbed in condition to handle the passenger trains, now common, of twelve or more coaches, travelling at a schedule of 55 to 60 miles an hour.

It must be evident that a transfer of a large part of the destructive work from the ties and ballast to the rail itself, cannot but result in the rail's having to sustain a greatly increased duty, and showing the effects of this heavy duty more plainly than the smaller rails.

THE COST OF STEAM POWER IN VARYING UNITS.

By Wm. O. Webber.

Mr. Webber's article is essentially a discussion of the power costs presented by Mr. Snow in our May issue. It carries the interest of a different point of view, and (we need not argue) an experienced and well-informed judgment.—The Editors.

IN order to discuss fully the power-cost question on a fair and equitable basis, it is necessary, in the first place, that all items affecting the costs, in different instances, shall be fully weighed and taken into consideration.

For instance, an estimate upon a water-power development which considers simply the cost of the dam, head gates, canal, wheels, and, say, generators, does not and will not give a basis on which to determine the cost of the power. In every instance with which I am familiar, sums from $5 to $100,000 have been paid for flowage rights and the water "privilege." Now, the proportion that this sum bears to the total power developed is sometimes a very large one, and at other times, a comparatively small one; and the results are generally affected by the proximity of the location to an existing developed market. Otherwise it is impossible to reconcile the variations in the cost of larger water powers from $130 a horse power to $42, as all the difference could not arise in the construction alone.

In a similar manner the cost of steam power must be considered. The first cost of steam turbines and water-tube boilers is very much larger than that of horizontal engines and horizontal tubular boilers; but when the land and buildings required to house the two plants are taken into consideration, the differences in cost of original installation are very much reduced, and entirely change the aspect of the figures. There will be no question as to the advisability of the installation of the water-tube boiler and turbine plant in New York city or Chicago. It would be a very open question whether that should be the type of plant to be installed to operate, say, the Pacific mills, at Lawrence, Mass., or the Amoskeag mills, at Manchester, N. H.

The theory often advanced that the land and part of a building occupied by a small power need not be taken into consideration because the ground space and buildings are already available without additional purchase, is fallacious; for the reason that, if they are not occupied by the power plant, they are available for an extension of the industrial plant and it is, of course, readily seen that the amount of room required for an individual electrical power-generating plant would be many times that of the room required for the motors necessary to drive the same machinery if current were purchased.

In fact, one of the great arguments that I know of in favor of a manufacturer purchasing an electric current outside, to drive individual motors in each room or department, is that he practically does not feel the loss of the small amount of room required for the motor, as it oftentimes is placed upon the wall or ceiling, where it really occupies no space available for other purposes, and the ability to draw from such sources at any hour during the twenty-four hours often makes the only real economic reasons for so obtaining power.

COST OF ONE STEAM HORSE POWER PER BRAKE HORSE POWER PER YEAR.
Simple Engines.

Size of plant in horse power......	10	20	40	60	80
Cost of plant per horse power.....	$230.	$200.	$190.	$180.	$175.
Fixed charges at 14 per cent......	32.20	28.	26.60	25.20	24.50
Coal per horse power per hour....	15.	12.	10.	9.	8.
Cost of coal @ $4.00 per ton......	82.50	66.	55.	49.50	44.
Attendance 3,080 hours...........	50.	30.	20.	15.	13.
Oil, waste and supplies per year...	10.	6.	4.	3.	2.60
Total	174.70	130.	105.60	92.70	84.10
Without coal	92.20	64.	50.60	43.20	40.10
Coal @ $5.00....................	195.	146.50	119.35	105.07	95.10
" " 4.50....................	185.01	138.25	112.47	98.80	89.60
" " 4.00....................	174.70	130.00	105.60	92.70	84.10
" " 3.50....................	164.38	121.75	98.72	86.51	78.60
" " 3.00....................	154.06	113.50	91.85	80.32	73.10
" " 2.50....................	143.74	105.25	84.97	74.13	67.60
" " 2.00....................	133.42	97.00	78.10	67.95	62.10

ACTUAL COST OF ONE HORSE POWER PER YEAR IN SEVERAL PLANTS.

Average Horse Power.	Cost of Coal per Ton 2,240 Lb.	Total Cost per Annum.	Remarks.
182	$3.50	$57.59	No land or building cost.
133	3.25	60.00	" " cost.
100	3.50	65.60	" " or building cost.
97	4.45	86.80	All costs included.
75	2.90	92.40	No land or building cost.
50	4.75	111.05	" " " " "
20	4.45	133.50	All costs included.

I had recently to make a careful analysis of the relative costs of small powers in very small units, from steam, electricity, gas (both city and producer), and gasoline, and I was very much struck with the fact that, when all the items were taken into consideration, there was comparatively little difference in the costs, and still more struck

Cost of One Steam Horse Power per Brake Horse Power per Year.

Compound Condensing Engines.

Size of plant in horse power........	100	200	300	400	500	600	700	800	900	1,000	1,500
Cost of plant per horse power......	$170.00	$146.00	$126.00	$110.00	$96.00	$85.00	$76.00	$69.00	$64.00	$60.00	$58.00
Fixed charges at 14 per cent........	23.80	20.40	17.65	15.40	13.45	11.90	10.65	9.65	8.95	8.40	8.12
Coal per horse power per hour......	7.00	6.50	6.00	5.50	5.00	4.50	4.00	3.50	3.00	2.50	2.00
Cost of fuel @ $4.00 per ton........	38.50	35.70	33.00	32.00	27.50	24.70	22.00	19.20	16.50	13.75	11.00
Attendance, 10-hour basis	12.00	10.00	8.60	7.25	6.20	5.40	4.70	4.15	3.75	3.50	3.25
Oil, waste and supplies.............	2.40	2.00	1.72	1.45	1.24	1.08	.94	.83	.75	.70	.65
Total..........................	76.70	68.10	60.97	56.10	48.39	43.08	38.29	33.83	29.95	26.35	23.02
Coal @ $5.00 per ton..............	86.40	77.10	69.22	61.90	55.29	49.28	43.79	39.73	34.05	29.80	25.77
" " 4.50 " "	81.50	72.60	65.07	58.10	51.79	46.18	41.04	36.28	32.00	28.05	24.39
" " 4.00 " "	76.70	68.10	60.97	56.10	48.39	43.08	38.09	33.83	29.95	26.35	23.02
" " 3.50 " "	71.90	63.70	56.82	50.50	45.04	39.98	35.54	31.48	27.87	24.60	21.64
" " 3.00 " "	67.00	59.20	51.67	46.70	41.49	36.88	32.79	29.03	25.80	22.90	20.27
" " 2.50 " "	62.30	54.75	48.59	43.00	38.09	33.83	30.04	27.18	23.75	21.20	18.89
" " 2.00 " "	57.45	50.25	44.47	40.10	34.64	30.73	27.29	24.23	21.70	19.47	17.52

Cost of One Steam Horse Power per Brake Horse Power per Annum, 308 Days.

Triple Condensing Engines.

Size of plant..............................	3,000		4,000		5,000		6,000	
Cost of plant per horse power...............	$54.00		$52.00		$50.00		$48.00	
Coal per horse-power hour..................	1.375 lb.		1.25 lb.		1.125 lb.		1.00 lb.	
Fixed charges @ 14 per cent................	$7.56		$7.28		$7.00		$6.72	
Fuel @ $4.00 ton...........................	10 h.	24 h.	10 h.	24 h.	10 h.	24 h.	10 h.	24 h.
Fuel @ $4.00 ton...........................	$7.46	$14.92	$6.87	$13.75	$6.18	$12.37	$5.50	$11.00
Attendance, 10-hour basis..................	2.75	5.50	2.50	5.00	2.25	4.50	2.00	4.00
Oil, waste and supplies....................	.50	1.20	.40	.96	.35	.84	.30	.72
Total, coal, @ $4.00.......................	18.27	29.18	17.06	26.99	15.79	24.72	14.52	22.44
" " " 3.00.......................	16.40	25.45	15.40	23.56	14.24	21.90	13.14	19.69
" " " 2.50.......................	15.47	23.59	14.38	21.84	13.47	20.22	12.46	18.32
" " " 2.00.......................	14.54	21.72	13.76	20.12	12.69	18.53	11.77	16.94

COST OF INSTALLATION OF A 10 HORSE-POWER STEAM PLANT.

Land for engine and boiler room, 300 sq. ft. @ $1	$300.00	
Boiler and engine-room building, 300 sq. ft. @ $1.50	450.00	
Chimney, 18 in. by 40 ft.	400.00	$1,150.00
10 horse-power boiler	$241.00	
Boiler foundation and setting, 3,900 C. B., 500 F. B.	160.00	
Blow-off tank	31.00	
Damper and regulator	75.00	
Injector tank	10.00	
Water meter	40.00	
Piping for same	20.00	
Pump and vacuum	122.00	
Feed-water heater	40.00	
Pipe covering	50.00	789.00
Engine, 7 by 10	$184.00	
Foundation for same	60.00	
Steam separator	35.00	
Oil separator	25.00	
Piping	95.00	
Freight and cartage	30.00	429.00
		$2,368.00

COST OF INSTALLATION OF A 60 HORSE-POWER STEAM PLANT.

Land for engine and boiler room		$2,500.00
Buildings for engine and boiler room		2,500.00
Chimney		1,200.00
80 horse-power boiler	$790.00	
Ash pan for boiler (below high tide level)	120.00	
Boiler and engine settings	1,282.00	
Blow-off tank	31.00	
Damper regulator	75.00	
Injector tank	10.00	
Water meter	60.00	
Piping for same	22.13	
Pump and receiver	146.50	
Feed-water heater	70.40	
Pipe covering	70.75	2,677.78
Engine, 12 by 30	$1,065.00	
Pan for engine fly-wheel	72.00	
Steam separator	60.00	
Oil separator	41.80	
Piping, freight and cartage	1,026.41	2,265.27
Shafting in place	$550.00	
Belting in place	285.00	835.00
		$11,977.99

$$\$11{,}977.99 \div 60 = \$199.63.$$

with the fact that in the explosion engines the cost per horse-power hour, while of course varying with the size of the unit, kept proportionally the same when developed part of the time or full time, on the same unit, whereas in the steam engines this was not so.

Another feature of the costs of small powers is almost universally forgotten. For instance, it having been generally advertised that a gasoline engine would produce a horse power on ⅛ gallon per hour, it is generally assumed that this will always be so no matter whether any given engine is being worked up to 100 per cent load factor or on a 25 per cent load factor. As a matter of fact, it will be found that almost any gasoline engine, of the single-cylinder type, which will operate on ⅛ gallon at 100 per cent load factor will require over a gallon per horse power at a 10 per cent load factor; and a small steam engine which would run on 5 pounds coal per horse power per hour, at full load, would be using 15 pounds of coal per horse power per hour at one-quarter load. This is fully recognized by the big electrical-service companies, who make big reductions in their power charges as the power consumed in any one month increases.

The industrial world is beginning to recognize that the actual cost of power is growing to be a very important item which is going to increase steadily in importance as our natural resources, such as coal, oil, natural gas, and water power decrease, and methods will have to be devised to produce the maximum of result for the minimum of expenditure, in order to keep the power problem within due bounds as an item of productive costs.

To comment further on the figures given by Mr. W. E. Snow in The Engineering Magazine for May, 1908, we seem to agree quite closely at the two ends of the line regarding costs of plant per horse power, my figure for 10 horse power being $230, Mr. Snow's being $220, and, at 2,000 horse power, my figure being $56, and Mr. Snow's being $53.20. Where we vary most is from 40 to 100 horse power, my figure for 40 being $190, Mr. Snow's figure being $110, my figure for 100 being $170, Mr. Snow's figure $106.

I should also criticise his boiler costs, including setting, and should say that his figures would just about furnish the boilers without the setting. I am afraid, also, that in the coal consumption per horse-power per hour he has taken only the coal consumed during running hours, and has allowed nothing for banking and keeping up steam in cold winter nights, all of which must be taken into account.

I should also criticise his attendance items. My experience has been that the average cost of attendance is fully 50 per cent higher than Mr. Snow allows for.

With these exceptions, and the neglect to take into account the item of ground rent, I think Mr. Snow has contributed some exceedingly valuable data, and I wish we could obtain similar data on gas-producer and other forms of power.

PATENT-OFFICE CONTESTS BETWEEN RIVAL CLAIMANTS TO AN INVENTION.

By Edwin J. Prindle, of the New York Bar.

This article is supplementary to Mr. Prindle's study of Patents in Manufacturing which we published some months ago. We shall shortly issue the entire series in book form, and the manual will be of the utmost value to all in any way connected with the development, use, manufacture, or sale of patented articles or devices.—The Editors.

WHEN an inventor gets into the Patent Office and finds another is claiming the right to a patent for the same invention, it usually develops that his own right to prevail over the other claimant depends upon the history of the invention before the application was filed, and his success or failure in the contest will frequently depend on acts or omissions in that history which were entirely within his control, and on his ability to prove those acts which were essential. Usually, too, all this history is made before the invention is ready to patent, and therefore before it is brought to the attention of counsel, so that the acts and the laying of the foundation for their proof depend entirely upon the unadvised judgment of the inventor, or those owning the invention. It is therefore of importance that those having to do with inventions should have sufficient knowledge of the general principles upon which such contests are decided to arrange those things which are in their control so as to give them the best possible chance of a favorable decision.

The production of an invention begins with a mental conception and ends with a reduction to practice. The conception of an invention does not consist in perceiving the mere desirability of accomplishing a certain object, but it consists of a complete working idea of at least the principal elements of some means for accomplishing that object, and of the correlation of those elements. This difference between a perception of the desirability of accomplishing a certain object, and the conception of the invention, might be illustrated in this way. Many people before Bell had thought of the desirability of being able to talk at a distance by means of electricity. This, however, did not benefit the public in any way. The public was no more able to talk at a distance than it had been before. Bell, however, thought out in his own mind how a telephone should be constructed which would transmit speech at a distance by means of electricity. This conception of Bell's would, if put into practice, give the public practical possession of the invention. When a telephone had actually been constructed according to Bell's conception and used, the invention was what is known as "reduced to practice." The conception alone does not make an inventive act. A man might fully conceive how to make a valuable machine, but if he never puts that conception into practice, he has done the public little or no service, and the law does not regard him as an inventor. To illustrate further: Suppose a person perceived the desirability of making chain from a wire rod by an automatic machine. This would not in any sense be a conception of an invention within the meaning of the law. But suppose he clearly thought out the shape of the parts which were to cut off the blank from the rod and bend the blank into a link, and to thread the next blank through the link and bend it into a link, so that he knew exactly the shape and relative motions and times of operation of the several parts which would operate directly upon the blank and link. If the conception was so fully worked out that any mechanic of ordinary skill could supply what was missing in the way of gearing for operating some of these parts, the conception would be considered complete even though such parts had not been worked out. The invention would, however, be reduced to practice only when a machine had actually been constructed.

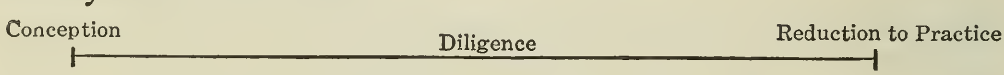


FIG. I. DIAGRAM OF THE PRODUCTION OF AN INVENTION.

The theory of the law is that the production of an invention is a single act, beginning with the conception and ending with the reduction to practice, and the law awards the patent to that inventor who first conceived the invention, whether or not he was the first to reduce the invention to practice, so long as the time between his conception and reduction to practice was occupied by reasonably diligent efforts to reduce the invention to practice. This act may cover a considerable period. Many months may elapse between the conception of the invention and its reduction to practice provided the inventor is reasonably diligent in his efforts to reduce the invention to practice, or, at the time of the advent of his rival, was exercising reasonable diligence. Thus a complete inventive act consists of a complete conception of the invention followed by a reduction of the invention to practice, the conception being coupled to the reduction to practice by reasonable diligence. The inventive act might be illustrated by the diagram in Figure I, in which the first vertical line represents the conception, the horizontal line represents the diligence, and the second vertical line represents the reduction to practice.

Conception of the Invention.

While the nature of the conception of an invention has been pretty fully indicated before, some further discussion of it may be desirable. The conception of the invention must originate in the mind of the inventor. He cannot be entitled to a patent if he obtains knowledge of the invention in any other way than by generating the idea in his own mind. It may come in a flash, or it may be the result of months or years of experiment and thought. It may be suggested to the inventor by something not the invention. For instance, a father happened to see his little son nailing together some sticks. The boy had nothing more in mind than to drive nails into the sticks and fasten the sticks together, but as it happened there were four sticks fastened together by four nails in a peculiar way. The child having driven the nails picked up the sticks, and as he lifted them, they swung on the nails, as on pivots. The sticks had a peculiar motion, and this motion suggested to the father a mechanical movement which he invented and applied to two different purposes and patented. Obviously, the invention never existed in the sticks. The child would have thrown them away or knocked them to pieces, and the invention would never have come into existence, if it had not been for the operation of the mind of the father on the nebulous idea contained in the sticks accidentally fastened together in a peculiar way. Thus the invention was the result of the suggestion, and yet it was a real invention supporting a valid patent.

The reverse of the mechanical-movement incident was a case of the invention of a metal bar for reinforcing concrete, which bar was provided with a large number of indentations, or corrugations on its surface to give it a strong hold on the concrete, and yet the corrugations on opposite sides were so arranged that the cross section of the bar was substantially uniform throughout its length, and thus its strength was not impaired. One of the claimants for the patent, J——, showed that he had made bars which had corrugations or indentations on opposite sides, and these corrugations were so shallow that the cross section happened to be fairly uniform throughout the length of the bar. The corrugations, however, were not accurately staggered with reference to each other on opposite sides of the bar, and he was unable to show that at the time the bar was made he had any realization of the advantage of accurately staggering the corrugations so as to make a bar which, while roughened, would be substantially uniform in cross section. It was held that he had no conception of the invention at the time he made the bar. J—— did not realize the importance of making the corrugations staggered and the next bars he should make were just as likely to have the corrugations in line with each other (in which relation they would weaken the bar) as staggered, and it was only when something later showed him the advantage of staggering the corrugations that he appreciated the invention.

As it would obviously be inequitable to permit an inventor to establish the date of his conception of an invention by his own unsupported testimony, it is required by the Patent Office and the courts that his testimony be corroborated in some manner. The temptation to put the date farther back than it really was is strong, and the settled principle has been adopted that no earlier date will be awarded an inventor than the earliest date when he can show some corroborative evidence. This evidence would usually be the evidence of some person to whom he described the invention at the date in question, or some writing. The person to whom the invention was said to have been disclosed must be able not only to fix the date but to testify that a complete disclosure of the proposed structure of the invention was made to him. It will not usually be sufficient for him to allege merely that the invention was disclosed to him at a certain date, unless he can establish the correctness of the date by reference to some event which was of sufficient importance or peculiarity so that he was not likely to have been mistaken as to the date of the event, or by reference to some memorandum which he made concerning the invention at the date in question. The corroborating witness will not sufficiently corroborate if he simply testifies that the inventor gave him at that time a complete description of how the invention was to be constructed, but he will have to be able to testify as to the details of that construction—at least sufficient details so that his description answers to the requirements of a conception of the invention. He will at least have to be able to testify as to the main features of the invention.

F. had no corroboration of his conception of the invention except statements in a memorandum note-book which he had written. He was able to produce a witness who testified that F. had such a book at a given date, but, as the witness had not seen the entry, it was held that the date was not established.

In the case of joint inventors the single conception must be the product of the two minds in order to be a joint invention. In other words, it is not sufficient that one inventor conceived of certain parts of the invention and the other inventor conceived of other and unrelated parts of the invention, to make a joint invention, but the conceptions of the two minds must be so interwoven as to make together a unitary invention. For instance, if one man invented a new construction of the runner of a centrifugal pump by which a higher efficiency was obtained, and another inventor improved the bearing of the shaft of the pump, this would not be a case of joint invention, because it is obvious it would be immaterial to the more efficient action of the runner what kind of a bearing was used, so long as the friction was reduced to the same degree; and it would, on the other hand, be immaterial to the action of the bearing what sort of an object was carried by the shaft.

An application for letters patent filed in the Patent Office is of course evidence of conception of the invention at the date of filing. Since an inventor's right to a patent may turn wholly on his ability to establish the date when he first conceived of the invention, it is desirable that each step in the progress of the conception be recorded in some way. The inventor should preferably make a careful description or drawing, or both, of the idea as it first occurs to him, and should fully explain it to some person capable of thoroughly understanding it, and should sign the description and drawing himself and write the date upon it himself, and should ask the person to whom he has explained it also to sign the description and drawing. It would also be desirable that the witness should write the date in his own handwriting, so that there could never be any question as to the correctness of the date when the signatures were placed upon it. It is also very desirable that there should be no changes made in the description or drawing after it is signed. As each additional step is worked out, if the invention is worked out step by step, the new step should be shown in a new description and drawing, carefully witnessed as was the first one.

Caveats.

When the inventor has a theoretically complete idea as to how an invention may be carried out, but it is evident that before the invention will be of practical value he must spend a considerable amount of time in further work and experiment, the law provides that he may file in the Patent Office a description of the invention as far as he has gone, in the form of a caveat. This caveat is notice to the Patent Office that the inventor is working on the invention, and it entitles him to notice if any other inventor files an application for patent for the same invention or an invention involving the same principles. When the application is filed in the Patent Office, the Patent Office will suspend action on the application and notify the caveator and give him a limited time in which to complete the invention and contest with the applicant the right to the patent. Where an invention is complete, there is no advantage in filing a caveat, and there is in fact a disadvantage, because a caveat is never regarded as equivalent to a reduction to practice, while the filing of an allowable application is so regarded as will later appear. The inventor, when his invention is complete, should file an application for patent, not a caveat.

Reduction of the Invention to Practice.

Actual experience shows that many ideas may be described in words, or eyen most carefully worked out in drawings, but yet do not operate successfully, when actually tried. Therefore the law requires that an inventor shall actually reduce the invention to practice by building and testing the physical thing (with certain exceptions mentioned later) before the invention will be considered complete. This reduction to practice is, as above stated, the final step in the inventive act. The inventive act consists of a mental part, the conception, and a physical part, the reduction to practice. The safest and most complete reduction to practice is the actual building and using of the device. There are some devices so simple that it is certain from a mere inspection of them that they will successfully perform their intended function, and in these cases no test is required, but only the actual construction of the device. For instance, in a contest between two inventors over an envelope, one of them showed that he had made the envelope at a certain date but had never actually put it into commercial use. It was held that a mere inspection of the envelope was sufficient to show beyond question that it would perform its intended function, and so the mere construction of the envelope was a complete reduction to practice.

It is, however, dangerous for an inventor to stop short of actual use of the device, because it is frequently a matter of opinion whether or not actual use was necessary to demonstrate the practicability of the invention. Some very simple inventions have been held not to have been reduced to practice where the invention was constructed but not actually used. For instance, in the case of a roller bearing, the inventor who first constructed his bearing was held not to be entitled to the patent as against a later inventor, because he had not actually used the bearing. Even so simple a device as a garment hook was held to have required use to complete the reduction to practice.

An inventor must be careful not to let his conduct after an actual reduction to practice be such that it will discredit the reduction to practice. If he treats the machine which he built and used in such a way as to raise the inference that he does not regard the machine as a success, he may destroy his right to a patent. For instance, a stamp-cancelling machine was completed and operated in cancelling stamps in a post-office at Boston several hours a day for several days. This would ordinarily be a satisfactory reduction to practice, and, if the inventor had immediately filed his application for patent, he would have prevailed as against a later inventor of the same machine. The inventor of the Boston machine, however, took the machine back to the shop and partly dismantled it and then laid it aside and never again operated it or tested it in public. A second inventor made the same invention and applied for a patent, and afterwards the first inventor applied for a patent. It was held that the first inventor's conduct raised the presumption that the use of the machine in the Boston post-office was a mere abandoned experiment instead of a successful reduction to practice, and that the second inventor was the one entitled to a patent. The mere fact that a second and better machine on the same principle was made after the first machine would not discredit the first machine, but the first machine would be held to show diligence in reducing the invention to practice. The device which is claimed as a reduction to practice must be sufficiently perfect to demonstrate the practicability of the invention. It must operate successfully; but if it goes that far, it does not destroy its value as a reduction to practice to show that the machine was crudely constructed. The mere accidental production of an invention without appreciation of what has been done is not a reduction to practice of the invention. A mere model, which, although complete in its form, and illustrating how a real machine would be constructed, but which model was itself incapable of successful operation, is not a successful reduction to practice. A device, however, which, although intended as a model, is capable of and does actually successfully perform the intended function, is a reduction to practice even though the inventor intended to use better and different materials in the commercial manufacture of the machine, and this although the model may be only half the size of the commercial machine.

As I have indicated, there are some exceptions to the requirement than an invention be actually and physically reduced to practice. In the case of the Bell telephone patent, Bell's application for patent was in a contest with other inventors, and the evidence did not show that Bell ever actually made a telephone transmit speech before the filing of his application for patent; but as his application for patent fully described how such a telephone should be built, and as the experts of the Patent Office had decided that a telephone built as described in the application would work, and as telephones so built had worked, the Supreme Court of the United States held that the filing of this allowable application for patent raised a presumption that he had actually and physically reduced the invention to practice, and that therefore the filing of the application was a "constructive reduction to practice" and counted for him the same as if he had actually constructed and operated such a telephone at the date of the filing of his application. Thus, when an inventor has filed an application for patent which is held by the patent office to be allowable, he has done what is legally the same thing as building and testing his invention. This is very valuable, as it frequently and usually costs much less to file an application for patent than to build and test the invention. It some times happens, however, that an opponent in the contest is able to show that the invention, if constructed as described in the application for patent, would not operate successfully, and if it would require more than the skill expected of the ordinary good mechanic to correct the defect, the application loses its value as a reduction to practice. It is, therefore, important, when possible actually to reduce the invention to practice.

Diligence.

If no rival claimant enters the field, an inventor may take as long as he pleases in reducing his invention to practice, provided the public does not get a knowledge of the invention in some other way and put it into use. If, however, a rival enters the field, the first conceiver must be exercising reasonable diligence, or the second conceiver will be held to have the superior equities and be entitled to the patent. This qualification that the diligence must be "reasonable" is interpreted in each case in the light of its circumstances. For instance, it would be an insufficient excuse to say that an inventor did not have money to reduce the invention to practice, if he was at the same time spending money in other inventions; or to say that he did not have money to apply for a patent, if at the same time he were applying for patents on other inventions. It would not be sufficient to say that he was delayed by illness, if the illness only covered a part of the time. The excuse must cover the whole time with which he is chargeable. Temporary insanity or great poverty or serious illness would be a sufficient excuse. The mere making of drawings is not a sufficient excuse, if that is not promptly followed by actual construction. Evidently, the safest plan is to proceed with all reasonable speed actually to reduce the invention to practice. The steps connected with the reduction to practice and testing of the machine or other invention should be recorded in the way indicated in connection with the conception of the invention.

Interferences, or Contests between Rival Claimants.

We will now consider how the Patent Office decides some typical cases of contests or "interferences" between rival claimants.

The most important principle is, that the first to conceive the invention is entitled to the patent if he couples his conception with a reduction to practice by reasonable diligence. Another important principle is that the first inventor to file an application for patent is presumed to be the first inventor in fact, and the burden of proving that he is not the first inventor lies on the inventor who comes later into the Patent Office. This second principle shows the importance of getting promptly into the patent office.

Before the Patent Office lets either partly know who his opponent is, it requires each party to file, under oath, what is known as a "preliminary statement." In this the inventor is required to state: (1), the date of the original conception of the invention; (2), the date upon which a drawing was first made; (3), the date upon which the invention was first disclosed to others; (4), the date of the reduction to practice of the invention; and (5), a statement showing the extent of use of the invention. The inventor will not ordinarily be given the benefit of proof of any earlier dates than those set up in his preliminary statement, because of the strong temptation to change the dates after he has seen his opponent's dates.

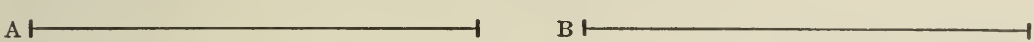


FIG. 2.

Taking now a few typical cases.

A (first) conceived and (second) reduced to practice; and B (third) conceived and (fourth) reduced to practice. Here A's invention was complete before B's entered the field, and the interval between A's conception and his reduction to practice is unimportant, however great, and he is entitled to the patent. See Figure 2.

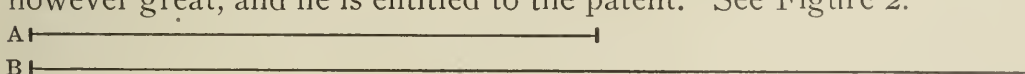


FIG. 3.

A and B conceived simultaneously, but A reduced to practice before B. Obviously A is here entitled to the patent. See Figure 3.

A (first) conceived and (second) reduced to practice, and then concealed the invention for a long time, waiting for commercial developments that would justify his putting the invention on the market. B (third) conceived the invention; A (fourth) filed an application for patent, and B (fifth) reduced the invention to practice, having been diligent from his conception to his reduction. A's concealment of the invention puts his original reduction to practice in the category of an

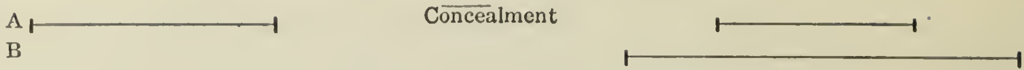


FIG. 4.

abandoned experiment, since the law does not favor such concealment; and thus A's filing of his application for patent is held to be his date of conception and also his date of constructive reduction to practice. Although B did not reduce to practice until after A's application, he is entitled to the patent, because he conceived the invention before A filed his application for patent, (and therefore before A's legal date of conception) and coupled his conception with his reduction by reasonable diligence. This case is illustrated in Figure 4.

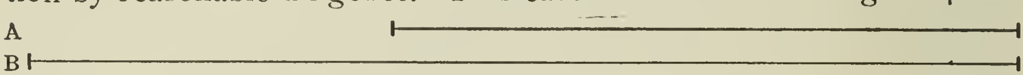


FIG. 5.

A and B simultaneously reduced the invention to practice. Obviously the equities as to the reduction to practice are equal here, and he who first conceived the invention would be entitled to the patent, provided he was reasonably diligent when the second one entered the field. This case is illustrated in Figure 5.

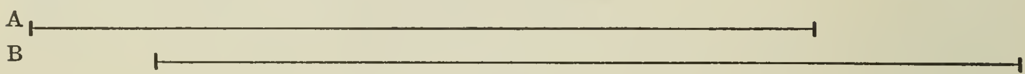


FIG. 6.

A (first) conceived the invention; B (second) conceived the invention; A (third) reduced the invention to practice, and B (fourth) reduced the invention to practice. Here B's conception took place before A's reduction to practice, but as A began the inventive act before B and carried it through to completion with reasonable diligence, he is entitled to the patent. This case is illustrated in Figure 6.

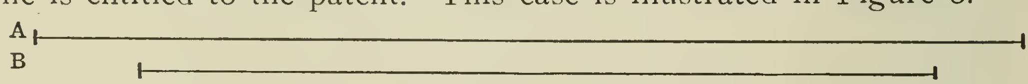


FIG. 7.

A (first) conceived the invention; B (second) conceived the invention; B (third) reduced the invention to practice, and A (fourth) reduced the invention to practice. Assuming that both inventors were reasonably diligent, A would be entitled to the patent, because he who first begins the inventive act is always entitled to the patent, if he carries it through diligently.

This article is not intended in any sense to be a complete statement of the law of interferences, but is only intended to show what precautions it is necessary to observe in the production of an invention and in making records of the various steps, and to show the importance of promptness and thoroughness, because these must be attended to, if at all, before the invention is brought into the Patent Office.

MODERN IDEALS IN MECHANICAL-ENGINEERING EDUCATION.

By Walter Rautenstrauch.

Professor Rautenstrauch's article is more than a critical review of foregoing proposals for engineering education. It is a strong piece of constructive work, vigorously supported by justification of its ideals and demonstration of its methods. We are glad indeed to be the medium for presenting so able a contribution to the topic just now engrossing the attention of two great technical societies.—The Editors.

VISITS of European engineers to American engineering schools and shops; visits of American engineers to European establishments; the creation of committees and commissions for the study of industrial conditions, with a view to the establishment of appropriate educational systems; the establishment of special apprentice courses in large works, and the ever-present and rapidly increasing public and private conferences between the officials of our schools and practicing engineers—all indicate an awakening to the national importance of a proper system of industrial education. But the diversity of opinion and the differences between the courses of instruction indicate that there is yet no agreement and that the subject requires continued study.

With but few exceptions, the growth of the greater industries in this commercial age (which is essentially an age of machinery) has been coincident with the development and application of machinery, without which they could not exist. As in the early days the machinist who constructed machines developed into the machine designer and machine operator, so in later days this type of man through scientific education developed into the mechanical engineer, who through his study of the forces in machines and their applications involved in production and applied to specific needs, proved to be the best qualified to study the forces controlling the men who must make and use these machines in the great industrial organizations. Mechanical engineering has thus become that profession which is concerned with machinery and men, and its practice includes the design, construction, performance, and use of machinery in the generation of power; the manufacture of the articles of commerce; and the management of labor and of the economic conditions which affect the output and marketing of the products of the factory. It is a fact, therefore, that a knowledge of mechanical engineering is the only foundation on which can be built a system of industrial education. Its function is to furnish the officers and administrators, while the ranks and file must be recruited through the trade-schools and the shop itself. A careful consideration of the above requirements should determine the subject matter of a course of instruction in mechanical engineering, together with the educational methods required for professional preparation.

That these conditions have not been met in many of the older courses of study in our engineering schools to be due to a species of mental inertia. The establishment of the principles of thermodynamics by Clausius and Hirn seemed to offer means for analyzing the performance of heat engines and for producing more efficient machines. At the same time the development of the theory of elasticity by Fairbairn and Unwin seemed to offer means for correctly proportioning parts of machinery for strength. These two mathematical theories, together with the then well-known laws of hydraulics, analytical mechanics, chemistry, characteristics of materials, and the necessary mathematics for the proper understanding of the subjects, all seemed to require (because of their inherent difficulties, and the small number of men who understood them) the establishment of courses of study for their proper teaching. Thus the courses in mechanical engineering which have characterized American schools grew up, and consisted very largely in a consideration of these subjects, on the assumption that their study was a proper preparation for the practice of mechanical engineering.

It is difficult for those men who have spent their lives with this idea, even though its limitations have been prominently brought out by years of experience, to change or to admit the necessity for a modification to meet the actual demand. There has been a gradual separation of the work of the schools from the practice of the profession, indicated by the frequently heard distinction between "practical" and "theoretical." This distinction would not have to be made, nor would the apprentice courses in large industrial works have had to be established, had the graduates of our technical schools been able to fit into the scheme of professional practice. Thermodynamics contributes very little to the actual building of steam engines, for while it pretends to give all the conditions for economy of operation and their proper relation, yet it is impossible today to calculate or to predict the steam consumption of an engine or the performance of a boiler. In spite of the great development of thermodynamics in recent years, the economy of steam plants can be fixed only by test; it is not a subject of prediction through the laws of thermodynamics, but rather a subject of judgment based on practical experience as much as if not more than on formulated thermal relations. The test, therefore, remains the criterion, although mathematical thermodynamics may point the way and prevent the attempting of much that is certainly impossible. Furthermore, the design of the structural parts entering into the engine can be calculated only by making assumptions of the working conditions, and their actual construction depends on the correction of the mathematical theory of elasticity, however implied, by a study of breakages which would not have ever occurred were the theory complete. Not only do the mathematical theories of thermodynamics and elasticity fail to provide what is necessary for the prediction of results in the complete machine, and therefore, fail to provide a complete theory for the design of that machine, but both have absolutely ignored the conditions which prompt its construction—that is, the conditions of economic demand. There is a demand for simple and complicated, for highly efficient and very inefficient, engines; for engines adapted to skilled and unskilled operating labor; and for engines to meet a multitude of local requirements, none of which can be formulated, but all of which result in a real demand which the designer and builder must satisfy. Thermodynamics most positively indicates the superiority of gas engines over steam engines; yet the progress of gas engines has depended little, if at all, on this long-known principle, but rather on entirely outside practical considerations such as difference in first cost, size, space occupied, repair and maintenance costs, and the nature and quantity of labor required for their operation.

All these conditions, and many more, enter into the question of true economy, and are entirely outside of the consideration of thermodynamic economy. Therefore, any theory of power-generating machinery which fails to include the various factors of cost (including labor as well as capital charges) and their variations with local conditions, is not a complete theory and therefore not a theory to teach engineering students. These mathematical laws are very valuable in explaining results attained and preventing attempts at the impossible, but not nearly so useful in that prediction of results, which is the prerequisite of design of whatever sort, as many of their professional advocates have for years taught their students to believe. For many years past the average course of study absolutely ignored all those subjects or methods of treating subjects that were not capable of formulation. The labor and cost questions, although they are at least of equal importance, have been ignored; while the mathematical or pure technological has often been carried to absurd extremes. It is almost a proverb among graduates of the engineering schools that fully half of the instruction they received contributed no more toward the practice of their profession, nor to the true preparation for it, than may be included under that vague term "mind training," which "mind training" might just as well have been secured by the treatment of other subjects of greater contributory value.

Ideals and theories are always beyond doubt absolutely essential. It is not the purpose here to belittle them, but rather to place them in their proper position as partially and not by any means wholly preparatory subjects. It is indeed important to teach students to lay out machines, to determine the forces in the mechanism, and to proportion the parts to resist resulting stresses, but it is equally important that they be taught what a great variety of machines might be designed to perform precisely the same thing, perhaps with various degrees of goodness, but certainly with great variations in cost not only to build them but to operate them. Unless a machine can be built cheap enough to meet the demand it should never be built, and there is absolutely no use in designing a machine if its cost of production or operation exceeds what can be properly paid. It is certainly important to teach the student how a bar can be turned round or a plate made flat, or how every operation necessary to make a machine may be carried out by a mechanic; but it is equally important that he should know their relative costs so that he may avoid the expensive operations or reduce their use to a minimum. He should also be taught that the maximum economy in producing that machine will result when it is made in quantity, and that quantity production will involve changes in design, changes in shop processes because it permits the use of special instead of standard tools, and finally, and most important, that quantity production involves many men, and that many men require management that each may produce the maximum for his wages, and that such an organization for economic production is subject to laws and principles of far greater consequence than all the thermodynamics that was ever formulated.

It is because the old courses of study have failed to correlate properly conditions of commercial economy with conditions of pure technique, or because they have been academic rather than practical, or because they have contented themselves with contemplation of the results of the past and with elaborate discussions concerning these results rather than with the work of the present and its essential requirements, that differences are now springing up between the schools. The more alert minds, most closely in contact with practical affairs, are realizing this situation and contributing to its improvement. It is too much to expect of any one man teaching our students, in a course with such aims as should apply to the training of the mechanical engineer as the developer and organizer of our technical industries, that he should be equally well equipped in all quarters. There is probably no such man in existence. Dependence must, therefore, be placed on various workers, each in his specialty, to contribute his mature judgment on the relative weight that is to be given not only to the possible available subjects, but also to the possible methods of treating them.

It must be recognized, however, that no course of study which consists wholly of commercial subjects is sufficient to meet the present demand of industrial education. Such subject matter must be so incorporated and correlated, and presented by such methods of instruction, that there can be no leaning to the one side or the other, but the absolute interdependence of the two shall be shown. Without that training in the analysis of observations, in deduction from them, and in the drawing of generalizations and the correction of generalization by further observation, which is the result of the purely, technical training, and which leads so positively to systematic thinking and orderly mental procedure, a successful attack upon the problems of organization and control of great industries cannot result; and without it they would not exist today. Such rigorous habits of thought cannot be developed by the simple business training alone, but when applied to business problems they will surely yield results. It is these qualities, developed by the mechanical engineer in the practice of his profession—not always because of the school from which he graduated, but too frequently in spite of it—that have made possible the enormous progress in manufacturing in recent years. Their importance is indicated by the report of the last president of the American Society of Mechanical Engineers, which shows that over 50 per cent of the members of the society are directly concerned with the organization and management of capital and labor, while the rest are either engaged in the practical preparation for this work or in strictly technical pursuits.

For some time past the department of mechanical engineering at Columbia University, under the direction of Professor Charles E. Lucke, has had under consideration this general problem, and the result has been the establishment of a new course of study which, it is believed, is a step in the right direction; it is submitted as one attempt to bring about the desired result. The entire four years of student work has been revised and co-ordinated, both in subject matter and methods of instruction, with the above aims in view. It is felt that the preparatory and fundamental subjects of mathematics, mechanics, chemistry, physics, shop work, and drawing should all be made to lend themselves to the oneness of purpose so essential for the accomplishment of good results. Mathematics, which establishes the relation of dependent quantities, the laws by which the functional relations may be predicted by deduction from formulated observations; deductions; mechanics and physics, which treat of the laws governing the relation of forces, their action on masses, their variation with respect to time and space, together with the basic ideas of energy, heat, light, electricity and magnetism, and the properties of matter in solid, liquid and gaseous form; and chemistry, which goes still farther into the question of force relations in their molecular aspect and which leads to the clear conception of the constitution of matter and its possible and impossible transformations—all lend themselves most admirably to exposition by means of elementary engineering problems. Such problems serve to give these fundamental laws the forms and associations required for the work of the engineer, and to make them become real instead of mere word statements in the student's mind. The necessary conceptions can never be considered acquired unless the student becomes their master by using them, instead of being mastered and repulsed by contact with them. By replacing a large part of the hand work of the manual-training shops by lectures and demonstrations, and by alternative practice in pattern making, forging, machine and foundry work and the exposition of their relative economic values, critical comparison—of great value in its future application for this type of man—is substituted for muscular effort and finger-skill, for which he has little application. The elementary ideas underlying modern drafting-room practice, followed by later applications, are substituted for work of the old type—drawing instruction involving the making of geometric figures and the solving of trick line problems. Such a preparation in the early days, involving the same subjects as heretofore taught but with different proportional allotment of time and methods of treatment, makes a proper foundation on which to base the more strictly engineering instruction. A tabulated statement of the subjects constituting this course of study leading to the degree of M.E., and the time devoted to each, is given on the opposite page.

First Year.

First Half Year.	Hours per week. Class.	Lab'y.
Analytical Geometry ...	3	
General Inorganic Chemistry	4	
Elementary Mechanics, Properties of Matter and Sound	5	
Engineering Drafting ..	1	14
Descriptive Geometry...	3	
Gymnasium		2
Total..............	16	16

Second Half Year.		
Spherical Trigonometry.	2	
Analytical Geometry....	3	
General Inorganic Chemistry	3	
Light, Heat, Electricity and Magnetism	3	
Qualitative Analysis ...	4	13
Theory of Surveying...	2	
Gymnasium		2
Total..............	17	15

Summer Work: Five weeks surveying practice.

Second Year.

First Half Year.		
Physical Laboratory....		6
Elements Electr. Eng...	2	
Calculus	5	
Industrial Chemistry....	3	
Empiric Design	2	3
Structural Drafting		3
Steam Power Machinery	3	
Pattern Making		6
Gymnasium		2
Total..............	15	20

Second Half Year.		
Elements Electr. Eng...	2	
Analytical Mechanics....	5	
Industrial Chemistry....	3	
Kinematics		6
Steam Power Machinery	3	3
Machine Shop		9
Iron and Steel.........	2	
Gymnasium		2
Total..............	15	20

Second Summer: 125 hours in College shops; 6 weeks practical work in shops and drafting rooms of manufacturing establishments, with report. A total of 9 weeks.

Third Year.

First Half Year.	Hours per week. Class.	Lab'y.
Direct Current Lab....		3
Dynamo and Motor Practice	2	
Mechanical Laboratory..	1	3
Resistance of Materials.	5	3
Metal Work		6
Machine Design	1	6
Thermodynamics	2	
Technical "	2	
Total..............	13	21

Second Half Year.		
Electrical Plants	2	
Hydraulic Laboratory... } Metallographic " ... }	1	3
Hydraulics	2	
Tech. Thermodynamics.	2	
Materials Testing Lab..		3
Mechanical Laboratory..	1	3
Principles of Machine Manufacture	2	
Machine Design	2	6
Standard machinery for pumping, compressing, elevating and conveying, heating and cooling	6	
Total..............	18	15

Third Summer: 6 weeks practical work in power plant, with report.

Fourth Year.

First Half Year.	Hours per week. Class.	Lab'y.
Alternating Current Laboratory		3
Electric Power	2	
Electrical Distribution..	2	
Engine Design	6	12
Mechanical Laboratory..	2	3
Steam Turbines	2	
Seminar	1	
Total..............	15	18

Second Half Year.		
Industrial Law	3	
Economics	3	
Gas Power Machinery..	4	3
Water Power Machinery	3	
Manufacturing Plant Design	2	3
Power Plant Design....	3	6
Works Management....	2	
Total..............	20	.12

In all those courses which are of a direct engineering character, constant reference is made to the commercial relations in which the problems arise and create necessity for their consideration, while at the same time a most rigorous treatment is maintained of their mathematical and analytical aspects constituting the pure technology of the subject and its scientific basis. Nowhere is superficiality allowed to creep in. Habits of independent thought are fostered and the powers of observation and judgment cultivated in all the work in class rooms, laboratory, and drafting room, by repeated analysis of existing situations, and attempts to apply the generalizations there developed to the synthetic type of problem by designs and projects. It is recognized that the function which the mechanical engineer serves demands that he be possessed of analytical and executive ability, a capacity for bold and independent thought, and the power of selection, which is born of a broad and thorough kuowledge of his subject and which cannot be acquired by any process of instruction that requires the student perpetually to absorb what he is told. Possessed of such qualities, his information becomes an instrument in his hands, subordinate to his habits of orderly mental procedure which always yield results in the attack of new problems, however strange. The experimental work in the laboratories serves as one valuable means toward the development of clear, fearless thinking, while, at the same time, it serves to fix the principles taught in class by giving the student opportunities for personally demonstrating them to himself. The laboratory systems by which it is sought to bring this about have been set forth in a paper* by Prof. C. E. Lucke, head of the department.

For each afternoon's work per week in the laboratory there is assigned one lecture per week, at which the problems to be solved are assigned and the method of attack explained and illustrated by examples. Before performing the laboratory work the student must prepare for himself the first three of the seven paragraphs in his report, which are given below:

WORK TO BE DONE BEFORE THE EXPERIMENT.

1.—Concise definition of the problem to be solved. This is given by the instructor, and in practice often includes several problems more or less interdependent to be solved; in this case each being stated separately.

2.—Justification of the problem. By an examination of the problem in the light of experience or theoretic principles the nature or magnitude of the results demanded by the problem will be found to be wholly or partly impossible to predict, and hence must be measured. This is intended to induce the preliminary application of a man's whole fund of experience to the case in hand and to assist, by so doing, in the solution.

3.—Analysis of the problem in the light of available apparatus and basic principles, to such detail elements that it becomes possible to set down a list of observations to be made and a list of assumptions or constants needed and where they may be found.

* Trans. A. S. M. E., The Function of Laboratory Courses in the Engineering Curriculum.

After the completion of this examination of the problem the student is ready to begin experimental work, and he is not permitted to do so until he has handed in his preliminary report with the study of the subject as explained.

In the laboratory his attention is devoted to finding the answer to the problem rather than filling in columns or wondering what to do with the reading of some thermometer, or what good the reading is after he has it. This leads naturally to the rest of the report, which contains paragraphs each with a guiding title as follows:

Work to Be Done During and After the Experiment.

4.—Results of the observation with as much of the method of making them as is necessary to judge of their quality or limits of application under new conditions. This is really nothing more than a brief summary of the actual experience in the laboratory.

5.—Answer to the problem, using the observations and assumptions found by the analysis to be necessary. Where the answer involves a variation of one thing with anything else the nature of the variation is indicated by plotted curves.

6.—Accuracy and errors. In this part of the report it is freely acknowledged that nothing found experimentally can be absolutely right, but results may approach accuracy more or less. Three errors are to be considered:

(*a*) Apparatus error, due to unfitness or lack of adjustment as affecting observations.

(*b*) Personal error in all work.

(*c*) Resultant error due to accumulation or neutralization of many elementary instrumental and personal errors.

7.—Interpretation of results. The full significance of the results is not always apparent by mere statement, but requires some study to clarify. The interpretation usually takes the form of an explanation of the results, or the probable reasons why things were as they were found.

When by this method the student has arrived at an answer to his problem he is immediately conscious of success, and not only confident of the results for the next case, but eager to attack anything. He has thought out the basic principles involved in the problem, found for himself its elements and made observations which he himself decided were necessary, and obtained generally in spite of the stress of noise, heat and other annoyances.

The working out and interpretation of results calls again for application of all the principles known and comparison with results of other experiments, and might well be the daily experience of any of our best engineers, while the clear writing of a concise report on the whole process is likewise no more or less than common engineering practice.

These methods are applied to all of the laboratory work, of which it will be noted there is considerable, running through the courses in gas-power machinery, water-power machinery and steam-power machinery, in addition to those courses specifically devoted to it.

The conduct of the work in the drafting room is also designed to accomplish these same results. The ability to recognize fundamental principles and economic conditions in practical problems is considered just as essential as a knowledge of the principles and conditions as such. Accordingly, therefore, the student is required to determine for himself, from the conditions of operation and service, all the factors requisite to the design of many classes of machines and their component parts. The knowledge and experience thus gained, together with the instruction in the principles of machine manufacture, is the basis of the work in synthetic design of machines for the performance of specific functions. Preceded by instruction in those factors in design which do not submit to formulations but which are largely evolved from commercial considerations; in kinematics, dealing with the forces and the relations of forces, reactions and interactions, paralleled by the instruction in shop processes; manufacturing-plant experience in the summer months; the principles of machine manufacture, machine design; metallurgy; resistance of materials, and materials testing laboratory, there is established a series of courses as outlined below, which serve as the necessary preparation for those courses which deal directly with the problems involved in industrial engineering, such as manufacturing-plant design and works management; the nature of these may also be seen from the given outline. Space limits confine the definition of most of the courses to the descriptive title alone. In some which exhibit best the recognition of economic elements, the main skeleton of the topical division is indicated. For further details, reference must be made to the catalogue of the university.

Empiric Design—Proportioning of Machine Parts by Empiric Methods and the Production of Shop Drawings and Sketches. Modern practice.

Kinematics of Machinery—Determination of Paths of Motion, Velocity, Acceleration and Kinetic Forces of the Moving Parts of Machines with the Resulting Reaction Forces of the Frame.

Manufacturing Plant Summer Work—Practical Work and Directed Study in the Shops and Drafting Rooms of Representative Manufacturing Establishments with Report. Each student is provided with a printed copy of the things to be studied and reported on in detail.

Functional operation, characteristics and powering of machine tools, capacities, layout of shop, size of shafting, belting and motors for independent and group drive. Report on specific observations on time of setting work, time of forming and finishing, number of pieces turned out per hour. Facilities for producing pieces in quantity.

Machine tools used in the pattern-shop, arrangement, capacities, adaptability, handling and storing of material and finished product.

Appliances used in the foundry and forge. Methods of molding. Time involved. Composition of the charges and mixtures, temperatures, pressures, time required to charge, to melt, to pour, cool and clean. Time involved in production.

Drafting Room. Standards and conventions used. Standard parts in stock.

General Mangement and Organization. Methods of recording time of workmen and their time distribution over on different jobs. Drawing of materials used from storeroom and charging to orders.

Principles of Machine Design—Analysis of the Stresses in Machine Parts of Standard Form under Varying Conditions of Service and the Proportioning of the Machine Elements to Safely Resist the Resulting Stresses.

Principles of Machine Manufacture—The Economic Elements in Shop Processes, Time and Power per Unit of Surface Finished or Cut and per Unit of Metal Removed with the Conditions for Most Economic Production. Processes in the shop, functional operation of machine tools and limits of economic production, time of setting, handling, forming and finishing of parts for job and repetition work in quantity. Limits of time, power and cost for finishing surfaces per sq. in. and removing per cu. in. and per lb. by hand and machine operations. Economy of portable tools. The selection of economic cutting conditions and analysis of recent experiments. Adaptation of economic cutting speeds to machine tools. Labor-saving devices. Limits of labor, power and fuel per ton of castings. Labor and power per lb. of forging as affected by tools, size and form of work.

Machine Design—Application of the Principles of Kinematics, Resistance of Materials, Design of the Machine Elements, Shop and Foundry Methods to the Design of Complete Machines. Analytic and synthetic treatment.

Works Management—Manufacturing Organizations and Methods of Accounting. Effect of methods of manufacture and capacity on systems of management of mills and factories. Analysis of the elements of factory accounting and determination of the factors entering into the cost of production. Methods for keeping record of the cost of labor and materials in the production of specific articles. The determination of establishment charges. Interpretation of costs and use of comparative values. Organization and functions of the department of the business. Purchase of raw material and sale of product. Utilization of scrap and waste. Factors affecting the cost of production.

Manufacturing Plant Design—Methods of Procedure for the Design of a Plant for the Manufacture of an Assigned Product at a Given Rate. Determination of kind and quantity of materials needed, processes by which they may be most economically worked, selection of machinery for each process, determination of the number of each kind of machine required, power necessary to drive. Layout of shops for most direct production. Estimate of costs of equipment and installation. Layout of heating, ventilating and lighting systems, power transmission systems and facilities for reduction of fire hazard. Layout of system of management and cost determining system.

Developed parallel with the courses which constitute the "Design Series" are courses which deal with the performance of machinery. The functional operation of power-plant machinery, the development and applications of the laws of thermodynamics exemplified by the laboratory instruction, hydraulics, and hydraulic-laboratory and practical power-plant instruction in the summer months, are subjects contributory to the proper consideration of the work in power-plant design and water, steam, and gas-power machinery. The scope of the work in this series of courses may be learned from the following brief descriptions:

Steam Power Machinery—Functions, Forms and Principles of Operation of the Typical Steam Power Plant Units, Auxiliaries and Connecting Elements. Methods of receiving, storing and firing coal, coal handling machinery, grates, stokers and furnaces for the combustion of coal; flow of gases through boilers, flues, dampers; operation of boilers, boiler settings and foundations. Methods and apparatus for feeding water to boilers. Flow of steam from boilers to engines, and the grouping of engines and boilers, piping, valves, fittings and pipe covering. The heating of boiler feed water in feed water heaters and economizers. Boiler strength tests and inspection laws. Steam pipe condensation and drainage. Steam traps, separators, steam superheating and superheaters. Condensing operation of steam engines. Typical steam engines and the variations in form and character of their important parts. Regulation of engines and engine governors. Relation between engine construction, foundations, vibrations and balancing. Steam turbines. Typical steam plant arrangements for various special and standard conditions.

Afternoon work in laboratory, power house and drafting room, sketching apparatus, setting valves, plotting diagrams and demonstration of principles of operation taught in class.

Technical Thermodynamics—Laws of Heat Generation by Combustion, Heat Transfer and Transformation into Work.

Gas Power Machinery—Theoretical and Practical Consideration Affecting the Generation of Power by Gas Engines, Including Oil Vaporization, Coal Gasification and the Design of the Machinery. Efficiency.

Water Power Machinery—Principles of Design and Economy of Operation of Turbine Wheels and Water Power Plants.

Power Plant Summer Work—Report based on not less than six weeks' practical work in an Operating Power Plant, including the Output, Load Conditions, Labor and Material for Operation and Maintenance, Operating Cost per Unit and the Essential Dimensional Relations between the Various Units and Auxiliaries Producing this Result.

Steam Power Plant Design—Relation Between the Cost of Power and Thermal Efficiency of the Plant. Commercial Value of Refinements. Determination of engine and boiler ratings and corresponding efficiencies and probable coal and water consumption for plant on given load curve, etc.

The work done by the students during the summer months in manufacturing and power plants, which has been referred to, has been a source of much good in promoting the asking of questions and the inquiring into conditions which they could not understand, in arousing an interest in the work of the subsequent years.

Because of the inherent difficulties of treatment and the necessity of further exemplification of the laws underlying the design and performance of machinery, there is incorporated a series of courses, the treatment of which is according to the system of Case Law. As in the practice of law, so also in the practice of engineering it is found that the principles underlying and interwoven in the structure of the problems presented for solution are comparatively few, while their applications and modifications are many. It seems expedient, therefore, that for a direct preparation for the practice of engineering, as for the practice of law, requiring such rigid analysis for the discovery of underlying fundamental principles and the untangling of the many exemplifications, the case system should be adopted.

To this end there has been included in the course of instruction a series of subjects concerned both with design and performance, experimental investigation, and economic considerations which are also treated after this system. These subjects are air machinery, pumping machinery, elevating and conveying machinery, refrigerating machinery, gas-power machinery, and steam turbines, thus outlined:

Elevators and Conveyors—Mechanical Handling of Solid Materials by Standard Elevating and Conveying Machinery, Characteristics, Speed, Tonnage and H.P. per Ton, Computations and Adaptability to Special Service. Hand handling of materials, limits, cost and conditions warranting use of machinery. Pneumatic and hydraulic elevators for freight. Passenger elevators, rope and plunger types. Automatic weighers of materials; coal and ore storage systems. Excavating machines and dredges. Coal and ore handling machinery. Coke oven chargers and dischargers. Grain handling.

Refrigeration Machinery—Relative Equipment, Space Occupied, Fuel and Water Consumption per Ton of Refrigeration or of Manufactured Ice for Principal Systems.

Air Machinery—Structures, Adaptability and Economy of Fans, Air, Gas and Vapor Compressors, Blowing Engines, Jet Blast Apparatus and Important Applications.

Pumping Machinery—The Mechanics of Moving Liquids and Standard Machinery for Pumping. Water elevators.

As a necessary adjunct to this complete consideration of the commercial relations in which all problems in engineering are involved, instruction is given by the Departments of Law and Economics in the principles of industrial law and economics, and in their application to relations and responsibilities between man and man and to the affairs of groups of men.

In the desire and necessity for a closer co-operation between the conditions involved in our educational system and their connection with the practice of the profession, which has previously been mentioned, there have been secured the services of men in practical life who through their years of experience and thorough training are qualified to give instruction in the several subjects, advise in all the affairs of the department which concern the course of study, and thus serve to make this bond. These men have been assigned to the conduct of those particular courses mentioned under the "case law" for which they are particularly fitted. The work of these special lecturers, with the assistance of the instructors in the laboratories, recitation and drafting rooms, is not accompanied by any departure from the regular methods of instruction pursued in the other courses and is not to be confused with the general system of special lectures on isolated and non-related subjects which is also carried out by our student engineering societies.

In the last number of this magazine there appeared an article by Prof. Hugo Diemer of the State College of Pennsylvania on a proposed course in Industrial Engineering aimed to prepare men for leadership of our industrial enterprises. In view of the opinions which I have attempted to bring out in the foregoing, it seems hardly necessary to state that I think the plan both inadequate and misdirected. A few words may suffice to make this clear.

It appears that while there are several good subjects scheduled, such as Banking, Theory of Money, Factory Administration and Commercial Law, there is an entire lack of good mechanical-engineering instruction so necessary for the industrial work of which it is the foundation. The author states that it is necessary for the industrial engineer to be "thoroughly familiar with productive processes," yet at the same time he proposes to devote only one hour per week in one term to instruction in "shop methods," which may not even be on the processes of production.

There is nothing offered in technical thermodynamics, the foundation of all work in steam and gas engineering, yet in the senior year there is scheduled a course in "Gas Engines, Refrigeration and Turbines." Without thermodynamics these courses can only be descriptive and superficial. There is nothing on machine design, which subject together with the principles of machine manufacture, and leading to instruction in manufacturing-plant and design and works management, is the very foundation of Industrial Engineering instruction. With the exception of a few hours instruction in electric measurements, there is nothing whatever on Electrical Engineering in its broadest sense.

Such courses are vastly more important than Quantitative Analysis, History of Architecture, Architectural Drawing, Bridges and Roofs, Theory of Structures, etc. The industrial engineer is very rarely concerned with these things. He is concerned, however, with machinery and all the relations of machinery to human affairs.

The author further states "The men we must provide must be trained in three distinct lines. They must be thoroughly grounded in engineering. They must have creative ability in applying good statistical and system methods to production, and finally they must know something about men." In the proposed schedule I fail to see where a thorough grounding in engineering is given. I do not hesitate to say that with so little instruction in engineering, the student would know practically nothing about the subject and especially of those things which are the very foundation of the manufacturing industries. Upon the second point, it does not appear how the creative ability of the student can be developed in this particular unless he thoroughly understands the design and construction of machinery and the methods of production—unless he knows how and what to produce. The third purpose is "to know men" and "train for leadership." The first essential for leadership is the capacity for bold and independent thought. A leader must possess the ability to picture clearly in his mind the course which must be followed to bring about the desired ends, must possess the executive ability to organize his forces so that every effort is directed toward the accomplishment of his purpose. And it is believed that the courses of instruction should be so conducted that these qualities must be exercised to the end that the student may know if he does or does not possess them. Leadership cannot be taught in school—it may be developed from experience in life.

OBTAINING ACTUAL KNOWLEDGE OF THE COST OF PRODUCTION.

By F. E. Webner.

III. COMPARISONS OF COSTS AND THE PROFITABLE USE THEREOF.

Mr. Webner's series began in our May issue, and previous numbers have discussed "What Constitutes a Knowledge of Costs" and "When and Where a Close Knowledge is Needed." The parts following after this month will be: "Use and Abuse of Mechanical Aids in Cost Finding"; "The Organization of the Cost Department"; and "Cost Records as Part of the General Accounting."—The Editors.

THE end and aim of cost accounts should be to know, not how much a certain shop order cost for its constituent production elements, but *why* it cost what it did and under what conditions the cost might be reduced.

The "Material" element is not without its need of comparisons, as it frequently discloses the need of buying at closer figures, or possibly the advantages of a judicious use of some "just as good" material, or again the desirability of contracting for a season's supply rather than relying on "pick-ups."

Perhaps the most important element to compare and watch carefully is the labor; the length of time spent on a job often involves the difference between a profit or a loss on the work, and inasmuch as the number of hours spent on the job affect the burden of expense as well as the labor cost, it is quite essential to scrutinize the cost records and to compare time of operations with time previously spent on similar operations, and to set about to learn the cause. Inefficiency of foremen or employees is often brought to light, the discovery resulting in improved labor conditions; and that, incidentally, is the most potent factor in the minds of workmen against the introduction of cost records. Records mean, fundamentally, the assurance of a full measure of value for all assets in the transition from one stage or state to another state or condition; hence friction results.

Aside from certain conditions, the grumbling of workmen should not be seriously considered when a cost system is being installed, else it will never come to a point where it discloses any facts not already known.

It is a foregone conclusion that both foremen and workmen will frown on any attempts to get accurate data concerning labor operations. The foreman may, to all appearances, evince a desire to advance the best interests of the management; but his heart usually is with his men and their wishes when it comes to putting one man against another in tests of speed for record; that is especially true with foremen who have served their time in subordinate capacities in the particular department over which they hold sway.

Instances are not few in which rapid piece workers have been let out for no cause whatever except that their "excessive" production caused dissatisfaction among less-nimble-fingered workmen; such cases however, were in times when labor was in sharp demand and a workman might at any time find another job across the street; then the whims of disgruntled workmen carried somewhat more weight than they do in times when factories run on part time only, and the general run of workmen are glad enough to be kept busy.

The management of a factory should be alone the judge of how far it will allow the workman to dictate the policies of the business; the introduction of a cost system may embody plans which might set the teeth of the workman on edge and cause serious labor difficulties, and therefore such plans must be diplomatically launched and carefully guided in order to avoid disturbances. It is not the purpose of this article to tell just how such plans may be carried out as regards the workmen, for each factory is a case peculiar unto itself and must be specifically treated with remedies best known to, or worked out by, the management. One bright superintendent was able to load cars and have other manual labor done where groups of men could be utilized to advantage, by fanning the flame of race prejudice—Irish *versus* Germans, Norwegians *versus* Poles, etc. If the contending groups were not working simultaneously, then a glowing record of achievement was always available for reference and the group of workmen nearest at hand were gibed into a contest to equal or surpass the record. This plan was started as a joke, but latterly carried on in all earnestness purely as a means of reducing the cost of handling material; and before the men realized what had been done they had all acquired a quick movement which was not allowed to lessen through lack of urging; here was a profitable use of comparisons.

In order to make any use whatever of comparisons of labor operations on parts of product, the starting and finishing time must be required, and not merely an offhand statement on the time report that each operation or job performed took a certain amount of time; the latter plan is too prolific of possibilities to doctor the time report either intentionally or unintentionally—the man may be honest and yet easily make a mistake in the time unless he puts it down, and if he is to put it down at all, let it be on the time ticket; then it is authentic.

Where starting and finishing time is required on each job or operation, the full benefit is not being derived therefrom if a close record and sharp watch are not kept of the variations in time required on a given operation; for this purpose a record card should be maintained for each constituent part of the product, with a full classification showing each operation wherever such operations are singly performed. The successive entries should show date, name of operative, number of pieces finished, elapsed time, and time per unit. At intervals an average time per unit should be shown, and the secret of any success or benefit arising from the plan is to have the records always up to time as far as posting is concerned. If comparisons demonstrate that a certain man has far exceeded a reasonable time per unit on a given job, then while the matter is still fresh the reason can be ascertained through proper channels and a possible remedy applied, whereas if the records are four or five weeks—or even one week—behind the actual work, the workman can very conveniently have forgotten all about it; in which event the records avail nothing and the time spent in maintaining them will have been practically wasted.

Where records are promptly posted the men very soon learn that they are being closely watched, and there is much less dead time likely to exist than where the men are to a large extent given their freedom with but an occasional rebuke by the foreman. Habitual slowness of one man on a certain kind of work will demonstrate, perchance, that he is too expensive on the work, and duties for him can be found which are confined to operations more in keeping with his natural bent; thus the system operates to cut down costs. It frequently happens that one man can prepare a tool or machine in less than half the time other men take to do it, and this difference in time of preparation possibly accounts for a glaring difference in the time per unit required for the operation considered as a whole. In some shops the setting-up process is done on time work, while the subsequent operation is on a piece-work basis, so that there is often a tendency to postpone the time-recording act as long as possible, in order that piece-work operations may be taking place while the "time" also is going on. This is nothing more or less than petit larceny; men who are detected at this trick usually ought to be watched, as they are more than likely to repeat it as often as the opportunity presents, and in cases of this kind the records should show the setting-up time separate from the balance of the operation so that close tab can be had on the time work. The deferred-time-recording trick is attempted in many cases where the premium system is in vogue; when a workman for any reason has time to spare on the job just finished he will start on the new work and not ring or record "out" in the finished job until the spare time is consumed. The most sure preventive of this act is a penalty to be levied against his premium whenever he is discovered at it, and the comparisons to be made in this sort of case are in the factory and not in the cost office. The foreman should make it a practice to make a number of trips during the day, going the rounds of his department to scrutinize the job tickets of every employee. These trips at irregular intervals should cause no hardship, but rather the reverse, as the foreman should necessarily be in close touch with the work of the men—that is what he is or should be there for. In some cases it is possible without loss of time to have the next job ticket issued only after the preceding job is completed, or again each workman can have two or three jobs laid out ahead of him with definite instructions given him for each, but he may not be allowed to know which he is to take up next until he finished the preceding. For this plan a good arrangement is to have a rack for job tickets, and to have the rack equipped with an electrical contrivance wherein each workman's tickets are placed face inward on a separate hook or ring; each ring is so connected that when opened (to remove a job ticket) it breaks a circuit, thereby electrically recording the hook number and the time the ticket was lifted.

Every works manager knows that a group of efficient workmen if left entirely without a pusher would have "Fat Costs and Lean Production." An old axiom says that comparisons are odious, and that is quite as true in factory comparisons as elsewhere. With a comprehensive system of comparisons, the workman to whom such comparisons are odious is forced to put forth such efforts as are necessary to bring his work up to or above standard, and by those efforts he can change the conditions so that "Fat Production and Lean Costs" will result.

EDITORIAL COMMENT

A photograph of "a mile of idle engines," 120 in number, was recently taken by the New York Central and exhibited as "an argument for raising freight rates." The economic twist of this argument, as a leading editorial writer remarks, is very curious. If selling goods were in question, instead of selling transportation, the futility of meeting the depressed conditions by raising prices would appear quickly enough. The railroad point of view seems to be rather that of the man who "needed the money."

Curiously enough, the New York Central is also the road which has startled the industrial quiet by placing an order with the American Locomotive Co. for 139 new engines. Evidently the officers of the road are sure not only of early use for the mile of idle engines, in such service as they are fitted to perform, but also for a mile and a quarter of new and better engines. As the writer just referred to asks, why not photograph the new construction with its gospel of optimism, instead of the passing evidences of depression and pessimism?

The enormous and often-opposite variations in our industrial energy and the load put upon it, constitute one of the greatest inefficiencies of our era. A year ago the overload was almost universal—factories swamped with orders, shops running overtime, freight congested everywhere, and railroads hopelessly unable to handle the volume of business pouring in upon them. Construction suffered expensive delays waiting for material. Shippers fumed over the car shortage which deprived them of facilities for moving away goods sold to make room for fresh raw material. And now, quickly forgetful of the past, and needlessly skeptical as to the future, priceless time is allowed to slip idly by; costly equipment stands motionless; productive capacity rests unused, as if there were never to be a demand or an active market any more. The curious part of it all is that every one knows the over-demand will soon appear again, and the days now passed in idleness will be paid for in overtime at high wages and at low proportionate output. If we could but have a regulator of some sort, to store our power of production at times of light load and help us again by returning it when the load reaches a peak!

For those who can seize it an unusual opportunity is here. An editorial in "The American Lumberman" defines it thus, as it appears in the building trade:

"It is possible now to secure more and better work for the same price than at any time within the last two years. Materials are cheaper, labor is cheaper, anxious for employment and earnest in its desire to give full value. These certainly are factors which the wise investor should take into account.

"Lumber, brick, stone and other materials necessary to the construction of buildings, purchased and put into place at this time, will be worth in the new relation they bear one to the other a great deal more a year or two from now than the present cost. Furthermore such structures will be ready for use."

The same conditions apply in many lines of mechanical and engineering work.

With the progress of the summer, the much-magnified "uncertainties of the future" will shrink to nothing and disappear. Resumption will become a very simple thing, and with resumption prosperity will return.

"The way to resume is to resume."

The Province of the Engineer.

THE movement for a readjustment of engineering education, now appearing in many of our greater colleges and universities, is realized to be of so much national importance that it is to engross the attention of the summer conventions of two great professional societies—the Institute of Electrical Engineers and the Society for the Promotion of Engineering Education.

It seems to result from a general awakening to the breadth of the field the engineer is called upon to occupy. He is no longer merely a technician—a designer of machines or structures—a professional adviser on the theoretical elements of any problem in his specialty. He is more and more generally the actual manager and executive of great productive enterprises, and has increasing need for a sound knowledge of economics, commercial relations, systems of organization, conditions of labor employment—of all the factors involved in efficient and economical production, whether this be of transportation, of structures, of ingots and metal shapes, of machine tools, of textiles. The industries of a great nation, in a century which is characteristically and commandingly an era of manufacturing, are passing largely into the hands of the engineer. His training must be such as to make him soundly educated, broad-minded, professionally conscientious. He must love efficiency, and abhor waste; and that he may know what efficiency is obtainable and whether waste exists, his eyes must be opened to the meaning and value of quantities not to be found in mathematics, thermodynamics, or chemistry.

The increasing pressure of life in manufacturing countries, the growing density of population, and the visible depletion of the natural resources by which we live, must be met and relieved by stopping leaks, saving wastes, conserving our energies, and improving our efficiencies. In the intelligent, earnest, humane pursuit of this philosophy lies one of the strongest hopes for the solution of the great and menacing problems of the day. The lesson will not be learned readily, perhaps, but the common sense of it will gradually prevail and pervade, and early professional teaching of the root ideas will be one of the strongest fostering influences.

The new Gospel of Efficiency is ably preached by Mr. Emerson, whose opening chapter in this issue is commended to our readers. It is a foretaste of possibly the strongest industrial hope of the Twentieth Century.

Costs of Steam Power.

MR. Wm. E. Snow, whose figures of steam-power costs were published in our May issue, requests us to acknowledge his indebtedness to Mr. Chas. T. Main for the original compilations upon which this later work is based. Mr. Main's data were collected ten years ago, for a special purpose; the changed conditions now existing, and especially the rise of prices for materials and labor, make the modern figures entirely different. Mr. Snow adopts larger units also for coal and steam consumption per horse power. His costs in the average run 10 to 15 per cent higher than Mr. Main's. The unit subdivisions and the detailed form of the tables, however, were adopted by him as admirable standards, and the basic data of Mr. Main's earlier work much facilitated Mr. Snow's computations. His thanks are most cordially acknowledged.

REVIEW OF THE ENGINEERING PRESS.

"THE WORLD IS ITS FIELD"

THE EFFICIENCY OF THE GAS ENGINE.

THE EFFECT OF STRENGTH OF MIXTURE AND OF SCAVENGING ON THERMAL EFFICIENCY.

Bertram Hopkinson—Institution of Mechanical Engineers.

A REVIEW in these columns of THE ENGINEERING MAGAZINE for January outlined the main points of a paper read by Prof. Bertram Hopkinson before the Institution of Mechanical Engineers in October, 1907, which embodied the results of a series of experiments on the mechanical efficiency and indicated power of a 40 horse-power Crossley gas engine. The principal features of these researches were the use of a new optical indicator and a full investigation of the mechanical losses under various conditions. The investigations showed that the methods developed by Prof. Hopkinson for the measurement of gas supply and indicated power gave much more accurate results than those usually employed and the paper mentioned elucidated many obscure and puzzling points connected with gas-engine efficiency. Prof. Hopkinson has since applied his methods to the investigation of the effect of strength of mixture and of scavenging on thermal efficiency. The results of his researches were presented to the Institution of Mechanical Engineers on April 10 and we take from his paper the following extracts which contain the more important of his conclusions.

"The weakest mixture used in these tests contained about 8.65 per cent. of coal gas when in the engine, the proportion of air to gas drawn in being about 9½ to 1. The diagram was quite normal, the explosion line being nearly vertical. Weaker mixtures than this, however, would not ignite regularly. At the other end of the range the proportion of air to gas was about 7½ to 1, the excess of air being about 1½ times the volume of gas; slightly heavier charges than this could be used, but it is possible that the combustion would not be complete, and the pressures in the engine would become dangerously high. The range of mixtures tested therefore covers all which could be practically used. Within that range the efficiency diminishes steadily as the strength of mixture increases, the difference between the weakest and strongest charge amounting to 4½ per cent. in efficiency, or 12 per cent. on the work done.

"That the efficiency will increase as the strength of mixture is reduced, so long as the combustion is substantially complete, is to be expected from the now well-established fact that the specific heat of the working substance increases with the temperature. The work done in the gas engine cycle is mainly determined by the rise of pressure which occurs on explosion; and in the same engine the area of the diagram with different mixtures is about proportional to this rise, when corrected for the change in volume during combustion. If the specific heat of the working substance were constant, as is assumed in the air-cycle, the rise of temperature and therefore of pressure at the explosion end of the diagram would be proportional to the heat supply, and the efficiency would therefore be constant. But the specific heat being, in fact, greater at high temperatures, the rise of temperature or of pressure on explosion increases in a less ratio than the heat supply, and the efficiency therefore diminishes as the supply of heat is increased.

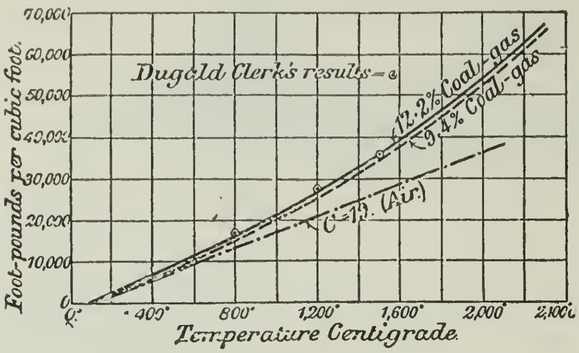


FIGURE I. INTERNAL ENERGY CURVES.

"The ideal efficiency of a gas-engine, by which is meant the efficiency which would be attained if all heat losses to the walls were suppressed, and if combustion were complete and instantaneous at the in-center, is easily calculated if the internal energy of the working fluid is known as a function of its temperature. It cannot be said that we yet possess this knowledge in any high degree of accuracy, but enough is known to enable an estimate to be formed of the effect of strength of mixture on efficiency. Figure I shows the internal-energy curves corresponding to the weakest and strongest mixtures used in these experiments. The ordinate of the curve is the quantity of heat in foot-pounds required to heat a standard cubic foot of the burnt products, at constant volume, from 100 degrees Cent. up to the temperature represented by the abscissa. These curves are calculated from the figures given by Langen for the specific heats of CO_2, H_2O and air, between 1500 degrees and 1900 degrees, and from the results of Holborn and Austin and Holborn and Henning, at lower temperatures. The values given by Clerk for a mixture of intermediate composition are also shown. The ideal engine efficiencies for the two mixtures can be calculated from these curves by the method given in an appendix. The ideal efficiencies corresponding to mixtures containing respectively 8.8 per cent. and 11.4 per cent. of coal-gas, calculated by this method, are 42.4 and 39.4 per cent. respectively. For mixtures of other compositions the efficiency will follow a straight-line law sufficiently nearly for present purposes, and this straight line is shown dotted in Figure II (below). It is worth noting that the two straight lines on that figure, if produced, would cut the line corresponding to a zero gas-consumption, at 50.6 per cent. and 52.6 per cent. respectively. The air-cycle efficiency for this engine is 52.2 per cent. In other words, if it were possible to burn weaker mixtures—say, by using stratification—and if the actual and ideal efficiencies continued to bear a linear relation to the gas-consumption, these efficiencies would tend to become equal to one another and to the air-cycle efficiency with a very small gas-consumption. The ideal efficiency ought, of course, to approximate to the air-cycle efficiency when the charge is greatly reduced; the close agreement in the other case is no doubt, to some extent, accidental, but something of the kind is to be expected.

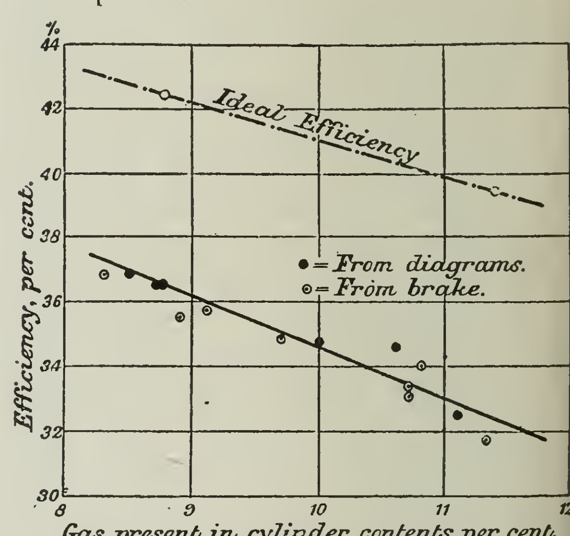


FIGURE II. THERMAL EFFICIENCY.

"Without laying too much stress on the absolute values of the real and ideal efficiencies shown in Figure II, it is apparent from the ratios that they bear to one another, that while much of the superiority of the weaker mixtures is to be ascribed to increase of specific heat, that cause is not sufficient to account for the whole of the effect. Comparing the actual with the ideal efficiency, it will be seen that for a mixture containing 8.5 per cent. of coal-gas the ratio—usually called the efficiency ratio—is 0.87, but when the proportion of coal-gas is increased to 11 per cent. it is only 0.83; the weaker mixtures, in addition to giving a higher ideal efficiency, come nearer in practice to realising that ideal. This is due to the fact that the percentage of heat lost to the walls during expansion is less with small gas charges than with large. The difference is sufficient to counterbalance an influence tending the other way—viz., the more rapid combustion of the stronger mixtures. This has been established by a series of experiments directed to that end. . . .

"When the engine is running light or partially loaded, so that each explosion stroke is followed by one or more scavenging strokes, the suction temperature is about 50 degrees Cent. as against 100 degrees Cent. when running fully loaded. With a given charge of gas, therefore, the mixture will be weaker under these conditions than when fully loaded, and the efficiency will be correspondingly higher. For example, if the engine is taking 0.11 cubic foot of gas per suction, the percentage of coal gas in the charge will be about 9.6 when running fully loaded, but it will be only 8.2 when the engine is scavenging. Referring to Figure II, it will be seen that the corresponding efficiencies are about 37½ per cent. and 35 per cent. respectively. There is some uncertainty about the suction temperatures on which this calculation is based (taken to be 100 degrees Cent. and 50 degrees Cent. respectively), but making full allowance for that, it may be said that the mean pressure realised with the same gas-charge should be at least 5 per cent. greater when the engine is scavenging than when it is running fully loaded—assuming, of course, that the strength in each case is such as to give regular and normal ignition.

"A number of experiments were made with the object of testing this conclusion. Diagrams have been taken with the engine running light on half-load; and have been compared with full-load diagrams taken at the same time, the gas-consumption being measured in each case. The results of one such test were at a gas-charge of 0.1275 gave a mean pressure of 108.4 on light load, as against 102.2 at full. Further, a charge of 0.100 at full, and a charge of 0.114 at light load, corresponding in each case to a mixture strength of about 8.5 per cent., give approximately the same efficiency of 37 per cent.

"These results were confirmed generally by other diagrams taken at light load, and also by running the engine at half-load, so that most of the explosion strokes were followed by one or more scavenging strokes. The results, however, were not so consistent as in the full load tests, the mean pressure sometimes falling short by as much as 6 per cent. of that which was anticipated from the gas-consumption. In the case of the full-load trials the mean pressure can be predicted from the gas-consumption within 2 per cent. This want of regularity is due in part to variation in the suction temperature, which was always assumed to be 50 degrees Cent. after a scavenging stroke and 100 degrees Cent. after an explosion. As a matter of fact, both temperatures vary to some extent with the number of explosions per minute, and possibly also a little with the gas-charge; there will be corresponding differences between the actual mixture strength and that calculated. But a more important cause of irregularity is the fact that the combustion of a scavenged charge is generally incomplete, the fuel discharged unburnt sometimes amounting to 4 or 5 per cent. In all, four analyses were made of the exhaust when the engine was missing about every other stroke. The quantities of unburnt gas found were respectively 4.2, 3.2, 5.4, and 4.5 per cent.—average 4½ per cent. These analyses are not so accurate as those of full load because of the dilution of the exhaust with air, and there seems to be some selective combustion, as the quantities of steam and CO_2 formed in the combustion tube are usually not in the proportion obtained by the complete burning of the coal-gas. But there is no question that a good deal of unburnt gas is sometimes discharged when the engine is missing explosions. The effect is quite apparent in the heat-balances at half-load, which all show a bigger deficiency than can be accounted for by radiation.

Five trials at half-load showed balances unaccounted for ranging from 297 to 433 thermal units per minute, the average being 350, or about 10 per cent. on the heat supply (higher value). Six trials at full load with the same jacket temperature (75 degrees Cent.), and taken with the same appliances, showed deficiencies ranging from —58 to +189 thermal units; average +25 thermal units. The systematic errors were probably the same in all these trials. The radiation is a little greater in the full-load trials because the piston is hotter, but the difference in this respect cannot be very large. Thus, after allowing for radiation, the heat unaccounted for in the half-load trials is some 300 B. T. U. per minute more than at full load, and this must mainly be due to a greater proportion of unburnt gas. In the last of these trials the thermal efficiency obtained from the brake load by addition of the mechanical losses (separately measured at the same time by observing the light load indicated power) was 32.7 per cent. About three-fourths of the explosions were followed by scavenging strokes, and the gas-charge was 0.1285 as measured in the holder. The average strength of mixture, calculated on the above-mentioned assumptions as to the suction temperature, was 10 per cent., and the corresponding efficiency 34.5 per cent. Thus the mean pressure was 5 per cent. less than that calculated. In this case 4½ per cent. of unburnt gas was found in the exhaust, and the deficiency on heat-balance was 433 thermal units per minute out of a total supply of 3740.

"It is not possible to say how far the combustion is incomplete when the engine is running quite light; but it seems likely, from the high mean pressures sometimes realised under these conditions, that it may under some circumstances be more nearly complete than in the half-load tests. From a study of the latter it would appear that when allowance is made for the gas discharged unburnt, the efficiency is not much affected by scavenging provided the strength of mixture is kept the same, which implies an increase of about 15 per cent. in the gas-charge with, of course, a corresponding increase of mean pressure."

FUEL SPECIFICATIONS AND CONTRACTS.

A DISCUSSION OF THE POINTS TO BE COVERED BY FUEL SPECIFICATIONS AND THE ADVANTAGES OF PURCHASE BY CONTRACT.

William D. Ennis—The Engineering Record.

FUEL, which represents the principal item in the raw material bill of a considerable number of industries and an important item in nearly all, is the only commodity still bought by luck. In the case of all other materials the modern commercial establishment endeavors to fulfil the logical aim of all trading, to buy only such materials as are satisfactory and to pay for only such quantities as are actually received. But fuel is still bought at the valuation placed upon it by the seller and only in rare cases does the purchaser attempt to satisfy himself that the quality of coal supplied him is such as his requirements demand and that the quantities paid for are actually received, or to relieve himself of the burden and expense of providing large storage accommodation by fixed contract regulation of deliveries. The lack of logic in this haphazard method of purchase is admirably set forth in an article by William D. Ennis in *The Engineering Record* for April 25. We abstract from this article the following summary of the points which should be covered by fuel specifications and the advantages which may be expected from the purchase of coal on contract.

The fundamental unit of value in power production is the heat unit and it is illogical to pay for fuel by the ton or carload when the value cannot be measured on scales. The determination of heating value is a simple matter. The calorimetric method is best, but for anthracite or semi-bituminous coals computation from the ultimate analysis gives sufficiently close results for comparative purposes. When coal is regularly received from one source, frequent determinations of heating value may be unnecessary, as the proximate analysis alone indicates any marked variation in quality. The proximate analysis shows the percentages of fixed carbon, volatile matter, moisture and ash. Serious errors may be made in the complete examination of a coal for these constituents and it is necessary that the checking of shipments should be done by an experienced man and preferably always by the same man.

Moisture reduces the heating value of a coal both by taking the place of combustible matter and because of the actual loss of the heat in the combustible portion required to evaporate it. The proportion of moisture is controllable by the miner within certain limits and excessive moisture should be considered as adulteration. Like moisture, ash decreases the combustible portion of the coal, but although almost any percentage of moisture may be permitted if the price is correspondingly reduced, the effect of ash is much greater than would be represented by its numerical percentage. When ash reaches a certain percentage the coal becomes practically useless and proportions below this limit result in losses of value which increase more rapidly than the percentage of ash. The character of the ash is also important. A fusible ash increases the cost of firing, is hazardous to good steam service and is detrimental to efficiency of combustion. The determination of this constituent is therefore of the utmost importance and in the purchase of coal a limiting percentage, based on the dry coal weight, should be set for it.

Sulphur in coal reduces the heating value, but it is particularly undesirable on account of its detrimental effects on grates and boiler surfaces. The sulphur content of coal should be limited arbitrarily to small proportions, a condition readily conceded by shippers.

The percentage of volatile matter serves to classify the coal and since only one class of coal can be burned economically in a boiler furnace of any special design, the determination of the volatile constituents is of the highest importance. On it depends the determination of the suitability of the coal for the plant. In general, boiler efficiency decreases as the volatile matter increases. Increase in volatile matter adds slightly to the heating value and the estimation of a coal's value based on the latter element must be modified by the consideration of the influence of excessive proportions of volatile matter on boiler efficiency and smoke production. Specifications should establish a standard heating value with a fixed minimum limit for volatile hydrocarbons. The determination of fixed carbon checks the determination of the volatile matter and is necessary for the computation of heating value from analysis. When the latter is determined by calorimeter, the fixed carbon may be used as a check on the result.

The idea that the heating value of a coal can be determined only by actual trial under boilers is a delusion. Chemical and physical tests are all that are necessary to determine the relative fitness and value of coals for producing power, so long as tests are intelligently made and only such coals are considered as are by their grade adapted to the general type of boiler furnace installation. It is important of course that the testing system should be as correct and as complete as possible. Accurate sampling is one of the most essential elements of a successful system.

Apart from chemical composition, the two most important points to be covered in a fuel contract are the questions of weights and deliveries. The purchaser should have some check on the sellers' statement of weight and the contract should contain provisions for the adjustment of variations from the billed weight in favor of either the buyer or seller. While it is important that the purchaser should get all the coal he pays for, it is equally important that the seller should be paid for all he delivers. Contract provisions covering the adjustment of weights should be drawn without prejudice to the interests of either party. The question of deliveries is of even more importance than that of weights. It is a fact that even under contract the delivery of coal is uncertain but the buyer should be careful to eliminate from the contract unreasonable clauses of exemption. It is well to err on the side of leniency but the sweeping strike exemption clauses and other relieving stipulations of some contracts give but little protection to the purchaser and practically leave the question of deliveries under exceptional circumstances to the discretion of the seller.

"The cost of a systematized method of coal purchasing is not great. In large works the sampling and laboratory work may usually be conducted in connection with the other duties of the staff chemist. Even when outside analysts are consulted, the expense is small where a daily or weekly regular report is arranged for. Contracts must make provision for arbitration when an analysis or other result is disputed, the expense of the analysis to be borne by the party at fault. The method of sampling should be carefully provided for in the specifications, samples should be preserved for a stated length of time and the sample taken as provided for should be the only sample recognized. A part of each of such samples could, of course, be furnished the seller if desired. All sampling should be done at the point of delivery of the coal.

"The contract should stipulate a fixed price for standard coal with limiting percentages of volatile, ash, moisture and sulphur and a minimum limit for heating value. Within the limits a premium should be paid for heating value in excess of standard and a forfeit imposed for heating values below standard. Both premium and penalty should be arranged on a sliding scale. This is by far preferable to rigid specifications and a fixed price, since there is no tendency then in times of shortage to accept fuel slightly below standard grade.

"There are many objections raised to the purchasing of coal on specifications. Certain natural objections emanate from the sellers. They claim that they cannot control the quality of the coal; that it costs them so much to dig it out of the earth and they ship it as they find it. Does a slate quarryman expect to have his product valued like Carrara marble? An objection perhaps more logical is that the shipper can sell his coal anyway and does not care to become entangled in elaborate contracts. This is too true. The price of anthracite is increasing and the production of soft coal is not keeping up with the demand. The balance of trade is in favor of the shipper. But it should be remembered that in purchasing coal to specification the buyer is not seeking to get something for nothing; he is not trying directly to get more heat units for a dollar and certainly not more pounds of coal for a dollar. He is simply endeavoring to eliminate variations in what he does get for his dollar and to pay for what he actually gets. When he draws up his specification he knows, or should know, what he can afford to pay for coal of the average grade which he has been getting. He is willing to pay the market price for this and a better sum for better coal. On the other hand, he asks the shipper to take less for inferior coal. This is fair and costs the shipper nothing. Where a flat price and flat heating value are named in the specifications the arrangement is not fair and the shipper must quote a sufficiently high price to insure himself against losses due to the rejection of the coal. The buyer, of course, pays this insurance, and consequently loses. But where the sliding scale is employed there is no reason why competition should be restricted on contracts for the supply of coal to specification. It has been reported that one buyer who inaugurated a system of purchasing to specification was obliged under a sliding scale contract to pay double the former price for one lot of coal. If this is true, it furnishes an extreme instance of inaccuracy in determining the average quality prior to drawing up specifications and of a poorly framed contract, but it shows also that coal specifications do not necessarily injure the shipper.

"With clear-cut contracts regarding delivery the purchaser may know what his chances of securing coal will be under abnormal conditions, and is then in a position to decide as to necessary provision for storage. To be without storage is ruinous, and to provide abundant storage is almost ruinously expensive, not merely on account of the cost of handling, but because of the loss in quantity and quality of fuel. Where cessation of deliveries is in default of contract such expense should be charged against the coal shipper.

"From a buyer's standpoint while the purchase of coal to specification may only slightly, if at all, reduce the coal cost per unit of output, it has the overwhelming advantage that it eliminates variations in the cost of his prime material of consumption. No business is well administered in which there is a lack of definite responsibility for any element of cost, and in the average industry, as coal is now purchased, no individual is fairly responsible for the cost of fuel or of power. This removes a definite standard of efficiency from the engineering force and leads to imperfect operation. In one large plant the coal varied in heating value from 12,700 to 14,300 B.t.u., and in percentage of ash from 8 to 12. There was a considerable production of smoke and some difficulty in maintaining steam at times. By adopting a specification limiting ash to 9 per cent., volatile to 21 per cent. and sulphur to 1½ per cent., with a sliding scale of prices, based on heating value, all troubles were eliminated, the price of coal per ton advanced about 5 cents, the heating value about 2 per cent., and the curve of coal cost per unit of output became a straight horizontal line."

THE PARKER BUILDING FIRE.

RECOMMENDATIONS FOR STRUCTURAL FIREPROOFING BASED ON AN INVESTIGATION BY THE NEW YORK BOARD OF FIRE UNDERWRITERS.

Engineering News.

As Mr. J. K. Freitag pointed out in The Engineering Magazine for February, the total destruction by fire of the twelve-story Parker Building in New York, a structure of a type popularly considered "fireproof," contains many lessons of the highest importance to architects and engineers. Mr. Freitag's discussion, it will be remembered, dealt more particularly with the striking demonstration of the necessity for auxiliary fire-fighting apparatus in buildings of this type. An interesting supplement to Mr. Freitag's paper is contained in the recently published report of the New York Board of Fire Underwriters, abstracted in *Engineering News* for May 21. The recommendations contained in this report, reprinted below, give not only the lessons regarding structural fireproofing to be drawn particularly from the Parker Building fire, but embody practically all the latest ideas in this field.

"In buildings of mercantile, manufacturing or storage occupancy, it is absolutely essential that all vertical openings be thoroughly enclosed in *substantial* fireproof shafts having standard fire doors at all openings or so arranged that the shaft is without openings directly into the various stories. Unprotected vertical openings through buildings are the greatest factor in the loss of life and property by fire and the proper safeguarding of this hazard demands the most careful attention of all concerned.

"The height of fireproof buildings of mercantile, manufacturing or storage occupancy should be limited to correspond to the degree of protection the Building Equipment and the Fire Department is able to furnish. In other words, if adequate fire protection in any building is not available above a certain height, the building should be limited to such height.

"Buildings of large unbroken floor areas filled with combustible contents develop the severest fires and constitute one of the most dangerous sources of general conflagration. Floor areas in buildings of this character should be subdivided by substantial brick fire walls sufficient to form a positive barrier to the spread of fire.

"Fireproof buildings, no matter how well designed and constructed, do not prevent the destruction by fire of contents in any story; and it is essential that high buildings of mercantile, manufacturing or storage occupancy be thoroughly protected by a standard equipment of automatic sprinklers.

"Exterior openings in buildings should

be thoroughly protected against exposing fires. Universal efficient fire protection of exterior openings will practically eliminate the danger of conflagration in cities.

"High buildings of mercantile, manufacturing or storage occupancy should be provided with large, properly enclosed stairways in sufficient number to afford safe exit at time of fire. Such buildings should also be provided with outside fire escape and standpipe equipments.

"Buildings of mercantile, manufacturing or storage occupancy should be provided with adequate systems of inside standpipes equipped with linen hose and nozzles suitable for fire department use, and, in addition, a smaller linen hose and nozzle suitable and safe for the use of occupants. These equipments should be accessible and in sufficient number to effectively cover all portions of the building. They should extend through all stories and should be supplied from a reliable source of water under adequate pressure, in addition, to siamese steamer connections on the outside at street level.

"The use of perforated pipe systems should be prohibited, as such systems are unreliable, inefficient and liable to result in water damages wholly disproportionate to the extent of fire. Where it is desirable to protect only a part of a building, a system of automatic sprinklers with adequate water supply should be employed and the portions protected plainly marked at the siamese steamer connections on the outside of the building.

"Cast-iron columns should not be used in high buildings, as their failure is usually complete and and results in sudden total collapse of the sections supported. Girders and beams cannot be rigidly attached to such columns and defects in the material cannot be easily detected.

"It is essential that all structural members of fireproof buildings be protected by a sufficient mass of fireproofing to thoroughly insulate them against the heat which would be developed by the rapid burning of all materials permitted in any story of such buildings. It is also essential that all fireproofing be firmly anchored, or otherwise securely held in position, where it is of such a nature or so designed that it will become loose as a result of heat. On account of their great importance structurally, columns should be insulated by at least four inches of fireproofing; and no pipes or conduits should be placed in or back of the fireproofing material. On account of the heavy mass of fireproofing with which girders and floor beams are in contact, a lesser amount of protection can be safely employed at the soffits. Generally this should not be less than two inches for girders and one and one-half inches for floor beams.

"All floor arches should be provided with a large factor of safety so as to safely carry the imposed loads, not only under ordinary conditions, but when severely exposed by fire.

"Arches of all forms in common use are seriously damaged when directly exposed to high temperatures of long duration. In buildings containing large quantities of combustible material, they should be so designed or protected against fire that serious structural damage will be prevented.

"No wood or other combustible material should be employed in the construction of fireproof partitions and all metal supports or reinforcements should be thoroughly insulated from heat. Fireproof doors and wired glass in standard metal frames should be used at necessary openings in corridor and room partitions. Provision for expansion in the material used and in metal supports entering into the construction of fireproof partitions is essential, particularly where hollow terra cotta blocks are employed. All fireproof partitions should rest on solid incombustible material.

"In buildings of fireproof construction all floor surfaces, doors, window frames, sash and other trim and finish should be of incombustible material.

"The support of heavy safes and machinery on wood floors and wood skids in fireproof buildings is a menace to both life and property, and should be absolutely prohibited. Heavy shafting should be attached to ceilings in such a manner that it will not fall as a result of fire."

THE NEW BRITISH PATENT LAW.

A REPLY TO FOREIGN CRITICISM OF THE COMPULSORY WORKING CLAUSE.

Engineering.

As might have been expected, a great deal of criticism is being directed against the new British Patents Act, and particularly against the "compulsory working" clause, which renders liable to revocation patents for inventions which, after a certain period, are found to be worked exclusively or mainly outside the United Kingdom. On the Continent, and, within the last few weeks, in the United States, this clause is attacked as unfair and as virtually a subterfuge to obtain Protection under the guise of Free Trade. An interesting editorial refutation of these charges is contained in *Engineering* for May 8, from which we quote at length below.

"That an outcry would be raised abroad against the new patent legislation was only to be expected. It is merely human nature that those who have been able to make a preserve of the British market for years should send up a wail of indignation on finding that they can no longer take advantage of a law which was framed with a totally different object. Such an attitude is unreasonable, of course, but it is not unnatural. When, however, these same people proceed to tax us with unfair commercial dealing, and accuse the Government of making a change in the Patent Law an opportunity of indulging Protectionist tendencies, they overstep the mark; such a distortion of the facts calls for refutation. What are the true facts?

"For upwards of a quarter of a century Great Britain has been exposed to attacks on her industrial life through the abuse by foreigners of her Patent Laws. To put the case briefly, British patents have in numberless instances been obtained by foreign manufacturers and used simply as cover for the importation into England of goods made abroad under the corresponding foreign patent; or, perhaps, not even under any patent at all. As the result of this practice, the British nation has suffered a three-fold injury. It has been made to pay long prices for the patented article imported from abroad; it has been deprived of the advantage of participating in the manufacture of the patented article whilst the patent existed; and, finally, when the patent expired, it has been placed under the disability of lacking the practical knowledge and experience essential to enable it to start and carry on the manufacture in the teeth of foreign competition. If proof be needed that this was, not only in a moral, but also in a strictly legal sense, an abuse of the privileges of a British patent, it is only necessary to refer to the famous passage in Darcy *v.* Allin, which has always been regarded as an accurate statement of the legal and economic basis of our patent system:—'Where any man, by his own charge and industry, or by his own wit or invention, doth bring any new trade into the realm, or any engine tending to the furtherance of a trade that never was used before, and that for the good of the realm, in such cases the King may grant to him a monopoly patent for some reasonable time, until the subjects may learn the same, in consideration of the good that he doth bring by his invention to the commonwealth, otherwise not.' Subsequent legislation, whilst clearly marking out the bounds of legal monopolies, in no way relieved the patentee of the obligations cast upon him by the common law.

"So long as British patents were granted solely to British subjects, the necessity for enforcing the conditions of working did not arise. If the invention was worked at all, it was naturally worked in England. But when, at the beginning of the nineteenth century, our Patent Office was thrown open to foreigners, the position was altered, and the enforcement of this condition became (if only it had been realised at the time) a matter of vital importance. Unfortunately, the need for insisting upon its observance did not make itself felt at once. The foreigner, however, was not slow to take advantage of this indulgence, and it was not long before the British public awoke to find their patent system utilised, not for the purpose of planting new industries on British soil, but for the diametrically opposite purpose of fostering foreign industries to the detriment of British trade. That no serious effort was made, when this abuse was first realised, to bring the foreigner to a right sense of his duties as a British patentee, is remarkable. There is good ground for believing that, had a concerted and well-directed effort been made, say, by one of our Chambers of Commerce, means could have been found, either through the medium of the Courts or the Privy Council, and without the need for further legislation, of compelling the foreigner to work his invention in the United Kingdom in accordance with the conditions of his patent. As it was, however, the very existence of this particular condition seems to have been all but forgotten; at any rate, the power to enforce it had, by long neglect, become, so to speak, atrophied. The more formal and pressing obligation of the patentee—viz., the requirement that he should publish his invention by lodging a specification—appears to have overshadowed, even to the point of total eclipse, the far more important duty of establishing the invention as a new manufacture within the realm, and instructing the community in its use. Anyhow, whatever the explanation may be, the fact remains that no such effort was made.

"The provision, introduced by the Patents Acts of 1883, for obtaining compulsory licenses from defaulting patentees fell far short, even in theory, of what the public had a perfect right to require from the patentee; and in practice it proved hopelessly ineffectual as a remedy for the existing abuse. The attempt to cure the evil by means of compulsory licenses was fundamentally wrong, and proceeded from an inadequate diagnosis of the case. A compulsory license throws the burden of proving the necessity for working the invention in this country upon the petitioner, whereas it is upon the patentee that the duty should lie of absolving himself from this requirement, and of showing that such necessity does not exist. What was wanted was the strict enforcement of this primary obligation, in the absence of reasonable grounds for its remission.

"This is now effected by the 'compulsory working' clause of the new Patents Act. Though popularly regarded as an innovation of a somewhat radical nature, this provision is, as has been shown elsewhere, nothing more than a tardy insistence by dint of statute, upon the performance of an obligation which the common law has always—at least in theory—attached to the grant of letters patent.

"It is also to be observed that this very condition, which has caused such a general outcry on the Continent, is merely the analogue of a clause that appears prominently in the patent code of almost every one of our rivals in commerce. The Americans, it is true, have no compulsory working clause. But the case of America is in every way exceptional Occupying, as it does, a position of splendid isolation, and fenced round with tariff walls sufficiently lofty to keep outside all articles which it may seem more desirable to manufacture at home, America has nothing to fear from the relaxation of this obligation. The patentee must needs work his invention on American soil if it is to be used in that country at all.

"This provision of our Patents Act is not only justified, therefore, by the traditions of our own patent system, but also by the practice of the very people who presume to criticise it.

"So much, then, for the taunt of unfair dealing; the answer to the charge of harbouring 'Protectionist tendencies' may be given more briefly.

"Foreigners have no right to dictate to this country what its fiscal policy shall be; and whether the present Government is true to its avowed principles of Free Trade, or not, is simply a matter for its supporters. At the same time, to be bound hand and foot by foreign-owned British patents, and compelled to buy from Germany or France, or elsewhere, according as the patentee dictates, goods which could, and should, have been manufactured in England under the

British patents, is a condition of things as far remote from the ideal of Free Trade as can well be imagined. It is an approach in the direction of Free Trade, and not a recession from it, to insist that Great Britain shall no longer be a close market to one or another foreign manufacturer, but that the importation of foreign goods shall henceforward compete on equal terms with similar goods manufactured in this country. It is a perversion of language to characterise as a step in the direction of Protection a piece of legislation the tendency of which is to break down oppressive patent monopolies and throw the manufacture open to the public unless the patentee consents to comply with the conditions upon which alone his patent was granted."

THE ECONOMICS OF WOOD PRESERVATION.

THE COSTS AND RESULTS OF THE PRESERVATIVE TREATMENT OF TIE TIMBER.

Eugene P. Schoch—Southwestern Electrical and Gas Association.

A VERY interesting and comprehensive paper on the present practice and economics of wood preservation, presented by Mr. Eugene P. Schoch at the recent convention of the Southwestern Electrical and Gas Association, is abstracted in the *Electric Railway Review* for May 9. Notwithstanding the great attention which is being paid to this subject, a broad, general, comparative discussion of the various methods in use and their economic results is seldom met with and Mr. Schoch's data on actual costs and results, which we present below, are of the highest interest and value. Mr. Schoch is concerned mainly with the results obtained in the preservation of railway ties. We are glad to be able to announce that a similar economic discussion of the value of the preservative treatment of structural timber will be contributed to a future number of THE ENGINEERING MAGAZINE by Mr. Carl G. Crawford, of the Bureau of Wood Preservation of the Department of Agriculture.

The causes of decay of timber are bacteria and fungi which attack the fibers of the wood. These grow best where they have an abundant supply of food and certain conditions of heat, moisture and air. The aim of timber treatment should be, therefore, as much the prevention of these conditions as the poisoning of the organisms. Proper seasoning by air or furnace drying is the most essential first step in the preservation of timber, not only on account of its removal from the interior of the wood of the food on which the destructive organisms thrive, but also because preservative liquids cannot be injected into the wood until space is made for them by the removal of the sap.

"If through proper seasoning the interior of the timber has been rendered practically free of conditions for the development of bacteria and fungi, all future attack becomes possible only through the entrance of moisture from without. If, then, the moisture entering the wood is thoroughly saturated with poisonous substances which inhibit the growth of bacteria and fungi decay is effectively prevented. This is the basal idea of the preservative treatment. Many substances have been used as antiseptics for this purpose. At present there are four distinct kinds of substances used as wood preservers. First of all, coal tar distillates—creosote; second, poisonous salts of metals—zinc chloride, corrosive sublimate; third, crude oil; and fourth, wood tar distillates. These substances are far from being equally successful. They are mentioned here merely as the substances that are actually thought of today as possible preservatives. In some processes combinations of several of these substances are used. The American Railway Engineering and Maintenance of Way Association, in the proceedings of the fifth annual convention, states that the following processes have stood the test of time: Creosoting, zinc chloride with cresote, zinc chloride alone and zinc chloride with glue and tannin. The latter are added merely to fix the zinc chloride in the wood and prevent its being washed out. Corrosive sublimate also has been used and has proven itself very efficient, but its extremely poisonous effect upon high organisms makes it an objectionable substance. These substances are essentially antiseptics; that is, water that has come in contact with these substances inhibits the growth of bacteria and fungi.

"The third class of substances, mineral oil or crude oil, has recently been thought of as a wood preserver, and a few experimental trials have been made. A record of results published by the American Railway Engineering and Maintenance of Way Association, shows that crude oil does not effectively preserve wood except when used in sufficiently large quantities to exclude moisture from the wood.

"The fourth class of wood preserving substances, distillates of wood tar, might be expected to be just as efficient as distillates of coal tar. Such is far from being the case. They have been offered to the public for many years, but they do not appear to have come into any extended use."

The tar oil distillates hold the highest rank among the admittedly good preservatives. There is no question as to the efficiency of the complex mixture of tar oils known as creasote but all of the component parts of creosote are not of equal value. The general conclusions reached in several independent investigations on this point are:

"(1) That the tar acids, such as carbolic acid, which formerly were considered to be the most valuable constituents of creosote, are soon lost, either washed out or evaporated from the wood, and hence do not serve permanently to preserve the wood. (2) Naphthalene and the low boiling oils are markedly evaporated from the wood during the early years of exposure. (3) The high boiling tar oils, notably the portions boiling from 270 degrees and upwards, are the substances that permanently remain in the wood. All investigators agree that these high boiling oils are the most valuable portions of creosote."

The preservative action of zinc chloride and corrosive sublimate is due to their germicidal power. Moisture entering wood impregnated with these salts forms with them a germicidal solution in which it is impossible for bacteria and fungi to live. Creosote, in addition to a strongly germicidal action, has the power of absolutely excluding moisture, if used in sufficiently large quantities. If a high quality of creosote is used, the high-boiling oils, besides forming strongly germicidal solutions with any moisture which happens to enter, are not readily volatile and are permanent in their effect. The difficulty with the zinc and mercury salts is that, on account of their solubility, they are readily washed out of the wood.

"It is unfortunate that the life of timber in its natural state and as treated by different preservatives cannot be definitely given, because so many factors enter into the determination of its life. There is first of all the kind of wood, the season in which it is cut, the extent of seasoning or drying, and all the other special points which have been called the 'idiosyncrasies' of timber. Above all, the local climatic conditions determine the life of timber, or of timber treated with different preservatives. However if we bar unusually favorable or unfavorable local climatic conditions, and remember that individual pieces of timber may show results differing considerably from the averages, then the following few statements based on a large number of observations may be ventured. Life of white oak and cedar ties, untreated, 10 years; inferior woods, such as tamarack, loblolly pine, etc., 4 to 5 years. Inferior wood ties treated as follows: Burnettizing 12 years; creosoting, very light treatment, about 4 to 5 pounds per cubic foot, 16 years; 12 pounds creosoting, 20 years; 18 or more pounds creosote, 25 to 30 years. In addition the following, found by the railroads of the United States, may be considered as particularly reliable: Pine ties treated with zinc chloride, east of the Mississippi, 10 2-3 years; west of the Mississippi, 11 2-3 years; treated with creosote, even with light treatment, the life is greater than with zinc chloride. Reference has already been made to the fact that wood tar distillates and crude oil used in moderate quantities have not increased the life of timber to a satisfactory degree.

"Considering next the quantity of preservative used and the cost of the operation, I may offer the following as general averages obtained in the operation of the large 'pressure' plants and as actual cost conditions, to which a reasonble amount of profit must be added before a commercial price can be arrived at. Cost of Burnettizing, 5 cents per cubic foot, or 15 cents per tie of 3 cubic feet. Cost of Wellhouse zinc tannin process, 6 cents per cubic foot, or 18 cents per tie. Cost of the zinc chloride-creosote process, 9 cents per cubic foot, or 27 cents per tie. Creosoting, light treatment, enough for 16 years life, 10 cents per cubic foot, or 30 cents per tie. Twelve pounds creosote, 18 cents per cubic foot, or 55 cents per tie. Heavy treatment, enough for 30 years, 28 cents per cubic foot, or 85 cents per tie. The operating cost of large pressure plants is from 5 to 8 cents per cubic foot of timber. The efficiency of the pressure treatment using a sufficient quantity of a good creosote is beyond question and needs no further comment. In some cases, for instance piles for marine exposure, nothing else will answer. It appears to be the conclusion of the railroads that pressure treatment is the most efficient. Doubtless this is partly due to the fact that they own and operate their own plants and operate on a large scale. The high price of creosote led the railroads to try zinc chloride extensively. The substance is comparatively readily washed out of the wood, so that its use in moist regions is inadvisable. In dry regions it appeared to be serviceable, particularly because the ties are destroyed by wear and tear in about 10 years, and zinc chloride is able to prevent decay for this length of time. Since the introduction of tieplates and of the Rueping process, which uses only small quantities of creosote, the tendency is to abandon zinc chloride treatment. The use of zinc chloride for poles gives little promise of success, because the salt is so readily washed out.

"Purchasers of treated timber are confronted with the same difficulties in a sense that they are confronted with in buying a commercial brand of wood preserver In the first place, the word 'treated' is entirely too vague—the details of treatment must be specified. In good pressure treatment the following amounts are injected: Zinc chloride, from ¼ to 1 pound per cubic foot of timber; creosote, from 5 to 15 pounds per cubic foot (the latter is the maximum that should be asked for for land exposure). The zinc-creosote process treats first with 12 pounds of 2 per cent zinc chloride solution per cubic foot, then allows the timber to dry for 10 days, and subsequently injects 3 pounds of creosote per cubic foot. With the stipulation of the amount of injection should go the specification for the kind of creosote.

"The railroads have come to the conclusion that it is profitable to use the best creosote only. Their standard specification for coal tar creosote runs as follows: Specific gravity at 38 degrees C., 1.03; no distillate below 200 degrees C.; up to 210 degrees not more than 5 per cent; up to 235 degrees not more than 25 per cent; residue beyond 355 degrees, if it exceeds 5 per cent in quantity, must be soft.

"Purchasers should insist on being furnished with the statement of the tests on the creosote with which the wood is said to be treated. But even with all the specific statements as to quantity and quality of the creosote which has been injected, fraud is possible and has been practiced. Professor Alleman of the United States forest service states that of 12 specimens cut from a consignment of piling guaranteed to contain 16 pounds of oil to the cubic foot of timber, some contained less than 3 pounds and none over 7 pounds. The writer has examined many samples of creosote in the market, and has met some samples which would be little better than crude oil or wood tar distillates—they are nothing but low boiling oils with tar dissolved or suspended in them. The purchaser should take sample borings from the shipment and have them analyzed by a competent chemist to determine the quantity and quality of the creosote or zinc present."

APPRENTICESHIP IN FRANCE.

A DISCUSSION OF THE CAUSES OF ITS DECLINE AND POSSIBLE REMEDIES.

Paul Besson—Société des Ingenieurs Civils de France.

ACCORDING to a recent paper presented by M. Paul Besson before the Société des Ingenieurs Civils de France and published in the *Mémoires* for February, the apprenticeship problem, while of considerable importance in all industrial countries, has reached a much more acute stage in France than elsewhere. On account of the dearth of skilled workmen, many French industries, especially that large and most important class which depends on a superior quality of craftsmanship, have reached a veritable crisis. The causes which make for the decline of apprenticeship have been much stronger in France than in any other country and no remedies have been adopted to deal with these conditions. The country is now paying dearly for neglect of so vitally important a problem, and only strong and immediate measures can retain for France her pre-eminence in those special industries in which she has for so long been unrivalled or ensure a satisfactory progress in other fields. M. Besson's estimate of the causes of the decline of apprenticeship and the possible remedies is most interesting and we outline it briefly in the following abstract of his paper.

The principal cause he considers to be a moral one, inherent in the manners, customs and aspirations of the French people. On this point he quotes Le Bon's "Psychologie de l'Education" with full approbation: "The principal reason which causes the people of France to shun manual labor and everything which resembles it is not so much the effort which it demands as the contempt which it inspires. Among all the Latin peoples, the lowest clerk, the humblest public officer, the most modest teacher, consider themselves to be of a class immensely superior to that of the tradesman or artisan, although the earnings of the latter are larger and their work requires a much higher order of intelligence. The result is that most parents of the lower ranks aim to place their sons in what they consider to be the superior class." M. Besson quotes also from the writings of an eminent educationalist, M. Keller: "The workman of today does not wish his son to work with his hands, but prefers to make of him an ill-paid clerk. In the country districts, the small farmers do not wish their sons to cultivate the soil, but seek to place them in some public office. The condition amounts in reality to a disease, and one so prevalent, that France is forced to import her artisans, laborers and farmers from Italy and Belgium."

Closely allied with this attitude of mind of the laboring classes is an economic cause which has much to do with the decline of apprenticeship. The growing desire for ease and comfort impels parents to demand that each child should begin, at the earliest possible moment, to make contributions to the family purse. The education of the child ceases as soon as he has reached the legal age and he is placed in a business house or public office where he works for a mere pittance. Apprenticeship in a trade is never considered, since, in addition to the loss of social prestige, the beginner usually receives no compensation for his labor beyond the instruction given him. In this regard the employers are not blameless. Instead of encouraging apprenticeship, they offer very few inducements to young men and in a large number of cases they positively discourage apprentices. The employers wish for skilled labor and when it is not to be had they make every effort to improve on their machinery rather than teach the trade to young men. This attitude on the part of the employers has a strongly deterrent influence on boys who might otherwise become apprentices. There seems to be a very general fear that the apprentice will serve his time only to find that the trade he has been learning has disappeared.

Legislative blunders also have had much to do with the establishment of the present conditions. Apprenticeship is still regulated by a statute passed in 1851 and the elastic nature of this law has been responsible, to a large extent, for the disrepute into which the system has fallen. By its provisions apprenticeship could be entered into by a written contract, a verbal contract or no contract at all. Unquestionably it was the expectation of the framers of the statute that by far the larger number of apprenticeship agreements would be put in writing, but the actual result has been that in Paris, since 1860, less than 25 per cent. of such contracts have been so expressed. Verbal contracts are taken seriously by neither party to them and the feeling of irresponsibility on both sides deprives both employer and employed of all the benefits which the system might otherwise confer.

Subsequent legislation, in 1874, 1892, and 1899, was devoted to the regulation of the hours of child labor and, in the main, its aims and results have been satisfactory. In 1900, however, a law was passed in modification of the law of 1892 establishing a maximum day of ten hours for workers of both sexes under eighteen years of age and in addition fixing ten hours as the maximum day for all adults working in establishments where women and children are employed. This astonishing provision, which prevents overtime in any shop where apprentices under eighteen are employed, has practically completed the destruction of the apprenticeship system. Both workers and employers are united to discourage a system accompanied by such unfair restrictions.

Technical and trade schools, M. Besson says, are proposed as a remedy for present conditions, but no school instruction, no matter how competent and thorough, can take the place of the teaching of actual shop and factory experience. He quotes the opinions of many authorities in support of this view. The moral and economic causes of the decline of apprenticeship, he fears, can be removed only by a complete alteration of the habits and aspirations of the people. He reviews the proposals put forward by various bodies, but finds in most of them too great an inclination to regulate apprenticeship by hard and fast legislative enactments. On account of the peculiar nature of the French temperament, a law making the instruction of young workmen obligatory on their employers could never be enforced. The only possible means of restoring the apprenticeship system to its rightful position lies in bringing home to the employers of labor the great importance of the problem, with the removal of the present legislation as a necessary first step. The written contract should be made obligatory and all legitimate means should be taken to stimulate a healthy rivalry among apprentices. The solution of the problem, however, can never be arrived at by legislation, but it must be found by the employers themselves.

UNSOLVED PROBLEMS IN METAL MINING.

A PART OF THE SIXTEENTH JAMES FORREST LECTURE DEALING WITH DRILLS AND DRILLING.

Henry Louis—Institution of Civil Engineers.

A PAPER covering the broad subject of the unsolved problems of metal mining in so comprehensive a manner as that read by Prof. Henry Louis on April 27, as the sixteenth James Forrest Lecture before the Institution of Civil Engineers, does not lend itself to compression into the limits of a short review. Prof. Louis treated his subject under the various heads of prospecting, the opening up of deposits, their actual exploitation, the transportation of ore to the surface of the earth, the dressing and preparation of the crude material for use in the smelter, and, finally, the question of safety in metal mining. The numerous problems still unsolved under each of these divisions were discussed with a wealth of historical and technical detail which we cannot hope to reproduce. The following extracts, therefore, are limited only to Prof. Louis' comments on machine drills and drilling, subjects which are attracting considerable attention at the present time.

"The first practical rock-drill for hard rock, a pneumatic percussive drill, was designed, not for mining, but for tunnelling purposes, by Sommeiller for the Mont Cenis tunnel; priority of conception seems to belong to an American, Fowle, who patented such a drill in 1851, and an Englishman, Bartlett, in 1855; but the Sommeiller machine, designed in 1857, was the first to be actually used, in 1861; it seems to have been first applied to mining at Moresnet, in Belgium, in 1863. The early machines were clumsy and inefficient, but improvements came apace, so that in 1875 there were already several patterns doing satisfactory work; about this time we find them in use for driving the St. Gothard and the Arlberg tunnels, and in the former careful experiments showed that the newer drills were working three times as fast as the older Sommeiller drill. All these machines were of what is now known as the 'piston-drill' type, in which the drill steel is firmly secured to the piston-rod, in contradistinction to 'hammer-drills,' in which the piston-rod strikes as a hammer might, upon the butt end of the drill steel. The former type answers perfectly in open workings, shafts, levels, and other places in which there is a fair amount of room to enable it to be set up and worked. Of recent years, however, a demand has sprung up for a lighter form of machine drill, that can be used in confined spaces and awkward corners, such as the working-places or stopes of most mines present, the essential qualifications for a stoping-drill being portability, compactness, and ease of handling, so as not to be too much for one man to work alone. The Western States of America appear to have led the way ten or fifteen years ago in the use of machine-drills for stoping, but it was not long after that the need of such a machine began to make itself urgently felt in the gold-mines of the Witwatersrand, where the cramped conditions of the stopes, owing to the narrowness of many of the reefs, and their flat dips, render the problem one of exceptional difficulty. The shortage of labour that attended the reopening of the mines after the Boer War accentuated the need, the gravity of which is evidenced by the fact that the Transvaal Government, in co-operation with the Transvaal Chamber of Mines, is offering two prizes of 4000*l.* and 1000*l.* respectively for the best rock-drill suitable for narrow stoping work under the working conditions that obtain on the Witwatersrand. It will be remembered that a preliminary competition of this kind was held in Johannesburg in January last, at the instance of the *South African Mines* newspaper. Nine drills were entered for this contest, five being small drills of the piston-drill type, whilst the other four were hammer-drills. Here I need only say that the first place in the competition was taken by a hammer-drill, the final opinion of the judge, Professor Orr, being expressed as follows: — 'One is forced to the conclusion that for lightness combined with drilling capacity the hammer type is essential.'

"The first hammer-drill that I know of is the Francke drill, used about 1890 in the copper-mines of Mansfield. This was a small and extremely light drill, weighing only some 16 pounds, was held in the hand, and was run at the very high speed of over 8000 blows per minute. This particular machine does not seem to have been altogether successful, but it was not long before other drills, which were practically adaptations of the pneumatic caulking-tool, etc., were introduced.

"It is obvious that a hammer-drill, in which the drill steel is not attached to the piston, admits of being run at a far higher speed than a piston-drill, and can therefore be made equally efficient with the latter, though having a shorter stroke, thus enabling the whole machine to be made much lighter and more easy to handle in a confined space. I do not, of course, wish to suggest that the result of the above test, carried on, as it necessarily was, under competitive conditions, can be looked upon as anything more than an indication, but it tends to show that in the future a special type of drill, not merely an ordinary drill upon a reduced scale, will have to be devised for stoping and breaking out ore, as distinct from sinking or driving.

"The great drawback shared by all forms of pneumatic drills is their excessive power consumption. Careful tests in South Africa have shown that an ordinary rock-drill only develops 1.7 horse-power against a face of rock, whilst the drill-cylinder indicates about 5 horse-power, and at the same time it requires as much as 28 horse-power at the compressor-engine to work it, the heavy compression losses and pipe-line losses being almost inevitable. Electric transmission of power, which has been of such immense value in most departments of mining, has hitherto been unsuccessful when applied to percussive rock-drills, the steady torque produced by the electric current not being readily adaptable to the reciprocating action required for percussive drilling. A number of electrically-driven percussive drills have been devised, but it cannot be said that any one of them has yet shown itself capable of competing with the pneumatic drill under the strenuous conditions of actual mining work. The best prospect of success up to the present is, in my opinion, afforded by the Temple drill, in which a small electric motor works a pulsator, which sends puffs of compressed air alternately into either end of the cylinder of what is practically a valveless pneumatic rock-drill. The machine is too new to enable any definite statements to be made about it; it has the advantage of small power consumption, a 5-horse-power motor working it; but, on the other hand, the necessity of having the two machines, the pulsator and the drill itself, at the working face is a decided drawback.

"My own impression is that the ultimate solution of the drilling problem will be found in the adoption of an electrically-driven rotating drill. The advantages of such a drill in rock soft enough to admit of its use under present conditions are sufficiently obvious. For example, electrically-driven twist-drills are doing excellent work in the comparatively soft ore of the Cleveland ironstone mines, and I have already mentioned how completely the rotating hand-machine of the coal-miner has displaced the percussion jumper. The success of the hydraulically-driven rotary Brandt drill in the Simplon Tunnel will be fresh in the memories of many here; the same drill has also done good work in several mines where the workings are large enough to enable a 3-inch borehole to be used with advantage. This drill works under heavy hydraulic pressure (700 pounds to 2000 pounds per square inch), but its rate of rotation is slow, being only three to ten revolutions per minute.

"An electrically-driven drill will necessarily have to rotate at a relatively high speed, and it seems safe to predict that such machine will come into use as soon as a suitable material for the cutting edge of the drill shall be discovered; here again we need a metal distinctly harder than quartz at least, and strong enough to resist the severe torsional strains to which it will be exposed. I am a very strong advocate of rotary drilling, not only because I consider it as mechanically the better system, but because I hold that it will afford the most complete solution of the dust problem. It is now fairly well established that that dread disease, miners' phthisis, the greatest danger to health to which the worker underground is exposed, is largely due to the inhalation of the fine sharp-edged particles of mineral thrown off by the action of the percussive drill. Something has been done to combat this danger of late years, notably by the use of jets or sprays of water, and particularly by the use of hollow drill steels, through which a stream of water can be carried to the very face of the drill-hole, but I am inclined to think that it is only by rotary boring, of course with the aid of water, that this deadly enemy can be finally conquered.

"I may add that the argument, occasionally put forward in favour of the pneumatic drill, that it helps to ventilate a close end, has, in my opinion, very little weight, because it is obviously easy to produce any desired amount of ventilation by means of small electrically-driven fans, which will give a continuous air-current, whereas the drill does not supply any air at the times when this is most needed—that is to say, after shots have been fired, and whilst the men are doing their hardest manual work—namely, setting up the drill."

THE UTILIZATION OF BLAST FURNACE SLAG.

A REVIEW OF METHODS FOR THE MANUFACTURE OF SLAG BRICKS AND CEMENT.

The Chevalier C. de Schwarz—Iron and Steel Institute.

AN interesting paper on the utilization of blast-furnace slag for the manufacture of bricks and cement was presented by the Chevalier C. de Schwarz at the recent meeting of the Iron and Steel Institute. A particularly important point in this paper is the demonstration which M. de Schwarz gives of the incorrectness of the belief held by many writers on the subject, that no cement can be made from the slag produced in the manufacture of white pig iron. In the brief abstract of the paper which is given below, M. de Schwarz's comments on this point are given in full.

The first process for the utilization of blast-furnace slag was patented in 1728 by an Englishman, John Lane. He succeeded in making large solid blocks of artificial stone for use in river and canal embankments, by working liquid slag thoroughly to expel air or gas bubbles, adding a quantity of sand or crushed slag, and compressing the resulting doughy mass in cast iron moulds. The utility of his process was limited, however, by the fact that it could be applied successfully only to slags high in silica and poor in iron.

Considerably later the hydraulic properties of granulated basic slag were recognized by Fritz Lürmann, who made bricks by mixing granulated slag with lime cream and pressing the mixture into moulds. The lime combined with the free silica of the slag to form a cement and the bricks hardened on exposure to the air in six to eight weeks. This primitive method, however, produced bricks of only very moderate strength and many improvements have been necessary to bring the slag-brick industry to its present importance. Chief among these may be mentioned the introduction of appliances for the automatic feeding and mixing of proper quantities of materials, of power presses capable of applying a gradually increasing pressure, and, lastly, of ball mills for the fine crushing of slag and lime. Plants embodying these improvements produce, per press, about 2,000 8-pound bricks per hour at a cost of about 8 shillings per thousand. To drive each press and its auxiliaries requires about 25 horse power. Bricks made by this method have a crushing strength of 1,700 pounds per square inch. Recently, improved machinery invented by Paul Thomann in Germany has considerably cheapened the cost and improved the quality of bricks manufactured by this method.

Another process, too expensive for any purpose other than making artificial stones of special size, consists of compressing in moulds a mixture of one part of Portland cement with four to five parts of granulated slag. The best slag bricks are manufactured according to the English method, in which no binding medium, such as cement or slaked lime, is used. It is based on the fact that insoluble silica is rendered soluble by exposure to high steam pressure for a certain time. Bricks of excellent shape and great strength, are produced by this method at a cost of 13s. per thousand.

"Slag bricks have the following advantages over ordinary baked clay bricks:—(*a*) They have a considerably higher resistance against crushing; (*b*) houses built with slag bricks are never damp, and can be occupied without danger to health as soon as they are built; (*c*) slag bricks are more accurate in shape and dimensions, because they are not baked, and therefore do not shrink like clay bricks.

"For certain purposes slag bricks, manufactured according to the English process, are, on account of their accurate shape and extreme hardness, preferred even to natural stone; for instance, in Brussels such bricks are used for the facing of walls for houses, and paid for at the rate of 60 francs (48s.) a thousand. For ordinary masonry, slag bricks manufactured according to the other methods are used because they are considerably cheaper."

The manufacture of slag cement, however, is of much more importance than that of bricks or artificial stones and this problem is receiving a great deal of attention. Many erroneous statements are made by writers on the subject. "For instance, it has been repeatedly stated that no cement can be made from slag resulting from the manufacture of white pig-iron. This is incorrect, as may be proved by the fact that Portland cement of good quality can be made from such slag, containing 42 per cent. of lime and 4½ per cent. of oxide of manganese. The cement made from such slag showed not the slightest trace of instability of volume even after six years' use; it also stood all the tests required by the standards for Portland cement. The manganese oxide in the cement gave it a somewhat brownish colour, which, however, was not considered a fault by some customers, but on the contrary was preferred to the ordinary tint for making artificial stones.

"To a certain extent the presence of metal oxides, such as those of iron and manganese, which, as a rule, are higher in slag from white pig-iron, makes the cement made from it more apt to resist the influences of sea water, as already mentioned in previous papers. Secondly, the presence of metallic oxides reduces the temperature of fritting, necessary for the formation of clinker, thus effecting saving in fuel as a consequence. As the majority of blast furnace slag produced nowadays results from white Thomas pig, it may be considered advisable to draw attention to this fact, as hitherto the general belief was that only slag resulting from grey pig can be used for making cement on account of its higher percentage of lime and its small percentage of manganese oxide. It has been proved that a high percentage of lime in Portland cement is not only not necessary, but is to a certain extent even injurious, as, being to a certain extent free, it causes the cement to 'blow.' Therefore such cement, rich in lime, must, as every experienced cement maker knows, be kept for some time in a cement silo before being ready for use, in order to give it time and opportunity to absorb carbonic acid and water from the air for the purpose of converting the free lime it contains into carbonate of lime and into hydrate of lime respectively. Experience has also shown that cement, rich in lime, cannot be used advantageously for buildings in sea water."

M. de Schwarz reviews the more recently invented processes for the manufacture of slag cement, those of Mathesius, Renfert, Canaris, Colloseus, and others, and finds that the Colloseus process is the only one commercially successful. He describes the machinery used in connection with the process and gives the following general details:

"According to this process, solutions of alkaline salts are injected into the hot liquid slag and thus intimately mixed with the latter, the nature and concentration of the injected solutions depending on the chemical composition of the slag, principally on its contents of lime. The quantity of the solution to be injected should be as high as possible; however, the slag thus treated must be perfectly dry after the operation. The salts used for preparing the solutions are principally alum, sulphate of magnesia, and nitrate of lime. The concentration, as a rule, varies from 2 to 5 per cent. of salt to from 95 to 98 per cent. of water.

"On account of the great heat the salts are decomposed, most of the sulphur escaping as sulphurous acid and sulphuretted hydrogen. The slag is chemically and physically changed, and gets the appearance of a porous clinker easily broken up and reduced to powder.

"In case slag with a comparatively high percentage of silica and a lower percentage of lime is to be converted into cement, the concentration of the alkaline solution is raised to a maximum of 10 per cent. of the salt to 90 per cent. of water; besides this a small addition of common cement, clinker rich in lime, has been found beneficial in such cases.

"As to the quality of this cement, it may be said that, according to information received, it has stood all the tests prescribed for Portland cement by English, French, and German authorities. The cement has been employed for about a year in the erection of viaducts, railway embankments, bridges, houses, etc., showing, up to date, not the slightest trace of damage."

THE BY-PRODUCT COKE OVEN IN AMERICA.

A DISCUSSION OF ITS PRESENT STATUS AND PROBABLE FUTURE.

William H. Blauvelt—American Society of Mechanical Engineers.

SINCE the introduction of the by-product coke oven into the United States in 1894, the growth of that branch of the coking industry has been only moderately rapid. According to some figures given by Mr. William H. Blauvelt in his paper before the semi-annual meeting of the American Society of Mechanical Engineers, just closed, in 1897 out of a total production of 13,288,-984 tons of coke, 1.97 per cent. were produced in by-product ovens, and in 1906, 12.52 per cent. out of a total production of 36,401,217 tons. But even this large increase leaves the by-product industry in a position of much less relative importance than it occupies in Europe. A number of reasons can be assigned for its relatively slow growth, among them the cheapness and high quality of coals generally available, the absence of chemical industries, the comparatively small demand for tar for use in the briquetting industry and on roads, and the lack of appreciation of the value of ammonium sulphate as a fertilizer. Mr. Blauvelt, however, considers that the conditions which has retarded its growth in the past are rapidly disappearing and he looks for a much more rapid extension of the use of the by-product oven in the future. The following abstract touches only the main points of his very comprehensive paper.

Coke ovens may be generally divided into two classes, beehive ovens and retort ovens, the various special types of the latter arising from two root forms, the Coppée oven, with a long, narrow coking chamber and vertical side flues, and the Knab-Carvés oven, with a coking chamber of similar form but with horizontal side flues. In the beehive oven the coal is coked in a flat layer about 25 inches thick. The combustion which produces the heat for coking takes place within the coking chamber, above the coal. Air is admitted at the front door and the products of combustion escape through a hole in the roof. The beehive oven as now built in America is about 12 feet in diameter and 6 feet 9 inches high. The usual charge is about 6 tons and the coking process takes from 48 to 72 hours, making the output per oven about 1.5 to 2 tons per day. In the present unstable condition of the iron industry the beehive oven has certain substantial advantages. It is cheap and easy to build and it can be shut down with relatively small loss and started up again with ease. It is unlikely, however, that the beehive oven will long retain its present prominence. The increasing stability of the iron industry will gradually remove its peculiar advantages but a more potent cause in its replacement by the retort oven will be the exhaustion of the coals adapted for use in the beehive type. Many large deposits of coal exist which are not well suited to the beehive open but which can be used with excellent results in ovens of the retort type and in many sections of the country these deposits are the natural sources of supply for important metallurgical works. It is particularly in such cases that the retort oven is coming into prominence.

The retort oven consists essentially of a long, narrow, firebrick chamber, 30 to 40 feet long, 7 to 9 feet high, and 16 to 20 inches wide. The average capacity is about 12 tons per day. In the coking chamber the coal is coked by heat generated by the combustion of gases in flues in the side walls. The essential difference betwen the beehive and retort oven processes is that in the latter air and the products of combustion are carefully excluded from the coking chamber. The retort process, therefore, results in a true distillation of the coal. The gases produced by the two processes differ considerably in composition and in value. In the beehive oven the admission of air reduces the quantity and quality of the tar products and destroys practically all the ammonia. Hence by-product recovery in connection with beehive ovens is no longer practised in the United States. The only representative of beehive by-product ovens in the country is the Newton Chambers and the plant in which ovens of this type were installed has been closed down for some time.

"The four types of by-product ovens in operation and under construction in the United States are all of the retort type, and have all been developed from the original types of the Coppée or Knab-Carvés designs. Of these there are 11 plants of the Otto-Hoffman and the United Otto type, 13 plants of the Semet-Solvay type, three plants of Rothberg ovens, and one plant, under construction, of Koppers ovens, making a total of 28 plants or 4763 ovens." The United Otto and Koppers ovens are developments of the Coppée, vertical-flue type; the Semet-Solvay and Rothberg ovens, of the Carvés or horizontal-flue type. The distinguishing features of the various ovens have no influence on the coking process. The difference between the types exist, for the most part, in the arrangement of the flue systems, the methods of preheating the air, and the methods of controlling the admission of the air and gas. The operation of the ovens is essentially the same. Coal is charged into the retort chamber through holes in the roof and is coked by the heat produced by the combustion, in flues in the walls and bottom of the chamber, of part of the products of distillation. The products of distillation, carrying the tarry vapors and ammonia, are drawn from the tops of the ovens into a main which extends the length of the battery. The recovery of by-products is optional, depending on market conditions and the quality of the coal coked. In case by-products are to be recovered, the gas is led to a recovery building for treatment. If not, a proper proportion of the gas is returned to the oven flues, where it is burned with a proper admixture of air, and the remainder is available for raising steam. The heat in the waste gases from the flues is utilized for preheating the air supply by regeneration or recuperation or for raising steam for the operation of the plant.

The process of by-product recovery is similar to that in plants for the manufacture of illuminating gas. The gas coming from the main is cooled slowly in large air- or water-cooled vessels, a common form of cooling plant being a series of vertical cylinders containing tubes like a vertical boiler. During this cooling process most of the tarry matter and the water vapor are thrown down, the latter carrying with it a considerable part of the ammonia. The tar remaining in the gas is extracted in a special tar extracter and the gas is then drawn through scrubbers for the separation of the ammonia, benzol and cyanides. In these scrubbers, which may be of either the bubbling or the rotary type, the ammonia is absorbed by water, the benzol by heavy tar or petroleum oils, and the cyanides by an alkaline solution of ferrous sulphate. After this treatment the gas can be returned to the ovens or it can be used as a fuel, in gas engines, or for illumination. When used for the latter purpose, it must be purified of sulphur and it is usual also to omit the removal of the benzol.

Further treatment of the by-products includes the separation of the tar from the ammonia liquor and the distillation of the latter. The tar and ammonia liquor are separated in large tanks by the difference in their specific gravities and the tar is then ready for shipment. The ammonia exists in the liquor in various combinations and its extraction is somewhat complicated. The final product of the distillation may be crude ammonia liquor, pure aqua ammonia, or ammonium sulphate. Benzol is recovered from the heavy oils used to absorb it by heating the oil with steam and condensing the benzol oils driven off to crude benzol. Cyanides are not being recovered in any American plants.

The mechanical problems of a by-product coking plant are numerous. Among the more important may be mentioned the arrangements for coal handling and storage, the crushing and briquetting of the coal, if such treatment is necessary, the charging of the ovens, the drawing and quenching of the coke and its preparation for market, and the operation of the recovery plant. The development of the mechanical appliances about the plant has been one of the special features of the growth of the by-product oven in America.

"In addition to the various problems in mechanical and chemical engineering presented by the operation of the by-product coke oven, there are a number of metallurgical problems, some of which have been solved with material gain in the efficiency of the coking operation and the yield of by-products; the solution for others is yet to be found. The driving off of the hydrocarbons from coal by distillation is a very complex process. Each change in conditions of the temperature, rate of distillation, etc., gives different results, and on account of the hydrocarbons being so complex in composition, no definite figures can be placed on the operation. Many experiments, for example, have been made to determine the amount of heat absorbed in the coking process per unit of coal coked. Many processes have been devised for converting the major portion of the nitrogen in the coal into ammonia. These and other problems, however, are not much nearer solution than when the by-product process was first introduced into this country. The experience in the retort house of the gas works has shown that high heats and rapid coking increase the volume of gas and tend to break down the heavier hydrocarbons, and the same is doubtless true in a measure in the retort oven, although the much greater bulk of the charge, the different relation between the volume of the gas produced in proportion to the heated surface of the retort, etc., modify these conditions.'"

After an extended consideration of the economic aspects of the problem, Mr. Blauvelt summarizes his conclusions as follows:

"What is to be the development of the by-product oven in this country? Compared with many industries its growth has been slow, but this, as has been pointed out, is largely due to the condition of the chemical industries in this country, which must of necessity keep pace, at least in a measure, with the sources of their raw materials. The capital required in the installation of the by-product oven is relatively large, and the results would have been serious if the rate of oven building had been greatly in excess of the demand for its by-products. In all industries depending upon the by-products of coke a promising future is apparent. The use of gas for illuminating purposes has become firmly established, and the rapid introduction of the gas engine affords a market for fuel gas. But we must look to agriculture as the principal consumer of any largely increased production of ammonia. Through the growing influence of Government and State Experimental Stations and agricultural colleges, science is being applied more and more to agriculture, and this cannot but lead to the general use of artificial fertilizers which naturally follows a higher standard of farm work. As a fertilizer base, sulphate of ammonia, with its nitrogen in the most available form, plays a most important part.

"During the last few years the production of tar has exceeded the demand, so that large quantities have had to be burned as fuel at low prices, but the outlook for this by-product is more favorable than it has been. While it may be some time before the highly specialized chemical industries for the production of anilines and dyes have reached any important growth, yet the prospects for the development of the cruder tar products are encouraging. The rapidly increasing price of lumber is forcing the necessity of creosoting, with the attendant consumption of creosoting oil, onto large lumber users like the railroad companies.

"The practical start in the commercial manufacture of briquettes promises an early development of that industry, and a very modest position as a producer of fuel would mean consumption of a large amount of pitch. If the number of by-product ovens and the output of tar therefrom were doubled, a production of less than 3,000,000 tons of briquettes per annum would consume all the pitch from this increase, without providing for any growth in the important roofing and paving industries, and without providing for any consumption of tar in the new tarred roads. This tonnage of briquettes, compared with the 60,000,000 tons of anthracite which will probably be produced this year, and the 340,000,000 tons of bituminous coal mined in 1906, suggests that briquetting when once established, even as an 'infant industry,' may soon reach the condition which exists in continental Europe, namely, where its growth would depend only upon the available supply of pitch. Briquetting pitch must always be sold at a moderate price, unless the conditions of our fuel supply change materially. But, as in Europe, when once developed, briquetting will probably be the principal consumer of pitch produced in the United States.

"The by-product oven belongs to the present day. The production of coke at the blast-furnace plant, where the operation is assured by large storage of coal and where the labor is under better control than in less developed regions, is in line with today's manufacturing methods. The higher economy of its operation, its special adaptability to control by the modern scientific organization, the ability to draw coal from several fields, and the successful adaptation of labor-saving appliances to its various operations, all point to its being the oven of the future."

THE GASES OCCLUDED IN STEEL

A REPORT OF THE FIRST OF A SERIES OF INVESTIGATIONS ON THEIR NATURE, DISTRIBUTION AND LIBERATION.

Dr. G. Belloc—Société d'Encouragement pour l'Industrie nationale.

COMMENTING editorially on the industrial importance of the subject of the occlusion of gases by steel and iron, *The Engineer* for May 15 says: "That immersion in a weak solution of acid and water affects the physical properties of steel is, it would seem, beyond doubt; at any rate, such experts as Mr. Stead, Professor Ledebur, Mr. Stromeyer, and others appear to have no doubt about it. How it weakens the metal they are, however, not fully able to explain, and they advance a theory which, up to the present, lacks really substantial verification. This theory is that during immersion hydrogen gas is, under the action of the acid, generated and occluded in the body of the steel itself. This is a hard saying, and a few years ago, before the microscope had revealed the structure of steel, it would have been wholly unbelievable. Even now there are plenty who cannot understand how the acid bath can possibly have more than a superficial effect, and who demand some other explanation of the extraordinary brittleness which has been frequently observed in pickled bars. The problem is further complicated by the fact that very moderate heat treatment is sufficient to expel all the evil which pickling has put into the plates or bars. The Admiralty specifies that all boiler plates and tubes shall be dipped to remove scale, and it does not fear that the boilers will be rendered dangerous by that process, since it is held that at a temperature of 300 degrees F., or so, the occluded hydrogen is driven out, and the metal returns to its normal condition. Other people will not have pickling at any cost, as they believe that permanent injury is caused to the plate thereby. The widest diversity of opinion on the whole subject exists, and it is one of industrial importance that might well be taken up and thoroughly investigated."

An inquiry on the subject has been started in France under the auspices of the Société d'Encouragement pour l'Industrie nationale and in the April number of the *Bulletin*, Dr. G. Belloc, who is in charge of the researches, presents the results of a preliminary series of investigations. Dr. Belloc hopes by his researches to settle the questions of the state in which the gases exist in steel, their distribution, their variation with the processes of manufacture and their effects on the physical and mechanical properties of the steel. For the present the phenomena of pickling have been disregarded. Dr. Belloc's preliminary researches have been based on the theory that it is during the process of cooling that the gases are shut up in the steel. His method has been, therefore to drive out the enclosed gases by reheating, to capture them and analyse them. It is impossible to give here a description of the highly involved methods of the investigation but a brief outline of the conclusions he has already reached is given in the following abstract of his report.

The liberation of the gases has a direct connection with the critical points of iron and from this point of view it may be considered to take place in three main stages. The gases begin to appear at a variable and not well defined temperature between 150 and 400 degrees C. In general, however, there is only a slight liberation while the iron remains in the alpha form, though the amount of gas given off tends to increase with the temperature. At temperatures around 300 degrees the latter general relation between temperature and liberation of gases is subject to slight irregularities. Between 500 and 600 degrees, at the beginning of the transformation of alpha into beta iron, gases are given off in abundance but as the transformation becomes more complete the liberation of the gases diminishes. Another point of abundant liberation occurs, however, with the transformation of the beta into gamma iron. Although the liberation reaches a maximum during the course of that transformation it seems to have a tendency to increase as the temperature rises after the iron has reached the gamma form. The transformation in the condition of the carbon, in a 0.12 per cent. carbon steel, has no apparent influence.

The gases liberated are mixtures of carbon dioxide, carbon monoxide, hydrogen and nitrogen. Carbon dioxide appears first and at the beginning of the action forms practically all of the gas liberated. It disappears at about 550 degrees, either because it has all been driven off or because what remains is reduced by hydrogen. As carbon dioxide ceases to appear the liberation of nitrogen begins. It continues at all temperatures higher than 550 degrees, but in quite small proportions, usually under 10 per cent. Above 400 degrees hydrogen and carbon monoxide form practically all the gas liberated. Their relative proportions are subject to sudden change with changes of temperature and even vary greatly at the same temperature in different specimens. However, these researches lead to the conclusion that the minimum percentage of hydrogen is reached betwen 600 and 700 degrees and that above 800 degrees carbon monoxide predominates, that is when the iron is in the gamma form.

In one of the two bars tested the ratio betwen the total volume of the gases liberated and the volume of the steel was much greater, and the liberation of the gases began at a much lower temperature, than in the other, though the two bars were prepared under the same conditions and were cut from the same ingot. A possible explanation of this phenomena is the fact that the latter bar was turned to size with much lighter cuts than the former; it is possible that the slower turning process resulted in the escape of a larger fraction of the gases from the cold bar. Another possible explanation may be that the amount of gas varies in different parts of the longitudinal section of the ingot. The question is one which requires fuller investigation.

In the bars themselves the gases are very irregularly distributed. In one of the bars tested the total proportion of the gas was much larger in the intermediate portion than in the central or superficial portions. The ratio betwen the hydrogen and the carbon dioxide was equally irregular. It is possible that the distribution of gases in the cross section of the ingot varies according to determinable laws like that of other substances in steel. On this point also further investigation is necessary.

As to the state in which the gases exist in the solid metal, the investigations give no evidence of the existence of a tension of dissociation. The maximum of liberation at the beginning of each change in the state of the iron would suggest the idea that the molecular movements consequent on the transformation act, first of all, as a sort of mechanical agitation, without prejudice to a sudden change in solubility or a variation in the law of solubility.

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

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(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

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The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

A Working Method for Masonry Arch Design. William T. Lyle. Explains method. 1200 w. Eng Rec—May 2, 1908. No. 92072.

See also Reinforced Concrete, under Bridges.

Bascule.

Bascule Bridge of the Rall Type at Peoria, Ill. Illustrates and describes the general design of this bridge and details and methods of operation. 2000 w. Eng Rec—May 9, 1908. No. 92207.

Columns.

Safe Stresses in Steel Columns. Discussion by William Cain. 1500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92646 E.

Drawbridges.

Raritan River Bridge; New York & Long Branch Railroad. Illustrated detailed description of the construction of this new 28-span plate-girder bridge, with draw-span of 331 ft. 1600 w. R R Gaz—May 8, 1908. No. 92170.

See also Pontoons, under Bridges.

We supply copies of these articles. See page 658.

Floors.

Waterproofing Bridge Floors. Considers the requirements and methods. Ills. 1800 w. Ry Age—May 15, 1908. No. 92329.

Masonry.

See Arches, under BRIDGES.

Pontoons.

Pontoon or Floating Draw-bridges. Illustrates and describes types, giving information relating to them. 5000 w. Eng News—April 30, 1908. No. 92012.

Quebec.

The Theory of Latticed Columns, a Comparison of Cantilever Bridge Chords, and a Discussion of the Quebec Bridge Specifications. Appendices 16, 17, 18 and 19, with inset sheet. 11800 w. Eng News —April 30, 1908. No. 92015.

The Fall of the Quebec Bridge (L'Effondrement du Pont de Québec). G. Dupont. Describes the structure and discusses the causes of the catastrophe and the findings of the Commission. Ills. 5000 w. Génie Civil—April 4, 1908. No. 92416 D.

Reinforced Concrete.

A Three-Hinged Reinforced Concrete Arch. Charles W. Comstock. Illustrated description of the design and construction of a bridge in Denver, Colo. 3000 w. Cornell Civ Engr—May, 1908. No. 92603 C.

A Light Three-Hinged Concrete Arch Bridge in Rock Creek Park, Washington, D. C. Illustrated description of a design for a bridge in a thickly wooded gorge, aiming at harmony with surroundings. 1200 w. Eng News—May 21, 1908. No. 92398.

Reinforced Concrete Overgrade Highway Crossings. Photograph, drawings and description of a crossing built by the Vandalia R. R. between Terre Haute, Ind., and Brazil. 800 w. R R Gaz—May 22, 1908. No. 92522.

See also Trestles, under BRIDGES.

Steel.

Quick Replacing of a Double-Track Steel Span. States conditions and gives illustrated description of work. The structure was out of service only 36 minutes. 900 w. Eng Rec—May 9, 1908. No. 92210.

The Erection of the Towanda Bridge. Brief illustrated description of a plate-girder bridge across the Susquehanna River carrying double-tracks of the Lehigh Valley R. R. 2200 w. Eng Rec—May 2, 1908. No. 92069.

Erection of the Bellows Falls Arch Bridge. Discussion by F. W. Skinner giving illustrated descriptions of examples of the principal types of long-span arch erection, with time and cost. 2500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92645 E.

See also Column, Drawbridges, Quebec, and Williamsburg, under BRIDGES.

Trestles.

Concrete Coal Trestle and Ash-Handling Plant. Illustrated description of the D., L. & W. plant at the Hoboken terminal. 900 w. R R Gaz—May 8, 1908. No. 92173.

Viaducts.

See Elevated Railways, under STREET AND ELECTRIC RAILWAYS.

Williamsburg.

Williamsburg Bridge Towers. Brief illustrated description of new construction to strengthen the structure for possible service. 1200 w. Eng Rec—May 23, 1908. No. 92534.

CONSTRUCTION.

Columns.

See same title, under BRIDGES; and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Concrete.

See Foundations, under CONSTRUCTION; Concrete, under MATERIALS OF CONSTRUCTION; Sewers, under MUNICIPAL; Dams, under WATER SUPPLY; and Conduits, under ELECTRICAL ENGINEERING, TRANSMISSION.

Earth Pressures.

Earth Pressures (Sulla Spinta delle Terre). Carlo Parvopassu. A mathematical discussion of the theory of earth pressure. Ills. 3500 w. Serial. 1st part. L'Ing Ferro—April 16, 1908. No. 92425 D.

Earthwork.

Comparative Costs of Earthwork. A P. Davis. Projects carried out in connection with the U. S. Reclamation service are compared. Ills. 4000 w. Eng Rec—May 16, 1908. No. 92308.

Estimates.

The Use and Abuse of Cost Data. W. W. Patch. Shows how misleading cost analyses may prove. 1100 w. Eng News —April 30, 1908. No. 92011.

Fireproofing.

The Parker Building Fire: Report of the New York Board of Fire Underwriters. Abstract of the final and authoritative report. 2500 w. Eng News—May 21, 1908. No. 92500.

Floors.

The Phelan Building Floor Construction. Illustrated detailed description of building details complicated by the irregularity of the lot. 2000 w. Eng Rec —May 2, 1908. No. 92071.

Foundations.

Recent Developments in Pneumatic Foundations for Buildings. Discussion of the paper of D. A. Usina. 2500 w.

Pro Am Soc of Civ Engrs—May, 1908. No. 92648 E.

Concrete for Foundations of Buildings and Machinery. Henry Adams. Suggestions in regard to its use and the methods employed. 3300 w. Pub Works—April, 1908. No. 92641 B.

Concrete Foundations in Shifting Grounds. Describes conditions and the remedy of the difficulty as worked out at Boomer, W. Va., at a mine plant. Ills. 700 w. Eng News—May 21, 1908. No. 92501.

Difficult Sub-Surface Building Work in Chicago. A 9-story reinforced-concrete warehouse, with a 4-story terminal station for the freight-tunnel system under it, being built on the north bank of the Chicago River, is described. Ills. 3000 w. Eng Rec—May 23, 1908. No. 92533.

See also Piling, and Underpinning, under CONSTRUCTION.

Piling.

United States Steel Sheet Piling. Illustrated description of its use in the foundation for the A. A. Pope building, Cleveland, O. 900 w. Ir Age—May 28, 1908. No. 92649.

Spirally Armored Concrete Piles. Illustrated description of "Considère" piles, and their use. 1200 w. Engr, Lond—May 8, 1908. No. 92360 A.

Reinforced Concrete.

A Reinforced-Concrete Band Stand. W. F. Creighton. Illustrated description of a novel design built at Nashville, Tenn. 800 w. Eng News—May 28, 1908. No. 92636.

A Reinforced Concrete Stock House. A. Jordahl. Illustrated description of a building under construction near Montreal, Can. 2500 w. Cement Age—May, 1908. No. 92296 C.

The Bostwick-Braun Building, Toledo, Ohio. C. A. P. Turner. Illustrated description of this reinforced-concrete structure. 2000 w. Eng Rec—May 2, 1908. No. 92067.

The First National Bank Building in Oakland, California. Illustrated detailed description of the methods of constructing this reinforced-concrete building on a triangular area. 2500 w. Eng Rec—May 16, 1908. No. 92315.

Reinforced-Concrete Brackets Under Skew Sidewalks. C. L. Slocum. Illustrated description of construction work in connection with improvements on the N. Y., N. H. & H. R. R. 500 w. Eng News—April 30, 1908. No. 92014.

The Influence of Transverse Stresses on the Arrangement of the Reinforcement in Reinforced-Concrete Beams (Einfluss der Querkräfte auf die Anordnung der Armierungen bei Eisenbetonbalken). Jhs. Thieme. A mathematical paper on beam design. Ills. 3300 w. Beton u Eisen—April 1, 1908. No. 92467 F.

See also Foundation, Piling, Stacks, and Underpinning, under CONSTRUCTION; Reinforced Concrete, under MATERIALS OF CONSTRUCTION; Tanks, under WATER SUPPLY; Piers, under WATERWAYS AND HARBORS; and Ties, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Skylights.

Skylight Construction. M. W. Pehl. Deals with systems of manufacture of metallic skylights. Ills. 700 w. Metal Work—May 2, 1908. Serial. 1st part. No. 92054.

Stacks.

Safe Design and Construction of Reinforced-Concrete Chimneys. The report of Sanford E. Thompson to the Assn. of Am. Portland Cement Mfrs. is given at some length. 7500 w. Engng-Con—May 20, 1908. No. 92512.

An Unusual Concrete Chimney. Brief illustrated description of the use of reinforced concrete for a combination of chimney, smoke and spark arrester, at Cumberland Mills, Me. 500 w. Eng Rec—May 2, 1908. No. 92074.

Steel Buildings.

A Companile 700 Feet High. Brief illustrated account of the tower of the Metropolitan Life Insurance Company's building, on Madison Sq., New York City. 1500 w. Sci Am—May 2, 1908. No. 92018.

The Construction of the New Kiel Theatre (Konstruktionen im neuer Stadttheater in Kiel). O. Leitholf. Illustrates and describes the structure and some constructive details. 5500 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 18, 1908. No. 92482 D.

See also Floors, under CONSTRUCTION.

Tunnels.

The Thames Tunnel. Reprint of a pamphlet published in 1840, describing the work, and giving the original illustrations. 2500 w. R R Gaz—May 22, 1908. No. 92521.

The Washington Street Tunnel of the Boston Subway System. Illustrated description of conctruction work under many difficulties. 3500 w. Eng Rec—May 16, 1908. No. 92310.

The New Blue Island Avenue Water Tunnel, Chicago. Illustrates and describes the 8-ft. circular tunnel, 28000 ft. long, being driven to form a part of the system to connect the intake cribs with the pumping stations. 3500 w. Eng Rec—May 9, 1908. No. 92204.

Underpinning.

Deep Underpinning for a Brick Factory Building. Explains the difficult conditions and the successful methods employed. Ills. 1600 w. Eng Rec—May 2, 1908. No. 92073.

Method of Constructing Reinforced-Concrete Underpinning for 14-Story Building on Line of Washington Street Tunnel, Boston, Mass. Gives the plan adopted as described in the report of the chief engineer. 1200 w. Engng-Con—May 13, 1908. No. 92297.

Waterproofing.

See Floors, under BRIDGES; and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Cement.

Influence of Proportion of Water on the Compressive Strength of Cement, Mortar, and Concrete. Report of tests carried out by Herr Brabant, and published in the *Centralblatt der Bauverwaltung.* 500 w. Engr, Lond—May 15, 1908. No. 92567 A.

Concrete.

Tests of Coral Sand and Rock with Reference to Their Use in Concrete. Dewitt C. Webb. A report of tests and results. 500 w. Eng News—May 14, 1908. No. 92274.

See also Cement, and Reinforced Concrete, under MATERIALS OF CONSTRUCTION.

Mortar.

See Cement, under MATERIALS OF CONSTRUCTION.

Reinforced Concrete.

Reinforced-Concrete Columns. P. Gillespie and W. G. Swan. Discusses experiments conducted in the testing laboratory of Toronto University. Ills. 3500 w. Can Engr—May 1, 1908. No. 92062.

Tests of Concrete and Reinforced-Concrete Columns; Series of 1907. Arthur N. Talbot. A report and description of investigations made at the University of Illinois engineering experiment station. Ills. 12000 w. Bul Univ of Ill, No. 20—Dec. 15, 1907. No. 92582 N.

Immunity from Rusting of Reinforcing Steel in Concrete. A report of results of tests made in Berlin, Germany, showing that ordinary tension cracks do not permit corroding influences to affect the steel. Also tests made at Key West, Fla. 1200 w. Eng News—May 14, 1908. No. 92275.

Timber Preservation.

The Burlington Tie-Preserving Plant at Galesburg. Illustrated description. 1500 w. Ry Age—May 8, 1908. No. 92227.

Preservation of Railroad Ties. Samuel M. Rowe. A summary of this industry, describing the processes. 3200 w. Ry Age—May 15, 1908. No. 92332.

New Tie-Treating Plants on the Rock Island Lines. Describes plants at Kansas City and at Argenta, Ark., using the Lowry method of creosoting at the first, and the Rueping process at the second named plant. 1800 w. Ry & Engng Rev—May 16, 1908. No. 92365.

A Review of the Present Practice and Economies of Timber Preservation. Eugene P. Schoch. Abstract of paper read before the S.-W. Elec. & Gas Assn. A discussion of this subject, giving proof that the practice of wood preserving is profitable. 4500 w. Elec Ry Rev—May 9, 1908. No. 92223.

Impregnation Processes for Mine Timbers (Procédés d'Imprégnation des Bois de Mines). Léon Delcommune. A review of the present processes for the preservation of mine timbers by impregnation with preservative materials. 5000 w. Bul Sci d l'Assn des Elèves—April, 1908. No. 92404 D.

MEASUREMENT.

Surveying.

Methods of Surveying Oyster Beds on Maryland Shores. Description taken from a recent address by Swepson Earle. 1200 w. Eng News—May 21, 1908. No. 92397.

Pioneer Engineering. Frederic Shelford. Suggestions for camp equipment are given in the present number, with illustrations. 5000 w. Engr, Lond—May 8, 1908. Serial. 1st part. No. 92357 A.

Some Historical Facts as to the Discovery and Use of the Magnetic Needle. and Some Facts from the Author's Experience with the Compass and Jacob Staff in Land Surveying in Louisiana. M. P. Robertson. 3500 w. Jour Assn of Engng Socs—April, 1908. No. 92589 C.

See also Location, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

MUNICIPAL.

Drainage.

Some Economic Advantages of Large Size Drain Tile. F. M. Okey. Gives advantages claimed and reasons. 2500 w. Engng-Con—April 29, 1908. No. 92042.

The Development of Agricultural Drainage in Illinois and Iowa—Controlling Laws, Physical Conditions and Costs. Jacob A. Harman. Read before the Iowa Drainage Assn. A study of drainage and its effects. 5000 w. Engng-Con—May 13, 1908. No. 92298.

Reserve Basins (Ueber Rückhaltebecken). Th. Heyd. Describes the arrangements made in Darmstadt to take care of storm-water drainage for which the pipe lines installed were inadequate. Ills. 2300 w. Gesundheits-Ing—April 4, 1908. No. 92451 D.

Garbage Disposal.

Refuse Destructor and Electricity Generating Station at Greenock. Illustrated detailed description. 2500 w. Engr, Lond —May 8, 1908. No. 92358 A.

The Cleveland, Ohio, Garbage Reduction Works. An outline of the process employed and of the apparatus used, with results. 2500 w. Eng Rec—May 23, 1908. No. 92535.

A 60-Ton Refuse Destructor in Seattle, Washington. Illustrated description of destructor of the regular Meldrum continuous-grate type, with four separate ash-pits. 3000 w. Eng Rec—May 2, 1908. No. 92070.

Re-grading.

The Re-grading of Seattle, Washington. Illustrated description of the reconstruction of a large portion of the city. 5000 w. Eng Rec—May 9, 1908. Serial. 1st part. No. 92202.

Roads.

Cost Data on Experimental Oiling of New York State Highways Together with the Results Obtained. From the report of Arnold G. Chapman, who supervised the experiments. 2500 w. Engng-Con—May 6, 1908. No. 92167.

Experiments with Dust Preventives on a Road at Wayland, Mass. Notes from an official circular issued by the Office of Public Roads. 5000 w. Eng Rec—May 2, 1908. No. 92068.

The Effect of Motors on Roads. W. J. Taylor. Read before the Incor. Inst. of Auto. Engrs. Remarks on the physical character of English roads, the effect of motors on the surface and foundations, dust, etc., with suggestions. 10700 w. Surveyor—May 15, 1908. No. 92547 A.

Sewage Disposal.

Sewage Pumping Station and Submerged Force Main, Salem, Massachusetts. William F. Bates. Illustrates and describes interesting features of this tidal water disposal system. 3500 w. Eng News—May 28, 1908. No. 92638.

Biological Purification Plants (Biologische Kläranlagen). August Marussig. A general discussion of their utility and efficiency. 4400 w. Oest Wochenschr f d Oeffent Baudienst—April 18, 1908. No. 92454 D.

Sewers.

Phenomena of the Crushing of Sewer Conduits. James N. Hazlehurst. Extract from a paper before the Am. Soc. of Munic. Imp., giving an account of failures of pipe sewers. 2500 w. Munic Engng—May, 1908. No. 92294 C.

The Employment of Rammed Concrete in the Construction of Sewers in Dresden (Die Anwendung des Stampfbetons bei den Dresdener Kanalbauten). Herr Pressprich. Illustrates and describes the structures and their construction. 1400 w. Serial. 1st part. Beton u Eisen—April 22, 1908. No. 92469 F.

Sewer Ventilation.

Sewer Ventilation and the Intercepting Trap. Francis J. H. Coutts and John S. Brodie. Two papers and general discussion. 9500 w. Jour Roy San Inst—May, 1908. No. 92317 B.

Bacteria in House Drain Pipes. Dr. F. J. H. Coutts. Describes the experiments made by Major W. H. Horrocks, recorded in a paper before the Royal Society, discussing the results, and methods of sewer ventilation. 2500 w. Munic Engng—May, 1908. No. 92293 C.

Street Cleaning.

See same title, under MECHANICAL ENGINEERING, AUTOMOBILES.

WATER SUPPLY.

Conduits.

See Tunnels, under CONSTRUCTION.

Conservation.

New York State Water-Storage and Water-Power Investigations. A review of the recent report submitted by John R. Freeman, with editorial. 5000 w. Eng News—April 30, 1908. No. 92016.

Croton Watershed.

Maximum Economical Storage Capacity of the Croton Watershed. An illustrated account of the Croton system of reservoirs and their capacity. Map. 900 w. Sci Am—May 23, 1908. No. 92506.

Dams.

The Concrete Dam of the Lynchburg Water Supply. Illustrations and description of details in the concrete block dam on the Peddlar River. 1000 w. Eng Rec —May 16, 1908. No. 92311.

A Small Concrete Dam. Samuel H. Lea. Illustrated description of a dam in South Dakota, as an example of quick and economic work. 1500 w. Eng Rec—May 9, 1908. No. 92211.

The Cataract Dam, Sydney, N. S. W. Illustrated description of this recently completed dam—the largest yet constructed in the Southern Hemisphere. 2000 w. Engng—April 24, 1908. No. 92121 A.

Method and Cost of Lock and Dam Construction by the U. S. Government on the Upper White River, Arkansas. Describes this work as given in official reports. Ills. 13000 w. Engng-Con—May 6, 1908. No. 92168.

Movable Dams for the Barge Canal. James Cooke Mills. Illustrates and describes the system of movable dams with Boule gates chosen for the Mohawk River. 1500 w. Can Engr—May 1, 1908. No. 92063.

The Break in the Hauser Lake Dam, Montana. F. L. Sizer. Illustrated account of the failure of a dam on the Missouri River, built of steel bents supporting curved steel plates. 1000 w. Eng News—April 30, 1908. No. 92017.

Filtration.

The Experimental Water Filtration Plant and the Filter Plant Improvement of the People's Water Co., Oakland, Cal. W. W. de Berard and Langdon Pearse. Explains the conditions which made necessary a greatly increased supply, and describes the scheme developed to meet the demand. Ills. 3500 w. Eng News—May 21, 1908. No. 92396.

Sand Filtration (Discours over het Wezen der Zandfiltratie). J. M. K. Pennink. A very thorough discussion of all its features. Ills. 23500 w. De Ingenieur —April 18, 1908. No. 92495 D.

Fire Protection.

Fire Protection in the New Forrest Theater, Philadelphia, Pa. Especially describes the system of automatic sprinklers. 1700 w. Eng Rec—May 23, 1908. No. 92536.

See also Fireproofing, under CONSTRUCTION; Fire Boats, under MARINE AND NAVAL ENGINEERING; and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULICS.

Ground Waters.

Subterranean Waters. Inferences and illustration, based on a diagram and record, made by Prof. Adams, of registrations made in a bore-hole sunk in St. Paul's churchyard. 3500 w. Engr, Lond —May 15, 1908. No. 92565 A.

The Development of a Water-Supply from a Gravel-Bed. Edwin Duryea, Jr. Describes a development in the Santa Clara Valley, California. 2000 w. Cornell Civ Engr—May, 1908. No. 92601 C.

The Retention of Water by the Soil with Special Reference to the Formation of Ground Water (Das Verhalten des Bodens zum Wasser mit besonderer Berücksichtigung der Grundwasserbildung). Chr. Mezger. Ills. 10000 w. Gesundheits-Ing—April 18, 1908. No. 92453 D.

See also London, under WATER SUPPLY.

Irrigation.

Divi Pumping Project, Madras Presidency. Illustrates and describes works to supply water for irrigation of a portion of Divi Island, at the mouth of the Kistna River. 1200 w. Engr, Lond—May 15, 1908. No. 92566 A.

London.

Some Observations Upon the Underground Water Supplies to the Thames Basin. Clayton Beadle. Considers especially the Kent Water Works Co.'s area, the depletion, available supplies, future supplies and requirements, etc. Appendices and discussion. 9800 w. Jour Soc of Arts—May 15, 1908. No. 92548 A.

Oakland, Cal.

Outline of the New Water Supplies for Oakland, Cal., and Other Cities on the East Shore of San Francisco Bay. Philip E. Harroun. Map and description. 2800 w. Eng News—May 7, 1908. No. 92184.

Pipe Corrosion.

Corrosion of the Steel Water Supply Conduit at Rochester, N. Y. Richard H. Gaines. Describes the construction of the pipe lines, the rust leaks, method of combating the corrosion, method of repairing and related information. Ills. 14000 w. Eng News—May 28, 1908. No. 92637.

Pipe Flow.

Curve Resistance in Water Pipes. Ernest W. Schoder. Presents results of some measurements which seem to throw new light on this subject. Ills. 5500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92642 E.

Some Pitot Tube Studies. W. B. Gregory and E. W. Schoder. A study of the distribution of velocities and pressures in straight and curved portions of a six-inch water pipe. Ills. 3000 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92259 C.

Pipe Incrustation.

Experience with Water Pipe Incrustation at Quincy, Ill. Notes from papers by W. R. Gelston, and Dr. Edward Bartow, presented before the Am. Water Works Assn. 2500 w. Eng Rec—May 16, 1908. No. 92316.

Pipe Laying.

Cost of Hauling a Water Main Across Channel at Vancouver, B. C. Extracts from a paper by John Causley, before the Can. Soc. of Civ. Engrs., describing methods and giving costs of the work. 1700 w. Eng News—May 14, 1908. No. 92276.

Pipe Lines.

A Wood Pipe Conduit. T. Chalkley Hatton. Illustrated detailed description of work in Southern New Jersey. 2300 w. Munic Jour & Engr—May 6, 1908. No. 92153.

A Long Rifled-Pipe Line for Pumping Heavy Oils. Illustrated description of an 8-in. line in California, with a total length of 282 miles. 2800 w. Eng Rec—May 23, 1908. No. 92542.

Pipes.

Interesting Test of Spiral Riveted Pipe. Reports a test of 650 pounds per sq. in. without bursting. 900 w. Boiler Maker —May, 1908. No. 92089.

The Calculation of the Strength of Pipes under External Pressure (Festigkeits-Berechnung von röhrenartigen Körpern die unter äusserem Drucke stehen). E. Hurlbrink. A mathematical discussion of several forms, the first part of the serial dealing with conduits of elliptical section. Ills. 3000 w. Serial. 1st part. Schiffbau—April 22, 1908. No. 92464 D.

Purification.

Operating Results of the Water Purification Plant at Ithaca, N. Y. E. M. Chamot. Information relative to the results and operation of the mechanical filters. 6000 w. Eng Rec—May 23, 1908. No. 92541.

See also Water Works, under WATER SUPPLY.

Reservoirs.

See Croton Watershed, under WATER SUPPLY.

Softening.

Operations of the Water Softening plant at Oberlin, Ohio. Notes on the operation, taken from the last report of W. B. Gerrish. 1000 w. Eng News—May 7, 1908. No. 92182.

Tanks.

The Distribution of Stresses in the Walls of Cylindrical Reservoirs (Ueber die Spannungsverteilung in zylindrischen Behälterwänden). H. Reissner. A mathematical paper on reinforced-concrete construction. Ills. 3000 w. Beton u Eisen—April 22, 1908. No. 92468 F.

Testing.

The Bacteriological and Microscopical Examination of Water. W. J. Dibdin. Read at conference of the Munic. Build. & Pub. Health Ex. (Abstract). Considers the importance of studying the character of waters in connection with bacteriological examinations. 2000 w. Surveyor—May 15, 1908. No. 92546 A.

Water Meters.

See same title, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Water Works.

New Orleans Water-Works. Illustrates and describes the pumping and purification plant. 2500 w. Munic Jour & Engr—May 6, 1908. No. 92152.

The Water Works System of Ottawa, Kan. Describes purification works for a river supply. Lime and sulphate of iron are used as coagulants. 1500 w. Eng Rec—May 23, 1908. No. 92543.

The Water-Supply System of Seattle, Wash. Describes a supply through a conduit 26 miles long, delivered to high reservoirs in the city. Ills. 2500 w. Eng Rec—May 23, 1908. No. 92538.

Long Distance Water Supply, El Paso & Southwestern Ry. Describes the general character and features of a project in New Mexico. 2000 w. Ry & Eng Rev—May 16, 1908. No. 92366.

Wells.

Driving a 36-Foot Well. George P. Pearce. Describes the work, and the difficulties met. 1500 w. Power—May 12, 1908. No. 92229.

Methods and Costs of Cleaning Driven Wells at Lowell, Mass. Robert J. Thomas. Describes methods used. 500 w. Eng News—May 7, 1908. No. 92183.

Small Water Supplies. W. H. Booth. Read at conference of the Munic., Build., & Pub. Health Ex. Discusses well systems and small streams as sources of water supply for small communities. 5800 w. Surveyor—May 15, 1908. No. 92545 A.

WATERWAYS AND HARBORS.

Barge Canal.

See Dams, under WATER SUPPLY.

Canada.

Transportation. M. J. Butler. Briefly describes the physical characteristics of Canada, and its water transportation routes, and railways. 6000 w. Can Engr—May 1, 1908. No. 92064.

Coast Erosion.

Coast Erosion. Dr. J. S. Owens. Discusses under-currents and their effects, winds, the nature of the bottom and its effect upon erosion and deposition, and other questions related. 3500 w. Engr, Lond—May 15, 1908. No. 92569 A.

Docks.

See Harbors, under WATERWAYS AND HARBORS.

Floods.

The Flood of March, 1907, on the Sacramento and San Joaquin River Basins, California. Continued discussion. 2500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92644 E.

See also River Regulation, under WATERWAYS AND HARBORS.

Great Lakes.

Transportation on the Great Lakes. Walter Thayer. Describes the origin, character and method of handling of the tonnage of the Great Lakes. 5000 w. R R Gaz—May 15, 1908. No. 92289.

Harbors.

Notes Upon Docks and Harbors. Luther Wagoner. Gives comparison of European and American harbors. 4500 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92643 E.

Protection of Superior Entry. A criticism of the plan as now adopted to protect the entrance to the harbor at the city of Superior, Wis. Gives plan, and states objections, and gives a proposed plan. Ills. 3000 w. Marine Rev—April 30, 1908. No. 92055.

See also Coal Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Locks.

Notes on the Footbridge, Lock and Weir, Richmond (Survey). J. H. Brierley. Points on the improvement of a tidal river, explaining the conditions and causes and the remedy for the evils. Ills. 2300 w. Surveyor—May 15, 1908. No. 92544 A.

See also Dams, under WATER SUPPLY; and Mechanical Locks, under WATERWAYS AND HARBORS.

Mechanical Locks.

Electrically Operated Locks (Elektrisch betriebene Schiffs-Hebewerke). Albert Hundt. The first part describes the Henrichenburg locks on the Danube-Oder Canal. Ills. 2000 w. Serial. 1st part. Elektrotech Zeitschr—April 16, 1908. No. 92490 D.

Monongahela River.

The Monongahela River. T. P. Roberts. Some of its characteristics and brief sketch of methods undertaken for the improvement of its navigation. Discussion. 8500 w. Pro Engrs' Soc of W Penn—May, 1908. No. 92612 D.

Piers.

Concrete Pier Construction on the Pacific Coast. H. A. Crafts. Describes special applications of sheathed and reinforced concrete. Ills. 1200 w. Cassier's Mag—May, 1908. No. 92147 B.

River Regulation.

The Relation of Water Conservation to Flood Prevention and Navigation in the Ohio River. M. O. Leighton. A paper prepared as an appendix to the Preliminary Report of the Inland Waterways Commission. Discusses the reservoir system of river control. An important paper, with editorial. 12500 w. Eng News—May 7, 1908. No. 92179.

U. S. Waterways.

The Waterways Problem. Lewis M. Haupt. A review of the present situation in the United States and the remedies suggested. 6500 w. Jour Fr Inst—May, 1908. No. 92590 D.

The Relation of the Southern Appalachian Mountains to Inland Water Navigation. M. O. Leighton and A. H. Horton. Gives results of a study of most of the navigable rivers of this region, discussing the effect which a system of reservoirs and the preservation of the forests would have on the general value of these streams. 12000 w. U S Dept of Agri—Circ 143. No. 92581 N.

Water Powers.

See Conservation, under WATER SUPPLY.

MISCELLANY.

Egypt.

Engineering in Egypt and the Soudan. Reviews the "White Book of Egypt, No. 1 (1908)" in so far as the reports are of interest to engineers. 2500 w. Engr, Lond—May 8, 1908. No. 92361 A.

Natural Resources.

The Conference on the Conservation of Natural Resources. A report of the papers and proceedings, with editorial on the results attained. Plate. 21000 w. Eng News—May 21, 1908. No. 92399.

Saving the Forests and Streams of the United States. Dr. Thomas E. Will. Discusses the economic importance of this question. Ills. 3500 w. Jour Fr Inst—May, 1908. No. 92591 D.

The Conservation of Power Resources. H. St. Clair Putnam. Abstract of an address at the conference at Washington. Discusses the available sources of power. 4500 w. Power—May 26, 1908. No. 92599.

Conservation of Ores and Minerals. Andrew Carnegie. Part of address before the White House conference. On the waste and methods of delaying their exhaustion. 3000 w. Eng & Min Jour—May 23, 1908. No. 92531.

April Meeting on the Conservation of Our Natural Resources. A report of the meeting called by the President of the U. S. to coöperate for securing the conservation of the natural resources of the country. 5000 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92258 C.

Soil Erosion.

Forest Destruction and the Erosion of Arable Lands. Day Allen Willey. An illustrated account of earth erosion in the western part of the United States, and the results, and methods of prevention. 2000 w. Sci Am—May 23, 1908. No. 92507.

ELECTRICAL ENGINEERING

COMMUNICATION.

Condensers.

The Manufacture of Electrical Condensers. G. F. Mansbridge. Gives numerical data obtained from workshop tests, considering the subject from the practical point of view. 11000 w. Inst of Elec Engrs—May, 1908. No. 92347 N.

Cylindrical Condensers (Condensadores cilindricos). Ricardo Caro. A mathematical paper on the derivation of capacity formulae for condensers of this type. Ills. 4000 w. Energia Elec—April 25, 1908. No. 92430 D.

High-Tension Condensers and Their Industrial Applications (Los Condensadores industriales de alta Tensión y sus Applicaciones). J. M. Borrell. A theoretical discussion of their design and functions and a brief review of their more important practical applications. Ills. 3000 w. Rev Tech Indus—March, 1908. No. 92427 D.

Radio-Telegraphy.

See Tele-Photography, under COMMUNICATION.

Radio-Telephony.

A Practical System of Wireless Telephony. Leon L. Thomas. An illustrated explanation of the system of Dr. Lee De Forest. 2000 w. Jour Worcester Poly Inst—May, 1908. No. 92577 C.

Signal Horns.

Electric Signal Horns (Elektrische Signalhuppen). Kurt Perlewitz. Illustrates and describes many types. 3500 w. Elektrotech Zeitschr—April 30, 1908. No. 92493 D.

Telegraph Cables.

See Telephone Cables, under COMMUNICATION.

Telephone Cables.

The Design and Use of Telephone and Telegraph Cables. F. Tremain. Abstract of paper before the Newcastle Loc. Soc. of the Inst. of Elec. Engrs. Deals with the construction and use of paper-insulated lead-sheathed cables. 4000 w. Elect'n, Lond—April 24, 1908. No. 92117 A.

Telephone Exchanges.

The Destruction of the Central Telephone Exchange of Anvers and the Temporary Replacement of the Installations (La Destruction du Bureau Central des Téléphones d'Anvers et le Rétablissement provisoire des Installations). Emile Piérard. An account of the destruction of the exchange by fire and the temporary arrangements for the continuance of service during the construction of a new building. Ills. 6000 w. Soc Belge d'Elecns—April, 1908. No. 92406 E.

Telephony.

A Study of Multi Office Automatic Switchboard Telephone Systems. W. Lee Campbell. Discusses the enormous waste involved, the reasons that make the waste necessary in manually operated systems, and how it can be reduced in systems employing automatic switchboards. 7000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92390 D.

Tele-Photography.

Knudsen's System of Wireless Transmission of Photographs. Brief illustrated description. 7000 w. Elect'n, Lond—May 1, 1908. No. 92243 A.

DISTRIBUTION.

Fuses.

Cartridge-Type Fuses. Illustrates and describes various types. 1500 w. Elec Engr, Lond—April 24, 1908. No. 92110 A.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Modern Development in Single-Phase Generators. W. L. Waters. A discussion of the difficulties met and overcome. Ills 2200 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92382 D.

Parallel Operation of Alternators. Henry Herman. Analysis of the action in a synchronous unexcited machine, explaining the development of torque. Also editorial. 2000 w. Elec Wld—May 23, 1908. No. 92505.

Theoretical and Practical Notes on the Parallel Operation of Alternating-Current Generators (Theoretisches und Praktisches über den Parallelbetrieb von Wechselstrommaschinen). L. Fleischmann. A mathematical discussion. Ills. 2800 w. Elektrotech a Maschinenbau—April 19, 1908. No. 92462 D.

A New Method of Voltage Regulation in A. C. Dynamos (Ein neues System der Spannungsregelung für Wechselstrom-Generatoren). M. Seidner. Illustrates and describes the proposed arrangement. 4000 w. Elektrotech Zeitschr—April 30, 1908. No. 92494 D.

Deformation of the Voltage Curves of Single and Polyphase Generators under Load (Die Veränderung der Spannungskurven bei belasteten Ein- und Mehrphasengeneratoren). Egon Siedek. A mathematical paper, based on experiments, illustrated by curves and diagrams. 2800 w. Elektrotech u Maschinenbau—April 5, 1908. No. 92461 D.

The Deformation of the Voltage Curve of Alternators when Loaded. E. Siedek. Abstract translation from *Elektrotechnik und Maschinenbau*. An experimental study. 1500 w. Elec Engr, Lond—April 24, 1908. No. 92111 A.

See also Windings, under DYNAMOS AND MOTORS.

A. C. Motors.

A Single Alternating-Current Motor. Frederick E. Ward. Illustrated detailed description of how it can be built at home. 4000 w. Sci Am Sup—May 9, 1908. No. 92194.

The Single-Phase Commutator-Type Motor. B. G. Lamme. Describes methods of commutation at slow speed and full speed, the effect of reduction in frequency, discussing the question of power factor and other problems related. 6500 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92392 D.

Brakes.

A New Type of Friction Brake. H. D. James. Illustrated description of a cast-iron brake bearing on a cast-iron wheel. 1500 w. Elec Jour—May, 1908. No. 92292.

D. C. Dynamos.

Direct-Current Generators for Light, Power and Tramway Service. E. Korrodi. Considers the advantage of using one type of generator for the combined service, and the operation of the machines. 2000 w. Elect'n, Lond—May 1, 1908. No. 92242 A.

Parallel Operation of Direct Current Generators. H. R. Mason. Considers some modifications demanded under certain circumstances. Diagram. 2000 w. Power—May 26, 1908. No. 92600.

The Iglésis-Regner Dynamo with Constant Output at Variable Speeds (Dynamo Iglésis-Regner à Débit Constant sous Vitesses variables). M. Iglésis. Illustrates and describes a dynamo particularly adapted to train lighting. 6000 w. Bul Soc Int d'Elecns—April, 1908. No. 92407 F.

See also Interpoles, under DYNAMOS AND MOTORS.

D. C. Motors.

Direct Current Motors. An explanation of some of the terms and the operation of such motors. 1200 w. Ry & Loc Engng—May, 1908. No. 92059 C.

See also Interpoles, under DYNAMOS AND MOTORS.

Induction Motors.

Operation of Polyphase Induction Motors. R. H. Fenkhausen. Treats of autostarters, motor installation, causes of short circuits, etc. 2000 w. Power—May 5, 1908. No. 92141.

See also Electric Power, under MINING AND METALLURGY, MINING.

Interpoles.

The Influence of Interpoles on the Operation of D. C. Dynamos and Motors (Der Einfluss der Wendepole auf die Leistung der Gleichstromdynamomaschinen und -Motoren). Hermann Zipp. The first part of the serial is mathematical and theoretical. Ills. 2400 w. Serial. 1st part. Elektrotech u Polytech Rundschau—April 17, 1908. No. 92463 D.

Pole Pieces.

Pole Piece Design for Dynamos. E. A. Löf. Gives present practice in designing the punchings, end-plates, rivets and bolts. Ills. 700 w. Mach, N Y—May, 1908. No. 92094 C.

Railway Motors.

Motors for Electric Traction (Tracción electrica : Motores). Luis Pereda. A discussion of the various types adapted to railway service. Ills. 5000 w. Energia Elec—April 10, 1908. No. 92429 D.

Windings.

Application of Fractional Pitch Windings to Alternating-Current Generators. Jens Bache-Wüg. Considers points leading to the use of chorded winding for a.-c. generators from the standpoint of manufacture and design, indicating the influence the winding has on the performance of a machine. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92387 D.

ELECTRO-CHEMISTRY.

Alkalies.

The Electrolytic Alkali and Bleach Industry in 1907. John B. C. Kershaw. A report for Europe and America of the present capacity of the works. 2000 w. Elect'n, Lond—April 24, 1908. No. 92114 A.

Calcium Cyanamide.

The Manufacture of Calcium Cyanamide. John B. C. Kershaw. General remarks on artificial fertilizers with a description of the Frank and Caro process for the fixation of nitrogen. Ills. 3000 w. Elec Wld—May 9, 1908. No. 92178.

Corrosion.

Electrolytic Corrosion. W. W. Haldane Gee. Abstract of paper and discussion presented at the Manchester Loc. Sec. of the Inst. of Elec. Engrs. Deals with the conditions which may produce corrosion, and with suggestions for its prevention. 7500 w. Elect'n, Lond—April 24, and May 1, 1908. Serial. 2 parts. No. 92241 each A.

Electrochemical Society.

Albany Meeting of the American Electrochemical Society. An illustrated account of the recent meeting with abstracts of papers presented, dealing with resistances, absorption, cells, fundamental units, corrosion, light, alloys, concentration, refining, etc. 18800 w. Elec-Chem & Met Ind—June, 1908. No. 92619 C.

Electro-Metallurgy.

The Electro-Chemical Industry (Die elektrochemische Industrie). Dr. Stange. Begins a statistical and historical review of the development of electro-metallurgy. 2500 w. Serial. 1st part. Elektrochem Zeitschr—April, 1908. No. 92433 D.

Glass Making by Electricity (Fabrication électrique du Verre). E. Zampini. Illustrates and describes the application of the electric furnace in the glass industry. 1500 w. Serial. 1st part. Rev d'Eletrochim et d'Electrométal—Feb.-March, 1908. No. 92408 F.

A New Electric Arc Furnace for Laboratory Researches, due to Louis Clerc and Adolph Minet (Sur un nouveau Four électrique à Arc applicable aux Recherches du Laboratoire dû à MM. Louis Clerc et Adolphe Minet). Adolphe Minet. Illustrated description. 1500 w. Serial. 1st part. Rev d'Electrochim et d'Electrométal—Feb.-March, 1908. No. 92409 F.

See also same title, under MINING AND METALLURGY, IRON AND STEEL.

Electro-Plating.

Copper Plating. Frederich Hartmann. Trans. from *Das Verzinnen Verzinken.* An explanation of methods. 1000 w. Sci Am Sup—May 9, 1908. No. 92193.

Recovery of Gold and Silver Residues. Dr. Theodor Koller. Abstract translation from *Handbuch der Verwertung, etc.* Practical suggestions. 3000 w. Sci Am Sup—May 23, 1908. No. 92510.

Russia.

Technical Electrochemistry in Russia. N. Piltschikoff. Read before the Faraday Soc. 500 w. Elec Engr, Lond—May 8, 1908. No. 92349 A.

ELECTRO-PHYSICS.

Cells.

Electricity from Coal. Editorial discussion of the claims of carbon-consuming batteries. 2500 w. Elec Age—April, 1908. No. 92218.

Electrons.

The Electron Theory. Edward A. Partridge. An explanation of the electron theory, describing briefly its experimental foundations. 4000 w. Jour Fr Inst. May, 1908. No. 92594 D.

Oscillations.

A New Method of Obtaining Undamped Oscillations. O. M. Corbino. Translated from *L'Elettricista.* Explains method and principle upon which it is based. 700 w. Elect'n, Lond—April 24, 1908. No. 92116 A.

GENERATING STATIONS.

Accumulators.

Installation and Operation of Electric Accumulators (Installation et Fonctionnement des Accumulateurs électriques). Marcel Fontan. Their construction, installation, operation and care are discussed. Ills. 2000 w. Rev d'Econ Indus —April 16, 1908. No. 92401 D.

Central Station.

Power Station for Delaware & Hudson Company. Illustrated description of steam-turbine station at Mechanicsville, N. Y. 1300 w. St Ry Jour—May 9, 1908. No. 92166.

Recent Extensions of the Manchester Electrical Department. An illustrated article showing the rapid development taking place in this city. 2300 w. Elec Rev, Lond—May 15, 1908. No. 92554 A.

The Commonwealth Edison Company. Illustrates and describes the system supplying electricity for Chicago and vicinity. 2500 w. Elec Rev, N Y—May 16, 1908. No. 92304.

The System and Operating Practice of the Commonwealth Edison Company, Chicago. Illustrated detailed description of the system and its operation. 13500 w. Elec Wld—May 16, 1908. No. 92338.

See also Garbage Disposal, under CIVIL ENGINEERING, Municipal.

Hydro-Electric.

Ice Troubles in Hydraulic Power Work and Methods of Overcoming Them. John Murphy. Address at McGill Univ. Explains troubles caused by frazil ice and success by fighting it with a small steam plant. Ills. 5000 w. Can Engr—May 1, 1908. No. 92065.

The Kashmir Power Scheme. An illustrated descriptive account of the development of the Jhelum River, which is to develop 20000 h.p. 2500 w. Elec Engr, Lond—May 15, 1908. No. 92553 A.

A Hydro-Electric Development in American Fork Canyon, Utah. A. P. Merrill. Illustrated description with information relating to the work. 3000 w. Eng Rec—May 9, 1908. No. 92206.

The Post Falls Development of the Washington Water Power Company. C. S. MacCalla. Illustrated description of a plant in Idaho to be operated in parallel with the Spokane hydraulic and steam plants, with controlling works for the storage of water. 2500 w. Elec Wld—May 23, 1908. Serial. 1st part. No. 92503.

A Combined Steam and Hydraulic Generating Station in Switzerland. Frank Koester. Illustrated description of a plant at Beznau on the Aare, employing high and low-water hydraulic turbines as well as steam turbines. 2500 w. Eng Rec—May 16, 1909. No. 92309.

The High-Tension Power Development of the Urft Valley (Die Hochspannungs-Kraftübertragung an der Urfttalsperre). Illustrated description of dam, power house, transmission lines, etc. 1500 w. Serial. 1st part. Elektrotech Zeitschr—March 19, 1908. No. 92486 D.

The Power Developments of the Rur Valley Company (Die Kraftübertragungsanlagen der Rurtalsperren-Gesellschaft). Franz Bauwens. Illustrated description of the four power plants and the transmission line and other installations of this large company. 6000 w. Serial. 1st part. Zeitschr d Ver Deutscher Ing—April 18, 1908. No. 92481 D.

Management.

Meter Department of the Central Station. Joseph B. Baker. Considers the evolution of the meter department, meter readings, numbering systems, the stockroom, records, etc. 5400 w. Elec Age—June, 1908. No. 92367.

Operation.

See A. C. Dynamos, under Dynamos and Motors.

Switchboards.

Meter and Relay Connections. Harold W. Brown. Presents a few principles to be observed in making connections, applying them to questionable cases. 2000 w. Elec Jour—May, 1908. No. 92291.

Tariffs.

Modern Methods of Charging (Beitrag zur modernen Tarifbildung). Th. Gruber. A comparison of methods of establishing charges for electrical energy for lighting and power. Ills. 3500 w. Elektrotech Zeitschr—March 26, 1908. No. 92489 D.

Transformers.

See same title, under TRANSMISSION.

LIGHTING.

Illumination.

The Problem of Illumination. Arthur J. Sweet. Read before the Pittsburg Sec. of the A. I. E. E. Considers the paramount importance of efficiency and the meaning of the term. 5500 w. Elec Age —April, 1908. No. 92220.

Economical Aspects of the Various Electric Illuminants. Alfred A. Wohlauer. Gives economic statistics and conclusions. 1500 w. Elec Wld—May 16, 1908. No. 92340.

A New Method of Obtaining Polar Curves of Distribution of Light of Artificial Illuminants. W. Voege. Abstract translation from *Elek. Zeit.* Explains the use of a thermopile and the precautions to render the method sufficiently accurate for practical use. 1800 w. Elect'n, Lond —May 8, 1908. No. 92353 A.

Incandescent Lamps.

The New Incandescent Lamps. Francis W. Willcox. Abstract of a paper before the Iowa Elec. Assn. Discusses the tantalum, and the tungsten lamps and the effect they will have on the lighting industry. 3500 w. Elec Rev, N Y—May 16, 1908. No. 92307.

Tungsten Development. A. H. Keleher. On the present standing of the new tungsten lamp. 1200 w. Elec Rev, N Y— May 16, 1908. No. 92305.

Metallic and Carbon Filaments (Filaments métalliques et Filaments de Carbone). Compares the results of comparative researches on illuminating power of various filaments, made by Hirschauer in Germany and Loring in America. Ills. 2000 w. L'Elecn—April 25, 1908. No. 92413 D.

The Metallic Filament Incandescent Lamps (Les Lampes à Incandescence à Filaments Métalliques). G. de Lamarcodie. A review of recent advances in tantalum, tungsten, osmium and zinconium lamps. Ills. 3000 w. Rev Gen d Sci—April 15, 1908. No. 92410 D.

Photometry.

Photometers. Joseph H. Hart. Remarks on their development and use. 1800 w. Elec Rev, N Y—May 23, 1908. No. 92517.

MEASUREMENT.

Cable Testing.

The High-Tension Testing Plant of the Siemens-Schuckert Cable Factory, Nonnendamm (Die Hochspannungsprüfanlagen der Kabelfabrik der Siemens-Schuckertwerke, Nonnendamm). Leo Lichtenstein. Illustrated description of equipment and methods. 2400 w. Serial. 1st part. Elek Kraft u Bahnen—April 14, 1908. No. 92474 D.

Dynamo Testing.

Artificial Loads for Testing Electrical Generators. R. K. Morcom and D. K. Morris. Abstract of a paper read before the Birmingham Loc. Sec. of Inst. of Elec. Engrs. Deals with the use of water resistances as artificial loads and gives details of a tank for high-tension testing, giving an account of experimental investigations. Discussion. 5000 w. Elect'n, Lond—April 17, 1908. No. 91994 A.

Insulator Testing.

See Insulators, under TRANSMISSION.

Meters.

See Management, under GENERATING STATIONS.

Power Factor.

Three-Phase Power Factor. Austin Burt. Derives a general expression which will enable the mean power-factor to be determined, and develops a method by which the required values may be determined from the standard switchboard instruments. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92385 D.

Stroboscope.

The Measurement of Rotary Speeds of Dynamo Machines by the Stroboscopic Fork. A. E. Kennelly and S. E. Whiting. Calls attention to what has been accomplished and to a modification of the principle which has been developed by the authors. Ills. 3500 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92391 D.

Transformer Testing.

Transformer Testing. W. M. Hollis. Outlines a method of determining the full-load efficiency in which only a fraction of the full-load energy is required and few instruments. 1300 w. Elec Wld —May 2, 1908. No. 92005.

TRANSMISSION.

Arcing Grounds.

Tests with Arcing Grounds and Connections. Ernst J. Berg. A report of tests. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92389 D.

Cable Records.

Subway and Cable Records for Electric Light Companies. Charles Holmberg. Directions for drawing a cable report. Ills. 1200 w. Elec Wld—May 2, 1908. No. 92004.

Cables.

See Telephone Cables, under COMMUNICATION; and Insulation, under TRANSMISSION.

Cable Troubles.

A Few Unusual Burn-Outs of Underground Cables. D. W. Roper. Describes cable troubles where the arc at the point of break down, or the current flowing to the lead sheath, injures other cables. Ills. Discussion. 9000 w. Jour W Soc of Engrs—April, 1908. No. 92321 D.

Conduits.

Underground Conduits. E. S. Larned. Illustrates and describes a new monolithic duct system for telephone, telegraph, electric light and power conduits. 2500 w. Cement Age—May, 1908. No. 92295 C.

Inductance.

Inductance of Electric Transmission Lines with Unsymmetrically Disposed Conductors. Alfred Still. Gives an analysis of the e.m.f.'s induced in a multiphase transmission line. 1800 w. Elec Wld—May 23, 1908. No. 92504.

The Inductive Effect in Parallel Conductors (Ueber die Induktionswirkungen paralleler gestrekter Leiter). E. Orlich. A mathematical discussion. Ills. 2500 w. Elektrotech Zeitschr—March 19, 1908. No. 92487 D.

Insulation.

Cable Insulation. Compiled from notes by W. A. Del Mar. Deals with materials used, their thickness, calculations, tests, etc. 4000 w. Elec Age—June, 1908. No. 92368.

Insulators.

The Testing Laboratory of the Hermsdorf Porcelain Works. William Weicker. Illustrated description of this laboratory in Germany and the tests made. 2000 w. Elect'n, Lond—April 24, 1908. No. 92115 A.

Lightning.

Studies in Lightning Performance, Season 1907. N. J. Neall. Discusses line disturbances on the Taylor's Falls line of the Minneapolis Electric Co.; and station lightning phenomena at Cumberland Mills, near Portland, Me. Ills. 8000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92381 D.

Lightning Protection.

Comparative Tests of Lightning Protection Devices on the Taylor's Falls Transmission System. J. F. Vaughan. Gives data obtained on an operating line equipped experimentally with various protective devices. Ills. 4000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92380 D.

Lines.

Distribution of Niagara Energy in Auburn. Illustrates and describes an interesting secondary system for distributing energy. 1200 w. Elec Wld—May 2, 1908. No. 92002.

Central Station Distributing System. H. B. Gear and P. F. Williams. A discussion of secondary distributing systems, their design, advantages, etc. 5000 w. Elec Age—April, 1908. No. 92219.

See also Hydro-Electric, under GENERATING STATIONS.

Protective Devices.

Modern Arrangements for Protection against Dangerous Currents in Transmission Lines (Moderne Schutzeinrichtungen gegen gefahrbringende Ströme in elektrischen Netzen). Karl Kuhlmann. A theoretical and practical discussion of such devices. Ills. 4500 w. Serial. 1st part. Elektrotech Zeitschr—March 19, 1908. No. 92488 D.

Substations.

See same title, under STREET AND ELECTRIC RAILWAYS.

Transformers.

The Series Transformers. E. S. Harrar. Explains the action, developing formulae. 2000 w. Elec Wld—May 16, 1905. No. 92341.

The Choice of Transformers for Central Stations. L. A. Sterrett. Claims that low all-day efficiency is not economical, and that the best and cheapest service is secured by buying the transformer with the best regulation. 800 w. Elec Wld—May 2, 1908. No. 92003.

See also Transformer Testing, under MEASUREMENT.

Voltage Regulation.

Compensation of Pressure Variations on Alternate-Current Networks Supplying Motors. A. Heyland. Describes several arrangements which not only compensate the drop, but may produce "over-compensation" if desired. 2500 w. Elect'n, Lond—April 24, 1908. No. 92113 A.

Wire Suspension.

The Tangential System of Suspending Overhead Trolley and Transmission Wires. Robert N. Tweedy. Read before the Dublin Sec. of the Inst. of Elec. Engrs. Presents the advantages of this system and its economy. 5000 w. Elect'n, Lond—May 15, 1908. No. 92557 A.

MISCELLANY.

A. C. Diagrams.

The Alternating-Current Circle Diagram. Charles F. Smith and William Cramp. Gives a number of cases illustrating their use. 2500 w. Mech Engr—May 1, 1908. Serial. 1st part. No. 92237 A.

Fire Risk.

Electricity as Viewed by the Insurance Engineer; Should the A. I. E. E. Interest Itself in Fire Protection? C. M. Goddard. Gives statistics of fire losses, urging united action. 2200 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92388 D.

Franco-British Exhibition.

The Franco-British Exhibition. An illustrated description of the electric lighting and wiring. 3000 w. Elect'n, Lond—May 15, 1908. No. 92558 A.

Hotel Equipment.

The Electrical Equipment of the Piccadilly Hotel (London). Illustrated descriptions of the applications for lighting, power, telephones, bells, heating, clocks, etc., at this new hotel. 2500 w. Elect'n, Lond—May 8, 1908. No. 92352 A.

Kelvin.

The Kelvin Lecture. Abstract of the first of the Kelvin annual lectures, delivered by Prof. Silvanus Thompson, the subject being "The Life and Work of Lord Kelvin." 6000 w. Elect'n, Lond—May 8, 1908. No. 92351 A.

Resistance Coils.

Construction of Resistances. Shows how a little care in construction can make appliances nearly perfect. 1100 w. Elec Engr, Lond—April 24, 1908. No. 92109 A.

INDUSTRIAL ECONOMY

Apprenticeship.

The Crisis of Apprenticeship (La Crise de l'Apprentissage). Paul Besson. Discusses the moral, economic and legislative causes of the decline of apprenticeship in France and the possible remedies. 6500 w. Mem Soc Ing Civ de France—Feb., 1908. No. 92402 G.

Commercial Research.

Commercial Research. C. E. Skinner. An address at Purdue University. A discussion of its field and methods, with particular reference to the electrical manufacturing industry. 7000 w. Elec Jour—April, 1908. No. 92038.

Cost Systems.

A Practical Foundry Cost System. Explains methods used in a foundry at Seneca Falls, N. Y. 1400 w. Foundry—May, 1908. No. 92050.

Obtaining Actual Knowledge of the Costs of Production. F. E. Webner. This second article of a series, explains when and where a close knowledge is needed. 2000 w. Engineering Magazine—June, 1908. No. 92623 B.

Education.

The Teaching of Evening Students in Engineering. W. J. Crawford. Discusses the necessary qualifications, and the methods of the teachers. 4000 w. Elec Rev, Lond—May 15, 1908. No. 92556 A.

Technical Welfare Work. Sydney Whitmore Ashe. Considers the raising of the standing of employees who have not had a college training. 3000 w. Elec Wld—May 16, 1908. No. 92342.

Discussion on "The Education of the Electrical Engineer," at New York, January 24, 1908. 27000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92379 D.

Mathematics and Engineering. Prof. W. C. Kernot. Read before the Victorian Inst. of Engrs. A discussion of how much and what kind of mathematics is needed by an engineer. 2500 w. Aust Min Stand—April 8, 1908. Serial. 1st part. No. 92255 B.

The Relation Between Recent Industrial Progress and Educational Advance. Frank T. Carlton. An interesting review of the industrial development of the United States and the demands on the educational system. 7000 w. Pop Sci M—June, 1908. No. 92617 C.

President Humphreys' Address at the Annual Alumni Dinner of Stevens Institute. A presentation of the author's opinions on certain features of engineering education. 6500 w. Stevens Ind—April, 1908. No. 92586 D.

Engineering and Industrial Education. Fred A. Geier. On the results obtained by coöperation between manufacturers and the Univ. of Cincinnati. 3200 w. Am Mach—Vol. 31. No. 19. No. 92156.

A Four-Years Course in Industrial Engineering. Hugo Diemer. Presents a proposed scheme for preparing the student for industrial work, comparing with twelve well-known courses. 4500 w. Engineering Magazine—June, 1908. No. 92624 B.

Engineering.

A Study of Engineering. Albert J. Himes. An address delivered at the 5th annual banquet of the Cornell Assn. of Civ. Engrs. 6000 w. Cornell Civ Engr—May, 1908. No. 92602 C.

Engineering Ethics.

See same title, under MINING AND METALLURGY, Mining.

Exhibitions.

The Franco-British Exhibition. Plan and illustrated description of buildings and other features. 2500 w. Engng—May 15, 1908. Serial. 1st part. No. 92563 A.

Labor.

The Young American Workman as Seen by a Shop Superintendent. C. R. McGahey. A reply to an article in the April number of this magazine. Considers trade schools a remedy for defective home and union training. 1000 w. Engineering Magazine—June, 1908. No. 92626 B.

Management.

Task and Bonus in Management. H. L. Gantt. Gives an application of this method. 3500 w. Stevens Ind—April, 1908. No. 92584 D.

Storing, Issuing and Accounting for Material. Oscar E. Perrigo. Eighth of a series of articles on cost keeping and shop management. 3500 w. Ir Trd Rev—May 7, 1908. No. 92161.

The Management of Engineering Workshops. Eustace Thomas. Read before the Inst. of Elec. Engrs. Gives examples of modern management. 7000 w. Ir & Coal Trds Rev—April 24, 1908. No. 92135 A.

Maximum Production Through Organization and Supervision. C. E. Knoeppel. This third article of the series deals with economy in the use of materials and time. 5000 w. Engineering Magazine—June, 1908. No. 92627 B.

See also Commercial Research, Cost Systems, and Wages, under INDUSTRIAL ECONOMY.

Profit Sharing.

Co-Partnership. Sir George Livesey. Abstract of paper read before the Gt. W. Ry. Lecture and Debating Soc., London. An explanation of the system and its advantages. 3000 w. Ir & Coal Trds Rev—April 24, 1908. No. 92134 A.

Safety Devices.

The American Museum of Safety Devices. Herbert T. Wade. Explains the purpose and economic value, giving an illustrated description of exhibits. 4500 w. Engineering Magazine—June, 1908. No. 92622 B.

Stores Keeping.

See Management, under INDUSTRIAL ECONOMY.

Wages.

Piece Work and Premium Work. An editorial on the strength and weakness of these plans with special reference to railroads. 2000 w. R R Gaz—May 8, 1908. No. 92169.

Experience with the Piece Work and Premium Plans. Clinton Alvord. Gives instances showing the working of these systems. 2000 w. Am Mach—Vol. 31. No. 19. No. 92157.

MARINE AND NAVAL ENGINEERING

Armor.

Regarding Armor and Its Attack. J. B. Van Brussel. Reviews the history of its use for the protection of ships, the improvements made and processes of manufacture, discussing the attack, and giving tests. Ills. 2500 w. Sci Am Sup—May 2, 1908. No. 92019.

Battleships.

H. M. SS. Agamemnon and Indomitable. Illustrations with brief description. 600 w. Engr, Lond—April 24, 1908. No. 92131 A.

The New German Battleship "Ersatz-Bayern." Illustrates a recently launched vessel, with brief description. 500 w. Sci Am Sup—May 9, 1908. No. 92191.

Cruisers.

The French Armored Cruiser Edgar Quinet. J. G. Peltier. Illustrated description of the largest armored cruiser ever built on the continent of Europe. 700 w. Int Marine Engng—June, 1908. No. 92374 C.

Dredges.

New Sea-going Dredge Raritan. Brief description, with illustration. 700 w. Naut Gaz—May 28, 1908. No. 92631.

Electric Power.

The Electric Generating Station on Shipboard (Le Centrali elettriche a Bordo delle Navi). Giuseppe Belluzzo. A discussion of electric power for ship propulsion as a means of avoiding the difficulties of high-speed in steam turbines. Ills. 3000 w. L'Indus—April 12, 1908. No. 92422 D.

Fire-Boats.

Electrically-Propelled Fire Boats for Chicago. Describes the boats and their equipment, giving plan and elevation. 2000 w. Elec Wld—May 16, 1908. No. 92339.

Gas Engines.

Capitaine Producer-Gas-Driven Ship. An account of trials carried out upon the Clyde. 1200 w. Sci Am Sup—May 23, 1908. No. 92508.

Gasolene Engines.

The Redbridge 8-Cyl. Marine Engine. Illustrates and describes the constructional features. 1200 w. Auto Jour—April 25, 1908. No. 92104 A.

The Internal-Combustion Engine. W. G. Winterburn. An elementary description of the gasolene engine as used for propelling small vessels. 2500 w. Naut Gaz—May 29, 1908. No. 92632.

See also Motor Boats, under MARINE AND NAVAL ENGINEERING.

Hydroplanes.

The Hydroplane (L'Idroplano). G. Arturo Crocco. Discusses fully the theory of their design and describes the types already built. Ills. 10000 w. Rivista Marit—April, 1908. No. 92421 E + F.

Motor Boats.

How to Build a Launch for $100. Describes the building of the launch "Minnow." Ills. 2000 w. Rudder—May, 1908. Serial. 1st part. No. 92137 C.

Commercial Power Boats of the Northwest Pacific Coast. F. M. Foulser. Shows the important place won for the gasolene engine in the fishing and coasting industries, and for river and lake boats. Ills. 2500 w. Rudder—May, 1908. No. 92139 C.

Oil Firing.

A Patent Oil-Firing System. A. K. Fisher. Illustrates and describes the system invented by Ernest Koerting, used so successfully on the British destroyers of the Mohawk class. 1200 w. Int Marine Engng—June, 1908. No. 92378 C.

Propellers.

Results of Further Model Screw-Propeller Experiments. R. E. Froude. Read before the Inst. of Nav. Archts. A report of experimental investigations. 3000 w. Engng—April 24, 1908. Serial. 1st part. No. 92122 A.

Resistance.

Ship-Model Experiments. — A New Method of Research Work on Fluid Resistance and Ship Propulsion. H. Wellenkamp. Explains method of investigating towing resistance, frictional and air resistance, and propulsion. Ills. 5000 w. Engng—April 24, 1908. No. 92125 A.

Ship Design.

Factors of Safety in Marine Engineering. John Oliver Arnold. Read before the Inst. of Naval Archts. A criticism of methods of design. 2500 w. Engng—April 24, 1908. Serial. 1st part. No. 92126 A.

Steamboats.

New Steamer City of Cleveland. Illustrates and describes a new vessel for service between Detroit and Cleveland, with report of trial trip. 2000 w. Marine Rev—May 7, 1908. No. 92195.

Steam Boilers.

See Oil Firing, under MARINE AND NAVAL ENGINEERING.

Steam Engines.

See Superheating, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Steamships.

Egyptian Mail Turbine-Steamers "Heliopolis" and "Cairo." Plates and description of new vessels for service between Marseilles and Alexandria. 2500 w. Engng—April 24, 1908. Serial. 1st part. No. 92124 A.

Steam Turbines.

See Steamships, and Yachts, under MARINE AND NAVAL ENGINEERING.

Steering Gear.

Notes on Steering Gear. Illustrates and describes various types. 2000 w. Int Marine Engng—June, 1908. No. 92377 C.

Submarines.

A Submarine Boat for Sponge Fishing. Capt. Jourdan. Illustrated description. 900 w. Sci Am—May 9, 1908. No. 92187.

Italian Submarines. R. G. Skerrett. An illustrated account of some large submarines. 2200 w. Sci Am Sup—May 23, 1908. No. 92509.

Shipping Submarines Intact to the Philippines. Brief illustrated account of the method of shipping two boats on the deck of the collier "Caesar." 800 w. Sci Am —May 9, 1908. No. 92189.

Tugs.

Thames Conservancy Tug and General Service Steamer Darent. Illustrated description. 900 w. Engr, Lond—May 15, 1908. No. 92570 A.

Yacht Lighting.

Electric Lighting. D. A. Richardson. Illustrates and describes details of the correct plant for boats of various sizes 2500 w. Rudder—May, 1908. No. 92138 C.

Yachts.

The New Turbine Yacht Alexandra. Illustrated description. 700 w. Cassier's Mag—May, 1908. No. 92146 B.

The Twin Screw Steam Yacht Liberty. Benjamin Taylor. Illustrated description of a vessel built for Joseph Pulitzer, of New York. 1800 w. Int Marine Engng—June, 1908. No. 92376 C.

A Clyde-Built Turbine Yacht for America. Benjamin Taylor. Illustrated description of the "Vanadis," built for C. K. G. Billings. 800 w. Int Marine Engng—June, 1908. No. 92375 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air Cooling.

Air-Cooled v. Water-Cooled Engines. A. J. McKinney. Presents the advantages of the air-cooled engine for small light cars. 3500 w. Auto Jour—May 2, 1908. No. 92234 A.

Atholl.

A New Scotch 25 H. P. Car. Illustrated description of a new medium-priced pleasure car. 2000 w. Autocar—May 9, 1908. No. 92343 A.

Carburetters.

See Napier, under AUTOMOBILES.

Clutches.

Clutches, with Special Reference to Automobile Clutches. Henry Souther. Illustrates and describes various types and their applications. 7500 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92262 D.

Commercial Vehicles.

Commercial Motor Vehicles. Reviews the recently issued report of the trials conducted by the Royal Automobile Club. 4000 w. Engng—May 1, 1908. Serial. 1st part. No. 92247 A.

See also Omnibuses, and Street Cleaning, under AUTOMOBILES.

Daimler.

The De Luca Daimler. Illustrated description of an Italian example of the 17-21 h.p. Daimler. 1500 w. Autocar—May 16, 1908. No. 92551 A.

Electric.

Maxim's Re-Entry into the Electric Field. Brief illustrated description of the new Maxim and Goodridge electric. 1600 w. Automobile—April 30, 1908. No. 92041.

See also Omnibuses, under AUTOMOBILES.

Gears.

The Hope-Maberly Variable Gear. Illustrated description of an ingenious epicyclic mechanism. 2000 w. Auto Jour—May 9, 1908. Serial. 1st part. No. 92344 A.

Electric Clutches and Speed Changing Gears on Combustion-Motor Vehicles (Embrayages et Changements de Vitesse électriques sur les Automobiles à Essence). Illustrates and describes various devices. 3000 w. Génie Civil—April 11, 1908. No. 92418 D.

Hispano-Suiza.

The 1908 Hispano-Suiza Cars. Illustrated detailed description of cars built in Barcelona, Spain. 900 w. Auto Jour—April 25, 1908. Serial. 1st part. No. 92103 A.

Horns.

See Signal Horns, under ELECTRICAL ENGINEERING, COMMUNICATION.

Ignition.

Electric Ignition Devices. S. F. Walker. A plea for greater strength and greater care. 2500 w. Autocar—May 2, 1908. No. 92236 A.

Metallurgique.

The Metallurgique Cars, 1908 Models. Illustrates and describes the special features. 2000 w. Auto Jour—May 16, 1908. Serial. 1st part. No. 92549 A.

Motors.

The Six-Cylinder Automobile. Herbert L. Towle. Considers the relative advantages of four and six-cylinder engines. Ills. 2500 w. Cassier's Mag—May, 1908. No. 92149 B.

The Two-Cycle Question (Beiträge zur Zweitaktfrage). Herr Schwerdtfeger. A discussion of the present status of the two-cycle motor for automobiles. 3000 w. Zeitschr d Mit Motorwagen Ver—April 30, 1908. No. 92466 D.

See also Air Cooling, under AUTOMOBILES.

Napier.

The 80-H.P. Napier Touring Car and Carburettor. Brief description with views of the carburettor. 1800 w. Auto Jour—May 16, 1908. No. 92550 A.

Omnibuses.

The Greenwood and Batley Petrol-Electric 'Bus. Illustrated description. 800 w. Elec Rev, Lond—May 1, 1908. No. 92240 A.

Motor Omnibus Traffic in Paris (Der Pariser Motoromnibusverkehr). Herbert Bauer. Describes the cars used, their maintenance and operation, etc. Ills. 5000 w. Zeitschr d Mit Motorwagen-Ver—April 30, 1908. No. 92465 D.

Road Trains.

Road Traction by Renard Trains (Traccion en los Caminos : Trenes Renard). Francisco J. Casas. An elaborate discussion of the history of road trains, the operation of the Renard train, design, resistance, loads, etc. 5600 w. Ann de Ing Col—April, 1908. No. 92428 D.

Street Cleaning.

An Automobile for Street Sweeping and Sprinkling in Paris (Balayeuse-Arroseuse Automobile de la Ville de Paris). E. Bret. Illustrated detailed description. 4000 w. Serial. 1st part. Génie Civil—April 18, 1908. No. 92419 D.

Testing.

Horse-Power at the Road Wheels. Illustrated description of a machine to test the effective power of any car, with records of four tests. 2000 w. Autocar—May 2, 1908. No. 92235 A.

Tractors.

The Hornsby Chain-Track Tractor. Illustrates and describes a device for traveling over natural ground. 1600 w. Auto Jour—April 25, 1908. No. 92102 A.

The "Caterpillar" Tractor. Illustrates and describes a novel engine invented by David Roberts. The Hornby chain tractor, and its operation. 1700 w. Sci Am—May 16, 1908. No. 92263.

Wheels.

Detachable Rims and Wheels. Illustrated description of various types. 5000 w. Autocar—April 25, 1908. No. 92105 A.

COMBUSTION MOTORS.

Exhaust Mufflers.

Exhaust Mufflers for Gas Engines. H. Addison Johnston. Describes an almost noiseless muffler made by the writer. 1000 w. Power—May 19, 1908. No. 92370.

Gas Engines.

New Features in Gas-Engine Construction. George W. Malcolm. Illustrates and describes a double-acting tandem machine of unusual type. 2500 w. Am Mach—Vol. 31. No. 22. No. 92633.

Westinghouse Gas Engines. An illustrated article giving information in regard to these engines. 3500 w. Ir Age—April, 30, 1908. No. 92009.

The Westinghouse Horizontal Gas Engine. Gives a summary of some important points, with illustrated description of installations. 6000 w. Ir Trd Rev—April 30, 1908. No. 92040.

The 2000-KW. Gas-Electric Set for the Bessemer Works of the United States Steel Corporation. Illustrated description. 2700 w. St Ry Jour—May 2, 1908. No. 92037.

Tandem Gas Engine at Watson-Stillman Plant. George W. Malcolm. Illustrated description of a machine differing materially from the conventional type. 2200 w. Power—May 5, 1908. No. 92140.

Interesting Gas Engine Cycle Development. Ernest Coler. Illustrates and describes an internal combustion motor having a modified cycle, invented by Robert Miller. 1500 w. Automobile—May 21, 1908. No. 92513.

The Horse Power, Friction Losses and Efficiencies of Gas and Oil Engines. Lionel S. Marks. Explains a proposed new measure of power. 3000 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92260 C.

The Starting of Internal-Combustion Motors (Das Anlassen der Verbrennungskraftmaschinen). P. Meyer. Considers methods and the phenomena of starting two- and four-cycle gas engines. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—April 11, 1908. No. 92480 D.

Researches on the Combustion Process in the Gas Engine (Untersuchungen über den Verbrennungsvorgang in der Gasmaschine). W. Borth. Illustrates the methods and gives the results. 6000 w. Zeitschr d Ver Deutscher Ing—April 4, 1908. No. 92477 D.

See also Exhaust Mufflers, and Ignition, under COMBUSTION MOTORS; Gas Engines, under MARINE AND NAVAL ENGINEERING; and Blowing Engines, under MINING AND METALLURGY, IRON AND STEEL.

Gasoline Engines.

See same title, under MARINE AND NAVAL ENGINEERING.

Gas Power Plants.

Erection and Equipment of Producer Gas Plants. Louis Bendit. Illustrated description of the plant for the Nancy-Helen mines of Cobalt, Ont., showing the economy of the arrangement. 1500 w. Min Wld—May 9, 1908. No. 92215.

Gas Producer By-Products.

Discussion on Mr. F. J. Rowan's Paper on "Ammonia Recovery in Connection with Gas Producers." 5000 w. Jour W of Scotland Ir & St Inst—Feb., 1908. No. 92579 N.

Gas Producers.

The Chief Requisites for Successful Gas-Producer Operation. A. S. Atkinson. Calls attention to the need of skill in the operator, the importance of the vaporizer, etc. 1800 w. Power—May 12, 1908. No. 92231.

Producer Gas for Engine Use: Its Manufacture and Characteristics. W. B. Tuttle. Abstract of a paper read before the S.-W. Elec. & Gas Assn. Deals mainly with gas producers. 1200 w. Elec Ry Rev—May 9, 1908. No. 92224.

Test of a Small Suction Gas Producer Plant. H. B. MacFarland. Considers the requirements of a producer, describes the Atkinson automatic suction-gas producer and its operation, and describes tests made to determine efficiency, reliability and adaptability. Ills. Discussion. 13000 w. Jour W Soc of Engrs—April, 1908. No. 92319 D.

See also Open Hearth, under MINING AND METALLURGY, IRON AND STEEL.

Gas Turbines.

See Turbines, under STEAM ENGINEERING.

Ignition.

Construction of a Spark Coil. F. C. Mason. Directions for building such a coil, with illustrations. 600 w. Elec Wld—May 2, 1908. No. 92006.

Location of Gas Engine Igniters. M. R. Wells. Gives indicator diagrams showing the effect of different locations. 1000 w. Power—May 19, 1908. No. 92372.

Hints on the Causes of the Failure of Electrical Ignition. Sydney F. Walker. Discusses failures due to want of strength and want of attention. 2000 w. Gas Engines—May, 1908. No. 92136.

Oil Engines.

See Gas Engines, under COMBUSTION MOTORS; and Air Compressors, under POWER AND TRANSMISSION.

Producer Gas.

See Gas Producers, under COMBUSTION MOTORS.

HEATING AND COOLING.

Air Liquefaction.

Tests of a Liquid Air Plant. C. S. Hudson and C. M. Garland. An illustrated description of apparatus used and tests made at the laboratory of the University of Illinois, giving results. 3800 w. Bul Univ of Ill, No. 21—March 1, 1908. No. 92583 N.

Fans.

The Performance of Fan Blowers. Walter B. Snow. Gives rules, formulæ and tables for computing the required power to drive them, and their capacity. 7000 w. Power—May 19, 1908. No. 92373.

Gas Heating.

Heating a Swimming Pool with Gas. A plant installed in the University Club at Pittsburgh is illustrated and described. 2000 w. Met Work—May 23, 1908. No. 92527.

Hot-Air Heating.

The Merits of the Warm Air Furnace. Charles S. Prizer. Presidential address before an association organized to advance furnace heating. 3500 w. Met Work—May 16, 1908. No. 92303.

Hot-Blast Heating System for a Hospital. Illustrated description of the equipment of the new Freedmen's Hospital building, Washington, D. C., with special reference to temperature control. 1000 w. Heat & Vent Mag—May, 1908. No. 92615.

Heating and Ventilation of the First Church of Christ, Scientist, Boston, Mass. Charles L. Hubbard. Explains the conditions imposed, and describes the plant. Ills. 1500 w. Met Work—May 9, 1908. Serial. 1st part. No. 92185.

Hot-Water Heating.

The Choice of Temperature Difference Between the Riser and Return Mains of a Rapid-Circulation Hot-Water Heating System with Double or Single Main (Die Wahl der Temperaturdifferenz zwischen der Zu- und Rückleitung einer Warmwasserheizung und einer Schnellumlaufheizung beim Zweirohrsysteme und beim Einrohrsysteme). H. Roose. 4000 w. Gesundheits-Ing—April 4, 1908. No. 92-452 D.

Industrial Buildings.

Heating Systems for Mills. Notes from a paper by A. G. Hosmer, read before the Nat. Assn. of Cotton Mfrs. Discusses direct radiation, the indirect or hot-blast system, and forced hot-water circulation. 2800 w. Eng Rec—May 9, 1908. No. 92203.

Piping.

See Steam Pipes, under STEAM ENGINEERING.

Refrigeration.

Calcium Chloride. S. W. Calhoun. Considers some of the advantages and disadvantages of its use in place of salt for refrigeration. 1000 w. Ice & Refrig—May, 1908. No. 92154 C.

Pipe-Line Refrigeration for General Service. Jos. H. Hart. Discusses its mechanical difficulties and their possible removal. 2000 w. Engineering Magazine—June, 1908. No. 92629 B.

Steam Heating.

Some Results of Steam Heating from a Central Station. James A. White. Presents results of this system, explaining its advantages. Ills. 2200 w. Cent Sta—May, 1908. No. 92269.

Ventilation.

How Cave Air is Used to Regulate the Temperature of a House. C. H. Claudy. Illustrated description of a house in Virginia, built on a hill above the caverns of Luray, and deriving its air through an airshaft from the caverns. 1200 w. Sci Am—May 16, 1908. No. 92264.

See also Hot-Air Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Characteristics of Centrifugal Pumps and Their Derivation from the Results of Tests (Charakteristische Eigenschaften der Kreiselpumpe und ihre Ermittlung aus Versuchsergebnissen). Johannes Bente. A discussion of the correct interpretation of test results. Ills. 2000 w. Die Turbine—April 5, 1908. No. 92-470 D.

See also Turbines, under STEAM ENGINEERING.

Pumping Plants.

Modern Fire Pumping Stations for Brooklyn, New York. Explains the system of high-pressure, and illustrates and describes one of the stations. 2500 w. Ind Wld—May 4, 1908. No. 92061.

See also Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL; and Irrigation, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Rotary and Steam Fire Pumps. Ezra E. Clark. Reviews the development of pumps, and their adoption for the protection of mills and factories, their construction and installation. Ills. 6000 w. Ins Eng—May, 1908. No. 92574 C.

Turbines.

Hydraulic Turbines of Maximum Output (Note sur les Turbines hydrauliques de Rendement maximum). M. Bonnifet. A mathematical and theoretical paper discussing the design of turbines to obtain maximum power under any given conditions. Ills. 10000 w. Revue de Mécan—April 30, 1908. No. 92412 E + F.

See also same title, under STEAM ENGINEERING.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

The Factor of Safety in Ball Bearings. G. T. Rennerfelt. Shows the advantage of four balls, and gives diagrams and description of bearing designs. 1500 w. Am Mach—Vol. 31. No. 19. No. 92158.

Ball Bearings in the Construction of Machine Tools with Special Reference to the Bearings of Lathe Spindles (Die Kugellager im Werkzeugmaschinenbau unter besonderer Berücksichtigung der Drehbankspindellagerungen). August Bauschlicher. Illustrates a number of applications. 3000 w. Serial. 1st part. Zeitschr f Werkzeug—April 5, 1908. No. 92460 D.

Chains.

See Chain Making, under MACHINE WORKS AND FOUNDRIES.

Clutches.

See same title, under AUTOMOBILES.

Graphical Charts.

The Construction of Graphical Charts John B. Peddle. Explains how charts are plotted from equations by analyzing, substituting values and selecting scales. Gives examples. 7500 w. Am Mach—Vol. 31, No. 20. No. 92272.

Piston Rings.

Piston Rings of Uniform Strength. W. Osborne. A brief discussion of the problem, with drawings. 1400 w. Am Mach—Vol. 31, No. 19. No. 92159.

Springs.

The Design of Springs for Gas Engine Valves. F. E. Whittlesey. Considers only compression springs of round steel wire. 1000 w. Mach, N Y—May, 1908. No. 92093 C.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

German Methods of Marine Boiler Construction. Walter Mentz. Describes the machinery used and the shop operations. Ills. 2000 w. Boiler Maker—May, 1908. Serial. 1st part. No. 92090.

Brass Founding.

The Method Now Used for Coloring Plumbers' Yellow Brass Goods Red. Explains the method. 1200 w. Brass Wld—May, 1908. No. 92526.

Production of the "Old Brass" Finish. Explains the treatment of cast brass, and of brass plated goods. 1200 w. Brass Wld—May, 1908. No. 92525.

The Manufacture of Brass in Early Times and the Formation of the First Brass Trust. Erwin S. Sperry. A review of early history. Ills. 3500 w. Brass Wld—May, 1908. No. 92524.

Case Hardening.

The Gas Process of Case-Hardening. J. F. Springer. Illustrated description of this process of gas carbonization, developed by Adolph W. Machlet. 2500 w. Ir Age—May 28, 1908. No. 92650.

Castings.

Iron and Castings for Piston-Ring Blanks. A. Manchester. Suggestions for small-diameter piston rings. 1200 w. Am Mach—Vol. 31, No. 18. No. 92001.

The Production of Solid Castings by the Use of Deoxydizing Fluxes (Herstellung dichter Güsse durch desoxydierende Zuschläge). Th. Geilenkirchen. A discussion of the use of ferro-manganese, ferro-silicon, aluminium, natrium, magnesium, etc., with data on the results obtained. 2500 w. Stahl u Eisen—April 22, 1908. No. 92441 D.

Chain Making.

Chains and Chain Making. James H. Baker. Reviews the history of chain-making and describes the process, giving information relating to their strength, reliability, etc. Discussion. Ills. 6000 w. Pro Engrs' Soc of W Penn—May, 1908. No. 92613 D.

Core Boxes.

Difficult Metal Core-Box Work. Ethan Viall and J. J. Voelcker. Illustrates and describes methods used in the manufacture of brass goods and high class plumbing fixtures. 2500 w. Am Mach—Vol. 31 No. 20. No. 92273.

Cores.

Core Binders. E. D. Frohman. Read before the Pittsburgh Found. Assn. Considers the various raw materials used in the manufacture of cores. 2000 w. Ir Age—May 14, 1908. No. 92268.

Cupolas.

Operation and Care of the Cupola. W. S. Anderson. Modern practice is discussed. 2000 w. Foundry—May, 1908. No. 92051.

The Modern Cupola (Der moderne Kupolofen). Karl Schiel. A discussion of modern cupola practice, referring to fuel, air blast, etc. 2800 w. Stahl u Eisen—April 29, 1908. No. 92443 D.

Cutting Metals.

Cutting Metals with Oxygen. Jacques Boyer. Illustrated description of the German Oxhydric Co.'s process. 900 w. Sci Am—May 9, 1908. No. 92186.

Drilling Machines..

A New Variable-Speed Sensitive Drill Press. Louis W. Rawson. Describes a multiple-spindle drill used at the Washburn Shops, Worcester, Mass. Ills. 2000 w. Jour Worcester Poly Inst—May, 1908. No. 92578 C.

Forging.

Drop and Stamp Forgings. Joseph Horner. Reviews the development of stamping processes, discussing materials and their treatment, etc. Ills. 3000 w. Mach, N Y—May, 1908. No. 92095 C.

Forging Presses.

A Large Flanging Press for Boiler Sheets. William J. Withem. An illustrated description of an hydraulically operated press having only two supports for the head and cylinders. 500 w. Am Mach—Vol. 31, No. 18. No. 92000.

Foundries.

The Foundry Plant of the Deutz Gas Engine Works (Die Giessereianlagen der Gasmotoren-Fabrik Deutz). E. Neufang. Describes the equipment and methods. Ills. 2800 w. Serial. 1st part. Stahl u Eisen—April 1, 1908. No. 92435 D.

Foundry Practice.

Milling Machine Framing. A. C. Brock. (Prize paper.) Describes the making of the pattern, core-boxes and mold. 3500 w. Mech Wld—May 1, 1908. No. 92-246 A.

Facings and Facing Sands in the Foundry. Walter J. May. Information regarding the preparation and use of facing sands. 1200 w. Prac Engr—April 24, 1908. No. 92108 A.

Gear Cutting.

The Cincinnati Gear Cutter. Illustrated description of the new line of gear cutters and their operation. 1200 w. Ir Age—April 30, 1908. No. 92008.

Gun Making.

Big Gun Making in Sweden. An illustrated account of works at Bofors, Sweden, the built-up guns made, and other information. 2000 w. Engr, Lond—May 1, 1908. No. 92250 A.

Lapping Machines.

A Lapping Machine of Novel Construction. Illustrated description of a machine for finishing cylindrical surfaces by means of reciprocating laps which are automatically adjusted. 800 w. Am Mach—Vol. 31, No. 21. No. 92394.

Lathes.

The New Morris Geared-Head Lathe. Illustrated detailed description. 4000 w. Ir Age—May 28, 1908. No. 92651.

A Double-Ended Spindle Boring Lathe. W. F. Groene. Illustrated detailed description of a powerful machine. 1000 w. Am Mach—Vol. 31, No. 19. No. 92155.

An Engine Lathe with Many Novel Features. Illustrates a lathe for using high-speed steel, which has many new features. Designed by W. L. Shellenbach. 5000 w. Am Mach—Vol. 31, No. 22. No. 92634.

Levels.

Precision Levels and Accurate Leveling. Articles on setting boring-mill uprights with a novel form of level, and leveling planers properly for accurate work. Ills. 2000 w. Am Mach—Vol. 31, No. 18. No. 91996.

Machine Tools.

See Ball Bearings, under MACHINE ELEMENTS AND DESIGN.

Molding.

Method of Molding a Dome Casting. W. W. McCarter. Illustrated description of a novel yet simple method. 800 w. Foundry—May, 1908. No. 92052.

Molding a Narrow Foundation Plate. Jabez Nall. Illustrated description of an economical method. 1200 w. Foundry—May, 1908. No. 92053.

Molding Machines.

Machine-Molded Stove Plate. Illustrates and describes modern development in the art of molding stove castings. 2500 w. Foundry—May, 1908. No. 92049.

A French Universal System of Machine Molding. Frank C. Perkins. Illustrated description. 800 w. Sci Am—May 16, 1908. No. 92265.

Shop Design.

Location, Arrangement and Construction of Manufacturing Plants. George M. Brill. An illustrated discussion of features of importance applicable to a variety of manufacturing plants. Discussion. 8000 w. Jour W Soc of Engrs—April, 1908. No. 92318 D.

Shop Hygiene.

Improvements in Shop Hygiene (Améliorations dans l'Hygiène des Ateliers). Albert Berthiot. A review of the improvements effected under the French factory laws. 2000 w. Rev d'Econ Indus —April 16, 1908. No. 92400 D.

Shop Practice.

Machining Multiple-Throw Crankshafts. J. C. Spence. An illustrated description of the method developed by the Norton Grinding Co. aim at economical production. 1200 w. Am Mach—Vol. 31, No. 22. No. 92635.

The Product and Methods of European Locomotive Works. Charles R. King. The present number deals with German works and their product, describing new tools and processes, and showing advancement on American design. Ills. 5000 w. Engineering Magazine—June, 1908. Serial. 1st part. No. 92625 B.

Shops.

A Study of the Michigan Factory Systems. Berne Nadall. Illustrated article describing the Packard plant, at Detroit, plants at Pontiac, Mich., the Oakland car, and notes on the Ford plant. 3000 w. Automobile—May 14, 1908. No. 92284.

Shop Ventilation.

Exhaust Fan Installations (Impianti di Aspirazione). Siegfried Herzog. Has particular reference to the removal of dust in the grinding trades in the first instalment. Ills. 2100 w. Serial. 1st part. L'Indus—April 19, 1908. No. 92423 D.

Tools.

See Tool Steels, under MATERIALS OF CONSTRUCTION.

Welding.

Oxy-Hydrogen Welding. Frank Koester. Illustrates and describes the production of the oxy-hydrogen mixture and the welding process. 2500 w. Elec Wld—May 9, 1908. No. 92177.

MATERIALS OF CONSTRUCTION.

Alloys.

White Brass and White Bronze. C. U. Prum. An explanation of the difference between these alloys. 1500 w. Mech Wld—April 24, 1908. No. 92100 A.

Alloy Steels.

See Rare Metals, under MINING AND METALLURGY, MINOR MINERALS.

Metallography.

The Gas Occluded in Steel (Gaz Occlus dans les Aciers). M. G. Belloc. Gives results of extensive investigations to determine its character and amount. Bul Soc d'Encour—April, 1908. No. 92476 E + F.

The Principles of Microscopic Metallography (Principios de la Metalografia microscopica). Luis Daunis. Discusses the preparation of specimens, the use of the microscope and gives a brief review of the metallography of steel. Ills. 2500 w. Rev Tech Indus—March, 1908. No. 92426 D.

Steel.

Hardness in Steel and Its Variations. Albert F. Shore. An explanation of different kinds of hardness as measured by the scleroscope and the causes. 3500 w. Am Mach—Vol. 31, No. 18. No. 91998.

Practical Experiments in Steel. Charles L. Huston. A report of experiments made to obtain knowledge of the internal structure of boiler plate steel. Ills. 2000 w. Jour Fr Inst—May, 1908. No. 92593 D.

Tool Steels.

Annealing, Hardening and Tempering Tools. James Steele. Suggestions for the treatment of tool steel. 1200 w. Am Mach—Vol. 31, No. 18. No. 91997.

MEASUREMENT.

Hardness.

Researches on Hardness and Hardness Testing (Untersuchungen über Härteprüfung und Härte). Eugen Meyer. A record of extensive investigations on the Brinell method. Ills. 6500 w. Serial 1st part. Zeitschr d Ver Deutscher Ing—April 25, 1908. No. 92483 D.

See also Steel, under MATERIALS OF CONSTRUCTION.

Pyrometry.

A New Radiation Pyrometer. Charles Burton Thwing. Describes an instrument for the accurate measurement of the higher temperatures. 1500 w. Jour Fr Inst—May, 1908. No. 92592 D.

Telescope Method.

The Mensuration of Small Angles and Minute Lengths. John G. A. Rhodin. On the advantages of using the telescope and scale, and the applications of the method. 3000 w. Engr, Lond—April 24, 1908. No. 92128 A.

Testing Methods.

The Shock Test on Nicked Bars (L'Essai au Choc sur Barreaux entailles). H. C. Ehrensberger. An elaborately illustrated discussion, giving the results of tests of the method, presented before the German Association for Testing Materials. 6000 w. Rev de Métal—April, 1908. No. 92497 E + F.

POWER AND TRANSMISSION.

Air Compressors.

Air Compressors. On the compression of air, and the use of air compressor diagrams. 2500 w. Mech Wld—May 15, 1908. No. 92560 A.

A Variable-Volume Air Compressor. H. V. Haight. Illustrated description of an unloading device which varies air delivered by quarter-loads and maintains full compound efficiency. 1400 w. Am Mach—Vol. 31, No. 18. No. 91999.

A High-Speed Oil-Engine Air Compressor: Features of Design and Results of Tests. Illustrates and describes the Mietz & Weiss oil-engine and its application for driving a direct-connected air-compressor. 2000 w. Eng News—May 7, 1908. No. 92181.

Belt Driving.

The Determination of the Loss of Power in Belts (Bestimmung von Riemenverlusten). F. Niethammer and R. Czepek. Describes tests and gives results. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—April 25, 1908. No. 92484 D.

The Efficiency of Belt Driving (Ueber den Wirkungsgrad von Riementrieben). Karl Kobes. A mathematical discussion. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—April 17, 1908. No. 92457 D.

Chain Driving.

Power Transmission by Chain. Edward T. Flax. Illustrates and describes special applications. 3500 w. Cassier's Mag—May, 1908. No. 92150 B.

The Proper Way to Use Link-Belt. Staunton B. Peck. Considers the best conditions and how to run the chain. 1000 w. Am Mach—Vol. 31, No. 20. No. 92271.

Costs.

Steam-Electric versus Hydro-Electric Power. Henry Docker Jackson. Discussion of features that should control the selection of a source of power. 5000 w. Power—May 19, 1908. No. 92371.

Electric Driving.

Electric Power in Iron and Steel Mills. W. Edgar Reed. On the applications made of electric power, and the problems connected, with description of a few installations. Discussion. Ills. 9000 w. Pro Engrs' Soc of W Penn—April, 1908. No. 92257 D.

Electricity Applied to Rolling Mills (L'Electricité appliquée aux Trains de Laminoirs). Reviews technical considerations and gives the results obtained in European plants. Ills. 5500 w. All Indus—April, 1908. No. 92414 D.

See also Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

Lubrication.

Economical Lubrication of Large Plants. William M. Davis. Considers how to secure economical engine lubrication without lowering the efficiency of the plant. Discussion. 8000 w. Jour Assn of Engng Socs—April, 1908. No. 92588 C.

Mechanical Plants.

Mechanical Plant of the United States Express Company's Building, New York City. Brief description of the building, with detailed description of the plant for heating, lighting, power and ventilation, and a refrigerating plant. 5000 w. Eng Rec—May 16, 1908. No. 92314.

Power Plants.

The Steam Turbine Power Plant of the Pacific Mills. Illustrated description of a plant for large textile mills. 1500 w. Eng Rec—May 23, 1908. No. 92539.

The Power Plant of the American Biscuit Company, San Francisco. Alfred H. Potbury. Brief description of a successful private plant. 1000 w. Eng Rec—May 9, 1908. No. 92205.

See also Ash Handling, under TRANSPORTING AND CONVEYING.

Turbo-Compressors.

Turbo-Compressors for Blast Furnaces (Ueber Hochofen-Turbinengebläse). P. Langer. Illustrates and describes the various types. 1200 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 10, 1908. No. 92471 D.

See also Turbines, under STEAM ENGINEERING.

STEAM ENGINEERING.

Boiler Efficiency.

Some Results Due to Improvement in Boiler and Furnace Design. A. Bement. A report of results of tests made at Chicago, and Cedar Rapids, Ia., with comparison, and general discussion. Ills. 27000 w. Jour W Soc of Engrs—April, 1908. No. 92320 D.

Boiler Fittings.

Some Notes on the Boiler Blow-off. Warren H. Miller. Information relating to the design of blow-offs and their dangers, illustrating by example. 2000 w. Eng Rec—May 9, 1908. No. 92209.

Boiler Furnaces.

Automatic Damper Regulators. W. H. Wakeman. Explains the principles by which such regulators operate. Ills. 1500 w. Elec Wld—May 2, 1908. No. 92007.

Furnace Design in Relation to Fuel Economy. E. G. Bailey. Considers losses in the operation of steam boilers, giving data of tests. General discussion. 11000 w. Jour Assn of Engng Socs—April, 1908. No. 92587 C.

Boiler Management.

Care of the Horizontal Tubular Boiler. M. Kennett. Suggestions for the management. Ills. 2500 w. Power—May 12, 1908. No. 92232.

Fuel Economics and Steam Generation. W. Francis Goodrich. Discusses aspects of fuel economy of interest to steam users such as machine firing, hand firing, smoke prevention, etc., giving details of tests. 7500 w. Pub Works—April, 1908. No. 92640 B.

Boiler Waters.

See Feed-Water Heating, and Water Meters, under STEAM ENGINEERING.

Engine Failures.

Failure of a Cross-Compound Engine. W. H. Wakeman. Analysis of the accident and conclusion concerning the cause. Ills. 1500 w. Power—May 12, 1908. No. 92228.

Engine Lubrication.

See Lubrication, under POWER AND TRANSMISSION.

Engines.

A Large Twin-Tandem Compound Direct-Connected Reversing Mill Engine. Illustrated description of a noteworthy engine. 3300 w. Ir Trd Rev—May 7, 1908. No. 92160.

4000-Horse-Power Engine at the Central Electric Generating Station, Brussels. Illustrations and report of tests. 3000 w. Engng—May 1, 1908. No. 92248 A.

The Most Powerful of All Steam Engines. James Tribe. Illustrates and describes features involved in the design and construction of a large reversible rolling-mill engine at the Carnegie Steel Works. 2200 w. Am Mach—Vol. 31, No. 20. No. 92270.

The Actual State of Heat Engines (Consideraciones sobre el Estado actual de los Motores termicos). Carlos Barutell. The first part of the serial begins a discussion of steam engines. 3000 w. Serial. 1st part. Energia Elec—April 25, 1908. No. 92431 D.

Engine Troubles.

Engine Knocks—Their Causes and Remedies. Hubert E. Collins. Analyzes these troubles, giving directions for their prevention or cure. Ills. 3000 w. Power—May 5, 1908. No. 92142.

Feed-Water Heating.

Tests on Live Steam Feed Water Heating. Sydney B. Bilbrough, *Transvaal Inst. of Mech. Engrs.* An account of experiments conducted in South Africa to observe the heat transmission through boiler plate under varying conditions. 3500 w. Power—May 12, 1908. No. 92230.

Fuels.

The Calorific Power of Fuels. F. N. Morton. Suggests a definition which, when the calorific value is stated in terms of British thermal units, will admit of no ambiguity. 1800 w. Stevens Ind—April, 1908. No. 92585 D.

Liquid Fuel. W. H. Booth. Discusses questions in connection with oil-burning systems. 2000 w. Power—May 12, 1908. No. 92233.

Fuels. Charles L. Hubbard. Brief review of various grades of coal and other fuels used for the generation of steam. 2000 w. Elec Rev, N Y—May 16, 1908. No. 92306.

Coal from the Standpoint of the Engineer. George H. Ashley. Discusses the elements of coal, its heating value, purchase, use, etc. 2800 w. Sib Jour of Engng—May, 1908. No. 92614 C.

The Best Kind of Coal for a Factory. E. G. Bailey. Read before the Nat. Assn. of Cotton Mfrs. Calls attention to things a manufacturer should know to secure the most economical fuel. 3000 w. Sci Am Sup—May 9, 1908. No. 92192.

The Purchase of Coal on a Scientific Basis. John B. C. Kershaw. Condemns methods in present use and advocates a system of valuation based on the heat unit content. 3300 w. Cassier's Mag—May, 1908. No. 92151 B.

Wood as Fuel—Notable Wood Burning Plants. William D. Ennis. Discusses the calorific values of woods; the best kind for steam-plant uses, etc. Ills. 4000 w. Power—May 26, 1908. No. 92595.

Fuel Testing.

Determination of the Value of Coal for Steaming Purposes. Richard K. Meade. Describes methods used in the analysis of coal, with formulæ and terms. 1800 w. Min Sci—May 14, 1908. Serial. 1st part. No. 92337.

Indicators.

Indicators and Indicator Diagrams. W. A. Tookey. Abstract of a paper before the Assn. of Engrs. in Charge. Remarks on the value of the records, with illustrations of indicators and descriptions of details. 3500 w. Mech Engr—May 1, 1908. Serial. 1st part. No. 92238 A.

Injectors.

Points on the Injector. P. E. Capraro. Considers the selection of an injector, their use, and troubles. Ills. 1600 w. Mech Wld—May 1, 1908. No. 92245 A.

Pressure Gauges.

Hydrostatic Pressure Gauges in Plant Management (Hydrostatic Druckmesser als Betriebskontrollapparate). Paul de Bruyn. Describes the various uses of these recording gauges in steam plants and steel works. Ills. 2400 w. Serial. 1st part. Oest Zeitschr f Berg- u Hüttenwesen—April 18, 1908. No. 92446 D.

Steam Pipes.

Draining of Steam and Water Pipes. H. A. Jahnke. Explains simple methods of making connections in order to avoid pocketing, water hammer and freezing. Ills. 1200 w. Power—May 26, 1908. No. 92597.

The Capacity of Pipes for Conveying Steam. E. C. Sickles. Explains the principles underlying the flow of steam in pipes, giving charts from which may be read the capacity with given pressure drop, or vice-versa. 1700 w. Power—May 26, 1908. No. 92596.

Stokers.

Mechanical Stokers. John Egerton Barnes. Abstract of a paper read at Inst. of Mech. Engrs. Grad. Assn. Describes features of the principal types in use, discussing their advantages and drawbacks. 3500 w. Elec Engr, Lond—May 1, 1908. No. 92239 A.

Superheating.

Use of Superheated Steam with Marine Engines. Felix F. T. Godard. Read before the Inst. of Naval Archts. Information concerning the trials that have been made and the results. Ills. 2000 w. Mech Engr—April 24, 1908. No. 92107 A.

The Thermal Properties of Superheated Steam. R. C. H. Heck. Considers the best available data in regard to the specific heat of superheated steam, the value and variation, and derives a convenient table for general use. 6500 w. Pro Am Soc of Mech Engrs—May, 1908. No. 92261 C.

See also Locomotive Superheaters, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Thermodynamics.

Thermodynamics of Pressure Drop or Throttling. R. C. H. Heck. An explanation of what takes place whenever the steam is throttled or wire-drawn. 3800 w. Power—May 26, 1908. No. 92598.

Turbine Plants.

See Power Plants, under POWER AND TRANSMISSION.

Turbines.

The Rateau Steam-Turbine. Illustrated detailed description. Plates. 4000 w. Engng—May 15, 1908. No. 92562 A.

Exhaust Steam Turbines. P. J. Mitchell. Explains the chief features of the Rateau system and describes plants installed. 4500 w. Jour W of Scotland Ir & St Inst—Feb., 1908. No. 92580 N.

The Melms and Pfenninger Steam Turbine (Die Dampfturbine System

Melms & Pfenninger). Oskar Peschke. An illustrated description of this turbine which combines features of both the impulse and reaction types. 2500 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 18, 1908. No. 92472 D.

The Westinghouse Double-Flow, Impulse-Reaction Turbines at the Brunot Island Power Station of the Pittsburgh Railways Co. Describes a recent extension of this plant and the new machinery installed. Ills. 3300 w. Eng News—May 28, 1908. No. 92639.

Construction Details of a Reaction Turbine. Henry E. Schmidt. Deals with blade material and height; clearance, radially and axially; the design of balance pistons and steam passages, etc. Ills. 2500 w. Power—May 19, 1908. No. 92639.

The Efficiency of Steam Turbines. F. A. Lart. Reviews the mechanical means of utilizing the energy of the steam and presents the advantages of the Field-Morris aërated steam system. 6000 w. Cassier's Mag—May, 1908. No. 92148 B.

The Theory of Rotating Guides in Turbines (Zur Theorie rotierender Umsetzer bei Turbogeneratoren und Turbomotoren). J. Novak. Discusses all classes of turbine machinery, gas, water and steam turbines, and centrifugal pumps, blowers, and compressors. Ills. 2000 w. Serial. 1st part. Zeitschr f d Gesamte Turbinenwesen—April 30, 1908. No. 92473 D.

Valve Gears.

Piston Valves. Discusses the objections to piston valves and their advantages. Ills. 2000 w. Prac Engr—May 8, 1908. Serial. 1st part. No. 92346 A.

Water Meters.

Lea's Water Recorder. Illustrated description of a recording instrument of general application, but especially suitable for the measurement of boiler feed water and the discharges from air pumps. 1500 w. Elect'n, Lond—May 8, 1908. No. 92354 A.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

See Hoisting, under TRANSPORTING AND CONVEYING.

Ash Handling.

See Trestles, under CIVIL ENGINEERING, BRIDGES.

Coal Handling.

Coal Handling in Austrian Harbors (Der Kohlenumschlag an der Oesterreichischen Seeküste). Hermann R. v. Littrow. Illustrates and describes the dock arrangements and coal handling facilities of the various harbors through which coal is imported with information as to the extent of the coal trade, etc. Ills. 2000 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—April 3, 1908. No. 92455 D.

Conveyors.

Conveyor System at the New Kleinfontein Mill. Edward J. Way. Illustrated description of labor-saving apparatus installed in South Africa. 4000 w. Eng & Min Jour—May 2, 1908. No. 92075.

Cranes.

A Tower Crane for the Bremer Vulkan Shipbuilding Yard. Illustrated description. 1000 w. Engr, Lond—April 24, 1908. No. 92130 A.

Electrical Cranes for Dock and Harbor Work. Illustrated description of a portion of the equipment of 134 portal cranes at the Kuhwaeder Dock, Hamburg. 900 w. Elec Rev, Lond—May 8, 1908. No. 92350 A.

A Window-Cleaning Traveler for the Carnegie Library, Pittsburg, Pa. Explains the methods adopted for the protection of the books in a smoky city, and gives illustrated detailed description of the arrangements for cleaning the hermetically sealed windows. 3500 w. Eng Rec—May 9, 1908. No. 92208.

See also Hoisting, under TRANSPORTING AND CONVEYING.

Dock Machinery.

See Coal Handling, and Cranes, under TRANSPORTING AND CONVEYING.

Hoisting.

The Transformation in Hoisting Machinery due to Electricity (Die Umgestaltung der Hebemaschinen durch die Elektrotechnik). Prof. Kammerer. Considers cranes, aerial tramways and electric hoists. Ills. 3000 w. Serial. 1st part. Elektrotech Zeitschr—April 23, 1908. No. 92491 D.

Ore Handling.

Modern Ore Handling Machinery. Walter G. Stephan. Illustrates and describes types of machinery used, and states their advantages in reducing cost. 4000 w. Ir Trd Rev—May 14, 1908. No. 92283.

MISCELLANY.

Aeronautics.

The Cornu Helicopter. An illustrated article describing how this novel type of flying machine was developed. 2500 w. Sci Am Sup—May 16, 1908. No. 92267.

The Record Flight of the Delagrange Aeroplane. An illustrated account of the flight on April 11th, when it remained in the air 9¼ minutes, and covered about 4 miles. 800 w. Sci Am—May 11, 1908. No. 92190.

The Actual State of Aviation (L'Etat actuel de l'Aviation). G. Espitallier. The first part of the serial is mainly historical. Ills. 3000 w. Serial. 1st part. Génie Civil—April 4, 1908. No. 92417 D.

The Present Status of Aerial Navigation (Der gegenwärtige Stand der Luftschiffahrt). Carl Steiger. A critical study of present air ship design. Ills. 3000 w. Serial. 1st part. Schweiz Bau —April 4, 1908. No. 92449 D.

Air Resistance.

Experimental Researches on the Resistance of the Air Carried Out at the Eiffel Tower (Recherches expérimentales sur la Résistance de l'Air exécutées à la Tour Eiffel). G. Eiffel. Describes the apparatus used and gives the results. Ills. 2400 w. Mem Soc Ing Civ de France—Feb., 1908. No. 92405 G.

Clocks.

A Clock with a Forty-foot Dial. Illustrated description of a clock on the Jersey City side of the North River in which the hand moves 23 inches a minute. 1500 w. Am Mach—Vol. 31, No. 21. No. 92393.

Cyclometers.

Making the Veeder Cyclometer. Describes methods used in printing, threading, marking and testing cyclometers and odometers. Ills. 1100 w. Am Mach —Vol. 31, No. 92395.

Glass Making.

The Colburn Window-Glass Machine. An illustrated description of a machine for drawing window glass continuously in any width. 2500 w. Sci Am Sup—May 16, 1908. No. 92266.

Minting Machinery.

Mechanical Equipment of the Ottawa Mint. A. H. W. Cleave. Illustrated description. 6000 w. Can Elec News—May, 1908. No. 92196 C.

MINING AND METALLURGY

COAL AND COKE.

Analysis.

See Fuel Testing, under MECHANICAL ENGINEERING, Steam Engineering.

Coal Cutting.

Tests of a Sullivan Coal Cutting Machine at the Göttelborn Colliery (Versuche mit einer Schrämmaschine der Sullivan Machinery Company auf dem Königlichen Steinkohlenbergwerk Göttelborn). Dr. Hoernecke. Describes the tests and gives results. 2000 w. Glückauf—April 25, 1908. No. 92448 D.

Coke.

Arsenic-Free Gas Coke. H. O'Conner and Dr. Drinkwater. Abstract of a paper read before the Roy. Scottish Soc. of Arts. Investigations made on account of the scare of arsenic poisoning in beer, with a description of the test of fuels used in brewing, and method of treating coke. 2000 w. Ir & Coal Trds Rev—April 24, 1908. No. 92133 A.

Coke Ovens.

Transition in Coke Making. William L. Affelder. Illustrates and describes some new forms of ovens and machines for quenching and drawing coke and leveling coal in ovens. 4000 w. Mines & Min—May, 1908. No. 92031 C.

The "Simon-Carves" Vertical Flued By-Product Coke Oven. Illustrates and describes both the regenerative and non-regenerative types, with comparison. 2000 w. Ir & Coal Trds Rev—May 1, 1908. No. 92251 A.

See also Refractory Materials, under Miscellany.

Coking.

The Effect on Coal of Water and Fine Crushing. H. M. Chapman and Edwin Barnhart. Reports tests made which show a lessened weight of wet and fine coal. 1200 w. Ir Age—May 7, 1908. No. 92163.

Coking By-Products.

The Recovery of By-Products from Coke Ovens. Reviews a paper on this subject by W. H. Coleman, recently read at Manchester, Eng. 2300 w. Engr, Lond—May 8, 1908. No. 92359 A.

The Marchal Apparatus for Estimating the Value of By-Products in Fuel. From *Revue Univ. des Mines.* Illustrated description of the apparatus and its operation. 1500 w. Col Guard—May 8, 1908. No. 92355 A.

Coking Plants.

Some Recent Coking Plants. W. Archie Weldin. Illustrates and describes the recent plants of the H. C. Frick Coke Co. which involve various unusual features. 5000 w. Eng Rec—May 23, 1908. No. 92540.

Starting By-Product Coke Oven Plant. A. Thau, in *Gluckauf.* Illustrates and describes the starting of the plant. 5000 w. Ir & Coal Trds Rev—May 8, 1908. No. 92364 A.

Electric Power.

Electrical Installation at Tribley Pit. Illustrates and describes an installation for colliery purposes. 2000 w. Elect'n—May 15, 1908. No. 92559 A.

Electrically Operated Coal Mines in Alabama. Frank C. Perkins. Illustrates and describes details of operation in the

Birmingham district. 1500 w. Min Wld—May 2, 1908. No. 92085.

Explosions.

Dinas Main Colliery Explosion. Information concerning this explosion in the Swansea district, Wales, in Dec., 1907, as taken from the Home Office Report. 4000 w. Col Guard—May 15, 1908. No. 92561 A.

The Hanna, Wyoming, Mine Disaster. R. L. Herrick. Illustrated account of the two explosions, the probable causes, and the conditions leading up to them. 3200 w. Mines & Min—May, 1908. No. 92028 C.

Mine Dust.

Report of the French Commission on Explosives and Coal Dust. L. Didier. Trans. from *Bul. Soc. Industrie Minerale.* 1200 w. Col Guard—April 24, 1908. No. 92120 A.

Dust Made in Mining Coal. C. E. Scott. A comparison of the amounts of dust made in cutting coal by chain and by puncher machines. 1000 w. Mines & Min—May, 1908. No. 92029 C.

A Spraying Device for Laying Dust in Coal Mining. William Clifford. Illustrated description of apparatus for removing dust and conveying it from the mine. 1200 w. Mines & Min—May, 1908. No. 92032 C.

See also Ventilation, under COAL AND COKE.

Mining.

Mining Coal with the Panel System. Audley H. Stow. Discusses the operation with reference to concentration and economy. Ills. 3800 w. Eng & Min Jour—May 2, 1908. No. 92076.

Some Experiments and Improvements in Mining in Austria (Einige Versuche und Verbesserungen beim Bergbau in Oesterreich). Discusses present practice in coal mining, outlining methods of blasting, timbering, lighting, etc. Ills. 2000 w. Serial. 1st part. Oest Zeitschr f Berg- u Hüttenwesen—April 4, 1908. No. 92444 D.

Montana.

The Coal Industry of Montana. Jesse P. Rowe. Information concerning the extent of the deposits, their value, development, etc. Ills. 3300 w. Eng & Min Jour—May 23, 1908. No. 92532.

Ohio.

Desiccation Conglomerates in the Coal-Measures Limestone of Ohio. Jesse E. Hyde. Considers a type of intra-formational conglomerate, giving a possible explanation of the origin. 3500 w. Am Jour of Sci—May, 1908. No. 92022 D.

Production.

Past and Future Coal Production in the United States. E. W. Parker. Estimates of the amount of coal deposits, with statistics of past production and probabilities for the future. 4000 w. Mines & Min—May, 1908. No. 92027 C.

Rescue Appliances.

Rescue Apparatus in Coal Mines. Walter E. Mingramm. Illustrated description of the Draeger apparatus. 1200 w. Eng & Min Jour—May 2, 1908. No. 92077.

Ventilation.

Need of Thorough Ventilation in Coal Mines. J. R. Robinson. Shows that lack of ventilation and presence of dust are the chief causes of explosions. 1800 w. Eng & Min Jour—May 9, 1908. No. 92201.

See also same title, under MINING.

COPPER.

Blast Furnaces.

See Refineries, under COPPER.

Casting Machines.

A Machine for Casting Converter Copper. J. H. Klepinger. Illustrates and describes a machine in use at Great Falls, Montana. 1000 w. Eng & Min Jour—May 2, 1908. No. 92078.

Lake Superior.

See Copper, under ORE DRESSING AND CONCENTRATION.

Reduction.

The Reduction of Copper from Its Ores by Mechanical Energy (Ueber Kupfergewinnung aus Erzen wesentlich durch mechanische Energie). Dr. O. Frölich. Describes a new method of agitation and leaching with ferric chloride and precipitation of copper on iron. Ills. 2000 w. Elektrotech Zeitschr—April 23, 1908. No. 92492 D.

Refineries.

The Tank House and Copper Furnaces of the New Addition to the Raritan Copper Works. Frank D. Easterbrooks. Illustrated detailed description. 2000 w. Elec-Chem and Met Ind—June, 1908. No. 92621 C.

Smelters.

The Great Cobar Smelting Works. Illustrates and describes a copper-smelting plant in Australia, showing latest practice. 3000 w. Eng & Min Jour—May 9, 1908. No. 92199.

Utah.

The Boston Consolidated Mining Company. Abstract of report of progress presented Jan. 20, 1908. 5000 w. Mines & Min—May, 1908. No. 92024 C.

See also Copper, under ORE DRESSING AND CONCENTRATION.

GOLD AND SILVER.

Alloys.

See same title, under MISCELLANY.

Assaying.

United States Assay Office at Helena, Montana. Evans W. Buskett. Illustrated description of the building, equipment, and methods. 1200 w. Min Wld—May 16, 1908. No. 92335.

Australia.

Golden City of the Commonwealth of Australia. John Plummer. Information concerning Bendigo. Ills. 1000 w. Min Wld—May 23, 1908. No. 92572.

Cobalt.

Report on Cobalt District for Year 1907. Arthur A. Cole. Extracts from the report, with comments. 2500 w. Can Min Jour—May 1, 1908. No. 92143.

Coniagas Mine and Its Management, Cobalt. Alex. Gray. An illustrated description of this property and its equipment. 2000 w. Min Wld—May 9, 1908. No. 92214.

Metallurgical Conditions at Cobalt, Ontario, Canada, 1908. F. N. Flynn. A general description of conditions with the aim of interesting those who have successfully treated this class of ores. 14000 w. Qr Bul Can Min Inst—May, 1908. No. 92611 N.

Colorado.

Cripple Creek Rejuvenated. R. L. Herrick. Outlines present conditions and problems in this district. 3500 w. Mines & Min—May, 1908. No. 92030 C.

Cyaniding.

See Gold Milling, and Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Dredging.

Recent Developments in Gold Dredging, particularly in the Guianas (Les récents Développements des Dragages aurifères dans le Monde et particularièrement dans les Guyanes). L. Delvaux. An elaborate paper discussing gold dredging problems of all kinds and reviewing the present state of the industry. Ills. 18400 w. Mem Soc Ing Civ de France—Feb., 1908. No. 92403 G.

Montana.

Discovery of Large Gold Nuggets in Montana. Matt. W. Alderson. An account of large nuggets found and the difficulty in locating their origin. 1500 w. Min Wld—May 2, 1908. No. 92086.

Nevada.

Goldfield, Nevada. T. A. Rickard. The history of its discovery and development. Ills. 2500 w. Min & Sci Pr—April 25, 1908. Serial. 1st part. No. 92044.

Placers.

Geology and Economics of Rio San Juan, Utah. Arthur Lakes. The peculiar structure is described, and a theory of the origin of the placer gold is given. 1000 w. Min Wld—May 9, 1908. No. 92217.

Rand.

Notes on Rand Mining. Tom Johnson. A critical review of the mining practice and changes that would tend to economy. 9000 w. Jour Chem, Met & Min Soc of S Africa—March, 1908. No. 92345 E.

River Beds.

Improved Apparatus for Mining in River Beds. J. W. Hunsaker, V. Beisswingert, and R. L. Davis. Illustrates and describes an invention for reaching pockets of gold-bearing sands or gravels. 2000 w. Min Wld—May 23, 1908. No. 92571.

Utah.

See Placers, under GOLD AND SILVER.

IRON AND STEEL.

Armor Plate.

See Armor, under MARINE AND NAVAL ENGINEERING.

Assaying.

The Determination of Sulphur in Pig Iron and Steel by the Hydrogen Jet Method. Randolph Bolling. Gives a method applicable to brands that do not give satisfactory results with the "evolution method." Ills. 2000 w. Eng News—May 7, 1908. No. 92180.

The Influence of the Presence of Other Metals on the Reinhardt Method of Titration for Iron (Ueber den Einfluss der das Eisen begleitenden fremden Metalle auf die Eisentitration nach C. Reinhardt). The results of researches to determine the influence of copper, arsenic, chromium, nickel, cobalt, titanium, lead and antimony on the accuracy of the permanganate method. 3500 w. Stahl u Eisen—April 8, 1908. No. 92437 D.

Bessemer Process.

The Flohr Improvement of the Basic Bessemer Process. Abstract translation from the article by Dr. P. Goerens, in *Stahl und Eisen*. A review of the conditions affecting this process. 1600 w. Ir Age—May 28, 1908. No. 92653.

Blast Furnace Practice.

Blast Furnace Calculations. S. J. Koshkin. Gives calculations for everyday practice, suggesting new ideas. 4500 w. Ir Age—May 28, 1908. No. 92652.

Practical Blast-Furnace Management. Randolph Bolling. Shows how mechanical improvements have relieved managers, and discusses the needs of the metallurgical department. Ills. 2000 w. Eng & Min Jour—May 16, 1908. No. 92299.

Blowing Engines.

A 2000 H. P. Gas Engine Blowing Unit. Illustrated description of an example of recent gas engine and blowing engine development as installed in a Pittsburg plant. 3500 w. Mach, N Y—May, 1908. No. 92092 C.

Canada.

The Iron Ores of Canada. C. K. Leith. Gives a comparison of Canadian ores with types in the United States and discusses their commercial importance. 5500 w. Qr Bul of Can Min Inst—May, 1908. No. 92604 N.

China.

The Iron Industry of China. A short description of the Hanyang Iron & Steel Works, from an article by C. Blauel in *Stahl und Eisen*. 2500 w. Ir Age—May 7, 1908. No. 92162.

Duplex Process.

See Steel Works, under IRON AND STEEL.

Electro-Metallurgy.

The Reduction of Iron Ores in the Electric Furnace. R. Turnbull. Outlines the progress since March, 1906. 2500 w. Qr Bul of Can Min Inst—May, 1908. No. 92608 N.

Commercial Electric Steel and Gas Power. R. H. Wolff. An editorial letter giving an account of what is being accomplished with the Héroult electric process, with tables from the works laboratory at La Praz, France. 1200 w. Elec-Chem & Met Ind—June, 1908. No. 92618 C.

Electric Induction Furnaces (Elektrische Induktions-Oefen). The first part of the serial reviews the history of this type of furnace. Ills. 1500 w. Serial. 1st part. Elektrochem Zeitschr—April, 1908. No. 92434 D.

India.

Do Conditions in India Justify a National Steel Industry? Axel Sahlin. Abstract of a lecture delivered in India. A discussion of the resources and conditions, with favorable conclusions. 5800 w. Ir & Coal Trds Rev—April 24, 1908. No. 92132 A.

New Brunswick.

A New Iron Ore Field in the Province of New Brunswick. John E. Hardman. An Account of deposits of merchantable iron ore near the Bay of Chaleur. 3000 w. Qr Bul of Can Min Inst—May, 1908. No. 92606 N.

Norway.

South Varanger Iron Ore Deposits. Information concerning these large deposits, taken from a lecture by Mr. Wiull, to the Chem. Soc., at Christiania. 1600 w. Ir & Coal Trds Rev—May 8, 1908. No. 92363 A.

Ontario.

The Iron and Steel Industry of the Province of Ontario, Canada. Jas. Grannis Parmelee. Gives an outline of the more important plants. Ills. 7000 w. Qr Bul of Can Min Inst—May, 1908. No. 92605 N.

Open Hearth.

Important Points in the Construction and Operation of Gas Producers in Open Hearth Plants (Wichtige Gesichtspunkte für den Bau und Betrieb von Gaserzeuger-Anlagen bei Martinwerken). C. Canaris. Emphasizes particularly the importance of using perfectly dry gas for firing open-hearth furnaces. 4000 w. Stahl u Eisen—April 15, 1908. No. 92438 D.

Rails.

See same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Rolling Mills.

Improvements in Plate Rolling Mills. Andrew Lamberton. Read before the Iron & Steel Inst. Illustrated description of a new form of plate mill designed by the writer, specially for light plates, but suitable for ordinary ship and girder-plates. 3200 w. Engng—May 15, 1908. No. 92564 A.

Power Requirements of Steam and Electrically Driven Rolls (Kraftbedarf von Umkehrwalzwerken mit Dampf- und elektrischem Antrieb). H. Ortmann. A comparison of power consumption and costs. Ills. 2100 w. Stahl u Eisen—April 22, 1908. No. 92440 D.

Electrically Driven Reversing Mill at the Georgs-Marien Works (Elektrisch betriebenes Umkehr- Blockwalzwerk der Georgsmarienhütte). Karl Wendt. An illustrated detailed description of the equipment and operation of this plant, with data on power consumption, etc. 5200 w. Stahl u Eisen—April 22, 1908. No. 92442 D.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Steel Making.

Calcium Silicide for the Purification of Metals, Particularly Steel. Hans Goldschmidt. An account of this new and effective purifying agent which is used exactly like aluminum. 600 w. Elec-Chem & Met Ind—June, 1908. No. 92620 C.

See also Bessemer Process, under IRON AND STEEL.

Steel Works.

The Duplex Steel Process at Ensley, Alabama. Illustrated description of the new Bessemer and open-hearth plant of the Tennessee Coal, Iron & Railroad Co., and the connected blast furnaces of modern type. 8500 w. Ir Age—May 21, 1908. No. 92502.

LEAD AND ZINC.

Pigments.

From Mine to Battleship. T. A. Rickard. An illustrated account of the manufacture of white lead paint. 11500 w. Min & Sci Pr—May 9, 1908. No. 92278.

Missouri.

Calamine Deposits of Southwest Missouri. Otto Ruhl. Describes the deposits and methods of mining. 2200 w. Min Wld—May 16, 1908. No. 92334.

See also Royalties, under MINING; and Zinc Milling, under ORE DRESSING AND CONCENTRATION.

MINOR MINERALS.

Cement.

Mill B of the Pacific Portland Cement Company, Con., near Suisun, Cal. F. D. Wood. Illustrates and describes a fire-proof plant, and its equipment. 3000 w. Eng Rec—May 23, 1908. No. 92537.

Cobalt.

See same title, under GOLD AND SILVER.

Graphite.

Modes of Occurrence of Canadian Graphite. H. P. H. Brumell. Considers deposits in the Archaean rocks in the counties of Labelle and Argenteuil, Quebec. Discussion. 5500 w. Qr Bul of Can Min Inst—May, 1908. No. 92609 N.

Manganese.

Manganese Mining in Bukowina (Manganerz-Bergbau in der Bukowina). Theodor Naske. Describes the ore-dressing methods in this Austrian district. Ills. 2500 w. Stahl u Eisen—April 15, 1908. No. 92439 D.

Oil.

Prospecting in the Oil Fields of Western Colorado. Arthur Lakes. Describes five oil-bearing zones west of the Continental Divide. Map. 2000 w. Min Sci—April 30, 1908. No. 92081.

Rare Metals.

The Rare Metals, Cobalt, Vanadium, Molybdenum, Titanium, Uranium and Tungsten, and their Uses, especially in the Steel Industry (Die seltenen Metalle, Kobalt, Vanadium, Molybdän, Titan, Uran, Wolfram und ihre Bedeutung für die Technik unter besonderer Berücksichtigung der Stahlindustrie). A. Haenig. Gives considerable information of the ores, sources, uses, etc., of the metals named. 2300 w. Serial. 1st part. Oest Zeitschr f Berg- u Hüttenwesen—April 11, 1908. No. 92445 D.

Tungsten.

The Occurrence of Tungsten Ores in Canada. T. L. Walker. Information regarding recently recorded discoveries, describing some occurrences. 1200 w. Qr Bul of Can Min Inst—May, 1908. No. 92610 N.

MINING.

Drills.

Development of the Air-Hammer Rock Drill. Claude T. Rice. Describes new features of the Kimber and the Flottmann machines. Ills. 800 w. Eng & Min Jour—May 23, 1908. No. 92528.

Electric Hoisting.

The Application of the Extended Cascade Connection in Hoisting and Similar Plants and in the Operation of Electric Railways (Die Verwendung der erweiterten Kaskadenschaltungen in Förderanlagen und ähnlichen Betrieben und in elektrischen Bahnbetriebe). A. Heyland. Illustrates and describes the proposed arrangement. 2000 w. Serial. 1st part. Elektrotech Zeitschr—April 2, 1908. No. 92485 D.

See also Hoisting, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Electric Power.

Electricity in Mines: Breakdowns of Machinery, and the Causes of Accidents. A criticism of English practice. 2000 w. Elec Rev, Lond—May 15, 1908. No. 92555 A.

The Choice of Electric Motors for Mine Equipment. A. W. K. Peirce. Deals with three-phase motors of the induction type. 5000 w. Jour S African Assn of Engrs—March, 1908. No. 92101 F.

See also same title, under COAL AND COKE.

Engineering Ethics.

Advice to Mining Students. J. H. Collins. The Le Neve Foster lecture to the students of the Royal School of Mines. A survey of the work of the mining engineer. 3800 w. Min & Sci Pr—May 9, 1908. No. 92279.

Fans.

The Barclay "Drum Pattern" Mine Fan. Illustrated description of a new type of fan for ventilating mines. 1600 w. Col Guard—April 24, 1908. No. 92119 A.

Finance.

Stock Companies and Company Promotion. Henry A. Butters. A synopsis of two lectures delivered to the Seniors of the School of Mines, University of California. 5500 w. Min & Sci Pr—May 2, 1908. No. 92164.

Freezing Process.

Application of Refrigeration to Mining Work. Jos. H. Hart. Describes its use in the sinking of shafts and building of tunnels, etc., and the various processes. 2000 w. Min Wld—May 9, 1908. No. 92216.

Hoisting.

Over-Balance Weight for Single-Drum Hoist. S. A. Worcester. Explains the principles of the arrangement and the advantages. Ills. 1400 w. Eng & Min Jour—May 2, 1908. No. 92079.

Law.

The Rights of the Miner. Theo. F. Van Wagenen. Discusses existing laws as related to prospectors, laboring miners, mining engineers, and mining investors. 5000 w. Min & Sci Pr—May 16, 1908. No. 92511.

Short Talks on Mining Law. A. H.

Ricketts. The first of a series of articles discussing this subject. 2000 w. Eng & Min Jour—May 9, 1908. Serial. 1st part. No. 92198.

Ore Contracts.

Ore Contracts from a Producer's Point of View. Henry M. Adkinson. Discusses ore contracts, treatment charges, competition, and gives examples and results. 1500 w. Eng & Min Jour—May 16, 1908. No. 92300.

Problems.

On Some Unsolved Problems in Metal Mining. Prof. Henry Louis. The James Forrest lecture, before the Inst. of Civ. Engrs., April 27, 1908. Considers problems of mining and extraction of metals from their ores. 4500 w. Engng—May 1, 1908. Serial. 1st part. No. 92249 A.

Royalties.

Sliding Scale Royalty. Louis D. Huntoon. Read before the Engrs' Soc. of S.-W. Missouri. Explains a proposed system of royalties to obviate the disadvantages of the present system in the Missouri zinc region. 1200 w. Mines & Min—May, 1908. No. 92033 C.

Shaft Sinking.

Sinking a Concrete-Lined Mine Shaft. Illustrated description of work at the Woodward colliery, near Wilkes-Barre, Penn. 1200 w. Eng Rec—May 16, 1908. No. 92312.

Collar at No. 1 Allan Shaft. H. E. Coll. Read before the Min. Soc. of Nova Scotia. Describes methods of sinking through water-bearing sand. 1700 w. Can Min Jour—May 15, 1908. No. 92328.

See also Freezing Process, under MINING.

Stoping.

Stoping Without Timbers at the Homestake Mine, Lead, South Dakota. Mark Ehle, Jr. Illustrated description of a method adapted to working large ore bodies. 1800 w. Mines & Min—May, 1908. No. 92026 C.

Timbering.

Timbering Methods in Missouri-Kansas District. Otto Ruhl. Methods of lacing and "swinging crib" to strengthen shaft timbering are described. Ills. 3000 w. Min Wld—May 2, 1908. No. 92084.

Developments in Mine Timbering (Neuerungen im Grubenausbau). Dr. Hecker. Refers to the use of iron and concrete in place of wood. Ills. 4200 w. Glückauf—April 18, 1908. No. 92447 D.

Wood and Iron as Mine Timbering Materials (Holz und Eisen als Ausbaumaterial in Strecken- und Abbaubetrieben). Heinrich Steffen. A discussion of their respective merits. Ills. 2100 w. Serial. 1st part. Stahl u Eisen—April 1, 1908. No. 92436 D.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Valuation.

Mine Valuations. Algernon Del Mar. Explains the basis of calculation. 1400 w. Eng & Min Jour—May 23, 1908. No. 92530.

Structural Maps and Their Use in Making Up Reports. J. E. Tiffany. The advantages of topographical information in the calculating of estimates of costs of development and construction. 1600 w. Min Sci—May 7, 1908. No. 92213.

Ventilation.

The Economy of Modern Colliery Ventilation. J. R. Robinson. Claims that high-speed centrifugal fans afford seven times the efficiency of screw-type ventilators and effect an annual saving of $5000. 5400 w. Eng & Min Jour—May 16, 1908. No. 92302.

ORE DRESSING AND CONCENTRATION.

Briquetting.

See Magnetic Separation, under ORE DRESSING AND CONCENTRATION.

Copper.

The Calumet & Hecla Stamp Mills, Lake Superior. Robert H. Maurer. Illustrated description of mill and equipment for treating copper ore. 3000 w. Min Wld—May 2, 1908. No. 92083.

Three-Thousand-Ton Concentrator of the Boston Consolidated Mining Company, at Garfield, Utah. Robert B. Brinsmade and R. L. Herrick. Illustrates and describes the arrangement of machinery and the methods, giving estimates of cost. 3500 w. Mines & Min—May, 1908. No. 92023 C.

Gold Milling.

Goldfield Consolidated Mining Company's New Mill. Describing the location, construction, equipment, flow sheet and methods. 1200 w. Min Sci—May 7, 1908. No. 92212.

Montana-Tonopah Stamp and Cyanide Mill. Illustrated description of plant where the crushed ore is concentrated on Wilfley tables and vanners and the slimes are treated in Hendryx cyanide agitators. 1200 w. Eng & Min Jour—May 9, 1908. No. 92200.

See also Conveyors, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Magnetic Separation.

Progress with the Gröndal Process of Concentrating and Briquetting Iron Ores. P. McN. Bennie. Shows how the mining of certain kinds of iron ores has been stimulated by the demands of metallurgy, and the progress of this process. Discussion. 3000 w. Qr Bul of Can Min Inst—May, 1908. No. 92607 N.

Mixed Sulphides.

Concentrating Mixed Ores at Rosas, Sardinia. Umberto Cappa. Describes the separation of lead and zinc from mixed oxidized and sulphide ores by crushing in ball mills and washing over Ferraris tables. 1200 w. Eng & Min Jour—May 9, 1908. No. 92197.

Slimes Treatment.

The Separation of Slime in Cyanide Treatment. Horace G. Nichols. Describes the process and gives a report of experimental tests and information related. 2500 w. Min & Sci Pr—April 25, 1908. No. 92045.

Zinc Milling.

Milling Methods in the Kansas-Missouri Zinc Fields. Doss Brittain. Description of methods and development. Ills. 1200 w. Min Sci—April 30, 1908. No. 92082.

The American Mill at Oronogo, Joplin District. Doss Brittain. Illustrates and describes a typical plant for concentrating sheet-ground ore, but differing in some essential details from practice prevailing at Joplin. 1600 w. Eng & Min Jour—May 23, 1908. No. 92529.

MISCELLANY.

Alloys.

The Alloys of Gold (Les Alliages d'Or). M. A. Portevin. Discusses the metallographic properties of alloys of gold with bismuth, cadmium, copper, iron, nickel, palladium, platinum, lead, antimony, tin, thalium and zinc, after articles in the *Zeitschr. an. Chemie.* Ills. 4000 w. Rev de Métal—April, 1908. No. 92496 E + F.

Brazil.

The Mining Industry in the State of Minas Geraes, Brazil. G. Campbell. Discusses mining laws, labor, wages, etc. 1800 w. Min Jour—April 25, 1908. Serial. 1st part. No. 92118 A.

British Columbia.

Mineral Locations on Moresby Island—One of the Queen Charlotte Islands. Abstract of Bul. No. 1, issued by B. C. Bureau of Mines. Historical and descriptive. Map. 3500 w. Can Min Jour—May 15, 1908. Serial. 1st part. No. 92327.

Colorado.

The Various Mining Districts of Colorado. G. W. Miller. First article of a series describing the mining camps, their history, geology, ores, methods of mining and ore treatment. Maps. 1400 w. Min Sci—May 14, 1908. Serial. 1st part. No. 92336.

Fireclay Crucibles.

Zinc Retorts and Refractory Crucibles: A New Method of Construction. Illustrates and describes a process for the manufacture of composite retorts for the metallurgy of zinc and composite crucibles. 2200 w. Ir & Coal Trds Rev—May 1, 1907. No. 92252 A.

New Guinea.

Papua Mining. J. H. P. Murray. An account of this richly mineralized region and the difficulties that confront prospectors. 6000 w. Aust Min Stand—April 1, and 8, 1908. Serial. 2 parts. No. 92254 each B.

Ore Deposits.

Formation of Mineral Veins. Dr. Willis Eugene Everette. Analysis of rocks and the metals extracted from them. 2800 w. Sci Am Sup—May 2, 1908. Serial. 1st part. No. 92020.

The Genesis of Ores in the Light of Modern Theory. Horace V. Winchell. Considers the influences and conditions that have an important bearing on the question of ore formation. 4000 w. Pop Sci M—June, 1908. No. 92616 C.

Tendencies in the Study of Ore Deposits. Waldemar Lindgren. Abstract of a presidential address before the Geol. Soc. of Washington. The prevailing theoretical tendencies are outlined. 4000 w. Min & Sci Pr—April 25, 1908. No. 92046.

Peru.

The Mining Districts of Central Peru. J. C. Pickering. An illustrated account of the silver, copper, coal and lead mines near Cerro de Pasco. 3800 w. Eng & Min Jour—May 16, 1908. No. 92301.

Refractory Materials.

Refractories Used in the Construction of Coke Ovens. J. R. Campbell. Discusses the maximum impurities permissible for satisfactory service. 3000 w. Mines & Min—May, 1908. No. 92025 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Safety in American Railway Transport. Charles A. Howard. Considers methods for reducing the number of casualties. 3500 w. Cassier's Mag—May, 1908. No. 92144 B.

The Shrewsbury Railway Accident. A review of the accident occuring Oct. 15, 1907, and of Col. Yorke's report. Also editorial. 7500 w. Engr, Lond—April 24, 1908. No. 92129 A.

Signalling.

Experiments with Railway Signal

Lights Upon Persons Having Normal and Abnormal Color Sense. Prof. W. A. Nagél. Trans. from *Zeit. für Sinnesphysiologie.* Discusses how such tests should be made. 2500 w. Ry Age—May 22, 1908. No. 92573.

MOTIVE POWER AND EQUIPMENT.

Air Pumps.

Care of Air Pump. Suggestions for care and maintenance. 2000 w. Ry & Loc Engng—May, 1908. No. 92058 C.

Cars.

Passenger Cars for the Philippine Railway. Illustrated description. 1000 w. Am Engr & R R Jour—May, 1908. No. 92097 C.

A 28-Ton Bogie Coal Wagon. Illustrated description of cars for the Federated Malay States Rys. 300 w. Engr, Lond—May 15, 1908. No. 92568 A.

High-Capacity Wagons for Indian Broad-Gauge Railways. H. Kelway-Bamber. Shows the development during the past fifteen years, discussing the earning power and carrying capacity. Ills. 1200 w. Engng—May 8, 1908. No. 92356 A.

Car Springs.

Laminated Springs for Private Owners' Wagons. Editorial on the desirability of uniformity in the testing and working of laminated springs. Ills. 1400 w. Engng—April 24, 1908. No. 92123 A.

Draft-Gears.

Draft-Gear Proposition. R. P. C. Sanderson. Discusses the shocks and strains that modern cars must sustain, and the efficiency of the draft gear. General discussion. 19000 w. N Y R R Club—April 17, 1908. No. 92290.

Electrification.

The Electrification of the Suburban Zone of the New York Central and Hudson River Railroad in the Vicinity of New York City. Continued discussion, with diagrams. 10800 w. Pro Am Soc of Civ Engrs—May, 1908. No. 92647 E.

From Steam to Electricity on a Single Track Road. J. B. Whitehead. Describes the Annapolis Short Line, giving reasons for the change, and discussing and comparing results, costs, etc. 10000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92386 D.

Locomotive Boilers.

Locomotive Boilers. W. L. French. On the growth from the small to the large boiler, its construction, testing, care, etc. 2000 w. Boiler Maker—May, 1908. No. 92091.

Locomotive Fuels.

Burning Lignite Coal in Locomotives. O. N. Terry. A report of the success attained on the Burlington road in the use of this fuel. Ills. 1800 w. Am Engr & R R Jour—May, 1908. No. 92096 C.

Locomotives.

Remarkable Locomotives of 1907. J. F. Gairns. A review of progress in Europe and America, illustrating 27 locomotives. 8500 w. Cassier's Mag—May, 1908. No. 92145 B.

Ten-Wheel Passenger Locomotives for the 'Frisco. Illustrated detailed description. 700 w. R R Gaz—May 8, 1908. No. 92175.

Ten-Wheel Passenger Locomotive—St. Louis and San Francisco Railroad. Illustrated description. 600 w. Am Engr & R R Jour—May, 1908. No. 92098 C.

Pacific Locomotive for the New York Central. Illustrated description of the heaviest passenger engines ever built for this road. 900 w. Ry Age—May 1, 1908. No. 92087.

Prairie Locomotive for the Wabash. Illustrated description of engines of this type, of which 30 have recently been built. 400 w. Ry Age—May 8, 1908. No. 92225.

Central of Georgia 2-8-0. Illustrated description of a consolidation engine equipped with a feed water heater. 600 w. Ry & Loc Engng—May, 1908. No. 92057 C.

Pacific and Consolidation Locomotives for the Santa Fé. Illustrates and describes these types of recently built engines; seven for passenger, and 42 for freight service. Ten are for coal burning and the remainder for oil burning. 800 w. Ry Age—May 15, 1908. No. 92331.

Great Central Compound Engines and Their Work. Charles Rous-Marten. Gives particulars of work performed by these engines. 2200 w. Engr, Lond—April 24, 1908. No. 92127 A.

Consolidation Type Locomotive—Great Northern Railway. Illustrates and describes the somewhat unusual arrangement of the Walschaert valve gear. 500 w. Am Engr & R R Jour—May, 1908. No. 92099 C.

Double-Ended Goods Type Locomotive. Illustrated description of a new type recently constructed for the express passenger trains of the State Rys. of Italy. 1400 w. Engr, Lond—May 8, 1908. No. 92362 A.

German Locomotives with Schmidt Superheaters and Record of Trials. Illustrates and describes two of the latest designs for passenger and freight service, with an account of trials. 1500 w. Prac Engr—April 24, 1908. Serial. 1st part. No. 92106 A.

The Four-Cylinder 3/6-Coupled Compound Locomotive for High-Speed Service on the Baden State Railways (Die vierzylindrige 3/6-gekuppelte Verbund-Schnellzuglokomotive der Badischen Staatsbahnen). Herr Courtin. Illustrated description. Plate. 1500 w. Zeitschr d Ver Deutscher Ing—April 11, 1908. No. 92478 D.

See Shop Practice, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES; and Elevated Railways, under STREET AND ELECTRIC RAILWAYS.

Locomotive Superheaters.

The Origin of Superheaters, Consisting of U-Shaped Pipes Placed in the Boiler Tubes. Charles R. King. Reviews past history and considers de Montcheuil the original inventor of this type. Ills. 2200 w. Bul Int Ry Cong—April, 1908. No. 92322 G.

Wheels.

For Better Car Wheels. P. H. Griffin. On the danger of cast-iron wheels, as now made, under 50-ton cars, and the need of an agreement about car-wheels between all roads exchanging cars. 2200 w. R R Gaz—May 22, 1908. No. 92520.

PERMANENT WAY AND BUILDINGS.

Construction.

Railroad Grading by Hydraulic Methods on the Chicago, Milwaukee & St. Paul Railway. Illustrated description of work in the State of Washington. 4500 w. Eng Rec—May 2, 1908. No. 92066.

Curves.

A New Method of Joining Curves (Nouvelle Méthode de Raccordement des Courbes). E. Hallade. A mathematical paper. Ills. 9000 w. Rev Gen d Chemins de Fer—April, 1908. No. 92411 G.

Earth Slides.

The Improvement of a Sliding Cut on the Cleveland, Cincinnati, Chicago & St. Louis Ry. Information concerning measures adopted to remedy a wet and sliding sidehill cut. Ills. 1200 w. Eng News—April 30, 1908. No. 92013.

Location.

Mountain Railroad Location. J. J. Cryderman. Paper presented to the Pacific N.-W. Soc. of Engrs. Suggestions for the selection of the personnel of the party, the instruments, and other equipment, methods of work, etc. 6000 w. R R Gaz—May 15, 1908. No. 92285.

Rails.

Steel-Rail Breakages. Questions of Design and Specifications. Harold V. Coes. A comparison of views of maker and consumer as to the causes. 2500 w. Engineering Magazine—June, 1908. No. 92630 B.

Specifications for Bessemer and Open Hearth Rails. Gives specifications adopted by the American Ry. Assn., with remarks. 3000 w. Ir Trd Rev—April 30, 1908. No. 92039.

New Rail Sections and Rail Specifications of the American Railway Association. Extracts from the Committee reports, giving specifications, with comments, and editorial. 5500 w. Eng News—May 14, 1908. No. 92277.

Heat Treatment of Steel Rails. William Metcalf. On the principles and processes involved in the handling of steel, and the applications of those principles. Discussion. 8000 w. Pro Engrs' Soc of W Penn—April, 1908. No. 92256 D.

The Prevention of Play Between Rail and Fishplate. Leon Edelstein. Trans. from *Zeit. des Oest Ing. u Archt. Ver.* Describes a new method of overcoming the evils due to wear of rails and fishplates by use of steel packing prices. Ills. 1700 w. Bul Int Ry Cong—April, 1908. No. 92324 G.

Stations.

Ottawa Union Passenger Station. Illustrated description of a fine station. 900 w. R R Gaz—May 1, 1908. No. 92048.

Terminals.

Erie Terminal Improvements in Jersey City. An illustrated description of the proposed track arrangement, and the general plan of the Bergen Hill cut. 2000 w. R R Gaz—May 15, 1908. No. 92286.

Ties.

Metal and Reinforced Concrete Ties. Editorial discussion of various types. 4000 w. R R Gaz—May 1, 1908. No. 92047.

Experiments with Railway Cross-Ties. A report of an investigation of the timber accessible to the Northern Pacific Railroad, to determine the most economical system of handling and manufacturing into cross-ties. 2000 w. Eng Rec—May 16, 1908. No. 92313.

See also Timber Preservation, under CIVIL ENGINEERING, MATERIALS OF CONSTRUCTION.

Water Supply.

See Water Works, under CIVIL ENGINEERING, WATER SUPPLY.

Yards.

Some Notes on North American Goods Yards. Dr. Blum and E. Giese. Trans. from *Zeit. des Ver Deutscher Ing.* Describes American practice, giving plans. 6000 w. Bul Int Ry Cong—April, 1908. No. 92323 G.

TRAFFIC.

Car Efficiency.

Freight Car Efficiency. E. R. Dewsnup. A discussion of American freight operation, the adequacy of car equipment, and related matters. General discussion. 12000 w. Pro W Ry Club—April 21, 1908. No. 92575 C.

Car Interchange.

Report of the Committee of the Railway Club of Pittsburgh on the Revision of M. C. B. Rules of Interchange. Gives the changes recommended. 7000 w. Pro Ry Club of Pittsburgh—March 27, 1908. No. 91995 C.

Freight Rates.

Freight Rate Complaints Under the Hepburn Law. Logan G. M'Pherson. A classified review of the complaints entered. 4000 w. Ry Age—May 8, 1908. No. 92226.

MISCELLANY.

Accounting.

Railroad Accounting Under Government Supervision. M. P. Blauvelt. Abstracts of an address before the Assn. of Am. Ry. Acc. Officers. The question of depreciation is discussed. 2200 w. Ry Age—May 15, 1908. No. 92333.

Africa.

The Railways of French West Africa (Les Voies Ferrées de l'Afrique Occidentale Française). The first part discusses the general programme. Ills. 9000 w. Serial. 1st part. Rev Gen des Sci—March 30, 1908. No. 91520 D.

Alaska.

Railway Experiences in Alaska. John H. Brooks, Jr. An interesting account of conditions met in constructing the Alaska Central Railway. 4000 w. Jour Worcester Poly Inst—May, 1908. No. 92576 C.

Canada.

See same title, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

China.

Existing and Projected Railroads in China. Brief report of these lines and related information. 2500 w. R R Gaz—May 8, 1908. No. 92171.

The Shanghai-Nanking Railroad. An illustrated description of the construction of this and connecting lines. 800 w. R R Gaz—May 15, 1908. No. 92288.

France.

French Railroads in 1905 and 1906. C. Colson. A review of results and of conditions affecting the railroad industry, comparing with England and Germany. 5000 w. R R Gaz—April 24, 1908. No. 91905.

Government Control.

Work of Interstate Commerce Commission Under the Hepburn Act. E. A. Moseley. On the great increase of work and the methods of conducting it. 3500 w. Ry Age—May 15, 1908. No. 92330.

How Can the Railroads Best Serve the Public? Stuyvesant Fish. Recommendations are given. 700 w. R R Gaz—May 22, 1908. No. 92523.

Railroad Regulation. Robert Mather. From an address before the Traffic Club of Pittsburg. A discussion of the government control of railways and the effects. 3000 w. R R Gaz—May 15, 1908. No. 92287.

Practical versus Theoretical Railway Regulation. Martin S. Decker. Abstract of an address before the Traffic Club of New York. 2000 w. Ry Age—May 1, 1908. No. 92088.

Working of the Massachusetts Stock Law. From the majority report of the Commission on Commerce and Industry. Discusses some of the provisions for increasing the capital of public service corporations. 4500 w. R R Gaz—May 8, 1908. No. 92174.

See also Accounting, under MISCELLANY.

Guatemala.

The Guatemala Railroad. An illustrated account of this new line connecting the city of Guatemala with the Atlantic. 1000 w. R R Gaz—April 3, 1908. No. 91436.

India.

Indian Railway Facilities (Das Veckehrswesen Vorderindiens). Dr. Blum. Discusses traffic requirements, railway facilities, equipment, etc. Ills. 5000 w. Glasers Ann—Mar. 1, 1908. No. 91576 D.

Italy.

Railway Reorganization in Italy. Editorial discussion in *Bulletin des transports internationaux par chemins de fer.* 16300 w. Bul Int Ry Cong—April, 1908. No. 92326 G.

Management.

Personalism in Railroading. H. W. Jacobs. Discusses the individual element in railway organization. A study of changing conditions. 3500 w. Engineering Magazine—June, 1908. No. 92628 B.

Narrow Gauge.

The Krivaja Forest Railway in Bosnia (Ueber die Krivaja-Waldbahn in Bosnien). Herr Liebmann. A general description of this 0.76 metre gauge line and its equipment and traffic. Ills. 5500 w. Glasers Ann—April 15, 1908. No. 92459 D.

The Sokoliki-Stuposiany Timber Railway (Die Waldbahn Sokoliki-Stuposiany). An illustrated description of the line and equipment of this 0.76 metre gauge railway in Galicia. 2500 w. Mit d Ver f d Förd Lokal u Strassenbahnwesens—March, 1908. No. 92432 F.

Queensland.

The Queensland Railways and Maintenance Costs. Editorial review of the lately-issued report of the working of the State railways. 2000 w. Engng—March 20, 1908. No. 91278 A.

Southern Pacific.

The Sunset Route. Illustrated account of the line and its equipment. 1000 w. Ry & Loc Engng—May, 1908. No. 92056 C.

Turkey.

The Anatolia Railway (Die Anatolische Bahn). Herr Denicke. An illustrated general description. 4500 w. Glasers Ann—April 1, 1908. No. 92458 D.

Austria.

The Selection and Application of Alpine Water Powers as Sources of Power for Electric Operation of Trunk Lines (Die Auswahl und der Ausbau alpiner Wasserkräft zum Zweck des elektrischen Vollbahnbetriebes). Dr. W. Conrad. A discussion of the technical and economic aspects of railway electrification in Austria. Ills. 1800 w. Serial. 1st part. Zeitschr d Oest Ing u Arch Ver—April 10, 1908. No. 92456 D.

Baltimore.

Generating and Distributing Systems of the United Railways and Electric Company of Baltimore. Illustrated detailed description of the work of reconstruction and extension in progress. 2500 w. Elec Wld—May 9, 1908. No. 92176.

The Reconstruction of the Power System of the United Railways & Electric Company of Baltimore. Explains the circumstances that made the reconstruction necessary, illustrating and describing the extensions and improvements, etc. 4000 w. St Ry Jour—May 9, 1908. No. 92165.

Brakes.

Pringle's Groove Skid Emergency Brake. Illustrated detailed description. 2500 w. Elect'n, Lond—May 1, 1908. No. 92244 A.

Pringle's Emergency Brake. Illustrated description, with statement of advantages claimed, and report of tests. 1500 w. Elec Rev, Lond—April 24, 1908. No. 92112 A.

Car Maintenance.

Graphics as Applied to Car Maintenance. William Arthur. Describes a system evolved to meet the requirements of frequent service of heavy passenger trains at high speed. 1800 w. Elec Ry Jour—June 6, 1908. No. 92733.

Conductor Testing.

Conductor Rail Measurements. S. B. Fortenbaugh. Ills. Explains methods used on the Underground Electric Railways of London. 2000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92384 D.

Controllers.

See Train Control, under STREET AND ELECTRIC RAILWAYS.

Electrification.

See same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Elevated Railways.

The Northwestern Elevated Extension at Evanston, Ill. An illustrated account of the line and equipment. 5000 w. St Ry Jour—May 23, 1908. No. 92514.

Elevated Railways of New York. George H. Jackson. Reviews the early history and illustrates early locomotives. 1500 w. Ry & Loc Engng—May, 1908. No. 92060 C.

The Paris "Elevated." George B. Ford. Illustrated article showing the aesthetic possibilities of elevated construction. 2500 w. Archt Rev—Feb., 1908. No. 92253 E.

Freight Service.

Electric Express Service at Birmingham, Ala. An illustrated account of methods of conducting an extensive express service at freight rates. 1200 w. St Ry Jour—May 16, 1908. No. 92282.

Interurban.

Recent Work on the Fairmont & Clarksburg Traction Company's System. Important additions to this system in W. Va. are illustrated and described. A power plant, transmission line, substations and car house. 1700 w. St Ry Jour—May 16, 1908. No. 92280.

The Growth of the Kokomo, Marion & Western Traction Company. C. A. Tupper. An illustrated account of this system and its development. 3500 w. Elec Ry Rev—May 9, 1908. No. 92221.

The Indianapolis, Crawfordsville & Western Traction System. Illustrated description of a new line built for high-speed operation. 3500 w. St Ry Jour—May 23, 1908. No. 92515.

The Buffalo, Lockport & Rochester Railway. An illustrated description of the construction and equipment. 3500 w. Elec Ry Jour—June 6, 1908. No. 92732.

London.

Tilbury Railway Electrification. Illustrates and describes new work in London to relieve the congestion of traffic. 1800 w. Tram & Ry Wld—May 7, 1908. No. 92518 B.

Maintenance.

Maintenance Regulations Proposed by the Australian Street Railway Association. Regulations covering track, line, and rolling-stock. 1200 w. St Ry Jour—May 2, 1908. No. 92036.

Memphis, Tenn.

Electric Railway Traffic in Memphis. Map, and description of system serving a population of 150,000. 2500 w. Elec Ry Jour—June 6, 1908. No. 92734.

Operating Expenses.

Cost of Carrying Passengers to Coney Island. Gives an analysis of operating expenses on the passenger-mile basis. 2000 w. St Ry Jour—May 30, 1908. No. 92679.

We supply copies of these articles. See page 658.

Safety Guards.

A New Safety Guard and Sanding Device for Tram Cars. From *E. K. und B.* Illustrated description of a device experimentally tried in Vienna. 500 w. Elec Engr, Lond—May 8, 1908. No. 92348 A.

Sanding Devices.

See Safety Guards, under STREET AND ELECTRIC RAILWAYS.

Schedules.

The Determination of the Shortest Possible Interval Between Successive Trains on Urban and Suburban Lines. R. Pfeil. Trans. from *Elek. Kraft u. Bahnen.* Explains a short way of determining. Ills. 4700 w. Bul Int Ry Cong—April, 1908. No. 92325 G.

Shops.

New Shops of the Cleveland, Southwestern & Columbus Railway Company. Illustrated description. 1600 w. St Ry Jour—May 2, 1908. No. 92035.

Useful Armature Repair Shop Methods. Norman G. Meade. Illustrates and describes devices found useful in repair shops. 900 w. Elec Ry Rev—May 9, 1908. No. 92222.

Some Useful Shop Schemes. H. M. Ashenfelter. Brief illustrated notes on methods of facilitating repairs at the South Bend, Ind., shops. 900 w. Elec Ry Rev—May 2, 1908. No. 92080.

Single Phase.

Single Phase Equipment for the Richmond & Chesapeake Bay. Illustrated description of this single-track electric road with turn-outs. 1000 w. R R Gaz—May 8, 1908. No. 92172.

Tests of Single Phase Electric Traction on the Seebach-Wettingen Line (Traction électrique : Essais par Courant monophasé sur la Ligne de Seebach à Wettingen). Jean Landry. The first part of the serial discusses experiments with single-phase traction in Europe and America and their results. 4000 w. Serial. 1st part. Bul Tech d l Suisse Romande—April 10, 1908. No. 92415 D.

Single-Phase Electric Traction on the Seebach-Wettingen Line (Die elektrische Traktion mit Einphasenwechselstrom auf der S. B. B.-Linie Seebach-Wettingen). Hugo Studler. The first part of the serial gives a description of the generating station. Ills. 2700 w. Serial. 1st part. Schweiz Bau—April 11, 1908. No. 92450 D.

The 15000-Volt A. C. Railway from Seebach to Wettingen (Die 15000-Volt Wechselstrombahn Seebach-Wettingen). S. Herzog. Illustrated description of line, generating stations, equipment, etc., of this single-phase line. 1700 w. Serial. 1st part. Elek Kraft u Bahnen—April 14, 1908. No. 92475 D.

Substations.

The Avoca Substation of the Lackawanna & Wyoming Valley Railroad Company. Illustrated description of the station and its equipment. 2000 w. St Ry Jour—May 16, 1908. No. 92281.

The Determination of the Economic Location of Sub-Stations in Electric Railways. Gerard B. Werner. A consideration of interurban and trunk line projects, or of relatively long roads. 3000 w. Pro Am Inst of Elec Engrs—May, 1908. No. 92383 D.

Subways.

Report on the Capacity of the New York Subway. Abstract of the fourth report of Bion J. Arnold, on the capacity of the subway, and making recommendations. 5500 w. St Ry Jour—May 30, 1908. No. 92680.

Power Consumption and Speed in the New York Subway. L. B. Stillwell. A report of speed and power tests carried out in the N. Y. subway about two and one-half years ago. 3000 w. Elec Ry Jour—June 6, 1908. No. 92731.

The Crossing of the Seine by Line No. 4 of the Metropolitan of Paris (Le Métropolitan de Paris. Traversée de la Seine par la Ligne No. 4). A. Dumas. Illustrates and describes the building and sinking into place of the five sections of this part of the Paris subway. 4000 w. Génie Civil—April 25, 1908. No. 92420 D.

Switzerland.

Electric Traction on the Rigi Railroad (La Trazione elettrica sulla Ferrovia del Righi). Illustrates and describes the line, equipment and operation of this mountain railroad in Switzerland. 2700 w. L'Ing Ferro—April 1, 1908. No. 92424 D.

See also Single Phase, under STREET AND ELECTRIC RAILWAYS.

Track Construction.

Track Construction. Mark Lowd. Read before the S.-W. Gas & Elec. Assn. Deals with T-rail construction in paved streets. 2000 w. St Ry Jour—May 23, 1908. No. 92516.

Track Maintenance.

Way Department of the Public Service Railway Company. Martin Schreiber. Illustrates and describes some of the methods in construction and maintenance work, especially tracks and buildings. 4500 w. St Ry Jour—May 2, 1908. No. 92034.

Train Control.

Multiple-Unit Train Control on the Lancashire and Yorkshire Railway. Illustrated description of the direct electromagnetic system, with solenoids carrying the main return current from the train motors to the rails. 1800 w. Tram & Ry Wld—May 7, 1908. No. 92519 B.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language,* together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cts. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w,* a bi-weekly, *s-w,* a semi-weekly, *m,* a monthly, *b-m,* a bi-monthly, *t-m,* a tri-monthly, *qr,* a quarterly, *s-q,* semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

CURRENT RECORD OF NEW BOOKS

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

Shop Management.

Betterment Briefs. A Collection of Published Papers on Organized Industrial Efficiency. By H. W. Jacobs. Size, 9 by 6 in.; pp., 240. Ills. Price, $3.50. Topeka, Kans.; Published by the Author.

About four years ago the Santa Fe broke loose from the ranks of traditional railroading and adopted a general plan of shop betterment work that to many was radical if not of a revolutionary nature. That the plans outlined and carried into effect were practical and not visionary has been demonstrated in a manner as evident to the directors and stockholders as to the humblest mechanics.

Articles dealing with various phases of this work have appeared from time to time, setting forth some of its prominent objects. We now have before us a book treating of the subject of mechanical betterment in a comprehensive manner, which elucidate the elements and general principles not only as applied to the shops and management of the Santa Fe motive power, but as applicable to the practice of any progressive railroad. The plan adopted in the prosecution of this work and the methods described will strike home to every man having an interest in railroad problems. The detail descriptions of practical accomplishments will be of especial interest to railroad men who will, more than others, appreciate the magnitude of the undertaking and the far-sighted aims of the Santa Fe management in putting a pioneer work of this kind into effect. The Vice-President in charge of maintenance and operation, is known as a man who has an unusual appreciation of the relative importance of the problems confronting such an officer, and he does not hesitate to strike out into new paths if they enable the journey to be accomplished more effectively.

The betterment method described in this book is a striking example throughout of the working out of such a policy.

BOOKS RECEIVED.

The Wyoming Voluntary Publicity Law. Compiled by Henry C. Beeler. Size, 9 by 6 in.; pp., 11. Cheyenne, Wyo.: Office of the State Geologist.

Twelfth Annual Report on Highway Improvement, Ontario, 1908. Size, 10 by 6½ in.; pp., 110. Ills. Toronto, Ont.: Department of Public Works.

Proceedings of the American Railway Master Mechanics' Association, Vol. XL, 1907. Size, 9 by 6 in.; pp., 453. Ills. Chicago, Ill.: Published by the Association.

Annual Report of the Isthmian Canal Commission for the Year ended June 30, 1907. Size, 9 by 6 in.; pp., 239. Ills. Washington, D. C.: Government Printing Office.

Methods and Devices for Bacterial Treatment of Sewage. By William Mayo Venable. Size, 9 by 6 in.; pp., 236. Ills. Price, $3, 12/6. New York: John Wiley & Sons; London: Chapman & Hall.

Practical Calculations for Engineers. By C. E. Larard and H. A. Golding. Size, 7½ by 5 in.; pp., 455. Ills. Price, $2. Philadelphia: J. B. Lippincott Company; London: Charles Griffin and Company.

Proceedings of the Fifteenth Annual Convention of the Traveling Engineers' Association held at Chicago, September, 1907. Size, 9 by 6 in.; pp., 340. Ills. Buffalo, N. Y.: Published by the Association.

Massen-Destillation von Wasser insbesondere zur Erzeugung von Trinkwasser und Lokomotiv-Speisewasser. By Ludwig Bothas. Size, 9 by 6 in.; pp., 53. Ills. Price, M. 2. Berlin: Julius Springer.

The Pollution of New York Harbor. By George A. Soper. Reprinted from the Journal of the Association of Engineering Societies, June, 1906. Size, 9 by 6 in.; pp., 33. Ills. New York: George A. Soper.

A Treatise on the Principles and Practice of Harbour Engineering. By Brysson Cunningham. Size, 9 by 6 in.; pp., xii, 283. Ills. Price, $5. Philadelphia: J. B. Lippincott Company; London: Charles Griffin & Company.

British Standard Specifications for Copper Alloy Bars for Use in Automatic Machines. Published by the Engineering Standards Committee. Size, 13 by 8 in.; pp., 13. Ills. Price 2/6. London: Crosby Lockwood & Son.

Experimental Work Conducted in the Chemical Laboratory of the United States Fuel Testing Plant at St. Louis, Mo., Jan. 1, 1905, to July 31, 1906. Size, 9 by 6 in.; pp., 49. Washington, D. C.: United States Geological Survey.

THE ENGINEERING MAGAZINE
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EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

II. NATIONAL EFFICIENCIES; THEIR TENDENCIES AND INFLUENCE.

Mr. Emerson's series began last month with a review of typical inefficiencies and their significance. In the part now presented he sketches most graphically the peculiar qualities which have caused the greatness of the leading industrial nations—Great Britain, Germany, France, Japan, and the United States—using the past and present thus revealed as a basis for the deduction of very valuable suggestions for the future. Next month's paper will take up the "Strength and Weakness of Modern Organization," and the following part will begin an examination of the averages attained in standard practice.—THE EDITORS.

INEFFICIENCY is a form of waste, of loss; it lurks everywhere—in processes, in materials, in individuals and in nations. There is however a difference in kind between the two forms of inefficiency, one manifest in processes and materials and the other manifest in individual or nation. To the efficiency of a process or in the use of a material there is a clearly ascertainable maximum, and when it is exceeded the material gives way, as in the Quebec bridge, but to the efficiency of an individual or of a nation there is no predeterminable limitation. In the passion for modern scientific accuracy it has proved more interesting, and more has been done, to solve the lesser problem of efficiency, in process or material, the larger problem of individual or national efficiency being in fact almost wholly ignored.

Men are quick to catch and appropriate the ideas of other designers as to bicycles, steam engines, gas engines, automobiles, so that the same standard designs and performances occur in widely scattered countries; but individuals and nations differ fundamentally not nearly so much in the degree as in the nature of their characteristics. They differ not as one coal from another, but as sulphur, carbon, hydrogen and radium differ. The analogy of fuels is illuminating and may further a better understanding of the whole question of efficiencies. If a coal yields 13,000 B. t. u. the combustion problem is to utilize as large a percentage of them as possible. Other elements in combination with oxygen may evolve only 4,000 B. t. u. per pound, as sulphur, or 60,000 as hydrogen; or radium, without troubling to combine with oxygen, will evolve per pound 210,000,000,000 B. t. u. or thereabouts.

It is the province of the chemist to determine the actual number of heat units in any element or combination, so that we have, for each, a theoretical maximum. It is the task of the combustion engineer to devise apparatus which will utilize the largest percentage of the heat units in the fuel; but the more difficult problem of the economic engineer is to select the fuel and burn it so as to secure the desired result at lowest cost.

It is more difficult to select intelligently the power installation for a tug boat, between the limits of a drift-wood burning furnace and a Diesel crude-oil motor, than it is to design and secure good furnaces, good boilers, or good engines. A very elementary furnace and boiler will yield 50 per cent efficiency; the best boiler and furnace, and then only under exceptional test conditions, may yield as much as 85 per cent; and no increase of expenditure, no increase of designing skill, will realize 90 per cent. When, however, one passes from sulphur to carbon, from carbon to hydrogen, from hydrogen to radium, the progression is not one of 80 per cent improvement between best and poorest, but the best, radium, is fifty million times better than the poorest, sulphur.

Applying the analogy of fuels to individuals and nations we have as yet no analysis of humanity which will enable any one to determine their capabilities. We do know how the best individual will react against some definite mechanical proposition; we do know the best record as to running or swimming or any other athletic or manual performance, with the certainty that it will never be appreciably bettered; but even this knowledge has as yet been utilized to very small extent, outside of sport, to increase individual efficiency in a particular task. Our manipulators of human material are constantly using human radium on a grate intended for lignite coal, very much as the early engineers in the natural-gas fields used natural gas expansively to drive engines originally built for steam.

The difference between sulphur and radium as evolvers of heat is fully paralleled in the difference between the Italian immigrant (who, with wheel-barrow, works at less than 20 per cent efficiency on the railroad dump), and the Corsican, of poverty-stricken antecedents, who in early manhood pushed the whole of Western Europe and also the two Americas a hundred years forwards. It is not assumed that every immigrant boy is an embryo Napoleon; but from John Jacob Astor on, foreign immigrants who would have remained peasants in their own country, have become dynamic forces in the New World, simply because, to these radium individuals, opportunity occurred.

As to any man, and as to any nation, the as yet unsolved problems of efficiency are: (1), to enable each to accomplish the uttermost in reaction with the task set, average present efficiencies being about 60 per cent; and (2), to set each at the highest task of which it is capable, present average efficiencies being so much below one per cent of the best as not to warrant an estimate.

The differences between coal and coal are molecular; the differences between sulphur and radium are atomic. The differences between the speed of one runner and another, the natural resources of one nation and another, are physical; the difference between the spirit of Diogenes and the spirit of Napoleon, between the spirit of the Papuan and the spirit of the American, are psychical.

Inherited wealth and inherited power have rarely made men great, although when young heirs first come into their inheritance they may for a short time dazzle by their prodigality. Great natural resources will not in the long run maintain nations, although during the period of reckless squandering they may seem prosperous to themselves and to others. For the past 10,000 years Central Africa has teemed with natural resources, but it was the Vikings of bleak Norway who conquered the European and Mediterranean littoral, incidentally also taking possession of Iceland, Greenland, and probably visiting the northeast coast of America.

Alaska is a better country than Norway or Switzerland. It has 100,000 square miles of agricultural land, the best coal in North America, lead, copper, silver and gold mines, vast forests, rich fisheries, a great fur trade, and 10,000 miles of ice-free sea coast, harbor-indented, along the great Pacific highway between all Asiatic and all North American ports. The Eskimo, Aleuts, Indians, and mongrels of Alaska, surrounded by unparalleled natural resources, have accomplished little, although their supineness has been no greater drawback than the stupendous ignorance, neglect, and corruption to which this empire of the future (if men are forthcoming) has been subjected by some of the departments at Washington. The Swiss, for whom nature has done so little, have, individually and nationally, developed high efficiency. When Alaska, the relatively richer country of the two, has as many inhabitants as Switzerland in proportion to its area, it will be a nation of 120,000,000. No wonder the Canadians, with nearly six times the area of Alaska, have hopes of repeating in America the polar drift of empire so manifest in Europe, Asia, Africa, and South America.

Between one civilized country and another there are extremes of variation in natural resources, yet all are prospering. The efficiency of the workers in all of them is low, yet each country is growing rapidly in wealth. The cause of prosperity cannot lie in natural resources, since some of the countries with the most resources are most backward and others with the poorest resources are most forward. The cause of prosperity cannot lie in the ability or fidelity of the workers, since all of them, when checked up, are found to be of low average efficiency. The cause of success must therefore lie either in some common trait which all possess or in the exploitation of some different trait in each. The only common trait is ambition, the desire for success and wealth; but the gratification of ambition, the attainment of material success, has each time been due to a different psychical instinct. In Alaska the eagle, the seal, and the bear all grow fat by feeding on salmon. The food is common to all three, but the method of appropriation is different. The eagle descends from the air, and lifts the salmon out of the sea, the seal pursues and seizes the salmon in the water of the sea, and the bear scoops him out with his paw when he finds him in the shallow brooks. The British, French, Germans, hunt success along lines as different as those of the eagle, seal, and bear. It is easier to describe the physical differences between eagle, seal and bear than to describe the psychical differences between the great industrial nations. Nevertheless the differences exist, and the causes of the respective successes cannot be understood unless the reaction of success of these psychical traits is understood; and, what is more important, that nation will in the long run reach a higher level which is able not only to appropriate the best designs and processes of its rivals but, what is immeasurably more important, to appropriate also and possibly to improve their psychical inspirations.

The English, the French, the Germans, the Japanese, the Americans, are not great because they all have schools and sea ports and coal, but because schools and sea ports and coal mines have fed wholly different natural characteristics. To discover these different national characteristics it is necessary to back off, both in space and time, so as to lose details and see only the governing traits. No nation can be reduced to a formula, but an attempt will be made to separate out, for a number of leading industrial nations, traits of which they more or less seem to possess a monopoly, and which for that very reason merit careful analysis by their rivals.

In recent centuries Great Britain has been easily the leader both commercially and industrially. The English also were up and doing before daybreak in other directions, and by the time the other nations woke up, either yawningly or to the sound of some revolutionary alarum, the English were anywhere from several decades to several centuries on their way. They limited the power of kings, 1215 A. D.; they abolished divine right in 1649, and selected by vote their own sovereign in 1689. The American colonists woke up in 1776, the French in 1789, the Germans in 1871. During the period when other nations were pulling each other down in continental Europe, the English were appropriating large parts of Asia, America, and Africa as well as the continental islands. When other nations were using wood and developing charcoal burners, the British were opening coal mines. When other nations were building post roads, the British were stringing iron rails; when the Americans were building the best and fastest wooden clipper sailing ships, the British were not only building iron steamers, but they were also calmly taking possession of all the strategic points of the seven seas. While other nations were stretching wires on poles along railroad rights of way within their own boundaries, the British were enmeshing the globe with submarine cables. It is not because the British are the greatest shipbuilders that they control the sea, but they incidentally build ships and a few other things because at least 100 years before any one else realized its importance, they made the unclaimed empire of salt water their own. For any other power at this late date to aspire to rivalry on the sea is futile—is laughable.

Consider the North Sea. Sweden, Russia, Germany, Holland and Belgium, all the immense maritime trade of Northern Europe, goes to and comes from the Atlantic Ocean and all there is beyond, through what the English proudly call the English Channel, with the cliffs of Dover at one end and on one side and the Channel Islands at the other end and on the other side. Consider the Mediterranean, bottled up at one end at Gibraltar and at the other by the French-conceived, designed, and dug, but at present English-owned Suez Canal, with Malta conveniently and centrally located in the waist, with

Cyprus watching the egress from the Black Sea of both Turk and Russ. The only nations in Europe who can go to sea without British consent are the Norwegians, the French, the Spanish and the Portuguese. Consider the Atlantic Ocean, north and south, studded with British mainland ports and island outposts along all its four sides, and up and down through the middle. Consider the Indian Ocean—Cape Colony at the western southern end, Australia at the eastern southern end, the western northern entrance blocked at Aden, the eastern northern entrance blocked at Singapore, with Mauritius, Ceylon and sundry other islands scattered centrally around, very useful for all sorts of purposes, coaling and repair stations, landings for submarine cables, shores for space telegraph installations. Consider the Pacific Ocean —not quite so completely a British sea, but nevertheless even in it they would be first in length of sea coast were it not for Alaska's indented mainland and islands. Although second, as to mere length of shore line, they have, both on American and Asiatic side, strategically a greater number of important posts, not counting Australia and New Zealand to the South, than any other power, and when the all-British cable was laid from Vancouver to Australia and New Zealand, as many British islands as were needed turned up conveniently for mid-ocean stations.

Not content with commanding the European Mediterranean, they also command the American Mediterranean, with the counterpart of the Suez Canal in the St. Lawrence River, the deep-water channel between the Great Lakes and the Atlantic. They also control one side of the water passage from Lake Superior to Lake Huron, from Lake Huron to Lake Erie, from Lake Erie to Lake Ontario. On the Pacific side of North America it is the same. There is another though smaller inland sea there, the matchless Puget Sound, but, in spite of 49 degrees north, the treaty boundary line, they not only reserved their own independent sea outlet, north of Vancouver Island, but they established another Gibraltar at Esquimalt, on the north side of the Fuca Straits, only entrance to the largest and most important American harbor on the west coast.

Although the United States at last controls Panama, during the whole of the last century it was not any American statesman who foresaw the importance of this control, nor was it any American ambition that dared attempt the task of breaking the Isthmus.

Two-hundred years ago the British appropriated a complete chain of islands cutting off both Gulf of Mexico and Caribbean Sea from the Atlantic Ocean; in 1827 Goethe, in a masterly discussion of the importance of the Isthmian Canal said: "I would be surprised, if the United States would miss the chance to get such a work into her own hands. It is entirely indispensable for the United States to make the passage to the Pacific Ocean, and I am certain that she will accomplish it." It was however not the near-by United States that first undertook the work, but the distant French.

So early and so persistent was the British instinct of sea control that surprise is caused, not that the British have so much, but that they let so much of value slip through their fingers.

By right of exploration they might have taken possession of the whole of equatorial Africa; they might, without any one making protest, have annexed both sides of the Straits of Magellan; they might have seized on both the Diomede Islands in the middle of Bering Straits; and it is incredible that after discovering the Hawaiian Islands they should have let them go.

For the British these islands have strategic location and value as the only direct sea route on which they are situated is the one between Vancouver and New Zealand. They are of no value strategically to the United States, as they lie at least 1,000 miles south of any direct route from the United States to Asia, lie 1,000 miles out of the course of steamers making the run from Panama to Singapore, and the attempt to magnify them as an important sea possession of the United States merely accentuates the difference between the deep, set purpose of the English and a fatuous impulse.

So sensitive are the British as to anything that appertains to the control of the sea that they get into a panic at the mere suggestion of tunneling the English Channel, and when the Germans built the fastest steamers for the Atlantic trade the English did not rest until they had evolved a new form of steam engine, a new form of screw propeller, had built larger boats than any other flag possessed, and with the combination, regained the lost blue ribbon of the sea. Similarly, as soon as the French, Germans, Americans laid a few straggling sub-oceanic cables, the British at once set up space telegraph stations so that soon no British steamer anywhere need be beyond call from British land.

This persistent far-sight, this stubborn holding onto an idea, characterizes the British bull-dog in all things, although illustrated above only as to sea power; and it is perhaps well for the rest of the world that on the whole he is good-natured and that he does not have too many ideas.

The predominant characteristics of the French are quite different; none the less admirable—in fact, more progressive. The French are brilliant innovators and as a nation they think logically and execute artistically. Their revolution had its inception in the work of the encyclopedists, and its culmination in the Code Napoleon. In the Théatre Français the prices of the seats are cut into the solid marble, but the monogram of the government is detachable, because forms of government are the accident of the moment but the principles of art are eternal. The English follow up persistently a few all-important matters. The French evolve brilliantly many entirely new things. The French invented and made practical the bicycle, the French were the first to ascend into the air in balloons, and France still holds all the official records for all sorts of flight—distance, dirigible, heavier than air. The French started both the gas engine and the automobile; they first used rapid-fire machine guns, the mitrailleuse; their passenger locomotives make the fastest regular runs in the world; they developed compound locomotives, and also, the most powerful freight locomotive, the Mallet articulated, is of French design. To the French we owe the first successful submarines; to a Frenchman, Daguerre, we owe photography, and to another, pyrometry which has placed metallurgy on a scientific basis. The French invented and put into effect the decimal system, which has been universally adopted for money (except by the insular British) and the French also established and maintained bi-metallism, without a hitch, for 70 years, although in that period the greatest fluctuations that the world has ever experienced occurred in the relative production of gold and silver. The French have always been bright enough to avoid the financial panics that have disgraced Great Britain, Germany, and the United States. The French dug the Suez Canal and also started the works at Panama. Most appropriately, we owe to the French modern stearine candles, the Argand burner, and the brilliant use of the electric current for light. Storage batteries of both types were discovered in France, as also plate glass, rolled glass, and wire glass. A Frenchman first deciphered the hieroglyphics of Egypt; another Frenchman, Pasteur, expanded and made rational the practice of inoculation; another one, Berthelot, developed modern chemistry, and to the French we owe artificial silk.

It was because the French teem with revolutionary ideas that Franklin's ability received from them more immediate and cordial recognition than from either Americans or from British.

The characteristic trait of the French is brilliant innovation carried out in an orderly, logical and artistic manner.

Germany is one of the world's greatest industrial powers—so menacing, in fact, that the eyes of the industrial and commercial world are turned apprehensively in her direction. Until recently however she has always been bringing up the rear, the slow but sure turtle among the nations. When France, Spain, and England were parts of the Roman Empire, assimilating Roman civilization, Germany was a storm center of savage ferment. Italy officially adopted Christianity in the fourth century, France became Christian in the fifth century, but it was not until the ninth century that Charlemagne gave the Saxons their baptism of blood. When the French and English were evolving parliaments and courtly manners, the Germans were engaged in their thirty-years war. It is characteristic that the renascence in Italy and France took the form of a revival of classic art, literature, and culture; in Spain and England took the form of oversea adventure; but in Germany the form of religious revival and reform. It is also not less characteristic that while other nations have made progress through revolution and violence, the Germans are rapidly overtaking them through peaceful evolution.

American wooden clipper vessels were the queens of the sea from 1800 until the introduction of steam. Previous to 1870 the only German ship-building was in the Baltic yards where American models were imitated, but shortly after 1870 Germany "resolved" to build ocean steamers and in 25 years her ocean liners, German designed, German built, German manned and officered, were the fastest and finest vessels afloat. It required extraordinary effort on the part of the English to regain the lead. America built more locomotives and owned more miles of railroad, many times over, than Germany, but in this year of Grace 1908 it is the German principle of superheating that is being applied to American locomotives.

Germany succumbed helplessly before the genius of Napoleon in 1806, but less than two generations later Von Moltke had remodeled the oldest of all organization—military—by adding to line organization the principle of developed staff organization, and it is staff organization that has made Germany during the last 40 years easily the pre-eminent military power in the world.

An English authority on iron and steel has recently shown that in spite of adverse natural and economic conditions which make the average production cost of German pig iron 50 per cent higher than the average cost of British warrants, yet owing solely to better organization and more advanced industrial discipline, German exports of iron and steel increased 350 per cent in the decade from 1897 to 1906-7 while the British increase in the same period was only 10 per cent.

This habit of the Germans of "resolving" that they will accomplish certain results, and then forthwith succeeding, is exceedingly disconcerting to commercial and industrial rivals. Whether the subject be military organization, the designing of ocean steamers or of locomotives, technical or industrial training, industrial and commercial expansion, all the German needs to do is to desire to surpass and he succeeds, not by far-sighted annexation of a field not yet taken, not by brilliant creation of a new field, but by patient improvement on the model supplied. "Billig und schlecht!" said Prof. Reuleaux of the German exhibits at the Centennial in 1876; "made in Germany," the legislative badge of inferiority in 1880; but today German products are no longer "billig und schlecht" and, in many lines "made in Germany" is a label of highest excellence.

It is fortunate for their rivals that German efforts are so often indiscriminate, that they will elaborate mathematically the theory of the Dutch windmill and overlook the sirocco blower, that they perfect staff organization in the army and that they have failed to apply it to their shops, being in this respect far behind the best American developments!

Americans have little of the persistence of the English, little of the brilliancy of the French, and not any of the patient science of the Germans. The immigrants or adventurers who of their own choice, full of faith and hope, come to the land of sunshine and opportunity, were the restless daring spirits of all the nations of Europe; first the Spaniards, then the French, later the English, and more recently the Irish, the Germans, the Russians and the Italians. For all these the past held but light ties; they came to stay, and the little they did bring of mental or material equipment proved of scant value. There has been in all of them, of whatever decade or nationality, the common restlessness, the common eagerness to make good. Before them stretched out the promised land, forest and plains, farms and urban sites, transportation monopolies, minerals. The gold-seeker in California, equipped with elementary courage and pick and shovel, exhausting the shallow placers, and spending the proceeds in individual aggrandizement; such is the true type of the American, whether he be named Astor or Vanderbilt, Rockefeller or Morgan, Jas. J. Hill or Harriman, Carnegie or Guggenheim. Because there were no traditions to hamper, because those prospered most who acted most energetically, American enterprises have been characterized by spasmodic and disconnected impulses, very different from the dogged pluck of the English or the logical development of the

French or the studied results of the Germans. In America personality has been everything—personality inbred until often in one generation it became sterile from lack of cross fertilization. Because of different personality, not because of different problems or different opportunity, the New York Central and the Pennsylvania Railroads have grown and prospered, but the Erie Railroad, between the same terminals has always been in difficulties; and because of varying personality, far more than varying conditions, such railroads as the Union Pacific, the Northern Pacific, have swung up and down and then up again between extremes of inflation and depression. Not in religion, politics, transportation, commerce or industry is there either persistence or clear thought or profound preparation.

An agent of Lloyd's visiting the Atlantic Coast ship yards of the United States reported that American materials were fully as cheap as English materials, that American wages were no higher than British wages, but that the very greatly increased cost of American-built ships was due wholly to the enormous inefficiency of organization and performance. Yet, when the mood takes the American, creations more stupendous, more beautiful than the world had ever dreamed of, suddenly spring from nothing, as in the filmy beauty and sublimity of the World's Fair grounds and building at Chicago, but as suddenly these creations fade back into nothingness leaving only a memory.

The American, whether at Chicago in 1903, or on the Alaskan White Pass in 1899, crowds the progress of 2,000 years into a single year; but to mark the milestones of time, he leaves no pyramids nor cathedrals, nor palaces nor anything else that holds out a promise of secular endurance. Individuality has been supreme, it has accomplished so much. There have been great inventors—Edison, Westinghouse, F. W. Taylor—but what they have created has rapidly become the property of all mankind. When lavish opportunity no longer exists, when invention becomes less the inspiration of the moment and more the result of patient research, how then will it fare with the American in the cosmopolitan struggle for first place?

Latest of the civilized nations are the Japanese. The occidental world was opened to them by Perry in 1853 and as late as 1867 they were still using bows and arrows, two-handed swords and chain armor. The Germans and the Japanese (not counting oriental Europe) emerged latest from feudalism and rose into world prominence about the same date, and for that reason both have proved dangerous, because both were compelled to absorb so much from others, and yet were able to supplement it with their own special virtues. The Japanese, with an open-mindedness unparalleled in the history of the world, sent forth their brightest young men to England, to France, to Germany, to the United States; they adopted eclectically all that was best, adapted to their own needs what they had selected, and soon they became adepts. They have sat at the feet of the English in all matters appertaining to the sea, from ship yards to ship officers, from ship models to ship insurance; they have sat at the feet of the Germans in all matters appertaining to military organization, and, as the expedition to Pekin and the Russian war showed, improved on their models; they are as logical as the French and more progressive than the Americans.

Ascribing to the English the efficiency of wise anticipation and continuous persistence, to the French the efficiency due to their innovations of supreme value and merit, the efficiency of the Germans to their perfection of organization, discipline and scientific minuteness, to the Japanese the efficiency due to open-mindedness and marvelous power of assimilation, to the Americans the efficiency due to individuality—it cannot be doubted that it would be more desirable and produce better results to endow a nation of individuals with persistence, clear habits of thought, scientific patience and open-mindedness, than to let loose intense individuality among the English, French, Germans and Japanese. The trouble with the American is that as yet he is provincial, skeptical as to the value of anything outside his own limited experience, a trait perhaps amusingly illustrated in the way he takes for granted that millions of foreigners shall cheerfully give up their allegiance for the sake of American citizenship, but is indignantly surprised when any American seeks naturalization in Europe.

The boundless natural resources of American are being exhausted. Will the American forever be able to maintain a lead through intense individuality alone, or will he industrially as a nation recede before the German, even as native American names have disappeared from Broadway, New York, and been replaced by miles of German names? Will mere resourcefulness suffice in the future? Because he is resourceful, because he is adaptable, because he has always delighted to force the game to the uttermost, it may be that all he needs is a set of higher standards, and that if they are supplied he will realize them sooner than any competitor.

Standards except as to a few performances are as yet undetermined in the industrial world. If the American sets them high, he may attain them, and the prevalent democracy may make it easier for each worker to rise to the limit of his capacity.

THE EXCAVATION OF HERCULANEUM BY MINING METHODS

By Alex. Del Mar.

THE Roman city of Herculaneum (the Heracleia of the Greeks), which was injured by an earthquake in A. D. 63, and buried by an eruption of Vesuvius 16 years later, lies now from 30 to 120 feet beneath the surface, at a distance of about 5 miles southeast from Naples, with the town of Resina (population 20,000) on top of it and the overlying space filled with volcanic material. It is distant about five miles westward from the most recent crater of the volcano, about two-thirds of a mile from the Portici Station of the Naples-Pompeii Railroad, and about half a mile from the seashore and the continuation of the railroad line, which here hugs the shore.

The ancient city was not built upon a level, but upon a bluff descending to the sea, with the result that some of the buildings differ in the altitude of their foundations by 100 feet or more. Excluding scattered villas, the buried ruins probably extend over several hundred acres, of which less than 40 acres, constituting the higher and more easily accessible portion of the city, have already been laid bare, or rudely excavated, by means of tunnels.

The origin of Herculaneum, its ancient history, its tragic catastrophe, the various excavations of its ruins made in the reign of Constantine the Great, and again between 1709 and the present time; and the manuscripts, sculptures, paintings and other objects of interest rescued from its ruins in modern days, form the subjects of a very considerable literature, an epitome of which and a guide to the works themselves will be found in the current encyclopedias and other works of reference, and in magazine articles. Among the latest of these is the brief but interesting essay of Professor Rodolpho Lanciani, in *Munsey's Magazine* for 1907.

The most valuable objects thus far recovered from the ruins consist of statuary, paintings, vases, and coins; and the most numerous objects, several thousand manuscripts; but among them, so far as has been disclosed by the excavators who had charge of the works under the Neapolitan princes of the eighteenth and nineteenth centuries, none of those productions of the Augustan age of Rome, which, like the missing books of Livy or Tacitus, would have earned for the excavators the gratitude of an expectant world. These are among the prizes which await the future explorer: for it is confidently believed that Herculaneum, which Lanciani has aptly termed "the Newport of Rome," still hermetically preserves in its tenacious care the lost literature of the classical ages.

A portion of the excavations of Herculaneum thus far made are what a miner would call an "open-cut," where all the superincumbent earth, or volcanic material, has been removed, and the buried remains laid bare to the day, as in the Roman Forum and in Pompeii. Another portion has been excavated underground by means of shafts and galleries, as in a rock mine; and still another portion, by means of short tunnels run in from the seaside, as in a drift mine. All of this work, except the open-cut (which though very expensive was mechanically simple) was done, from a miner's point of view, unscientifically, and from the archæological point of view, as Lanciani observes, vandalically.

Some years ago, Prof. Charles Waldstein, of King's College, Cambridge, attempted to enlist the aid of a number of eminent and wealthy persons in England, Italy and the United States, in raising a fund to purchase the lands of Resina and remove the entire mass of volcanic material which covers the city of Herculaneum; but without success. The enterprise was deemed too vast and the plan too expensive. An American company now proposes a different plan—that of exploring Herculaneum as a rock mine and with all the mechanical appliances and devices which have elevated the art of mining in America to the dignity of a scientific industry. The outline of the plan proposed has already secured the approbation of Prof. Spinazzola of the San Martino museum of Naples, Prof. Dall'Osso, inspector of excavations at Pompeii, Prof. Cosentini of the University of Naples, and Prof. Lanciani, University of Rome, and other eminent scientists in Italy, besides many distinguished persons in England, France, Germany and America. It is the details of this plan which we propose to lay before the reader; it being premised that as yet, the writer, who has been nominated by the American company to superintend the mining works, knows the ground only by casual survey and description. Upon exploring it more minutely, some of the following details may undergo modification.

The material to be dealt with consists for the most part of tufa, or a semi-hardened volcanic mud. The theatre, already excavated, was found filled up to the very head of the arches with tufa, and under circumstances which prove that the conversion of mud into this stone takes place in a comparatively short time. Until exposed to the atmosphere it yields readily to the pick: afterwards it hardens into pozzolana, or pudding stone, when it becomes refractory. Other portions consist of sand, ashes, fragments of lava and whitish pumice, inclosing grains of uncalcined lime, similar to the materials found in Pompeii. These were evidently transported by water, hot from the volcano; for they sometimes fill and choke up the most narrow, intricate and remote places, and in a manner that no subsequent seepage of rain water from the surface could have effected. In some places streams of hardened lava are covered with soil and again by lava, and so on for six successive times, implying long ages between the various floods of volcanic materials. Briefly, the engineer will have to deal with hard lava, pozzolana, tufa, pumice, sand, and seepage water, to say nothing of other and as yet unknown materials, such as underground springs of water; structures which have fallen into and choke volcanic fissures; old workings unskilfully constructed, or defectively supported; etc.

It is proposed at the outset, and until the workings suggest different openings, to excavate Herculaneum by means of four principal openings, two vertical and two horizontal, of which only one pair will need to be described; the other pair being, for all engineering purposes, merely duplicates. One of the perpendiculars, which will be called the main shaft, will tap the ancient city at a point between the theatre and the seashore; the corresponding horizontal entry will penetrate from the seashore until it connects with the main shaft. This plan will secure several important advantages. It will afford a natural drainage for the entire workings; it will afford an easy and economical exit for the material to be removed and transported by gravitation to a point where it can be utilised for other purposes; and it will afford an avenue of egress for the workmen and inspectors, in case of temporary interruption to the working of the main shaft.

To facilitate and cheapen the work of excavation, a compressed-air plant will be installed which will run sufficient air-hammer drills of the most approved type to hasten the work in any ground that requires blasting. The exhaust air from the drills will improve the ventilation in remote places not easily reached by natural draft.

As, in conformity with the plan of the undertakers, Herculaneum will become a popular show place, to which numbers of people, both natives and foreigners, will resort, to view its remains of antiquity *in situ*, it is proposed to construct the main shaft in an enduring manner, and both earthquake- and fire-proof. Instead of the usual timber frame and board sheeting, the main shaft will be constructed throughout of steel. It will be sunk from the surface to a depth below which it will be useless to search for antiquities. It will have at least four stations, one at about the level of the roofs of Herculaneum, one at the level of the principal street, one at the level of the cellar floors of such street, and another to connect with the seashore tunnel. The main shaft will be divided into three compartments; two for workmen and freight and one for visitors. The former will be provided with safety cages, and the latter with a luxurious elevator, handsomely furnished, and worked by an independent engine. After connection is made with the tunnel, one of the workmen's cages will be dispensed with, and converted into a supplementary passenger lift. The head of the main shaft will be enclosed in an edifice constructed to suit the purposes of the administration, including a visitors' room, inspectors' room, sifting room, ticket office, etc.

In order to meet the necessary requirements of the administration, the exit to the tunnel will also be enclosed. This tunnel will be 2.2 metres, or about 7 feet high; and 1.4 metres or about 4½ feet wide. At the bottom of the tunnel, in the centre, will be constructed a drainage channel; and on each side of this channel will be laid a line of narrow-gauge rails, upon which will run the dump cars employed in transporting the excavated material to the sifting room, and eventually to the seaside. The tunnel will form a more or less direct line from its mouth to the main shaft; but cross-cuts will be driven wherever these can be made to advantage. As the line of the tunnel will form a continuous descent from the main shaft to the sea, nearly all the excavated material will be removed by gravity and at small expense. At first the empty cars will be pushed by hand; eventually the entire system will be worked by machinery, and in a system by which the momentum of the loaded cars will be utilised to haul up the empties.

One of the most important cares of the engineers will be to support the superincumbent earth and the edifices of Resina which surmount it. This will be done in various ways, one of which will be to leave untouched all those portions of the mine, or buried city, which contain no structures. These portions comprise all the open spaces, such as the ancient gardens, empty lots, and sections of the streets, or roadways. In addition to the natural supporting pillars thus to be formed, it may be necessary in some places to construct artificial supports by devices familiar to the miner. When it is remembered that the Comstock mine, six miles in length, containing the numerous huge chambers from which the "bonanzas" had been extracted, were excavated, while Virginia City with its numerous heavy structures reposed in perfect security on top of the mines, there need be no fears that the difficulty of supporting the smaller city of Resina will be overcome in an equally satisfactory manner. The bonanza cavities of the Comstock mines reach downward to a depth of over 2,000 feet, and the shafts, galleries and other workings, downward to a depth of over 3,500 feet; yet Virginia City remains and the workings continue. The horizontal area of cross section of its bonanza cavities may be realised from the fact that, upon a floor filling one of these, an opera was performed before a large audience, with plenty of space for proscenium, scenery, dressing-rooms and orchestra.

The Herculaneum openings will be lighted throughout by electricity, and so vividly as to leave no part of the workings obscure. To provide against accident to the electric works, an independent electric system of lighting will also be installed; and as additional security, provision will be made for a third system, independent of the others, the details of which the engineers do not desire to make public. The telephone will be installed throughout the workings, and telephonic slot-box stations, open to the public upon deposit of a small fee, will be erected at convenient points. Refectories and other places of entertainment for visitors will be provided by the administration; so that an entire day may be spent in the Habitation of the Past, with both edification and pleasure.

The subterranean workings, by embracing the numerous detached villas of Herculaneum, will eventually cover so extensive an area that one of the most essential provisions of the engineering faculty will be the installation of a suitable and effective system of ventilation. Unless mephitic vapors from continuing sources are encountered—a condition of affairs which there is no reason to apprehend—such a system of ventilation is expected to be attained in a natural and inexpensive way. A continuous draft of fresh and invigorating air from the sea is expected to find its way to the shafts; and this draft can be diverted at pleasure to any desired part of the openings. Provision is made in the working plan for a cheap and effective device to overcome any interruption that may occur to the natural draft. A small fire department, with installation of running water, hose pipes, ladders, and hand implements, completes this interesting plan for the excavation and exhibition of the buried city of Herculaneum.

GENERAL VIEW OF THE SANDVIKEN IRON WORKS.

MINING AND INDUSTRIAL PROGRESS IN SWEDEN.

By John Geo. Leigh.

In a preceding article Mr. Leigh reviewed broadly the principal mining, mechanical and general engineering undertakings or projects now receiving attention in Sweden. The present paper is concerned chiefly with the individual characteristics and equipment of the leading establishments.—THE EDITORS.

As indicated in the preceding article, the countries with which Sweden has the largest commercial intercourse are the United Kingdom and Germany. In each case, indeed, the trade is more considerable than appears from official statistics, for there can be no doubt that a not insignificant percentage of products shipped to Denmark, and consequently classed as exports to that country, are in reality destined for England or Germany. For equivalent reasons, the trade between Sweden and the United States is probably much larger than is suggested by commercial records, England being, in this instance, the "country of destination" to which the goods are first shipped. A comparative statement of the value in thousands of £ of the recent commerce of Sweden with the three nations mentioned is given below:—

	1895.		1900.		1905.	
	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.
United Kingdom.......	7,268	5,433	9,402	9,805	8,855	8,002
Germany	2,375	6,456	3,624	10,438	4,733	12,464
United States..........	521*	591	875*	510	1,039*	2,302

The greater part of the Swedish exports of iron, steel, and forest products, raw and manufactured, goes to the United Kingdom, from which, in return, Sweden buys large quantities of coal and all but an inconsiderable proportion of her requirements, raw material and machinery, for her textile and leather industries. German imports include food products and luxuries and a great variety of manufac-

* Including a small percentage of Norwegian products.

tures, largely the output of engineering and chemical establishments, while the exports to Germany mainly comprise iron ore, partly wrought iron and steel, unwrought timber and joinery. From the statistics, it will be seen that Sweden's increased demands for coal—the effect, in the main, of her new-born industrial activity—have alone saved England from actual retrogression in the Swedish market, and that, on the other hand, and notably in respect of machinery sales, Germany has considerably improved her position. This, I am assured, is not the result of any natural preferences on the part of Swedish manufacturers, but rather in defiance of them, for the circumstance has occasioned more regretful concern in Sweden than, apparently, among those primarily interested and responsible. The last-mentioned, it would seem, have yet to learn that however willing the Swedes may be to acquire British machinery, they can scarcely be expected to over-exert themselves to this end in the absence of encouragement, and while it is comparatively easy to enter into arrangements with the agents of other countries, who are continually calling upon them or supplying information of mutual service.

Some responsibility, also, seems to attach to British ship-owners in fostering an impression that Sweden's industrial development is matter of indifference to the United Kingdom. The transportation and shipment of practically the entire output of iron ore, intended for export, from the central provinces and Norrland is today controlled by a single corporation, the Grängesberg-Oxelösund Traffic Company. This possesses large interests in the Grängesberg and neighbouring mining fields, and it has been in order to facilitate ore exports from these that the company has acquired shares in the railways to the coast and created a special harbour at Oxelösund. A few years ago the shipping of ore from this port was almost exclusively in the hands of British ship-owners, but since then it has been allowed to pass into those of the Dutch and Germans. In 1906 not one, and last year only one, British steamer carried ore from Oxelösund, and this in spite of the fact that each year the exports approximated 800,-000 tons. The circumstance is the more remarkable as the port is open all the year, no harbour or pilotage dues are charged, and shares in the owning company are held to a considerable amount in England.

Reverting to the subject of imported machinery, I regard with no little interest the following valuation in thousands of £ of Swedish exports and imports of machinery in specified years:—

1895.		1900.		1905.		1906.	
Exports.	Imports.	Exports.	Imports.	Exports.	Imports.	Exports.	Imports.
307	619	643	1,281	859	1,314	1,075*	1,048*

* Approximate, and not including steam-engines or sewing machines.

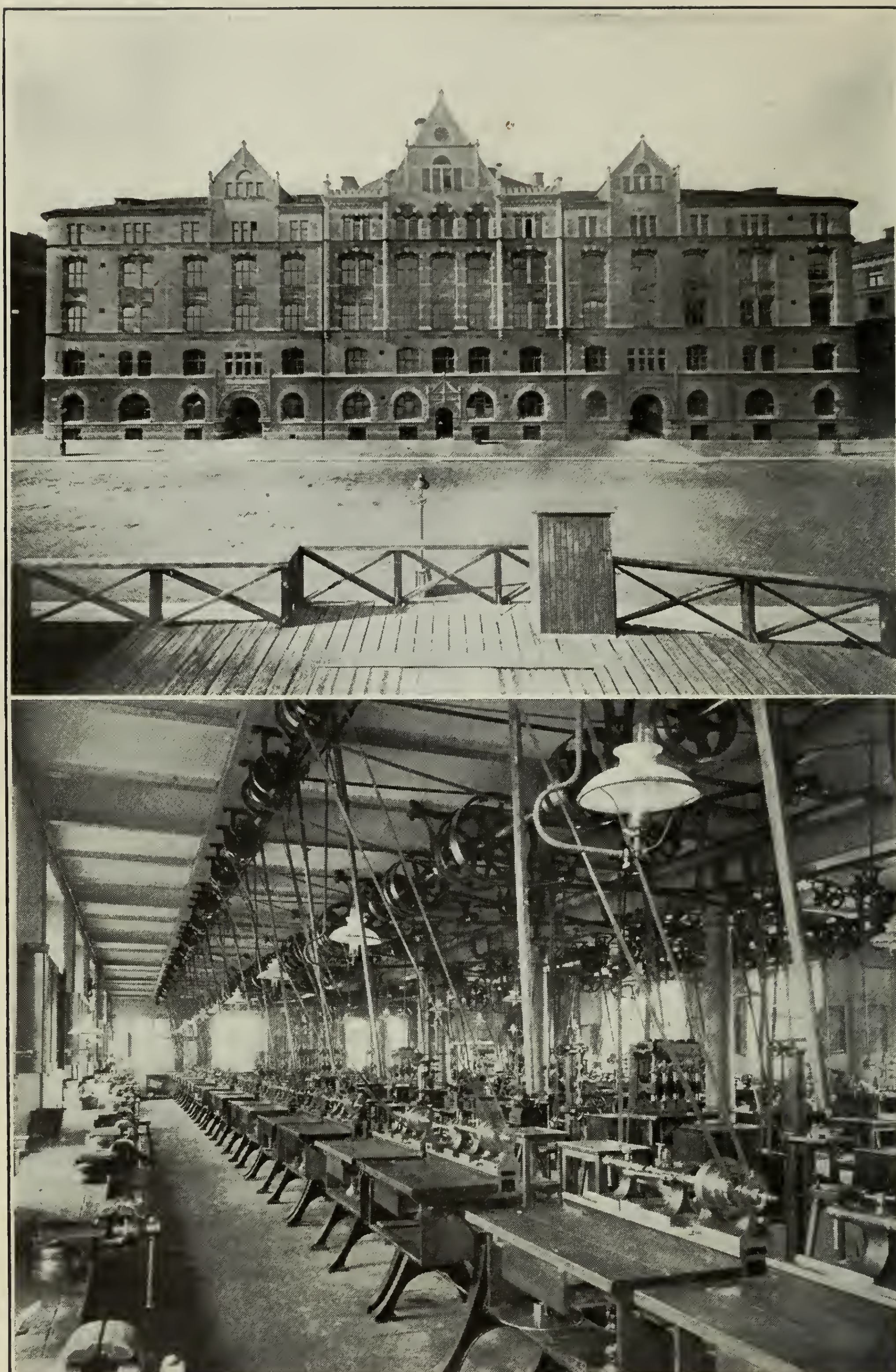
The figures need little explanation or comment, for both classes, imports no less than exports, bear testimony to marked industrial expansion. Owing to geographical position and heretofore existing political exigencies, the Swedes have in a larger degree than the majority of nations been able to preserve a distinctive social development, free, however, from any measure of that stagnation which usually follows isolation. Sufficient reasons for this may be found, first, in the high standard of culture which has always characterised the country, and, secondly, in the inherent interest of its people in all things foreign. This trait may have accentuated in some degree the tendency, not unknown in other countries, to over-estimate things of external origin at the expense of home products. On the whole, however, it has not been without value, especially during recent years in connection with the great industrial movement, inasmuch as it has strengthened—without danger of provoking opposition or captious criticism from the more conservative element—the laudable ambition of all classes of manufacturers to avail themselves to the fullest possible extent of the experience and appliances of other countries. As a result, one finds in Swedish workshops the best examples of machinery and machine tools from England, Germany and the United States, and throughout the community a unanimous sentiment that, so far from being regarded as unwelcome, the increased imports under this head should be esteemed high among the evidences of material progress.

It may perhaps surprise many readers, and even those amongst them who are personally acquainted with the arrangements and output of existing establishments, to learn that it is only within the past fifty years that Sweden has possessed mechanical works and foundries, as we today understand these terms. Such works as existed or were built in the early year of the second half of the last century devoted themselves, in the main, to repairing or furnishing coarser castings for agricultural and factory wants. Then, gradually, in order to give the small staffs regular employment, special manufactures were introduced; but, for a long time, only of such articles as were required in the country, or, in the great majority of cases, in the immediate neighbourhood of the works. Today the outlook is vastly different; compensation for the lack of coal has been found in the ever-increasing use of waterfalls, that other great natural source of power for industrial enterprise; many of the older works have been enlarged and modernized, and to their number have been added scores of establishments, equipped with the most suitable machinery and conducted on the newest and best approved lines, for the exclusive purpose of special manufactures, not only for home but also for foreign consumption. Many of these works have already secured deserved honours at international industrial exhibitions, and not a few are able to point to continuous and increasing activity in regard to external trade.

It is from all points of view fitting that the first establishments of this class to be specifically mentioned should be those which have been founded on Swedish inventions or have been peculiarly active in securing recognition abroad of the Swedes' well-won reputation for technical skill. For machines and implements for dairy work the Scandinavian kingdom has long been pre-eminent. The value of such articles annually manufactured in the country now approaches £600,000, and of this output about seven-eighths is exported. Of the many establishments devoted to the industry, the largest, of course, is that of the Separator Company, Limited, of Stockholm. In its extensive and admirably-equipped workshops and head offices over 1,200 highly-skilled workmen and more than 60 engineers and clerks find employment, and to these should be added the personnel of branches in Germany, Denmark, Austria, Hungary, etc. An important off-shoot, holding the American patent rights in the Alfa-Laval separator and other inventions, is the De Laval Separator Co., of Poughkeepsie and New York. Another works of great interest abroad is that founded on Mr. L. M. Ericsson's many improvements in regard to the telephone and its accessories. Its factory in Stockholm is one of the finest of its kind to be found in any country, employs 1,300 hands, and is a model for equipment and administration.

The manufacture of scientific instruments—surgical, mathematical, physical, chemical and navigation—has attained considerable proportions, is distinguished by a high standard of technical perfection, and offers export figures not unworthy of note. Whereas during the twenty years ended 1880 the annual value of exports under this head averaged but £1,000, it has now risen to about £165,000, an amount equivalent to that spent on similar articles from abroad. In no country probably have magnetic instruments been used so long and with better effect for the discovery of ores and in preliminary exploring work; and in this connection mention may be made of the magnetometer and vertical power balance, constructed by Professor Thalen, of Upsala University, and the Tiberg inclinator. A great economy of shaft and gallery excavations appears to have followed the widespread use of these instruments, and to the same cause may be attributed the excellence of Swedish mine maps and models.

The marked development of the electrical industry during recent years is the result, in large measure, of the nation's enhanced appreciation of the wealth of natural motive power awaiting application in



EXTERIOR AND PART OF INTERIOR OF L. M. ERICSSON & COMPANY'S NEW FACTORY, STOCKHOLM.

its peat-mosses and waterfalls. Of peat-mosses, it has been estimated, Sweden possesses 9,880,000 acres, with an average depth of 6½ feet, capable of yielding not less than 8,000,000,000 tons of peat for fuel, each ton being equivalent in heating power to two tons of coal. On the basis of present prices, and having regard to relative calorific values, machine-made peat at the place of production is about half as dear as coal and 30 per cent cheaper than pine firewood. Its bulk, however, is considerable, which makes it a costly article to transport, and it yields as fuel a large percentage of ashes. To these disadvantages and the ever-increasing recourse to water power must be attributed the comparatively small part which has been played by peat in recent industrial developments.

What, on the other hand, is the industrial value of the energy already utilised or running to waste in Sweden's waterfalls? Calculations necessarily vary, but it seems a conservative estimate to suggest as a fairly approximate figure 4,000,000 horse power. What this implies to Sweden—and, indeed, to countries beyond the Baltic and North Seas—may be gathered from the facts that the entire manufacturing and mining industries of Sweden have at their command today less than 500,000 horse power, and that one horse power, when put to profitable use, represents a capital of £50, or more. Very frequently, of course, the immediate vicinity of a waterfall is unfavourable for the erection of mechanical works, owing to the absence of raw material in the district, great distance from a market for the disposal of the finished articles, or other causes. Most of these objections, however, are today of comparatively small moment, thanks to the practicability of transforming water-power into electrical energy and conveying it in this form over considerable distances. The first important demonstration in Sweden of the value of hydro-electric power was in 1891-2, when energy was transmitted from Avesta, on the Dalelfven, to the Norberg mining region; and since then activity in this field of enterprise has been so continuous that there are now few large industrial establishments—whether connected with agriculture, mining, iron and steel-making, wood-working, or general manufactures—which do not rely upon electricity, wholly or in part, for motive power. At first the machinery and other electrical apparatus were imported from Germany, but the home industry developed so rapidly that it has long since been able to satisfy local requirements and, in addition, to compete successfully abroad with the products of other lands.

The oldest and largest electrical works in Sweden—indeed, in northern Europe—are those at Vesteras, the property of the General Electric Company of Sweden. This corporation, which now has branches in the principal towns of Sweden and many foreign capitals, secured a considerable advantage over its competitors by its possession of the patents of Jonas Wenstrom, a famous Swedish electrician and co-founder of the three-phase system. Among the most notable plant supplied by it may be mentioned the great rolling-mill motor of 600 horse power at Fagersta, large alternating-current machines delivered to the Marconi Wireless Company, the new generators for the Stockholm electricity works built for a tension of 20,000 volts direct on the armáture, power-distribution for many of the leading iron works, and electric hoists, drilling machines and magnetic ore-separators for use in the mines. Among other energetic electrical companies calling for notice are Luth and Rosen, of Stockholm, and the Magnet, of Ludvika.

Each year is adding to the large group of other mechanical works devoting themselves to special manufactures. During 1906, for instance, 761 companies, of which 324 were purely manufacturing and industrial, were formed with an aggregate paid-up capital of £4,278,000, as against in the preceding year 438 companies and £3,319,000 nominal capital. To the establishments of this group, interesting though they are, the exigencies of space forbid more than cursory reference. Restricting myself, accordingly, to firms of comparatively long standing, with annual outputs valued at over £100,000 (several, of course, largely exceed this figure), and employing more than 750 hands, I note the following establishments as fairly typical of the present position of the Swedish machine industry:—

The Atlas works, Stockholm, manufacturing locomotives and other railway and tramway material, steam engines, boilers and compressors, pneumatic tools, conveying plant, etc., employing about 1,000 workmen; the Bergsund works, of Bergsund and Finnboda, both near Stockholm, builders of cruisers, torpedo-boats and other steamers, bridges, and every description of steam plant, number of workmen about 1,400; J. and C. G. Bolinder's works, Stockholm, specialising on wood-working machinery and petroleum motors, about 1,000 hands; Gothenburg mechanical works, steamship, crane and engine builders, about 900 workmen; Carl Holmberg's mechanical works, Lund, manufacturing dairy implements, peat and brick-making machinery, steam engines and castings; the Huskvarna works, employing about 1,200 hands in the manufacture of sewing machines, bicycles, stoves and other cast articles; the Karlstad and Kristinehamm works, manufacturing machinery for pulp and paper mills, turbines, railway material, steam boilers, etc., about 750 hands; the Ludwigsberg works, Stockholm, mining and refrigerating machinery, pumps, air compressors, fire engines, etc.; Motala works, locomotive and steamship builders, land and marine steam engines and boilers, bridges, pumps, turbines, hydraulic machinery and rolling-mill products; the Munktell works, Eskilstuna, steam engines, boilers and pumps, saw and grinding mills, peat machinery, dredging plant, cranes and machine tools; and Nydquist and Holm, Trollhatte, locomotives, turbines, bridges, water-works machinery, etc., about 900 hands.

A TYPICAL FACTORY. MUNKTELL'S MECHANICAL WORKS, ESKILSTUNA.

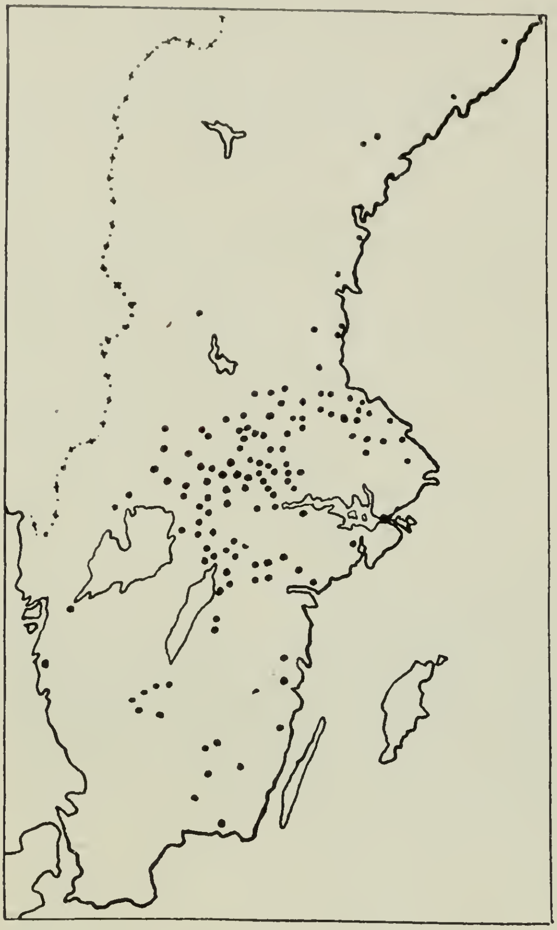
No apology need be offered for devoting particular space and attention to Eskilstuna and the so-called "Eskilstuna industry." The town, in the first place, demands notice as the most perfect type of manufacturing centre to be found in Sweden, rivalling, in this regard, even Borås and Norrköping, the principal seats of the textile industry. Its interests are, and have ever been, essentially industrial, and their growth and expansion are in an eminent degree symbolical of the wider movement and national development on which it has been my purpose to centre attention. Even its very origin is an object lesson for today, for there can be no doubt that it was the presence of the powerful waterfalls which serve to unite the great lakes Hjalmaren and Malaren that first led far-sighted men of long ago to believe that here was the ideal location for a purely industrial town. To create this was one of the peaceful ambitions, frustrated by incessant wars, of King Charles IX (1599-1611). Then the idea slumbered for half a century, until, in 1654, Charles X Gustavus granted to one Reinhold Rademacher, a burgher of Riga, the first of a series of privileges which, it was hoped, would bring about the foundation of "a manufacturing works for iron, steel, copper and brass," to be called "Karl Gustaf Town." The works, however, languished, despite Government support, and, indeed, were confiscated for debt soon after Rademacher's death; and today perhaps the most effective reminder of their former existence is the name Karl Gustaf used to designate the State rifle factory situated on the boundary of the seventeenth-century concession.

TUNAFORS FACTORY, ESKILSTUNA.

In 1771 Eskilstuna was founded as a "free town," the charter providing that everyone who settled within its territory should occupy himself for a livelihood in the working of iron or other metal, enjoy exemption from the capitation tax and customs duties, and have the right of using the urban water-works for a small fee. This arrangement readily adapted itself to the conditions which had prevailed during and since the time of Rademacher, and produced a peculiar manufacturing community, consisting mainly of small householders, each owning also a forge or small workshop. Remains of this old industrial town are to be found in the Eskilstuna of our time, and, as a matter of fact, in modified forms, are the bases of its latter-day prosperity. This may be said to date from the arrival, early in the nineteenth century, of Johan Teofron Munktell, an engineer from the Royal Mint at Stockholm and a pupil of the English mechanic Samuel Owen, who had made his home in Sweden and achieved a reputation which survives to this day. Munktell established in Eskilstuna a small workshop, which he lived to see develop into one of the largest manufacturing concerns of the country, and played also a conspicuous part in bringing about the application of modern principles to all branches of Sweden's metal industries.

Though, of course, on a very diminutive scale, Eskilstuna can quite aptly be compared to Birmingham, plus Sheffield, in the variety and character of its products. Engaged in what, for want of a better name, has been called the "Eskilstuna industry," there are at present about 55 factories; and of these several, including the largest of all, the Tunafors cutlery works of the Eskilstuna Iron Manufacturing Company, carry on the system familiar to the town since the days of Rademacher. They supply the smaller manufacturers with iron, steel, copper or brass in all suitable forms and dimensions (bars, tubes, plate, etc.) for special requirements, and purchase from the artificers the whole or greater part of the finished products. As survivals, in a transition stage, of old-time industrialism, the small factories are well-deserving of notice, for even the smallest are equipped, more or less completely, with modern machinery, and nearly always with an electric motor. One characteristic, and often very artistic, speciality of the local trade is the method of ornamenting a great variety of products, usually by deep-etching on steel surfaces, often combined with decoration in different coloured enamels, or by ground-etching on copper, brass or silver. This work is performed either by special workmen at the several factories or, in a more wholesale way, by two corporations, the Eskilstuna Metal-etching and Steel-etching Decorating Companies. Closely associated with or outside what may be described as its staple industries, Eskilstuna possesses probably a larger number of manufacturing establishments of the first rank than any town of its size throughout the world. The population, which in 1805 was 1,530, in 1850 3,960, and in 1900 but 13,660, now numbers more than 27,000. For purity and goodness of municipal government, the town enjoys the highest of reputations—even in Sweden, the country *par excellence* of progressive and efficient local administration; everywhere in it one finds evidences of prosperity and healthy competition, and symptoms of an expansion in the near future not less remarkable than that of recent years.

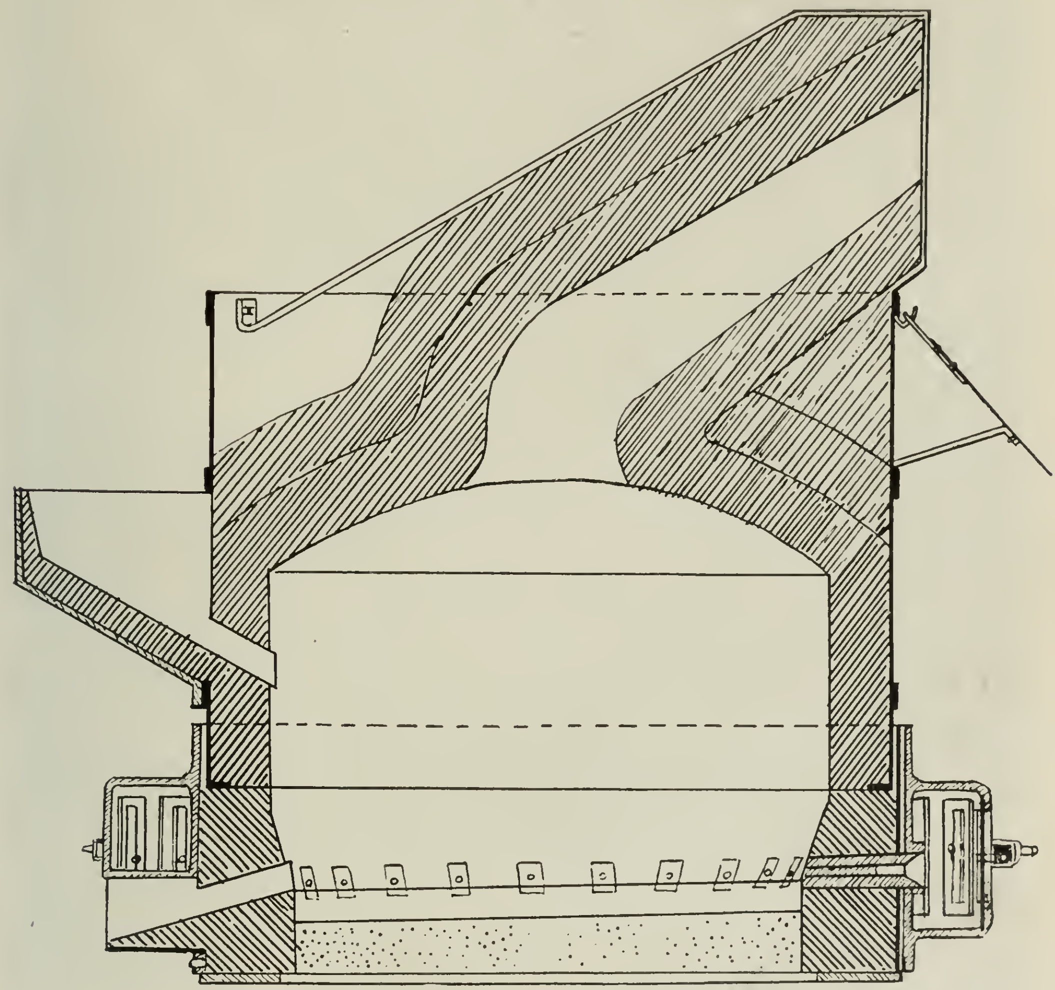
Of peculiar interest are the great iron and steel works, brass forges, etc., which, in addition to special manufactures and the business incidental to mechanical workshops, concentrate much attention on the extraction of metals from the ore and their first refining processes. These, by reason of their size, mechanical equipment, number



DISTRIBUTION OF LEADING IRON WORKS IN SWEDEN.

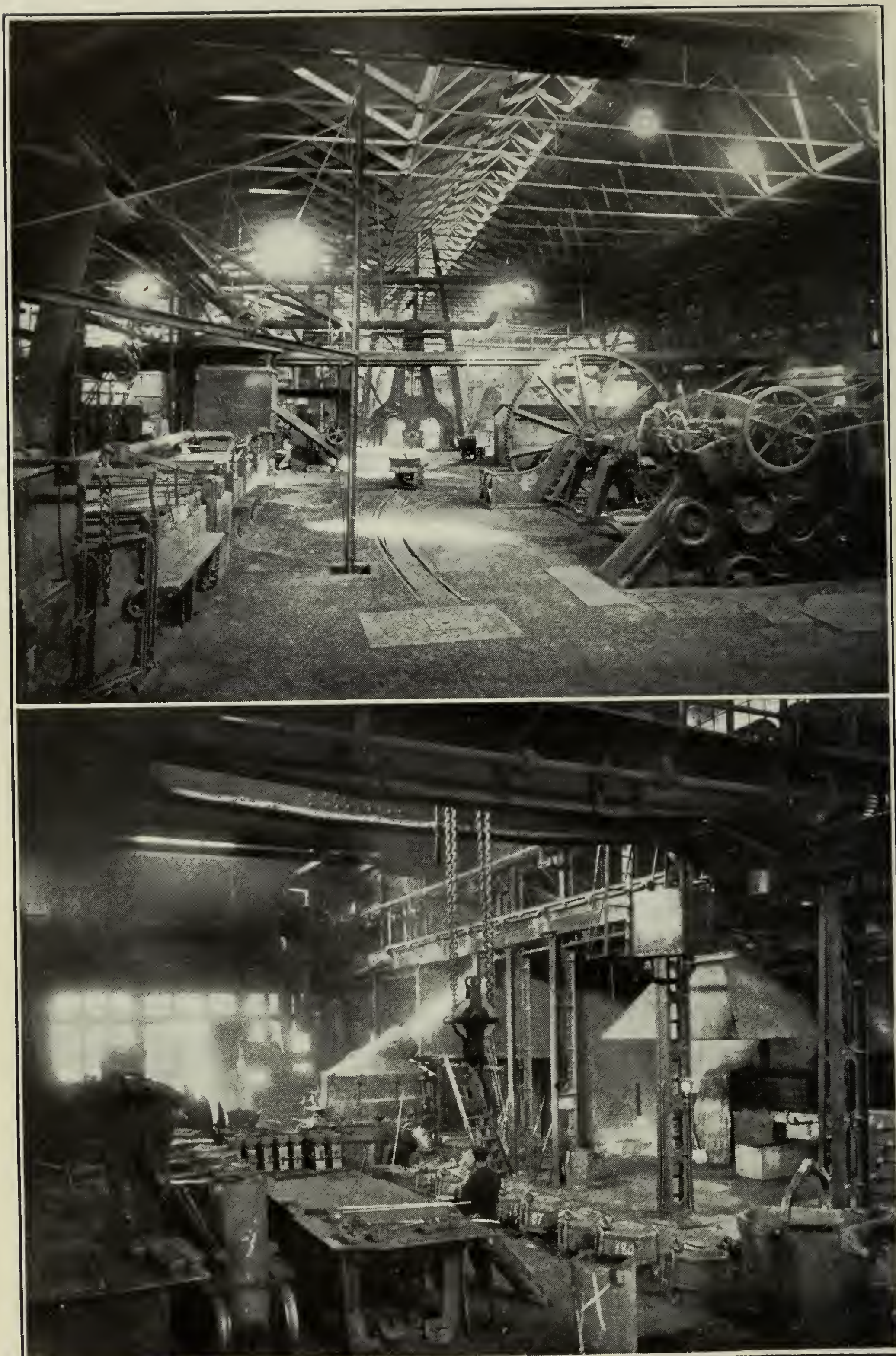
of employees, necessarily acute administration and variety of output, occupy a position of great importance in Swedish industrial life. Such, to mention but a few, are the great iron works at Domnarfvet, the largest of their kind in northern Europe, employing some 2,500 workmen, and including mechanical works, smelting furnaces, rolling mills, Bessemer and Martin works, etc.; Sandviken, employing about 2,000 men; Bofors, Bjorkborn and Fingspang, notable for guns and war material; Ankersrum, Avesta, Boxholm, Dannemora, Degerfors, Fagersat, Falun, Forsbacka, Hofers, Iggesund, Karmansbo, Kolsva, Lesjöfors, Söderfors and Surahammar. With some of the products of at least two of these, visitors to recent international exhibitions will be already familiar.

It happened that during the evening following a prolonged visit to the Sandviken works I was present at a banquet which most assuredly merited the definition "unique," inasmuch as it took place many hundreds of feet below the surface and amid the weird surroundings of the ancient workings of the great Kopparbergs mine—once not inaptly called the "Treasury of Sweden." I allude casually to this gathering because it afforded me opportunity to eulogise the very diverse industrial enterprises in which the inheritors of the historic property are now engaged, and the invaluable services of the founder and first manager of the Sandviken works in connection with the revolution in steel making which followed the perfection and widespread adoption of the so-called Bessemer process. Everyone, of course, knows that to Sweden belongs the credit of bringing the experimental stage to a close and of proving, even when Bessemer himself was beginning to despair, that the new process of refining was at once theoretically correct, feasible, economical and advantageous. The story of how this came about is so intimately bound up with the foundation of Sandviken that I may refer to a few unfamiliar details.



BESSEMER FURNACE AT EDSKEN, 1858.

At the time when the industrial world was startled by the first announcements of Mr., afterwards Sir Henry, Bessemer's remarkable investigations, there was living in England Pontus Kleman, a Swedish merchant and owner of ironworks at Dormsjö and Garpenberg. Kleman was an enthusiastic believer in the future of the process, and, aided by drawings furnished by Bessemer and a compatriot engineer, named John Leffler, promptly erected at Dormsjö a furnace for the purpose of continuing, on a sufficiently large scale, the English inventor's experiments. The results achieved were far from satisfactory, and of a nature to justify much of the criticism aroused by Bessemer's proposals. They failed, however, to convince Consul G. F. Göransson, then member of a firm of wholesale merchants which owned the Hogbo iron works and Edsken blast furnace. He purchased in 1857 Bessemer's patent for Sweden, and for many months continued ex-



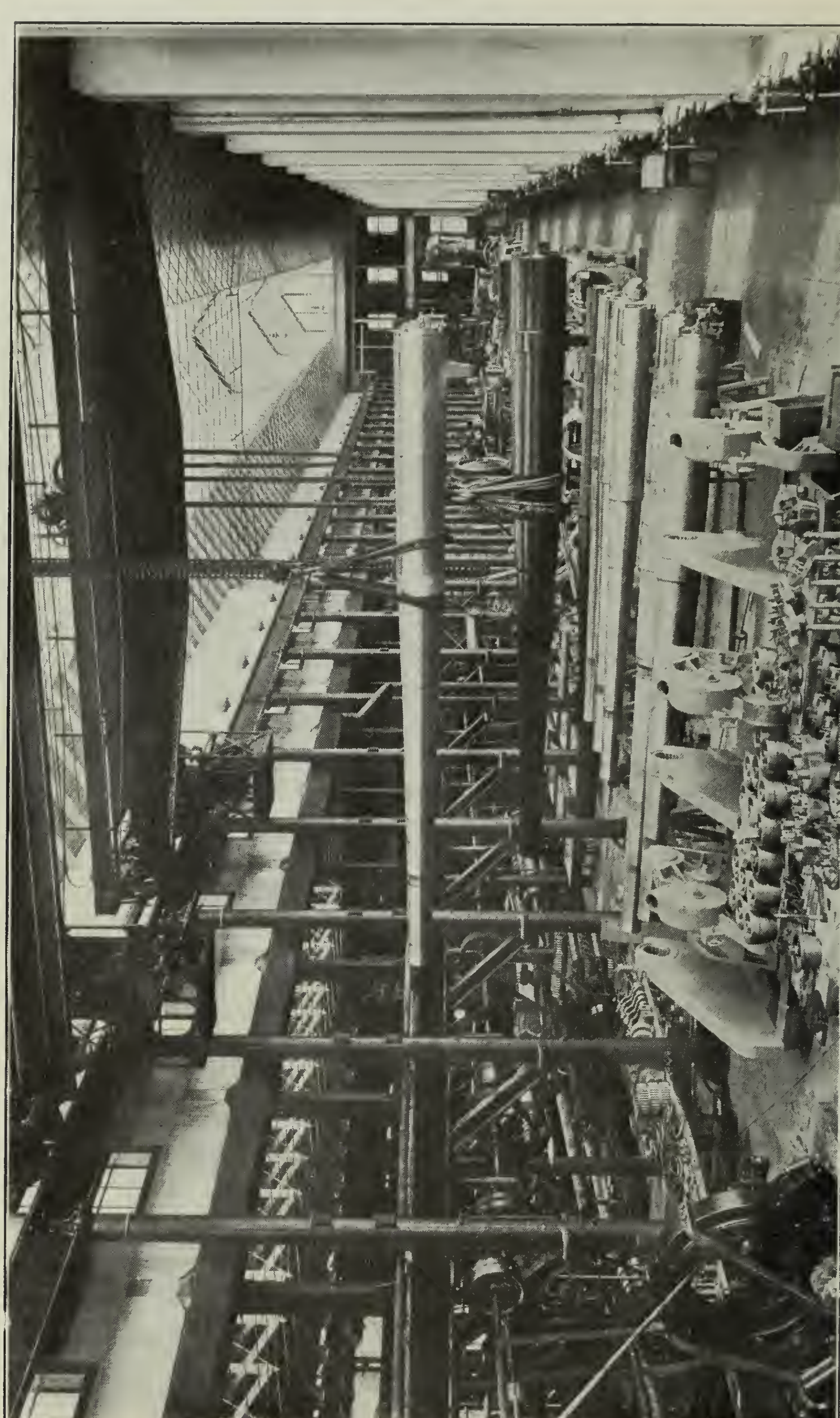
PARTS OF THE SANDVIKEN IRON WORKS.

Above, the forges and tire rolling mill; below, Bessemer converters.

periments at Edsken with variable and inconclusive results. At length, on July 18, 1858, after certain modifications in the furnace, a blowing was made which verified the highest hopes founded on Bessemer's method—the steel flowed easily, was of close grain, could readily be tapped and, in test forging, showed excellent qualities.

PART OF THE SANDVIKEN IRON WORKS.
Band rolling mill, 800 horse power, to the left; tube rolling mill to the right.

The process was continued at Edsken until 1866, and was gradually, in the meanwhile, introduced into other Swedish iron works. Generally, however, owing to the circumstances that the works were small, that the old stationary furnaces were less convenient than converters, and that there were no rolling mills to work down the steel ingots, the advantages expected were not immediately realised. It was to overcome such difficulties that the company was formed, with Göransson as managing director, which in 1862-3 built the nucleus of the present great Sandviken works. Mr. Göransson died in 1900, full of years and honours, and was succeeded by his son, Mr. A. Henrik Göransson. The now largely-extended works provide employment for 2,000 men, and include three blast furnaces, four Bessemer converters, eleven forge rolling mills, complete equipment for cold rolling, tempering and polishing, wire-drawing mills, special shops for the manufacture of saw-blades, spring steel, etc., foundries and great mechanical workshops, all provided with the best shop appliances.



INTERIOR OF GUN SHOP, BOFORS WORKS.

PART OF THE WORKMEN'S VILLAGE, SANDVIKEN.

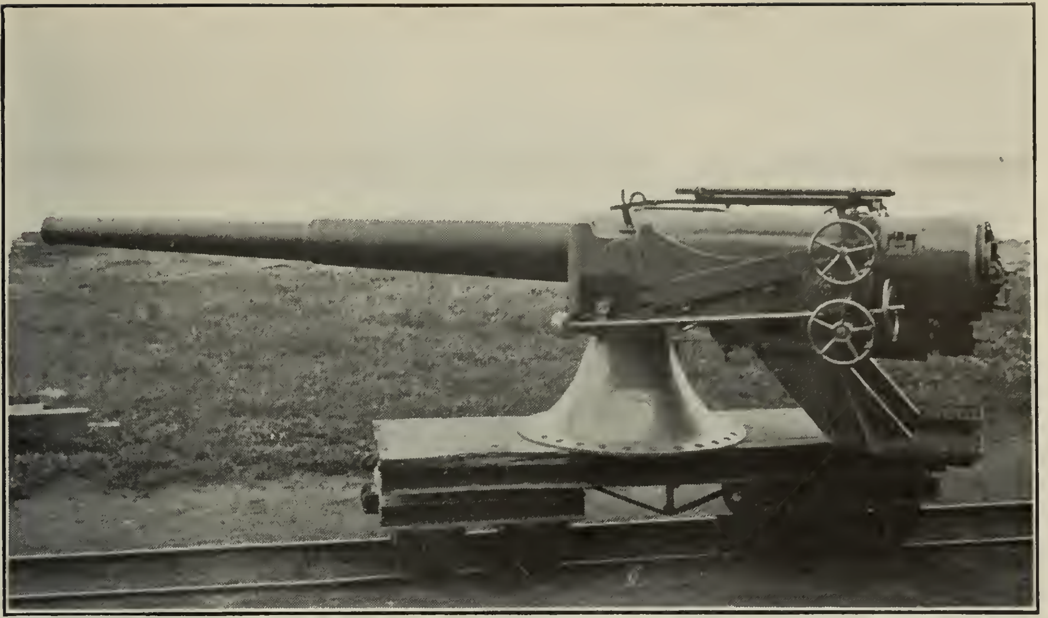
Power is furnished by 68 boilers and 24 steam engines aggregating 3,800 horse power, eight hydraulic turbines of 700 horse power, and 122 dynamos, the last deriving their electric energy from a waterfall some 30 miles distant from the works. The blast furnaces are fed exclusively with charcoal, their annual consumption being 25,000 tons.

Prominent among the specialities of this works may be mentioned hollow puddled blooms for weldless-tube making, of which Sandviken supplies two-thirds of the Swedish exports; weldless hot-rolled boiler tubes, tyres for railway rolling stock, hammered or hot-rolled steel for files, cutlery and various tools, steel for shells and other projectiles, hollowed wire for umbrella frames, pressed steel, spring steel, steel rods and wire, and cold-rolled steel for such purposes as bicycles, saw blades, and writing pens. The perfection attained in manipulating smaller articles may be gathered from the following data:—

	Length, Yd.	Width, In.	Thickness, In.	Weight, Lb.
Ribbon saw*	65.6	12	.0787	675
do.	26	.17	.08	300
Cold-rolled band steel........	1145	2.3622	.0011	47.5
do.	760	7.8741	.0177	1105

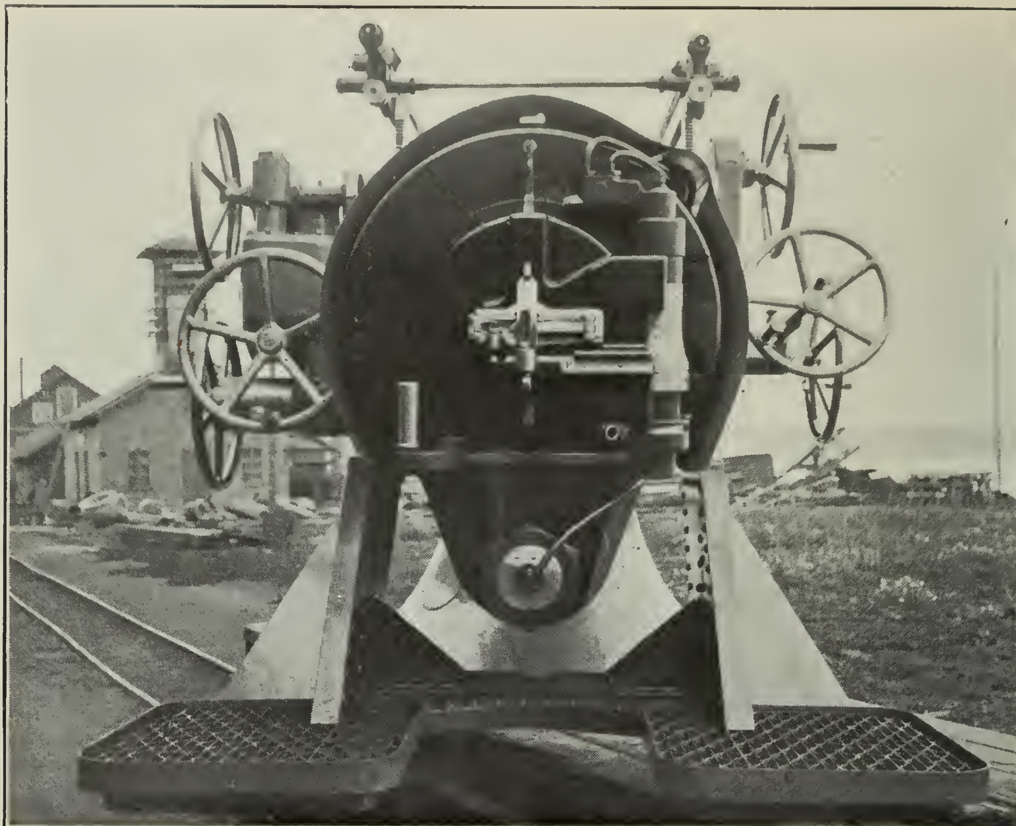
* This saw, first exhibited at Stockholm, secured grand prizes at Chicago in 1903 and San Francisco in the following year.

RAM AND STERN POST FOR COAST-DEFENSE SHIP, BOFORS IRON AND STEEL WORKS.



NEW MODEL 5.9-INCH GUN, BOFORS WORKS.

By a happy accident, serving to make conspicuous the diversity of the iron and steel interests of Sweden and the technical skill of the men who stand at the head of these industries, the next establishment to be described happens, unlike Sandviken, to have specialised on the heaviest classes of products. Bofors, owing to its position half-way between the Baltic and the Kattegat and in close proximity to the western boundary of the central ore regions, has been identified with the iron industry for at least three centuries; but, needless to say, on a very different scale to that which has made the place famous in modern days. The works of the Bofors-Gullspang Company certainly offer no evidences of antiquity, for most of the departments have either been recently built or reconstructed, and, even at the time of my visit, extensions were still in progress. They at present include three blast furnaces, one Lancashire forge, two open-hearth furnaces with an aggregate capacity of 45 tons, rolling mills for bar and sheet iron, a large building for annealing gun ingots and armour plates, steel foundry, gun shops, etc. For modern equipment, arrangements and methods, the various departments and workshops challenge comparison with those of the largest establishments abroad, and I noted with much interest, distributed over the works and in active operation, cranes, forge presses and a great variety of machine tools, of British and American manufacture. Prominent among the products may be mentioned guns and projectiles, homogeneous rolled or cast oil-tempered armour for cupolas for coast and land defence, and steel castings, such as rudder frames, propellers, anchors, etc., up to 45-tons weight.



BREECH END OF BOFORS 5.9-INCH GUN.

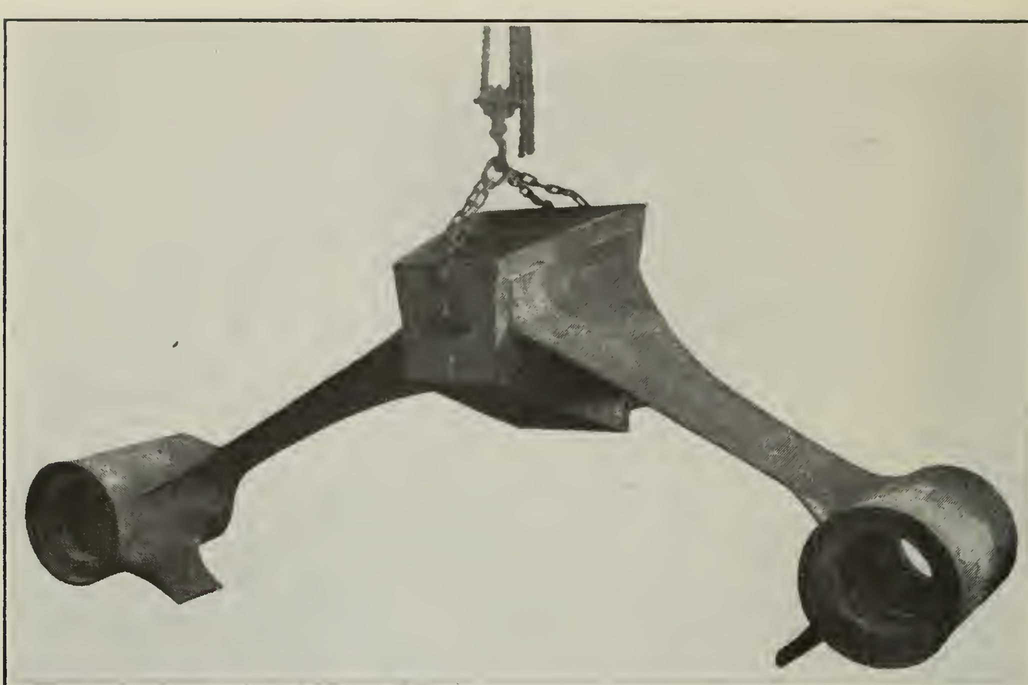
Increasing attention has been devoted during recent years to the manufacture of war material, and so far at least as guns of big calibre are concerned Bofors may be said to enjoy a unique reputation. Elsewhere, all trials with a view to making such guns of cast unwrought steel have resulted in failure, owing, apparently, to difficulty in securing sound ingots of sufficient strength and ductility. At the Bofors works, however, thanks to special methods of casting and annealing, elaborated after long series of experiments, no such trouble is experienced. The ingots are cast solid with large dead heads, but in other respects of about the size intended for the gun. The core is then bored out, the tubular block being subsequently subjected to a series of heat treatments in order to secure the proper physical qualities. Then the gun is built up from various parts in the usual manner. At times, the ingot with the dead head is of the phenomenal length of 60 feet, and I myself witnessed a furnace drawn and a column cast, 50 feet long, for which 14 tons of metal were used, for subsequent conversion into a 9-inch gun. Although guns cast at Bofors have been in service twenty years without showing other defects than usual wear, many ordnance experts, especially in England, continue to regard with undisguised distrust big guns of unwrought steel, professing that the tests cannot have been of the most severe character. Against this view, however, the Bofors authorities are able to submit records of the most elaborate tests, and to point to guns from which thousands of rounds have been fired. It is certainly noteworthy that, except in two instances, when high explosive shells have exploded in the bore, there has been no record of the bursting of a Bofors-cast gun, although at times the gas pressure in the bore at firing tests has exceeded 30 tons per square inch. Perhaps, however, the most significant defence (if such be needed) will be found in the facts that Bofors is at present supplying all the big guns required by the Swedish Government, and has provided the three latest Danish ironclads with heavy armament.

The following are details of a gun quite recently completed and tested at the works:—

Calibre	5.9 in.
Length in calibres	50
Weight of gun	7.6 tons
" " charge	33.6 lb.
" " projectile	90.4 lb.
Muzzle velocity	3,065 ft. per sec.
Max. gas pressure	18.2 tons per sq. in.

This weapon varies in some respects as compared with the gun delivered to the United States Artillery in 1901 in connection with tests, in competition with other designs, resulting in the adoption of the Bofors breech mechanism for 6-inch guns. This, also, was 50 calibres in length, but much lighter, weighing only 6 tons, while the projectile, weighing 100 pounds, secured an initial velocity of but 2,800 feet per second. Moreover, the mechanism was semi-automatic, as against fully-automatic in the case of the latest design.

With increased industrial life and its tendency to mass mankind within limited areas, new social problems arise and older ones become more acute. Though Sweden is a large country, sparsely populated, it is no paradox to say that for a considerable and increasing section of its people there is no room to live—in other words, its most pressing difficulty today is the question of housing. The State and municipalities and many semi-philanthropic and other organisations have done something, and attempted more, in the direction of ameliorating conditions arising out of the lack of habitations, with reasonable rents, for the growing army of artisans. So far, however, as the large towns are concerned, the results achieved have been pitifully inadequate. Elsewhere, not a few industrial establishments have found it both necessary and advantageous to build dwellings for their workmen on an extensive scale. In the majority of these cases, the habitations are granted rent-free, but in others endeavours have been made,



SUPPORT FOR PROPELLER SHAFT OF THE CZAR'S YACHT "STANDART." WEIGHT 9 TONS.
Made at the Bofors iron and steel works.

by means of loans, etc., to satisfy the men's natural desire for "own homes." The existence of the problem necessarily came most prominently under my notice in the capital, and it was with particular interest that I studied the conditions at works subsequently visited.

At Sandviken, sufficiently removed from the works to ensure for the artisans and their families pleasant surroundings and a sense of personal freedom, I found a small industrial community of some 6,600 persons, occupying quite a considerable area. Here the majority of the workmen with their families, to the number of about 4,500, live rent-free in 145 houses erected and owned by the company. The latter has also built a church, to the expenses of which it is a liberal subscriber; two hospitals, adequately staffed; five schools, provided with 19 teachers, in which 1,000 children are educated free of charge; club houses and recreation rooms, and a bath house, excellently equipped and of such dimensions that 150 persons can be accommodated at one time with swimming and other baths. Moreover, there exists a self-help society, with a membership of nearly 2,000, which provides grants in cases of sickness or death; a pension fund for aged workers, widows and orphans, and other organisations in which the company takes an intelligent and sympathetic interest. Perhaps, from most points of view, the best feature of all the machinery devised by the company for ensuring the physical and moral well-being of its dependents is the absolute freedom, consistent with ordinary discipline, enjoyed by all members of the community. Even here, however, I noticed an imperfection, not uncommon in northern Europe, to which I shall later refer.

Among other industrial corporations which have, on a large scale, erected dwellings for their workmen are the Grängesberg Iron-mining, Huskvarna Manufacturing, Bolinder Mechanical, and Rorstrand Pottery Works Companies. The houses built by the first-mentioned are of wood and contain sets of four rooms, each set having a separate entrance. As the rent charged is but 5 shillings monthly, there is naturally keen competition among the married men privileged to become tenants. The Huskvarna Company has not only erected dwellings, which it rents to its employees at from £5 10s. to £8 per annum, but also grants building lots and loans enabling them to build houses of their own, any parts or the whole of which may be sub-let. As the need becomes more pressing, there will, no doubt, be a more general move in the direction indicated, but accompanied, it may be hoped, with larger tendency to increase the room accommodation. Where I found so much to praise, it may seem ungracious to criticise; yet I cannot avoid the conclusion that it is neither logical nor conducive to the best social conditions that the provision for large or small families is normally the same—seldom exceeding three rooms.

In conclusion, a few words may perhaps be permitted in explanation of the inquiries of which these papers are the outcome. It was as a journalist, as the guest of professional *confrères* of Sweden, that I took part in the tour to which allusion has been made. It was no small undertaking, for a comparatively few busy literary men, to arrange and carry through, within the necessarily limited period of the visit, and without visible hitch, such an extensive and diversified programme. Though they no doubt reckoned upon the cooperation of the authorities and the public, they must surely have been surprised, equally with their guests, at the heartiness of the response. From the much-lamented King, Oscar II, his Ministers and provincial representatives down to the humbles wood-cutter in far-away Norrland, everyone conspired to make the tour uniformly pleasurable and interesting, the welcome cordial and national. Individually, perhaps, I have especial cause for expressing appreciation, for, as representing The Engineering Magazine and peculiarly interested in questions more or less outside the common programme, the most ample opportunities were at all stages granted me, always with extreme kindness and courtesy, for personal study and investigation. My cordial acknowledgements are due to not a few of my hosts, the education authorities and the heads of many large industrial establishments.

THE ECONOMIC ASPECTS OF WOOD PRESERVATION FOR STRUCTURAL PURPOSES.

*By Carlile P. Winslow.**

The following discussion of the preservative treatment of structural timber is in striking contrast to the majority of publications on the subject. In the voluminous body of literature which has already appeared, the technical details of preservative processes have received most ample treatment, but little information is to be found on the economic aspects of the problem. Mr. Winslow's article has, therefore, a peculiar interest, in that he gives many definite practical data on the costs and economic results of the practice as applied to a variety of types of engineering structures.—The Editors.

PRESERVATION of wood against decay by treatment with chemicals has, until late years, received but scant attention in the United States, and even at the present time the consumers of wood for structural purposes give far less attention to this question than its importance justifies. The supply of the better grade of timber, which through its own properties resists decay for a reasonable time, has been so plentiful and the initial cost so small, that timber with less favorable properties has been practically disregarded. Now, however, the supply of the superior grades of timber is rapidly waning, prices are rising despite the indications offered by the present temporary setback, and the difficulty of obtaining the best timber at a reasonable price is rapidly increasing. Lumber dealers, on the one hand; railroad managers, mine superintendents, and other consumers of timber for structural purposes, on the other—are finally awakening to this fact, and are gradually turning their attention to ways and means of substituting cheaper and more plentiful kinds of timber for the more expensive and superior grades.

Owing to the rapid growth of the country, its advance in industrial and manufacturing lines, and the many and varied uses to which wood is put, the amount of the annual cut of timber is almost inconceivable. It has been estimated that, in 1906, approximately 40 billion feet, board measure, of lumber, 11 billion shingles, 100 million railroad ties, 4 million poles, 20 million fence posts, 170 million cubic feet of round mining timbers, 3 million cords of pulpwood, 1½ million cords of tanbark, and about 100 million cords of firewood were cut, which, together with the quantity used for miscellaneous pur-

* Expert, Office of Wood Preservation, Forest Service.

poses, gives a total of approximately 40 billion cubic feet. The Forest Service has computed that this figure exceeds about three times the annual growth on the forests of the country, and it is therefore evident that unless some radical change be made a serious shortage of structural timber is inevitable. This is especially true of the hardwoods. The region of supply of this class of timber is limited since none is found in the western States. When the supply in the East, and more especially in the Appalachian district, is exhausted, many important industries, which demand hardwood for their products, will be severely handicapped.

A feasible and effective method of relieving this situation is by the chemical treatment of the timber to protect it against decay. A successful treatment of this sort, provided the cost be kept within economical limits, will not only in the long run greatly decrease the cost to the consumer, but also will tend to reduce the annual demand for timber. When wood preservation was first introduced in America, the great drawbacks to its extensive adoption were the expense of the treatment and necessary apparatus, and the lack of reliable information regarding the results. Now, however, methods have been devised whereby the treatment may be carried out on an economical basis; scientific investigation has determined just what kind of treatment is best suited to the different classes of woods and to the different conditions under which they are to be used; and reliable figures have been obtained regarding the actual increase of life obtained from various treatments. As a result, a new and increasing market has been created for many timbers not formerly used; timber consumers are gradually breaking away from their former custom of adhering closely to a few well-known kinds of timber, with a consequent general disregard of others because of a belief based largely on tradition or prejudice and not on actual disqualifications; and there is an increasing realization that by the use of cheaper woods properly treated with preservatives, as good or better results can be obtained, together with a reduction of the annual costs. This last item, the saving in dollars and cents, is the all-important feature in the future of wood preservation. As soon as the customer fully understands that his annual expenses can be actually reduced by these methods, it is only natural to conclude that a strong effort will be made for their adoption.

It has already been demonstrated that the life of timbers in many situations has been increased at least twofold by the use of preservatives, and often the increased life is very much greater. Suppose, for example, that certain timbers put to a certain use will last five years without treatment. Disregarding interest charges, it is then evident that in order to effect a saving, the cost of treatment must be less than the additional cost of new timbers five years later, plus the cost of their setting. In treating on a large scale the additional cost will in most cases not exceed the present purchase price of the timber; therefore the saving secured will be, at the least, the cost of resetting the timbers, plus the advance in the price of the timber over a period of five years. For example, the popular grade of mining timbers in the West has increased some 40 to 50 per cent in price within the last five years, and it is reasonable to suppose that a corresponding if not greater increase will occur within the next five years. Therefore, the corresponding financial saving from treatment will be equal to the cost of placement (naturally a variable quantity) plus 50 per cent of the present cost of the timber. This figure will be very materially increased by a treatment which will triple or quadruple the life, and this can be obtained at a cost that does not very greatly exceed that which gives the double length of life. Another factor entering into the economic value of the treatment is that often the replacement of timber is an expensive undertaking, entailing the shutting down of the work in hand during the period of replacement, with a consequent more or less serious financial loss. For instance, the replacement of the timbering in a permanent mine shaft will often partially, if not wholly, stop all work through that section during the period of replacement, with a corresponding financial loss to the company. Since by treatment these replacements may be easily reduced by one-half, and often to a greater extent, it can be seen that this element bears an important relation to the financial saving accruing to preservative treatments.

The advisability of artificial preservation, as well as the kind of preservative and the process, depends upon the structural characteristics of the timber and the particular conditions under which it is to be set. Practically all trees in the United States form two distinct classes of wood during their growth—namely, the outer zone or sapwood, which is the live or growing portion of the tree; and the inner zone or heartwood, generally of a more compact or dense texture than the sapwood, and consequently more difficult to impregnate with a preservative. It is therefore evident that those species containing a large percentage of porous sapwood are best adapted for treatment, for, other things being equal, the success of any treatment depends fundamentally upon the penetration secured. By a comparative study of the salient characteristics of various woods, some idea as to their respective decay-resisting qualities and the benefit to be derived from a preservative treatment may be formed, but only by actual experience can definite knowledge be obtained. From long years of usage it is now generally conceded that osage orange, red cedar, black locust, redwood, cypress, white cedar, catalpa, black walnut, post oak, white oak, and chestnut, are prominent among the species which stand up well against decay; and, where available, they have been used for a great variety of purposes where inferior species could have been made to do as well. It is important to realize that the more prevalent of these woods, white oak and cedar, are rapidly being consumed; that others, osage orange and black locust, are difficult to obtain; and that it is essential that the supply of these timbers be carefully handled and used only for purposes where substitution of inferior grades is impossible.

A wide field for the betterment of these conditions exists in the more general introduction of preservative treatment with reference to railroad ties. During the year 1906 approximately 103,000,000 ties were purchased, the majority of these being oak, cedar, and chestnut. Formerly, oak was the most popular and widely used species for this purpose, but in the past ten years the cost of an oak tie has more than doubled and the railroads have consequently been turning their attention to other species. Thus, loblolly pine in the South; hemlock and tamarack in the Lake States; lodgepole pine and Engelmann spruce in the West; birch in Wisconsin and the New England region; and maple and beech in Michigan, Pennsylvania, New York, and Vermont, are gradually attaining recognition and are found when properly protected from decay and mechanical wear to give satisfactory results. For example, it has been estimated by the Chicago & Northwestern Railroad Co. that the cost of the average untreated hemlock or tamarack crosstie when laid for use west of the Mississippi, is about $0.75. The cost of a satisfactory impregnation with zinc chloride is about $0.12 per tie, making the cost of the treated tie $0.87. On the basis of an annual charge computed from the formula

$$a = p \frac{(1 + r)^n r}{(1 + r)^n - 1}$$

in which a is the annual charge, p the initial expenditure, r the rate of interest expressed decimally and n the years of the recurring period, the following comparative statistics are derived, using as the basic data the estimated life of an untreated tie as 5 years, and an interest rate of

4 per cent. Then the annual charge on an untreated tie costing 75 cents is 16.8 cents. For a treated tie costing 87 cents and lasting 6 years the annual charge is 16.6 cents; lasting 7 years, is 14.5 cents; lasting 8 years, is 12.8 cents, and 10 years, the estimated life of a treated tie, is 10.7 cents. These figures demonstrate that an added life of a single year makes the cost of treatment practicable, and an added life of 5 years (a conservative estimate) secures a saving of 36.3 per cent in the annual charge. By the substitution of a creosote for the zinc-chloride tréatment, although at some increase of the initial cost, the tie can be conservatively counted upon to resist decay for 20 years, and this added length of life will amply repay the extra cost of the treatment.

But in considering the maximum life to be obtained from a tie the mechanical wear upon it is an important factor. It is of no use to preserve a tie chemically to resist decay for from 20 to 30 years when its mechanical life will be less than one-half as great. The use of tie plates and some form of screw spike in substitution for the present "barbarous" cut spike has been successfully adopted in Europe, but has received scant attention in America. By the more general use of such means for prolonging the mechanical life, combined with a treatment to preserve against decay, the maximum efficiency of a tie will be obtained.

The vast number of poles annually used for telephone, telegraph, and electric power lines has also an important bearing upon the development of wood preservation. During the year 1906, 3,574,666 poles were purchased, with an average value per pole of $2.65 at the point of purchase. Although no figures have yet been obtained as to the number used during the past year, it was undoubtedly much larger than that quoted for 1906. Of these, nearly nine-tenths were cedar and chestnut, cedar forming about three-fifths and chestnut over one-fourth. The region of supply of these species is very limited, cedar being obtained almost entirely from the Lake States, while chestnut is chiefly confined to parts of Pennsylvania, Maryland, Virginia, and West Virginia. The cost of transportation is consequently apt to be very great, often more than equaling the initial cost at the point of purchase. This then, coupled with the facts that the available supply of these poles is rapidly diminishing, with a consequent increase in cost, and that practically all untreated poles must be renewed within 15 years, makes it of paramount importance that some other class of timber be substituted and something be done to prolong their life. In the southern States the pines are very prevalent, and most species possess all the necessary structural requirements for poles with the single exception of their inability to resist decay. By a thorough treatment with creosote this drawback may be overcome. For example, let us consider the loblolly or old-field pine. The cost of a 30 or 35-foot pole of this species, including hauling and setting, may be assumed as approximately $5, in its region of growth, while its natural life will probably not exceed 5 years. Considering the interest on the investment as compounding at 5 per cent, the annual charge is found to be $1.15. A pole of this sort may be given a satisfactory butt treatment with creosote for approximately $1.00, and, unless set in a very unfavorable condition, a service of 20 years may thereby be expected. The annual charge on the treated pole, then, with the same rate of compound interest, is only $0.48. Thus, an annual saving of $0.67 per pole is obtained by the treatment, and if the yearly increasing cost of a pole be considered, this saving will be considerably increased. So also in the far western States it has been found that the yellow or "bull" pine of that region may be successfully treated with a preservative at a cost not exceeding $2.50 per pole and its natural life of two years thereby increased fully ten times.

Other opportunities for the introduction of so-called "inferior" grades of timber for pole usage exist in the great stand of fire-killed timber in the Rocky Mountain district. Prominent in this class are the lodgepole pine and Engelmann spruce. Owing to the general but erroneous belief that fire-killed timber is unfit for structural purposes, the demand for these two species has been small and the initial cost consequently low. By actual tests, however, it has been found that sound fire-killed timber is often twice as strong as freshly cut green timber of the same species, and when preserved against decay can be very advantageously used for poles, posts, mine timbers, and other structural purposes. In view of the present low cost of fire-killed Engelmann spruce and lodgepole pine, these species can be given a thorough preservative treatment, and the initial cost be kept well within economic limits.

The annual demand for timber for use in mines has reached vast proportions. In 1906 the round timbers alone used for this purpose amounted to approximately 170,000,000 cubic feet, but owing to the great quantity of square timbers also used the total figure is considerably larger. Much of this it would not be advantageous to treat with preservatives, as current mining practice is such that a large percentage of the timber serves its purpose in a short time and is then lost; as in the long-wall system in coal mining and, in metal mines, in the stulls in prospect raising, and timber set in stopes. But it has been estimated that approximately from 40 to 50 per cent fails from decay, and on account of the great increase in price of mine timbers during the past ten years, it is of great importance to the mining industry that something be done to correct this extravagant waste. The average life of mine timbers set for permanent use can be considered as not more than three years. Douglas fir and western yellow pine, two of the most widely used species for this purpose in the West, cost, where they grow, approximately $14 or $15 per thousand feet board measure and this price is continually rising. A thorough preservative treatment with creosote can undoubtedly be obtained at a cost not to exceed $20 per thousand feet board measure; fairly good treatment which will increase the length of service to at least ten years will cost about $15 to $16 per thousand feet board measure. These figures are of necessity only approximations, since the condition of the timber, method of treating, and quantity and quality of preservative injected are the determining factors in the cost. But the economic value can not be doubted, for assuming a combination of the worst conditions (high cost of treatment—$20 per thousand; and short service—nine years) the saving per thousand feet is found to be approximately $10, or slightly over $1 per year.

The application of a chemical preservative to timbers for use in piling and bridge construction is also an important factor in the development of wood preservation. Mr. A. F. Robinson in a report at the recent meeting of the American Railway Engineers and Maintenance of Way Association, says:

"At the present market prices, pile bridges built of untreated softwoods and designed for the heavy rolling loads used, will cost from $8 to $14 per linear foot. For bridges with piles, caps, and sway braces creosoted, (other parts untreated), and no freight haul over local line included, the cost will vary from $10 to $15 per linear foot. Because of the comparatively restricted areas in which acceptable softwoods are obtained, the great demand and long freight haul, there is little probability of these timbers ever costing much less than at present." Hence, a satisfactory treatment will increase the cost of the bridge from $1 to $2 per linear foot. It is estimated that the life of untreated bridge timbers varies from ten to sixteen years, while well creosoted piling will give approximately thirty years service. Thus at a maximum cost of treatment of only one-fifth the initial cost of the bridge, it can be made to give from two to three times the service it will yield when untreated. But it is essential for the successful treatment of piling that a preservative which is insoluble in water be used, and in large quantities; where the piles are to be placed in salt water, a preservative of strong antiseptic qualities is the only effective kind. Otherwise the *"Xylotrya"* and *"Teredo,"* the two most common marine wood borers, more commonly known as "ship worms," will attack the piles with very detrimental results. Since a deep and thorough penetration of the preservative is not only desirable but essential, the woods with relatively high absorbing qualities should so far as possible be chosen. Thus, the pines on the Gulf of Mexico and Atlantic coast give very good results when properly treated.

The use of treated timber in heavy building construction is also growing in favor. In the low, moist portions of New Orleans sanitary floors have long been in use and have given satisfactory results. The heavy sleepers upon which the floor is laid are impregnated with creosote. Besides being rendered very resistant to decay, the floors are sanitary and resist the growth of pathogenic organisms. Boardwalks and railway platforms can also be successfully treated. Large amounts of timber are annually used in such construction, and no other material has been found to meet these exacting requirements. In the construction of roofs, especially those subjected to damp vapors (as in certain pulp works) treated timbers can be successfully and economically employed. In fact, timber preservation will prove economical in all construction where the wood is placed in damp, warm, ill-ventilated situations and in which timber is costly or difficult to replace. The resistance of wood to the transmisison of heat makes it a particularly valuable structural material for buildings, and especially is this true for greenhouse construction and for shingles. Mixed with stain, shingles can be creosoted by the open-tank process at a cost of less than one dollar per thousand. This permits attractive, economical and durable construction.

As a final example of the future field for wood preservation, together with its bearing upon the more general use of wood for structural purposes, the introduction of creosoted wood-paving blocks may be considered. The natural properties of wood, such as low traction resistance and freedom from dust, have led to many attempts for the utilization of untreated blocks in the past, but no very satisfactory results were obtained. If thoroughly seasoned before placement, moisture was rapidly reabsorbed; if placed in an unseasoned condition, moisture was evidently present at the start. In either case decay soon set in, the maximum efficiency was lost, and the maintenance charges for repairs and replacements consequently exceeded economic limits. But by a thorough treatment with creosotes, it seems probable that these difficulties may be overcome. Certainly a creosoted block will better resist decay than an untreated one, and the creosote present will act against the absorption of moisture and thus tend to produce the maximum mechanical efficiency of the block. The initial cost of this class of pavement, however, is a serious drawback to its wider use. An average of the costs, taken from ten cities in which it has been used, gives $3.10 per square yard when laid, no allowance being made for excavation and curbing. Whether or not this high initial cost will be repaid by the length of service obtained, can not be definitely stated, since no such pavements have been laid in the United States for a sufficient period to give accurate results. The best example at present is the Rush Street Bridge in Chicago, Illinois, which was paved with creosoted longleaf pine in 1899, and the blocks are still in good condition and give prospects of several more years service. That longleaf pine was used not only in this bridge, but practically for all paving blocks formerly placed, goes to prove the afore-mentioned tendency to adhere to popular grades of timber. There is no reason to believe that Douglas fir, western larch, white birch, and hemlock, when properly treated, will not give satisfactory results, and test pavements of these species have been laid in Minneapolis, Minnesota.

In the scope of this article, only a few of the more striking and important fields for the development of wood preservation can be cited, but there are many other opportunities for the successful introduction of preservative methods. In general, wherever timbers are to be placed for permanent use, under conditions favorable to decay, or where a subsequent replacement would entail heavy charges, a thorough treatment of the best quality is recommended. Oftentimes, when a company is using large quantities of timber, the establishment of a treating plant will well repay the cost of the investment.

THE PRODUCT AND METHODS OF EUROPEAN LOCOMOTIVE WORKS.

By Charles R. King.

Mr. King's review of Continental locomotive design, steam practice, shop methods, and mechanical devices began in our issue for June. His first instalment dealt with the practice and product of German works; his second, with recent advances in Switzerland and France, and the utility of the new welding processes in the work of railway shops. This third and concluding section covers, principally, the newest Italian locomotives, and, with less detail, the most recent types introduced on the railways of Roumania, Denmark, Belgium, Hungary, and Russia.—The Editors.

THE change of control in the Italian railways, which are now operated by the State, has had the effect of standardising locomotive types and has resulted in the ordering of great numbers of engines and cars of the value of 155 million lire, of which 33 millions are for locomotives so far ordered this year. About half the value of the orders has gone abroad—principally to Prussia—the home firms not being able to quote such low prices or to deliver so early. All of these, except for an insignificant number, are two- and four-cylinder compounds. This is the outcome of years of extended experience with these systems. It is a fact that after a hard and rough service of 15 years—and that with indifferent care as compared with newer engines—a two-cylinder compound will show a yearly saving of 14 per cent in fuel cost as compared with engines identical in number of parts, of the same type, same weight, same steam-pressure, same service, but only differing in having unequal instead of equal-sized cylinders. Such a result cannot be realised by any arrangement at once so simple and thoroughly practical. Nor are there of necessity any inventor's fees to reduce the full value of the economy obtained. This 14 per cent is an average economy for two-cylinder compounds in various countries where the necessary acumen has been employed in their design. Little though the designer, in his short passage through the offices of a certain company, may suspect the result of his work, it may be mentioned here that such results are obtained this day in 1908, from the engines designed in 1891-2 by M. Edouard Sauvage, of literary repute. The decision in Italy to build large numbers of two-cylinder compound is therefore amply justified by results. The cost of upkeep is also less with such compound engines, not only as the result of the lessened consumption of fuel in the firebox, but by reason of the more evenly distributed efforts on the pins and journals due to the later cut-off of the valves, whereby the maximum piston efforts are low in proportion to the average, through one revolution, as compared with single-expansion engines in which the piston effort at the beginning of the stroke is high in proportion to the average driving effort. Where two-cylinder compounds are booked for general repairs with a whole series of single-expansion engines of the same class it is difficult to estimate the value of the mechanical saving, but the late Prof. von Borries, formerly of the Prussian State Railways, gave the averages of 9 to 11 years working as follows: average mileage between repairs, two-cylinder single-expansion engines = 2,300 miles; between repairs, two-cylinder compound, = 2,920 miles.

The new Italian compounds of this type are built with inside and also outside cylinders. In all cases the cylindrical valves are placed outside of the frames.

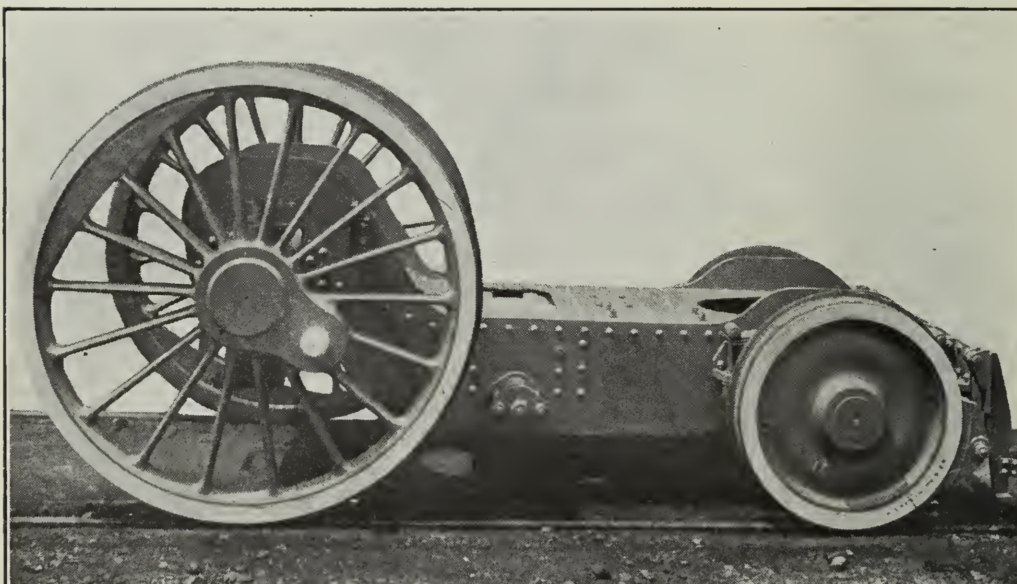


FIG. 28.* ZARA TRUCK FOR o OOO o LOCOMOTIVES.

In four-cylinder compounds the most notable change has been, for express engines, the supplanting of the four-wheel pilot truck by a two-wheeled pony. The former trucks weigh, in the "Adriatic" *oo OOO* engines, 5,805 kilogrammes and the latter, in the *o OOO o* engines, only 2,885 kilogrammes. The saving in weight is of much importance on railways where the wheel load permissible is under 15 tons per pair. The new truck is an adaptation of the Krauss-Helmholtz (Munich) which borrows one of the driving-wheel axles as the

* The figure numbers are consecutive with those in Mr. King's two preceding articles.

second axle to combine as a four-wheeled truck, but with a fixed and rigid center pivot to the frame. In the Italian modification the center pivot is supported by swinging links permitting a radial movement to the whole frame on its oscillating center. This improvement renders the truck safe for speeds of 70 miles per hour on roads abounding in curves and as compared with 40 miles on the Krauss truck. The illustration, Figure 28, of this truck is self-explanatory. It is used for all six-connected passenger engines in Italy—four-connected engines being now obsolete practice. In the Tellina Vale and Simplon electromotors, all of *o OOO o* type, one truck is placed at each end of the locomotor frame. The designer of the truck also introduced the oscillating axle box cheeks that are now applied to every axle in passenger locomotives in Italy—see Figure 29. The object of these oscillating liners is to enable axles, when on curves, to depart freely from their normal parallelism in respect to the transverse alinement of the frames and as caused by the super-compression of the springs due to the super-elevation of the outer rail and to the centrifugal force, at high speed, acting against the outer rail. Ordinary axle boxes tend to maintain the axle parallel with the transverse line of the frames and with the tendency to strain the axle-box guides and frames, as also to cause undue pressure at one extremity or the other of the journal and brass. Plate frames have frequently been broken in service on short-radius curves, the break being attributable to this action, which is completely avoided in these oscillating axle boxes.

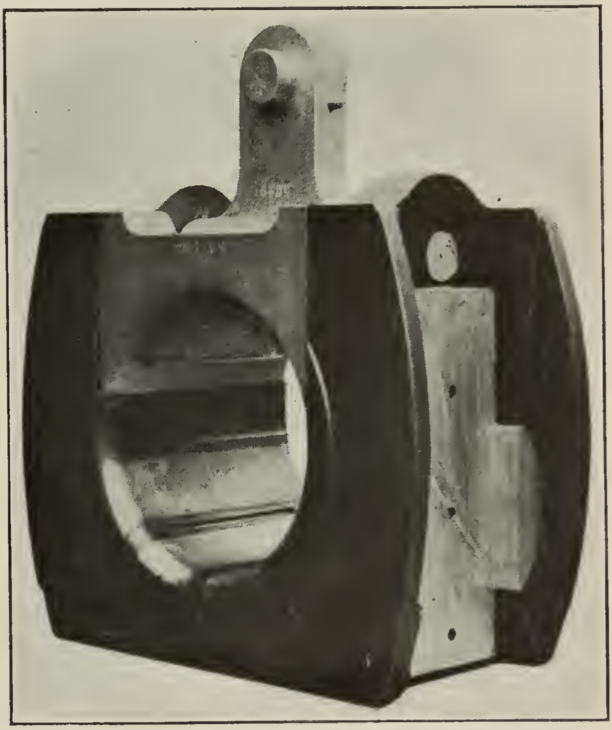


FIG. 29. ZARA OSCILLATING AXLE BOX.

Another improvement by Giuseppe Zara, designer of the new Italian locomotives and of the electromotor trucks of the Italian railways, is the tri-phasic action throttle valve shown in Figure 30. It is really a safety device to prevent the ordinary equilibrated throttle valve from opening of itself, or by accident. To avoid such possibility it is usual to fit the throttle handle with a latch as shown in Figure 7, in June. Briefly explained, the throttle is fitted with a pilot valve, which may be inside the main valve or fitted outside of the steam pipe, the opening of which requires but little effort. Closed, the whole pressure of the steam holds the main valve down to its seat, but the pilot valve admits steam below a loosely fitting cylindrical portion of the main valve, and then part of the steam relieves the pressure on the main valve and part of it passes around the outside of the cylindrical valve and escapes to the cylinders so commencing the first period of pressure on the pistons; at this moment the drop-seat valve at the head of the throttle is lifted from its coned seating and the second period of pressure is begun; the sectional area of the opening continues to increase with the lift until the drop valve is clear of the valve chamber, then the third period of full pressure is entered. The effect of the arrangement is said to be to increase the pressure on the pistons gradually and to diminish slipping of the wheels in starting and risk of undue strains on the motion gear. For four-cylinder compound engines it is usual to admit steam automatically to the low-pressure cylinders during the first revolution of the wheels. This is done by means of the small pipe, shown in Figure 30, connecting the lowest part of the throttle valve chamber with the low-pressure cylinder valve chests. In these latter a simple device on the valve stem prevents the passage of this steam into the receiver except when the valves have full travel, as is only the case when starting.

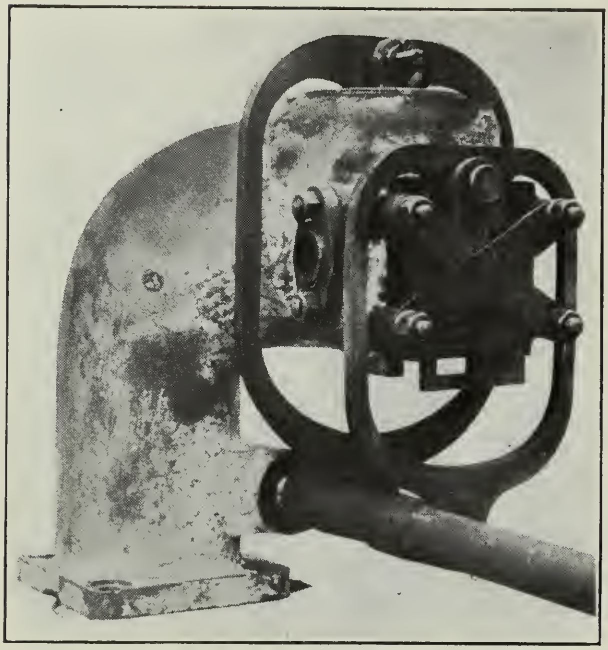
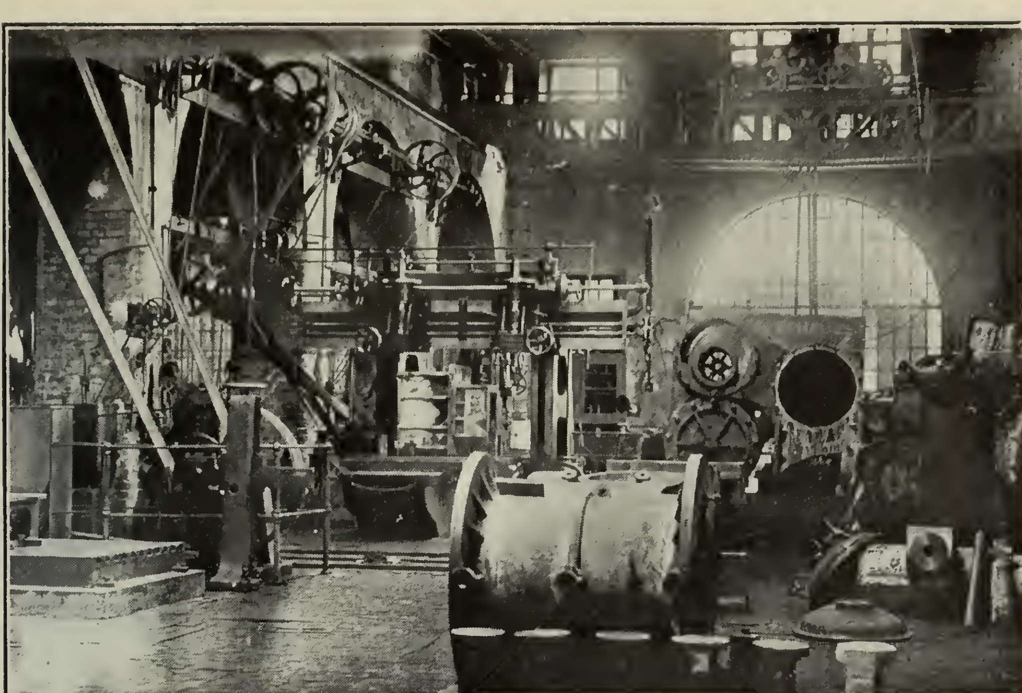


FIG. 30. ZARA THREE-PHASE THROTTLE COMBINED WITH BYE-PASS.

Flat valve for direct steam admission to low-pressure cylinders.

The cylinders of the four-cylinder engine now built and building in such large numbers for Italian railways differ from the cylinders



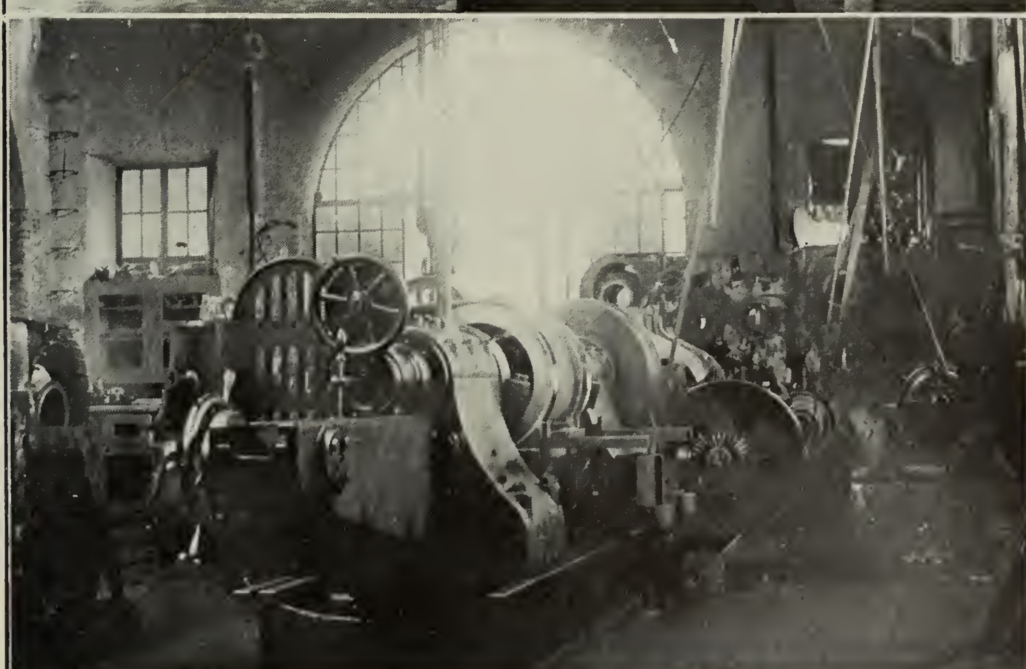
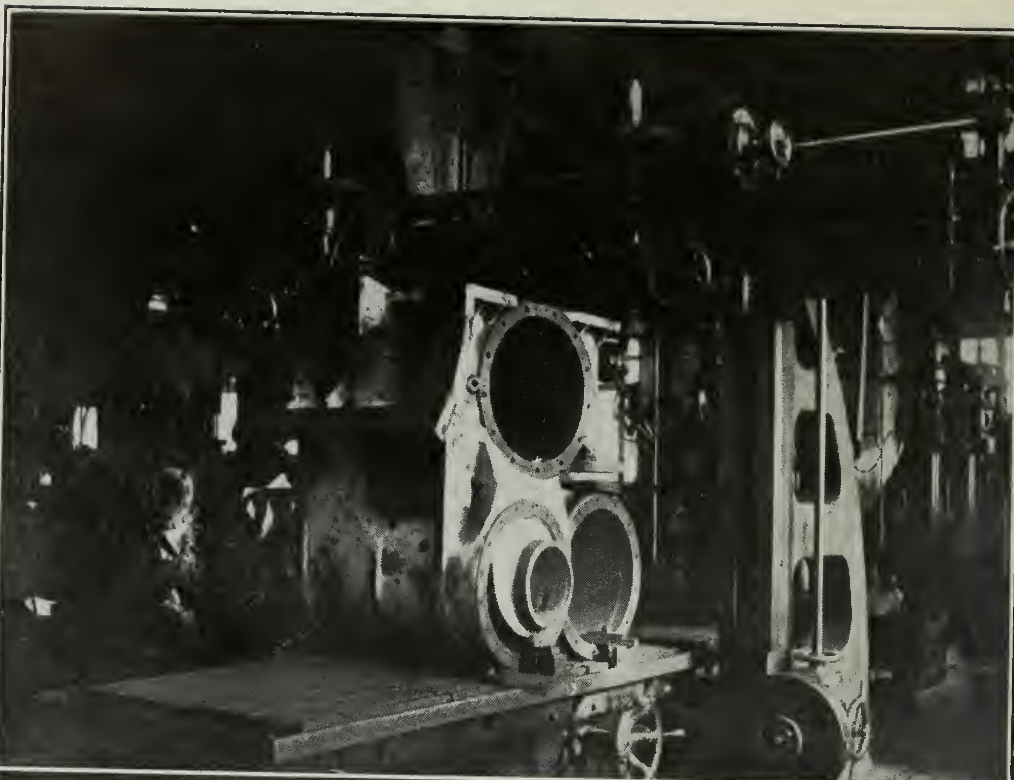


FIG. 32. MILLING MACHINE FOR LARGE CYLINDERS.
FIG. 31. ROUGH-BORING CYLINDERS ON NILES BORER.

employed anywhere else in the world. There are four cylinders, but the valves are only two in number just as usual in the most ordinary two-cylinder engine. Relatively to the number of cylinders, the Italian arrangement is therefore simpler than engines which require one valve for every cylinder. Here, one valve suffices for two. The engine is, effectively, a double two-cylinder compound—the cylinders



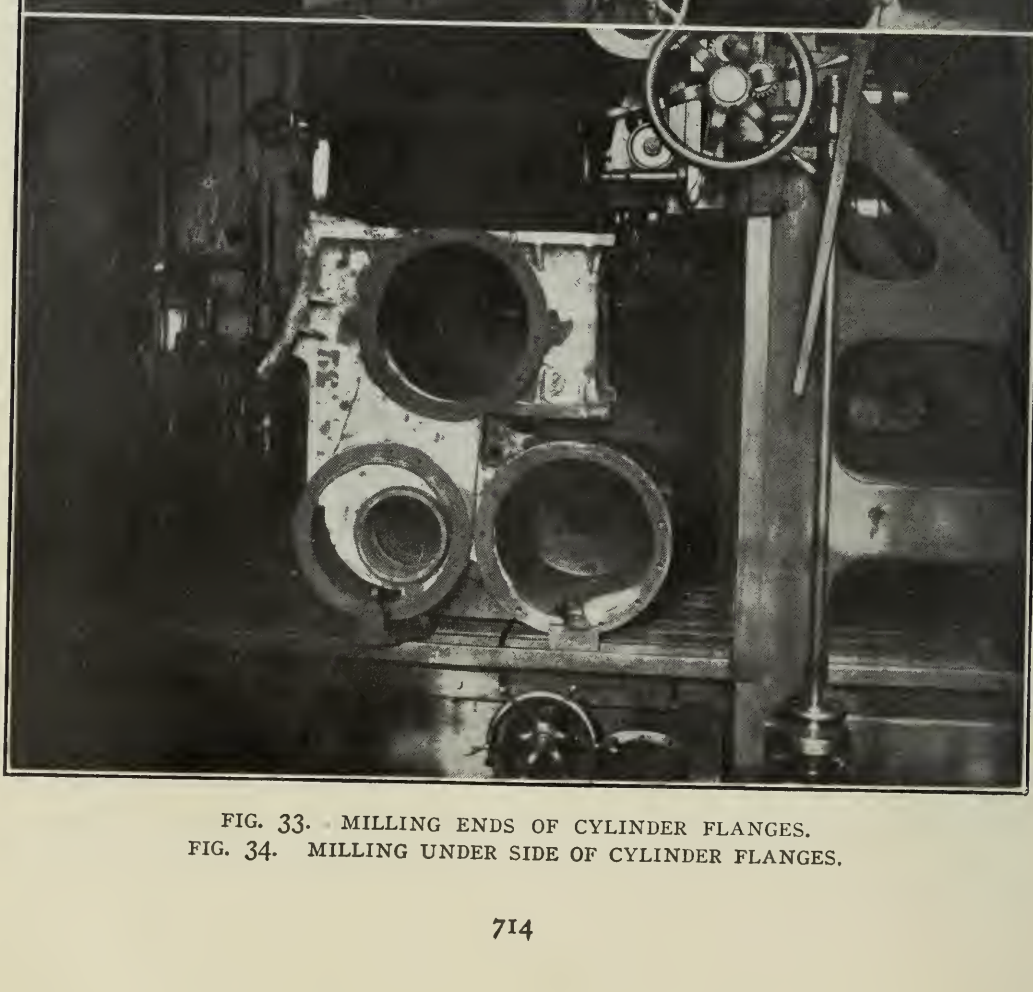


FIG. 33. MILLING ENDS OF CYLINDER FLANGES.
FIG. 34. MILLING UNDER SIDE OF CYLINDER FLANGES.

remaining with the same disposition as in the original two-cylinder compound arrangement introduced by M. Anatole Mallet in 1876, but twinned—with two high-pressure on one side and two low-pressure on the other—an arrangement that has given the very best of results in service, there being no compound engines which run with greater regularity of movement. At the time of writing, 88 engines are in construction with these cylinders, of which 12 are at Maffei's. The machining of these pieces is interesting by reason of the size of the whole group when bolted together—close to the center line. The process of working as carried out in the Ernesto Breda Locomotive Works of Milano, Italy, is shown in the accompanying views. The cylinders are rough-bored for detecting any defect which would at once condemn the casting. A double-headed cylinder borer by the

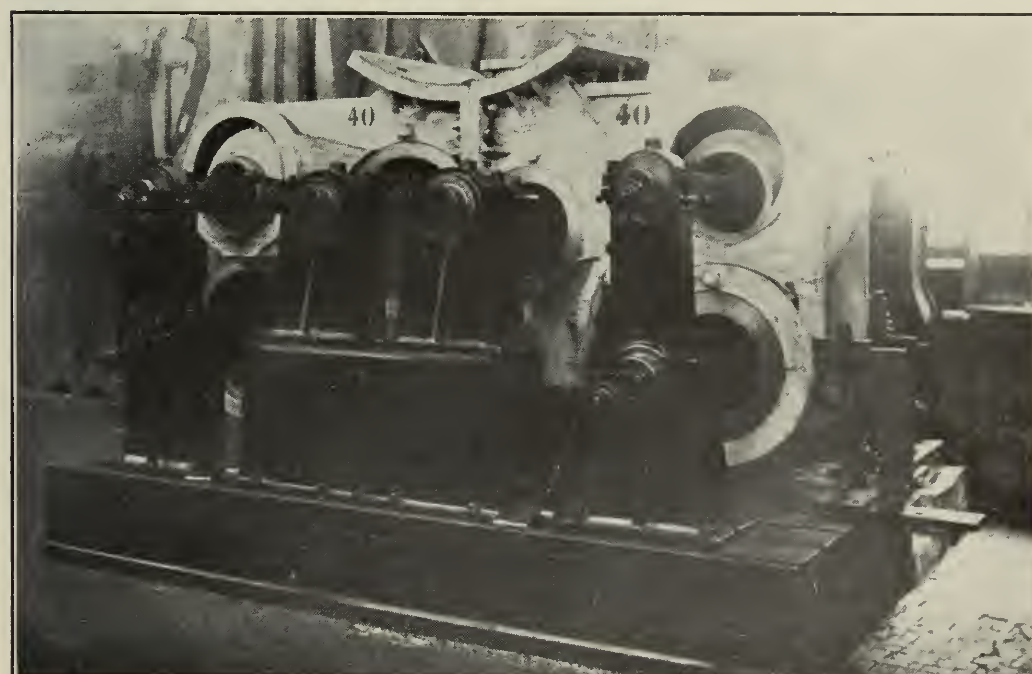


FIG. 35. SIX-SPINDLE CYLINDER BORER AT WORK.

Niles Tool Works, Figure 31, is employed for this work and the castings are then passed on to the large double-spindle milling machine by Guller & Zust of Intra, Lago Maggiore, Figure 32, which machines the central joints for the bolting together of the two castings. This machine does face and edge milling. Figure 33 shows both spindles engaged in edge milling the ends of the central lugs, and Figure 34, milling the underside of the same joint with the casting simply run forward on the carriage. The cylinders are then bolted together and accurately bored, all four cylinders and two valves simultaneously, on the six-spindle horizontal boring machine shown in the view

Figure 35. This is a new machine designed and constructed specially for the work by the Ernesto Breda Locomotive Co. with the co-operation of the noted Italian tool-makers Guller & Zust of Lago di Maggiore. The machining done by it has the accuracy of jigged work. The illustration will serve all purposes of written description.

The cylinder castings are made in the works' foundry and on account of the crossed ports in the high-pressure group some little skill has to be exercised. Expressed in kilogrammes per square millimetre the tensile strength of the metal is 18 to 24 kilogrammes and it is submitted to special shock tests. The port edges are milled and rounded. Valve-chest liners, of cast iron, are forced in place by hydraulic pressure—a practice not approved by some makers and repairers. The domed valve-chest covers are, of course, steel castings—the rest, cast iron. The high-pressure group when complete is tested by water pressure of 20 kilogrammes per square centimetre; the low-pressure group to 10 kilogrammes per square centimetre. The entire cylinder battery weighs 7,245 kilogrammes.

The pistons, in the newest engines, are of forged iron of 44-49 kilogrammes strength and 15-25 per cent elongation. Gisholt lathes, Figure 36, are much used for this repetition work. The piston valves are steel castings of 44-49 kilogrammes strength with 15-25 per cent elongation. Elastic segments for valves and rings for pistons are of cast iron. The piston rods are of hard forged steel of 65 kilogrammes strength and 12 per cent elongation set on the pistons under pressure. Crossheads and crosshead guide bars of forged steel have the same tenacity and elongation. Guide-bar milling is done on a battery of Ingersoll Milling Machine Co.'s tools—Figure 37. The nearest of the machines has the electromotor mounted on the main milling spindle. Slippers for crossheads are steel castings of 44-49 kilogrammes tenacity and 15-25 per cent elongation. They are lined with white metal: 83 per cent tin, 6 per cent copper, 11 per cent antimony. Crosshead pins of iron have 37-44 kilogrammes tenacity and 20 per cent elongation. The main driving and side coupling rods—see Figure 38—are of mild forged steel, 45-55 kilogrammes tenacity and at least 22 per cent elongation. The outside main rods weigh 267 kilogrammes and the inside main rods 339 kilogrammes. All rods of the valve mechanism are of forged mild steel, 44-55 kilogrammes tenacity, 22 per cent minimum elongation, the eyes of all rods and levers being bushed with hardened steel set in with hydraulic pressure. The expansion links, of 37 to 44 kilogrammes tenacity and 22 per cent elongation, are hardened on their wearing surfaces.

FIG. 36. GISHOLT LATHES WORKING ON PISTONS AND CYLINDER COVERS.
FIG. 37. MILLING GUIDE BARS ON A BATTERY OF INGERSOLL MILLING TOOLS.

The boilers of the four-cylinder compound engines are designed for a working pressure of 16 kilogrammes = 215 pounds per square inch, and formed of homogeneous iron—mild steel—plates, 18½ millimetres thick in the barrel and 22 millimetres thick in the round-topped firebox, the tenacity being from 34 to 42 kilogrammes with 27 per cent elongation. For all flanged work, throat sheet, back plate and smokebox flue plate etc, Breda's employ the hydraulic press with steam intensifier shown in Figure 39. This steam-hammer type of press was made exclusively for the firm by Haniel & Luig of Düsseldorf and is highly prized, for its handiness. It bends the whole contour of the plate to be flanged at one pressure, and to the required size, by the use of suitable dies and templates. The plate to flange is placed on the lower convex die and the upper concave die is then lowered so far that the concave die rests on the plate under a pressure of 700 pounds per square inch. The piston rod of the steam pressure transmitter then enters into the cylinder of the hydraulic ram and the pressing continues under tensions of from 4,200 to 7,000 pounds per square inch. For pressing out the openings for fireholes and other large holes a special hydraulic cylinder is mounted on the lower press table, and operates in ascending. In this space it is scarcely possible to describe the press further. It is made for pressures of 300 metric tons; has a reach of 4 feet, a single stroke of 4 inches,

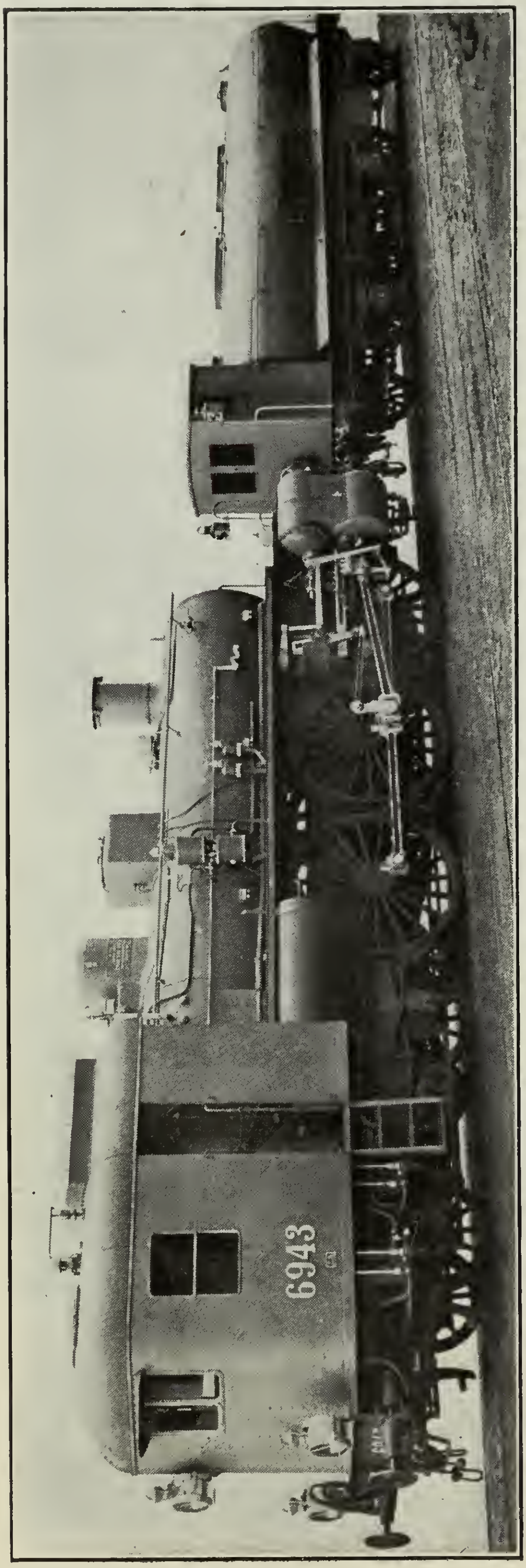


FIG. 38. ADRIATIC-TYPE LOCOMOTIVE OF THE MOST RECENT MODEL.

and total stroke of about 2 feet.

A forging which tends to become more and more intricate with the introduction of specially-shaped and wide fireboxes—derived from the Wooton and Belpaire wide-grate types—is the mud ring, foundation ring, or *cadre du bas du foyer* or *quadre fornello.* The Paris-Orléans' mud-ring (Figure 25) is, except for its shape, a simple piece, only having the two projections, as visible on the back end. This peculiarly shaped mud ring is forged from iron or extra-mild weld steel, the first having a tensile strength of 34 kilogrammes per square millimetre with 20 per cent elongation. For a grate of 4.27 square metres it weighs 460 kilogrammes. The Italian water-space frames are more difficult—see Figure 40. Here there are broad splay feet on the back end for bearing on the brackets riveted outside of the engine frames, and also large central blocks on back and front ends for maintaining the firebox central with the frames. They are forged from homogeneous iron having a tenacity of 37-44 kilogrammes and 20 per cent elongation. The inside and outside fire-

FIG. 39. STEAM HYDRAULIC FLANGING PRESS AT THE MILAN WORKS.

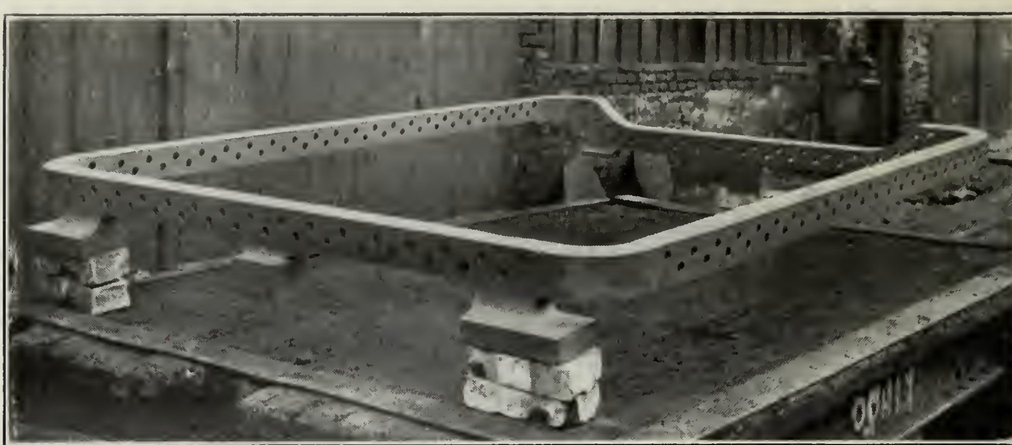


FIG. 40. MUD RING FOR PRAIRIE O OOO O LOCOMOTIVE.

boxes are further secured together by their fire holes, flanged and riveted together as in the Webb system, and by the copper stays in the sides, the latter being in part of ordinary arsenicated bronze and part of manganese bronze, 94 per cent copper, 5 per cent manganese. The ordinary stays have a tenacity of 23 kilogrammes, 35 per cent elongation, and the latter 30 kilogrammes and 30 per cent elongation. The firebox itself has copper plates of 22 kilogrammes tenacity and 35 per cent elongation. The stays are cut to the lengths required and screwed on the twin-head or duplex "Acme" screwing machine, Figure 41.

Crown stays and other stay bolts and ties are of mild steel 37-40

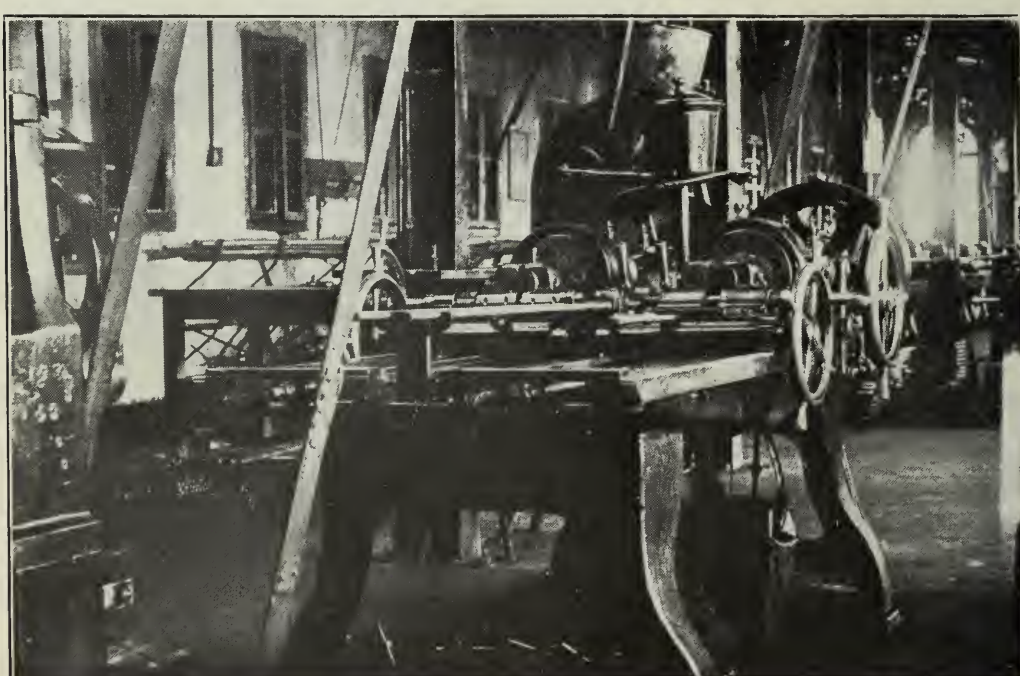


FIG. 41. SCREWING COPPER STAYS ON ACME DUPLEX SCREWING MACHINE.

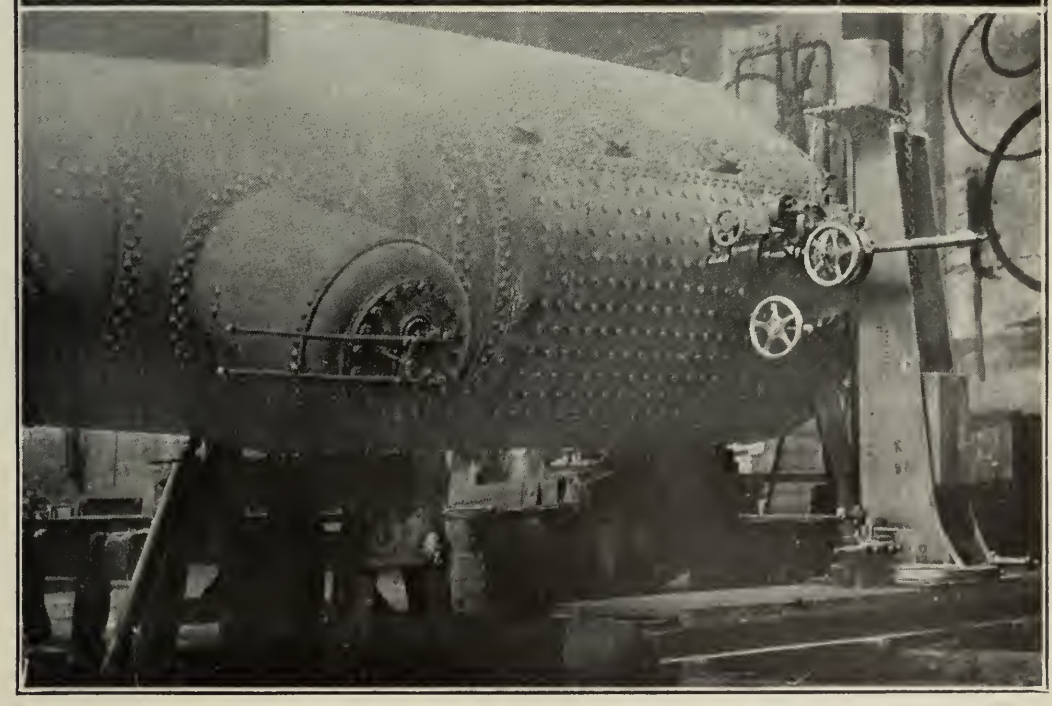


FIG. 42. WIDE FIREBOX BOILERS FOR ITALIAN FREIGHT ENGINES.
FIG. 43. SAWING OFF CROWN-STAY BOLT HEADS ON COLLET & ENGLEHARDT DRILLING AND TAPPING MACHINE.

kilogrammes tenacity and 27 per cent elongation. In the round-topped wide type fireboxes for freight locomotives shown in Figure 42 the crown stays have to be sawn off, after being screwed in place, to the angle of the crown sheet. A very handy semi-portable electric drilling machine by Collet & Engelhardt, shown in Figure 43 at work sawing off bolt ends, is employed also for drilling, reaming, tapping and screwing home the stays of fireboxes. It serves a purpose and serves it well, but of all machines the boiler drill is of the most variable, no two makers having the same special requirements. At the La Chapelle, Paris, works of the "Nord" railway the boilers, on rails, are advanced under a rolling rectangular framework, from all sides and the ends of which, electric drills attack four sides of the firebox at the one time. Less elaborate than this, or the Maffei drill—Figure 6—is the compact semi-portable arrangement, used in many shops, made by the Saxon Engine and Tool Works of Chemnitz, Figure 44. This is of the horizontal type, with three drilling spindles variable in height, in angle and in longitudinal position, while the boiler can be conveniently turned around and about on its back by means of the rack and rollers on the three base plates. The boiler tubes now em-

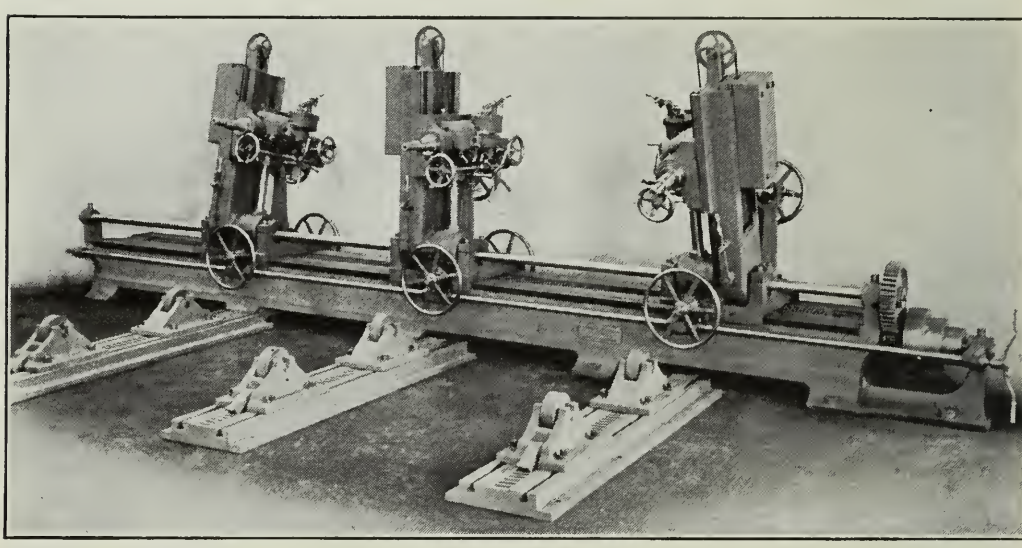


FIG. 44. TRIPLE HORIZONTAL LOCOMOTIVE-BOILER BORING MACHINE.

ployed for Italian locomotives are smooth, for, effective as were the Serve ribbed tubes, they have been found too rigid, and therefore liable to cause leakage of the flue sheets. The rupture of the firebox flue sheet—generally near the outside corners—is due to the considerable difference of dilation of tubes and of boiler barrel, and rigid tubes increase this trouble. Flues, until lately of brass, are for new Italian engines, once more of iron and with copper ends. The bottom of the boiler barrel is lined with 2-millimetre sheet copper to prevent corrosion. Some railways formerly employed cement, but it scaled at the seams—probably from some action of the red lead employed there. The grate bars are now steel castings. The whole generator of four-cylinder compounds weighs 20,880 kilogrammes.

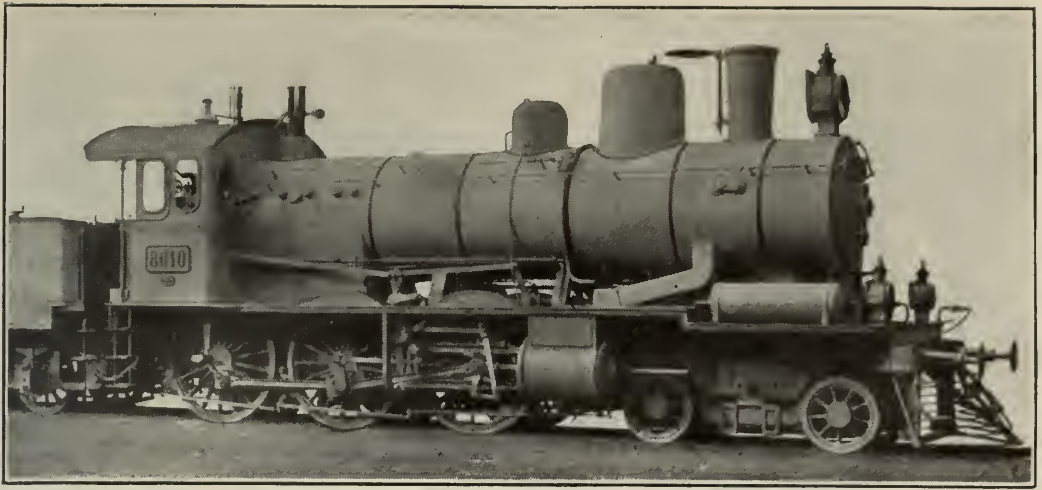


FIG. 45. oo OOO DE GLEHN LOCOMOTIVE FOR ROUMANIA.

The remarkable-looking *oo OOO* locomotive shown in Figure 45 was built also by the firm of Breda for the Roumanian State Railways. In this the de Glehn arrangement was followed for the cylinders of which the inside high pressure group is shown in Figure 46. The crank axle is of the Z type, but of round section for the sake of lightness and its design called for elaborate geometric [graphic] calculations. The axle load is very low and difficulty was experienced in making a large engine of this de Glehn type sufficiently light.

Denmark has also imported locomotives from Breda's. A bar frame of Prussian origin is constructed at Hannover for the *oo OO o* type balanced compound engines of the Danish Railways. This bar frame weighs, complete, 6140 kilograms. It has four cylinders, served by two piston valves which are so placed that a variable ratio of cut-off is not possible between the two valves as in the Italian locomotives, where each valve has its own reversing gear to adapt the engines to extreme variations in the conditions of service. The Saxon Engine Works

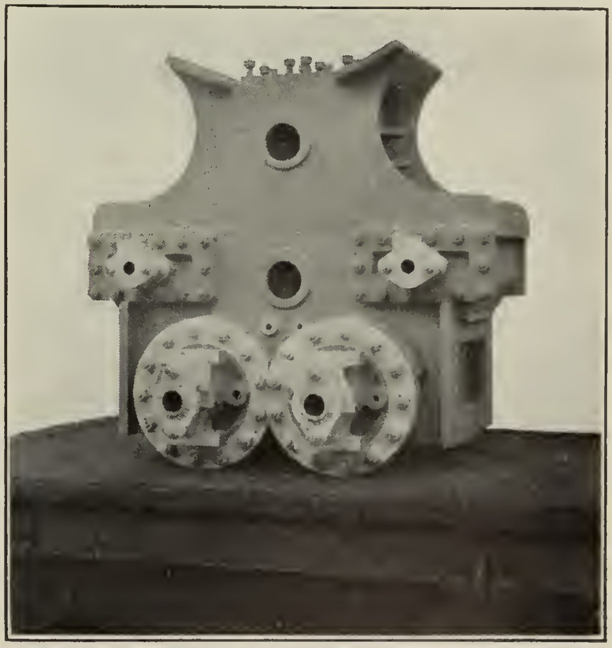


FIG. 46. INSIDE CYLINDER FOR ROUMANIAN oo OOO TYPE COMPOUND.

has also made bar frames, as shown in the view, Figure 47, but these were for exportation to Canada and were steel castings.

Belgium which had for a number of years relinquished initiative in the matter of locomotive design and had imported Scotch plans of Scotch engines, began building modern engine types in 1904 and the finest specimen, known as "Type 19," is of the Central European balanced compound arrangement with cylinders all exactly in line and driving on one axle only—the boiler being the plain simple Scotch type without superheater. Constructively, the engine is of the same disposition as Nos. 3302 and 3303, balanced non-compound engines, Figure 48, one of which has a superheater in the boiler tubes. In these latter, the rocker drive for the outside piston valves is similar in principle, if not in construction, to the gear Mr. Webb applied to his first four-cylinder balanced compounds. The third new balanced type is the engine illustrated in Figure 49 built by Cockerill's. Here the cylinders are in line, but their rods drive upon different pairs of driving wheels, as in the Henry system.

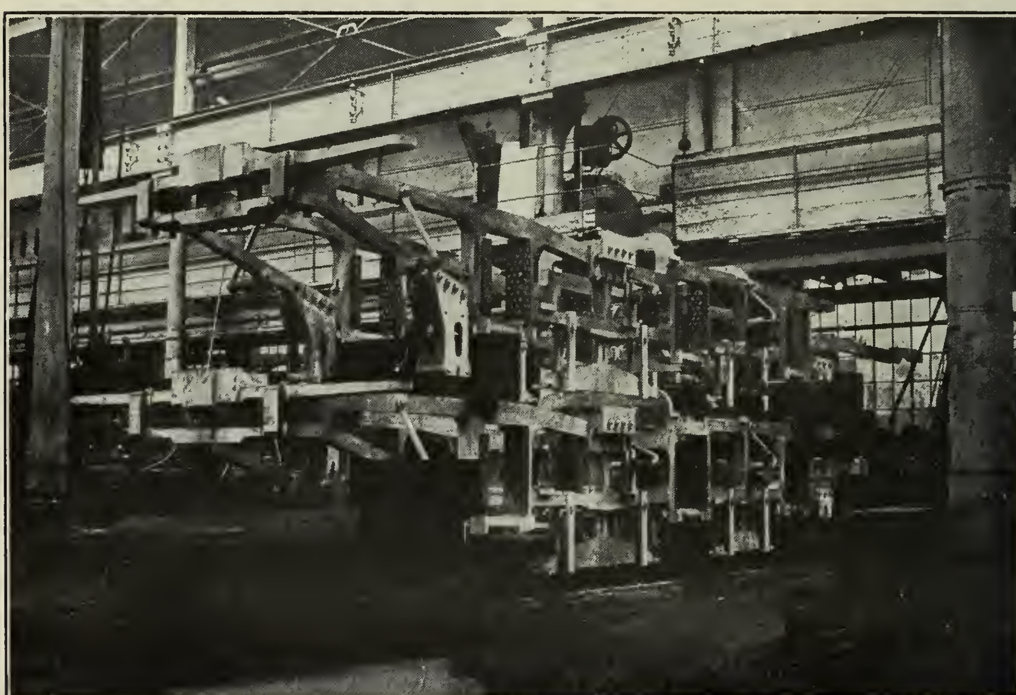


FIG. 47. BAR FRAME COMPLETE, AS MADE OF STEEL CASTINGS IN SAXONY.

In France the most recent type of locomotive of the Henry system was designed under Mr. Baudry, late of the Paris-Lyon Ry., in 1904, Figure 50. It has four valve mechanisms but the low-pressure variation is practically non-existent, as the cut-off for them remains at 63 per cent whatever admission is given by the high-pressure valves, thus differing from all other French distributions.

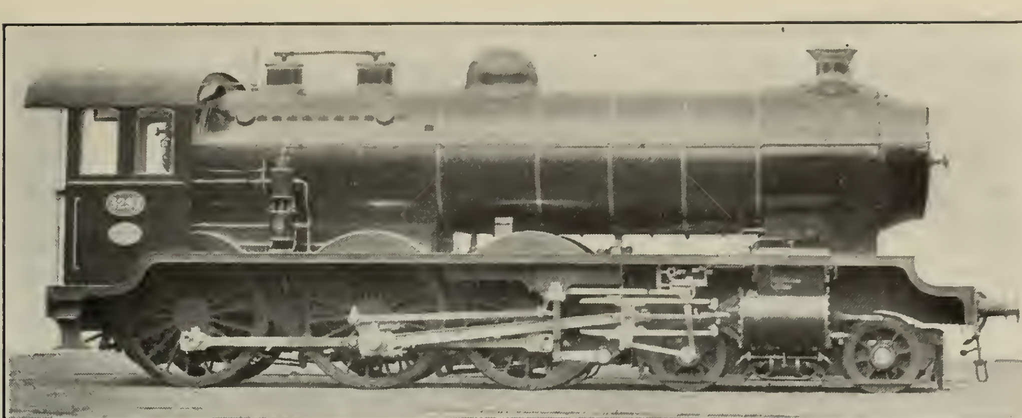


FIG. 49. RECENT BELGIAN BALANCED COMPOUND, REPRESENTING SCOTCH ENGINES ADAPTED.

FIG. 48. BELGIAN STATE FOUR-CYLINDER NON-COMPOUND, NO. 3302 SERIES.

The four-cylinder balanced "Adriatic" compound shown in Figure 38 is the last of its series. The enginemen, although infinitely better off with the reversed arrangement of the boiler, disliked the idea, in

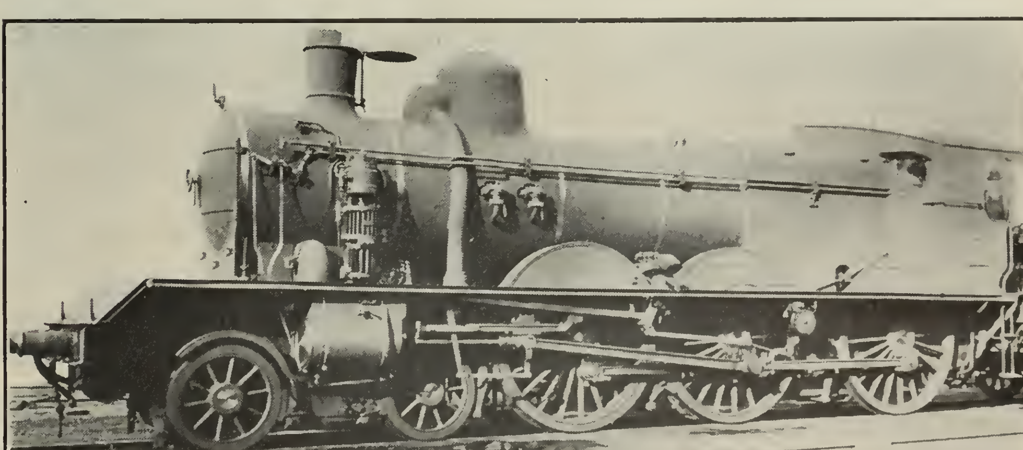
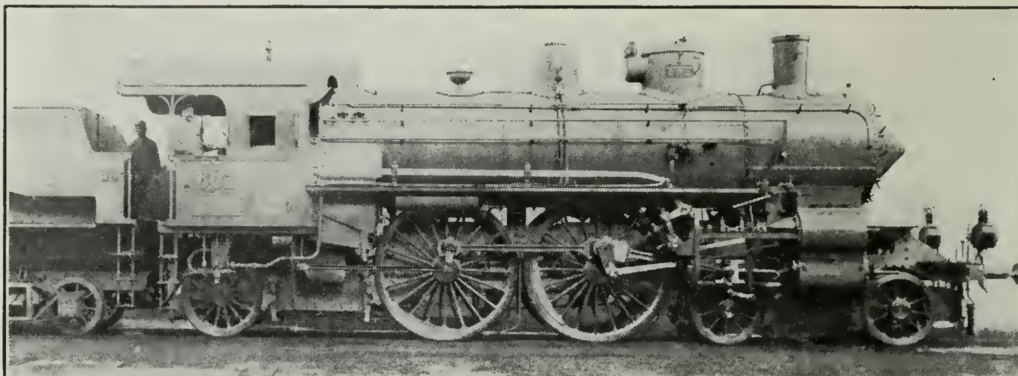


FIG. 50. MOST RECENT EXAMPLE OF HENRY-BAUDRY COMPOUND LOCOMOTIVE, PARIS-LYON RAILWAY.

prospect of head-on collisions, preferring to be between engine and tender in case of accident—as at Shrewsbury. For passengers' safety and for comfort of the enginemen the front cab was, by experience, shown to be unquestionably and vastly superior. The engine system survives in the new "Prairie" locomotives. Of these "Adriatic" engines, the chief engineer of the "material" testing department at Rome has reported as follows:—"By the experience of the last four years we know that, regularly hauling express trains weighing 200 to 350 tons behind the tender, these 'Adriatic' engines only consume, on



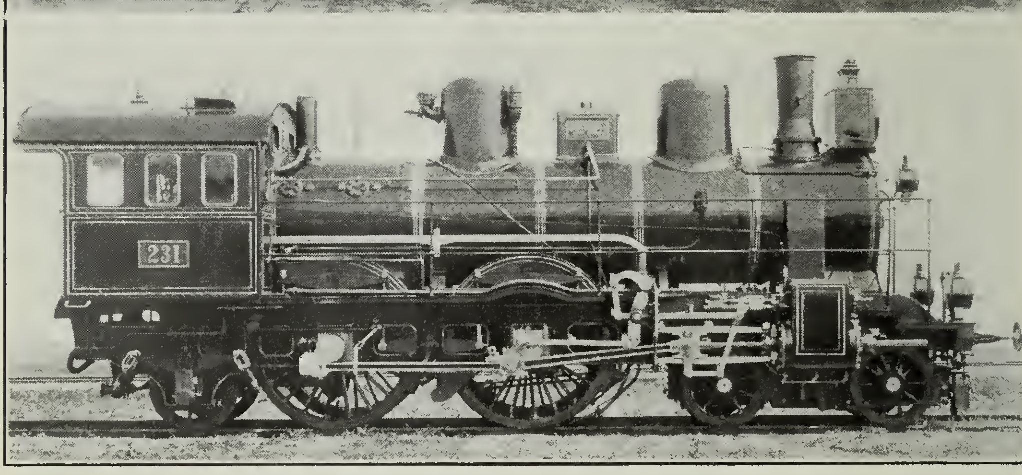


FIG. 51. FIRST BALANCED COMPOUND, HUNGARIAN STATE RAILWAYS. EXCEPTIONALLY FAST ON LEVEL LINES.

FIG. 52. NEW TYPE COMPOUND, RUSSIAN RAILWAYS. PLATE FRAMES.

average, 13 kilograms of coal per kilometre, that is, hardly 5 per cent more than the single-expansion engines which take, on average, 100 tons less and frequently require piloting." These engines are unusually economical. They regularly save 35 per cent of the coal used by single-expansion engines operating the same service of trains—the yearly returns showing the fuel consumption per 100 car kilometres run to be 6.73 kilogrammes for single expansion and 4.37 kilogrammes for double. It would be daring to assert that no single-expansion was ever so economical on fuel, but this much is indisputable—that they are more economical and more powerful, weight for weight and wheel for wheel, than has recently been shown as the "ideal maximum, but not realisable in regular service," obtained exceptionally in specially prepared trials of locomotives fitted with patented superheaters whose effects were claimed to be so brilliant that similar results had never been obtained by saturated steam in engines of the same weight and number of axles—results which have, however, been far exceeded by the "Adriatic" type locomotives in regular service according to the routine records of their work.

Hungary is the most recent place of adoption of the Central European compound locomotive, see Figure 51. This is, however, the only example of such in which an intercepting valve is employed, much though the elimination of this organ has been studied elsewhere. In service, remarkably high speeds have been attained with this engine. The valve rockers are similar to those of the Belgian locomotives type "19" and "19 bis."

An example of Russian compound locomotive figures in Figure 52. This country has been the earliest home of the Mallet original two-cylinder compound and the Mallet articulated four-cylinder compound locomotives, and it is certainly remarkable that superheating the steam in that country does not appear to produce any result worthy of mention. Other compound systems, as the de Borodine-Wolff tandem system, have, in their time, there been productive of results even difficult at times to be equalled by the Italian compounds.

In the future, water-tube boilers, with superheaters, and compound engines, with improved valves, may be expected greatly to increase the economy and working capacity of locomotives until the arrival of a substitute for the turbine—which experiments show to be wholly unsuitable for such machines.

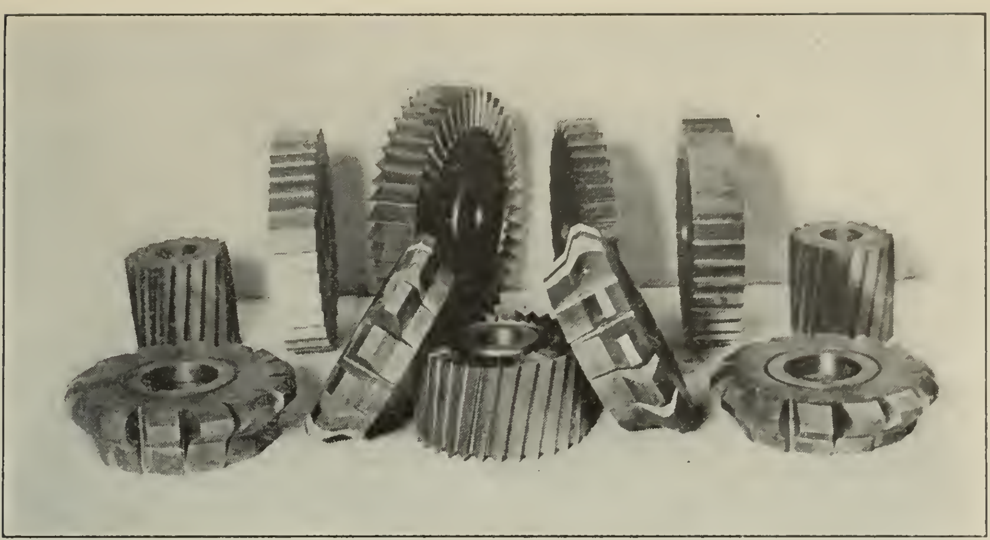
HARDENING HIGH-SPEED STEEL TOOLS BY THE BARIUM-CHLORIDE PROCESS.

By O. M. Becker.

Thorough study of the alloy steels, and especially of the rapid-cutting types, has solved many of the difficulties that sometimes led to disappointment in their use in earlier days. One point very clearly fixed is that comparatively small temperature-differences in heat treatment are the cause of very great differences in the properties developed. The methods defined by Mr. Becker are among the improvements enabling exact results to be secured in regular practice. In a later issue we shall present a very thorough review of the whole range of the special steels and their qualities, by M. Léon Guillet, one of the foremost experimenters in the field.—The Editors.

BEFORE the day of high-speed steel even, it was felt that there should be found some method of hardening which would obviate the nuisance of oxidation and scaling of the surface of fine tools. The advent of high-speed steel, with its much higher hardening temperatures, emphasized the evil of scaling. This has made the discovery of some simple process of hardening which would avoid the difficulty, or reduce it to a negligible minimum, a matter of much concern. It is well-known that as ordinarily treated, fine tools often lose size, and in general have to be made over-size in the first place to allow for the refinishing necessary after hardening and tempering. The various methods of packing tools in muffles and similar devices, while troublesome, help a good deal to overcome the trouble; but even these methods do not entirely remedy the difficulty. The lead bath, reasonably satisfactory in the case of carbon-steel tools, cannot be relied upon in the case of high-speed steel tools.

Lead melts at a relatively low temperature, but can be raised to that required in hardening the new steels without great difficulty. At this high temperature however the lead oxidizes rapidly, leaving a scum of lead oxide floating on the surface to obscure the appearance of the bath. But while it can be used, and is used regularly by some tool makers, it is more or less uncertain, and besides does not prevent some oxidation while the tool is passing from heating bath to quenching bath, if one be used. Not infrequently this alone is sufficient to ruin a delicate tool, though ordinarily it is of no particular consequence in carbon-steel tools. With high-speed steel tools the very high temperature (a dazzling white) at which the tool is car-



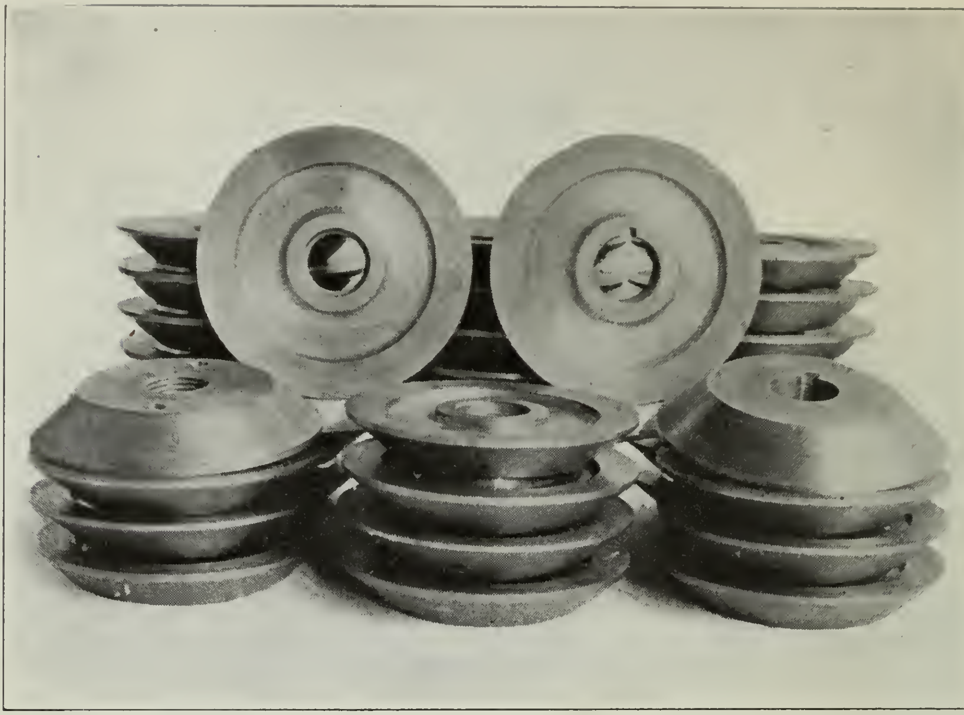
TYPES OF HIGH-SPEED TOOLS FOR WHICH THE BARIUM PROCESS IS ESPECIALLY DESIRABLE.

It leaves perfect surfaces and cutting edges, does not impair the accuracy of size, and makes it possible to have very hard cutting edges combined with tough stocks or bodies.

ried from the heating furnace or bath to be quenched, frequently causes trouble, if indeed it does not necessitate refinishing the tool by reason of impaired size or damaged cutting edges. When the quenching is done in an air blast the trouble obviously is accentuated. The oil quenching bath of course prevents this part of the trouble, and this is now coming to be more and more generally used.

Another troublesome point in the hardening of fine tools, especially of small ones or those having keen cutting edges, is that of securing absolute, or even approximate, uniformity of temperature in heating. This exceedingly important result is, in the case of such small tools, rather difficult of attainment by reason of the frequent and sometimes considerable fluctuations in the interior of a gas furnace, which latter is otherwise undoubtedly better adapted to the heating of high-speed steel tools than any other type. With large tools these fluctuations, arising from variations in pressure, areas of openings, and the like causes, make little difference on account of the considerable length of time required to affect a large mass. In the case of small ones however, where the time of heating is comparatively short, any such fluctuation may be sufficient to affect the quality of the tools. This difficulty also has been overcome in the past by the use of the lead bath and muffles, which however have the disadvantages already mentioned.

The distortion sometimes occurring in long and slender or specially shaped tools, when heated in the ordinary gas or coke fires,



THE BARIUM PROCESS LEAVES THE SURFACE OF A TOOL ABSOLUTELY UNIMPAIRED, IF IT BE QUENCHED IN OIL.

The only difference in the appearance of hardened and unhardened tools is a very slight darkening of the color, so slight as to be unnoticeable except when compared with an untreated surface.

causes trouble. This is avoidable in part in all cases, and wholly in the case of straight tools, by heating them suspended in a cylindrical gas furnace. Ever since the advent of the new steels, these difficulties have suggested the need for some method of heating tools of this sort which would do away entirely with oxidizing, warping, refinishing, and the like troubles. In Europe particularly, experiments were carried on from time to time with the purpose of developing such a method, and with some success.

It was in Germany, I believe, that a bath of melted barium chloride was first used to replace the lead bath; and I am told that in the shops of the Ludwig Loewe Co., at Berlin, it was used to a considerable extent in their work of hardening high-speed tools. It was not however either generally known or practicable for general use until the importance of the process was recognized by the eastern representatives (Wheelock, Lovejoy & Co., Boston) of the Firth-Sterling Steel Company, and by them and by the Chicago representative of the same company (E. S. Jackman) developed by long and patient experimentation to its present state of utility. These people not only use the process extensively in their own hardening plants for the benefit of their customers, but have made known the method to all inquirers.

Essentially the barium-chloride process consists in melting the commercial substance of that name in a suitable vessel and heating it to the required temperature. The tool to be hardened is then plunged into the bath until it has reached the temperature of the bath (except as hereafter indicated) and is then withdrawn and quenched in the customary manner, preferably in an oil quenching bath. Barium chloride is, as its name indicates, a compound of barium, which latter is one of the so-called alkaline earths, belonging to the same group as calcium (lime) and strontium. The chloride, like the other barium salts, is poisonous.

Barium chloride melts at a temperature considerably below that required in hardening high-speed steel; but it can be readily raised and maintained at the required temperature (approximately 2,150 degrees Fahrenheit or 1,180 degrees Centigrade) in a suitably designed furnace. A graphite crucible is necessary, and even this must have the bottom well supported to prevent its dropping out. The crucible is placed at the center of a cylindrical furnace somewhat resembling those sometimes used in ordinary hardening, and sealed to the top with fire clay in such a way as to prevent the escape of gases from the furnace body except through the vent. The gases must not come into contact with the melted barium chloride.

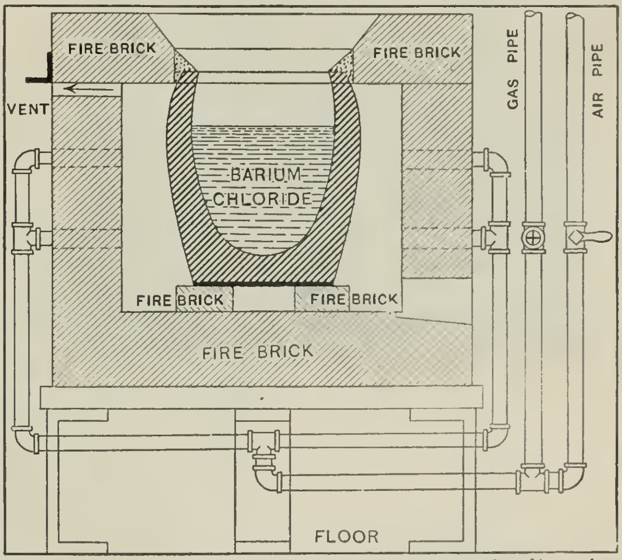
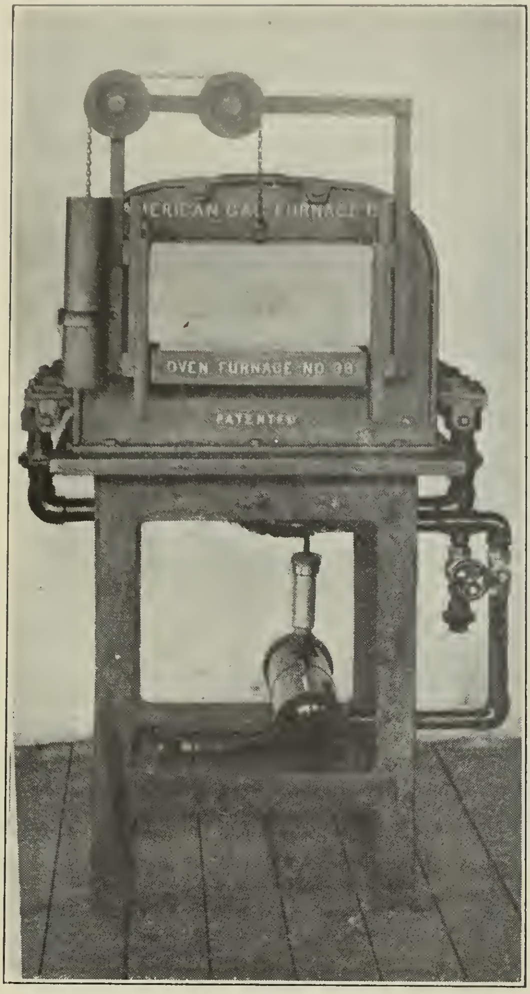


DIAGRAM OF BARIUM CHLORIDE FURNACE.

Either oil or gas may be used, in a furnace adapted to the particular fuel, though in general gas is recommended because of its greater convenience and the greater ease with which exceedingly high temperatures are reached and maintained. A gas furnace in which the flame has a rotary motion around the crucible has been adapted to this use by at least one builder of furnaces. The nozzles from which the mixture of gas and air issues are placed tangentially to the inner surface of the furnace, throwing the flame not directly against the crucible in one or several spots, but enveloping it in a whirl of flame which heats it uniformly on all sides. The firebrick blocks upon



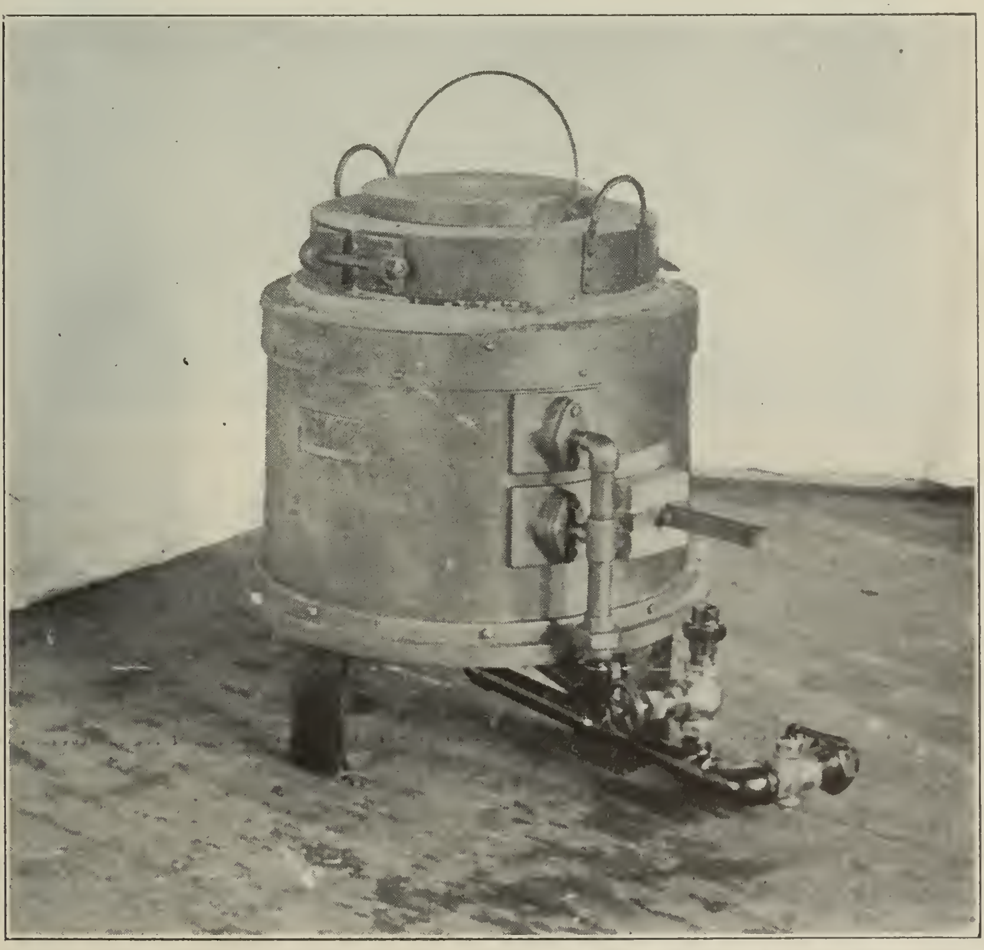
LARGE OVEN FURNACE AS USED IN PRE-HEATING LARGE TOOLS PREPARATORY TO PLUNGING INTO THE BARIUM BATH.

The same furnace is an excellent one for the ordinary hardening work.

which the crucible rests are so disposed as to allow the flames to circulate below, as well as around the crucible, the contents of which are therefore kept at a uniform temperature throughout—an important condition to success with this process. The furnace of course is supplied with both air and gas under pressure, the air being supplied preferably by a small blower. Furnaces can be had equipped with individual blowers, if desired. Ordinarily, in a plant where a number of furnaces of the several kinds useful in the treatment of tools are installed, a single blower for the group is most economical. Not only the barium furnace, but all others in a hardening plant, and the quenching bath also, should be provided with suitably designed exhaust hoods, properly connected up, for the removal of gases and for frequently changing the heated air of the room. The chlorine fumes rising from the barium-chloride bath in spite of precautions to prevent, are very irritating when breathed.

A well equipped hardening plant will of course have a considerable variety of furnaces and other apparatus, especially adapted to the various kinds of work. In addition to the barium chloride furnace there will be the large oven furnace for heating large tools and for reheating certain classes of tools preparatory to the barium bath treatment; and perhaps a small oven furnace. A lead bath is almost indispensable where there is a wide range of work. There should be also an oil tempering furnace, for "drawing" the temper of such tools as require this treatment.

The various furnaces may of course be heated by any desired fuel adapted to them, and in some cases will vary from the forms mentioned. A coke furnace, for example, would replace the oven furnaces mentioned above. The furnaces preferred are all gas-heated, these being most convenient to operate and most certain in control. The cost of operation, moreover, is little or nothing higher than that of the other forms unless the price of gas is exorbitant. In that case a small plant for manufacturing gas would be desirable. Provisions for quenching, of course, are essential. And finally, there should be a fairly good pyrometer, for observation of temperatures. The novice especially needs the guidance of such an instrument. Pyrometers suitable for this purpose are now obtainable in a variety of forms, both reading and recording, at very moderate cost; and these give very satisfactory service, some of them continuously and accurately with little or no attention. Such an adjunct to a hardening plant is of course desirable, and indeed essential, under ordinary circumstances; but it is especially important in connection with the barium bath, while the operator is becoming familiar with the process, if not later.



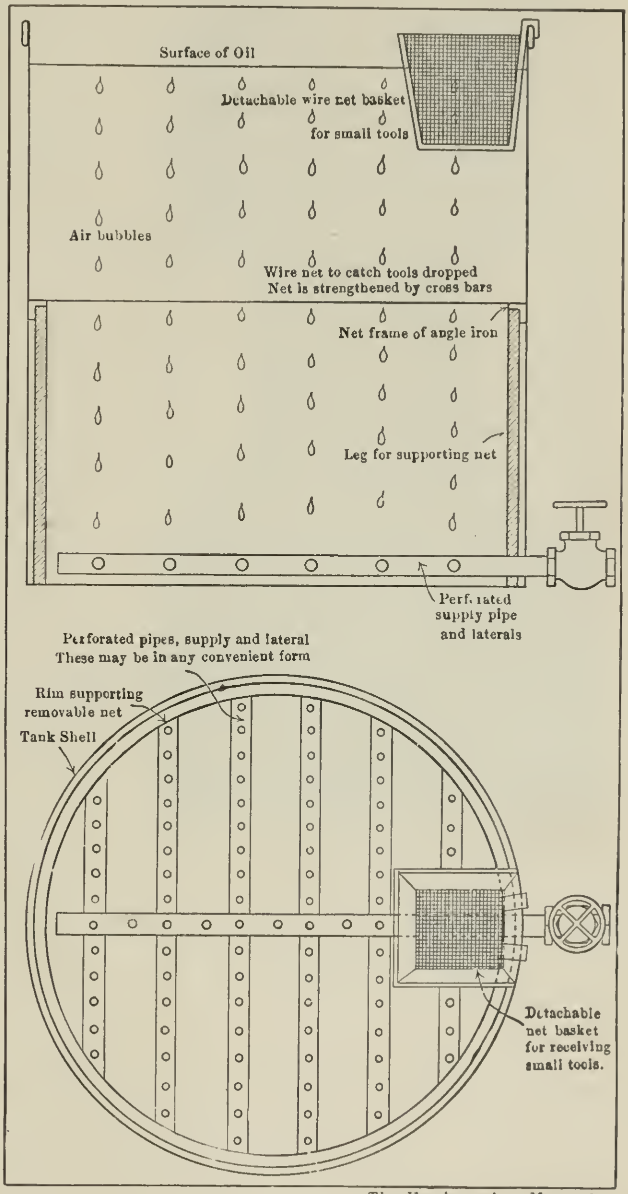
A CYLINDRICAL FURNACE (HOOD NOT IN PLACE) WITH GRAPHITE CRUCIBLE.
Used in hardening high-speed steel tools by the barium-chloride process. Made by the American Gas Furnace Co., New York.

A TYPICAL ARRANGEMENT OF A TOOL-HARDENING PLANT.

The furnaces and other apparatus are preferably placed in a straight row, and each unit provided with an exhaust hood for drawing off the fumes, as well as helping to renew the air of the room.

A word as to the arrangement of the units of a hardening plant may be of interest. The point of course is to so arrange them as to be most convenient. A good order would be, beginning at the left: Large oven, small oven, lead bath, barium bath, quenching bath; and oil tempering furnace. The line should be straight. The more convenient semicircular arrangement is impossible because of the intense heat concentrated upon the operator, in this case.

The quenching, as already mentioned, can be by any of the methods customary with high-speed steel. Water, of course, must not be used. With the barium-chloride process air quenching can be used to better advantage perhaps than ordinarily, for no oxidation of the tool can take place in it after the latter is taken from the heating bath. Air however is more expensive to use than is the oil bath, and has no advantage over it. It is recommended that wherever practicable, all quenching, whether of tools heated in the barium-chloride bath or otherwise, be done in an oil bath. An excellent form for this purpose was illustrated at page 249 of THE ENGINEERING MAGAZINE for November, 1905. A still better form for all-round use is illustrated herewith.



The Engineering Magazine

A GOOD DESIGN FOR TANK FOR OIL QUENCHING.

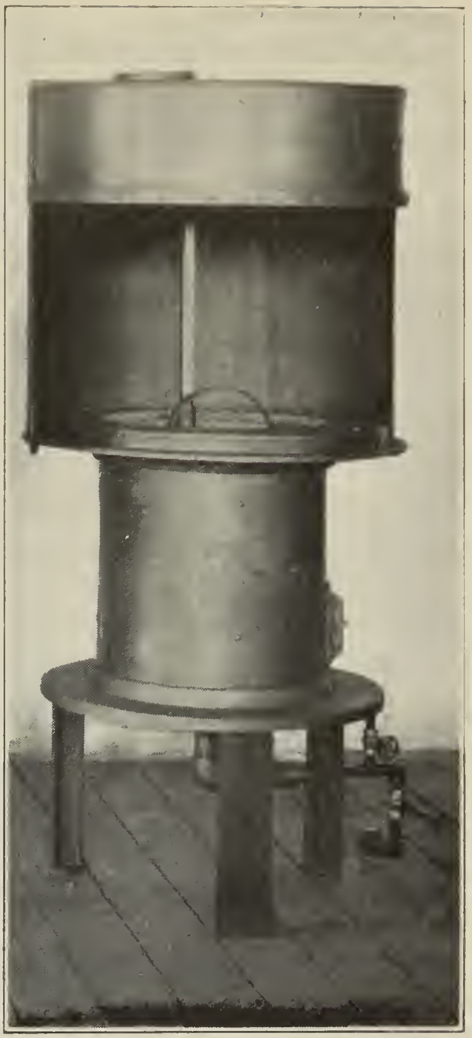
At the bottom of a cylindrical galvanized iron tank is laid a series of pipes branching from a central supply pipe, all perforated in the upper side. Air from the blower, or from the compressor if the pressure has been sufficiently reduced, bubbles up from the bottom, keeping the oil in the tank in circulation. It is therefore kept well mixed and of uniform temperature, and the temperature is kept sufficiently low by the loss of heat to the air bubbles constantly escaping.

About half-way to the bottom, or elsewhere as required, a removable wire netting is placed, properly supported, to catch any large tools that might accidentally be permitted to slip from the tongs. If the netting be near enough to the top the tools can be dropped into the bath and removed at pleasure. Besides the netting mentioned, there is at one side of the tank a removable net basket, of mesh fine enough to prevent any tool that might be placed in it from falling to the bottom of the tank. Into this basket all small tools are dropped for quenching, to be removed as desired.

When tools are to be hardened, the crucible is filled with commercial barium chloride (the cost, in quantity, is about three cents per pound), which is melted. Into it is then thrown a handfull of sodium carbonate, commonly known as soda ash. This should be about 2 per cent of the contents of the crucible. It floats upon the barium chloride and partially prevents the latter giving off the offensive chlorine fumes which not only are irritating when breathed, but discolor tools with which they come in contact. The ash seems to have some additional effect, as yet not very well understood. It must be renewed from time to time, as it becomes exhausted; but care must be taken not to have an excess of it. In that case the boiling point of the barium chloride is altered, and the temperature cannot be raised high enough to give the tools a proper hardening heat.

The bath is rapidly brought to the required temperature, which for high-speed steel ranges from about 1,000 degrees to 1,180 degrees Centigrade, or 2,000 to 2,125 degrees Fahrenheit, or thereabouts. This is slightly lower than the temperature usually preferred in the ordinary hardening furnace, but is sufficient for the kind of work to be done. In the open furnace, when heating unfinished tools, the temperature is preferably raised to the point where the flux begins to run, 100 degrees or more above that just mentioned. But where keen edges are to be preserved, as in tools best hardened by the barium-chloride method, it is not safe to bring the heat quite so high. Until the operator has become thoroughly familiar with the appearance of the bath at the proper temperature, he should give the pyrometer frequent readings.

Large tools, say those above ⅜ inch in diameter or thickness, are generally pre-heated in a gas furnace, the heat however not exceeding a low red. At this temperature there is little or no surface oxidation, and pre-heating may safely be done with most large tools intended for the barium bath. The object of pre-heating is to prevent a sudden lowering of the temperature of the barium bath upon the introduction of a large mass of cold steel, and the consequently longer time required for the heating, as well as the need for carefully readjusting the temperature of the bath to the right point. Pre-heating saves considerable time when many tools are to be hardened. It is objectionable however in the case of smaller tools (which do not need it) and tools with keen edges to preserve, because of the exceeding care required to prevent oxidation either in the furnace or on the way to the barium bath. When it is necessary to pre-heat such tools, it is best done in a lead bath.



CYLINDRICAL OIL TEMPERING FURNACE WITH HOOD.

Used for "drawing" the temper of such tools as require this treatment. The thermometer is essential to this type of furnace. American Gas Furnace Co.

Small tools plunged cold into the bath quickly heat through and do not noticeably affect the bath itself. According to the diameter or thickness of the tool, from a fourth of a minute to a minute is required when the tool is to be heated through, as it should generally be. Larger tools of course take longer. The dazzling white is easily recognized, and the operator has but to examine the tool from time to time, in order to be sure it is hot enough for quenching. Thus immersed the tool heats uniformly from all surfaces toward the center.

When withdrawn from the bath the tool is covered with a thin film of barium chloride, which adheres to the surface until quenching, and ordinarily prevents air coming in contact with the tool itself. There is consequently no oxidation, unless the tool be quenched in an air blast. The film disintegrates in the air blast and permits some oxidation to take place. The surface of the tool, after the scales of barium chloride have been brushed away, comes from the oil quenching bath with almost exactly the same appearance it had before heating, and the finest finished surface is absolutely unaffected. Even an expert cannot tell the difference, except perhaps by a darkening of the color so slight as to be quite unnoticeable except when compared directly with an untreated surface. From its appearance alone no one would suspect a high-speed steel tool to have been heated, when hardened by the barium-chloride process. It is seen therefore, that there is no need whatever for refinishing or grinding tools so treated. The keenest cutting or finishing tool is not impaired in the slightest degree.

This is of especial advantage in such tools as taps, threading dies, screw-machine formed tools, and the like. Formerly high-speed steel was little used for tools of this sort. It was difficult to harden them without their losing size and more or less roughening the surfaces and cutting edges. The barium process entirely obviates this difficulty, and also another which formerly gave much trouble. Tools with projecting or overchanging cutting edges, when hardened in the customary way, were too brittle and the teeth or cutters frequently broke away. When the body of the tool was small, that also was liable to breakage. If the temper was reduced enough to overcome this trouble, the tool usually was too soft to give the best service. The improvements in high-speed steel itself have done much to eliminate this trouble. However that may be, nothing of the sort can occur if such tools are given the indicated treatment with the barium process.

By plunging a tool, as a tap for example, into the barium bath just long enough to let the cutting edges become heated to the hardening temperature, and then withdrawing the tool before the stock has had time to get very hot, it may be quenched with the result that the cutting edges alone are hardened, the stock remaining in the annealed state and retaining all its toughness. This same quality, that of a very hard cutting edge combined with a tough stock or body, is desirable also in many other kinds of tools, especially in twist drills, milling cutters, and the like.

It should be remembered, in thus hardening tools of this class, that flaws often result from strains set up in hardening, generally by reason of the outside portions of a tool cooling and hardening more rapidly than the interior, and the consequent tendency of the outside and inside portions to adjust themselves. The interior of tools thus heated on the outside only does not expand much if at all; and when the highly heated thin outer skin is quenched, the sudden shrinkage sometimes causes flaws. A little care on this point will prevent the difficulty.

The tempering or "drawing the temper" of those tools needing it, as most keen-edged tools do, is accomplished in the customary way, preferably in the oil tempering furnace, as has been explained in a previous article in this magazine.*

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* Page 251, THE ENGINEERING MAGAZINE, November, 1905.

ALCOHOL AS A FUEL FOR INTERNAL-COMBUSTION ENGINES.

By Thos. L. White.

Mr. White examines, in the following pages, the problem of obtaining cheap and ample supplies of fuel alcohol from a variety of raw materials. In a subsequent article he will discuss the suitability of alcohol as a substitute for gasoline.—The Editors.

THE object of the present article is to offer an analysis of the various elements which enter into what may be termed the industrial alcohol situation in America at the present time. That there is great need of some such process of "stocktaking" is evident from the experience of the past two years, which has shown conclusively that European standards and precedents have little application in America because the accompanying conditions cannot be reproduced, and that consequently the problem of the development of the alcohol industry in America is in essentials a problem *de novo*. It is to frame a tentative answer to such questions as:—What will alcohol be made from? What will the price be? Can it be used for automobiles? Will it ever take the place of gasoline?—that the present survey is intended; and that such an attempt is even now feasible is due to the large body of technical information which has recently become available for reference, and which we owe to various investigating committees, notably, the Technologic Branch of the U. S. Geological Survey, the Office of Experimental Stations of the U. S. Department of Agriculture, the Fuels Committee of the Motor Union of Great Britain, and to such private investigators in the same field as Prof. Lagerheim of Stockholm University, Mr. Victor Frestadius, Sir William Ramsay, Eckardsström and Raynaud.

Few recent measures in passing Congress attracted wider attention or gave rise to more lively anticipation in all quarters of benefits to come than the Payne Act making industrial alcohol duty-free, and the public attitude towards the net result to date, viz., denatured alcohol at 40 cents per gallon in five-gallon lots, and that procurable only in important centers, is naturally one of some disillusion. In justice, however, to the future of a very young industry, and in a lesser degree to those engaged in the manufacture of the new product, it must be conceded that this high price is in the main due to causes which are being, or which can be, modified.

In the first place, although industrial alcohol has been duty-free, so far as the statute book is concerned, for fifteen months, it is only during the last six months that the industry has been freed from certain vexatious, expensive, and, as has proved, quite unnecessary regulations by which it was hampered at the start, and which virtually constituted an indirect tax. These were framed by the excise authorities with a too zealous eye to the safeguarding of the revenue from spirits, and entailed a needless outlay of about 6 cents per gallon on the distiller, who, of course, added the charge to the retail price. Whether the consumer has as yet enjoyed the full relief coming to him, only the producers of alcohol are in a position to say.

In the second place, the alcohol furnished to the American market to-day is almost exclusively a corn product, and corn during the past year has fluctuated around the 60-cents-per-bushel mark, a price much in excess of normal. While it would be absurd to credit the whole difference between the actual price of alcohol and the price at which we should like to see it to the present inflated condition of the corn market, there is no doubt that when the present high price has had time to react by increasing the acreage under cultivation, alcohol will be procurable at a more reasonable figure. Whether corn will continue to be the principal alcohol base, and whether corn-made alcohol will ever be cheap enough to be substituted for gasoline as a fuel, are questions of normal limitations rather than of market conditions: but as we shall point out presently, there are other raw materials for the manufacture of alcohol which seem more promising.

The fact of the matter is that in its inception, and up to the present, the production of industrial alcohol has been in the hands of the whiskey distillers. This was inevitable, for they were the only people equipped to supply the market at the time of the passing of the Payne Act, and they naturally continued on the lines to which they were accustomed, regarding the new product, not as the basis of a new industry, but as so much additional output of an old one. If things had not fallen out this way, the result would have been, not cheaper alcohol for heat, light, power, and the manufactures, but no alcohol at all. A price reflects, not prospective industrial conditions, but actual industrial facts, and while there has been a good deal said and written about farmers making alcohol in co-operative stills from farm refuse, and visions of alcohol at 3 cents per gallon from corncobs have been vouchsafed to enthusiastic souls, the benefit to the consumer of alcohol from these sources has been confined to the realm of theory.

There are no statistics bearing on the point, but it is not probable that the passing of the Payne Act was heralded by any extensive or sudden demand for the new product. So far as alcohol for the purposes of heat and light is concerned, such a demand would premise a distributing system, the education of the people to the use of alcohol as a source of heat and light in the house, and the supplying them with suitable lamps, stoves, and similar apparatus. With regard to the use of duty-free alcohol in the arts and manufactures, those industries which had been compelled to use alcohol in the past merely continued its use under the new law, the output of their product, and consequently their consumption of alcohol, remaining virtually the same. In other industries, where the use of grain alcohol and wood alcohol was alternative, but the former the more advantageous in practice, the change over to the new product did of course constitute a new demand; but in the vastly more important field of motive power, the high price of alcohol, the difficulty of obtaining it, the general lack of knowledge regarding its use in motors, and the abundance of cheap gasoline, seemed in their cumulative effect the practical negation of the opinion of every expert who has examined the fuel question, and of every technical committee that has sat on it, that alcohol is the coming fuel. In fact it has become fairly evident that even if new and economical systems of making alcohol from farm refuse, sawdust, and what not, had been actually established at the time of the passing of the Payne Act, there would have been practically no market for the alcohol produced. This is directly opposed to popular opinion which places the onus on the distiller, but it is nevertheless true; and it means, not that the alcohol industry was still-born, but that it needed, and yet needs, time to find itself.

It is the sovereign claim of alcohol, and the principal ground of the belief that it will one day supersede all other liquid fuels, that it is the product of the four seasons. It is made by converting to sugar, and then fermenting, the carbohydrates in plants and vegetables, and its production has no limit set to it by the ultimate exhaustion of some natural reservoir of stored energy, such as a coal measure or an oil field. So long as the annual cycle of plant generation goes on, so long can alcohol be produced, for alcohol takes nothing from the plant but carbon, oxygen, and hydrogen, and these elements are supplied to each succeeding generation of plant life by the moisture and carbon dioxide of the atmosphere.

From an economic point of view, the most valuable of the elements that enter into plant life is nitrogen. It is taken up into the structure of the plant from the soil, and it can be assimilated by the growing tissue only when it is presented in the form of a soluble nitrogeneous compound. In a state of nature, the decaying vegetation returns to the soil the nitrogen that it has taken from it, but when land is under cultivation, the soluble nitrogen is removed with the crops, and the ultimate exhaustion of the soil is only a matter of time. In new countries, where large and fertile tracts are available, this depletion of the nitrogenous content of the virgin soil is not of immediate importance, but in settled districts it represents a problem of the first magnitude. Now, as we have pointed out, nitrogen does not enter into the composition of alcohol, so that the manufacture of alcohol does not constitute a direct drain on the nitrogenous capital of plant life; nevertheless if the residue from the alcohol stills, which contains the combinable nitrogen of the base from which the alcohol is made, is not returned to the soil but is wasted or otherwise dissipated, the result is virtually the same. In order, then, that the claim made for alcohol—that in its production the fertility of the soil is conserved—may hold good in practice, it is clear that the relation between agriculture and the manufacture of alcohol must be of even a closer character than is implied in the mere statement that alcohol is an agricultural product. We should in fact expect the distilleries to be situated in the agricultural districts, and the base from which the alcohol is made to be selected with an eye not only to the fermentable yield, but also to the suitability of the residues from distillation for use as fertilizers. As a matter of fact, in France and Germany where the problem of producing alcohol has been worked out to suit the requirements of a soil that has long been cultivated, there is a large majority of agricultural distilleries, and the value of the residues represents 50 per cent of the value of the alcohol manufactured.

Mention has been made of the difficulty of adapting foreign standards to American conditions, which prevents the general application in the United States of experience in the alcohol industry gained on the other side. One of the reasons of this is that in its diversity of agricultural and industrial conditions the United States is not a country but a continent. Take the case of the German agricultural distilleries which we have just cited as illustrating the tendency of the alcohol industry to graft itself onto the nitrogen cycle of agriculture. It would not be difficult to find sections in the State of New York where the land has been worked long enough to render the question of residues as important as in Germany. Suppose that in some such section the farmers undertook the cultivation of the alcohol potato and erected co-operative distilleries, trusting to sell their alcohol in the cities. What is there to prevent their enterprise from being ruined by the competition in a common market of alcohol made, we will say, from sugar refuse in the southern States and shipped in tank steamers? The German farmer is protected from this sort of attack because the agricultural conditions in Germany are sufficiently uniform to be treated and looked after as a unit. Nor is the difference in the economic conditions of the production of alcohol as between America and Europe any less marked. The widest field for industrial alcohol is without doubt as a source of heat, light and power, and it is precisely in this field that alcohol in America is subjected to a degree of competition to which in Europe it is a stranger. On the other side petroleum products are a heavily taxed import, while the manufacture of alcohol is State-aided. In America, kerosene and gasoline are to all intents and purposes natural resources of the country, and the standard of cheapness thus set for fuel alcohol is one that seems hard to meet without recourse to new methods of production. Those in vogue at present reduce on examination to a number of alternatives each no better and no worse than the rest, and all inadequate. There is no merit in resting in the belief that the Payne Act had some of the quality of an edict from above, and that alcohol was ordained from the first to replace gasoline. Providence in commercial matters is generally found on the side of low prices, and alcohol is a better fuel than gasoline only provided that it can be made cheap enough. In order to reconcile the immense possibilities of alcohol on the one hand and the unrealised promises of the Payne Act on the other the situation seems to call for something more radical than has hitherto sufficed—some departure which will enable alcohol to be used for whatever purposes its qualities best suit. That the oil wells are being exhausted and that the demand for the lighter petroleum distillates is increasing faster than the means of meeting it, is probably true; but the actual problem which at the present moment faces the producers of industrial alcohol in the United States is to find a base for fuel alcohol which is comparable in price with the crude oil from the wells. In brief, is it practicable to make alcohol on commercial lines from some material which may be had for the taking, and of which there is a great and easily accessible supply? In the light of the successful manufacture of alcohol from peat by Lagerheim and Frestadius, two Swedish chemists, an affirmative answer seems at least possible.

Although the normal cycle of plant life is to return to the soil the elements taken from it, there exist certain conditions under which this process of restitution may be suspended indefinitely, and the remains of countless generations of plant life preserved in a state of arrested decay. Deposits of vegetable matter formed in this way are known as peat bogs, and they can exist only where the subsoil is capable of retaining water, the climate humid, and the mean temperature sufficiently high to stimulate a rapid growth of the aquatic plants to which the peat owes its formation. The result of such a combination of conditions is that the decaying sedge in the early stages of its decomposition becomes pickled, the "pickle" being furnished by the decaying vegetation itself, in the form of certain peat acids of an antiseptic character which act as a preservative. The important point to the alcohol manufacturer is that the decay of the peat-forming plant life is arrested before its qualities as an alcohol base have become impaired, and the early recognition of this fact led a number of investigators to try to turn it to practical use. They were all however unable to surmount certain difficulties, the character of which they failed to understand rightly, and it seems to have been reserved for Lagerheim and Frestadius to be the first to work out a satisfactory process. Their discoveries have been corroborated by the investigations of Sir William Ramsay, Raynaud and others.

The species of peat which is best suited for the production of alcohol is that found in the extensive peat fields of North America, and technically known as sphagnum moss. It is procurable in a good state of preservation down to 30 feet in depth, and to give some idea of the alcohol content of such deposits, it may be stated that the Great Dismal Swamp of Virginia is alone capable of yielding 40,000 millions of gallons of 96 per cent alcohol, or sixteen-hundred times the total output of Germany in one year.

To avoid unnecessary handling of the peat the apparatus for the new process is designed for erection in the vicinity of the peat bog from which the raw material is taken. It consists primarily of a battery of closed boiling vessels or autoclaves, each of which is connected by a common pipe to a steam-generating plant. There are two manholes in each vessel, one at the top to admit the wet peat, the other at the bottom for removing the treated charge.

The first stage in the treatment of the peat consists in digesting it with sulphuric acid and water in the autoclaves, steam being meanwhile admitted through the steam pipe connection until most of the air in the peat has been slowly expelled. The temperature is then allowed to rise until a pressure of three atmospheres is reached, and this condition is maintained for about forty minutes, which is a sufficient period of time for the contents of the autoclaves to become reduced by the action of the steam to the consistency of a jelly. The charge is then blown out through the lower manholes into a neutralizing tank, treated with a definite quantity of carbonate of lime, and thence conveyed to the fermenting vats.

The carbonate of lime is obtained locally as an ingredient in a species of clay, which in most peat fields is a constituent of the upper portion of the substratum immediately underlying the peat. Its presence there is due to the deposit in the past of the shells of countless myriads of aquatic micro-organisms, and it is found associated with certain phosphates, oxides, and nitrogenous compounds which serve for the prolification of the yeast in the fermenting vats, and which would otherwise have to be supplied from an outside source.

In all previous attempts to manufacture alcohol from peat, the efforts of the experimenters had been directed to the conversion of the cellulose in the charge, and the real advance made by Frestadius and Lagerheim was the discovery that there are in peat matters other than cellulose, which are saccharifiable, and from which, consequently, alcohol can be made. These matters may be descriptively termed "gums," and the important point is that the yield of alcohol from them is twice that obtainable from the cellulose with which they are associated. That such a vital fact should have been overlooked in prior experiments is due to the readiness with which these gums are attacked by the joint action of heat and acid. They saccharify much more quickly than cellulose, and when once converted into sugar they are charred if the boiling with acid is continued. In the absence of any method of accurately testing at any moment the percentage of sugar in the semi-solid peat mash, it is easy to understand how their conversion into sugar and subsequent destruction was overlooked; and, translated into practice, the departure in the new process consists in so regulating the period of digestion in the boiling vessels that the contents are discharged at the moment when the conversion of the "gums" is complete, the more stubborn cellulose remaining virtually unaltered.

When the digested peat mash is blown out into the neutralizing tanks, there is no attempt made to express the liquid part of the jelly-like mass with its dissolved sugar in order to procure a clear wash. Indeed, it is claimed that such a separation, even if it could be conveniently effected, is undesirable, seeing that a considerable proportion of the sugar formed in the autoclaves is never dissolved at all, but remains held in the fibres of the peat. Be this as it may, the practice of admitting the whole mass of the treated charge to the fermenting vats is a very desirable simplification, for it evades the difficulty which is always encountered in pressing peat free of water, which, with the alternative difficulty of finding a ferment capable of acting effectively within the interestices of the peat, had stood in the way of previous experimenters.

The yeast used in the Lagerheim-Frestadius process is a special one prepared from a berry which is found growing on the peat fields. It has twice the efficiency of ordinary beer yeast for treating peat mash, and when the contents of the vats are subjected to its action, their physical character gradually changes as the operation of fermentation proceeds, the whole loosening up and becoming more and more fluid, until, when, the fermentation is completed, the solids separate and fall to the bottom, carrying with them the yeast cells and the nitrogenous matter which they contain. The whole operation of fermentation is conducted under more acid conditions than have hitherto been customary, and to meet this development, the special yeast is trained by special culture to resist at least 6 per cent of acidity with the result that, any impure ferments present in the mash being rendered inoperative by the excess of acid, the alcohol made is as pure as that obtained from corn.

After fermentation, the liquor in the vats, which contains most of the alcohol, is decanted, and, instead of being distilled in the ordinary way, is re-introduced into the autoclaves, together with a fresh supply of peat and acid, and steam admitted. When most of the air has been driven off, the mingled steam and air are made to pass over to a condenser, carrying with them the alcohol, the aromatic contents of the peat, and certain ethers whose formation is due to the presence of free acid in the charge. When, as nearly as can be judged, all the alcohol has been distilled, the connection with the condenser is cut out, and the autoclave connected up with the next autoclave, which has just been replenished with peat and fermented juice ready to be distilled. Any alcohol left in the first autoclave is thus saved and added to the yield of the second. The distillate is rectified in the usual way.

This method of distilling, besides being very efficient in practice owing to the large surface presented by the peat in the autoclaves, permits of two important economies, the one in the steam, which serves the double purpose of continuously digesting fresh peat while it is carrying over the alcohol, the other in the acid, a portion of which is returned from the vats to the autoclaves instead of being wasted.

It has been mentioned that the solid matter precipitated in the vats during fermentation contains all the nitrogen in the original peat, and it is of course possible to submit it to any treatment to recover that nitrogen that could be applied to the fresh material. There is however this difference between the two cases that whereas the nitrogen from the residues in the vats has been put through a cycle in which, without being diminished in quantity, it has served to feed the yeast during fermentation, the same nitrogen if extracted directly from the raw peat performs no such duty. In one case we have fixed nitrogen *plus* alcohol, in the other simply fixed nitrogen.

Since fuel is needed for generating steam and other purposes in the process, the residues from the fermenting vats, after being dried on an inclined still to drive off any remaining alcohol, are subjected to dry distillation, and the peat gas produced is burned under the boilers and peat ovens. Of the by-products, the most important are ammonia, which is collected over sulphuric acid, paraffin, creosote, various oils, tar, and methyl alcohol. The presence of the latter is especially opportune, as it serves as a denaturing agent for the alcohol. In fact, considering the process as a whole, it is remarkable that the only ingredient that has to be imported onto the ground is the sulphuric acid used in the autoclaves and for collecting the ammonia. Everything else necessary is found on the spot or is produced as a by-product.

Coming now to the consideration of the economic side of the Lagerheim-Frestadius system, several points present themselves. First there is the matter of cost, and it is conservatively estimated that reckoning the price of sulphuric acid at $7.50 per ton, the alcohol can be marketed at a profit at 5 cents per gallon. The extent to which the price of the acid enters into this estimate may be figured on the basis that an increase of 10 per cent in the cost of this ingredient would entail an increase of 2 cents in the selling price of 40 gallons of alcohol; or, to put the matter in another way, if the price of the acid were to double, the proportionate advance in the price of the alcohol would only be ½ cent per gallon. This is in contrast to present conditions where the price of alcohol is dependent principally on prices over which the alcohol manufacturer has no control and which are the determining element in the cost price of his product.

In all manufacturing industries the proximity of the locality where the commodity is made to the market where it is sold is an important consideration. In the present case it need only be said that the situation of the peat fields, distributed as they are over the country, is at least as central as that of the oil fields; and that in the matter of transport, alcohol presents exactly the same problem as petroleum.

The yield of alcohol in the Lagerheim-Frestadius process varies from 30 to 40 gallons per ton of dry peat. As peat in the natural state contains from 85 per cent to 95 per cent of water, the yield per ton of peat as it is taken from the bog is from 3 to 4 gallons. This corresponds to about 2½ gallons of 96 per cent alcohol per cubic yard of wet peat. The yield of sulphate of ammonia is about 2 pounds per gallon of alcohol produced; and the process can be inclined to yield more sulphate or more alcohol as desired.

OBTAINING ACTUAL KNOWLEDGE OF THE COSTS OF PRODUCTION.

By F. E. Webner.

IV. USE AND ABUSE OF MECHANICAL AIDS IN COST FINDING.

Mr. Webner's series began in May, and his preceding themes have been: "What Constitutes a Knowledge of Costs?"; "When and Where a Close Knowledge is Needed"; and "The Profitable Use of Cost Comparisons."—The Editors.

"WHAT is one man's meat is another man's poison" is an expression that aptly fits the matter of mechanical brains, for on every hand can be seen ill-fitting "aids" in the shape of devices which under certain conditions actually cost more to operate than the value of the time saved. By this it is not meant that such devices are without merit, but rather that what is known as good salesmanship has succeeded in installing a machine in a cost department that would be better off without it. Even such an erstwhile good friend as an adding machine can cost more than it saves, by having men killing time while waiting for one or more users ahead of them; that can be construed as an abuse of the machine in that it overloads it at too great a cost; the solution is additional machines.

The same condition obtains in the case of time recorders on individual job numbers. When workmen are required to walk too far to register, then the cost is too great and the frequent congestion about the machine makes the plan burdensome and interferes with the volume of production to an appreciable extent. The remedy is plain, though not always recognized, the trouble being most often charged against the cost department as an insuparable difficulty.

The function of the man known as the "lightning calculator," at a high rate of wages, in nine instances out of ten in this machinery age can be fulfilled by a bright boy at consistent wages, aided by a modern device which may cost anywhere from $35 to $1,000 but which probably quickly pays for itself many times over.

There are machines for adding, for multiplying, for determining elapsed time, for computing interest, for extending pay-rolls and invoices, and for almost every mathematical calculation necessary to a well organized cost department; and there are instances where by slight reapportionments of duties and the installation of mechanical devices, the burden of expense of cost finding can be cut down and the efficiency heightened.

Users of machinery do not always get out of such machinery the maximum results, for the reason, primarily, that not enough study is put upon the matter. It is a foregone conclusion that the installation of any machine in the line of mechanical brains is going to necessitate a reapportionment of duties in order to effect any saving of time or money, as the mere act of doing by a machine what the human brain formerly did will serve only to relieve the brain but will not save any great amount of time. The act of writing down figures is not in this sense considered as purely brain work; as an example take an adding machine; if a column of figures is already on paper it is indeed a poor clerk who cannot correctly foot the column mentally, in almost if not quite as quick time as he can foot it mechanically. Now the beauty of the modern wide-carriage machine is to be able to use it primarily as a listing and recording devise, to which the adding feature is but an incident; and if the system is planned with that idea in view, then the adding machine will be a big help; but if it is not intelligently planned, it may be likened to a general in command of a corporal's squad; it is good in the lesser capacity but its fullest possibilities are not exercised.

There are several mechanical arithmetical contrivances on the market that do not print or list; therefore they are brain relievers only and cannot perform any other functions; some are very wonderful indeed in executing intricate calculations involving multiplication and division, and may be made good use of in estimating departments and in numerous other capacities—such for instance as the auditing department of large railroads, where such machines are used actually by dozens and give good satisfaction; they are not however fitted for use in a cost department except as brain relievers.

There is a new billing machine about to be put on the market which is a typewriter combined with an arithmetical machine, very different from those that have been on the market for several years. This device automatically extends prices and deducts discounts, and at the same time accumulates the quantities and extensions; it will probably work into a place of value in a cost office. There is one weakness about multiplying machines that have existed in the past—they all have needed manual assistance and none have possibilities to set the multiplicand and the multiplier as the first act and let power do the rest, but with a multiplier of say four figures the contrivance must functionate one place at a time and must either be assisted to the next higher place or figure by means of the operator's hand, or the next figure must be set after the carriage has moved.

On "in and out" time reports for use on time recorders a numbering machine can be made to play an important part. There are large-sized numbering machines which have date stamps attached—the numbering feature being used to put the workmen's numbers on consecutively in large clear figures, while the dater puts the period-ending date on each card. These numbering machines perhaps do not save a large volume of time, but they make a uniform series of cards in a short space of time and they make no mistakes—which counts for considerable. By the use of certain other modern devices, the "in and out" time and the numbering machine just mentioned can be dispensed with and replaced by a form of job ticket which can be used for pay-roll computations as well as charges against individual shop-order numbers. Such a job ticket is made on the perforated-coupon plan, by means of which each separate shop order can get its proper charge and the coupons for a given shop-order number can be detached and filed under such number and become subject to ready reference. A stub containing the totals can be filed under the workman's number and held there until the payroll is made up, at which time all the cards therein can be removed and summarized on an adding machine for the pay-roll. The plan for recording the time on the coupons is to use a time stamp for the starting time and finishing time of each job during the day; the number of coupons in the strip can perhaps vary so as to fit the needs of different workmen—some may complete six jobs in a day while other men may have longer jobs and use perhaps not more than two coupons a day. When the entire day's work is recorded on the one strip it is hardly necessary to require the "in and out" time at the factory entrance or elsewhere, as the first and last time impression on the day's time report will answer the purpose.

The great bugbear of any cost system is the usually enormous amount of figuring on time tickets; it is not profitable or advisable to attempt to make book-keepers of shop hands, and if the class of help employed in a given shop is illiterate, then with the use of modern accounting devices the shop hands can in a way act as automatons and accomplish the desired results. A child can learn how to stamp with a time stamp and the average workman has no difficulty in that respect—sometimes though they learn how to abuse the stamp by unnecessarily hard blows upon it, which actions should be summarily dealt with when discovered. With a time stamp or recorder the workman has hardly to think, as it becomes purely mechanical to record the time and it lays it upon the cost department to reduce that time record to a comprehensive statement of labor values. Formerly that was a matter of considerable moment; latterly however mechanical brains can be used; there is a device for taking care of such time reports, the operator setting on it the workman's rate of pay per hour, also setting on it the starting time and the finishing time as shown on the time report, and by the turning of a wheel printing upon the coupon the number of hours and minutes elapsed and the exact money value—truly a wonderful invention. Its functions do not end there; the machine has a tape equipment upon which is recorded every time ticket computed, and when a total thereof is desired the turn of a lever prints a total of time consumed and a total of the labor cost involved. This machine in connection with the time recorder is perhaps the most important in use in a cost department; by its means the work of several clerks is accomplished by one low-priced clerk. Totals of time of a given workman for the day; totals of all workmen on a given order number; all workmen in a department or all departments in the factory can be accumulated.

There are a number of clever devices on the market for computing pay-roll extensions, and where pay-rolls are made up from "in and out" time these are labor savers; the differences between the several devices of this kind are purely mechanical, and all or nearly all perform practically the same operations. There is one pay-roll machine in particular which has the additional feature of computing elapsed time and also earnings under a premium system. This is accomplished by means of an indicator for setting the time of starting on the work and one for setting the time allowed for the job; by reference to the finishing time can then be seen, directly opposite, the amount of time elapsed and the money value at the man's rate per hour, also an additional amount equal to ½ of the time saved.

Where certain cost clerks, through constant practice, have become veritable computing machines it often happens that mechanical devices will not save those men enough time to be worth while to change the existing systems. If the lightning calculator employee can be replaced by a less expensive man and a machine, then it may be worth while. While corporations are said to have no souls, sometimes we see cases where faithful men are retained in positions for effect rather than for cause, and it may be such desired effect that will keep out the mechanical brains temporarily; but when the higher priced faithful men have passed to their reward, then the easiest way of filling the vacancy is more than likely the less expensive man and the machine with no prejudice to overcome.

JAPANESE FACTORY HANDS AND LABOR CONDITIONS.

By M. Kawara

Mr. Kawara's review of the Japanese iron industry will be well remembered, and has been widely quoted. His present topic is even more actively interesting, because so closely associated with the greatest problem perplexing Western employers.—The Editors.

SOCIAL conditions in Japan are drawing nearer to those of the West each year, bad as well as good characteristics of the nation being either consciously or unconsciously discarded. Naturally the changes are slowest in the lowest strata of society. The majority of the laboring masses are still governed by the old ideas and customs, but some workingmen are quite westernized, conspicuous among the latter being iron workers. This is very natural, since modern iron industry is strictly of western origin. The iron workers wear European clothes while in the shops, use the inch and foot or the metric system as the standard of measure, call the tools by English or French names, Japanized of course—hammer is "hama," scraper "sikarap," wrench "suppana."

The changes are not limited to superficial matters alone. The attitude of the men toward their employers is also entirely westernized, and the corresponding changes on the employers' side are also apparent. The old relation of master and servant, which works beautifully if the employer is considerate and the employed obedient, is gone, and the friction between capital and labor is well under way. We no longer see a good-hearted employer going from house to house of his employees to see if the families are well provided for, or the employed flocking to their employer's mansion to do whatever they can, not for any compensation, but simply to please their bread giver. Instead, nowadays we often hear men talk about strikes because their employer refuses to raise their wages to a reasonable amount, or because they are subjected to oppressive measures, etc., precisely in the same manner as the workingmen talk in the occidental countries.

For bringing about this hostile attitude the workingmen alone cannot be blamed; the capitalists are responsible in a large measure. The latter naturally try to get as much work as possible out of their employees at the smallest wages at which they can retain the workers.

Of course there are exceptions. Some capitalists are very considerate toward their men, notably those who own small establishments, in which all connected with the works become quite intimate. Here each party respects the interests of the other, resulting in mutual benefit. However, taken as a whole, the relation between employers and employed is far from satisfactory. Therefore, the united efforts of the latter are necessary in order to guard their interests.

The movement to organize labor associations, like those found in the Western countries, was started among the iron workers some ten years ago by men who proved later to be radical socialists. At first the movement seemed to be eminently successful, but within a year or two the enthusiasm of these leaders cooled down and, moreover, careless utterances of these men brought about the determined opposition of the government and the conservative elements of the nation. It was very unfortunate from the workingmen's standpoint that they gathered under the leadership of these men who were sure sooner or later to incur the displeasure of practically all classes. Conditions would have been quite different from what they are now, if both the workingmen and leaders had been more prudent.

The original leaders, who seem to have set themselves to this work merely to use the organizations as stepping-stones to get into the politics of the nation or, at best, to further their socialistic propaganda, began to desert the ranks of the workingmen when the latter realized the disadvantages of relying upon men who had a different end in view from that at which they themselves aimed. From this on there were many changes. Suffice to say that the percentage of men enrolled in the organization is very small, and that it is inefficient as the means of protecting and furthering their interests. There are two points to be noted in this connection: first, they exert their best efforts toward mutual assistance in cases of sickness of and accidents to their fellow-members, and establishment and improvement of co-operative stores; second, they do not meddle with politics.

The labor organizations in the West seem to be opposed to industrial schools and the apprentice system. This is not the case in Japan. Some fifty schools, training young men and boys in the arts of different trades, are receiving hearty support from all classes of people. At present men from these schools are few in number, because the schools are of recent origin. Nevertheless, they promise to furnish the best kind of help. Far the greater proportion of boys are trained by large establishments and by individual workingmen. In most factories regular courses are given. In the day time boys are assigned to simple work under the care of skilled workers, and at night lessons in mathematics, drawing, English, etc., are given. The wages paid to these lads are small, being not quite enough to support them. The individual apprentice system is quite different. A highly skilled artisan can take in boys under his exclusive care, and train them according to the ways he sees fit. He usually furnishes them food, clothes, and lodging, and even a little pocket money on holidays. Of course the wages the boys earn go into the master's pocket. When a youngster has spent several years in this way, he becomes a full-fledged artisan and can work independently.

Much has been said about the inefficiency and the lack of sense of responsibility among Japanese workingmen. As far as I can see there is no justification for the former accusation. I have seen men work both in Japan and in America, and failed to find any difference as to the quantity and quality of work done. There are several Japanese machinists in the Union Iron Works in San Francisco, California. All who have seen them work declare that they can do just as much as the average Americans. However, there is one exception—that is, the muscular strength of the Japanese is much less; hence for work that requires sheer physical strength the latter are far less efficient. As to the second point, viz: irresponsibility, I cannot say much for them. When I was working as a draftsman in a large government arsenal in Tokio, the fellows there used to pride themselves upon loafing as much as possible without being detected by the engineers in charge. Several times I saw a young man draw a line or two and no more in a whole day. In this plant it was not uncommon to find men sleeping on the bridges along the line shafting. It should not be understood, however, that such occurrences are frequent in commercial shops. In some of the latter establishments the shop organization is such that men have to work hard, and they do work hard.

What has been said is based on what I have observed among the iron workers; still, these general statements apply to all classes of working people with little if any modification. To sum up: (a), Western ideas and methods are finding their way among the Japanese workingmen, foreshadowing the troubles experienced elsewhere between labor and capital; (b), the Japanese workingman can do just as much work, if provided with proper means, except work in which physical strength is of prime importance; (c), when men are treated as men, and not merely as a sort of intelligent machine—in other words, when men are made to feel their responsibility—they perform their duties quite satisfactorily.

EDITORIAL COMMENT

The Freight-Rate Question.

THE sufficiency of existing railroad rates or the expediency of raising them, is a question upon which experts differ widely. There are few indeed, who are so strong masters of the facts and conditions that their dogmatizing on the subject would be anything but rashness. James J. Hill's achievements surely entitle him to foremost place among these few—"the greatest railway economist in the United States," a leading financial authority calls him, "whose early conceptions of cardinal principles of railroad operation have made the operation a science." Naturally, Mr. Hill's uncompromising advocacy of an immediate advance in freight rates has been widely noticed and is quoted with almost sensational effect. With Hill and Harriman—giants both in this railway world of giants—crying for the affirmative, who shall argue the negative?

But, after all, an argument is no stronger than its premises and its logic, whoever makes it, and Mr. Hill explains his position by figures and comparisons which any one may test for himself. Briefly, he states that unless the railroads "secure an advance in freight rates, they will be unable to expend the $600,000,000 or so a year for new rolling stock and facilities;" that this stoppage of outlay will react as a direct loss to manufacturers, producers of raw material, farmers, lumbermen, mechanics, laborers, and the people generally; that the railroads themselves will decay, and "all else will decay with them," for the railroads "by their large expenditures have given prosperity to the manufacturers and the people." And the advance in rates which would avert all this he says "is a mere bagatelle." It is strongly reminiscent of "all for the loss of a horseshoe nail." Recent bond sales suffice to show that railroad credit is at no such desperate ebb at present; and the things that have discredited railroads in the past have not been undercharging for freight or overpaying labor.

Now Wall Street is thoroughly familiar with the figure of the inverted pyramid, and knows better, probably, than any engineer or industrial manager how safely the enterprise of expending $600,000,000 a year could be based on "a mere bagatelle" of prospective increase in gross earnings. To an average man the position would seem unstable, and a plan affording broader foundations would appear less likely to lead to that dangerous "prosperity" of inflation which Mr. Hill himself has so keenly dissected. But perhaps the bagatelle of increased freights is intended to be larger than the term would suggest. In the case of the Pennsylvania Railroad alone, as the *Journal of Commerce* points out, it would amount to about $22,000,000 a year. If we increase the burden of transportation charges which all materials and products of husbandry and industry must bear, it can hardly fail to affect their consumption, to some extent at least— to reduce the business which producers, manufacturers, farmers, mechanics and laborers can do—the tons they can ship or the miles they can travel; and then we shall have shrinkage of railway income again in a yet more vicious form. The people are no more dependent on the railroads for prosperity than the railroads are on the people.

The natural presumption would be that an intricate structure such as the present system of freight rates, evolved over a long period of years by the constant influence and interplay of opposing forces, must be pretty near to its true balance of position. A horizontal marking up of the whole scale is manifestly a grave economic proposition. It savors strongly of those artificial operations which usually result in dislocation and greater distress.

Mr. Hill seems to feel this, and he makes certain comparisons with foreign conditions which appear to him to justify his views. American roads, he says, (the interview is signed and presumably is correctly reported) cost from one-half to one-fifth as much as those of other countries, carry nearly double the business per mile, pay double the rate of wages, and charge rates one-half to one-third as great.

Considering the enormous relief from fixed charges due to their low comparative cost, and the great advantage of more active use of the invested capital (the quicker turnover, so to speak) given by the double business, it would seem *prima facie* a fair deduction that American roads could and should pay higher wages and charge lower rates in the proportion stated, and still be at an advantage in net earnings. And we are yet more strongly inclined to this opinion when the very great difference in character of most of the service is taken into account. A heavy weight in the American average is carried by the figures for low-class, long-haul business, loaded, unloaded, and even made up into trains and handled at terminals by shippers and consignees, with a minimum of relative cost to the railroad company and a maximum of simplicity of service required from it. A very heavy factor in European business, on the contrary, is short-haul, small-load and parcel business, handled almost from door to door, with a maximum of labor and of complexity of service. Further, this business abroad is performed with a celerity and a security undreamed of here.

After all, this is the thing that shippers and receivers value—reliability and speed in the movement of freight from siding to siding or from platform to platform—from the point where the sender leaves it in the railroad's care to the point where the consignee can pick it up again. Of this, the time needed for movement over the open road is but part, and often a very small part; but this is the part upon which a wholly disproportionate amount of attention has been concentrated by American railroads. Huge locomotives and train loads permit a cost of carrying which, expressed in mills per ton mile is wonderful in its cheapness; but then we handle our magnificent cars so badly that in normal times they are not in motion on the average two days a month, and in seasons of peculiar congestion they do not total in their movement a mile an hour. The rest of the time they are standing in congested yards, delayed at transfer points, inaccessible on sidings, lost through errors, under repair because of needlessly frequent and rough handling—and meantime shippers and merchants suffer. In short, our progress is sadly unbalanced. In equipment and rolling stock it is most impressive; in permanent way it is indifferent; in efficiency of traffic management it is practically nil. The inefficiency in this department, overloaded to the breaking point by the existing car equipment, would be worse and not better if a large addition were made to the rolling stock in service, because it would increase the congestion which present systems of management create.

The extravagance and waste of average American railway management is on the dawn of correction. Some excellent work in the reduction of expense for fuel and stores and in the more economical maintenance of equipment has been begun. But in the inefficiencies of traffic management there is a field of possible savings so large that when the roads begin to realize them, raising freight rates or reduction of wages will appear insignificant in comparison. The solution of bettering the railroads' credit lies not in getting more money from their patrons or distributing less to their employees, but in saving that now lost through their own inefficiency.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE VENTILATION OF FACTORIES.

A REVIEW OF THE GENERAL PRINCIPLES AND METHODS FOR THE REMOVAL OF DUST AND FUMES.

Dr. J. S. Haldane—Royal Society of Arts.

THE removal of dust and fumes, often a most important and difficult problem in factory ventilation, was the subject of the fourth Shaw Lecture on Industrial Hygiene, delivered by Dr. J. S. Haldane before the Royal Society of Arts on February 27 and published in the *Journal* for May 22. This is a subject on which Dr. Haldane can speak with authority, on account of his connection with the work of the late Home Office Committee on Factory Ventilation. It is impossible here to reproduce the many practical illustrations he gives of the principles laid down in his paper but the following abstract giving the main points of his general review of principles and methods will be found of interest.

"Whether or not any variety of dust is known to cause dangerous effects when habitually inhaled, I think that every kind of dust produced in manufacturing process ought, as far as practicable, to be prevented, or removed from the atmosphere in which the work-people are present. The reason for this is not only that dusty air is, at the best, unpleasant to breathe, but that when dust is present the clothes, skin, and hair become very dirty, untidy, and uncomfortable. This inevitably tends to lower the social status and self-respect of work-people, if, at any rate, they have to go back to their homes in the same untidy condition. When dust and dirt cannot be avoided the provision of over-alls, or of means of washing and changing clothes on leaving work, is extremely desirable. . . .

"Apart from the reasons which I have just referred to, it is often urgently necessary, on the score of health, to prevent the inhalation of dust. Certain kinds of dust, when constantly inhaled during work, produce in time most disastrous effects, and we may pretty confidently say of every kind of dust—that it is to some extent harmful."

Of dusts which are definitely harmful, a very important class is that from the disintegration of hard stone or other material. The dust produced in mining hard rock or in stone dressing, the flint dust used in the pottery trade, the dust from dry grinding in the metal trades, and the steel dust produced in file cutting and other work are most harmful in their effects. Striking evidence of the disastrous effects of the inhalation of hard rock dust is given in a table showing the death rate of Cornish miners, 94 per cent. of whom die of lung disease at an average age of 37. Other dangerous dusts are those from poisonous materials of any kind, particularly from lead compounds. Dusts from textile materials are less serious in their effects and coal and cement dusts seem to have but little influence on the health of workers. Fumes from chemical processes and poisonous gases are always dangerous and should not be allowed to escape into the room at all.

"In many cases the best way of dealing with dust is to prevent its formation altogether. This can be effected by substituting wet for dry processes, and fortunately much of the most dangerous dust can be dealt with in this way—in particular the dust from disintegration of hard stone or steel. Thus the use of a jet of water prevents dust formation in rock-drill and other work in tin and granite mining, special rules to this effect being now in force. It is to be hoped that in all cases where dust from disintegration of hard stone, fire-clay bricks, and similar material, is apt to be inhaled, wet methods will also be adopted where possible. The substitution of wet for dry grinding, and for dressing of grindstones is another important step in the right direction, and I have little doubt that in many other dusty processes it would be practicable to use wet methods, though, unfortunately, wet processes are quite out of the question in very many cases.

"When dust formation cannot be avoided, its escape can sometimes be prevented by entirely boxing-in the dusty process. Where the dust is itself the product of the process, as in the grinding or breaking up of material, efficient boxing-in is an advantage to the process itself as well as to the persons employed in it. Where the dust is in other ways of some value, the same consideration applies. The use of dust-proof arrangements for filling and conveying dusty material, particularly where the dust is poisonous or otherwise dangerous, is a further advance in the same direction. By means of simple mechanisms for this purpose much dust-inhalation and loss of material may be prevented.

"In processes where fumes or noxious vapours are emitted closed vessels ought also to be used wherever possible, and if a closed vessel, or a boxed-in machine, is also connected with an exhaust pipe the fumes and dust are prevented from escaping at times when the vessel or machine has to be opened.

"In most cases it is unfortunately not possible either to prevent the formation of dust or to box in the dusty process completely, and the only method available is to draw away the dust by means of an air-current. There are certain general principles applicable to the removal of dust in this way. In the first place the dust ought to be removed at, or as near as possible to, the point of origin. The advantages of this are evident; by this means the dust is prevented from getting into the general atmosphere of the room and being inhaled by those present, as well as settling everywhere. A far smaller volume of air is also sufficient to remove the dust. This is important, not only from the point of view of expense, but because draughts and cold are also prevented. When dust is permitted to get into the general atmosphere of a factory, enormous volumes of air are required to carry it away, which means that equal volumes have to come in from outside, so that warming or prevention of draughts may be quite impracticable.

"A second general principle is that the air current from the source of dust to the exhaust opening should, as far as possible, envelope the source of dust, and be of sufficient velocity to carry the dust with it in spite of the ordinary slight draughts existing in the room, or produced by the dusty machine. It is unfortunate that in whatever direction an exhaust opening may point, the air entering it is sucked in from all sides. Hence the linear velocity of the draught towards the opening diminishes very rapidly with increasing distance; and at a distance of two or three feet an exhaust opening, unless very large, will fail to carry off dust efficiently, particularly from a machine which itself causes draughts. . . . An air current from an inlet can be directed from it, owing to the momentum of the moving air, but not a current to an outlet. The source of dust has therefore to be enclosed, as far as possible, by hoods or other coverings, to serve as air-guides. When a dusty machine can be enclosed on all sides, except where the material enters or leaves it, a very satisfactory result can be obtained. Where such enclosure is not possible, the best that can be done is so to arrange the inlets and outlets of air to the room that the dust is on the whole carried directly towards the outlets. A further important principle is, that as all dust tends to fall, it is often best to remove it in a downwards direction. This applies particularly in cases where the air-current carrying the dust towards the exhaust opening is very slow.

"It must not be forgotten, finally, that when exhaust ventilation is used for removing dust, provision must be made for corresponding inlet ventilation to the room, the air being warmed, if necessary. It is not uncommon to see exhaust ventilation rendered partially inoperative by failure to provide proper inlets.

"In producing an air-current along a duct we are imparting motion, and therefore energy, to a large quantity of gas. The amount of energy thus imparted—in other words the work done upon the air—varies in proportion to the mass of air moved and the square of its velocity. In the case of an air-current in a duct, however, the mass moved varies directly as the velocity. Hence the total work done will vary as the cube of the velocity of the air-current, measured at any one point in the duct. The work done on the air is also proportional to the mass of air moved multiplied by the pressure it is moved against, hence this pressure is proportional to the square of the velocity. Bearing these facts in mind we can readily understand the more important considerations relating to the proper arrangement of air-ducts.

"It is evident, in the first place, that the greater the sectional area of an air-duct is, the lower the velocity at which a current of a certain number of cubic feet per minute will pass, and consequently the less work (in proportion to the square of the velocity) will be needed to move it. There is, however, little advantage in increasing the cross-section of a duct to much more than the cross-section of the fan opening, as additional velocity would then have to be given to the air as it passed through the fan, with corresponding increase in resistance. Nor would it, as a rule, be an advantage to increase the size of the fan so as to permit of a low velocity through it, as in such a case the current is easily reversed by wind. The space occupied by the ducts and fan is also a material consideration. Any obstruction or narrowing in a duct will correspondingly increase the velocity, and therefore still more the resistance, so that all obstructions should be avoided, including those due to deposits of dust. Any sharp bend converts into heat the energy of motion possessed by the moving air, and an equivalent quantity of energy of motion has again to be communicated to the air beyond the bend. A sharp bend may thus double the resistance, and ought to be avoided if possible. A gradual bend causes much less extra resistance. A further factor in causing resistance is friction of the air along the sides of the duct. With the comparatively short and smooth ducts commonly used in factory ventilation, this factor is, however, small, and need scarcely be considered.

"Roughly speaking, the cross-section of the duct or its combined branches should be about equal to that of the fan opening; and if a centrifugal fan, capable of overcoming considerable resistance, is used, the duct may be much smaller, and the air-velocity in it much higher, than if a propeller fan is used. A propeller fan can only work against small resistance, while a centrifugal fan is adapted for much greater resistances. On the other hand, the horse-power required for the centrifugal fan is greater, in correspondence with the greater velocity of the air-current and consequent greater resistance.

"An important matter is the arrangement of branch ducts leading into the main duct connected with a fan. In exhausting dust-laden air from several dusty machines or dusty work-places, a corresponding number of branch ducts are required. If they are not properly arranged the amounts of air passing along the different branch ducts will differ considerably, so that at one place the exhaust current is too strong, and at another too weak. Unnecessary resistance may also be caused." Dr. Haldane describes experiments made by the

Home Office Committee to determine the best arrangement of branch ducts. The Committee found that "the loss of power at the junctions, and at the same time the tendency to inequality in flow through the branch ducts, may be avoided by the simple expedient of making the branch ducts join at a slant."

The concluding part of Dr. Haldane's paper deals with the relative merits of propeller and centrifugal fans for the removal of dust and fumes, and gave a number of illustrations of the application of the principles laid down to special cases. In concluding he referred particularly to the method of increasing the effectiveness of exhaust openings by blowing air towards them. Though the system involves the provision of two fans there are many cases, he thinks, in which the method could be successfully and economically used.

THE EXTENSION OF THE KAISER WILHELM CANAL.

NOTES ON THE PROPOSED ENLARGEMENTS AND THEIR ESTIMATED COST.

Engineering.

THE unexpected increase in the dimensions of ships in the last few years has made the enlargement of many canals an imperative necessity. This result of modern developments is nowhere more strikingly illustrated than in the case of the Kaiser Wilhelm Canal, which, though it has been in service only twelve years, is now much too small to accommodate the modern ships of the German merchant marine and especially the ships of the new German Navy. A project for its enlargement has recently been put forward by the Government, of which we take the following details from *Engineering* of May 29.

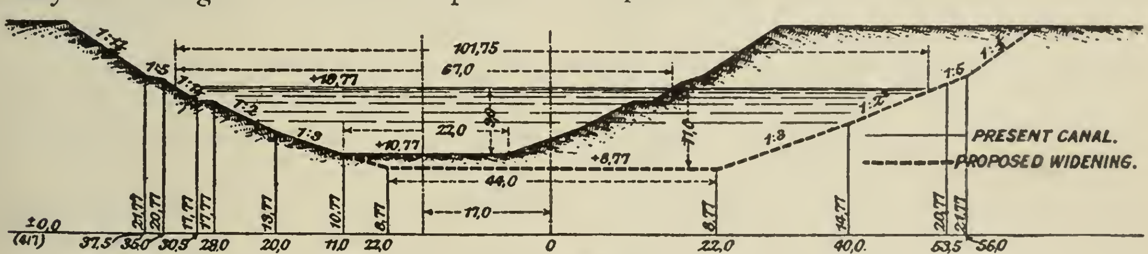
"The traffic of the canal has grown very materially during the twelve years it has been open, though not exactly on the lines anticipated, and the canal must be said to be at present taxed almost to the full of its capacity. The original calculation upon which the undertaking in question was based reckoned upon an annual traffic of 18,000 vessels, with an aggregate tonnage of 5,500,000 registered tons. The number of vessels was exceeded as early as 1896 (19,660 vessels), but, to begin with, the aggregate tonnage fell very much short of what had been expected, inasmuch as it was only 1,848,458 registered tons in 1896. Ten years after the opening of the canal (1905) the calculated tonnage was, however, not only reached, but surpassed (5,749,949 registered tons), and the number of vessels that year rose to almost twice the calculated number—viz., 33,147. Although the size of the vessels had grown about in the same proportion as their number—that is, it had nearly been doubled during those ten years—it is interesting to note that large vessels, on the whole, were rather shy of the canal, and that the traffic of deep-draught vessels has not increased at anything like the rate at which the traffic of smaller vessels grew.

"At the time of drawing up the original plan for the canal, the maximum dimensions of vessels for the Baltic trade were held to be 145 metres long, 22 metres broad, and 8.5 metres deep (477 feet by 72 feet by 28 feet). Only in odd years have there been more than fifty vessels between 26 feet and 28 feet draught. The above maximum measurements were not considered as likely to be much exceeded, and the dimensions of the locks were based upon them, inasmuch as their length was 150 metres, their breadth 25 metres, and their depth 10 metres, with the average canal water-level at Brunsbüttel (the western entrance), and with 9.5 metres at Holtenau (the eastern entrance). The present lock dimensions, it will be readily understood, are altogether inadequate. The breadth of some of the largest steamers now afloat exceeds that of the locks, which likewise— and this is of more vital importance—are incapable of accommodating the new large types of German warships.

"The extensions and alterations of the

canal comprise the construction of two new main locks, both at Brunsbüttel and at Holtenau. Local conditions and other considerations make it necessary that these new locks should be built close to the old, at Brunsbüttel on the northern, and at Holtenau on the southern side. In order to ensure a quick and safe passage for large ships at any time, it is necessary in fixing the dimensions of these two new locks to have regard to the size of vessels which in the future will require to pass the canal. The length between the gates will be 330 metres (984 feet), their breadth 45 metres (147 feet 8 inches), and their depth 13.77 metres (45 feet) below average canal water-level, which is the same as average level of the Baltic. With comparatively low-water level the locks will still have a depth of 12 metres (39 feet 4 inches). It is pointed out that the depth is of special importance at the Brunsbüttel lock, inasmuch as it, on account of its vicinity to the mouth of the Elbe, will facilitate the bringing into safety of damaged and often deep-laden vessels. The depth of the Holtenau lock might, perhaps, have been a little less, but it was deemed advisable not to make it so, considering the extent to which the canal will be deepened. The proposed dimensions of the new locks compare favourably with the locks of other large canal undertakings. Against the 330-metre length and 45-metre breadth of the new North Sea-Baltic Canal locks, those of the Panama sea-level canal are only planned at 305-metre length and 30.5-metre breadth; next come the proposed Antwerp locks, with respectively 300 and 35 metres; the proposed Wilhelmshaven locks, with 260 and 35 metres (to be widened up to 40 metres); and the proposed Bremerhaven, measuring 250 by 35 metres.

"The enlargement of the section of the canal, both as regards width and depth, will appear from the accompanying section; the depth beneath ordinary canal-level will be increased from 9 to 11 metres (29 feet 6 inches to 36 feet 1 inch), and the bottom breadth of 22 metres (72 feet), at 9 metres depth, will be increased to 44 metres at 11 metres depth, which means an increase of surface breadth from 67 to 101.75 metres (220 feet to 334 feet), and of sectional area of water from 413 to 825 square metres. These measures will allow of the high-level bridges at Grünenthal and Lewetzau being preserved, in spite of their comparatively slight foundation depth. Should a still greater depth of the canal section—say to a depth of 13.50 to 14 metres (44 feet 4 inches to 46 feet)—afterwards be decided upon, this can be brought about without a material increase in cost. This would, however, necessitate the building of two new high-level bridges, unless their foundations were carried to a sufficient depth."



PRESENT AND PROPOSED SECTIONS OF THE NORTH SEA-BALTIC CANAL.

Deviations from the present course of the canal will be necessary in only two places, where curves of small radius interfere with navigation. The total deviation will amount to about three miles. The number of passing places will be increased from eight to eleven. Four of these will be constructed as turning places, with 300 metres diameter at the bottom and 340 metres diameter at the surface. The length of the passing places will vary from 600 to 1100 metres.

"The crossings of the canal by railways and roadways comprise high-level railway crossings on the Neumünster-Heide line at Grünenthal, and the Kiel-Flensburg line at Levensau. Swing-bridge railway crossings occur at the Elmshorn-Tönder line at Taterpfahl and the Neumünster-Schleswig line at Rendsburg. Of other swing-bridge crossings there are the Westerrönfeld-Rendsburg road at Rendsburg, and the Kiel-Holtenau road at Holtenau. The railway swing-bridges are rather a serious obstacle and danger to shipping, inasmuch as the railways have the prior right of the road. Large vessels are apt to get beyond control when they have to pull up, and experience has shown that the consequences may be rather serious. The loss of time is also to be considered, and may occasionally amount to as much as half-an-hour, and there is no chance of making up for this loss of time, as there is a fixed maximum speed. It is more especially the navy that suffers from this inconvenience, and on a squadron passing through the canal the aggregate loss of time may amount to several hours. It is therefore considered necessary to make the canal and the railways entirely independent of each other, and as tunnels are not expedient, it is proposed to carry all the railways across the canal on high-level bridges, the lower edge of which will have a length of 74 metres, and a height of 42 metres (138 feet) above the level of the water. Of the present two high-level bridges, the one at Grünenthal complies with these demands, whilst the one at Levensau is only 38 metres long at the stipulated height of 42 metres. With some alterations the present Levensau bridge, however, is considered adequate for the time being. The swing-bridges at Taterpfahl and Rendsburg would in any case have to be replaced by other bridges, as the increased breadth of the canal forms a technical obstacle to their maintenance, and the building of high-level bridges has been decided upon at both places. At Taterpfahl the natural conditions do not present any difficulties, only the land is very flat, and this will necessitate the removal of the stations on either side to a place further distant from the canal: on the south side about 2 miles, and on the north side about 1½ miles, as the railway will pass the level of the present stations at a height of respectively 20 and 18 metres. Whilst the number of trains per day is about 25 at Taterpfahl it rises to 65 trains crossing the canal at Rendsburg, which fact makes a high-level bridge there still more desirable. The bridge will be located in the Osterrönfeld district, and the line will then be carried in a loop to the present railway station at Rendsburg, which there will be no necessity to remove. The present Osterrönfeld railway station will have to be abolished, and in its place a ferry across the canal will be established, which will shorten the way to the Rendsburg railway station. The ascent to the high-level bridge will extend over some 6 or 7 miles on each side, on account of the low-lying land; the portions nearest the bridge will be constructed on iron viaducts."

Another high-level bridge will be built at Holtenau and a swing bridge at Rendsburg, the canal here having the prior right of way. Other alterations and new structures made necessary by the widening of the canal include the rebuilding of thirteen locks, the relocation of seven loading places, an extension to Kiel harbor, and the removal or enlargement of several naval and industrial establishments.

"The cost is calculated at 221,000,000 marks, or about 11,050,000*l.* It has been objected that a great part—in fact, the greater part—of this large sum could have been saved had the canal been planned originally on lines similar to those now adopted; but this does not hold good. The saving in that case might have amounted to 2,000,000*l.*, or, perhaps, 2,500,000*l.*, so that the canal, if built in the first instance with the dimensions which are now deemed necessary, would have cost some 8,500,000*l.* more than was actually the case. As the canal, even if built on those larger lines, would hardly have yielded a materially bigger revenue than has been the case, the interest on the increase of the original cost during the fifteen years that have elapsed since its completion would have swollen the cost by another 5,000,000*l.*, so that the present extension in reality means a very considerable saving, of more than 2,000,000*l.*

"The total cost of the proposed extension amounts, as already stated, to about

11,050,000*l.*, to which may be added an additional item of 50,000*l.* for fortification work. It is proposed to raise the necessary funds by loan. The increase in the annual working expenses of the canal, after the extension, is not expected to exceed 20,000*l.*, and this sum is about covered by the surplus of the present revenue, reckoning the future working expenses. It is calculated that the extension can be completed in the course of seven or eight years, and whilst the work proceeds care will be taken to subject the traffic to as few interruptions as possible."

The estimated cost is distributed as follows: acquirement of land (2300 hectares), 560,000*l.*; excavation (99,570,000 cubic metres), 3,990,000*l.*; protection to the canal sides, 235,000*l.*; harbour and lock construction, 3,437,500*l.*; bridges and auxiliary structures, 1,745,000*l.*; buildings, 30,000*l.*; shops, docks, boats, etc., 75,000*l.*; engineering and administration, 125,000*l.*; workmen's barracks, sick funds, insurance, etc., 60,000*l.*; sundries, 692,500*l.* These are the principal items in the cost sheet. The remainder of the total estimated cost is intended to cover unforeseen contingencies.

THE FIXATION OF ATMOSPHERIC NITROGEN.

NOTES ON THE PRODUCTION AND UTILIZATION OF CALCIUM CYANAMIDE.

Dr. Albert Frank—The Faraday Society—Engineering.

WE have several times drawn attention in these columns to advances in processes for the fixation of atmospheric nitrogen, the last occasion being some two years ago, when we reviewed a paper by Prof. K. Birkeland, read before the Faraday Society, on the production of artificial nitrates by electricity. On June 9 last, a paper on another process, the fixation of nitrogen in calcium cyanamide, was read before the same society by Dr. Albert Frank of Berlin. This process has within recent years become of great economic importance and has taken rank among the most successful solutions of the problem. We take the following details of Dr. Frank's paper from an editorial review in *Engineering* for June 12.

"The process, on which Dr. A. Frank lectured, has been worked out since 1894, when Thomas L. Willson and Bullier and Moissan first made calcium carbide on a large scale; by Professor Adolph Frank, the lecturer's father; by the lecturer, and Dr. N. Caro. Frank and Caro, in 1895, first tried to fix the nitrogen by calcium (or barium carbide) mixed with sodium carbonate; the mixture absorbed nitrogen—isolated from the air—when heated up to 700 or 800 deg. Cent. They hoped thus to produce barium cyanide—$Ba\ (CN)_2$, from which they wished to prepare potassium cyanide, wanted for the extraction of gold, and other compounds. They noticed that part of the nitrogen was, indeed, bound as cyanide, but another part in the more complex form of barium cyanamide ($Ba\ CN_2$), the latter reaction being $Ba\ C_2 + 2\ N = Ba\ CN_2 + C$; that is, the carbide yields some cyanamide and, further, carbon. The ratio of the two products, cyanide and cyanamide, was about 2 : 3, 30 per cent. of the former and 45 of the latter being produced, the remainder appearing as carbon and barium oxide. Why the barium cyanamide with the formula $Ba\ CN_2$ should be more complex than the cyanide with the formula $Ba\ (CN)_2$ may be less manifest to the engineer than it is to the chemist. The lecturer and Caro subsequently observed that calcium carbide—of course, a cheaper product than barium carbide, as its raw material is limestone, in addition to coal—would, without any additional flux, yield nothing but calcium cyanamide. That was a step in advance, because the separation of the cyanide—for which we possess other sources—from the cyanamide would have been awkward. Then Messrs. Frank and Caro, together with Messrs. Siemens and Halske, and the Deutsche Bank, of Berlin, founded the Cyanid Gesselschaft, of Berlin, and the chief question was to utilise the new product, the calcium cyanamide, or Kalkstickstoff, for which recently the term 'nitrolim' has become customary.

"As the cyanamide yields ammonia when treated with water, one application was at once found. The process, Dr. Frank explained, was technically carried out by spreading the nitrolim on trays and passing steam up the towers in which the trays were fixed, the one above the other; the resulting ammonia was absorbed by sulphuric acid to form ammonium sulphate. The same decomposition into ammonia and calcium carbonate (limestone) took place very slowly in the soil; the ammonia was absorbed and bound by the mould, and not likely to be washed out by rains. The nitrolim thus proved a valuable fertiliser, and one, moreover, which had after-effects, the second crops profiting from the nitrogen not absorbed by the first. . .

"The other applications, Dr. Frank continued, were not less important. By fusing the cyanamide with suitable fluxes, a product known as 'surrogate,' and containing 25 per cent. of cyanide of potassium, was obtained; this product could be prepared on the spot for ore extraction. The cyanamide was also a raw material for many chemical products, including prussiate of potash, urea, the guanidines, and dicyandiamide $(CN_2H_2)_2$. The latter had proved a good 'deterrent' for lowering the temperature of combustion of high explosives; it liberated its 66.6 per cent. of nitrogen when burned together with cordite and smokeless powders, diminished the corrosion of the barrels, and suppressed the flash at the nozzle. This statement was confirmed by Mr. Walter Reid, F.I.C., of London, who has investigated this effect, and who pointed out how remarkable it was that the same apparently inert nitrogen which was the active constituent of so many explosives should also furnish us with compounds which restrained the high temperatures accompanying these decompositions. The dicyandiamide was, in fact, almost too effective in retarding explosions. Another application of interest to the engineer, mentioned by Dr. Frank, was the use of 'ferrodur,' a mixture of calcium cyanamide and certain fluxes for case-hardening and tempering iron and steel; the hardening penetrated to an extraordinary depth.

"The calcium cyanamide, as turned out of the furnace, is a substance looking in lumps like a slate-coloured limestone. It is ground up to a powder, and transported in sacks lined with paper, to keep out the moisture, which would make it expand without causing any loss of nitrogen, however. Crude nitrolim contained from 57 to 63 per cent. of pure cyanamide, as much as ammonium sulphate, in addition to 20 per cent. of lime, 14 per cent. of carbon, and 8 per cent. of silica, iron, and alumina. About the manufacture, Dr. Frank could, unfortunately, not give much information of technical value; he hoped to do so in a few months. The carbide coming from the electric furnaces was transported over to the cyanamide furnaces, in which it was heated, by gas or electricity; up to 800 deg. or 1000 deg. Cent. in an atmosphere of nitrogen, until the absorption of nitrogen, as controlled by the gas-meters, had ceased. The hard cake was then withdrawn, cooled under exclusion of the air, and ground. The gas furnaces used at the original works, at Piano d'Orta, in Italy, were horizontally arranged. The newer furnaces were vertical. The impressive photographs of the Odda works, exhibited by Mr. Cottrell, which had just been opened to turn out 12,500 tons of nitrolim per year (to be raised to 50,000 tons), showed 180 of these vertical cylindrical furnaces arranged in rows, and resting on brickwork pillars; the charging and discharging was done from overhead travellers. All this, we should think, must involve a good deal of labour. The nitrogen was either produced by the Linde process of distilling liquid air, when a nitrogen of 99.8 per cent. was obtained, or by passing air through retort-ovens charged with granulated copper; the nitrogen was equally pure, and the resulting copper oxide was afterwards reduced in the same ovens.

"Most carbide works obtained at present 2 tons of calcium carbide per kilowatt-year, and those 2 tons would bind 500 kilogrammes of nitrogen; 2 kilowatts, or 2⅔ horse-power, were hence required per year for fixing 1 ton of nitrogen by the Frank-Caro process, and ⅓ horse-power more had to be allowed for the heating, grinding, and other operations. The price of nitrolim was at present, in Germany, 1.12 marks, against 1.50 marks for Chili saltpetre; and Dr. Frank understood that the same price would be charged in England. We presume that these figures stand for 1 kilogramme of fixed nitrogen. As a fertiliser, nitrolim was about 10 per cent. cheaper than sulphate of ammonia, basing the comparison on the contents of available nitrogen. Nitrolim might be produced with less pure raw material than we needed for the calcium carbide which was to be transformed into acetylene; but equally pure materials are being used, because the yield of carbide would otherwise be impaired. It has long been attempted to carry the carbide and the nitrolim processes out in one operation, but success has not been attained. The views of the Oddo Works exhibited showed that the carbide furnaces adjoined the lime-kilns, 60 feet in height; then came the crushing-houses for the carbide, the crushing-houses for the nitrolim, the nitrolim furnaces, and the storage-bins for the nitrolim, 300 feet long, 50 feet in height. The other works were arranged on similar plans. The North-Western Cyanamide Company was established in 1906; the Sun Gas Company, now known as the Alby United Carbide Factories, and their directors, Mr. Albert Vickers, Sir Vincent Caillard, and Mr. A. E. Barton, took a leading part in it. The first cyanamide works were started two and a half years ago at Piano d'Orta, Italy, in connection with the calcium carbide works of Mr. Morani and the Società Generale per la Cianamide, of Rome. This company was now utilising large water-power also at Terni and at San Michel in the Val d'Aosta. It was water-power also at Odda, in Switzerland, and on the Niagara, in the Dalmatian works (at Sebenico, at Fiume, and at Almissa, 50,000 horse-power projected); at the Notre Dame de Briançon in Haute Savoie, opened six months ago (4000 tons of nitrolim annually); at Bromberg, in Eastern Germany; and on the Alz river, in Bavaria, where the Badische Anilin- und Sodafabrik also make nitric acid by their own electric furnaces. At Brühl, on the Rhine, the power is derived from the local lignite deposits.

"We thus see that many thousand horse-power are at present utilised in this industry, and much larger plants are rising for the same object of fixing the atmospheric nitrogen by the various processes of Birkeland and Eyde, of the Badische Anilin- und Sodafabrik, of Kowalski and Moscicki, Guye, Frank and Caro and others. Most of the fundamental facts underlying the process were understood a hundred years ago; their industrial application forms one of the most remarkable achievements of the last decade."

THE ECONOMICS OF METALLIC FILAMENT LAMPS.

A DISCUSSION OF THEIR ECONOMIC SIGNIFICANCE FROM THE STANDPOINT OF BOTH CONSUMER AND SUPPLIER OF ELECTRICAL ENERGY.

Engineering.

THE probable effect of the general introduction of the high-efficiency metallic-filament incandescent lamp on the electric-lighting industry is a subject to which a great deal of attention is being given in England. We present below a full abstract of an editorial discussion in *Engineering* for May 22, which gives a very clear and concise account of the factors in the problem.

"The introduction of the metallic filament lamp, with its high efficiency and other characteristics, is a matter of no little significance, regarded from the standpoint either of consumers or suppliers of electricity. There are at present on the market several types of metallic and other high-efficiency lamps, but two only as yet have obtained a really firm footing. These are the tantalum lamp and the osram lamp, the former having a filament manufactured from the metal tantalum, and the latter provided with a filament of tungsten. The two lamps have many features in common, although presenting individual peculiarities of an important nature. Both have an efficiency of, at least from two to three times that of the carbon lamp, with a useful life of about as long. Both are fragile, each in its own manner and degree, but neither having anything like the general robustness of the familiar carbon lamp. The peculiar weakness of the tantalum lamp has so far been the briefness of its life on alternating-current circuits, while the tungsten lamp could only be used with the bulb hanging vertically downwards. The makers of each type, however, now claim to produce lamps in which these defects are overcome, and no doubt further improvements will in due course be effected.

"The tantalum lamp, when new, consumes about 1.7 watts per British candle-power, and has, according to the makers' statement, a useful life of 800 hours, the useful life being taken as the period elapsing before the light is reduced by 20 per cent. The life of a carbon lamp is about the same, and it has a greater prospect of surviving to the normal end of its days; but its consumption is at least 3½ watts per candle, or more than double that of the tantalum lamp. The tungsten lamp is stated to consume 1.25 watts per British candle-power, and to burn about 1000 hours, with a reduction of efficiency of only 5 per cent. It is undoubtedly a frail lamp, but no other type can show an efficiency so high or sustained.

"From independent reports made recently upon osram lamps, supplied by the General Electric Company, Limited, of London, we notice that the watts consumed per mean hemispherical candle-power averaged distinctly less than the figure claimed above, and, in fact, did not attain this figure at the end of 1000 hours, in the case of many of the lamps tested. They were run on a commercial alternating-current circuit, with a voltage variation of 3 per cent. on either side of the mean, and five lamps out of a dozen lasted out the whole test of 2000 hours, none consuming then as much as 1.5 watts per candle. In another test of a dozen lamps, by a different authority, the efficiency was fractionally less. Two lamps failed at 700 hours, one at 2700 hours, and the remaining nine were still running when the test terminated, after 3350 hours. After 2700 hours the average consumption per candle-power was below 2 watts. The voltage during the test was maintained constant at 112 volts. As regards first cost, the present retail price of a tungsten lamp is about 4s., while the tantalum lamp costs 2s. 6d., and a good carbon lamp can be got for 1s.

"Were the new lamps strictly comparable with the ordinary carbon lamp, the latter would be at once driven from the market, in spite of its cheapness, for it could not hope to compete with lamps consuming half or a third the amount of current for the same amount of light. But, in addition to having the drawbacks we have already noted, the metallic lamps are at a serious practical disadvantage. From the nature of things, their filaments are of high conductivity, and must therefore be excessively long and thin to work upon even the lowest of commercial voltages. This not only favours fragility, but renders lamps of low power almost impossible to make. Moreover, the highest terminal pressure that can as yet be used across a single lamp of reasonable power is 130 volts for tungsten and 160 volts for tantalum, so that on most supply circuits in this country it is necessary to run two lamps in series. This involves carefully grading the lamps, for their life is very short under these conditions unless the resistances of both are equal. The General Electric Company have, however, recently put on the market high-power osram lamps designed for burning on pressures up to 260 volts, which cover every lighting circuit in the country.

"The consumer, then, is generally compelled to substitute two metallic lamps at a point in place of one carbon lamp. This means that he will get probably two or three times the light he previously had, and though it is far cheaper per candle-power, the total bill will be pretty much as before. If he wants the extra light, well and good; but it may be unnecessary, and even embarrassing to him, although he has obtained it for nothing. In places where two separate lights may be controlled by one switch, by means of a slight rearrangement of wiring, two carbon lamps in parallel may be replaced by a pair of metal lamps in series, and the full value of their efficiency obtained. Where the system of supply is alternating, the obvious course is to install a small auto-transformer, and reduce the voltage of the whole house to what is suitable for the particular lamps selected. There will be slight transformer losses, much of which, moreover, will be going on for the whole of the 24 hours, but the current wasted will be very small in comparison with that saved by the new lamps. For tungsten lamps the secondary pressure of the transformer may well be as low as 25 volts, which would allow the use of comparatively robust lamps of very high efficiency, and in units as low as 10 and 16 candle-power.

"Auto-transformers for use with metallic filament lamps are now being made in thousands. They should be so designed that the iron losses, which are going on all the time, should be kept low. and in practice need not exceed 5 watts on a 300-watt transformer, or 10 watts on a transformer of an output of 750 watts. The insignificance of this will be realised when it is remembered that a 16-candle-power carbon lamp consumes something like 60 watts. To avoid the iron losses, such as they are, it is, of course, possible to switch off the transformer when no lamps are needed. In fact, devices have been invented for automatically switching the transformer out with the last lamp, and in again with the first. Such elaborations show a very much exaggerated idea of the losses due to the transformer, which, as a matter of fact, are so small that frequently the current is not sufficient to operate the meter, and therefore never gets charged to the consumer at all.

"We have so far been considering the question of high-efficiency lamps from the consumers' point of view. But it cannot be gainsaid that their general use will seriously affect the business of electricity supply. We may say at once that, arguing from either history, analogy, or common-sense, the ultimate effect of their introduction must be to benefit the industry, although the immediate future may give rise to anxiety. The consumer only uses metallic lamps because he gets some advantage from so doing. Now his satisfaction may arise from one of two causes: either he has got the same light as before for less money, or he has got more light for the same money. Whichever of these conditions occurs, the supply company appears to come off badly, because even in the second case a greater proportion of the annual expenditure on lighting will be diverted into the lampmaker's pocket; while if the total expenditure is less than previously, and the lamps cost more, it is evident that the supply company must suffer even more. Of course, the satisfaction of this consumer with the results of the new lamps may reasonably be expected to cause others to take a supply of current, and thus the output of the station may be maintained. This, however, is not necessarily a benefit to the undertaking. Each unit costs just as much to generate whether it is consumed by one man or shared between a dozen, but in the latter case the price charged for it has to carry the charges on mains, meters, etc., required to give the supply to the eleven others. This may easily swamp any profit earned when the supply was taken by a single consumer.

"The greatest hope of the central-station engineers is that the cheapness of lighting by means of the metal lamps may induce customers to seek advantage rather in the increased quantity of light they may obtain for the same money as before than in the reduction of their current bills. The appetite for artificial light is one that grows by what it feeds on, as is proved by the continuously higher standard of illumination desired, or even considered essential. The lighting considered adequate a quarter of a century ago would not be tolerated today for a moment, and there is probably plenty of scope for increased illumination in houses and shops which have up to the present been reasonably satisfied with a camparatively few carbon lamps. In fact, the possibility of better light at equal cost is bound to create a demand for it, and the fact that the new lamps are of high individual power, and have frequently to be duplicated, will tend to foster the demand by accustoming customers to brilliant lighting.

"This is the brighter side of the picture, but the alternative has always to be reckoned with. There is no doubt that the lamp makers will very soon find some way of manufacturing lamps of smaller power that will burn singly on high voltages, and in certain districts and among certain classes of consumers the introduction of such lamps is bound to reduce the demand for current per house. Thus small consumers, who are now barely profitable to the undertaking, will be turned into sources of positive loss, because of the capital charges in connecting them to the station. Although we believe such cases will be few and transient, they must be dealt with, or the supply authorities must get into financial difficulties. Practically the only remedy is to raise the price of current or adopt some method of charging which will make every consumer bear his fair share of the costs of supply. Whichever one of these remedies is adopted, the consumer has no just cause of complaint, for he cannot expect to be supplied at a loss to the undertaking, and will certainly be getting better value for his money."

INDUSTRIAL LEGISLATION IN FRANCE.

A DISCUSSION OF THE ECONOMIC EFFECTS OF RECENTLY ENACTED AND PROJECTED STATUTES.

René Duchemin—Le Génie Civil.

WE have referred more than once in these columns to the extent to which the Socialist and Labor representatives in the Chamber of Deputies dictate the policy of the French Government on industrial matters. Their following in the country is much too strong to be disregarded by a Government whose position is never very secure and much ill-considered and pernicious legislation has been the price of their support. We have already outlined the policy of railway nationalization and the effects of the introduction of the eight-hour day in Government works. In the following short abstract of an interesting article by M René Duchemin in *Le Génie Civil* for May 9, are discussed the burdens imposed on French industry by the more recently enacted and projected social laws.

M. Duchemin's discussion is concerned with the workmen's compensation law of 1898, modified in 1902, 1905 and 1906, and the law of 1906 which instituted a weekly day of rest, as statutes already in operation; and with the projected statutes covering compensation for occupational diseases, and workmen's pensions, both of which have reached an advanced stage. He proposes to discover the actual burdens which these laws have placed on the employers of labor, taking as a basis for his calculations an establishment employing 100 workmen per 24 hours, in which the capital invested is a million francs, and in which there are average conditions of danger to workmen.

First, as to the law covering compensation for accidents. The premiums charged by the companies engaged in the accident insurance business vary from 0.6 to 12 per cent. of the pay roll in various classes of works. It is probable that 4 per cent. is rather under than above the average. On this assumption and taking the average wage as 4 fr. 50 per day, the charge for accident insurance for 100 men amounts, on the average, to not less than 18 francs per day, or 6,300 francs for a year of 350 days. These figures are likely to be increased largely in the near future, because the insurance companies have found that the premiums charged are not sufficient to cover their losses, on account of the abuses which are possible under the administration of the law of 1898. It is a common practice for workmen to make a comparatively insignificant accident the excuse for a long period of idleness. It is easy for them to find doctors, of a class who practically live by such practice, who will give them certificates of incapacity almost as long as desired in return for the opportunity of charging for visits. There is also a tendency on the part of the commissions to be very generous in awarding compensation and it is not an uncommon thing for a workman who has been awarded compensation for permanent disability to remove to a distant part of the country and secure other employment.

The law making a weekly day of rest obligatory recognizes two classes of establishments, those which are permitted to run seven days in the week, and those which have to close down on Sunday. The first class comprise those power using works in which fires have to be kept up continuously. In their case the law has created a new expense in that for one day per week they are obliged to hire a supplementary force of men equal in number to one-seventh of their regular workmen, with additional foremen and superintendents. This expense in itself would not be very great but in nearly every case the regular employees, whose weekly wage the law reduced by one-seventh, demanded and obtained increased pay. In this they were perfectly justified by their necessities but the increase in wages has added greatly to the expenses of the employers. The demand for increased wages could be met in two ways: by raising wages by one-seventh and reducing the number of workmen, and consequently production, in the same proportion; or, keeping production constant, by employing a supplementary force for the day of rest and besides raising the wages of the regular workmen by one-seventh. In the first case, the labor charge remained constant but the fixed charges would increase by an amount which would vary in different industries. In the second case, however, it is apparent that the labor cost would increase one-seventh; that is, in the case we are considering, by 64 francs per day or 22,400 francs per year of 350 days.

In the case of works which are obliged to close down completely one day per week, production could be maintained only by increase in the plant, and consequently in the capital invested. M. Duchemin estimates the annual increase in capital charges, for the case under consideration, at 7,150 francs, which, together with the increase in labor cost, makes a total additional expense of 29,550 francs.

The two laws already in operation, then, mean increases in annual expense of 28,700 francs in the case of works allowed to run seven days in the week, and 35,850 francs in the case of establishments which have to close down entirely one day out of the seven. These amounts represent, respectively, 2.8 and 3.58 per cent. of the invested capital.

As for the proposed legislation mentioned above, the law covering compensation for sickness proposes to establish two classes of indemnity, the first for occupational illnesses of more than thirty days' duration, and the second, for illnesses of any kind whatever lasting less than thirty days. The burden of the first class falls entirely on the employers; in the second, they are responsible only for that part of the illness which may be considered occupational, the workman contributing the rest. The administration of a law of this kind is bound to be unsatisfactory. Notwithstanding the elaborate machinery proposed to overcome the many difficulties that obviously must arise, it is probable that even more serious abuses than now flourish under the law regarding compensation for accidents will be widely practised. Under the circumstances it may be expected that the companies who go into the sickness insurance business will make their rates at least twice as high for this class of insurance as for accident insurance. This will mean that the employer of 100 men at an average wage of 4 fr. 50 per day will be obliged to pay 12,600 francs in sickness insurance premiums per year of 350 days.

The workmen's pension statute which has reached the Senate places the obligation of providing the funds for this purpose on the employers, the workmen and the State. It is proposed to give every workman in any class of employment, who has reached the age of 60 and has worked for at least 30 years, a life annuity of 360 francs. The employers set aside for this purpose 2 per cent. of the pay roll and the same percentage of his salary is provided by the workman, the State making up the rest. It is apparent that the employer whose case we are considering will have to lay aside 9 francs per day for this purpose, or a total of 3,150 francs per year of 350 days.

The total of the charges imposed on the employer by the two laws already in force and by the proposed legislation if it should finally be enacted amounts, therefore to 44,450 francs for works running continuously, and 51,500 for works shut down on Sundays. These totals represent 4.45 and 5.16 per cent. of the invested capital and they are worth careful study not only as burdens on individuals but also for the consequences they involve. M. Duchemin is in thorough sympathy with the principle of all laws designed to improve the condition of the working classes but, he says, in the elaboration of social laws the utmost precautions must be taken to prevent the impairment of the vitality of the nation, which depends to a large extent on its industries. Before passing additional laws it is necessary that Parliament should make a full and impartial investigation in order to assure itself that the French industries will be able to exist under the burdens which are constantly being added to the heavy load they already carry.

THE CO-OPERATIVE METHOD OF TRAINING ENGINEERS.

A GENERAL OUTLINE OF A PROPOSED SIX-YEAR CO-OPERATIVE COURSE IN ELECTRICAL ENGINEERING.

Magnus W. Alexander—American Institute of Electrical Engineers.

AT the recent Annual Convention of the American Institute of Electrical Engineers an interesting discussion of the co-operative system of engineering education was given by Mr. Magnus W. Alexander. For a number of years Mr. Alexander has been in close touch with the graduate apprenticeship course at the Lynn works of the General Electric Company and he has had abundant opportunity to study at close range the results of a well conceived and well conducted student course of recognized efficiency. He has come to the conclusion that, while the system has been successful in turning out many high-class engineers, the combination of four years mental activity in college with two subsequent years of shop work is not the most effective method of training, since it fails to give that insight into the practical side of electrical engineering and into the proper relation of the economic forces of an industrial organization which is demanded of the leaders in the industrial field. He considers the best solution of the difficult problem of technical education to lie in the co-operative system. We quote at length from his paper:

"A serious study of the situation has led me to believe that the best engineering education can be obtained under a plan which provides that the teaching of the theory and practice should go hand in hand, and, so far as practicable, successive steps in the one should be based on similar advances made in the other, at such intervals as to permit of the most advantageous interplay of the two; and further, that the colleges devote their whole time to the teaching of the theory for which they are so eminently adapted, leaving it to real workshops to initiate the student into practical work, for which they in turn are best equipped. From an educational standpoint, this plan should prove efficacious, for mental conception of any activity is facilitated by the physical perception of a given process, as illustrated in the whole development of the human being; and on the other hand, mental visions are more firmly clinched by concrete application. Moreover, under such a plan, the freedom enjoyed by students during the college career is happily interrupted by the stern discipline that must prevail in a business organization; the advantage of this college freedom in the development of the young man's character, in the spreading of his wings, so to speak, is not lost, but his freedom is regulated by frequently recurring intervals of discipline in the factory, so that he may be prevented from soaring to the skies in his fanciful ideas engendered by his personal irresponsibility and after four years find himself all too rudely pulled back to earth by the stern call of practical life with its demand for coöperation of all forces. This plan also trains and develops the young man in the very life to which he will devote his future efforts and gives him the love for it, which, after all, is necessary for his success. Economically this coöperative education is sound in principle, in that it will give to the industries engineers who are known to be capable of assuming responsibility and can therefore be placed in positions of leadership. An arrangement of this kind, carrying with it financial remuneration during a part of the time, will attract to engineering work young men who are mentally and physically adapted to it but who at the present time do not enter college for financial reasons or for lack of appreciation of the value of higher education.

"After passing a satisfactory educational and practical test, the young man begins a co-operative course of six years, corresponding to the six years at present occupied by the engineering college education and the factory student course. Under either plan, therefore, the junior engineer will start his life's work after the same length of preparation. The plan which I have in mind provides that the first five years be spent in alternating periods at the college and factory, leaving the sixth year to be devoted entirely to college work. Under this arrangement, co-operative students will be taught in separate classes for the first five years at college, but in their senior year, they may be merged with the regular seniors. The advantage of the latter provision lies in the opportunity which it gives to the engineering apprentice for uninterrupted attention to his thesis and original research work and for forming wider college associations by coming in contact with the larger body of regular college men. This plan has an economic value to the college and places both classes of college students on the same plane with regard to their final examinations and the attainment of their college degrees. The fact that the last year is spent away from the factory will strongly appeal to manufacturers in that those engineering apprentices who upon completion of the coöperative course enter the engineering staff of competing firms will not possess the data relating to the latest developments and experiments. For myself, I rather believe that the last year at college will be interpreted by most students as a leave of absence at the expiration of which they will gladly return to the establishment which made it possible for them to receive an engineering training, and which in turn will willingly offer adequate inducements to secure the services of those with whose special aptitudes it is familiar.

"As to the length of the alternating periods during the first five years of the course, extended experience alone will be able to determine the most efficacious arrangement. We may in the meantime, however, consider various proposals, and, by the process of elimination, narrow our consideration down to the few which in the light of logical reasoning might appeal as efficient. The length of the alternating period is a very important element in this plan, for too long or too short a time may defeat the very objects which the coöperative course seeks to accomplish. In the light of the aims of the course previously advanced, short periods seem to recommend themselves to us. A year or even six months spent alternatingly at college and at the factory would, I think, fail to give that close coördination of theory and practice that is an essential feature of the plan; nor would it establish that balance between the college freedom and the factory discipline which has already been referred to as very desirable. Short periods, on the other hand, will develop that facility in the young man's physical and mental make-up that will enable him to adjust himself quickly to the interacting influence of the college and the factory. The engineering apprentice should enter upon his factory work as a college boy with all the mental alertness and the inquiring mind fostered by the college; and he should return to the college as an industrial worker with the physical energy and the determined spirit of achievement that will be developed in a hustling factory organization. The attainment of these characteristics will to a large degree determine the success of the plan. Alternating periods of a day or even a week, to take the other extreme, might keep the young man's mind in a rather chaotic state, might not give the seed sown in the class room and factory, respectively, a fair chance to take root. Such time arrangement, moreover, would seriously interfere with the best economy at the factory, and largely forfeit that sympathetic interest of the shop foremen and workmen which seems to me not only desirable but decidedly necessary. Periods of such short duration would prevent also the complete carrying out by the same men of many pieces of work which should form part of their practical education. The finishing of such work by another set of men might often entail loss of time and even spoil the work itself.

"As already stated, any estimate arrived at now in regard to the length of alternating periods must be looked upon as experimental; different factory conditions might lead to different conclusions. Personally, I believe in the efficacy of an arrangement under which the periods increase in duration from the first toward the last year of the course, beginning perhaps with alternations of four or five weeks' duration and ending with time elements of college semesters. In that way, all the advantages of the coöperative course would be emphasized strongly at the beginning when they are of determining influence, and the economic consideration of the college and the factory would receive growing attention in latter years as justified by the increasing importance of the work. An important advantage under a system of alternating periods lies in the fact that one set of students can work in the shop while the other set is engaged at college, and vice versa, thereby keeping the educational and physical equipment employed practically at all times. This plan, of course, presupposes that during the college summer vacations, all engineering apprentices will be utilized at the factory, one-half of them during the first part of the summer with a vacation following during the latter part, and the other half enjoying a rest at the close of the college year and entering upon practical work again during the middle of the summer. . . . .

"The administration of the coöperative course would involve the appointment of a supervisory board with representation from each institution. This board would work out and supervise the details of the course of study both at the college and at the factory, and have general charge of the social and cultural needs of engineering apprentices. It would be an interesting matter to lay out a course of study which would cover the present four years' college course and at the same time lay particular stress on those subjects that may be classed under the general head of applied economics. In view of the elimination from the college course of most of the time now devoted to shop practice, mechanical drawing, and electrical testing, to which subjects the factory will give particular attention, and also on the assumption that the coördinated practical work in the shop will make it possible to cover more ground at college in a given time, it would seem that the present four years' college program could be very nearly covered in the first five years of the coöperative course. The sixth year, which is entirely spent at college, might, therefore, be devoted to thesis and research work and to special lectures both by the college instructors and by men of affairs in practical life on such subjects as business law and business organization, cost-keeping and factory accounting, the economics of production and methods of equipping and laying out of manufacturing establishments. Seminars for coöperative students in these latter subjects and in many more of a similar character which will take the place of some of the regular fourth year subjects already covered, will prove most interesting and instructive, because practical, and the presentation and discussion of such matters by men of affairs will bring the latter into contact with the student body to the advantage of both. The supervisory board will also from time to time confer and advise with the officers of the college and the industrial establishment as to their respective work, but they shall have no authority or responsibility in regard to the work of either as long as the course is carried out in conformity with the general plan approved by both institutions. . . . .

"Manufacturers are agreed as to the advantage of interweaving theory and practice in the training of engineers, and many educators are looking in the same direction for an advance in engineering education. It is significant that a technological college of the very first rank has recently expressed willingness to establish a coöperative electrical engineering course along the lines which I have set forth in this paper, and there is good reason to believe that a very prominent concern manufacturing electrical apparatus will soon join in such an undertaking."

COAL DUST AS A FACTOR IN MINE EXPLOSIONS.

A SUMMARY OF PRESENT KNOWLEDGE OF THE PHENOMENA OF DUST EXPLOSIONS.

Dr. Henry H. Payne—Coal Mining Institute.

AT the June meeting of the Coal Mining Institute of America a valuable paper on the subject of mine dust as a factor in coal mine explosions was read by Dr. Henry H. Payne. Dr. Payne is in a position to speak authoritatively on the phenomena of coal mine explosions from his own experience alone, but his paper is made doubly valuable by the fact that it presents a concise review of the more important publications on the subject and a summary of the conclusions reached in the extensive researches on the conditions determining the elements entering into and controlling the inflammability of various dusts, which have been made in England, France and Germany. In conclusion he sums up what his own experience and his wide reading lead him to believe are the established facts and the most credible theories. This part of his paper we reprint in full from *The Industrial World* of June 29.

"Granting that secondary explosions may be propagated indefinitely by the larger sizes, only coal dust which will pass through a No. 100 screen is capable of initial or primary explosion.

"Such dust, after having been subjected to ordinary atmospheric air for only a few hours, becomes largely decomposed and exists as a bubble of constituent gases whose film is composed of undisintegrated carbon and impurities, which, after combustion, are known as ash.

"Such dust, when suspended in a homogeneous cloud with a moderate air velocity, is susceptible of ignition either through shock, compression, or sufficient heat to inaugurate combustion.

"Such results will be classified as combustion or explosion, depending upon the volume of dust ignited, its supply of oxygen and the space within which combustion takes place.

"Where gas alone is ignited, and the mine is free from dust, a 'high explosive' effect is obtained, and the explosion may be strictly local, due to the cooling effects of the walls.

"The chief product of a dust explosion is carbon monoxide, whose expansion under combustion is greater than that of methane, and which receives its continuous supply of oxygen by feeding toward the intake.

"A dust explosion, while assisted by the intake air, must nevertheless, follow those entries or airways furnishing the most material upon which to feed; and when this course follows the return airways, the conversion of the carbon-monoxide to carbon-dioxide renders the air extinctive, and prohibits further propagation. Evidence of such a condition will be found in the coke splashing or crusts, formed by the deposit of red-hot cinders carried by the air waves, and testifying to incomplete combustion.

"The initial explosion may, and generally does, distil so large an amount of gas that complete combustion is impossible at the site of distillation, and this mass of gas and dust, in varying stages of ignition and combustion at a temperature greatly in excess of the point of ignition, were sufficient oxygen present, will develop into local explosions at irregular intervals wherever adequate atmospheric oxygen is available, such as at junctions of airways, widened passages for side tracks, or cavities where falls of roof rock have occurred, and are frequently called 'flame areas.'

"When such an explosion, either primary or secondary, travels toward a dead-end of an entry passage, the compression generated by its expansion and momentum causes an almost incredible rise in temperature, sufficient to distil the various hydrocarbons from even the ribs of the coal itself, and supplementing it with a heat potential far in excess of its losses through radiation and expansion.

"The liability of any coal dust to explosion increases almost directly with its percentage of volatile matter that is combustible; i. e., the quotient of its percentage of volatile matter divided by the sum of the percentages of volatile matter and fixed carbon.

"While coal dust alone, under the conditions enumerated, is distinctivel explosive, the presence of even th smallest amount of methane augment materially the susceptibility to ignitio

"On account of the great elasticit of air, it is highly probable that no prop er conception has yet been attained o the almost incredible speed with whic a dust explosion, through its gaseou products, may be extended to far dis tant portions of a mine under the forc of initial expansion, properly called th 'percussive theory.'

"Changes in barometric pressure onl affects the liability to explosion in s far as they allow, when the baromete is falling, a settling of any possible ac cumulation of methane from a dome i the roof-rock into the ventilating cur rent; but such small quantities of gas ar infinitely safer when diffused in the cur rent of air than when concentrated i one place. Moreover, even if we gran that a low barometer allows greater oc clusion, it also allows easier ventilatio for the diffusion of such occlusion.

"A mine may be overventilated unti the air-current has such a velocity tha it stirs up dust and would feed an slight ignition which might take plac and otherwise die out.

"The difference in the amount of rea dust made by either air-punchers o electric chain-machines is so slight, an so variable, depending on the nature o the coal and the skill of the machin man, that it cannot be said that eithe machine, as a class, creates more dust than the other.

"The results of experiments with elec tric ignition of dust show that the dan ger from electric wiring is no greate than that of stirring up a cloud of dus from a broken air-pipe or a loose con nection.

"Coal dust cannot be made wet, in th usual sense. The method of fine spray ing is indicative of the best results; bu even then, it is hypothetical if the mos careful system of watering is not merel an infinitesimal portion of the 'ounce o prevention,' and it is an open questio whether it is not positively detrimenta

"While the abolition of all explosive as recommended by the Belgium author ties, appears unnecessary and impracticable in this country, yet the greatest field of investigation now lies along that line, and only those explosives carefully tested and known to be uniformly prepared by well known and responsible manufacturers, should be used. The maintenance of a testing laboratory, even though on a small scale, and the employment of a competent chemical engineer, should be undertaken at every operation of commercial importance."

THE TESTING OF STEEL RAILS.

A CRITICISM OF PREVAILING SPECIFICATIONS AND A DISCUSSION OF THE DROP TEST.

Dr. C. B. Dudley—American Society for Testing Materials.

WE return to the subject of the steel rail situation in the United States, to which considerable attention has been given in both the leading articles and the review department of THE ENGINEERING MAGAZINE during the past year, to present a part of Dr. C. B. Dudley's presidential address before the recent meeting of the American Society for Testing Materials. Dr. Dudley's review of the situation is a most comprehensive one. He first outlines the alteration in conditions during the past twenty-five years and then inquires what the railroads and the rail manufacturers have done to meet the changed conditions. Of the many problems connected with rail manufacture to which he draws attention, he considers one of the most important to be the revision of specifications and methods for rail testing. He is firmly of opinion that the testing of rails can be so handled as to give much more satisfactory results than are at present obtained.

"During the past few years, much light has been thrown on this subject, and the truth compels us to say, that a situation has been found that in some respects would be ludicrous, if it was not so near the tragic. Let us see what the conditions have been:

"(1) The manufacturers have in many cases at least selected the rail end as sample for test. The specifications being silent on the selection of the test piece, they naturally have urged that there was nothing to prevent their doing this, and they naturally again have, so far as information can be obtained, chosen the best steel in the ingot for test. It is not claimed that all specifications have been so loosely drawn as to permit such a suicidal practice, but it is certain that some of them have, and that the practice has been in vogue.

"(2) The best two in three principle has pervaded many specifications, that is to say, if the first rail end stood test, the heat was accepted, but if it failed a second was tested. If this likewise failed the heat was condemned. If, on the other hand, it stood test, a third was tested, and the fate of the heat was decided by the majority. It would almost seem as though the specification had been drawn, not with the idea of being sure that only good rails should be accepted, but with the idea of being sure that as many heats as possible should be accepted.

"(3) Only one heat in five was tested, that is to say, as we understand the matter, if the rail end stood test and the heat was accepted, that acceptance carried four other heats with it. But, singularly enough, if, on the other hand, the heat was rejected, that rejection only covered the heat from which the test rail end came, and the four preceding or following heats, as the case might be, got another chance for their lives. The unsatisfactoriness of such a method of testing, it seems to us, must be evident to every candid mind that knows anything about the making of steel. As has often been stated, every heat of steel is a law unto itself, and there is no certainty that because one heat or blow is good the preceding or succeeding four are equally good any more than there is a reasonable presumption that if one heat is bad, the preceding or succeeding four are likewise bad. And while it is agreed that when everything is working well successive blows from the Bessemer converter may be similar in many respects, it is not agreed that testing one blow in five gives any reasonable assurance that only good rails are accepted for use.

"We fancy the rather loose testing described in the three items above started in the earlier days when the strain on the rail was far less than at present and the traffic far less dense, and has been perpetuated partly owing to inertia on the part of railroad engineers, and partly owing to the resistance of the rail manufacturers. The wonder is, with such loose, logrolling testing as has been in vogue, not that there have been so many rail failures, but that there have not been more.

"But this is not the whole story. Until quite recently the specifications have been equally loose in regard to the drop testing machine employed in making the tests. Weight of tup has been carefully stated, and the height from which it must fall has been given; indeed, in some cases the foot pounds of the blow are carefully given for each weight of rail, but it has apparently been forgotten that the anvil or support on which the rail rests when it receives the blow is a most important element in the problem. It has recently developed that at one steel works the anvil was a couple of ingots laid down side by side with appliances for holding them in place and supporting the test rail, the whole resting on boards placed on the ground. At another steel works, the anvil weighed 3000 lbs., and rested on boards, stones and gravel. One rail manufacturer recently said in my hearing, 'As long as the railroads did not object, why should we take measures to increase the severity of the test by putting in heavier and better supported anvils?' It is gratifying to be able to state that some of the more recent specifications, while according to our ideas still far from satisfactory in the matter of testing, do show marked improvement in some of the respects mentioned above, and still better, that the rail manufacturers are co-operating in and actually suggesting some of the improvements.

"A few words now in regard to some of the details of testing rails, and first in regard to the drop test. It is well known that many testing engineers do not favor the drop test for rails. To our minds, however, it is the only possible available one for the present, and the following considerations seem to us to have weight in confirming this view:

"(1) It tests the whole rail in the condition in which it goes into the track, instead of a small fraction of the rail, as is requisite in all cases of prepared test pieces.

"(2) It is sufficiently rapid, so that even though every blow is tested there is no fear of delaying the output of the mills, while waiting for test pieces to be prepared, or for slower tests to be made. We have known of a case where, with sufficient force to handle the test samples, 5.5 tests have been made in half an hour on a modern drop testing machine.

"(3) There seems little doubt but that some of the strains or shocks which the rail actually receives in track are similar to those produced by the drop testing machine. This is, we think, clearly the case with a loose joint and a rapidly moving train. In case the track bolts have become loosened, the end of the rail, when the approaching wheel mounts it, certainly gets a blow similar to that given by the drop testing machine. We have known rails which have given long service in track to be broken in this way, and the fracture showed perfectly clean, sound metal.

"(4) Finally, if the specification requires that the deflection be taken, the drop test reveals a good deal in regard to the physical properties of the steel.

"Second, in regard to the selection of the test piece. We fancy it goes, almost without saying, that this should always be made by the inspector. In regard to location of test piece, it is of course understood that in shearing the ingot into rail blooms it is necessary to make the bloom from which the test rail end is to be taken a little longer than the others. It is, therefore, essential that the inspector or the specification should designate the bloom from which the test will be taken. Some recent specifications, wisely, we think, designate the top bloom of the ingot for this purpose, it being generally understood that the so-called 'pipe', if there be any, and the greatest segregation and physical defects, will be in this bloom. We may, perhaps, wisely call attention to the fact that if a cover ably near the bottom end of the top of the ingot when it is cast, the poorest steel in the ingot will not be near the top end of the top bloom, but more probably near the bottom end of the top bloom, so that if the inspector takes his test piece from the top end of the rail made from the top bloom, he will be more apt to deceive himself than if he has the test piece cut from the bottom end of the top bloom. We have sometimes thought, when inspecting the practices of casting and cooling ingots in certain works, that it would be better to take the discard between the first and second blooms.

"Third, in regard to height of drop. We have always opposed extreme severity of tests. Owing to the defects in the anvil previously referred to, if indeed they have been general, it is apparent that but little information that is of value and that is safe to follow can be obtained from previous tests. Our own view is that something a little more severe than the rail will receive in actual service, enough for a reasonable factor of safety, is all sufficient. The trouble is we do not know how severe the shocks in service are. Some recent tests of rails which had broken short off in track made by the research committee of the Pennsylvania System, seem to indicate that a 15 foot drop with a 2000 pound tup and a 20,000 pound anvil would have rejected two-thirds of those which failed in service; also that the 15 foot drop actually broke as many test pieces as the 19 foot drop, other conditions being the same. These tests should be much amplified before final conclusions can be reached, but as far as they go they seem to indicate that we must look to other causes than defective or poor steel for a portion of the rail breakages, and that extremely severe testing is not necessary."

THE GAS PROCESS OF CASE HARDENING.

NOTES ON THE METHODS AND ADVANTAGES OF THE RECENTLY DEVELOPED MACHLET PROCESS.

J. F. Springer--Cassier's Magazine.

THE recent invention of the Machlet gas process is undoubtedly the most important single advance ever made in case-hardening methods. For many purposes case-hardened mild steel is an ideal material, but so little dependence could be placed in the ordinary cementation process to give satisfactory results that the proper extension of case hardening has not taken place. Now, however, with the main difficulties in the process removed case-hardened steel may be expected soon to rank as a popular and dependable material. The following notes on the gas process are taken from an article by Mr. J. F. Springer in *Cassier's Magazine* for July.

"If we consider the matter of quality, we shall find that pack-hardening is hardly to be regarded as absolutely reliable. Thus, on account of differences in chemical constitution of the packing, it is not to be expected that the amounts of carbon delivered at all points is the same or under equal pressure. Taking into account the inevitable inequality in thickness of the surrounding carbonaceous material, it can readily be seen that this method is not to be depended on for uniformity in carbonization. Further, when we reflect that carbonization begins at different points within the case at different times, owing to inequality of temperature, we can easily see that we have here an additional reason operating against uniformity throughout the case.

"At first sight, it may not be evident why uniformity is important. Remembering, however, that the contraction consequent upon the cold plunge at the moment of hardening differs for different degrees of carbonization, we can see that considerable distortion would follow, one part of a piece contracting differently from another part. To allow for this in pieces that are to be ground means expense in grinding.

"A new process, recently invented by Mr. Adolph W. Machlet, strikes at the root of most of the difficulties. This method dispenses with packing altogether, unless, indeed, we regard the work surrounded by gas as packed in gas. In this process there is introduced to the heated work a carbon-laden gas. From this gas the articles absorb carbon. Everywhere there is the same pressure, whether it be a small, threaded hole or some more prominent surface. As the carbon is absorbed by the metal fresh gas as admitted, while the old passes off. No repacking, with its expense for labour and heat and delay, is required, the process being continuous, effective in results, and economical of time and money. The container is continually rotated, which imparts a motion to the work itself. By this means the gas is circulated, which fact tends to improve still further the uniformity of the resulting carbonization.

"A further matter, and one to which attention is here directed, perhaps for the first time, is the fact that this method permits the operation of the process under pressure. This would seem to have possibilities within it. For thus it may be that carbonizations which now require a series of hours may ultimately be found possible of accomplishment in minutes. But in working along on this line it may be well to go slow, for gas under considerable pressures in a red-hot retort, whose walls are softened thus by heat, presents a generation not to be dealt with recklessly.

"The gas used to afford the carbon supply is a special product, produced in a generator specially designed for the purpose. No heat is applied, the process being purely a chemical one. A carbon vapour obtained from an oil is mixed with a neutral gas. It is supposed that the atoms or molecules of carbon are held in suspension in this gas until the moment of absorption by the glowing iron or steel articles to be carbonized.

"The furnace consists essentially of an inner and an outer cylinder. The articles to be case-hardened are placed in the inner cylinder and heat is applied through gas burners to the annular space between the inner and outer cylinders. Worm and worm-wheel gearing are provided to cause the rotation of the cylinder, thus giving all parts of the work equal exposure to the carbonizing gas. The retort itself is supported upon two wheels at each end, thus providing an anti-friction bearing, and also allowing for the expansion due to the heat. . .

"When the retort is to be discharged the lid and the discs connected with it are removed, and by operating a hand-wheel the rear of the furnace and the retort may be raised upon the hinge at the forward end and the contents discharged by gravity.

"Special methods are used for different classes of work, in order to control them properly during the rotation of the retort. Thus, if the pieces are rings, they are strung upon bars secured in the retort in a longitudinal position. Likewise, if the pieces are round bars, which it is desirable shall not mar each other by coming into contact, they may be supported in the perforations of two or more thin discs arranged transversely in the retort, corresponding perforations, of course, being in line. These are made slightly larger than the bars, to permit a rolling movement when the retort is rotated.

"A further difficulty arising under the old method and which is eliminated in the new is the tendency of the gaseous supply of carbon to rise. This would tend to increase the carbonization effected below. By rotating the retort and circulating the gas this is obviated.

"The accessibility of the work is something of marked importance. The work can be seen and its temperature judged directly and simply.

"The hardening operation is effected by a special apparatus designed for the purpose. It consists of the tank which contains the quenching liquid. A kind of funnel is at one end. Here the hot pieces are received. They then fall into a rotating vessel, also in the shape of a funnel. This is perforated and lies in the liquid, its larger end being next the receiving funnel. The hardening articles pass to this lower and smaller end. Here they are raised and discharged by an apparatus, which is principally a conveyor arranged like a chain in a chain-pump.

"It would seem that the economy of the new process promises a very wide application of case-hardening. Thus, screws, nails, nuts, etc., may be cheaply treated, producing articles whose value would be enhanced by surface hardening. As a method has been developed for straightening shafts while they are being hardened in the cooling bath, it seems possible that we may soon be able to purchase case-hardened and ground shafting by the foot and at commercial prices. This would mean a great deal in machine construction. A further possibility of the process is that of the manufacture of high-carbon steel, the application of the method to this work being largely a matter of cost."

TITANIUM IN CAST IRON.

RESULTS OF TESTS ON THE VALUE AND USE OF FERRO-TITANIUM IN THE FOUNDRY.

Dr. Richard Moldenke—American Foundrymen's Association.

THROUGH the development of the electric furnace, a number of metals, formerly despised on account of the difficulty of their fusion, have been given an economic value and a more or less important place in the metallurgy of iron. One of the latest of these to attain commercial importance is titanium, the ferro-alloy of which is now produced sufficiently cheaply to justify its extensive use. The utility of this alloy in the production of cast iron has recently been made the subject of an extensive series of tests, the results of which were communicated to the June meeting of the American Foundrymen's Association by Dr. Richard Moldenke. We present below a summary of the results and an abstract of Dr. Moldenke's comments.

"Of the two methods of preparing titanium for use in iron, the alumino-thermic and the electric furnace, the latter seems destined to make the cheaper product; and as the selling price of a 10 per cent. titanium iron alloy is now within commercial limits, its use for the foundry is worth considering closely. For this purpose a series of tests was instituted on behalf of the American Foundrymen's Association, the results of which are given herewith. In the preliminary tests two classes of alloys were tried, one in which the material was free from carbon, and the other having some 5 per cent. of this element present. The tests showed that while both alloys could be used for the rather small quantities of iron treated, the carbon titanium alloy was better adapted for foundry work, as the melting point is lower. However, the alloy free from carbon can be used in the foundry where large bodies of metal are to be treated, and time can be given for a thorough incorporation of the material.

"The apparent infusibility of the titanium iron alloys has heretofore militated heavily against their use, and hence a word about this matter. When the lumps of alloy are thrown into the ladle, they must be given time enough to heat up and alloy with the bath by thorough stirring. This takes some time, and usually, especially with steel, fear that the metal may cool too much results in pouring before the titanium has done its work. Hence the writer suggests that where large lumps of either alloy are used, they be heated up to redness in any convenient way before use.

"In making the tests in question, the standard 1¼ inch diameter test bar cast on end in a dry sand mold was used. The bars were brushed clean and then tested transversely on supports 12 inches apart.

Two classes of metal were used—broken car wheels and machinery pig iron. This gave gray iron and white iron castings. The alloy contained 10 per cent. titanium, so that 1 pound alloy to 100 pounds iron would mean the addition of 0.1 per cent. titanium. The following is a summary of the results:

	Gray.	White.
Original iron	2,020 lb.	2,050 lb.
Plus 0.05 Ti	3,100 lb.	2,400 lb.
Plus 0.10 Ti	3,030 lb.	
Plus 0.05 Ti. and C	3,070 lb.	2,420 lb.
Plus 0.10 Ti. and C	2,990 lb.	2,400 lb.
Plus 0.15 Ti. and, C	3,190 lb.	2,520 lb.
Total tests	23	40
Average strength	3,070 lb.	2,430 lb.

Increase in strength treated iron over original, Gray, 52 per cent.; White, 18 per cent.

"From the above summary it will be seen that the greatest increase in strength was in the gray iron. This is of interest in connection with the recent tests made with vanadium in cast iron where the contrary was observed. The improvement in gray iron is more marked than was the case in tests made by Mr. Rossi and the writer in 1902. The same peculiarities, however, were observed in the behavior of the metal.

"Looking over the averages above presented, it will be noted that the improvement is almost as marked whether 0.05, 0.10 or 0.15 titanium was used, which would seem to indicate that once the deoxidation has been effected, any additional titanium added is partially wasted. Hence, for ordinary foundry practice, 0.05 titanium added will be practically sufficient, larger amounts only being necessary in exceptionally bad cases or for special work.

"A further curious fact in connection with the use of titanium in the foundry is the lessening of the chilling action. And yet whatever chill may remain shows very much harder iron. This is important in car wheel work. Test pieces made in the Keystone Car Wheel Works with iron which chilled 1½ inches deep when treated with titanium in the ladle gave but 1 inch chill. Prisms cut from these chilled portions, the castings having been made from the same metal, when subjected to compressive strain and also tested for hardness with Brinell's test (use of diamond) gave the following results: The original iron crushed at 173,000 pounds per square inch and stood 445 in the test for hardness, soft steel running about 105. The treated piece ran 298,000 pounds per square inch and showed a hardness of 557. Testing the soft metal below the chilled portion for hardness gave 332 for the original and 322 for the treated piece, or practically the same material so far as hardness was concerned.

"The writer wishes to call attention to another curious phenomenon in connection with these tests. In order to see what effect the remelting of a titanium pig iron would exhibit, a special batch made in the electric furnace, containing 3.14 titanium and 5.78 graphite, was run through the cupola. The product was cast into test bars the usual way, and part of one ladle into a chill cup. The metal as it came from the electric furnace originally was so tough that it could be broken only with severe exertion. Much of this strength was lost in the cupola remelt, and the composition of the bars was as follows:

Silicon	0.97
Sulphur	0.067
Phosphorus	0.064
Manganese	0.27
Graphite	3.18
Total carbon	3.94
Titanium	0.72

"The bars were dark gray, where one would expect a heavily mottled or at least only very light shade of gray to exist, considering the composition and comparatively small diameter. It was noticed, however, that the bars when cast retained their red heat at least three times as long as ordinarily, and this opportunity for graphite to form may account for the dark gray fracture.

"Just what may be the true explanation for this must be left for future investigation, but perhaps some light may be thrown upon the subject by the following: Experiments made by Mr. Fitzgerald at Niagara Falls in treating molten iron with 1 per cent. titanium, the bath of metal being 2300 degrees F., showed that the addition in question raised the temperature some 25 degrees for a minute; it then slowly dropped to the original again. Evidently there was a reaction involving the giving out of heat. Possibly this may account for the long continued redness of the test bars cast in dry sand molds."

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,	(6) When published,
(2) The name of its author,	(4) Its length in words,
(3) A descriptive abstract,	(5) Where published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Arches.

Lines of Thrust in Masonry Arches. J. D. W. Ball. Methods of determining stresses are considered. 4000 w. Builder—June 13, 1908. No. 93215 A.

The Calculation of the Stresses in Solid Arches. Milo S. Ketchum. Considers only solid two-hinged and continuous arches constructed of masonry or concrete. 3000 w. Jour of Engng, Univ of Colo—No. 4. No. 93278 D.

A Simplification of the Design of Hingeless Arches (Vereinfachung der Berechnung gelenkloser Brückengewölbe). Max Ritter. A mathematical paper. Ills. Serial, 1st part. 1000 w. Schweiz Bau—May 30, 1908. No. 93152 D.

Bascule.

Vernon Avenue Bascule Bridge, New York City. Illustrated description of a double-leaf Scherzer rolling lift bridge. 1500 w. Eng Rec—June 27, 1908. No. 93346.

Notes on Electrically Operated Bascule Bridges (Opmerkingen over electrisch bewogen Basculebruggen). F. K. Th. v. Iterson. Illustrates and describes the op-

We supply copies of these articles. See page 823.

erating mechanism. 7800 w. De Ingenieur—May 30, 1908. No. 93188 D.

Columns.

See Latticing, under BRIDGES.

Concrete.

See Trestles, under BRIDGES.

Culverts.

Determination of the Area of Water-Way Required. E. A. Harrison. Considers some of the methods of computing the proper area of culverts. 1500 w. Can Engr—June 5, 1908. No. 92834.

Methods and Cost of Building a Concrete-Steel Culvert to Carry an Irrigation Canal Under a Creek Bed. Henry A. Young. 1500 w. Engng-Con—June 10, 1908. No. 92926.

See also Pipes, under WATER SUPPLY.

Floors.

The Effect of Flooring Plank in Distributing Concentrated Loads. Brief report of thesis work at the Univ. of Nebraska. 1500 w. Eng News—June 4, 1908. No. 92851.

Latticing.

Column Formulas and Lattice Bracing. Discusses the usual methods of calculating stresses, showing how little is really known regarding column strengths and lattice bracing. 2500 w. R R Age Gaz —June 5, 1908. No. 92819.

London.

The Architecture of the Bridges of London. Prof. Beresford Pite. Reviews briefly the architecture of London, and the value of the Thames, and its bridges, illustrating and describing many designs. General discussion. 11500 w. Jour Roy Inst of Brit Archts—May 23, 1908. No. 93006 C.

Reinforced Concrete.

Reinforced Concrete Bridge Over the Sangamon River. Illustrated description of a new bridge on the Wabash line, in Illinois. 600 w. R R Gaz—May 29, 1908. No. 92692.

The Guggersbach Bridge Over the Singine (Pont sur la Singine, à Guggersbach). Am. Gremaud. Illustrated description of a reinforced-concrete arch of 50 metres span. 2000 w. Bul Tech d l Suisse Rom—May 25, 1908. No. 93121 D.

See also Culverts, under BRIDGES.

Steel.

Erection of French River Bridge—Canadian Pacific Railway. C. N. Monsarrat. Illustrated description of interesting features of the work. 3300 w. Can Engr—June 5, 1908. No. 92838.

The Missouri River Bridge of the Chicago and Northwestern Railway at Pierre, South Dakota. Illustrated description of a single-track bridge with swing-span, and the method of erection. 2500 w. Eng Rec—May 30, 1908. No. 92662.

Erection of Heavy Bridges for the New York, New Haven & Hartford Railroad. Describes methods used for handling heavy members of overhead highway spans, without obstructing traffic on the tracks below. 2000 w. Eng Rec—May 30, 1908. No. 92669.

The Design of Bridge End Frames (Zur Berechnung von Brücken-Endquerrahmen). Friedrich Hartmann. Theoretical and mathematical. Ills. 3500 w. Oest Zeit f d Oeffent Baudienst—May 23, 1908. No. 93168 D.

Swing Bridges.

Equipment for Operating Swing Bridge by Power. C. J. Fensome. States the conditions and the methods of determining the power of the motor, the arrrangement, brakes, friction clutch, coupling, etc. 4200 w. Can Engr—June 5, 1908. No. 92836.

Trestles.

How to Build a Concrete Coal Trestle. Warren H. Miller. Illustrated detailed description of a durable trestle which can be built for less money than a wooden one. 2000 w. Power—June 2, 1908. No. 92698.

Viaducts.

Some Detail Points in the Design and Construction of a Railway Viaduct. Philip Aylett. Matters of importance that came to the writer's attention while constructing long bridges and viaducts for the Seaboard Air Line Ry. are discussed in detail. Ills. 3500 w. Eng News—June 18, 1908. No. 93041.

See also Austria, under RAILWAY ENGINEERING, MISCELLANY.

CONSTRUCTION.

Beams.

Bending Moments and Moments of Resistance in a Freely Supported Beam Under Load (Biegungs- und Stützenmomente eines frei aufliegenden Trägers unter einem Lastenzuge). Josef Schreier. A mathematical and theoretical treatment. Ills. Serial, 1st part. 3000 w. Zeitschr d Oest Ing u Arch Ver—May 29, 1908. No. 93162 D.

The Graphical Treatment of Continuous Girders on Rigid and Elastic Supports (Zeichnerische Behandlung der durchgehender Träger auf festen, auf elastisch drehbaren, elastisch senkbaren sowie auf elastisch dreh- und senkbaren Stützen). Chr. Vlachos. Discusses various cases. Ills. Plates. 9000 w. Oest Zeitschr f d Oeffent Baudienst—May 16, 1908. No. 93167 D.

Bins.

Reinforced-Concrete Cement Bins (Zementsilo in Eisenbeton). Emil Reich. A discussion of the design of a five-compartment building for cement storage, about 120 feet long by 33 feet wide. Ills.

3300 w. Beton u Eisen—May 14, 1908. No. 93153 F.

Caissons.

See Piers, under Waterways and Harbors; and Dry Docks, under MARINE AND NAVAL ENGINEERING.

Columns.

Notes on Euler's Theory of Rupture (Bemerkungen zur Eulerschen Knicktheorie). H. Lorenz. A mathematical discussion. Ills. 3300 w. Zeitschr d Ver Deutcher Ing—May 23 ,1908. No. 93183 D.

Concrete.

A Concrete Church with Ornamental Cast Concrete Details. Illustrated description of the church of "Our Lady of Loretto," in Brooklyn, N. Y. 1000 w. Eng News—June 25, 1908. No. 93338.

The Construction and Cost of a Concrete Gasholder Tank. Ernest Frith. Gives details of a tank at the works of the Runcorn Gas Co. Also discussion. Ills. 3800 w. Gas Wld—June 13, 1908. No. 93212 A.

See also Fireproof, under Construction.

Concrete Blocks.

Some of the Methods of Cuban Block Makers and Cement Workers. George Rice. Describes the method of using wooden molds, tamping devices, etc. Ills. 800 w. Engng-Con—June 17, 1908. No. 93089.

Earth Pressures.

The Pressure of Earth Filling on Bracing in Trenches. Milo S. Ketchum. Gives a solution of the problem of earth pressures on the sheeting of deep trenches. 1000 w. Jour of Engng, Univ of Colo—No. 4. No. 93285 D.

Ellis Island, N. Y.

Recent Improvements at the United States Immigrant Station, Ellis Island, N. Y. An illustrated account of the construction of an entirely new island, and of a group of 17 buildings, forming a hospital for the treatment of contagious diseases. 2000 w. Eng Rec—May 30, 1908. No. 92667.

Excavation.

Rock Excavation by Mechanical Power Instead of Explosions. Editorial discussion of the Lobnitz system. 2200 w. Eng News—June 25, 1908. No. 93340.

See also Sewers, under Municipal.

Failures.

An Apartment-House Building Failure, Washington, D. C. Illustrated description of the collapse of this steel-brick structure and discussion of the cause. 1000 w. Eng News—June 25, 1908. No. 93339.

An Unusual Building Accident: Foundation Failure During Construction. An account of an accident to a hospital building in Pittsburg. Ills. 800 w. Eng News—June 11, 1908. No. 92941.

Investigation of Collapse of Filter Roof During Construction at Lawrence, Mass. Sanford E. Thompson. Brief illustrated description of the method of construction, and of the condition after the fall, giving data collected and conclusions in regard to the causes of the failure. 3000 w. Jour N Eng W-Wks Assn —June, 1908. No. 93378 F.

Fireproof.

The Fireproof Properties of Concrete. Concise contributions from leading engineers and experts on the value of concrete as a fireproof material. Ills. 13500 w. Cement Age—June, 1908. No. 93009.

Fireproof Building Construction and Concrete Building Construction. Abstracts of two reports presented at the recent convention of the Nat. Fire Protection Assn. in Chicago. 2800 w. Eng News—June 11, 1908. No. 92936.

Foundations.

Concrete Pile Foundations to a Heavy Reinforced-Concrete Warehouse. Charles R. Coats. Describes work on uncertain ground at Louisville, Ky. 900 w. Eng News—June 4, 1908. No. 92853.

See also Failures, under Construction.

Masonry.

Masonry Work in Zero Weather. T. B. Kidner. A brief account of the methods of safely carrying on work in such weather. Ills. 1500 w. Builder—June 13, 1908. No. 93216 A.

See also Retaining Walls, under Construction; and Dams, under Water Supply.

Piling.

Concrete Piles. Stewart G. Collins. Discusses their advantages, giving illustrated description of the Raymond and the Simplex methods. 1400 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93387 N.

Reinforced Concrete as a Substitute for Wooden Piles and Cross-Ties or Sleepers. Alexander Crawford Chenoweth. Discusses this subject, presenting a method of construction, using no forms, producing a pile by simply rolling a sheet of concrete and metal netting into a solid cylinder. General discussion. Ills. 10500 w. Pro N Y R R Club—May 15, 1908. No. 93017.

See also Foundations, under Construction; and Cofferdams, under Waterways and Harbors.

Reinforced Concrete.

Reinforced Concrete in Municipal Engineering. W. Noble Twelvetrees. States some of the advantages of this material. 2000 w. Surveyor—June 12, 1908. No. 93213 A.

A Reinforced-Concrete Cold-Storage Building. William F. Tubesing. Illustrated description of the Roth Packing Co.'s cold-storage house at Cincinnati. 1500 w. Eng News—June 11, 1908. No. 92935.

Concrete Buildings for the Great Atlantic and Pacific Tea Company, Jersey City, N. J. J. P. H. Perry. Illustrated description of a plant consisting of a warehouse and general office building and a power house, discussing the method of construction. 2000 w. Archts & Bldrs Mag—June, 1908. No. 93088 C.

The Application of Reinforced Concrete to the Construction of the Lafitte Publishing Company's Building, Paris (Application du Béton armé à la Construction de l'Hôtel des Publications Lafitte, à Paris). Illustrates and describes this 7-story structure. 2500 w. Génie Civil—May 30, 1908. No. 93131 D.

See also Bins, Piling, Retaining Walls, and Stacks, under CONSTRUCTION; Sewage Disposal, under MUNICIPAL; Pipes, under WATER SUPPLY; Shaft Sinking, under MINING AND METALLURGY, MINING; and Coaling Plants, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Retaining Walls.

The Design of Retaining Walls. Harold A. Petterson. Discusses the most economical forms of wall for sustaining earth pressures, giving tables and diagrams which will facilitate their design. Masonry walls of gravity section and reinforced concrete walls will be considered. 1500 w. Eng Rec—June 13, 1908. Serial, 1st part. No. 92955.

Stacks.

A Tall Concrete Smelter Chimney. Describes a 350-ft. concrete chimney, with 18 ft. inside diameter, built at Butte, Mont. Ills. 2000 w. Eng Rec—June 6, 1908. No. 92832.

Steel Buildings.

Some Recent Steel Cage Buildings in San Francisco. Illustrates and describes structures, explaining the requirements of the building laws. 2500 w. Eng Rec—June 13, 1908. No. 92953.

The City Investing Building. Francis H. Kimball. Illustrates and describes interesting features of this 32-story building in New York City. 3000 w. Archts & Bldrs Mag—June, 1908. No. 93087 C.

Tunnels.

Itemized Cost of the Stampede Tunnel (9,850 Lin. Ft.) and Its Masonry Lining. Information in regard to a tunnel on the Northern Pacific Ry. 1500 w. Engng-Con—June 3, 1908. No. 92784.

Tunnel Breakage, Outside of Prescribed Cross-Section; Clinch Valley Division, Norfolk & Western R. R. Emile Low. Information in regard to the geological formation, and the causes of excessive breakage. Ills. 900 w. Eng News—June 18, 1908. No. 93045.

The Intake Tunnel of the Municipal Water-Works at Gary, Indiana. Illustrated description of the construction of 15,000 ft. of tunnel of horse-shoe shape, with cross-section equivalent to a 6 ft. circle. 2500 w. Eng Rec—June 27, 1908. No. 93343.

Underpinning.

Underpinning Six-Story Apartment Houses in New York City. Work in connection with the construction of the bridge-loop subway is illustrated and described. 1200 w. Eng Rec—May 30, 1908. No. 92663.

MATERIALS OF CONSTRUCTION.

Brick.

See Blast-Furnace Slag, under MINING AND METALLURGY, IRON AND STEEL.

Cement.

Iron-Ore Cement in Germany. Information from a Consular Report concerning the production and use of this cement. 1400 w. Eng News—June 25, 1908. No. 93342.

Destruction of Cement Mortar and Concrete by Alkali Salts at Great Falls, Mont., with Discussion of the Effect of Alkali on Portland Cement. On damage to sewers, and a report of investigations recently made. 2000 w. Engng-Con—June 24, 1908. No. 93329.

Tests of Some Pozzolane (Studio di alcune Pozzolane). Ernesto Isè. Compares their physical properties. Ills. 2800 w. Il Cemento—April, 1908. No. 93134 D.

A Microscopic Study of Pozzolana Cement (Studio microscopico delle Malte a Pozzolana). Gino Gallo. Illustrated by microphotographs. 11000 w. Ann d Soc d Ing e d Arch Ital—Mar.-Apr., 1908. No. 93132 F.

A Method for the More Thorough Investigation of Hydraulic Cement (Ein Studienplan für die weitere Erforschung der hydraulischen Bindemittel). Karl Zulkowski. Criticises present methods and suggests improvements. Serial, 1st part. 2000 w. Stahl u Eisen—May 13, 1908. No. 93144 D.

Concrete.

Permeability Tests of Concrete with the Addition of Hydrated Lime. Sanford E. Thompson. Read before the Am. Soc. for Test. Mat. Gives conclusions drawn from experiments, with a study of results. 3500 w. Eng Rec—June 27, 1908. No. 93347.

Comparative Tests of Sandstone and Slag as Concrete Aggregates. Frederick

W. Doolittle. Reports a series of tests made to determine the relative merits. 800 w. Jour of Engng, Univ of Colo—No. 4. No. 93290 D.

See also Cement, under Materials of Construction.

Paints.

Methods for Protecting Iron and Steel Against Corrosion. George B. Heckel. Reviews work on protective coatings, giving report of tests. Ills. 5500 w. Jour Fr Inst—June, 1908. No. 93260 D.

Reinforced Concrete.

Tests of Bond in Reinforced Concrete Beams. Morton O. Whitey. Read before the Am. Soc. for Test. Mat. Reports tests made. 2500 w. Eng Rec—June 27, 1908. No. 93344.

Comparative Rupture Tests on Reinforced Concrete Test Pieces Made of Königshof Slag Cement (Vergleichende Bruchversuche mit Probeobjekten aus Eisenbeton unter Verwendung des Königshofer Schlackenzements). M. Blodnig. Describes the tests and gives the results and conclusions. Ills. 3500 w. Beton u Eisen—May 14, 1908. No. 93154 F.

Steel.

New Uses for Steel. R. B. Woodworth. Deals with its application to substructure work, especially the cofferdam. Ills. Discussion. 8700 w. Pro Ry Club of Pittsburgh—April, 1908. No. 93365 C.

The Work of the Testing Department of the Watertown Arsenal, in Its Relation to the Metallurgy of Steel. A discussion of the paper of James E. Howard. Ills. 9000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93269 D.

Timber Reservation.

The Treatment of Timber. Carl G. Crawford. Abstract from a Circ. of the U. S. Dept. of Agri. An illustrated account of the open-tank method. 3000 w. Sci Am Sup—June 6, 1908. No. 92801.

Timber Preservation. Ralph H. Rawson. Illustrated description of the creosoting process and of the plant of the Pacific Creosoting Co. 2000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93389 N.

MEASUREMENT.

Earthwork.

An Excess Curve of Quantities for Trapezoidal Canal Sections. Harry E. Sovereign. Describes a curve designed in a field office of the U. S. Reclamation Service, found to be very useful. 800 w. Jour of Engng, Univ of Colo—No. 4. No. 93280 D.

Testing Laboratories.

A Laboratory for Testing Materials of Construction (Il Laboratorio sperimentale per i Materiali da Costruzione). Illustrated description of the Laboratory of the Technical Institute at Milan. 3000 w. Serial. 1st part. Il Cemento—April, 1908. No. 93135 D.

MUNICIPAL.

Blackpool.

Blackpool and Some of Its Municipal Works. John S. Brodie. Read before the Assn. of Munic. & Co. Engrs. Briefly describes the various works and undertakings. Ills. 7500 w. Surveyor—June 19, 1908. Serial, 1st part. No. 93411 A.

Garbage Disposal.

The Collection and Disposal of Municipal Waste and Refuse. X. H. Goodnough. Information concerning the quantity and character of city wastes, and the methods of disposal. 9000 w. Jour Assn of Engng Socs—May, 1908. No. 93369 D.

Gary, Ind.

Municipal Engineering at Gary, Ind. Will Lawrence Hammons. Describes the paved streets and concrete sidewalks, the water system, sewers, etc. 2000 w. Munic Engng—June, 1908. No. 93055 C.

Pavements.

The Evolution of Pavements. G. L. Clausen. A short résumé of the writer's observations during twenty-eight years' experience in municipal work. 1200 w. Munic Engng—June, 1908. No. 93057 C.

Hints on Fillers for Brick and Block Pavements. C. G. Atwater. Considers coal tar pitch the most satisfactory and the cheapest. 800 w. Engng-Con—June 10, 1908. No. 92927.

The Municipal Asphalt Repair Plant of the Borough of Brooklyn, and Data on the Cost of Operating It. Gives data covering the period from June 13 to Dec. 31, 1907. 2000 w. Engng-Con—May 27, 1908. No. 92687.

Roads.

State Road Building in Pennsylvania. Leonard C. Jordan. Describes the method of construction. 1600 w. Jour of Engng, Univ of Colo—No. 4. No. 93283 D.

Data on Tarvia Road Treatment in New York State, and Tar Macadam Work in Canada. Information from H. C. Poore's report to the Massachusetts Highway Commission. 3800 w. Engng-Con—June 3, 1908. No. 92782.

Roadways That Will Resist the Wheels of Automobiles. Editorial comment on the roads of Central Park, N. Y. City, and the effect of motor vehicles on the macadam and the remedy. 1200 w. Engng-Con—June 10, 1908. No. 92925.

The Effect of Motors on Roads. Douglas Mackenzie. An illustrated article discussing the nature of the injuries. Also Notes on Wheel Diameters. Col. R. E. Crompton. Discussed together. 9000 w. Surveyor—June 5, 1908. No. 92920 A.

Sanitation.

The Management of the Typhoid Fever Epidemic at Watertown, N. Y., in 1904. George A. Soper. Deals with features in the sanitary management of an epidemic caused by a polluted water supply. Ills. Discussion. 2500 w. Jour N Eng W-Wks Assn—June, 1908. No. 93374 F.

Sewage Disposal.

Chemical Precipitation v. Septic Tanks. Joshua Bolton. Gives results of tests made at Heywood. 2500 w. Surveyor—June 12, 1908. No. 93214 A.

Sewage Disposal for Private Houses. J. B. Neely. Illustrates and describes the main features of plants built from plans of A. Marston. 800 w. Eng Rec—May 30, 1908. No. 92666.

New Sewage Works at Twickenham. An illustrated description of a plant considered quite a model. 2500 w. Engr, Lond—June 5, 1908. Serial. 1st part. No. 92990 A.

Sewage Disposal at Boulder, Colorado. Clement C. Williams. Describes the method of sewage treatment, which is criticized, and suggests improvements. 1500 w. Jour of Engng, Univ of Colo—No. 4. No. 93287 D.

Special Features of the Sewage Pumping Machinery, Reinforced Concrete Rising Main, and Travis System Sewage Tanks in Progress at Norwich, England. Arthur E. Collins. Illustrated detailed description. 6500 w. Surveyor—June 5, 1908. Serial. 1st part. No. 92919 A.

Sewage Purification Works of the State Agricultural School, St. Anthony Park, Minn. Frederick H. Bass. Illustrated description of a system for domestic sewage only, consisting of a septic tank, percolating filter, settling tank and a sand filter. 1000 w. Eng News—June 25, 1908. No. 93335.

Sewerage Statistics. Collected and tabulated by the Sanitary Section of the Boston Society of Civil Engineers. 1700 w. Jour Assn of Engng Socs—May, 1908. No. 93370 D.

Sewers.

The Design of a Sewer. Frank R. Durham. Discusses systems of sewerage, the general principles if sewer design, giving diagrams and drawings of the writer's work. 6800 w. Surveyor—May 22, 1908. Serial. 1st part. No. 92736 A.

Excavators and Steam Shovels in Sewer Construction. Frank C. Perkins. A report of work done by labor saving devices. Ills. 1200 w. Munic Engng—June, 1908. No. 93056 C.

Outfall Sewer Extensions in Oakland, California. Explains conditions and describes changes made. 1200 w. Eng Rec—May 30, 1908. No. 92670.

The Winston-Salem Intercepting Sewer. J. N. Ambler. An account of the rebuilding of a sewer in North Carolina. Ills. 4000 w. Eng News—June 25, 1908. No. 93341.

Method and Cost of Building a Pipe Sewer Through Quicksand, Excavating the Ground with a Pump, Showing Remarkable Economy. Report of work at Wild Wood, New Jersey. 1200 w. Engng-Con—June 3, 1908. No. 92783.

See also Sewage Disposal, under Municipal.

WATER SUPPLY.

Aqueducts.

See Culverts, under Bridges.

Ashokan.

Some Geological Features Affecting the Catskill Water Supply. J. F. Sanborn. A brief outline of the most prominent geological features affecting the work under construction to give additional supply for New York City. Ills. 1200 w. Harvard Engng Jour—June, 1908. No. 93023 D.

Progress on the Ashokan Reservoir. An illustrated account of the great work in progress to secure additional water supply for New York City, and preparations made to meet the requirements. 6000 w. Eng Rec—June 13, 1908. No. 92952.

Conduits.

See Tunnels, under Construction.

Dams.

The Stresses in Masonry Dams. Illustrations and remarks on the experiments of Messrs. Wilson and Gore on model dams, as reported to the Inst. of Civ. Engrs. 1600 w. Engng—May 22, 1908. No. 92752 A.

The Government's Great Storage Dams. Henri V. Leménager. Discusses what they will accomplish toward the conservation and development of the natural resources of the west. Ills. 2500 w. Am Rev of Revs—June, 1908. No. 92912 C.

The Cataract Dam of the Water-Supply System of Sydney, New South Wales. Illustrated description of this large concrete and stone masonry dam, which has notable features of design and construction. 3000 w. Eng Rec—June 6, 1908. No. 92826.

Filtration.

Filter Operations, Investigations for Additional Supply and Construction of new Filter at Lawrence, Mass. Morris Knowles, M. F. Collins and Arthur D. Marble. Gives the history of the old filter, changes in methods of operation and equipment; the agitation for a new supply, with description of the filter and some items of cost. Ills. 10000 w. Jour N Eng W-Wks Assn—June, 1908. No. 93377 F.

Fire Protection.

City of Winnipeg, High Pressure Fire Service. Illustrated description of a system having a water pressure of 300 lbs. per sq. in. and a maximum capacity of 9000 imperial gallons per minute. 1500 w. Can Engr—June 5, 1908. No. 92839.

Ground Waters.

Geologic Basis for Artesian Prediction. N. H. Darton. Abstract of paper read before the Am. W.-Wks. Assn. Explains some of the fundamental principles which guide geologists. Ills. 1700 w. Eng Rec —May 30, 1908. No. 92661.

Hygiene.

Conservation of Life and Health by Improved Water Supply. Abstract of an address by George M. Kober, presented at the Conference on Conservation of Natural Resources. Discusses the influence of public water supply on the death rate. 6000 w. Eng Rec—June 6, 1908. No. 92831.

Irrigation.

The Alberta Irrigation Project of the Canadian Pacific Railway Co. J. S. Dennis. An illustrated account of the surveys and general engineering features. 3000 w. Eng Rec—June 13, 1908. No. 92947.

The Salt River Project. A. P. Davis. An illustrated account of conditions and difficulties met in developing the irrigation project in Arizona. 1200 w. Eng Rec —June 20, 1908. No. 93061.

See also Dams, and Reservoirs, under WATER SUPPLY.

Kalgoorlie.

Water Supply for Kalgoorlie. M. W. von Bernewitz. A brief account of the Mundaring reservoir supply. Ills. 900 w. Min & Sci Pr—May 23, 1908. No. 92683.

Pipe Flow.

Investigation of Flow Through Large Submerged Orifices and Tubes. Clinton Brown Stewart. The present paper gives experiments with submerged tubes four feet square, studying the effect of changing the length of the tube and of modifying the entrance conditions. Ills. 11500 w. Bul Univ of Wis, No. 216—April, 1908. No. 93367 C.

Pipe Incrustation.

Incrustation of Water Pipe. W. R. Gelston. Read before the Am. W.-Wks. Assn. The writer's experience at Quincy, Ill., emphasizing the fact that solutions of iron and lime should not be forced together through long lines of pipe. 1800 w. Munic Engng—June, 1908. No. 93-059 C.

Pipe Line Repairs.

Repairs to a 72-inch Steel Main Under 30 Feet of Water. A. W. Cuddeback. Abstract of a paper before the Am. W.-Wks. Assn. Describes repairs on a line under the Hackensack River, N. J. 2200 w. Eng Rec—May 30, 1908. No. 92668.

Pipes.

Tests of Cast-Iron and Reinforced-Concrete Culvert Pipe. Arthur N. Talbot. A report of tests made, comparing and discussing the results. Ills. 15700 w. Univ of Ills, Bul 22—April 29, 1908. No. 93011 N.

Protection.

Sanitary Patrol of Watersheds. Theodore Horton, in the *Monthly Bul. of the N. Y. State Dept. of Health.* On the importance of systematic inspection. 3000 w. Eng Rec—June 20, 1908. No. 93062.

Purification.

Experiments on the Preliminary Treatment of Potomac River Water at Washington, D. C. Francis F. Longley. Describes and discusses the experiments made. Ils. Also editorial. 8300 w. Eng Rec—June 27, 1908. No. 93350.

Sterile Drinking Water for Large Buildings. T. N. Thompson. Begins a discussion of the methods for purifying drinking water. Considers the limits of ordinary filters. 1200 w. Met Work—June 6, 1908. Serial. 1st part. No. 92766.

Reservoirs.

Preliminary Reports on Storage Reservoirs. Lyman E. Bishop. Discusses the problem of locating a flood water reservoir for irrigation. 3000 w. Jour of Engng, Univ of Colo—No. 4. No. 93288 D.

Stripping Reservoir Lands. J. M. Diven. Gives experience with stripped and unstripped land, describing conditions. 2500 w. Munic Engng—June, 1908. No. 93058 C.

See also Ashokan, under WATER SUPPLY.

Siphons.

The Operation of a 16-Inch Water-Main Siphon. From a paper by Howard A. Dill, before the Am. W.-Wks. Assn., describing the operation of a siphon at Richmond, Ind. 1600 w. Eng Rec—June 13, 1908. No. 92951.

Standpipes.

The Failure of a Wrought-Iron Standpipe at Waterloo, N. Y., from Pitting. H. J. Morrison. An illustrated account of the failure, describing the condition of the material. 1500 w. Eng News—June 25, 1908. No. 93333.

Stream Flow.

Comparison of Formulas for Computation of Stream Discharge. J. C. Stevens. Read before the conference of district engineers U. S. Geol. Survey. Gives a statement of conclusions reached and a report of the comparison made. 3000 w. Eng News—June 25, 1908. No. 93334.

Water Works.

The Troy (N. Y.) Water Works Extension. E. L. Grimes. Reviews the history of the water supply, and describes in detail the new system, giving cost and information of interest. Ills. 5500 w. Jour N Eng W-Wks Assn—June, 1908. No. 93375 F.

WATERWAYS AND HARBORS.

Breakwaters.

See Havre, under WATERWAYS AND HARBORS.

Canals.

The Extension of the Emperor William Canal. Editorial discussion of the extensions and alterations proposed in this North Sea-Baltic canal. 3000 w. Engng—May 29, 1908. No. 92875 A.

The Cape Cod Canal Project. William Barclay Parsons. A general discussion of this important work, the traffic that would use it, and matters related. 4000 w. R R Gaz—May 29, 1908. No. 92690.

See also Panama Canal, under WATERWAYS AND HARBORS.

Cofferdams.

An Extensive Cofferdam of Steel Sheet Piling. Illustrated description of work at Buffalo, N. Y. 1200 w. Eng Rec—June 13, 1908. No. 92950.

See also Steel, under MATERIALS OF CONSTRUCTION.

Dredging.

The Disposal of Dredgings in Closed Conduits (Refoulement des Produits de Dragages en Conduits fermées). MM. Vidal and Kauffmann. An elaborate account of reclamation work on the marshes surrounding Bordeaux carried out in connection with dredging operations on the River Garonne. Ills. Plates. 35000 w. Ann des Ponts et Chaussées—1907-VI. No. 93119 E + F.

See also Dredges, under MARINE AND NAVAL ENGINEERING.

East Coast Waterways.

The Pamlico Sound Section of the East Coast Inland Waterway. G. S. Scherer. Map and description of the proposed work. 1000 w. Eng News—June 4, 1908. No. 92848.

Floods.

See River Regulation, under WATERWAYS AND HARBORS.

Harbors.

See Havre, under WATERWAYS AND HARBORS.

Havre.

Havre Port Works. Detailed description of the construction of the new breakwaters, the deep water quay and the Florida lock. Ills. 2500 w. Engr, Lond—May 29, 1908. Serial. 1st part. No. 92-879 A.

Locks.

The Lock in the Charles River Dam, Boston. Walton H. Sears. An illustrated description of the lock and its appurtenances. 3500 w. Eng Rec—June 13, 1908. No. 92948.

See also Havre, under WATERWAYS AND HARBORS.

New Jersey.

Waterways of New Jersey. Abstract of an address by Hon. John Franklin Fort, before the Conference on the Conservation of Natural Resources at Washington. On the utilization of natural and artificial waterways, especially in the State of New Jersey. 5000 w. Eng Rec—June 20, 1908. No. 93065.

Ohio River.

See River Regulation, under WATERWAYS AND HARBORS.

Panama Canal.

Panama Canal: Final Plan and Present Condition of the Work. Diagrams. 1500 w. Sci Am—June 6, 1908. No. 92799.

Tangible Progress on the Panama Canal. Oliver G. Tubby. Aims to give an idea of the present condition of the work. Ills. 3000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93382 N.

Piers.

The California City Point Coal Pier. Illustrated description of a U. S. coal depot on the Pacific Coast. 2000 w. Eng Rec—June 27, 1908. No. 93345.

The Employment of Reinforced-Concrete Pneumatic Caissons for the Foundation of Quay Walls (L'Emploi de Caissons en Beton armé pour la Fondation de Murs de Quais à l'Aide de Procédés pneumatiques). M. Herzog. Description of work in Dieppe harbor with notes on the design of the caissons. Ills. 7000 w. Ann des Ponts et Chaussées—1907-VI. No. 93120 E + F.

See also Havre, under WATERWAYS AND HARBORS.

River Regulation.

The Application of the Reservoir System to the Improvement of the Ohio River. Capt. Wm. D. Connor. A critical discussion of a recent article by M. O. Leighton on this subect, with reply by Mr. Leighton, and editorial. 12000 w. Eng News—June 11, 1908. No. 92934.

The Effect of the Conservation of Flow in the Ohio Basin on Floods in the Lower Mississippi. A. H. Horton. Claims that the Ohio practically controls the lower Mississippi. 3000 w. Eng News—June 11, 1908. No. 92938.

River Regulation (Ueber Flussregulierungen). Ignatz Pollak. A review of experiences in Austria in connection with the improvement of inland navigation. Serial.

1st part. 3500 w. Zeitschr d Oest Ing u Arch Ver—May 1, 1908. No. 93160 D.

U. S. Waterways.

The Navigation Resources of American Waterways. Abridged statement from the paper of Prof. Emory R. Johnson before the Washington conference. 2700 w. Eng Rec—June 27, 1908. No. 93349.

The Mississippi River Problem. Walter Sheldon Tower. Discusses the importance of a deep waterway from the Great Lakes to the Gulf of Mexico, and the serious problems that must be solved; the suggestions for river control, and related subjects. 7700 w. Pop Sci M—July, 1908. No. 93368 D.

Water Powers.

Power Capacity of a Running Stream Without Storage. William G. Raymond. Aims to show that for streams upon which there is no storage, the only proper way to estimate the power available is to estimate it from the daily rather than the monthly flow. 2500 w. Jour N Eng W-Wks Assn—June, 1908. No. 93376 F.

MISCELLANY.

Natural Resources.

The Waste of Our Fuel Resources. I. C. White. Abstract of an address at the conference in Washington, D. C. Discusses the waste of natural gas, oil, and coal. 4500 w. Power—June 2, 1908. No. 92700.

The Natural Wealth of the Land and Its Conservation. James J. Hill. From an address at the conference at Washington, D. C. The importance of agriculture, the yield of the land, its deterioration and the remedy. 4000 w. Ir Age—June 4, 1908. No. 92724.

ELECTRICAL ENGINEERING

COMMUNICATION.

Army Signalling.

New Electrical Apparatus of the United States Signal Corps. C. H. Claudy. Illustrated description of special apparatus used, a portable telephone, wireless telegraphy, telautograph for transmitting gun ranges, etc. 2000 w. Sci Am—June 20, 1908. No. 93049.

Radio-Telegraphy.

Knudsen's Process of Transmitting Pictures by Wireless Telegraphy. Brief illustrated description. 1200 w. Sci Am—June 6, 1908. No. 92800.

See also Army Signalling, under Communication.

Radio-Telephony.

The Poulsen Wireless Telephone. Otto Nairz. Illustrated detailed description of the system of the German Wireless Telegraph Co. 1500 w. Sci Am Sup—June 6, 1908. No. 92802.

Wireless Telephony. R. A. Fessenden. A discussion of the theory, practical operation, and possibilities, with brief review of the history of wireless signaling. Ills. 1600 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93297 D.

Telegraph Cables.

An Oscillographic Study of Induction in Telegraph Cables (Oszillographische Untersuchungen zur Frage der Induktion in Telegraphenkabeln). E. F. Petritsch. A description of the researches and conclusions reached. Ills. Serial. 1st part. 3200 w. Elektrotech u Maschinenbau—May 10, 1908. No. 93171 D.

Tele-Mechanic.

Wireless. Information concerning Dr. F. H. Millener's apparatus for remote control of machinery. Ills. 900 w. Ry & Loc Engng—June, 1908. No. 92789 C.

Telephone Lines.

Method and Cost of Constructing a Telephone Line. L. E. Hurtz. (Condensed.) 3500 w. Engng-Con—May 27, 1908. No. 92688.

Telephony.

The Theory and Practice of Phantom Telephone Circuits. F. J. Mayer. Explains the term and the operation of such a circuit. 1200 w. Wis Engr—June, 1908. No. 93234 D.

See also Communication, under RAILWAY ENGINEERING, Conducting Transportation; and Train Despatching, under STREET AND ELECTRIC RAILWAYS.

Tele-Photography.

Seeing from Paris to Rome. An illustrated explanation of the principle of M. Armengaud's apparatus for seeing electrically at a distance. 1200 w. Sci Am—June 27, 1908. No. 93314.

The Electrical Transmission of Pictures (Transmission électrique des Images). M. Henry. A complete review of the principles and achievements in this field. Ills. 14000 w. Soc Belge d'Elecns—May, 1908. No. 93101 E.

DISTRIBUTION.

Alternating Circuits.

Vector Diagrams Applied to Polyphase Connections. Harold W. Brown. Aims to show by the use of vector diagrams the right connections for some of the more common polyphase circuits. 2500 w. Elec Jour—June, 1908. No. 93016.

Switch Boxes.

Easily Constructed Electrical Conduit and Service Boxes. T. C. Lerret. Illustrates and describes useful types of conduit and switch boxes. 1200 w. Elec Wld —June 6, 1908. No. 92774.

DYNAMOS AND MOTORS.

A. C. Dynamos.

A New Large Generator for Niagara Falls. B. A. Behrend. Illustrates and describes this generator which is remarkable on account of its speed of 300 rev. per min. 800 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93237 D.

The Relative Proportions of Copper and Iron in Alternators. Carl J. Fechheimer. Gives a method which aims to enable the designer to determine what value of flux to employ to give the cheapest machine. 6000 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93242 D.

A. C. Motors.

See Transformers, under TRANSMISSION.

Armature Testing.

Locating Grounds in Armature Coils. W. M. Hollis. Explains methods of finding the defective coil. 1200 w. Elec Wld —June 6, 1908. No. 92776.

Induction Motors.

Variable Speed Polyphase Induction Motors. R. H. Fenkhausen. Describes the connections and operation of these motors, their valuable features, etc. Ills. 1600 w. Power—June 9, 1908. No. 92904.

Induction Motors for Multi-speed Service with Particular Reference to Cascade Operation. H. C. Specht. Discusses mainly the characteristics and operation of two induction motors connected either in direct or in differential concatenation or as single motors. 3500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93236 D.

The Influence of the Flywheel in Induction Motor Operation (Ueber den Einfluss von Schwungmassen bei Induktionsmotorantrieben). Ludwig Kallir. Mathematical. Ills. 2500 w. Elektrotech u Maschinenbau—May 31, 1908. No. 93174 D.

The Sudden Change of Hysteresis Loss in the Rotor of the Asynchronous Motors (Ueber die sprunghafte Aenderung der Hysteresisverluste im Rotor des Asynchronmotors). Hermann Zipp. A theoretical explanation. Ills. 4000 w. Elektrotech u Maschinenbau—May 24, 1908. No. 93173 D.

Rotating Field.

Graphical Treatment of the Rotating Field. R. E. Hellmund. Aims to evolve diagrams by means of which nearly all the phenomena of the rotating field may be easily studied. 4000 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93240 D.

Standards.

British, American and German Standards for Electrical Apparatus. J. S. Peck. A brief comparison of the standard rules. 800 w. Elec Jour—June, 1908. No. 93014.

ELECTRO-CHEMISTRY.

Calcium Cyanamide.

The Fixation of Atmospheric Nitrogen —Cyanamide. A review of a lecture before the Faraday Soc. by Dr. Albert Frank, of Berlin, on the Frank-Caro process. 2000 w. Engng—June 12, 1908. No. 93326 A.

Cells.

The Cadmium Cell at a Low Temperature. Henry Tinsley. Remarks on observations made of their behavior at low temperatures. 1000 w. Elect'n, Lond—June 12, 1908. No. 93220 A.

The Mechanism of the Daniell Cell (Het Mechanisme van het Daniell-Element). E. Cohen, F. D. Chattaway, and W. Tombrock. A theoretical discussion. Ills. 9000 w. De Ingenieur—May 9, 1908. No. 93187 D.

Corrosion.

Rust: Its Formation and Prevention. M. Thornton-Murray. Abstract of paper read before the Birmingham Univ. Met. Soc. A review of the current theories on the formation of rust. 1500 w. Mech Engr—May 29, 1908. No. 92860 A.

Electro-Metallurgy.

See Refining, under MINING AND METALLURGY, COPPER; Electro-Metallurgy, under MINING AND METALLURGY, IRON AND STEEL; and Tin, under MINING AND METALLURGY, MINOR MINERALS.

Electro-Plating.

A Simple Method for Estimating the Quantity of Silver in Silver Plating Solutions. Detailed description of the volumetric sulphocyanate method. Ills. 3800 w. Brass Wld—June, 1908. No. 93053.

Review of 1907.

Recent Progress in Electro-Chemistry (Les récents Progrès en Electrochemie). C. A. Hofecker. A review of discoveries, advances, and publications during 1907. Serial. 1st part. 2000 w. Rev d'Electrochim et d'Electrométal—April, 1908. No. 93104 F.

ELECTRO-PHYSICS.

Electric Circuits.

The General Equations of the Electric Circuit. Charles P. Steinmetz. An attempt to investigate mathematically the phenomena which may occur in the most general case of an electric circuit. 13800 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93291 D.

Electricity.

Modern Theories of Electricity and Matter. Madame Curie. Abstract translation from *Revue Scientifique*. An explanation of modern theories. 3500 w. Sci Am Sup—June 20, 1908. Serial, 1st part. No. 93051.

Electrons.

The Dynamics of the Electron (La Dynamique de l'Electron). Henri Poincaré. An application of the ordinary dynamic laws to the electron theory. Ills. 16000 w. Rev Gen d Sci—May 30, 1908. No. 93106 D.

Magnetic Rays.

On the Probable Existence of a New Species of Rays (Magnetic Rays) Accompanying Discharge in a Magnetic Field. A. Righi. An account of observations and a proposed explanation. 1000 w. Elect'n, Lond—June 12, 1908. No. 93222 A.

GENERATING STATIONS.

Accumulators.

Performance of the Storage Battery and Its Relation to the Power Plant. W. B. Gump. Explains the performance of storage cells, the factors which determine the size of the battery to install and the fundamental considerations of an installation. 3000 w. Elec Rev, N Y —June 13, 1908. No. 92931.

Application of Storage Batteries to Regulation of Alternating-Current Systems. J. L. Woodbridge. Explains the advantages of a storage battery, and discusses the conditions to be met in the various a. c. systems. 7800 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93241 D.

Balancers.

Balancers. Arthur Imbery. Explains the action of balancers. 1100 w. Elec Rev, Lond—May 29, 1908. No. 92864 A.

Central Stations.

Power Plant Development at Birmingham, Ala. Illustrates and describes extensive improvements in the main generating station of the Birmingham street railway. 2000 w. St Ry Jour—May 30, 1908. No. 92678.

Turbo-Generator Station in Seattle, Wash. Illustrated detailed description of the station and its equipment. 3300 w. Elec Wld—June 20, 1908. No. 93037.

An 11,000-Kw. Turbo-Generator Station in Seattle, Wash. Illustrated detailed description of a station recently put in service. 4500 w. Eng Rec—June 6, 1908. No. 92829.

Wimbledon Electricity Undertaking. H. Tomlinson Lee. An illustrated description of this high-pressure a. c., single phase system. 3500 w. Elec Engr, Lond—May 22, 1908. No. 92747 A.

The Central Station of the Electrical Company of the North of France (La Station Centrale d'Electricité de l'Energie électrique du Nord de la France). Ch. Dantin. Illustrated description of this large steam-turbine station. 4500 w. Génie Civil—May 23, 1908. No. 93130 D.

See also Turbine Plants, under MECHANICAL ENGINEERING, Steam Engineering.

Design.

Concerning Overload in Electrical Plant. C. Turnbull. Discusses the mistake of supplying an engine more powerful than its dynamo, and other points related to economical operation. 1000 w. Elec Engr, Lond—June 5, 1908. No. 92979 A.

Economics.

Meeting Gas and Gasoline Competition in Small Stores. Gives points brought out by J. R. Cravath in a talk at the convention of the Nebraska Elec. Assn. 2500 w. Elec Wld—June 6, 1908. No. 92778.

See also Centrifugal Pumps, under MECHANICAL ENGINEERING, Hydraulic Machinery.

Hydro-Electric.

Water Power Development in the National Forests. A Suggested Government Policy. Frank G. Baum. Discusses the subject of royalties and outlines a government policy. 3500 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93293 D.

Hydro-Electric Development in Colorado. Lewis E. Ashbaugh. A report on the conditions and problems. Sketch maps. 2000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93385 N.

Hydro Power Transmission. Harold J. Wright. Illustrates and describes the development on the Styx River, Hillgrove, N. S. W. 1700 w. Aust Min Stand—May 6, 1908. Serial, 1st part. No. 92-883 B.

Hydro-Electric Plant of the La Crosse Water Power Company. George Merritt Ward. Illustrated description of a recent development in Wisconsin. 1600 w. Eng Rec—May 30, 1908. No. 92660.

The Hydro-Electric Power Plant of the Winchester & Washington City Railway Company. N. Wilson Davis. An illustrated account of a recently completed plant on the Shenandoah River. 2500 w. Eng Rec—June 20, 1908. No. 93063.

The Hydro-Electric Plant of the Great Northern Power Company. Arthur C. Ringsred. Illustrated description of a development on the St. Louis River, supplying power to Duluth and Superior. 2000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93383 N.

Some Engineering Features of the

Southern Power Company's System. J. W. Fraser. Describes this system and the proposed extension, showing how conditions affect the design. Maps and Ills. 2800 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93246 D.

A Modern American Low-Pressure Water Power Plant (Eine moderne amerikanische Niederdruck-Wasserkraftanlage). Guido E. Hemmeler. Begins an exhaustive description of the installations of the Southern Power Company. Ills. Serial, 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—May 30, 1908. No. 93199 D.

See Water Powers, under CIVIL ENGINEERING, Waterways and Harbors; and Surge Tanks, and Turbine Plants, under MECHANICAL ENGINEERING, Hydraulic Machinery.

Isolated Plants.

See Power Plants, under MECHANICAL ENGINEERING, Power and Transmission.

Operation.

Economical Operation of Small Generating Stations. Abstract of a paper by J. T. Whittlesey and Paul Spencer presented at the Chicago convention of the Nat. Elec. Lgt. Assn. Discusses the design and operation. 3500 w. Elec Wld—June 6, 1908. No. 92773.

Power Development in Small Stations. Charles Robbins and J. R. Bibbins. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Considers rates and how to increase the average load, giving a study of costs. 2000 w. Elec Rev, N Y—June 20, 1908. No. 93084.

Rates.

The Charges for Electrical Energy Supply in France. Georges Dary. Gives an idea of the general basis of rates in large towns. 1200 w. Elec Rev, Lond—June 19, 1908. Serial, 1st part. No. 93418 A.

Switchboards.

Operation of Large Hydro-Electric Station Switching Apparatus. F. E. Conrad. Considers important factors in the design, and discusses the operation. 4500 w. Elec Wld—May 30, 1908. No. 92689.

LIGHTING.

Arc Lamps.

Electric Illuminants and Their Efficiency. C. W. Kellogg, Jr. Read before the S. W. Elec. & Gas Assn. A discussion of efficiencies of arc and incandescent lamps, and the commercial considerations. 1700 w. Pro Age—June 1, 1908. No. 92764.

Electric vs. Gas.

Electricity or Gas?—The Problem of the Small Consumer. John D. Mackenzie. Discusses the objections urged against the use of electricity and explains a scheme of distribution. 2000 w. Elec Rev, Lond—June 12, 1908. Serial, 1st part. No. 93218 A.

European Practice.

Some Notes from Europe. Dr. Louis Bell. An account of different methods in use, especially in electrical equipments—lighting systems—etc. 2500 w. Elec Wld—June 27, 1908. No. 93307.

Illumination.

What Is Light? P. G. Nutting. An outline of the conditions which define light sensation in terms of radiation-power, discussing the three factors involved. Also editorial. 3500 w. Elec Wld—June 27, 1908. No. 93309.

The Number of Lamps for Uniform Illumination. Alfred A. Wohlauer. Gives convenient constants for use in determining the proper number and distribution of lighting units to obtain a desired effect. 1500 w. Elec Wld—June, 1908. No. 93312.

Incandescent Lamps.

An Incandecent Lamp Without a Vacuum. Information concerning the helion lamps. 1000 w. Sci Am—June 27, 1908. No. 93313.

High Voltage on Incandescent Lamps. Herbert S. Evans. Discusses the importance of using lamps rated at the voltage which is actually supplied. 1500 w. Jour of Engng, Univ of Colo—No. 4. No. 93282 D.

Faulting of Tantalum Lamp Filaments. Interesting pictures reproduced from microscopic observations by M. D. Abbott, showing these filaments at different stages of service, with different types of current supply. 500 w. Elec Wld—June 27, 1908. No. 93310.

Recent Progress in Tungsten Metallic Filament Lamps. H. Hirst. Historical résumé of the development of metallic filament lamps, with particulars of tests of osram, wolfram, tantalum and carbon lamps, showing the saving effected. 9000 w. Inst of Elec Engrs—May, 1908. No. 92746 N.

Recent Improvements in Incandescent Lamps. J. T. Morris. A lecture delivered at the School of Military Engng. at Chatham. Principally a consideration of recent progress in metallic filament lamps. Ills. 2800 w. Bul Int Ry Cong—May, 1908. No. 93373 G.

See also Arc Lamps, under Lighting.

Street Lighting.

Street Lighting in the City of London. The report of A. A. Voysey, drawing comparisons between electric lighting and gas lighting. Also editorial discussion. 3800 w. Elect'n, Lond—June 5, 1908. No. 92981 A.

Theaters.

European Practice in the Electric Equipment of Theaters. Frank Koester. Illustrated description of details, calling attention to differences from American practice. 1200 w. Elec Rev, N Y—June 27, 1908. No. 93354.

Electrical Equipment of the Forrest Theater, Philadelphia, Pa. Illustrates and describes interesting details of a new theater and its electrical arrangements. 2000 w. Elec Wld—June 27, 1908. No. 93308.

MEASUREMENT.

Conductivity.

The Measurement of Electrical Conductivity. Rollo Appleyard. Gives a summary of results of an investigation indicating the principles applied in the design of direct-reading instruments for the measurement of electrical conductivity. 1800 w. Elec Rev, Lond—June 5, 1908. No. 92973 A.

Frequency.

See Tachometers, under MEASUREMENT.

Instruments.

The Use of Direct-Current Portable Testing Instruments. E. P. Peck. Information concerning the errors in direct-current meters, and the care needed in using these testing instruments. 2000 w. Elec Wld—June 6, 1908. No. 92775.

Insulator Testing.

The Testing of High-Voltage Line Insulators. C. E. Skinner. Presents for discussion a proposed specification as standard for the testing of such insulators. 2500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93244 D.

Meter Calibration.

Calibration of Watt-Hour Meters. Joseph B. Baker. Directions for making the necessary adjustments. 2000 w. Elec Wld—June 27, 1908. No. 93311.

Meter Inspection.

General Inspection and Repairing of Service Meters. Joseph B. Baker. Considers electrical troubles of commutator meters and their remedies. 4000 w. Elec Wld—June 20, 1908. No. 93039.

Meters.

The Chauvin and Arnoux Portable Direct-Reading Wattmeter (Wattmètre de Précision portatif et à Lecture directe de MM. Chauvin et Arnoux). M. Aliamet. Illustrated description. 2400 w. L'Elecn—May 2, 1908. No. 93109 D.

Meter Testing.

Meter Laboratory of the Birmingham (Ala.) Railway, Light & Power Company. Brief illustrated description. 700 w. Elec Wld—June 20, 1908. No. 93038.

Potentiometers.

Potentiometer Design. Joseph H. Hart. Explains the potentiometer method of measuring electromotive force, the general designs and special applications for convenience and accuracy. 1500 w. Elec Rev, N Y—June 13, 1908. No. 92930.

Tachometers.

Resonance Instruments for the Distant Measurement of Revolutions and Frequency (Resonanzinstrumente zur Fernmessung von Umlaufzahlen und Frequenzen). Kurt Seidl. Illustrated description of various types. 2300 w. Glückauf—May 9, 1908. No. 93150 D.

Units.

The Absolute Value of the Ampere. A review of two recent papers before the Royal Society of London. "A New Current Weigher, etc.," by Messrs. Ayrton, Mather & Smith, and "The Silver Voltameter," by Messrs. Smith, Mather & Lowry. Also editorial. 5200 w. Elec Rev, N Y--June 6, 1908. No. 92796.

TRANSMISSION.

Insulators.

Electrical Porcelain. H. W. Brady. Abstract of a paper read before the Birmingham Dist. Elec. Club. Gives a classification and description of clays, discussing vitreous insulators for outdoor work and their manufacture. 3500 w. Mech Engr—May 29, 1908. Serial, 1st part. No. 92861 A.

Insulation of High Tension Transmission Lines. Francis S. Denneen. Abstract of paper read before the Cent. Elec. Ry. Assn. Considers the action of an insulator when subject to electrical stress, discussing the theory of insulator design and performance. 3500 w. St Ry Jour—May 30, 1908. No. 92681.

See also Insulator Testing, under MEASUREMENT.

Lightning.

Critical Study of Lightning Records on Taylor's Falls Transmission Line. Percy H. Thomas. Analyses of the paper punctures. 9000 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93294 D.

Lightning Protection.

Measurements of Lightning, Aluminum Lightning-Arresters, Earth Resistances, Cement Resistances, and Kindred Tests. E. E. F. Creighton. Describes briefly the instruments and methods used in the measurements, and the theory and practice of lightning protection. Ills. 18600 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93238 D.

Line Construction.

See Telephone Lines, under COMMUNICATION.

Line Design.

Fundamental Considerations Governing the Design of Transmission-Line Structures. D. R. Scholes. Briefly considers forces due to wind, sleet, low temperature, etc. 2500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93243 D.

Lines.

The 27,000-Volt Transmission System of the Obermatt Power Plant in Switzerland. Illustrated description of this high-tension transmission line, supplying Lucerne and vicinity. 1200 w. Elec Rev, N Y—June 13, 1908. No. 92928.

Electric Power Development on the Rio Grande Border. W. D. Hornaday. An account of the proposed transmission lines in N. & S. Laredo to operate pumping plants for irrigating the onion-growing districts of Texas. 1800 w. Elec Wld—June 6, 1908. No. 92771.

Distribution in Suburban Districts. George H. Lukes. Abstract of a paper read before the Nat. Elec. Lgt. Assn. Discusses details of line construction, substations, transformers, local systems, secondary distribution, etc. 4000 w. Elec Rev, N Y—June 13, 1908. No. 92929.

Losses.

High Voltage Measurements at Niagara. Ralph D. Mershon. A report of investigations on transmission losses, and results, especially the work at Niagara Falls. Ills. 10500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93245 D.

Protective Devices.

Switchgear Control Apparatus and Relays for Alternating-Current Circuits. Charles C. Garrard. Deals with instances where systems are designed on erroneous lines, and discusses other systems of control. 6000 w. Inst of Elec Engrs—May, 1908. No. 92866 N.

Protective Relays.

Alternating-Current Automatic Relays of Brown, Boveri and Co. (Relais automatiques Brown, Boveri et Cie. pour Courant alternatifs). L. A. David. Illustrated description of several types. 2500 w. L'Elecn—May 9, 1908. No. 93110 D.

Rotary Converters.

A New Type of Rotary Converter. H. L. Lincoln. Describes a split-pole converter produced by the General Electric Co. 900 w. Harvard Engng Jour—June, 1908. No. 93022 D.

The Sectional Pole Rotary Converter. Joseph L. Burnham. Describes these machines, which do not require any auxiliary apparatus for obtaining a variable d. c. voltage. Ills. 1500 w. Jour of Engng, Univ of Colo—No. 4. No. 93276 D.

Voltage Ratio in Synchronous Converters with Special Reference to the Split-Pole Converter. Comfort A. Adams. Gives a theoretical analysis with the object of showing how the field distortion of a split-pole converter does not necessarily involve electromotive force distortion. 6600 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93239 D.

Substations.

See same title, under STREET AND ELECTRIC RAILWAYS.

Transformers.

The Effect of Wave Form on the Core Losses of a Constant Potential Transformer. Fred H. Kroger. Experimental investigation. 700 w. Jour of Engng, Univ of Colo—No. 4. No. 93289 D.

Multiple Operation of Transformers. Royal W. Sorensen. Calls attention to some of the conditions that govern their operation, showing the simplicity of the problem. 1600 w. Jour of Engng, Univ of Colo—No. 4. No. 93286 D.

Leakage in Alternating-Current Transformers and Commutator Motors (Die Streuung bei Wechselstromtransformatoren und Kommutatormotoren). W. Rogowski and K. Simons. Mathematical and theoretical. Ills. Serial, 1st part. 3200 w. Elektrotech Zeitschr—May 28, 1908. No. 93184 D.

Voltage Drop.

Graphical Determination of Voltage Drop in Direct-Current Feeders. R. W. Stovel and N. A. Carle. Gives a diagram to facilitate calculations, explaining its use. 1200 w. Elec Jour—June, 1908. No. 93015.

Voltage Regulation.

Automatic Regulating Devices (Automatische Reguliervorrichtungen). Paul Thieme. Illustrates and describes several types of automatic switches. 2500 w. Elektrotech Zeitschr—May 28, 1908. No. 93185 D.

The Thury Automatic Regulators (Régulateurs automatiques Système R. Thury). J. A. Montpellier. Describes the construction and operation of types for use with direct and alternating currents. Ills. 3500 w. L'Elecn—May 30, 1908. No. 93112 D.

The Theory of the Tirril Regulator (Zur Theorie des Tirrill-Regulators). A. Schwaiger. Discusses the theory statically and dynamically. Ills. 2500 w. Elektrotech u Maschinenbau—May 17, 1908. No. 93172 D.

MISCELLANY.

A. C. Problems.

A Minimum Work Method for the Solution of Alternating-Current Problems. Harold Pender. Explains this new method and gives the solution of a number of problems. 3500 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93235 D.

Weather Bureau.

Electricity in the United States Weather Bureau. Day Allen Willey. An illustrated article showing how extensively electricity is used in this branch of government service. 2500 w. Elec Rev, N Y—June 6, 1908. No. 92795.

INDUSTRIAL ECONOMY

Apprenticeship.

The Apprenticeship System of To-Day. W. R. Warner. Read before the Nat. Soc. for Pro. of Ind. Ed. A discussion of the system. 1500 w. Ir Age—June 4, 1908. No. 92725.

Student Engineers and Their Work. Edward J. Cheney. Describes the training at the Schenectady Works of the General Electric Co., available for student engineers. 4000 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93381 N.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. This third article of a series discusses the profitable use of cost comparisons. 1500 w. Engineering Magazine—July, 1908. No. 93402 B.

Uniform Foundry Costs. A chart showing the distribution of labor, materials and burden, with extracts from the report submitted at the Toronto meeting of the Am. Found. Assn. 3500 w. Ir Age—June 25, 1908. No. 93301.

Depreciation.

Depreciation. Edwin S. Mack. Read before the Wisconsin Gas Assn. On the subject of depreciation in relation to public utilities. General discussion. 6500 w. Am Gas Lgt Jour—June 8, 1908. No. 92825.

Education.

Problems of Industrial Education. George Frederic Stratton. A critical discussion of the methods of manual training in the public schools, and of the general subject of apprenticeship. 3500 w. Cassier's Mag—June, 1908. No. 92997 B.

Engineering in Public Schools. Editorial discussion averse to teaching mechanical engineering in public schools, but favorable to the teaching of handicraft. 3000 w. Engng—June 12, 1908. No. 93227 A.

Machine-Tool Design in an Engineering Course. E. H. Fish. Describes work of the students of the Worcester Polytechnic Institute. 2200 w. Am Mach—Vol. 31, No. 25. No. 93034.

The New Method of Training Engineers. Magnus W. Alexander. Outlines briefly the system evolved by the General Electric Co. in the works at Lynn, Mass., and urges the coöperation of works and college to give the education needed. 5000 w. Pro Am Inst of Elec Engrs—June, 1908. No. 93247 D.

Modern Ideals in Mechanical Engineering Education. Walter Rautenstrauch. A critical discussion of mechanical engineering educational systems and the present requirements. 6000 w. Engineering Magazine—July, 1908. No. 93401 B.

The Academic Training of Mechanical Engineers in America and England (Die akademische Ausbildung der Maschinen-ingenieure in Nordamerika und England). Dr. Alexander Lang. A general review of the methods and curricula of mechanical-engineering education. 9000 w. Zeitschr d Ver Deutscher Ing—May 30, 1908. No. 93198 D.

The Development of Mechanical Engineering Training (Die Entwicklung des maschinen-technischen Studiums). A. Riedler. An important paper on conditions in Germany, with discussion. Ills. 23600 w. Zeitschr d Ver Deutscher Ing —May 2, 1908. No. 93181 D.

Eight-Hour Day.

Miners' Eight Hour Question. T. Good. Discusses the influence of the eight-hour rule on British industry. 2500 w. Cassier's Mag—June, 1908. No. 93001 B.

Engineering.

Engineering Personality and Organization. Walter C. Kerr. An address before the graduating class of Rensselaer Polytechnic Inst. 4000 w. Eng Rec—June 20, 1908. No. 93064.

Engineering Opportunities.

Opportunities for Young Technical Graduates in the United States. A discussion by authors residing in the East, West, and South. 2500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93384 N.

Industrial Development.

The Principles of Industrial Exploitation (Principes d'Exploitation industrielle). Max Furney. Outlines the circumstances which have favored the development of the industrial centres of France. Tables. 3000 w. Rev d'Econ Indus—May 16, 1908. No. 93100 D.

Industrial Legislation.

French Industry and the New Social Laws (L'Industrie Française et les nouvelles Lois sociales). René Duchemin. Discusses the effects of the employers' liability law, the weekly day of rest, and other recent acts. 3000 w. Génie Civil—May 9, 1908. No. 93126 D.

Management.

Recording and Accounting for Time. Oscar E. Perrigo. Ninth of a series of articles on shop management and cost keeping. 4500 w. Ir Trd Rev—June 4, 1908. No. 92785.

We supply copies of these articles. See page 823.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. The present number discusses typical inefficiencies and their significance. 3500 w. Engineering Magazine—July, 1908. Serial, 1st part. No. 93395 B.

Maximum Production Through Organization and Supervision. C. E. Knoeppel. This fourth and last article of a series discusses methods of securing better deliveries. 2500 w. Engineering Magazine—July, 1908. No. 93396 B.

Shop Order Tracing System. Charles M. Pond. Presents a system of chief interest to the manufacturer of tools, instruments, fixtures, and the like. 2500 w. Mach, N Y—June, 1908. No. 92697 C.

See also same title, under RAILWAY ENGINEERING, MISCELLANY.

New Zealand.

Industrial Conditions in New Zealand. J. J. Flather. Gives results of personal observations during an extensive tour in 1907. Ils. 2500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93386 N.

Patents.

Foreign Abuse of Our Patent Law. Editorial discussion of new patent legislation in England, and the foreign criticism of the "compulsory working" clause. 1800 w. Engng—May 8, 1908. No. 92499 A.

Patents and Inventors. E. C. Smith. An explanation of some of the difficulties and essentials. 2500 w. Mach, N Y—June, 1908. No. 92695 C.

Patent-Office Contests Between Rival Claimants to an Invention. Edwin J. Prindle. Supplementary to a series of articles concluded in the Dec. issue. Discusses the law of interferences and principles of its application. 4500 w. Engineering Magazine—July, 1908. No. 93400 B.

Stores Keeping.

See Stores Departments, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES.

Sweden.

Mining and Industrial Progress in Sweden. John Geo. Leigh. A survey of the important engineering enterprises under consideration is given. Ills. 5000 w. Engineering Magazine—June, 1908. No. 93393 B.

Wages.

See Management, under INDUSTRIAL ECONOMY.

MARINE AND NAVAL ENGINEERING

Battleships.

The New Method of Trying Battleships. An account of the trials required and tests made. Ills. 2000 w. Sci Am—June 13, 1908. No. 92907.

The Cult of the Monster Warship. William H. White. Discusses the increase in size and cost of recent warships, giving arguments for and against the new types. 11000 w. Nineteenth Cent—June, 1908. No. 93060 D.

Buoys.

Buoys and Beacons. Max Buchwald. Illustrates and describes various forms, explaining their purposes. 2500 w. Sci Am Sup—May 30, 1908. No. 92659.

Cruisers.

H. M. S. "Indomitable." Illustration, with notes on power, speed, etc. 1000 w. Engng—May 29, 1908. No. 92873 A.

The British "Dreadnought" Cruisers. Percival A. Hislam. Illustrates and describes the "Indomitable," one of the vessels of this class. 1000 w. Sci Am—May 30, 1908. No. 92656.

Dredges.

An Electrically Operated Dredge. Illustrates and describes an electrically driven suction dredge in use on the coast of California. 2500 w. Eng Rec—June 6, 1908. No. 92827.

A 5½ Foot Dredger with Two Trommels. D. Zicks. Describes a dredge built by the Poutiloff Works Co., Russia, for gold recovery. Ills. 6000 w. Min Jour—May 30, 1908. No. 92871 A.

See also Dredging, under MINING AND METALLURGY, GOLD AND SILVER.

Drydocks.

A Clever Substitute for a Drydock. H. M. Masdell. Illustrated description of caissons built to take the place of a drydock on Lake Ontario, for repairing a twin-screw steamer. 700 w. Sci Am—June 27, 1908. No. 93317.

Electric Power.

The Propelling Power of the Future. J. H. Biles. Discusses means of obtaining the full efficiency of turbines, describing the Mavor system of electric transmission for steam turbines. 2400 w. Marine Rev—May 28, 1908. No. 92686.

Fire Boats.

Fire-Fighting Tugboats. R. H. Newbern. Practical suggestions for converting tugboats into fireboats. 2500 w. Ins Engng—June, 1908. No. 93361 C.

New Fire Boats for New York. An account of the "James Duane" and "Thomas Willett," equipped with turbine-driven centrifugal pumps. 1200 w. Naut Gaz—June 11, 1908. No. 92921.

Model Basins.

Towing Tank at the University of Michigan. Day Allen Willey. Illustrated description of a tank for experimental work with ship models. 1500 w. Sci Am—June 13, 1908. No. 92908.

Models.

The Art of Marine Model Making. Illustrates various types of models and gives an account of fine work in their construction. 1000 w. Marine Rev—June 4, 1908. No. 92805.

Motor Boats.

The British Challenger for the Harmsworth Motor-Boat Trophy—A 400-Horse-Power Racing Craft. Illustrated description. 1500 w. Sci Am—June 13, 1908. No. 92910.

Piping.

The Protection of Ship Piping from Corrosion (Schutzmittel zur Verhinderung von Rohranfressungen auf Schiffen). Herr Schirmer. An illustrated discussion of the utility of various materials and methods. 1600 w. Schiffbau—May 27, 1908. No. 93156 D.

Propellers.

The Laying Out of Propeller Wheels. Charles S. Linch. Discusses the design and development. Ills. 1800 w. Int Marine Engng—July, 1908. Serial. 1st part. No. 93211 C.

Rudders.

The Evolution of the Rudder. Orlando Sumner. A brief review of the history and development, considering the effect of rudders upon fast power boats. 2000 w. Rudder—June, 1908. No. 92765 C.

Shipbuilding.

See Power Plants, under MECHANICAL ENGINEERING, Power and Transmission.

Ship Design.

Limitations Upon Ship Design. Brysson Cunningham. The principal difficulty is in regard to available depth of water. 1200 w. Marine Rev—June 4, 1908. No. 92806.

A New System of Ship Construction. J. W. Isherwood. Illustrated description of a new system of framing. 5000 w. Marine Rev—June 4, 1908. No. 92803.

Notes on the Form of High-Speed Ships. A. E. Long. A study of forms that may be used, with general discussion. 3 plates. 9000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1908. No. 93270 N.

Two Notes on Ship Calculations. W. S. Abell. Read before the Inst. of Naval Archts. The first note consists of a discussion of methods used, including a new rule for finding areas, etc., with a considerably less number of ordinates than usual. The second note gives a method of constructing an approximate metacentric diagram. 5000 w. Engng—June 5, 1908. No. 92988 A.

Ship Heating.

The Heating of Modern Ocean Liners. W. Carlile Wallace. Read before the Inst. of Naval Archts. Discusses the systems recently installed, favoring a system similar to that used on the Lusitania, combined with a system of electric heating under automatic control. 4500 w. Engng—June 12, 1908. No. 93229 A.

Steamboats.

A Survey Steamer for the Russian Government. Brief illustrated description of the Oxotckb. 200 w. Engr, Lond—May 29, 1908. No. 92881 A.

Steam Engines.

Marine Engine Design. Edward M. Bragg. Considers the main points of marine engine design, and the desirability of systematic data-keeping. 3000 w. Int Marine Engng—July, 1908. Serial. 1st part. No. 93208 C.

Steamships.

A Magnificent Lake Freight Steamship. Illustrated description of the Wilpen. 1000 w. Naut Gaz—June 4, 1908. No. 92781.

The Americo-Italian Emigrant Steamer Ancona. Benjamin Taylor. Illustrated detailed description. 700 w. Int Marine Engng—July, 1908. No. 93207 C.

New Holland-American Royal Mail Liner Rotterdam. Describes this large twin-screw steamer. 2500 w. Marine Rev—June 18, 1908. No. 93085.

New Japanese Transpacific Liners. Illustrated description of the largest ships ever built in Japan, and the first so built to be fitted with steam turbines, for service between Japan and San Francisco. 1200 w. Int Marine Engng—July, 1908. No. 93206 C.

Steam Turbines.

The Turbine Question. Henry Penton. A comparison of the turbines and reciprocating engines from the viewpoint of steam efficiency. 3000 w. Marine Rev—June 4, 1908. No. 92804.

Practical Experience with Marine Steam Turbines. Discusses some of the defects and some things of importance to avoid trouble. Ills. 2000 w. Int Marine Engng—July, 1908. No. 93209 C.

See also Electric Power, under MARINE AND NAVAL ENGINEERING.

Steering Gears.

The Control of Steam Steering Engines by Electric Motors (Ueber den elektromotorischen Antrieb des Wechselshiebers der Dampfrudermachine). A. Stauch. Describes several systems in use. Ills. 3000 w. Schiffbau—May 13, 1908. No. 93155 D.

Submarine Signalling.

The Development of Submarine Signalling. Robert G. Skerrett. Illustrates and describes electrical methods of communicating at sea. 2200 w. Cassier's Mag—June, 1908. No. 93000 B.

Torque.

Torque of Propeller Shafting: Some Investigations and Results. J. Hamilton Gibson. Read before the Inst. of Naval Archts. Discusses the application of torsion meters to propeller shafting, and describes the "Flashlight" torsion meter. 2200 w. Mech Engr—June 19, 1908. No. 93415 A.

U. S. Navy.

Admiral Evans's Report of the Needs of Our Ships. Editorial review of this report and its recommendations. 1200 w. Sci Am—June 13, 1908. No. 92905.

MECHANICAL ENGINEERING

AUTOMOBILES.

Chalmers New Detroit.

Chalmers New Detroit. Illustrated description of a new car of the E. R. Thomas Detroit Co. Commends the unit power plant. 1200 w. Automobile—June 11, 1908. No. 92924.

Commercial Vehicles.

Commercial Motor-Vehicles. A general discussion of their constructive features, motive power, and of points needing improvement. 4000 w. Engng—May 29, 1908. No. 92874 A.

The Berliet Motor Trucks (Camions automobiles, Système Berliet). A. Le Vergnier. Illustrated description, with details of costs of operation. 2200 w. Génie Civil—May 16, 1908. No. 93127 D.

The Construction and Economic Importance of Motor Omnibuses and Trucks (Bauart und wirtschaftliche Bedeutung der Motoromnibusse und Lastwagen). A. Hofmann. A review of their progress and present status. Ills. Serial. 1st part. 4800 w. Zeitschr d Mit Motorwagen Ver—May 15, 1908. No. 93157 D.

Tests of Motor Vehicles Carried Out by the Berlin Fire Department (Bericht über Versuche mit Kraftfahrzeugen bei der Berliner Feuerwehr von Branddirektor Reichel). A description of tests carried out during the past two years, giving results and conclusions. Serial. 1st part. 4000 w. Zeitschr d Mit Motorwagen Ver—May 31, 1908. No. 93158 D.

Construction.

Three Uncommon Bodies. Illustrated descriptions of types of comparatively short bodies. 2000 w. Autocar—May 30, 1908. No. 92858 A.

Driving Axles.

Simplifying Transmission of Power on an Auto. L. M. Dietrich. Illustrated description of the Dietrich universal automobile driving axle, explaining its principle. 1000 w. Automobile—June 4, 1908. No. 92780.

Farm Motors.

The Modern Farmer's Tireless Horse. Frank C. Perkins. Concerning uses to which the gasoline traction engine is being applied on American farms. Ills. 1200 w. Sci Am—June 27, 1908. No. 93315.

The Gasoline Tractor of the Future. George G. McVicker. Illustrated discussion of farm tractors for use in the west and southwest. 900 w. Gas Engine—June, 1908. No. 92728.

Fuels.

Petrol and Petrol Tests. G. H. Baillie. Read before the Roy. Auto. Club. Discusses the extent to which the fuel can be utilized, its condition, etc., giving a report of tests. 2500 w. Auto Jour—May 23, 1908. Serial. 1st part. No. 92737 A.

Ignition.

Ignition Cell Charging Plant. Fourd Ely. Describes the apparatus installed at the Dumfries Elec. Works. 900 w. Elec Engr, Lond—May 22, 1908. No. 92748 A.

Lorraine Dietrich.

The 20-30 H. P. Lorraine Dietrich. Illustrated description; the present number considering the engine and its control, the carburetter, and ignition. 1800 w. Autocar—June 6, 1908. Serial. 1st part. No. 92968 A.

Lubrication.

Lubrication on the Modern Automobile. Arthur H. Denison. Concerning the kind of oil required, the effect of poor lubrication, care in oiling, etc. Diagrams. 3500 w. Automobile—June 11, 1908. No. 92923.

Packard.

Packard's "Thirty," 1909. Illustrated description of this new model. 2000 w. Automobile—June 25, 1908. No. 93353.

Siddeley.

The 14 H. P. Siddeley Four-Cyl. Car. Illustrated detailed description. 1800 w. Autocar—May 23, 1908. No. 92738 A.

Silvertown.

Silvertown Electric Cars. Illustrated detailed description. 700 w. Autocar—May 30, 1908. Serial. 1st part. No. 92-859 A.

Sleds

Automobile Sled for Dr. Charcot's Expedition. Illustrates and describes a motor sled built for exploration of the Antarctic regions. 1200 w. Sci Am—May 30, 1908. No. 92655.

Spa.

The Spa Petrol Cars. Illustrated detailed description of this 60-h. p. Italian car. 1200 w. Auto Jour—May 30, 1908. Serial. 1st part. No. 92856 A.

COMBUSTION MOTORS.

Gas Engines.

Pre-ignition in Gas Engines. W. H. Booth. Discusses the causes. 1200 w. Can Engr—June 5, 1908. No. 92835.

Gas Engine Development Problems. Henry Harrison Suplee. Gives facts proving the reliability of the internal-combustion motor. 2500 w. Cassier's Mag—June, 1908. No. 93005 B.

Getting the Burned Gases Out of an Engine Cylinder. H. Addison Johnston. Gives diagrams and discusses the designing of exhaust valve cams, and other devices for providing a quick means of escape for the gas. 1500 w. Power—June 2, 1908. No. 92699.

The Present Status of the Gas Engine. H. D. Frary. Shows how obstacles that stood in the way of progress have been overcome, and discusses the advantages and disadvantages of the two-cycle engine. 2200 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93390 N.

See also Power Plants, under Power and Transmission.

Gasoline Engines.

The Schiske Aerial Petrol Motor. Photographs, drawings and description of the new features. 700 w. Auto Jour—May 30, 1908. No. 92857 A.

See also Power Plants, under Power and Transmission.

Gas Power Plants.

Gas Power Station at the Humber Company's Works. Illustrated description of a suction gas plant of eight gas engines with their separate suction gas producers, planned in such a way that any number or the whole can be used at once. 1000 w. Engr, Lond—May 29, 1908. No. 92878 A.

A Satisfactory Producer-Gas Plant. F. C. Tryon. An account of a factory plant in Brooklyn, N. Y., its operation and cost. 2200 w. Power—June, 1908. No. 92891.

Power Plant Operation on Producer Gas. Godfrey M. S. Tait. Discusses various types and arrangements, the difficulties met, experiments made, and information relating to operation. Ills. 3000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93254.

See also Pumping Plants, under Hydraulic Machinery; and Power Plants, under Power and Transmission.

Gas Producers.

Gas Producer Operation. Frank P. Peterson. A criticism of article by A. S. Atkinson in the May 12th issue of this paper. 1800 w. Power—June 16, 1908. No. 92996.

Gasification of Low Grade Fuels. L. G. Findlay. Abstract of a paper read before the Ohio Soc. of Mech., Elec. & Steam Engrs. Brief consideration of gas producers and the by-product oven. 1000 w. Power—June 23, 1908. No. 93096.

Gas Turbines.

Gas Turbines (Die Gasturbinen). Giuseppe Belluzzo. An abstract translation of a paper read before the Milan Society of Engineers and Architects. Ils. 2500 w. Serial. 2 parts. Zeitschr f d Gesamte Turbinenwesen—May 9 and 20, 1908. No. 93178 each D.

Oil Engines.

Notes on the Internal-Combustion Motor (Alcune Osservazioni sopra i Motori a Combustione interna). U. Bordoni. Refers particularly to the Diesel motor. Ills. 6500 w. Ann d Soc d Ing e d Arch Ital—May, 1908. No. 93133 F.

See also Pumping Engines, under Hydraulic Machinery; and Power Plants, under Power and Transmission.

HEATING AND COOLING.

Air Drying.

The Dehydration of Air. Joseph H. Hart. Examines methods of removing the moisture from air and applications made of the processes. 1800 w. Cassier's Mag—June, 1908. No. 92999 B.

Air Humidifying.

The Construction and Ventilation of a Weave Shed. Address before the Nat. Cotton Mfrs. Assn. Describes the building and the direct system of radiation adopted, the humidifying arrangements, etc. Ills. 1200 w. Heat & Vent Mag—June, 1908. No. 93029.

The Humidifying and Cooling of Air in Factories (Zur Frage der Luftbefeuchtung und Kühlung in Fabriken). E. Kronig. An elaborate paper giving many cost data. 12000 w. Gesundheits-Ing—May 2, 1908. No. 93169 D.

Central Plants.

Heating and Power Plant at Princeton Theological Seminary. Illustrates and describes a plant for a group of buildings already constructed, showing how a modern system of steam heating was adapted. 1300 w. Heat & Vent Mag—June, 1908. No. 93027.

Electric Heating.

Notes on the Electric Heating Plant of the Biltmore Estate. Charles E. Waddell.

States the reasons for the substitution of electricity for fuel and gives a detailed description of the systems. Ills. 3000 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93292 D.

Hot-Air Heating.

Heating and Ventilation of a Large Retail Store in San Francisco. Describes an interesting equipment of indirect heating by hot blast and exhaust ventilation. Ills. 2500 w. Eng Rec—June 6, 1908. No. 92828.

Hot-Water Heating.

The Calculation of Pipe Lines for Hot-Water Heating (Zur Berechnung der Rohrleitungen von Warmwasserheizanlagen). Criticisms of a paper by M. Haller by Herrn Dietz and Krell, with replies by Herr Haller. 2200 w. Gesundheits-Ing—May 2, 1908. No. 93170 D.

Refrigeration.

Air Cooling Problems. F. E. Matthews. How to calculate the amount of refrigeration needed. 1200 w. Power—June 9, 1908. No. 92903.

Fallacies of Refrigerating Theory. H. Rassbach. Discusses the principles involved in the change from the liquid to the gaseous form. 1800 w. Ice & Refrig—June, 1908. Serial. 1st part. No. 92798 C.

Mechanical Production of Low Temperatures. Sydney F. Walker. Considers the part the temperature of the refrigerant plays, and how the temperature of the cooling water affects the work of the engine or motor. 2500 w. Power—June 23, 1908. No. 93095.

A Modern Ice Making and Refrigerating Plant. Details of plan and construction of a 100-ton plant in Columbus, Ohio, and its equipment. 2500 w. Ice & Refrig—June, 1908. No. 92797 C.

Daily Routine in an Ice Plant. William S. Luckenbach. Considers points to be observed to realize the best economy. 2000 w. Power—June, 1908. No. 92888.

Electric Refrigeration in Philadelphia. John Meyer and R. L. Lloyd. Facts in regard to the experience in obtaining and retaining this class of business in the city named. Ills. 2500 w. Elec Wld—June 6, 1908. No. 92772.

How a Refrigerating Plant Was Remodeled. Warren O. Rogers. Deals with a refrigerating plant in a packing house where electric equipment was discarded and gas engines substituted, resulting in improved efficiency. 800 w. Power—June, 1908. No. 92889.

Steam Heating.

See Central Plants, under HEATING AND COOLING.

Ventilation.

See Hot-Air Heating, under HEATING AND COOLING.

HYDRAULIC MACHINERY.

Air Lifts.

Test of an Air-Lift Pumping Plant and Experimental Studies of Air-Lift Pumps. Describes the tests made at Atlantic City, N. J., and a series of experiments made by the Westinghouse Air Brake Co. 3000 w. Eng News—June 18, 1908. No. 93044.

Experiments with Air-Lifts. An account of the series of tests made on a driven well at Wilmerding, Pa., to determine the amount of water raised, air required and other conditions relative to pumping by direct air-pressure. 2000 w. Eng Rec—June 13, 1908. No. 92949.

Centrifugal Pumps.

The Motor-Driven Centrifugal Pump as a Central-Station Load. E. N. Percy. Points out the opportunities for a motor load for central stations presented by the use of such apparatus. 1800 w. Elec Wld—June 6, 1908. No. 92779.

See also Fire Boats, under MARINE AND NAVAL ENGINEERING.

Pumping Engines.

Notes on Two Recent Tests of Fuel Oil Pumping Engines. Describes the plants and conditions, and the tests made at Wrentham and at Wareham, Mass. 2000 w. Eng Rec—June 13, 1908. No. 92956.

Pumping Plants.

The Suction Gas-Producer Pumping Plant at Westford, Mass. Illustrated detailed description of a plant of the Westford Water Co. 1200 w. Eng Rec—May 30, 1908. No. 92664.

Operating Results of the Producer-Gas Pumping Plant at St. Stephen, N. B. Information from a paper by F. A. Barbour, giving results of a test of the equipment. Ills. 4000 w. Eng Rec—June 6, 1908. No. 92830.

The Testing of Pumping Plants (Ueber Untersuchungen an Wasserhaltungsanlagen). A description of a weir devised by Sulzer Brothers for the measurement of large discharges of water with results of its use. Ills. 2500 w. Glückauf—May 2, 1908. No. 93149 D.

See also Sewage Disposal, under CIVIL ENGINEERING, MUNICIPAL; and Nevada, under MINING AND METALLURGY, GOLD AND SILVER.

Pump Valves.

The Action of Automatic Pump Valves (Das Verhalten selbsttätiger Pumpenventile unter Voranssetzung des "Schwebezustandes"). H. Sieglerschmidt. Theoretical and mathematical. Curves. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—May 16, 1908. No. 93182 D.

Rams.

An Investigation of the Hydraulic Ram. Leroy Francis Harza. Investigations made to derive general mathematical laws which shall apply to all single-acting hydraulic rams under all conditions of use; and to show that the formulae are justified. Ills. 12000 w. Bul Univ of Wis, No. 205—March, 1908. No. 93366 C.

Suction Pipes.

The Design of Suction Pipes. James Anderson. Read before the Inst. of Marine Engrs. Discusses the theoretical side of the subject showing how the design is modified by the various conditions. 3000 w. Mech Wld—May 29, 1908. No. 92855 A.

Surge Tanks.

The Surge Tank in Water Power Plants. Raymond D. Johnson. A mathematical determination of the economical proportions of a device for aid in speed regulation and pressure relief in water power, with long pressure pipes and high velocities. 8000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93257 C.

Turbine Plants.

A Device to Increase the Effective Head of a Water Power Plant by Utilizing Waste Water. Describes Clemens Herschel's "fall increaser" designed to increase the effective head of turbine plants by the use of freshet water going to waste Ills. 400 w. Eng News—June 11, 1908. No. 92940.

The Fall-Increaser. Clemens Herschel. An account of experiments on negative pressure: made at the public testing flume of the Holyoke Water Power Co., with an apparatus designed to increase the fall acting on hydraulic turbines in cases of a low fall, when caused by back water; or, when existing naturally with a plentiful supply of water, for the purpose of increasing the speed. Ills. 3500 w. Harvard Engng Jour—June, 1908. No. 93021 D.

Turbines.

The Scope of Application of Turbines Built on the Usual Systems (Verwendungsbereich der im modernen Turbinenbau üblichen Turbinensysteme). Herr Holl. Discusses mathematically the various types of water turbines, beginning with the Francis. Ills. Serial. 1st part. 3500 w. Zeitschr f d Gesamte Turbinenwesen —May 20, 1908. No. 93179 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

The Resistance of Balls and Rollers (La Résistance des Billes et des Rouleaux). Maurice Koechlin. A mathematical paper deriving formulae and giving tables of results. Ills. 2500 w. Génie Civil —May 9, 1908. No. 93125 D.

Clutches.

The Wheeling Electric Induction Clutch. Illustrated description, with statement of advantages and applications. 2500 w. Ir Age—June 11, 1908. No. 92894.

Drafting.

See Management, under RAILWAY ENGINEERING, Miscellany.

Graphical Statics.

The Circle of Stress. M. Linenthal. An explanation of this graphical method for solving problems of internal stress. 700 w. Harvard Engng Jour—June, 1908. No. 93024 D.

Moments of Inertia.

Deduction and Application of Moment of Inertia. Mathematical explanation. 1000 w. Prac Engr—June 19, 1908. Serial. 1st part. No. 93414 A.

Rotating Discs.

Forms of Equal Strength with Special Reference to Rotating Discs (Ueber Formen gleicher Festigkeit mit besonderer Berücksichtigung der rotierenden Scheiben). Alfons Leon. An illustrated mathematical discussion. Serial. 1st part. 2500 w. Zeitschr d Oest Ing u Arch Ver —May 1, 1908. No. 93159 D.

Screws.

Comparison of Screw Thread Standards. Amasa Trowbridge. Gives a diagram used to study the problem, with remarks. 300 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93253.

MACHINE WORKS AND FOUNDRIES.

Boiler Making.

Helpful Hints for Boiler Makers. Charles Dougherty. Hints from the West Albany shops of the N. Y. C. & H. R. R. R. Gives a diagram for finding the length of rivets, and illustrates various tools and an oil burner. 500 w. Boiler Maker—June, 1908. No. 93008.

Boring Machines.

Large Turning and Boring Mill. Illustrated description of an unusually large machine built at Manchester, Eng. 500 w. Engr, Lond—May 29, 1908. No. 92880 A.

Cam Casting.

See Milling Machines, under Machine Works and Foundries.

Case Hardening.

Modern Methods of Case Hardening. J. F. Springer. An illustrated article describing processes used and their defects, and the advantages of a new process of applying hydrocarbon gases for case-hardening steel, which has been invented by Adolph W. Machlet. 2000 w. Cassier's Mag—June, 1908. No. 93002 B.

Annealing Steel Castings. W. M. Carr. Read at meeting of Am. Found. Assn. Considers an annealed casting less liable to fail in service, and discusses conditions. 900 w. Ir Age—June 11, 1908. No. 92896.

Castings.

Method of Obtaining a Circular and Uniform Chill in Rolls. Thomas D. West.

Read before the Am. Soc, for Test. Mat. Illustrates and describes the invention of Ralph H. West, designed to overcome the evil effects of a contracting crust, giving a detailed account of the operation. 1400 w. Ir Age—June 25, 1908. No. 93300.

Chain Making.

The New Works of Messrs. Hans Renold, Limited. Illustrated description of these chain-making works, describing the chains made, and the extensive use of chain-driving, giving examples of the applications. 4500 w. Engng—May 22, 1908. Serial. 1st part. No. 92750 A.

Core Boxes.

Making Core Boxes by Machinery. A machine which handles a large variety of shapes and sizes is illustrated and described. 1000 w. Am Mach—Vol. 31, No. 26. No. 93306.

Cupolas.

Cupola Construction. Walter J. May. Drawings and description of a cupola of simple form. 1500 w. Mech Wld—June 5, 1908. No. 92963 A.

Cutting Tools.

Possibilities of High Speed Tool Steel. L. R. Pomeroy. A review of recorded tests, horse power requirements, etc., giving data on high-speed steel performances of much interest. General discussion. 11000 w. Pro Cent Ry Club—May 8, 1908. No. 93019 C.

Dies.

An Index Die for Armature Punchings. K. S. Allen. Diagram and description of an index die used for slotting armature punchings. 2000 w. Am Mach—Vol. 31, No. 25. No. 93036.

Drilling Machines.

Advanced Designs of German Drilling Machines. Oskar Kylin. Half-tones and description of types made in Dresden. 1200 w. Mach, N Y—June, 1908. No. 92696 C.

Foundries.

Problems Involved in the Erection and Equipment of a Modern Foundry. W. T. Hatch. Read before the New England Found, Assn. Describes features of the foundry of the Brown & Sharpe Mfg. Co. 3000 w. Foundry — June, 1908. No. 92718.

Foundry Materials.

Grading Pig Iron, Ferro-Alloys and Coke. Gives grading prepared by Eliot A. Kebler. 4000 w. Ir Trd Rev—June 25, 1908. No. 93321.

The Selection and Testing of Foundry Irons. F. M. Thomas. Read before the British Found. Assn. Gives a classification and discusses the effect of different elements. 2000 w. Mech Wld—June 5, 1908. Serial. 1st part. No. 92964 A.

The Selection and Testing of Foundry Irons. F. M. Thomas. Read at meeting at the Birmingham, Eng., Tech. Sch. Considers the selection, classification, refining, local characteristics, effects of various elements, etc. 6000 w. Mech Engr—May 22, 1908. No. 92744 A.

Foundry Practice.

Semi-Steel Mixtures and Methods of Calculating the Charges. M. B. Smith. 1500 w. Foundry — June, 1908. No. 92715.

Latter-Day Radiator Practice. Illustrates and describes interesting features of coremaking and molding as practiced in a Toronto shop. 1800 w. Foundry—June, 1908. No. 92712.

Automobile Cylinder Manufacture. L. N. Perrault. Read before the Am. Found. Assn. Discusses the process, its complications and requirements, etc. 2500 w. Ir Age—June 18, 1908. No. 93031.

Galvanizing.

The Deposition of Zinc for the Protection of Iron and Steel Surfaces. Sherard Cowper-Coles. Abstract of paper read before the Glasgow Tech. College Sci. Soc. Describes the processes at present in use for applying zinc to iron and steel, explaining the advantages of Sherardizing, etc. Ills. 6200 w. Ir & Coal Trds Rev—May 15, 1908. No. 92761 A.

Gear-Cutting.

The Pedersen Gear-Cutter. Illustrated description of an ingenious machine of unusual type, manufactured by Messrs. Vickers Sons & Maxim, Ltd., Erith, Eng. 1500 w. Engng—June 5, 1908. No. 92984 A.

A Worm Wheel Hobbing Machine. W. F. Groene. Illustrates and describes the machine used by the R. K. Le Blond Co. for hobbing index wheels and the accurate results. 1000 w. Am Mach—Vol. 31, No. 24. No. 92898.

Lathes.

A Heavy Locomotive Wheel Lathe. A 90-inch driving-wheel lathe, built by the Sellers Co., Philadelphia, is illustrated and described. 1000 w. Am Mach—Vol. 31, No. 23. No. 92768.

Machine Tools.

Machine Tools at the Franco-British Exhibition. Joseph Horner. Deals principally with the English exhibits, giving illustrated descriptions. Plates. 5000 w. Engng—June 5, 1908. No. 92983 A.

Milling Machines.

Alignment Tests of Le Blond Milling Machines. Illustrated description of tests regularly made and of manner of supporting the machine column. 1300 w. Mach, N Y—June, 1908. No. 92693 C.

A Machine for Milling Screw-Machine Cams. J. P. Brophy. A miller with geared mechanism and positive control is illustrated and described. 1000 w. Am Mach—Vol. 31, No. 24. No. 92900.

Molding.

Molding a Steam Crane Cylinder. Joseph Horner. Illustrated description of a method of making a difficult casting. 1000 w. Foundry—June, 1908. No. 92716.

Molding Machines.

Spacing and Mounting Patterns. Alexander M. Thompson. Illustrates and describes a device for fitting patterns quickly and accurately on molding machines. 2000 w. Foundry—June, 1908. No. 92717.

Moulding and the Bonvillain and Ronceray Machines (Das Formverfahren und die Maschinen Patent Bonvillian & Ronceray). A. F. Hager. Discusses moulding machines in general and particularly the product of the machines mentioned. Ills. 2300 w. Oest Zeitschr f Berg u Hüttenwesen—May 23, 1908. No. 93148 D.

Patterns.

The Marking and Storing of Patterns. John J Jackson. Describes a system recommended. 2200 w. Mech Wld—June 5, 1908. No. 92962 A.

The Classification of Patterns. Oscar E. Perrigo. Explains a modern system of recording patterns. 3500 w. Foundry—June, 1908. No. 92714.

Errors in the Design of Patterns. Paul R. Ramp. Discusses changes that would overcome many difficulties. Ills. 2000 w. Foundry—June, 1908. No. 92713.

Pipe Founding.

Casting Pipes in Permanent Molds. Edgar A. Custer. Describes a method in which the supposed evils of unequal heating and cooling do not exist. Ills. 3500 w. Jour Fr Inst—June, 1908. No. 93-259 D.

Planers.

A Rotary Twin Planer and Its Work. Claude Aikens. Illustrated description of a machine for the new works of the Allis-Chalmers Co., explaining its advantages. 1500 w. Am Mach—Vol. 31, No. 26. No. 93305.

Notes on the Design of a 36 x 36-Inch Planer. Gives the general features of the design, the elements determined by computation, and others decided upon by judgment. 5500 w. Am Mach—Vol. 31, No. 23. No. 92770.

Pneumatic Fixtures.

Pneumatic Fixtures for Holding Work. M. E. Service. Describes the application of compressed air for holding various kinds of work to be machined and its effect on the cost of production. Ills. 3500 w. Am Mach—Vol. 31, No. 23. No. 92769.

Screw Machinery.

Making Watch Parts in the Commercial Automatic Screw Machine. Illustrated description of American watchmaking practices. 2500 w. Mach, N Y—June, 1908. No. 92694 C.

Shop Appliances.

A Machine Shop Square That Is a Square. John E. Sweet. Illustrated description, with statement of its advantages and uses. 700 w. Am Mach—Vol. 31, No. 25. No. 93033.

Shop Heating.

Heating Systems for Mills. A. G. Hosmer. Address before the Nat. Assn. of Cotton Mfrs. Considers the merits and demerits of the various systems used. 3000 w. Heat & Vent Mag—June, 1908. No. 93028.

Shop Practice.

The Product and Methods of European Locomotive Works. Charles R. King. This second article of a series gives time and cost data of the new welding process. 2500 w. Engineering Magazine—July, 1908. No. 93394 B.

Building the Lucas Boring Machine. Illustrates and describes interesting details of shop construction and methods used in securing accurate work. 1800 w. Am Mach—Vol. 31, No. 26. No. 93304.

Machine Work on Steel-Mill Machinery. Information from a Pittsburg plant as to time consumed in roll turning, use of milling cutters for machining bearings, and other methods of work. Ills. 1600 w. Am Mach—Vol. 31, No. 92897.

Hand Turning Operations in the Lathe. James Lomas. Illustrates and describes methods used in machining pulleys, facing gear rims and hubs and performing numerous other operations in the hand lathe with simple tools. 2200 w. Am Mach—Vol. 31, No. 25. No. 93035.

Shops.

A Modern Wood Working Machinery Factory. H. R. Cobleigh. Illustrated detailed description of the Rochester works of the American Wood Working Machinery Co. 5500 w. Ir Age—June 18, 1908. No. 93030.

The Famout Creusot Works of France. J. B. Van Brussel. Illustrated description of this important metal-working plant. 1600 w. Am Mach—Vol. 31, No. 23. No. 92767.

The Adams Manufacturing Company's Works, Bedford. Illustrated description of works where starting switches and speed-regulating rheostats are made. 1500 w. Elec Engr, Lond—May 29, 1908. No. 92863 A.

The Edgwick Works of Messrs. Alfred Herbert, Ltd., Coventry. Brief illustrated description of the new machine tool works. Plates. 4500 w. Engng—June 12, 1908. No. 93225 A.

See also Chain Making, under MACHINE WORKS AND FOUNDRIES.

Shop Ventilation.

The Removal of Dust and Fumes in Factories. J. S. Haldane. The 4th Shaw lecture on "Industrial Hygiene." On the dangers of dust, gases, etc., methods of preventing or removing, and apparatus employed. Ills. 5500 w. Jour Soc of Arts—May 22, 1908. No. 92735 A.

Stores Departments.

The Arrangement and Management of the Stores Department at Opladen (Innere Einrichtung und Betrieb des Werkstätten-Hauptmagazins Opladen). Herr Schwarzer. Illustrated description of stores-keeping methods at these large repair shops of the Prussian State Railways. 5500 w. Glasers Ann—May 15, 1908. No. 93166 D.

Tool Systems.

See also Management, under RAILWAY ENGINEERING, MISCELLANY.

Welding.

Electric Welding and Some of Its Products. Illustrated description of the plant and products of the Electric Welding Products Company, Cleveland, Ohio. 1100 w. Ir Age—June 4, 1908. No. 92722.

Autogenous Welding of Metals. L. L. Bernier. Discusses high temperatures for industrial purposes obtained by means of oxyhydric, oxy-acetylenic, and oxygen burners. Ills. 3000 w. Boiler Maker—June, 1908. No. 93007.

Autogenous Welding in Auto Construction. E. S. Foljambe. Describes methods of work, and operations to which it is adapted. 2500 w. Automobile—June 25, 1908. No. 93352.

The Autogenous Soldering of Aluminium in Aeronautic Construction. Remarks on the uses of aluminium and the problem of soldering or welding and its solution. 1000 w. Sci Am—June 20, 1908. No. 93048.

New Processes for Metal Cutting and Autogenous Welding. J. B. Van Brussel. An illustrated article dealing especially with blow-pipe processes, giving practical results. 3500 w. Engineering Magazine—July, 1908. No. 93397 B.

See also Shop Practice, under MACHINE WORKS AND FOUNDRIES; and Track Bonding, under STREET AND ELECTRIC RAILWAYS.

MATERIALS OF CONSTRUCTION.

Alloys.

White Alloys: White Brass, White Bronze, etc. Walter J. May. Shows that some of the alloys claimed as new are only old alloys with new names. 1400 w. Prac Engr—May 22, 1908. No. 92742 A.

The Smelting of White-Metal Drosses and Residue and the Manufacture of Solder and Babbitt-Metals. Lionel D. Waixel. Illustrates and describes methods used at the plant of the Union Smelting & Refining Co., New York City. 1000 w. Brass Wld—June, 1908. No. 93052.

New Bronzes for Machine, Gun, and Ship Construction (Neue Bronzen für den Maschinen-, Geschütz-, und Schiffsbau). Walter Rübel. Discusses the properties of the "Rübel" bronzes recently put on the market by the Skoda Works, Pilsen. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver —May 29, 1908. No. 93163 D.

Alloy Steels.

Vanadium and Its Application to Steel-Making. Information concerning this metal, giving tabulated results of tests of vanadium steels, etc. 2000 w. Ir & Coal Trds Rev—May 29, 1908. No. 92885 A.

Vanadium Steels (Lettre de M. Rey-Maréchal, à propos des Aciers au Vanadium). A letter from M. Rey-Maréchal with notes by M. Léon Guillet. 2200 w. Rev de Métal—May, 1908. No. 93113 E + F.

Cast Iron.

Titanium in Cast Iron. Dr. Richard Moldenke. Read before the Am. Found. Assn. How to use ferro-titanium, the effect, remelting, etc. 2000 w. Ir Age—June 18. 1908. No. 93032.

Cast Iron in the Construction of Chemical Plant. F. J. R. Carulla. Read before the Iron & Steel Inst. Discusses the questions of the effect of acids and other chemicals and the precautions necessary to meet special conditions. 1800 w. Ir & Coal Trds Rev—May 15, 1908. No. 92-757 A.

See also Metallography, under MATERIALS OF CONSTRUCTION.

Inspection.

Testing Is Not Inspection. W. A. Aiken. Read at meeting of the Am. Soc. for Test. Mat. Discusses commercial inspection methods. 2000 w. Ry & Engng Rev—June 27, 1908. No. 93410.

Irons.

Different Forms of Iron in Commerce. Henry Koehler. Brief consideration of pig-iron, cast-iron, steel, and wrought iron. 2500 w. Pro St Louis Ry Club—May 8, 1908. No. 93018.

Metallography.

The Metallography of Cast Iron (La Métallographie de la Fonte). Gives the results of researches on the effects of silicon. Ills. 2700 w. Génie Civil—May 16, 1908. No. 93129 D.

Nickel and Manganese in Cast Iron (Les Fontes au Nickel et les Fontes au Manganese). Léon Guillet. A metallographic study. 4000 w. Rev de Métal—May, 1908. No. 93114 E + F.

Semi-Steel.

See Foundry Practice, under MACHINE WORKS AND FOUNDRIES.

Steel.

Physical Qualities of Steel in Relation to Its Mechanical Treatment. James E. York. Read before the Ir. & St. Inst. Reviews the present methods of treatment, suggesting changes believed to result in more reliable rails and sections. 3300 w. Mech Engr—May 22, 1908. No. 92745 A.

Tool Steels.

See Cutting Tools, under MACHINE WORKS AND FOUNDRIES.

MEASUREMENT.

Hardness.

The Application of the Brinell Method to Special Steels (Application de l'Essai de Brinell aux Aciers spéciaux). M. Louis Revillon. Discusses especially the testing of small pieces. Ills. 2000 w. Rev de Métal—May, 1908. No. 93117 E + F.

Metric System.

The Engineering Pros and Cons of the Metric System. Arthur H. Allen. Outlines the origin and nature of the system, discussing its merits and defects. 5400 w. Soc of Engrs—June 1, 1908. No. 93020 N.

Pyrometry.

The Pyrometric Installation in the Gun Section, Royal Gun and Carriage Factories, Woolwich. Wesley J. Lambert. An illustrated description of the leading points of the system employed. 5500 w. Ir & Coal Trds Rev—May 15, 1908. No. 92760 A.

The Use of the Differential Galvanometer (Notes sur l'Emploi du Galvanomètre différentiel). M. A. Portevin. A mathematical discussion of its use in studying the heat treatment of steel. Ills. 3000 w. Rev de Métal—May, 1908. No. 93115 E + F.

Testing Methods.

A New Fatigue Test for Iron and Steel. T. E. Stanton. Read before the Iron & Steel Inst. An illustrated account of experimental investigations, describing the apparatus used. 1200 w. Engng—May 22, 1908. No. 92753 A.

Torsion Meters.

The Measurement of Mechanical Power by Torsion Meters (Emploi des Torsion-Mètres pour la Mesure des Puissances mécaniques). J. Izart. Illustrates and describes various types and their use. 4000 w. L'Elecn—May 16, 1908. No. 93111 D.

See also Torque, under MARINE AND NAVAL ENGINEERING.

POWER AND TRANSMISSION.

Air Compression.

Imperfect Intercooling and Efficiency of Compression. S. B. Redfield. The article is confined to compound or two stage compression, and presents diagrams and curves showing the results. 2500 w. Compressed Air—June, 1908. No. 93025.

Belt Driving.

A Chart for Belt Horsepower, Area of Cut and Weight of Metal Removed. J. J. Densman. Gives a chart for determining the power developed by any pulley, having given the diameter, width, and speed. 400 w. Am Mach—Vol. 31, No. 26. No. 93303.

Chain Driving.

See Chain Making, under MACHINE WORKS AND FOUNDRIES.

Compressed Air.

Compressed Air Calculations. E. A. Rix. Read before the Min. Assn. of the Univ. of California. An explanation of methods of determining the amount of compressed air required for various kinds of work, and related matters. 3500 w. Compressed Air—June, 1908. No. 93026.

The Moisture in the Atmosphere and Its Effect on the Operation of Compressed Air Machinery, Especially Air Brake, Multiple-Unit Train Control and Train Signal Systems. H. M. Provost Murphy. Points out the physical laws involved, explaining the most approved methods of securing "dry air," etc. 4000 w. Eng News—June 18, 1908. No. 93042.

Costs.

The Cost of Steam Power in Varying Units. William O. Webber. A discussion of power costs as given in an earlier article by Mr. Snow. 1500 w. Engineering Magazine—July, 1908. No. 93399 B.

Electric Driving.

The Electrical Equipment of the Cargo Fleet Iron Co.'s Works. An illustrated description of an up-to-date installation. 5000 w. Ir Trd Rev—June 4, 1908. No. 92786.

An Electrically Driven Woodworking Plant. Illustrated description of a new plant at Marion, Va. 1500 w. Wood Craft—June, 1908. No. 92719.

Power Transmission in Woodworking Plants. W. L. Crouch. Gives conclusions from recent experience in a good-sized woodworking shop. Ills. 1500 w. Wood Craft—June, 1908. No. 92720.

Electric Power Transmission. Ira J. Owen. Presents the advantages of the system, urging its use in shops and discusses the fire hazard. Ills. 1800 w. Ins Engng—June, 1908. No. 93362 C.

Electric Driving for Machine Shops, Railroad Shops and Manufacturing Plants Using Machine Tools and Woodworking Machinery. Norman G. Meade. A discussion of the engineering features of motor driving. 2000 w. Elec Wld—June 6, 1908. No. 92777.

Electric Driving in Cotton-Spinning Factories. William Hanna. Discusses the advantages and the outlook for the application in England. 2000 w. Elec Engr, Lond—May 29, 1908. No. 92862 A.

See also Rolling Mills, under MINING AND METALLURGY, IRON AND STEEL.

London.

Power Used in London Factories. T. H. Minshall. Gives statistics recently collected, with general remarks. 1500 w. Engng—May 29, 1908. No. 92872 A.

Mechanical Plants.

Plant of the Onondaga County Court House. Leo L. Post. Illustrated description of the plant and equipment. 2000 w. Power—June 9, 1908. No. 92901.

Mechanical Equipment of the Union National Bank Building, Pittsburg, Pa. Illustrated description of a very complete plant for a 21-story building. 2700 w. Eng Rec—June 27, 1908. Serial, 1st part. No. 93351.

Engineering of the Mechanical Equipment of a Large Store Building. Percival R. Moses. Describes the building and its equipment, discussing the different types of apparatus and systems of heating, lighting, power supply, ventilation, etc. Ills. 2500 w. Elec Rev, N Y—June 20, 1908. Serial, 1st part. No. 93082.

See also Central Plants, under HEATING AND COOLING.

Power Plants.

Internal Combustion Engines and Hydroelectric Power. Henry Docker Jackson. Outlines the possibilities of gasolene, gas and oil engines. 2000 w. Power—June 23, 1908. No. 93094.

Working Results from Gas-Electric Power Plant. J. R. Bibbins. Report of 30-day test on service plant, Richmond Works of the American Locomotive Co., Richmond, Va. 2500 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93296 D.

Power-House Equipment of the Fairfield Shipbuilding and Engineering Company, Ltd. Illustrated description of an exceptionally large private plant at Govan, Glasgow. 1000 w. Engng—June 12, 1908. No. 93226 A.

Messrs. Harland and Wolff's Works at Belfast. Illustrated description of the new power station and its equipment, and other improvements. 3000 w. Engng—June 12, 1908. No. 93228 A.

Identification of Power House Piping by Colors. William H. Bryan. Gives a tabulation of color schemes that have been tried, urging a uniform system. 2000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93252.

See also Coal Handling, under TRANSPORTING AND CONVEYING; and Trestles, under CIVIL ENGINEERING, BRIDGES.

Pulleys.

Methods and Means for Loosening Pulleys. Charles Herrman. Illustrates various methods. 1500 w. Power—June 23, 1908. No. 93097.

Rope Driving.

Rope Driving. W. H. Booth. Discusses briefly the velocity and stresses. 800 w. Power—June 16, 1908. No. 92995.

Sawmills.

Power Plants for Sawmills. W. J. Blackmur. Briefly discusses the advantages and disadvantages of steam, gas, and electricity as sources of power. 2000 w. Power—June 23, 1908. No. 93091.

Shafting.

Sizes of Shafts without Mathematics. John H. Barr. Gives chart for solving problems involved in designing or checking shafts having a solid, circular cross-section. 3000 w. Am Mach—Vol. 31, No. 24. No. 92899.

Textile Mills.

The Transmission of Power in the Textile Industry (Le Trasmissioni del Moto nell' Industria tessile). G. Beltrami. Discusses the relative merits of direct driving, gears, belts, ropes, and the electric drive. Serial, 1st part. 7000 w. L'Industria—May 10, 1908. No. 93-137 D.

STEAM ENGINEERING.

Boiler Management.

See Flue-Gas Analysis, under STEAM ENGINEERING.

Condensers.

Condensing Plant. W. Matthews. Brief consideration of various types of condensers. 1500 w. Mech Wld—June 19, 1908. No. 93412 A.

Air Leakage in Steam Condensers. Thomas C. McBride. A plea for scientific consideration of the subject. 3500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93255.

Cylinder Condensation.

Some Neglected Aspects of Cylinder Condensation. The first of a series of articles aiming to deal fully with this question. 3000 w. Engr, Lond—May 29, 1908. Serial, 1st part. No. 92877 A.

Ejectors.

New Ejectors. Diagrams and description of a new Westinghouse ejector of the self-starting type, which aims to maintain a higher vacuum than hitherto. 2000 w. Mech Engr—June 5, 1908. No. 92971 A.

Engine Design.

See Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Economy.

See Engine Tests, and Piston Speed, under STEAM ENGINEERING.

Engine Governing.

Unequal Points of Cut-Off. W. H. Wakeman. Gives diagrams showing uneven points of cut-off, explaining the cause. 1000 w. Power—June 16, 1908. No. 92993.

Angular Variation Between a Shaft Governor and the Fly Wheel. Jacob H. Wallace. Presents a method for determining experimentally the angular variation between the arm of a governor carrying the eccentric and the fly wheel of the engine. 1000 w. Jour of Engng, Univ of Colo—No. 4. No. 93284 D.

Engines.

A Comparison Between Single and Double-Acting Engines. H. Keay Pratt. Discusses engines up to 50 or 60 B. H. P. 1800 w. Prac Engr—June 19, 1908. No. 93413 A.

Engine Tests.

Economy Tests of High Speed Engines. F. W. Dean. An account of tests to determine economy and efficiency of non-condensing reciprocating steam engines in actual operation. Ills. 4000 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93256 C.

Entropy Diagram.

The Safe and Effective Use of the Entropy Diagram. S. A. Reeve. A discussion of the application of the entropy diagram to the solution of problems in engineering. 1500 w. Power—June 23, 1908. No. 93092.

Feed-Water Heating.

Steam Boiler Efficiency and Live Steam Feed-Water Heating. Albert Jonel. This first article of a series condemns the internal type of heater. 800 w. Elec Rev, Lond—June 19, 1908. Serial, 1st part. No. 93417 A.

Flue-Gas Analysis.

Does It Pay to Equip a Boiler Room with CO_2 Recorders? H. J. Westover. How to install the apparatus, the value of good records, how to read the chart, etc. 2000 w. Power—June, 1908. No. 92887.

Fuels.

Burning Oil for Power and Heating. William D. Ennis. Discussion of conditions under which best results are obtained, illustrating and describing types of equipment. 3500 w. Power—June 16, 1908. No. 92994.

Burning Oil for Power and Heating. William D. Ennis. A discussion of the properties and possibilities of fuel oil. 3000 w. Power—June 23, 1908. No. 93093.

Burning Liquid Fuel Without Steam or Compressed Air. Robert Schorr. Remarks on the Koerting system and its use with American oils. 1400 w. Min & Sci Pr—June 20, 1908. No. 93325.

Coal Briquettes and Their Use in Railroad, Marine and Domestic Service. F. R. Wadleigh. Reviews briefly the early use of briquettes, discussing the ends to be attained and the fuels used, methods, costs, etc. 2000 w. R R Age Gaz—June 19, 1908. Serial, 1st part. No. 93204.

Fuel Testing.

The Federal Fuel Testing Laboratory, Zurich. E. J. Constam. Illustrated description of this laboratory and the work carried on. 3000 w. Engr, Lond—June 12, 1908. No. 93232 A.

Piston Speed.

Piston Speed and Steam Engine Economy. R. L. Weighton. A report of a series of revolution trials with analysis of the results. 7 plates. Discussion. 5500 w. Trans N-E Coast Inst of Engrs & Shipbldrs—May, 1908. No. 93271 N.

Plants.

Modern Steam Plants (Neuzeitliche Dampfanlagen). Chr. Eberle. Illustrates and describes plants in various industries embodying modern developments and improvements. 5000 w. Serial, 1st part. Zeitschr d Ver Deutscher Ing—May 2, 1908. No. 93180 D.

Pressure Gauges.

The Thermometer as a Steam Gage. William T. Heck. Describes the method. 500 w. Power—June, 1908. No. 92893.

Steam Jackets.

Steam Jackets. William Matthews. Discusses the results published by the Steam Engine Research Committee, and the experimental researches of Dr. Mellanby. 1600 w. Prac Engr—June 5, 1908. No. 92969 A.

Steam Pipes.

Expansion and Contraction in Steam Pipes. William F. Fischer. Exposition of the calculation involved, in laying out a system of steam piping, to insure flexibility. Ills. 2000 w. Power—June 2, 1908. No. 92701.

Steam Properties.

The Properties of Steam. Describes Juhlin's apparatus and experiments on the pressure of saturated steam at low temperatures. 4500 w. Locomotive—April, 1908. No. 92654.

Steam Traps.

Some Steam Traps. Gordon Stewart. Illustrates and describes recent designs. 2000 w. Prac Engr—June 12, 1908. Serial, 1st part. No. 93217 A.

Thermodynamics.

Throttling as Related to Knoblauch-Jakob Tests. A discussion of Prof. Heck's article by Prof. S. A. E. Reeve and Dr. Harvey N. Davis. 2400 w. Power—June 2, 1908. No. 92702.

Throttling.

See Thermodynamics, under STEAM ENGINEERING.

Turbine Plants.

A Simple Turbine Plant in New England. Illustrates and describes an interesting installation at Nashua, N. H., in which the turbines are about the only apparatus to be seen in the engine room. 500 w. Power—June 23, 1908. No. 93090.

Double-Deck Steam Turbine Power Plants. J. R. Bibbins. Presents some of the engineering features of this new type of station which the author believes, deserve careful consideration and ultimate acceptance as standard. Ills. 5000 w. Pro Am Inst of Elec Engrs—July, 1908. No. 93295 D.

Turbines.

Steam Turbines. J. N. Bailey. Explains the action of steam flowing through a turbine, and discusses the means of securing highest efficiency, design, etc. Ills. 3300 w. Elec Jour—June, 1908. No. 93013.

Test of a 200-Kilowatt Melms-Pfenninger Turbine. Report of test made by Prof. Schröter. 800 w. Engng—June 5, 1908. No. 92987 A.

The Westinghouse Double Flow Turbine. Illustrated detailed description of this self-balancing unit, especially adapted for large capacities. 2500 w. Power—June 16, 1908. No. 92992.

The New Double-Flow Turbines at the Brunot Island Power Plant, Pittsburg, Pa. Illustrates and describes these 5000-kw. turbines. 4000 w. Eng Rec—May 30, 1908. No. 92665.

12,000 - Horse - Power Parsons - Type Steam-Turbine for the Electric Station, Buenos Ayres. Illustrated detailed description. 3200 w. Engng—May 22, 1908. No. 92751 A.

12,000 Horse - Power Steam - Turbine. Plate and description of the Parsons turbine for Buenos Ayres. 4000 w. Engr, Lond—May 22, 1908. No. 92755 A.

The 12,000 Horse Power Steam Turbine Built by the Firm of Franco Tosi, Legnano (La Turbina a Vapore di 12,000 H.P. construtta della Ditta Franco Tosi di Legnano). Illustrated description of this Parsons type turbine. 4800 w. L'Industria—May 10, 1908. No. 93136 D.

The Augsburg-Nürnberg Steam Turbine (La Turbina a Vapore della Maschinenfabrik Augsburg-Nürnberg). Illustrated description of this turbine of the Zoelly type. Serial, 1st part. 1500 w. L'Industria—May 17, 1908. No. 93-138 D.

Some Aspects of Steam Turbine Engineering. H. Holzwarth. Deals principally with the difficulties in steam turbine engineering,—critical speed, effect of water carried in steam, ball bearings, etc. Ills. 2500 w. Wis Engr—June, 1908. No. 93233 D.

The Derivation of the Principal Turbine Equation by Means of Vectors (Die Ableitung der Turbinenhauptgleichung mit Hilfe der Vektorenrechnung). Viktor Fischer. A mathematical discussion. Ills. 2000 w. Zeitschr d Oest Ing u Arch Ver—May 15, 1908. No. 93161 D.

Valves.

Use of Weightless Back Pressure Valves. W. H. Wakeman. Illustrates and describes several types, discussing the effect of back pressure on the piston, etc. 3500 w. Power—June 9, 1908. No. 92902.

TRANSPORTING AND CONVEYING.

Cableways.

Ropeway at a Spanish Mine. Illustrated description of a Roe endless-rope ropeway at work at the Asturiana mines in Spain. 900 w. Engr, Lond—May 22, 1908. No. 92756 A.

Coal Handling.

Three Tramway Bridges on the Coal-Storage Dock of the Berwind-White Coal Mining Co., Superior, Wis. An illustrated description of this coal dock and its equipment for handling coal without breakage. 2000 w. Eng News—June 18, 1908. No. 93040.

Engineering Practice as Applied to the Fueling Equipment of Power Houses. Harry P. Cochrane. Illustrates and describes various devices for the mechanical handling of fuel, discussing factors justifying their installation. 3000 w. Jour Fr Inst—June, 1908. No. 93258 D.

See also Ore Handling, under Transporting and Conveying; and Piers, under CIVIL ENGINEERING, Waterways and Harbors.

Conveyors.

Conveying Machinery in the Portland Cement Plant. C. J. Tomlinson. Concerning types that are being tested and the results. 1200 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93251.

Continuous Conveying of Materials. Staunton B. Peck. Illustrates and describes types of conveyors in general use which have proved efficient. 5500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93250 D.

The Belt Conveyor. C. Kemble Baldwin. Illustrated description of belt conveyors, showing the development and types, the driving machinery, discharging devices, etc. 5500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93249 C.

Elevators.

A Curious Electric Elevator. J. B. Van Brussel. Illustrates and describes a novel elevator recently installed at St. Moritz in Switzerland, for conveying passengers to a hotel built on a hillside. 500 w. Sci Am—June 27, 1908. No. 93316.

Material Handling.

Transportation in Steel Works (Neuere Gesichtspunkte bei Hüttenwerkstransporten). C. Michenfelder. The first part of the serial discusses the handling of ore and fuel. Ills. Serial, 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—May 30, 1908. No. 93196 D.

Ore Handling.

Hoisting and Conveying Machinery. George E. Titcomb. Illustrates and describes types used in loading and unloading ores on the Great Lakes, handling coal, freight, etc. 3500 w. Pro Am Soc of Mech Engrs—June, 1908. No. 93248 D.

MISCELLANY.

Aeronautics.

Aeronautics. A. J. McKinney. A discussion of motor balloons and their propulsion, flying machines, etc. 2200 w. Autocar—May 23, 1908. Serial, 1st part. No. 92739 A.

Dirigible Balloons and Aeroplanes. William Duane. A brief sketch of important points in connection with navigation of the air. Ills. 1200 w. Jour of Engng, Univ of Colo—No. 4. No. 93279 D.

The Wright Aeroplane Test in North Carolina. Short illustrated account. 600 w. Sci Am—May 30, 1908. No. 92658.

Our Aeroplane Tests at Kitty Hawk. Orville and Wilbur Wright. An account of the recent experiments. 900 w. Sci Am—June 13, 1908. No. 92906.

First Flights of the Aerial Experiment Association's Second Aeroplane. Brief illustrated description of the machine and its trial. 900 w. Sci Am—May 30, 1908. No. 92657.

A Gigantic Airship Disaster. A critical account of the disaster in California to the John A. Morrell airship. 800 w. Sci Am—June 13, 1908. No. 92909.

See also Gasoline Engines, under Combustion Motors.

Minting Machinery.

The Electrical Equipment of the Royal Mint, London. Illustrated description. 1500 w. Elect'n, Lond—June 12, 1908. No. 93221 A.

MINING AND METALLURGY

COAL AND COKE.

Brazil.

The Coal of Southern Brazil. Benedict Jose dos Santos. Information concerning the known deposits, the quality, etc. 1200 w. Min Jour—May 30, 1908. No. 92869 A.

Briquetting.

Binders for Coal Briquets. James E. Mills. A report of investigations made at the fuel-testing plant, St. Louis, Mo. 21300 w. U S Geol Surv—Bul. 343. (1908). No. 93010 N.

The Coal-Briquette Plant at Bankhead, Alberta, Canada. Edward W. Parker. Illustrated description. Discussion. 2800 w. Bul Am Inst of Min Engrs—May, 1908. No. 93266 C.

See also Fuels, under MECHANICAL ENGINEERING, Steam Engineering.

Coking By-Products.

By-Products from Coke Ovens. W. H. Coleman. Abstract of a paper before the Manchester Geol. & Min. Soc. Deals with sulphate of ammonia mainly, and its use in returning nitrogen to the soil. Also considers tar and benzol and their uses. 5000 w. Ir & Coal Trds Rev—May 29, 1908. No. 92884 A.

Coking Properties.

A Practical Test for Coking Coals. Max A. Pishel. A brief statement of the method of making an adherence test and the results obtained. Ills. Tabulated results. 2500 w. Ec-Geol—June, 1908. No. 93272 D.

Electric Power.

The Protection of Electric Motors and Apparatus Against Fire-Damp. Illustrates and describes a motor proof against fire-damp, following the principle of the Davy safety lamp. 1000 w. Elec Rev, Lond—June 5, 1908. No. 92972 A.

A Modern Electric Coal Mining Equipment. Frank C. Perkins. Brief illustrated description of a plant at Beth, W. Va. Coal is carried down a 1,300-ft. incline to the railroad. Electricity for power and light is furnished by a 110-kw. generator driven by belting from a high-speed engine. 1000 w. Min Wld—June 13, 1908. No. 92975.

Some Applications of Electric Power in Belgium (Quelques Applications de l'Electrotechnique en Belgique). Alfred Lambotte. The third part of the serial describes the installations at the L'Espérance and Bonne-Fortune collieries at Montegnée lez-Liége and the Flémalle-Grande colliery at Ougrée-Marihaye. Ills. Serial, 3d part. 11500 w. Soc Belge d'Elecns—May, 1908. No. 93102 E.

England.

The Kent Coalfield. An account of the development of this new British coalfield. Ills. 3500 w. Min Jour—May 23, 1908. No. 92749 A.

Explosions.

Notes on the Monongah Explosion. James Ashworth. Ideas suggested by the lay-out of the mine and the methods of blasting. 2800 w. Mines & Min—June, 1908. No. 92707 C.

See also Mine Dust, under COAL AND COKE.

Formation.

Some Problems of the Formation of Coal. David White. Calls attention to the need of further field observation, and to recent progress. 10500 w. Ec-Geol—June, 1908. No. 93274 D.

Kentucky.

Mining Coal in Big Stone Gap Field, Kentucky. John P. Shippen. Describes methods of mining and coking used. Ills. 2000 w. Eng & Min Jour—June 27, 1908. No. 93358.

Mine Dust.

Investigation of Coal Dust as a Factor in Mine Explosions. Dr. Henry H. Payne. Read before the Coal Mining Inst. Brief review of various phases of coal dust investigation, and discussion of the methods of elimination. 7000 w. Ind Wld—June 29, 1908. No. 93408.

Mine Fires.

The Use of Carbon Dioxide in Extinguishing Mine Fires. Sydney F. Walker. Explains the methods of generating and using the gas, giving examples of the successful application. 3300 w. Mines & Min—June, 1908. No. 92705 C.

Mining.

Working a Coal Seam of Moderate Thickness. George Raylton Dixon. Describes a method of extracting pillars without causing crush and creep. 1200 w. Eng & Min Jour—June 20, 1908. No. 93070.

The Longwall Method of Working in England. George Raylton Dixon. Discusses the advantages of the system, details of operation and the plans for supporting the roof. 2500 w. Eng & Min Jour—June 6, 1908. No. 92823.

Special Methods of Mining Coal in England. George Raylton Dixon. Describes modifications of standard plans to suit special circumstances, giving details of an economical system of pony haulage. Ills. 1800 w. Eng & Min Jour—June 13, 1908. No. 92961.

New Mexico.

The Koehler Coal Mine. Frank A. Young. Illustrated description of this new mine in New Mexico, and its novel water supply. 2500 w. Mines & Min—June, 1908. No. 92708 C.

Nova Scotia.

Coal Mining in Pictou County, Nova Scotia. H. E. Coll. Explains conditions and the methods of safely mining gaseous and dusty mines. Ills. 1800 w. Eng & Min Jour—May 30, 1908. No. 92676.

Poland.

The Coal Mining Industry of Poland. John de Ciechanowski. Brief review of the history of the development of coal mining, and its present condition. 1500 w. Ir & Coal Trds Rev—May 22, 1908. No. 92763 A.

Rescue Appliances.

Rescue Appliances: Lessons from Glencoe. H. Kestner. A discussion of appliances and their use, with recommendations for rescue stations for coal mines in South Africa. 6000 w. Jour Chem, Met, & Min Soc of S Africa—April, 1908. No. 92967 E.

How Rescue Work Can Be Carried On Effectively. W. E. Mingramm. The dangers of after-damp, rescue stations and their equipment, describing the Draeger apparatus. 2000 w. Min Wld—June 27, 1908. No. 93405.

Safety Lamps.

Tests of Benzin Safety Lamps with Special Reference to the Fillunger Igniting Apparatus (Ueber einige Durchschlagsversuche mit Benzin-Sicherheitslampen mit besonderer Berücksichtigung der Zündvorrichtung des k. k. Bergrates Dr. Fillunger). J. Mayer. Tests made of the liability of flame striking through the gauze. Serial, 1st part. 2800 w. Oest Zeitschr f Berg- u Hüttenwesen—May 30, 1908. No. 93197 D.

Virginia.

The Boissevain Plant of the Pocahontas Consolidated Collieries Co., Inc. Illustrated description of the surface arrangements, methods of mining, transportation, etc. 3500 w. Mines & Min—June, 1908. No. 92703 C.

COPPER.

Alaska.

The Copper River District, Alaska. Hermann A. Keller. Illustrated account of the geology, mines and transportation facilities. Rich deposits of copper sulphide ores. 2000 w. Eng & Min Jour—June 27, 1908. No. 93355.

Anaconda.

Anaconda Copper Mining Company. A Review of the report of this company for the year ending Dec. 31, 1907. 2000 w. Eng & Min Jour—June 13, 1908. No. 92960.

Assaying.

See Arsenic, under MINOR MINERALS.

California.

Copper Deposits in the Western Foot-Hills of the Sierra Nevada. William Forstner. A general description of the belt, with short description of some of the deposits. 5800 w. Min & Sci Pr—May 30, 1908. No. 92730.

Lake Superior.

Michigan Copper Mining Methods. Lee Fraser. Describes methods at various mines, especially at Tamarack, which is the deepest in the world. 2500 w. Min & Sci Pr—June 20, 1908. No. 93324.

Nevada.

Developments in the Ely District of Nevada. Leroy A. Palmer. An account of the copper mines opened at this old silver camp, with illustrated description of the works. 2800 w. Min Wld—June 20, 1908. No. 93074.

Refining.

The Electrolytic Copper-Refining Industry in 1907. John B. C. Kershaw. Information concerning the number of works using the electrolytic process, the new developments, etc. 1400 w. Elect'n, Lond—June 5, 1908. No. 92980 A.

Reverberatory Furnaces.

See Smelting, under Copper.

Smelter Stacks.

See Stacks, under CIVIL ENGINEERING, Construction.

Smelting.

Modern Reverberatory Smelting of Copper Ore. C. Offerhaus. Considers the application of the reverberatory furnace to the reduction of copper ores, giving an illustrated description of the latest furnace at Anaconda. 2500 w. Eng & Min Jour—June 13, 1908. Serial. 1st part. No. 92958.

United Kingdom.

Copper-Mining in the United Kingdom. Editorial review of this industry. 2200 w. Engng—June 5, 1908. No. 92986 A.

GOLD AND SILVER.

Assaying.

The Behavior of Tellurium in Assaying. Sydney W. Smith. An examination of the behavior of tellurium during pot fusion, scorification and cupellation. 4500 w. Inst of Min & Met, Bul No 44—May 14, 1908. No. 92915 N.

See also Cyaniding, under Gold and Silver.

Australia.

See Kalgoorlie, under CIVIL ENGINEERING, Water Supply.

Cobalt.

Notes on Cobalt's Past, Present, and Future. Alex. Gray. Discusses the mining industry and the present conditions at Cobalt. Ills. 3000 w. Min Wld—June 6, 1908. Serial. 1st part. No. 92842.

Colorado.

Primary Gold in a Colorado Granite. John B. Hastings. Describes the geology, and the results of sampling, showing that the gold was not present in paying quantity. 2000 w. Bul Am Inst of Min Engrs —May, 1908. No. 93263 C.

Cyaniding.

Laboratory Methods in Modern Cyanide Mills. Clyde H. Jay. Concerning the making up and standardizing solutions necessary in cyanide work. 2500 w. Min Wld—June 20, 1908. No. 93075.

Laboratory Methods Used in Modern Cyanide Mills. Clyde H. Jay. Concise statement of the methods used in cyaniding gold ores. 3000 w. Jour of Engng, Univ of Colo—No. 4. No. 93277 D.

Cyanidation of Ores. Dr. Wilbur A. Hendryx. Read before the Colo. Sci. Soc. Deals with the mechanical handling of ores and the apparatus employed. 3500 w. Mines & Min—June, 1908. No. 92709 C.

Laboratory Tests on the Use of Coarse and Fine Lime for Cyaniding. W. J. Sharwood. An account of experiments made to ascertain the relative rapidity with which commercial lime would dissolve. 3000 w. Jour Chem, Met, & Min Soc of S Africa—April, 1908. No. 92-966 E.

Cyanidation in Nevada. A. G. Kirby. Editorial letter describing the treatment of the ore and discussing costs, concluding that Goldfield ore can be more economically reduced by the wet method than by roasting and cyaniding the crude ore. 4000 w. Min & Sci Pr—June 20, 1908. No. 93409.

Dredging.

Gold-Dredging Practice in California. Robert Sibley. An illustrated description of the construction of the hull of a dredge, the machinery, the designs most in favor and the methods of operation. 6000 w. Eng & Min Jour—May 30, 1908. No. 92671.

See also Dredges, under MARINE AND NAVAL ENGINEERING.

History.

Gold Mining and the History of Civilization. F. Lynnwood Garrison. How the search for gold has extended civilization. 5500 w. Eng & Min Jour—May 30, 1908. No. 92674.

Mexico.

Ores and Mines of Santa Eulalia, Mexico. Claude T. Rice. Illustrated description of various silver-lead camps. 2500 w. Eng & Min Jour—June 27, 1908. No. 93357.

The Ore Deposits of Santa Eulalia, Mexico. Claude T. Rice. Outlines the history of this district, its ancient mines, and describes the geology, orebodies, manner of formation, etc. Ills. 2800 w. Eng & Min Jour—June 20, 1908. No. 93068.

Nevada.

Geologic Possibilities at Goldfield. Arnold Becker. Discusses especially the dacite of the Goldfield district. 800 w. Min & Sci Pr—June 20, 1908. No. 93323.

Round Mountain, Nevada. George A. Packard. Describes the geology and the gold ore deposits, and the mills. Ills. 2000 w. Min & Sci Pr—June 13, 1908. No. 93081.

Recent Work on the Comstock. Walter D. O'Brien. Information in regard to the new pumping plant, its cost, and what it has accomplished. Ills. 1200 w. Min & Sci Pr—June 13, 1908. No. 93080.

Quebec.

A Recent Discovery of Gold Near Lake Megantic, Quebec. Abstract of a report by John A. Dresser. Describes the district, geology, occurrence of ore deposits, etc. 2000 w. Can Min Jour—June 1, 1908. No. 92807.

Rand.

Present Mining Conditions on the Rand. Thomas H. Leggett. Discusses the development and future progress of the industry. Discussion. 6000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93261 C.

IRON AND STEEL.

Alabama.

The Brown Iron Ore Deposits of Alabama. William B. Phillips. The present article describes briefly the geological formations involved. Map. 3000 w. Ir Age—June 4, 1908. Serial. 1st part. No. 92726.

Assaying.

The Rapid Analysis of Pig and Cast Iron. Gives briefly method for the determination of the carbon, silicon, sulphur, phosphorus and manganese. 1500 w. Prac Engr—May 22, 1908. No. 92741 A.

The Gravimetric Determination of Phosphorus in Iron and Steel in the Form of Ammonium Phospho-Molybdate (Etude sur le Dosage ponderal du Phosphore dans les Fers, Fontes et Aciers sous Forme de Phosphomolybdate d'Ammoniaque). M. G. Chesneau. An account of extensive researches. 16000 w. Ills. Rev de Métal—May, 1908. No. 93-118 E + F.

See also Laboratories, under Iron and Steel.

Bessemer Process.

The Düdeling Modification of the Basic Bessemer Process (Das Düdelinger Verfahren zur Durchführung des Thomasprozesses). P. Goerens. A description of modifications in the Thomas process introduced by J. Flohr. 3200 w. Stahl u Eisen—May 13, 1908. No. 93142 D.

Blast-Furnace Charging.

New Blast-Furnace Charging Devices (Ueber neuere Hochofenbegichtungen). Illustrates and describes various types. 2400 w. Serial. 1st part. Stahl u Eisen—May 6, 1908. No. 93141 D.

Blast-Furnace Design.

The Design of the Iron Blast Furnace (Zur Berechnung und Profilierung der Eisenhochöfen). Josef von Ehrenwerth. A review of general principles. Ills. 2800 w. Oest Zeitschr f Berg u Hüttenwesen —May 9, 1908. No. 93146 D.

Blast-Furnace Fuels.

Charcoal and Coke as Blast-Furnace Fuels. R. H. Sweetser. Gives data and results of furnace operations with both fuels at Sault Ste. Marie, comparing and discussing the advantages and disadvantages. 2500 w. Bul Am Inst of Min Engrs—May, 1908. No. 93262 C.

Blast Furnaces.

The Furnace Plant of the Northwestern Iron Co., Mayville, Wis. Illustrated description. 2000 w. Ir Trd Rev—June 25, 1908. No. 93318.

Blast-Furnace Slag.

Utilization of Blast Furnace Slag. Chevalier C. de Schwarz. Read before the I. and S. Inst. An illustrated review of methods of utilizing slag for the manufacture of bricks and cement. Ills. 3000 w. Ir & Coal Trds Rev—May 15, 1908. No. 92758 A.

Canada.

The Iron Ores of Canada. C. K. Leith. Compares certain general features of Canadian ores with types of deposits in the United States. 6000 w. Ec Geol—June, 1908. No. 93273 D.

Electro-Metallurgy.

Electric Smelting-Furnaces. B. Igewsky. Read before the Iron & Steel Inst. Illustrates and describes the construction of a new type of electric furnace for the smelting of iron and other uses. 2000 w. Engng—May 22, 1908. No. 92754 A.

Electric Iron and Steel Furnaces. Reviews electro-thermic iron-smelting during the last ten years, dealing only with processes actually in operation. Ills. 4700 w. Engng—June 5, 1908. Serial. 1st part. No 92982 A.

The Electro-Metallurgy of Iron, Cast Iron and Steel in Mexico. Francis Louvrier. Shows how favorable are the conditions for electric furnaces, and the advantages over the blast furnace. 2000 w. Min Jour—May 30, 1908. No. 92868 A.

Electro-Metallurgy (L'Electrométallurgie). M. Matignon. A general review of recent progress in the electro-metallurgy of iron and steel. Ills. 9000 w. Bul Soc Int d'Elecns—May, 1908. No. 93103 F.

Casting Steel from the Electric Furnace (Stahlformguss aus dem elektrischen Ofen). Bernhard Osann. Describes the operation and results of Stassano's plant for the production of steel castings, at Bonn. Ills. 3500 w. Stahl u Eisen—May 6, 1908. No. 93140 D.

History.

Iron, from the Fifth to the Thirteenth Century (Das Eisenwesen vom 5 bis zum 13 Jahrhundert). Alfons Müllner. A historical review. Serial. 1st part. 2000 w. Oest Zeitschr f Berg u Hüttenwesen—May 16, 1908. No. 93147 D.

Laboratories.

The Metallurgical and Chemical Laboratories in the National Physical Laboratory. Walter Rosenhain. An illustrated account of this reorganized department and the work to be undertaken, especially researches on iron and steel assaying and metallurgy. Ills. 6000 w. Ir and Coal Trds Rev—May 15, 1908. No. 92759 A.

The Organization of the Modern Ironworks Laboratory (Zur Organisation moderner Eisenhüttenlaboratorien). A. Wencélius. Discusses the arrangement of the laboratory, the apparatus required, methods of work, etc. Ills. Serial. 1st part. 2000 w. Stahl u Eisen—May 13, 1908. No. 93143 D.

Lake Superior.

Diverting the Rivers at the Loretto Mine. Illustrated description of interesting work in this iron-mining district. 200 w. Ir Trd Rev—June 18, 1908. No. 93073.

The New Equipment at the Newport Mine. Illustrates and describes the new shaft house and its equipment and other features of the plant. 3500 w. Ir Trd Rev—June 18, 1908. No. 93072.

New York.

The Forest of Dean Iron Mine, New York. Guy C. Stoltz. An account of a deposit of magnetite within 50 miles of New York City, worked before the Revolutionary War, and still yielding commercial ore. 1200 w. Eng & Min Jour—May 30, 1908. No. 92673.

Open Hearth.

Recent Developments in Charging Machines. Illustrates and describes typical installations of the three general types of open-hearth furnace charging machines in use. 1800 w. Ir Trd Rev—June 25, 1908. No. 93319.

The Heating of Siemens-Martin Furnaces (Die Wärmetechnik des Siemens-Martinofens). F. Mayer. Gives the results of elaborate tests on the efficiency of the furnace under various conditions. Ills. Serial. 1st part. 5200 w. Stahl u Eisen—May 20, 1908. No. 93145 D.

Rolling Mills.

The Determination of the Sizes of Rolling-Mill Motors (Die Bestimmung der Grösse von Walzenzugmotoren). Th. Schmitt. Describes the determination of the power required and discusses the choice of a motor. Ills. 2500 w. Elek Kraft u Bahnen—May 23, 1908. No. 93177 D.

Segregation.

Piping and Segregation in Steel Ingots. A discussion of the paper of Prof. Howe. Ills. 10800 w. Bul Am Inst of Min Engrs—May, 1908. No. 93268 D.

Steel Making.

See Bessemer Process, and Electro-Metallurgy, under IRON AND STEEL.

Steel Works.

The Keystone Works of the Jones & Laughlin Steel Company. Illustrated detailed description of a new structural plant at Pittsburg, Pa. 2000 w. Ir Age—June 4, 1908. No. 92723.

A Structural Plant in the Philippines. Royal J. Mansfield. Illustrated description of the first structural steel works in the Philippines, and some of the structures built by it. 1000 w. Eng News—June 11, 1908. No. 92939.

See also Material Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

LEAD AND ZINC.

Colorado.

The Montezuma Mining District. Etienne A. Ritter. Gives the location of this lead and zinc district, describing the ores, methods of mining and transportation. Ills. 3000 w. Mines & Min—June, 1908. No. 92704 C.

Lead.

Notes on Lead. Prof. A. Humboldt Sexton. Deals with its physical and chemical properties, its oxides, lead minerals, ores and their distribution, in the present number. 3300 w. Mech Engr—May 22, 1908. Serial. 1st part. No. 92743 A.

Mexico.

See same title, under GOLD AND SILVER.

Missouri.

See Ore Deposits, under MISCELLANY.

Sardinia.

See Zinc Milling, under ORE DRESSING AND CONCENTRATION.

Tasmania.

Mining in Zeehan Silver-Lead Field, Tasmania. Ralph Stokes. Considers the geology of the deposits, and system of ore treatment, etc. Ills. 2500 w. Min Wld—June 6, 1908. No. 92845.

Zinc Production.

Production and Consumption of Zinc in 1907. Walter Renton Ingalls. Statistics of zinc ore production in the United States, Canada, and Mexico; and consumption according to uses. 3500 w. Eng & Min Jour—June 13, 1908. No. 92957.

MINOR MINERALS.

Antimony.

See Arsenic, under MINOR MINERALS.

Arsenic.

The Iodometric Determination of Arsenic and Antimony Associated with Copper. F. H. Heath. Describes the method used which gave results with errors of only a few tenths of a milligram. 1700 w. Am Jour of Sci—June, 1908. No. 93012 D.

Bauxite.

Bauxite: Its Occurrence and Production in U. S. W. C. Phalen. Information concerning the geology and development of the deposits. 2000 w. Min Wld—June 27, 1908. No. 93406.

Cement.

A 12,000-Barrel Cement Mill in California. Illustrated detailed description of the new mill at Davenport, Cal. 7000 w. Eng Rec—June 20, 1908. No. 93066.

An Iowa Portland Cement Plant. George M. Shepard. Illustrated description of the plant at Mason City, Iowa. 1700 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93391 N.

See also Blast-Furnace Slag, under IRON AND STEEL.

Gypsum.

Gypsum Deposits of Montana. J. P. Rowe. Brief description of the deposits and of the operations at Armington. 1000 w. Eng & Min Jour—June 20, 1908. No. 93069.

Lime.

The Determination of Lime in Limestone, etc. Richard K. Meade. Gives a comparison of various methods, describing method of precipitation in a solution of oxalic acid which gives results that check closely with a complete gravimetric analysis. 2000 w. Min Wld—June 13, 1908. No. 92976.

Manganese.

Mining and Preparation of Georgia Manganese. Thomas L. Watson. Gives the geology, mining methods, etc. Map. 1500 w. Min Wld—June 13, 1908. No. 92977.

Atopite and the Manganese Deposits of Miguel Burnier, Brazil. Dr. E. Hussak. Describes the deposits. 1000 w. Min Jour—May 30. 1908. No. 92870 A.

Mining in the Batoum District, Russia. From the report for 1907 of Mr. Consul Stevens. Concerning the manganese and petroleum industries. Map. 2800 w. Min Jour—May 30, 1908. No. 92867 A.

Natural Gas.

Natural Gas for Power Use in the Joplin District. Otto Ruhl. Information concerning the consumption and costs of natural gas piped from Kansas, and the advantages of gas fuel over coal. 2000 w. Min Wld—June 27, 1908. No. 93404.

Oil.

The Illusiveness of Petroleum. W. S. Eberman. Reviews briefly the early history of oil discovery in Pennsylvania, and also in other localities, and some points in regard to the geology. 1600 w. Min Wld—June 27, 1908. No. 93407.

See also Manganese, under MINOR MINERALS.

Talc.

Mining Talc in North Carolina. An illustrated account of the deposits, method of mining, finishing, etc. 2000 w. Ir Trd Rev—June 25, 1908. No. 93320.

Tin.

The Refining of Tin by Electricity (Die elektrische Raffination des Zinn). Dr. Otto Steiner. A description of the Strauss electrolytic method. Serial. 1st part. 1800 w. Elektrochem Zeitschr—May, 1908. No. 93139 D.

See also same title, under ORE DRESSING AND CONCENTRATION.

Vanadium.

Occurrence of Vanadium Near Telluride, Colorado. Edward R. Zalinski. Describes the deposits and the treatment of the ore. Ills. 1500 w. Eng & Min Jour—June 6, 1908. No. 92824.

See also Alloy Steels, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

MINING.

Blasting.

Group Electric Shot Firing. Sydney F. Walker. Discusses troubles with fuses and the remedy. 2500 w. Eng & Min Jour—June 20, 1908. No. 93071.

Bunk Houses.

New Type of Native Compound Building of All Metallic Construction. Diagrams and description of an economical building for housing native labor in South Africa. 1500 w. Jour Chem, Met, & Min Soc of S Africa—April, 1908. No. 92-965 E.

Cableways.

See same title, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Costs.

Costs and Profits in Silver-Lead Ore Production. James Ralph Finlay. Discusses factors governing costs, comparing conditions at several mines. 4000 w. Eng & Min Jour—June 27, 1908. No. 93356.

Drill Bits.

The Proper Shape of Rock Drill Bits. D. J. O'Rourke. Deals with the material used, and the shaping, sharpening, setting, etc. Ills. 2000 w. Engng-Con—June 24, 1908. No. 93330.

Electric Power.

Discussion on "The Electrical Equipment of Gold Mines." The paper of H. J. S. Heather is discussed. 14500 w. Inst of Min & Met, Bul 44—May 14, 1908. No. 92918 N.

Electric Power at the Clausthal Mines. Alfred Gradenwitz. An illustrated description of the equipment. Current from producer-gas engine and turbine plants drives the ore-dressing works during the day and the mine hoists at night. 2200 w. Eng & Min Jour—June 6, 1908. No. 92821.

Explosives.

A Magazine and Thaw-House for Dynamite. George F. Samuel. Gives a design, and results of tests made to determine the time required to thaw dynamite. 800 w. Eng News—June 25, 1908. No. 93337.

Finance.

Capitalizing and Promoting Mining Properties. W. A. Crooks. On the methods of organizing and financing a mine. 3200 w. Min Wld—June 6, 1908. No. 92843.

Hoisting Engines.

Winding Engine Tests, with Notes and Suggestions on the Design and Testing of Plant. S. L. Thacker. Abstract of paper before the Inst. of Min. Engrs. 4000 w. Mech Engr—June 19, 1908. No. 93416 A.

Law.

Discovery Before Location. R. W. Raymond. Brief discussion of laws in the United States having a bearing on the appropriation of mineral lands. 1000 w. Can Min Jour—June 15, 1908. No. 93086.

Mine Fires.

See same title, under Coal and Coke.

Mine Waters.

Mine Waters: Their Composition and Value. Alfred C. Lane. The analysis of mine waters may help to locate ore deposits. Methods of testing and related information. 1100 w. Min Wld—June 6, 1908. No. 92841.

Prospecting.

Constructing a Crude Smelter for Prospectors. Francis C. Nicholas. Illustrated description of methods of smelting iron ore in a crude way on a newly discovered prospect. 2200 w. Min Wld—June 6, 1908. No. 92840.

Reports.

Current Monthly Reports of Mines. H. S. Denny. Suggestions for the arrangement of the information so that the facts may be easily compared and summarized. 4000 w. Eng & Min Jour—June 6, 1908. No. 92822.

Shaft Sinking.

Sinking a Concrete Mine Shaft. Illustrated description of work in progress near Wilkes-Barre, Pa. 1400 w. Sci Am Sup—June 13, 1908. No. 92911.

Methods of Shaft Sinking. Brief illustrated descriptions of the "Kind-Chaudron" boring process, the freezing process, sinking by means of drop shafts, and subaqueous sinking work by means of sackborers. 2500 w. Ir & Coal Trds Rev —May 22, 1908. No. 92762 A.

Unwatering.

Reclaiming a Flooded Gypsum Mine. E. H. Fishack. Describes the rather unusual method employed at a mine in Ohio, near Sandusky Bay. 1100 w. Eng & Min Jour—May 30, 1908. No. 92675.

ORE DRESSING AND CONCENTRATION.

Classifiers.

The Dorr Classifier. J. N. V. Dorr. Illustrates and describes an apparatus for separating slime from sands and also for removing a large part of the water. 1200 w. Mines & Min—June, 1908. No. 92-711 C.

Crushers.

A Rock Crusher of 800 Tons per Hour Capacity. Richard Bernhard. Illustrated description of the largest stone crusher in existence, in operation at South Pittsburg, Tenn. 900 w. Eng News—June 4, 1908. No. 92847.

Gold Milling.

The Average Rate of Accumulation and Absorption of Gold Amalgam by Copper Plates. Edward Halse. Information on this subject, gathered by the writer. 2000 w. Inst of Min & Met, Bul 44—May 14, 1908. No. 92916 N.

The Absorption and Accumulation of Gold on Copper Plates. W. F. A. Thomae. Discusses the amount of gold locked-up on battery plates. 1400 w. Inst of Min & Met, Bul 44—May 14, 1908. No. 92917 N.

See also Nevada, under Gold and Silver.

Jigs.

Jigs and Jigging in the Joplin Zinc-Lead District. Otto Ruhl. Describes the construction and operation of the hand jig, the Cooley jig, and the Faust automatic jig. Ills. 3500 w. Min Wld—May 30, 1908. No. 92677.

First Practical Application of the Forest Jig. Doss Brittain. Describes an innovation in the milling practice of the Joplin district. Ills. 700 w. Eng & Min Jour—May 30, 1908. No. 92672.

Lead Milling.

See Tasmania, under Lead and Zinc.

Magnetic Separation.

Dry, Magnetic, and Electro-Chemical Separation Processes. W. G. Swart. Brief discussion of each of these processes and their limitations. 2200 w. Min Jour—June 13, 1908. No. 93223 A.

See also Zinc Milling, under Ore Dressing and Concentration.

Mixed Sulphides.

Dressing Sulphide Ores. E. B. Wilson. On the importance of adapting the methods of treatment to the peculiarities of the ores. 1800 w. Mines & Min—June, 1908. No. 92706 C.

Tin.

The Final Stages of Tin and Wolfram Dressing. S. L. Terrell. Deals with tin and wolfram after concentration, considering fine and rough concentrates. 2000 w. Min Jour—June 13, 1908. No. 93224 A.

Tube Mills.

The Economics of Tube Milling. H. W. Fox. Gives experiments showing the relation between the amount of ore, pebbles, and solution, and the amount of power consumed. 3000 w. Mines & Min—June, 1908. No. 92710 C.

Zinc Milling.

The Mechanical Preparation of Ores in Sardinia. Erminio Ferraris. Describes the ore-dressing methods, concentration, magnetic separation, etc. Ills. 7200 w. Bul Am Inst of Min Engrs—May, 1908. No. 93267 D.

Economical Treatment of Zinc Ores. R. C. Canby. A brief review of various types of magnetic separators and their adjuncts and value. 1500 w. Min Wld—June 6, 1908. No. 92844.

See Jigs, under ORE DRESSING AND CONCENTRATION.

MISCELLANY.

Alloys.

The Alloys of Aluminium (Les Alliages d'Aluminium). M. A. Portevin. Information taken from *Zeit. an. Chemie,* on alloys of aluminium with bismuth, calcium, cadmium, cobalt, copper, iron, potassium, magnesium, sodium, nickel, lead, tin and thalium. Ills. 4200 w. Rev de Métal—May, 1908. No. 93116 E + F.

British Columbia.

Mineral Production of British Columbia. Ernest Jacobs. Official returns, reporting a decrease in gold, silver and lead, but gains in coal and coke. 2500 w. Eng & Min Jour—June 27, 1908. No. 93359.

China.

Mineral Production of China in 1907. Thomas T. Read. Reports abundant resources of many kinds of ore, but slow development of the mineral industry. 3000 w. Eng & Min Jour—June 27, 1908. No. 93360.

Georgia.

Mining and Metallurgical Industry of Georgia. Henry A. Mather. Describes the geology of the Dahlsnega district, which yields gold, china clay, talc and rare ore deposits, but is neglected and thriftless. 1800 w. Min Wld—June 20, 1908. No. 93076.

Guatemala.

Mining and Transportation in Guatemala. Clarence C. Sample. Information of the railroads, mining and its development, etc. 2000 w. Eng & Min Jour—June 13, 1908. No. 92959.

Mexico.

Mexican Notes. Mark R. Lamb. Illustrated description of treatment-plants in Mexico. 1200 w. Min & Sci Pr—May 23, 1908. Serial, 1st part. No. 92729.

New Mexico.

Development of San Pedro Mountain, N. M. Robert B. Brinsmade. History of old Spanish mines which have produced gold, lead, copper and silver, now being worked by modern methods. Ills. 3500 w. Min Wld—June 27, 1908. No. 93403.

Ore Deposits.

Diffusion as a Factor in Ore Deposition. Lewis T. Wright. Discusses the flow of minerals by aqueous diffusion. 1800 w. Min & Sci Pr—June 20, 1908. No. 93323.

Waters, Meteoric and Magmatic. James F. Kemp. Considers the formation of ore bodies from solutions of underground waters. 3500 w. Min & Sci Pr—May 23, 1908. No. 92682.

Volcanic Waters. John B. Hastings. Discusses whether waters buried deeply with oceanic sediments can make their way to the conduits of molten material, quoting other investigators. 4000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93265 C.

Unconformity and Deposits. Otto Ruhl. Shows how the application of the theory that ore deposits are always accompanied by dynamic movements completely misconstrued the facts in ascribing an origin for the lead and zinc ore deposits of the Missouri-Kansas district. Ills. 1600 w. Min & Sci Pr—June 6, 1908. No. 92922.

Ore Volume.

The Relation of Density, Porosity, and Moisture to the Specific Volume of Ores. Warren J. Mead. Gives a diagram for determining the cubic contents of ores based on the relation of these factors, explaining its use. 2200 w. Ec-Geol—June, 1908. No. 93275 D.

Pegmatite.

Origin of Pegmatite. John B. Hastings. Gives information from various authorities concerning pegmatite, its microscopic features, and theories explanatory of its origin. 10000 w. Bul Am Inst of Min Engrs—May, 1908. No. 93264 C.

Sweden.

See same title, under INDUSTRIAL ECONOMY.

CONDUCTING TRANSPORTATION.

Communication.

Railway Telephony. W. E. Harkness. Read before the N. Y. Telephone Soc. An account of the service and the methods employed. 9000 w. Ry & Engng Rev—June 20, 1908. No. 93077.

New York Suburbs.

Improvement of New Jersey-New York Suburban Service. The first of a series of articles dealing particularly with the railroads in New Jersey which have their termini on the west shore of the Hudson River. The present article considers the Lackawanna Railroad. 1500 w. Sci Am —June 20, 1908. Serial, 1st part. No. 93047.

Signals.

The Electric Operation of Signals and Points at Schwerte Station. Mr. Schepp. Illustrated detailed description of the mechanism and its operation. 12000 w. Bul Int Ry Cong—June, 1908. Serial, 1st part. No. 93379 G.

The New Interlocking Signal System at the Broad Street Terminal, Philadelphia. Illustrated detailed description of the plant. 2500 w. Eng Rec—June 27, 1908. No. 93348.

The Electric Locking of the Westinghouse Signal and Switch Levers (Die elektrische Verkettung an den Westinghouseschen Signal- und Weichenstellhebeln). L. Kohlfürst. Illustrated description of the mechanism and electrical connections. Serial, 1st part. 2400 w. Schweiz Bau—May 23, 1908. No. 93151 D.

Electric Control for Block Signals (Elektrischer Antrieb für Eisenbahn-Mastsignale). L. Kohlfürst. A general description of signals recently installed on the Southern Railway of Austria. Ills. 3000 w. Elek Kraft u Bahnen—May 4, 1908. No. 93175 D.

See also Subway Signalling, under STREET AND ELECTRIC RAILWAYS.

Trains.

The Atlantic City Flyer. Describes the fast trains to this resort from Camden by the Philadelphia & Reading R. R. and the locomotives used. 1500 w. Ry & Loc Engng—June, 1908. No. 92787 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Westinghouse Brake Equipments. Describes various types. 2000 w. Ry & Loc Engng—June, 1908. No. 92791 C.

Brake Trials on the North-Eastern Railway. An account of an interesting series of tests made of the Maximus brake. 1200 w. Engr, Lond—June 5, 1908. No. 92991 A.

Brake Trials on Long Goods Trains, Made in June and July, 1907, on the Hungarian State Railway. Report of an interesting series of trials. 1700 w. 10 Tables. Bul Int Ry Cong—June, 1908. No. 93380 G.

An Early and Thorough Test of Continuous Brakes in England. C. H. Caruthers. A description of a thorough competitive test carried out between June 9 and 16, 1875, on a division of the Midland Ry. 1200 w. R R Age Gaz—June 19, 1908. Serial, 1st part. No. 93202.

Cable Railways.

A Remarkable Mountain Railway. Dr. Alfred Gradenwitz. Illustrations and brief description of a road at Bozen, Tyrol, with gradients of 70 per cent. in the upper half, and 66 per cent. in the lower. 800 w. Sci Am—June 20, 1908. No. 93050.

Car Design.

The Design of Sills (Calcul des Longerons armé). O. Lebeau. A mathematical paper, referring principally to the side pieces of railway cars. Ills. 2500 w. All Indus—May, 1908. No. 93123 D.

Car Oscillation.

The Oscillations in Cars at High Speed and Their Measurement (Theoretische Betrachtungen über die Schwingungen von schnellfahrenden D-Zugwagen und deren praktische Messung). Herr Mehlis. A theoretical and mathematical discussion of their production with practical data on methods of measurement. Ills. 7000 w. Glasers Ann—May 1, 1908. No. 93164 D.

Car Repairing.

See Management, under MISCELLANY.

Cars.

New Design Standard Steel Coach; Southern Pacific. Illustrated description. 700 w. R R Age Gaz—June 12, 1908. No. 92946.

Steel Passenger Cars. Abstract of a committee report presented at the convention of the Master Car Bldrs.' Assn. 2500 w. Elec Ry Jour—June 27, 1908. No. 93328.

Structural Steel in Freight Car Construction. G. A. Akerlind. An illustrated article describing the types of the National Dump Car Co., Chicago. 2000 w. Ry & Engng Rev—June 13, 1908. No. 92978.

Cars for the Virginia Coal Business.

Editorial, with illustrated detailed descriptions of cars on the Norfolk & Western, the Chesapeake & Ohio, and the Virginian Ry. 8500 w. R R Age Gaz—June 12, 1908. No. 92942.

Reinforcing Light Wooden Cars on the Santa Fe. Illustrates and describes the applications of a steel sub-frame. 900 w. R R Age Gaz—June 12, 1908. No. 92943.

First Class Dining-Car for the Lancashire and Yorkshire Railway Company. Plate, illustration, and short description. 600 w. Engng—May 29, 1908. No. 92-876 A.

Electrification.

Electric Traction on the Bavarian State Railways. Reviews a recent report of the Bavarian Government dealing fully with questions bearing on this subject. 2500 w. Elect'n, Lond—May 29, 1908. No. 92865 A.

The Electrification of the Bavarian State Railways (Ueber die Einführung des elektrischen Betriebes auf den Bayerischen Staatseisenbahnen). W. Reichel. An elaborate and thorough discussion of the problem of applying electric traction to all the railways of the state. Ills. Serial, 2 parts. 13000 w. Elek Kraft u Bahnen—May 4 and 14, 1908. No. 93176, each D.

Locomotive Crank Axles.

The Solution of the Crank Axle Problem. Howard H. Lanning. Describes improvements made in the construction of crank axles, and the re-turning machines used. Ills. 3000 w. Am Engr & R R Jour—June, 1908. No. 92812 C.

Locomotive Flues.

A Reinforced Flue Sheet. W. H. Lewis. Explains the object of the reinforcing sheet as attached to the firebox flue sheet of locomotives, describing details. 1500 w. Am Engr & R R Jour—June, 1908. No. 92809 C.

Locomotive Fuels.

See Fuels, under MECHANICAL ENGINEERING, Steam Engineering.

Locomotive Repairs.

The Cost of Locomotive Repairs on the Atchison, Topeka & Santa Fe. Calls attention to conditions which have an influence on the cost of repairs. 2000 w. R R Age Gaz—June 19, 1908. No. 93203.

The Repair of Locomotive Tube Plates (La Réparation des Plaques tubulaires des Foyers de Locomotives). S. Ragno. A description of the author's method and its results. Ills. 7000 w. All Indus—May, 1908. No. 93122 D.

Locomotives.

Mikado for the Kentucky and Tennessee. Illustrated description. 700 w. Ry & Loc Engng—June, 1908. No. 92794 C.

Mikado Locomotive for the Kentucky and Tennessee Railway. Illustrated description. 600 w. Ry Age—May 29, 1908. No. 92685.

Heavy 4-6-2 for the N. Y. C. Illustrated description of the heaviest passenger locomotives ever built for this road. 500 w. Ry & Loc Engng—June, 1908. No. 92788 C.

Denmead Ten-Wheel Freight Engine. J. Snowden Bell. Illustrated description of an engine probably built in the late fifties, showing the standard practice of that time. 500 w. R R Age Gaz—June 19, 1908. No. 93201.

Locomotives for Heavy Service on the Norfolk & Western. Illustrates and describes a Pacific (4-6-2) for passenger work, and a 12-wheeler (4-8-0) for freight. 400 w. R R Age Gaz—June 19, 1908. No. 93099.

Recent Narrow Gage Locomotives for Heavy Service. Illustrated descriptions of three recent types having a track gage of three feet. 1800 w. Ry & Engng Rev—June 20, 1908. No. 93078.

British Locomotives in 1907. Charles Rous-Marten. A review of progress made in design and performance. 6000 w. Bul Int Ry Cong—May, 1908. No. 93371 G.

The Locomotives of the Eastern Railway of France. Charles S. Lake. Begins an illustrated review of the successive developments in size and design on this important railway. 2500 w. R R Age Gaz—June 19, 1908. Serial, 1st part. No. 93205.

New Continental Locomotives. Illustrated descriptions of engines recently built for the Western Ry. of France, and for the Alsace-Lorraine Rys. 1500 w. Mech Engr—June 5, 1908. No. 92970 A.

Historic Locomotives at Purdue. Robert C. Schmid. Brief illustrated descriptions of types in the Purdue museum. 2500 w. Ry & Loc Engng—June, 1908. No. 92793 C.

Characteristics of Steam Locomotives. Edward P. Burch. Considers the characteristics of locomotives in common commercial service. 3500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93392 N.

A Tabular Comparison of Notable Examples of Recent Locomotives. Gives tables arranged with respect to classes and weights, and arranged in order of total weights. 2500 w. Am Engr & R R Jour—June, 1908. No. 92974 C.

Test of Mallet Articulated Compound Locomotive. An account of a recent test made on the Erie Railroad, giving results and interesting features peculiar to this type. Ills. 3500 w. Am Engr & R R Jour—June, 1908. No. 92811 C.

Mikado Locomotive for the Virginian Railway. Illustrated description of a Mikado (2-8-2) locomotive for gathering and distributing cars and hauling to the Princeton yard. 3500 w. R R Age Gaz—July 3, 1908. No. 93506.

Locomotive Stoking.

Bank Firing of Bituminous Coal. R. G. Donaldson. Explains this method of firing, discussing its advantages and disadvantages. 1500 w. Ry & Loc Engng—June, 1908. No. 92790 C.

Locomotive Valve Gears.

Walschaert Valve Gear. Illustrates and describes a design that has been developed on the Pennsylvania R. R. for use on high speed Atlantic type locomotives. 700 w. Am Engr & R R Jour—July, 1908. No. 93509 C.

Steam vs. Electricity.

Steam and Electricity Compared. W. B. Kouwenhoven. Considers only the increasing schedule speed, showing the advantages of electricity. 2000 w. Ry & Loc Engng—June, 1908. No. 92792 C.

See also Operation, under STREET AND ELECTRIC RAILWAYS.

Wheels.

Car Wheels—Forged and Rolled—History Past and Present. An illustrated review of the development of car wheels. 4000 w. Ind Wld—June 8, 1908. No. 92833.

The Chilled Cast Iron Car Wheel. P. H. Griffin. A discussion of problems growing out of the present practice of makers and the railroads. 3000 w. Ir Age—June 4, 1908. No. 92727.

Cast Iron Car Wheels. P. H. Griffin. An editorial letter taking issue with conclusions drawn by J. E. Muhlfeld, in a recent communication. 5000 w. R R Age Gaz—June 26, 1908. No. 93331.

Cast Iron Wheels. J. E. Muhlfeld. A summary of conclusions in regard to improving the efficiency of the chilled cast iron wheel, with a general review of conditions, materials, etc. Diagrams. 9500 w. R R Age Gaz—June 12, 1908. No. 92944.

I. For Safe and Economic Car Wheels. Charles T. Schoen. II. Chilled Cast Iron Wheels. P. H. Griffin. Two editorial letters discussing means of producing better car wheels. 6500 w. R R Age Gaz—June 19, 1908. No. 93098.

NEW PROJECTS.

K. C., M. & O.

Progress of the Kansas City, Mexico & Orient. An account of the development of this line, the mining districts it will serve, and other information. Maps. 2500 w. Ry Age—May 29, 1908. No. 92684.

PERMANENT WAY AND BUILDINGS.

Ash Lifts.

Ash-Lifts. F. Zimmermann. Illustrates and describes mechanical methods of handling ashes at the locomotive sheds in Germany. 1300 w. Bul Int Ry Cong—May, 1908. No. 93372 G.

Coaling Plants.

Reinforced-Concrete Locomotive-Coaling Station on the Norfolk & Western Ry., at Concord, Va.: A Type of the Most Recent Equipment. Illustrated description. 500 w. Eng News—June 25, 1908. No. 93336.

Culverts.

See same title, under CIVIL ENGINEERING, BRIDGES.

Curves.

Resistance of Railway Cars on Curves (Widerstand der Eisenbahnfahrzeuge in Gleisbogen). Herr Dietz. A mathematical treatment. Ills. 3500 w. Glasers Ann—May 1, 1908. No. 93165 D.

Rails.

The Steel Rail Situation. Synopsis of Dr. Charles B. Dudley's address before the Am. Soc. for Test. Mat. 2500 w. Ir Age—June 25, 1908. No. 93302.

Examination of a 100-lb. Rail. G. B. Waterhouse. Micrographs and description of tests made, with results. 500 w. Ir Age—June 11, 1908. No. 92895.

The Rail Maker versus the Rail Consumer. G. B. Waterhouse. A short discussion of breakage causes from a steel-mill viewpoint. 1500 w. Engineering Magazine—July, 1908. No. 93398 B.

Stations.

The New Union Station, Washington, D. C. Fully illustrated article, with description. Plates. 2500 w. Am Archt—June 3, 1908. No. 92721 N.

The New Union Station of the New Orleans Terminal Company. Illustrated detailed description of a terminal for the Frisco system and the Southern. 600 w. R R Gaz—May 29, 1908. No. 92691.

See also Terminals, under PERMANENT WAY AND BUILDINGS.

Terminals.

The Fort Garry Terminal; A Union Station at Winnipeg, Man. J. D. Matheson. Map, perspective view, general plan, elevation, and description. 5000 w. Eng News—June 18, 1908. No. 93043.

The Fort Garry Station and Local Freight Terminal, Winnipeg, Manitoba. J. D. Matheson. Detailed description of station and freight yard, covering 70 acres, about to be constructed for the joint use of the Canadian Northern and Grand Trunk Pacific railways. Plans. 4000 w. Eng Rec—June 20, 1908. No. 93067.

Ties.

The Life of Steel Ties. W. C. Cushing. A discussion of the tie problem giving much information in regard to metal ties and their durability. 4000 w. R R Age Gaz—June 5, 1908. No. 92818.

Steel Ties on the Bessemer & Lake Erie R. R. Illustrated detailed description of the practice of this road in the use of the steel tie, its maintenance and operation. 3000 w. Ry & Engng Rev—June 6, 1908. No. 92846.

Experiments with Railway Cross-Ties. H. B. Eastman. A report of investigations by the Forest Service in coöperation with the Northern Pacific Railroad. 4500 w. U S Dept of Agri, Circ. 146—April 25, 1908. No. 93054 N.

See also Track Construction, under PERMANENT WAY AND BUILDINGS; and Piling, under CIVIL ENGINEERING, CONSTRUCTION.

Track Construction.

Standards of Track Construction on American Railways. Gives 5 tables compiled from special returns furnished by the engineers of the various lines showing the character of construction adopted. Also editorial. 8000 w. Eng News —June 4, 1908. No. 92850.

Rail Fastenings and Ties. Andrew F. Macallum. Considers the common spike, and the screw spike, tie plates, ties of timber, concrete and steel, composite, the spacing of ties, etc. 3500 w. Can Engr —June 5, 1908. No. 92837.

The Wedging of Rails in Chairs and the Metal Wedge (Le Coinçage des Voies à Coussinets et le Coin métallique). M. Chateau. Discusses the relative efficiency of wood and metal wedges, describes various forms of the latter, etc. Ills. 4500 w. Rev Gen des Chemins de Fer—May, 1908. No. 93108 G.

Track Inspection.

A Simple Track Inspecting and Recording Machine. Illustrates and describes the invention of T. Ellis, now in actual service. 900 w. Eng News—June 4, 1908. No. 92849.

Tunnels.

See same title, under CIVIL ENGINEERING, CONSTRUCTION.

TRAFFIC.

Car Service.

Reducing Per Diem Charges Upon Freight Cars. F. Lincoln Hutchins. Considers means of effecting great saving in the change for car use and materially improving the service. 2500 w. R R Age Gaz—June 5, 1908. No. 92815.

Freight Cars.

Comparative Summary of Freight Cars in Service on the Railroads of the United States. Gives two tables, one covering 1900 and 1906, the other 1900 and 1907, considering 64 roads. 4000 w. R R Age Gaz—June 5, 1908. No. 92814.

Freight Handling.

The Measures Taken by the Northern Railway of France During Periods of Heavy Traffic (Note sur les Mesures prises par la Compagnie du Chemin de Fer du Nord pendant les Périodes de Trafic intensif). Albert Sartiaux. Describes the measures taken to secure the utmost efficiency of rolling stock, in freight handling, etc. 9400 w. Rev Gen des Chemins de Fer—May, 1908. No. 93107 G.

Freight Rates.

Railroad Freight Rates Too Low. Luis Jackson. Compares American and foreign rates, discussing present low tariffs, legislation, and the true basis of freight rates. 3000 w. Am Rev of Revs—June, 1908. No. 92913 C.

Relation of Rates to Commodity Costs. C. S. Sims. Gives results worked out on a number of articles showing the payment to the railroads for transportation of living supplies. 1400 w. R R Age Gaz—June 5, 1908. No. 92820.

New York.

Traffic Congestion in New York. George Ethelbert Walsh. Discusses the difficulties in handling merchandise and railway and steamship freight. 2000 w. Cassier's Mag—June, 1908. No. 93004 B.

MISCELLANY.

Accounting.

Railroad Accounting Under Government Supervision. M. P. Blauvelt. Address before the Assn. of Am. Ry. Acc. Officers. Discusses the attempt to have a uniform system, etc. 5000 w. Jour of Acc—June, 1908. No. 93363 C.

Railroad Cost Accounting. S. M. Hudson. Considers the necessity of developing a proper and just system of cost accounting, discussing necessary details and related matters. 3500 w. R R Age Gaz —June 5, 1908. Serial, 1st part. No. 92817.

Africa.

Note on the Waterval Boven Deviation. B. P. Wall. Describes a piece of railway construction in South Africa. Discussion. Plates. 4000 w. Jour S African Assn of Engrs—April, 1908. No. 92740 F.

Apprenticeship.

The Apprenticeship System. Report of a committee to the American Railway Master Mechanics' Assn. 3000 w. Ry & Engng Rev—July 4, 1908. No. 93508.

Austria.

New Railway Lines in the Austrian Alps (Les nouvelles Lignes de Chemins de Fer dans les Alpes autrichiennes). F. Hofer. A general review with a particular description of an important masonry viaduct at Salcano. Ills. Plate. 3000 w. Génie Civil—May 2, 1908. No. 93124 D.

France.

The Redemption of the Lines of the Western Railway of France (Le Rachat du Réseau des Chemins de Fer de l'Ouest). P. Maurice. A discussion of the proposal now before the French Senate to open the procedure for taking over the lines of this railway by the State. Ills. Serial, 1st part. 7000 w. Génie Civil—May 16, 1908. No. 93128 D.

Government Control.

Relation Between Railways and the State. A résumé of what has been done in England toward railway regulation. 3000 w. Engr, Lond—June 5, 1908. Serial,. 1st part. No. 92989 A.

The French Railway Companies and the State. An outline of the conditions which govern the French railway companies in their relations with the State. 2800 w. Engng—June 5, 1908. No. 92-985 A.

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India.

Indian Railways. A résumé of the report on Indian railway finance and administration for 1907. 2500 w. Engr, Lond—June 12, 1908. No. 93230 A.

Management.

Concerning American Railway Management. An editorial criticism. 2500 w. Eng News—June 18, 1908. No. 93046.

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A Practical Drawing Office System. G. I. Evans. Detailed description of the system at present in use in the motive power drawing office of the Canadian Pacific Ry. 4000 w. Am Engr & R R Jour—June, 1908. Serial, 1st part. No. 92808 C.

Preventable Wastes and Losses on Railroads. Harrington Emerson. An outline of the methods by which losses could be reduced and ultimately eliminated. 6500 w. R R Age Gaz—June 5, 1908. No. 92816.

See also Accounting, under MISCELLANY.

Scotland.

Through the Scotch Highlands by Rail. J. F. Gairns. Describes and illustrates the picturesque country of the Highland Railway. Map. 6000 w. Cassier's Mag—June, 1908. No. 92998 B.

Valuation.

Valuation of Railroad Property in Minnesota. A. S. Cutler. An account of the methods used for obtaining and checking the information. 2500 w. Engrs' Soc, Univ of Minn—Year Book, 1908. No. 93388 N.

STREET AND ELECTRIC RAILWAYS

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Bavaria.

See Electrification, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Car Barns.

Cottage Grove Avenue Car House of the Chicago City Railway Company. Illustrated description of a new fireproof car house for storing and repairing cars, and furnishing rooms for the comfort of employees. 2000 w. Elec Ry Jour—June 20, 1908. No. 93079.

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Observations on Pay-as-You-Enter Cars by the Mechanical Man. W. H. Evans. Discusses certain features of these cars, and of fare-collection. 2500 w. Elec Ry Jour—July 4, 1908. No. 93503.

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Hannover.

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Electrification of the Heysham, Morecambe, and Lancaster Line. Illustrated detailed description of this single-phase installation on the Midland Railway. 4000 w. Engr, Lond—June 12, 1908. Serial. 1st part. No. 93231 A.

Midland Railway Electrification. Illustrated detailed description and official information concerning the first single-phase system in Great Britain, the branch line connecting Heysham, Morecambe, and Lancaster. 10000 w. Tram & Ry Wld—June 4, 1908. No. 93299 B.

Substations.

Instructions to Operators in Railway Converter Sub-Stations. J. E. Woodbridge. Instructions for the manipulation of the apparatus under normal and emergency conditions. 3500 w. Elec Ry Jour—June 13, 1908. No. 92933.

Subways.

Construction of Section 903 of the Bridge-Loop Subway, New York City. Explains changes made in the plans, and describes the work. Ills. 3000 w. Eng Rec—June 13, 1908. No. 92954.

The Problem of Capacity in Rapid-Transit Systems: Report of B. J. Arnold on the New York Subway. Review, with extracts from the report, and editorial comment. 4500 w. Eng News—June 4, 1908. No. 92854.

Subway Signalling.

The Block Signal Train Indicating and Emergency Safety Equipment of the Interborough Rapid Transit Co., in the East River Tunnels, New York City. Describes the operating equipment of the two tubes from Bowling Green to Borough Hall, Brooklyn. Ills. 2000 w. Eng News—June 11, 1908. No. 92937.

Mr. Arnold's Report on the Subway Signals. Extracts from the preliminary report giving details of the signal system and the proposed improvements. 2500 w. R R Age Gaz—July 3, 1908. Serial, 1st part. No. 93507.

Track Bonding.

A Unique Application of Thermit Welding on Shallow Rail. Illustrated description of work on a viaduct near New York City. 1200 w. Elec Ry Jour—June 27, 1908. No. 93327.

Train Despatching.

Despatching Trains by Telephone. W. W. Ryder. A report of the success with the telephone on the Chicago, Burlington & Quincy. 2000 w. R R Age Gaz—June 26, 1908. No. 93332.

Wales.

Rhondda Valley Tramways. Illustrated description of a line of interest because of the local conditions. 2000 w. Tram & Ry Wld—June 4, 1908. No. 93298 B.

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The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Fôruerung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

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THE USE AND CONSERVATION OF WATER-POWER RESOURCES.

By *H. von Schon.*

The conservation of natural resources has been the subject of much recent discussion. Mr. von Schon's treatment of this special phase is constructive, rather than argumentative. He does not rest content with pointing out that "something should be done," but proposes a definite, and in his opinion feasible, plan for meeting existing conditions. His article therefore has the merit of a concrete proposition, which even though it may not be accepted by some, may furnish the basis for further development. A following paper will examine carefully the economic aspects of water-power conservation, and a concluding section will illustrate the proposed policy by working out a special typical case. While the primary interest considered is that of the hydro-electric power plant, the collateral provinces of irrigaton, navigation, and flood prevention—all engineering matters of great importance—are integrally related to the subject.—THE EDITORS.

NATIONS, like individuals, may squander their substance, no matter how plentiful the store they have to draw upon, and the only hope of remedy lies in the realization of the consequences.

Water-power is one of these assets and its great importance in the future development of the country is now generally appreciated. Indeed, water *per se* as an element enters into every phase of the conservation of resources—water in its beneficent and its destructive functions; to enhance the first and to diminish the second is worth our study and aim, as the economic values of obtainable results are simply incalculable. As one of the requirements of vegetation, the carrier of burdens, the indispensable life-sustainer of man and beast, the irresistible destroyer of all that human hands may rear, and last but not least, as the source of light, heat and power—what other element surpasses its importance? Forests and food stuffs may flourish on now arid wastes by the aid of irrigation, uninhabitable swamp areas be reclaimed, the products of the fields and the mill be transported, every community secure a bountiful and pure supply of water, homes and cities be lighted, factories and shops operated; and that the sometimes wholesale destroyer of life and property be not only rendered harmless but by the very process be made to enhance the available aggregate of its resourcefulness for all these functions—these results, and more, combine to make up the possible reward of intelligent conservation of the element, water.

In a manner we have learned to impress water for these manifold purposes, but so far only by surface methods with little thought or effort to conserve and economize, and this is especially true of its source as power.

When an individual fully awakes to the realization of wasting his substance, his first and most rational step is or should be to take an account of what remains. Water power is the expression of the dynamic energy of falling water, the energy represented by the weight of its falling volume, 80 per cent of which may be realized as mechanical, and 70 per cent as electrical power. It is in this latter form only that the future utility of water power need be considered—the form in which it may serve the purpose of men at the most convenient points, practically irrespective of distance from its prime source.

The measure of this resource is therefore the volume, flow or run-off, and its fall.

Each watercourse is a law unto itself as regards these factors, depending upon the catchment area, its character and climatic location, and the fall from its source to the efflux; and in order to take account of the available power the determination of these factors becomes necessary. The flow of streams has been the special subject of many years observation on the part of the United States Geological Survey Department, and the profiles of many rivers have been developed, but it remains to estimate what part of either is available for power development.

Theoretically, all the fall and flow of a river is available for power development, but the practicable limit is a question of economics. Successive dams may be placed so that the lower pool of one becomes the upper of the next; but this may prove in cases exceedingly wasteful in cost, as economic dam sites are not always arranged by nature with such regularity; however this ideal can be realized more frequently than may be conjectured, as it has been and is being done on American rivers for slack-water navigation; examples are the Fox river in Wisconsin, the Allegheny, Monongahela, Kanawha, Ohio, Kentucky, Green, Cumberland, Warrior in Alabama, and others.

But this is not the programme which has been pursued in the past on the rivers of New England and the northern and middle States, where dams were located because they afforded good mill sites; this was not a provident method for the utilization of all or most of the available fall. Here and there between these past developments good sites with ample fall remain unutilized, and those in the upper reaches or remote from transportation facilities still await development. At any rate, it may be considered generally practicable to develop from 70 per cent to 80 per cent of the total fall of a stream, excluding that occurring in the headwaters proper.

No such well defined limit can be quoted for the utilization of the flow. Precipitation and run-off are known well enough, but reservoir storage opportunities and extent are a closed book, except in the case of a few systems where the exploitation of navigation programmes has been extended to this feature—as for instance on the Mississippi and some of its important tributaries, the Wisconsin, Chippewa, Ohio, Allegheny and others. Lately some investigations have pursued in this direction in New York, New Jersey, Pennsylvania, Massachusetts, and Missouri, in connection with water-supply projects, but of the large number of rivers in the United States no conclusive surveys exist from which the storage opportunities and capacities could be discovered with any degree of useful accuracy.

This volume of available flow is as important a factor as the fall, as the product of fall and weight of volume represents the source of water-power energy. The past practice has generally been to ascertain the monthly run-off for a year, and to base the development upon some arbitrary condition, fluctuating, in accordance with the conservatism or haphazard judgment of the promoter or advisor, from the mean low to the mean monthly natural flow. Both extremes are wasteful either of the opportunity or of the investors' interests. Without the consideration of flood-flow storage, the determination of available flow basis should be developed from a consideration of the market demand and value of the output in order to decide how large an investment in auxiliary power plant or electric storage equipment the enterprise will stand, and the capacity of this added to the low-flow output will point to the volume which may be accepted as the available flow.

All this, however, ignores the practical storage of the flood flow, of which, as has been stated, no estimate whatever can be made because we lack the definite data. These should be plans showing the topography along the feeders, especially in the region of the headwaters, by five-foot contours or closer. The flow in rivers fluctuates in accordance with the ground-storage capacity of the catchment areas; an area of rocky and broken surface is of low storage capacity and flow fluctuations will be of extreme character, while an area of deep drift and gently rolling surface represents large storage capacity and limited flow fluctuations. Forests, swamps, and lakes increase the ground-storage capacity to a great extent.

The Grand River in Michigan illustrates the first of the ground-storage types; its flood flow is one hundred times the normal low; the Au Sable in the same State, not more than 150 miles distant, belongs in the second class; its flood flow does not exceed double its low flow. The Grand River may rise twenty feet at some points in three days; the Au Sable does not rise more than three feet in extreme flood; this is a fair sample of steam-flow fluctuations. Little or nothing has been done in connection with past water-power developments to secure any measure of flow equalization, while the cutting down of forests has done much to lower the ground-storage capacity of catchment areas and thus to increase the flow fluctuations. What portion of this flood flow can be stored to replenish the stream during the naturally low, the growing season, cannot be known until reservoir sites are surveyed, and therefore no reliable estimate can be made of the amount of undeveloped water powers nor of the increased output of the developed powers which may be secured from flood-flow storage.

We find ourselves in the position of the man who has done business without keeping books; we cannot take an inventory of our water-power asset, not for sometime to come; and until we have these facts the practice will continue as of the past, because it is a serious and exceedingly expensive undertaking to determine the storage opportunities and capacities of a river; besides, it concerns the powers of the entire system; how therefore can the interests of one particular site be expected to go into such an investigation? As a matter of fact, they do not concern themselves much with storage problems, but make the best of a wasteful condition.

It appears from latest statistics that the present output of developed water power is 2,050,000 horse power; and from data collected by the author the undeveloped water power of New England aggregates 600,000 horse power, of New York, Pennsylvania and middle States, 1,650,000 horse power, of the southern States, 4.000,000 horse power, of northern and north-western States, 1,050,000 horse power, of the Pacific Coast watershed, 800,000 horse power, a grand total of

10,000,000 horse power. This estimate is based upon the unconserved flow, or such a volume as is available during nine months of an ordinary dry year; in other words, it is the estimate in accordance with the present-day practice of ascertaining the available power output of a stream.

A table at the end of this article gives the high and low monthly flow of some 120 rivers with drainage areas exceeding 1,000 square miles; these are compiled from the latest report of the United States Geological Survey Department. Referring to them it will be seen that the high flow of the majority of rivers exceeds ten times the low monthly flow. Is it then excessive to assume that economically practicable flood-flow conservation would double the present available water-power output? In my judgment this is a very conservative estimate. It has been said by authorities on the subject that on some of the largest American river systems, flow regulation would increase the present water-power capacities tenfold and more. However, a few examples will serve to place the above estimate in line worthy of consideration for the purpose of this discussion.

The Ohio River system is one of those which have been extensively surveyed by the United States Government in connection with the consideration of the feasibility, programme, and cost of regulating the flow, reducing the flood run-off, and thus aiding navigation and incidentally water-power developments; and resulting from these investigations it appears that the water-power capacities of the different tributaries in the present unconserved, and the feasible controlled conditions, are:

River System.	Power Capacity. With Present Unconserved Flow.		Power Capacity. With Regulated Flow.	
Cumberland	20,000	horse power	200,000	horse power
Green	6,000	"	30,000	"
Kanawha	335,000	"	800,000	"
Kentucky	10,000	"	80,000	"
Monongahela	11,000	"	90,000	"
Ohio at Louisville	8,000	"	110,000	"
Tennessee	1,000,000	"	3,500,000	"
	1,390,000	"	4,810,000	"

According to this, the conservation of the flood waters in this system will triple the water-power capacity, and in this connection it must be understood that water-power development on these rivers under present conditions is often impracticable if the purpose is to supply continuous current service, as each flood puts the generating plant out of commission for some days, since the working head is drowned out; and to arrange for auxiliary power sources for the entire output is generally prohibitive in cost to the enterprise. As has been stated, the increase in power output shown above is three to one. The same result may be secured on many other stream systems, and generally speaking at a much reduced cost from that estimated for the regulation of the Ohio river.

A reasonable estimate of our available water-power assets appears to be 20,000,000 horse power, representing the annual equivalent in steam fuel of about 300,000,000 tons. At $100 per horse power, this would require an investment in water-power works of approximately $2,000,000,000 and a further investment in hydraulic and electric power-generating equipment (at $50 per horse power) of $1,000,000,000. At a valuation of $35 per horse-power per annum (about 0.75 cents per kilowatt hour) for continuous service, the income at 3 per cent represents a total earning on about $20,000,000,000.

The estimated cost of the works required to control and regulate the Ohio River flow, in accordance with the programme upon which the comparative power table is based, was $125,000,000. Interest on this at 3 per cent is $3,750,000, which if distributed over the water-power output of 4,800,000 horse power is considerably less than $1.00 per horse power. But what is the value of such flood control to other interests? The damages caused by the floods during the past year in the Ohio river system have been estimated as exceeding $100,000,000; and then there are the advantages to navigation. In the case of the Ohio River flow-regulation programme the cost per horse power added to the unconserved output is approximately $30; suppose it were $50 per horse power, or an aggregate of $1,000,000,000 for the conservation of flood flow on all power streams where the existing and gained power output would warrant such a programme; then the 3 per cent on the investment needed to conserve this resource could be met by the water-power at $1.50 or $2.00 per horse power, which would be more than saved in reduced expense of cost, maintenance, depreciation and operation of the otherwise required control works, and in the enhanced efficiency of all generating equipment due to the constancy of the power factors—the flow and the head—as compared with their present excessive fluctuations throughout the year on most large water-power plants. This charge would form a premium on the most desirable and beneficent insurance which a water power could desire.

What is the value of these collateral benefits to the American people—the navigability of the rivers as a whole, the prevention of the present annual flood destructions, the conservation and corresponding cheapening of heat fuels, and the enormous impetus given to the industrial development of the country by rendering serviceable these added power sources of the most economical form of all, hydro-electric?

Results like these here outlined can be realized only by the combined resources and powers of the whole people. The individual, the community, and State prerogatives dwindle into insignificance when considered in connection with a programme which would deal successfully with such issues. But even so, it seems feasible to outline a policy by which not only can the rights of each be fully preserved, but the benefits may be secured to the individual as well as to the people at large.

The promoters of a water-power development value the opportunity for the returns it may bring; for these they must look to the community where the power product may be most economically marketed. The interests of that community dictate that it shall facilitate the bringing to it of the hydro-electric product, provided it is offered at a cost which represents an economy from the prevailing price of power if already supplied. There is no steam or gas power plant which can compete successfully with a normally conditioned hydro-electric development; the product of the latter can always be sold for less than that of the most economically operated steam or gas plant and still leave a profit. The community's interest, therefore, is favored by granting such franchises as will enable the hydro-electric output to enter the town and compete for the light and power business, or will permit sale of the current to the existing power company.

With the way thus cleared to a promising market, the water-power people investigate the physical features of the project and very soon learn that farm land rises to city-lot prices; the farmer sees, or thinks he sees, his opportunity to sell his unproductive, perennially drowned bottom lands for more than his best upland values; and many a meritorious water-power development is shelved right there. At this point the people of the State should take knowledge, because it is to their interest as a State to have their resources developed. The development of a water power for the purpose of producing electric current for public-utility services is of as much public benefit as the establishing of a line of transportation—a railroad—and as the latter enjoys the right of eminent domain, of acquiring the necessary lands at a reasonable and just valuation, why should not the same privilege be extended to the water-power development which is projected to render public service? In some States such is the case now. With such a privilege it seems but proper that the distribution of the current, or a reasonable part of it, should be made within the State where it is exercised; this would rarely interfere with the natural market conditions. Now the water-power project enjoys all reasonable public support until the subject of flood-water conservation is approached. There are a number of other water powers on that river; some are developed, others remain untouched; the promoters of the project in question cannot cope financially with the whole problem of flood conservation, nor is there any reason why they should, as every power owner and user on that stream would be benefited; and in many cases the owners of lands along the river and whole communities are deeply interested in preventing flood rises and consequent destruction. This is certainly a matter for the State to take in hand. The first necessary determination is the feasibility, the second the recommendable scope, the third the cost. These are clearly beyond the subject of the individual development, because of their collateral importance to the people, to the other water-power interests, and therefore logically are an affair of the State.

The State of New York has provided for just such a situation. There a State Water-Supply Commission receives in public hearing the application of the water-power company or of the community who desire the current, and they exploit the feasibility, obtainable results, and cost, and embody their findings, with plans for proposed storage works, in a report with recommendations to the State legislature.

The investigations of flood-storage opportunities should be carried on by the State. Ordinary precautions would safeguard against considerations of impracticable schemes; but even if the findings pronounced flood-water storage impracticable or prohibitive in cost, as measured by the benefits secured, this result would not be without value to the people of the State, as the facts developed will sooner or later prove useful in other directions and they certainly would for once and all establish the maximum value of that stream system as a power source.

If storage of flood waters were determined to be feasible, the State commission should have authority to designate the reservoir sites as a State water and forest reserve, acquiring title by condemnation to sufficient land to control the reservoir feeders; they should then lease the same to the lowest bidder for the construction of the necessary storage works and their maintenance and operation, fixing the amount of tolls at a certain per cent on the investment for lands and works, which should be covered by a State bond issue. Tolls should be charged and collected from every water-power opportunity, developed and undeveloped, which will become the beneficiary of this storage, the rate being determined from the power capacity of each such power holding and assessed by the State as a tax against the properties which control a fixed minimum fall.

Where it is unconstitutional at present for the State to acquire lands for the purpose of water and forest reservations, or to construct such public works as would be required to store the flood waters, corporations could be organized and given legislative authority to perform all these functions until such time as the peoples of the States consider it desirable so to alter and order their constitutions as to give to themselves these powers and authorities, by the just exercise of which only these now wasting and constantly wasted resources can be conserved to them and their children and children's children.

The power development works should be exempted from taxation for a period of years, during which the principal of the capital investment remains a charge against them conditioned upon a specified programme of serial retirement of the securities and of their total redemption. The water-power company should be chartered by the State, the latter reserving the right of periodical inspection of its works, and of regulation of the rates charged for the product. And finally, the Federal Government upon the request of the State should examine the feasibility of creating navigation on the stream, its extent and cost; and if the findings are satisfactory, a proper navigation lock should be constructed with each power-development dam, under the supervision of the Government, and the cost thereof and of buildings and appurtenant navigation works should be defrayed by the United States Treasury, as well as the expense of any canalization or deepening of channels between such power sites. The power company should be required to acquire and lease to the Government the necessary lands for such navigation works and to furnish electric current for the operation of navigation works at an agreed-upon rate.

This, then, would secure the co-operation of individual enterprise and of the powers of the community, State, and Nation toward the object of conserving the water and all its collateral assets, of minimizing destruction from river floods, re-foresting the headwaters of streams, rendering them navigable, and developing the power resource of water to the fullest conservable extent, thereby placing within the reach of every community hydro-electric power products.

With such a policy established, water powers would assume a definite and fixed value quite different from their present speculative status; owners of such opportunities would not continue to hold them for future enhanced valuation, as the storage tax on the undeveloped power would be the same as of the developed power, and all powers would be developed to their greatest output capacity. The State water and forest reserves would fully insure public control of these two important resources for all time to come, fuel consumption would soon be checked, heat fuel would become less costly, and the application of electric current to domestic purposes, to cooking and heating, would become feasible because of the regulation of service cost within reasonable profits to the power company.

Thus the people would come back into their own—the enjoyment of natural resources, which should be obtainable by all for the lowest practicable cost; and this generation could look with pride upon the good work of the conservation of water for those that are to come after.

A following article is to treat of the relation and the effect of successful water-power conservation upon the future industrial development of the United States as represented by the manufacturing and transportation interests, and the probable economic results, national and individual.

High and Low Flow from Various Catchment Basins,

with Undeveloped Water Powers, in Cubic Second Feet per Square Mile Drainage Area.

From 1906 U. S. Geological Survey Reports.

River.	State.	Drainage Area. Square Miles.	Flow. High.	Low.
Clark Fork	Montana	6,000	0.9	0.2
Milk	"	14,000	0.3	0.001
Spokane	Washington	4,000	3.5	0.4
Methow	"	1,700	2.9	0.3
Chelan	"	1,000	5.1	1.0
Wenatchee	"	1,200	4.7	0.9
Yakima	"	5,230	2.3	0.03
Naches	"	1,100	2.9	0.06
Palouse	"	2,200	0.4	0.007
Snake	Idaho	18,000	1.1	0.2
Blackfoot	"	1,000	0.8	0.08
Boise	"	2,600	2.6	0.3
Payette	"	2,200	3.2	0.4
Owyhee	Oregon	10,000	0.7	0.002
Malheur	"	4,800	1.2	0.002
Grande Ronde	"	1,350	2.4	0.03
Umatilla	"	2,100	0.8	0.00004
John Day	"	7,800	0.8	0.03
Deschutes	"	9,200	1.2	0.06
Willamette	"	4,800	4.8	0.4
McKenzie	"	1,000	7.6	1.6

River.	State.	Drainage Area. Square Miles.	Flow. High.	Low.
Sacramento	California	9,300	4.5	0.7
Pit	"	3,000	1.5	0.008
Cache	"	1,300	2.3	0.001
Feather	"	3,600	5.9	0.5
Yuba	"	1,200	8.8	0.4
Kern	"	2,300	3.2	0.2
Kings	"	1,700	9.8	0.3
Merced	"	1,100	7.7	0.2
Tuolumne	"	1,500	9.2	0.2
Bear	Utah	6,000	0.8	0.2
Green	"	38,000	0.9	0.04
Humboldt	Nevada	14,000	0.1	0.002
Truckee	"	1,500	3.8	0.7
Walker	"	1,100	0.9	0.06
Carson	"	1,000	2.2	0.1
Yampa	Colorado	1,700	3.5	0.2
Grand	"	4,500	3.0	0.2
Gunnison	"	8,000	1.8	0.3
South Platte	"	20,000	0.07	0.001
Rio Grande	"	8,000	0.7	0.03
Sabine	Texas	3,000	1.5	0.08
Neches	"	8,000	1.2	0.1
Trinity	"	16,000	0.8	0.1
Brazos	"	44,000	0.2	0.02
Colorado	"	40,000	0.2	0.02
Guadalupe	"	5,000	0.2	0.1
Wateree	South Carolina......	2,600	5.6	1.8
Broad	"	4,600	4.0	1.0
Savannah	Georgia	7,300	4.2	1.1
Oconee	"	4,100	3.7	0.9
Ohoopee	"	1,280	1.9	0.3
Chattahoochee	"	3,300	3.5	1.3
Flint	"	5,000	2.2	0.5
Pea	"	1,180	3.1	0.7
Conecuh	"	1,290	2.9	0.6
Etowah	"	1,800	3.9	0.6
Coosa	"	7,000	4.8	1.0
Oostanaula	"	1,600	4.8	1.3
Alabama	Alabama	15,000	4.6	1.2
Tallapoosa	"	2,500	5.0	1.2
Cahaba	"	1,040	5.4	0.4
Tombigbee	"	8,800	2.0	0.3
Elk	"	1,700	5.1	0.5
Black Warrior	"	1,900	7.2	0.4
Tennessee	Tennessee	21,000	2.8	1.3
Holston	"	3,000	2.4	0.9
Little Tennessee	"	2,400	4.5	1.9
Hiawassee	"	1,200	4.7	1.6
Duck	"	1,200	3.5	0.1
Shoshone	Wyoming	1,500	3.2	0.2
Little Missouri	South Dakota........	1,900	0.3	0.004
Cheyenne	"	7,300	0.3	0.001
Belle Fourche	"	4,300	0.2	0.04
North Platte	Nebraska	28,000	0.3	0.04
Platte	"	56,000	0.1	0.01
Loup	"	13,000	0.4	0.1
Republican	"	23,000	0.06	0.01
Illinois	Illinois	13,000	1.7	0.5
Rock	"	6,100	1.9	0.1

River.	State.	Drainage Area. Square Miles.	Flow. High.	Flow. Low.
Cannon Ball	North Dakota	3,600	0.2	0.001
Red	"	25,000	0.7	0.05
Sheyenne	"	5,400	0.1	0.01
Pembina	"	2,900	0.8	0.04
Mouse	"	8,400	0.05	0.001
Red Lake	Minnesota	5,500	1.4	0.2
Rum	"	1,400	2.4	0.5
Minnesota	"	13,000	0.6	0.2
Chippewa	Wisconsin	6,700	3.6	0.7
Flambeau	"	2,100	3.4	0.6
Wisconsin	"	5,800	3.9	0.9
Iowa	Iowa	3,300	1.4	0.3
Cedar	"	6,300	1.7	0.3
Red Cedar	"	1,800	1.1	0.3
Des Moines	"	14,000	1.0	0.2
New	Virginia	2,700	2.9	0.9
James	"	6,200	3.3	0.7
Greenbrier	West Virginia	1,300	3.8	0.9
Shenandoah	"	3,000	2.7	0.5
Scioto	Ohio	1,000	2.2	0.2
Miami	"	2,450	2.1	0.2
Muskingum	"	5,800	2.4	0.4
Wabash	Indiana	12,000	2.4	0.3
Tippecanoe	"	1,900	1.8	0.3
Allegheny	Pennsylvania	8,600	3.2	0.3
Susquehanna	"	26,000	3.9	0.5
Juniata	"	3,500	3.7	0.7
Potomac	Maryland	9,600	2.3	0.5
Chenango	New York	1,500	4.0	0.3
Chemung	"	2,400	2.4	0.08
Mohawk	"	3,400	2.6	0.3
Aroostook	Maine	2,200	8.2	0.2
St. Croix	"	1,400	3.2	0.5
Penobscot	"	6,600	6.6	0.6
Mattawamkeag	"	1,500	6.8	0.2
Kennebeck	"	4,300	5.2	0.6
Androscoggin	"	2,200	4.9	0.9
Housatonic	Connecticut	1,000	4.6	0.9

OBTAINING ACTUAL KNOWLEDGE OF THE COST OF PRODUCTION.

By F. E. Webner.

V. THE ORGANIZATION OF A COST DEPARTMENT.

In the preceding instalments of his series, which began in our May issue, Mr. Webner has discussed the themes "What Constitutes a Knowledge of Costs"; "When and Where a Close Knowledge is Needed"; "The Profitable Use of Cost Comparisons"; and "The Use and Abuse of Mechanical Aids in Cost Finding." The series will be concluded next month with a consideration of "Cost Records as a Part of the General Accounting."—The Editors.

"DEAD time," "non-productive labor," "necessary evil," etc., are expressions often used to characterize bookkeeping work, and in those plants where it is so treated the character of the results obtained from the records usually merits the titles given to the work.

Accounting is the vital element of business, and statistics show that nine out of every ten failures in business are the direct result of a lack of proper knowledge of conditions—the deficiency being due to poor book-keeping methods, or none at all. It does not always follow that a man who fails in business has not been making sales at a profit. Any shrewd manufacturer knows the danger in over-buying, or in having too many obligations maturing simultaneously, or in accepting more orders than he has capital to carry or capacity possibly to fill; these and many other analogous causes, by reason of which far too many well-meaning men have gone upon the financial rocks, bespeak the ignorance of the manager's mind concerning the balance sheet and the records supporting it until after the mischief has been done. Like the man who falls back upon the time-worn expression "didn't know it was loaded," he tells those concerned that he failed to realize how much record books really meant.

One frequently comes in contact with men who carry their business in their heads and wax fat in their business; some men have wonderful memories for dates, numbers, and amounts; but indeed, how short-sighted for such men to load a busy brain up with details which might be handled by an inexpensive clerk to better advantage, thus leaving the brain free to act on larger things. On several occasions in my experience I have been engaged on cases involving the untangling of masses of figures resulting from certain proprietors carrying too much in their memory, and subsequently the business losing the benefits of such memory—by death or otherwise. That man is best equipped to enlarge the scope of his business who is able to duplicate himself in others; the picking of able lieutenants spells success for any enterprise. Organization efficiently builds railroads, moves mountains, spans oceans, and attains the seemingly impossible.

A highly organized selling force can move articles of inferior merit in the same territory where poorly organized forces may fail even though having the support of ample capital and a highly meritorious product. Business is a prolonged warfare, the placing of the fighting forces to do battle being arranged and possibly rearranged many times in accordance with the underlying and controlling policy. The success of army manœuvres does not rest with the fighting men alone—its engineer corps, its "flag-waggers," its commissary and hospital departments, are all important adjuncts and contribute largely to the general success; so largely that in war times we frequently heard of brilliant successes resulting almost entirely from achievements of efficient bodies of non-combatants. By the same hypothesis it must become patent to the captains of industry that the non-producers about a factory plant must be as highly organized in their respective lines as are the producers.

In years past manufacturers were, perhaps most naturally, interested first in their product and later in correcting such errors as may have crept into their original calculations and deductions; that is what first gave rise to the thought of evolving accurate costs of production. The same routine obtains even in this enlightened twentieth century when profits are calculated to a small fraction of a cent per unit. The new factory starts with a blare of trumpets and a flaunting of banners and with speeches and shouting galore; a little later on in the history of the concern the pencil and pad are brought into play to determine just where and why the mistakes were made, but these earnest searchers after truth are not always successful in gleaning the desired information; perhaps through lack of knowledge they do not discover how to make a proper start. Cost finding is an art and to one deeply interested it becomes a beautiful art. Ruskin says:

"The broader question of what these arts and labors of life have to teach us of its mystery, this is the first of their lessons; that the more beautiful the art the more it is essentially the work of people who *feel themselves wrong;*

who are striving for the fulfilment of a law and the grasp of a loveliness which they have not yet attained, which they feel even farther and farther from attaining the more they strive for it: and yet in a deeper sense, it is the work of people who know also that they are right. The very sense of inevitable error from their purpose marks the perfectness of that purpose, and the continued sense of failure arises from the continued opening of the eyes more clearly to all the sacredest laws of truth."

The old adage says "what is worth doing at all is worth doing well"; in a factory a hit-or-miss plan of guesses and logical conclusions based on a few accurate figures falls far short of the mark, and a cost system devised along such lines is indeed of low potentiality and is an expense, while a good cost system is a live asset.

The average patient, plodding machinist has not many aerial flights of thought while working at his trade; perchance he may have a retentive memory and carry in his storehouse of technical knowledge a wide range of usefulness of gears, pinions, sprockets, cranks, levers, ratchets, and all those other things mechanical which to the ordinary layman are considered only as "wheels and things." He may know and have already analyzed the construction of many unique applications of mechanical movements and be able to reproduce them, and yet have no inventive genius of his own whatever farther than perhaps to apply to a new purpose some movement he has seen elsewhere. We know him as a practical man and we have seen many of his kind develop into foremen and into *good* foremen——foremen who are worthy of and receive the respect and admiration of both their employers and employees.

Inventors of machinery are very largely dreamers and theorists—persons lacking a wide technical knowledge of modern machine-shop practice. It is not at all uncommon to inventors to think and even define an eccentric cam as a wheel with its center at one side; such men, however, usually have enough genius in their make-up to make themselves clearly understood by the machinist who is to undertake to carry out the plans of the inventor, after applying thereto his own technical knowledge of the movements embodied in the plan.

The difference between the theorist and the practical man is analogous to that difference which obtains as between the inventor and the machinist—one plans work for the other to do—one sets the mark for the other to strive for, and evolves plans with an eye single to the usefulness and beauty of the structure. The theorist and the inventor have dreams which they want realized; the function of the practical man is to carry out the plans of the dreamer with, perhaps, a change of detail here or there. Each needs the other, for it is an almost infallible rule that the so-called practical man is prone to measure efficiency by immediate results and fails to discern the greater and broader results which the theorist has in mind.

A cost department should be like a well built machine; and it can be, with the right kind of men—men who will devote their earnest energies to the cause and not "back and fill" in the harness, but will keep a firm determination to reach a successful climax. It sometimes happens that the practical man, not having his heart in the cause, will show his reluctance to acknowledge any possible short-sightedness by failing to apply records to their fullest use; this however is only a prolonging of the inevitable season of anxiety attendant upon the installation of a new cost system, or any other new system. If the originator of the plan has been commissioned to "carry a message to Garcia" and is given sufficient latitude to produce those results for which he is to be held accountable, all the petty annoyances and causes of friction will worry themselves out in due course of time. Ultimate success depends upon the decisions of the management in determining between the best interests of the business and the pig-headedness of certain of the men.

Theorists are safe enough when they take cognizance of known facts and cardinal principles and, by all means, the cost system should be planned by a theorist—a safe one—and carried on by a careful clerk—an optimist. Incidentally, an optimist has been defined as one who sometimes hears of people doing just as he would have done had he been there; the cost clerk must feel as though he would have done it the same way had he been asked how at the start; he will then unwittingly feel a certain proprietary interest in the general and detail plans; he *must* be in sympathy with them, else he cannot—or perhaps a more proper expression is that he *will not* —adhere strictly to the spirit as well as the letter of the rules governing his clerical operations.

To make the proposed cost system successful one man must be in supreme authority in the cost department; there may be as many sub-heads and subordinates as appear necessary, but one man must have the authority to adjust petty differences in his own realm, and to a limited extent he must have authority to enforce the cost-system rules made for the guidance of employees in the producing departments, through proper channels—that is to say, always through the foreman concerned and never with any attempt to pass over the foreman's head. The clerk or clerks who are to come in contact with the various foremen and the shop men should be possessed of a jovial disposition, so as to enable them to work smoothly and without friction in the discharge of their clerical duties; a crabbed clerk can do much to rub the shop men the wrong way and keep a spirit of discontent in constant ferment; this is a matter to be watched very closely in the assignment of duties in the cost department. In large plants where a number of clerks are to be required in the cost department, the subordinates can be picked just as they are for any ordinary clerkship, namely, by their personality, honesty, handwriting, and ability to handle figures correctly; their promotion should depend largely on ability to do effective work in the factory without incurring the displeasure of the workmen.

The chief end of business enterprise is net profit; many workmen overlook that fact; they will occasionally make spurts to get out a large volume of product in a given month, but are utterly unconcerned as to the burden of overhead expense. The average employee loses much of his possible value on this point and resents suggestions of economy. I have in mind an air-brake instruction car in existence some years ago; it was for teaching engineers the proper use of compressed air in stopping trains—the idea that any resentment should be felt did not occur to the management of the railroad, but the engineers did not take kindly to the measure and some were quite exercised over the matter. One of the great wastes in a factory is traceable to this weakness in human nature, and education on this point is well worth the judicious expenditure of money and effort.

The man in charge, upon whom devolves the carrying out of the ideas laid down by the originator or architect of a cost system, must be to such a cost system just what the practical machinist hereinbefore mentioned is to the inventor. The man in charge must be one who can and will do things as far as possible along the lines laid down for him, and not be ever ready with a hundred and one excuses and reasons why certain things cannot be accomplished. If obstacles arise that he cannot get around he must get over them—get on the other side some way or other, and get there without too great a cost. New systems of any kind have all up-hill work, and far too many of those concerned are quite too apt to place obstructions rather than clear the way for easy running. The moral support of every one concerned should be insisted on as far as possible, and subordinate clerks in the cost department should be instructed either to speak well of the innovation or, aside from their regular duties, not speak of it at all either inside or outside of the works. A thing is often damned by faint praise; and while superficially it might appear that the workmen in the factory have nothing to do but to follow instructions, they can, at times, follow with such an apparent density in comprehension as to make the general plan burdensome and costly. Hence, if the workmen can in a measure, be cajoled into making their reports promptly and correctly and accepting suggestions of economy without growling, it helps the good cause vastly more than to have them come in contact with cost clerks who themselves are inclined to be pessimistic about the good which is to result from their efforts, and therefore more or less lackadaisical about the performance of their duties.

The man who is put in charge must not have his hands tied so that he cannot accomplish results, and moreover he must be given moral support by the powers that be, and an *esprit du corps* should be encouraged.

Too much must not be expected from the newly organized force at the start; and if at the end of a year the results are showing fairly well, it can be considered a successful installation.

STORAGE BATTERIES. THEIR CONSTRUCTION AND USES.

By Percival Robert Moses.

In this article Mr. Moses discusses in very clear and practical fashion the utility of the storage battery as a means of energy storage in isolated electrical plants, the conditions to which it is best adapted, and the economies which may be effected by its use. The present instalment illustrates strikingly the function of the storage battery in a private plant by a review of the conditions under which such plants in New York City are supplied with auxiliary and breakdown service by the large electrical companies, and describes the construction and operation of the leading types of batteries on the market. A concluding section, to follow next month, will treat of the battery as an actual part of the generating equipment, the methods of charging and discharging, the types of boosters and other auxiliary apparatus adapted to various conditions, and the cost of installation and maintenance.—The Editors.

TO the average purchaser not trained in electrical matters, the storage battery is a somewhat mysterious, expensive piece of apparatus subject to costly maintenance charges; and as the battery is not as essential an element of a power plant as a boiler or an engine, the result of this general impression has been to prevent the installation of batteries where the economical operation of the system as a whole really indicated their installation.

The value of the storage battery in isolated-plant work has recently increased materially in New York City and vicinity, because of the ruling of the Public Service Commission to the effect that while the central-station company was bound to furnish breakdown or auxiliary service to owners of private plants, the central-station company was entitled to receive a guaranteed minimum annual receipt sufficient to pay fixed charges on the installation necessary to care for the customer's service. After much discussion, a rate of $30 per annum per kilowatt of maximum demand was agreed upon as a fair charge. It was also agreed that the customer could fix his maximum demand, and suitable circuit-opening arrangements would be installed to prevent the taking of more than the agreed allowance. It may be well to state, to avoid possible misunderstanding, that the customer is entitled to use current up to the $30 agreed minimum return per kilowatt maximum demand without additional charge, and this current may be used at any time during the year, additional current to be charged at regular rates.

The use of a means for storing electrical energy under such a contract is obvious where apparatus is to be supplied which requires rapidly varying quantities of electricity, such as electric elevators or direct-connected press motors. Without a battery the maximum demand would equal the high point of the load curve with a fair margin for contingencies and overloads. With the battery, the maximum

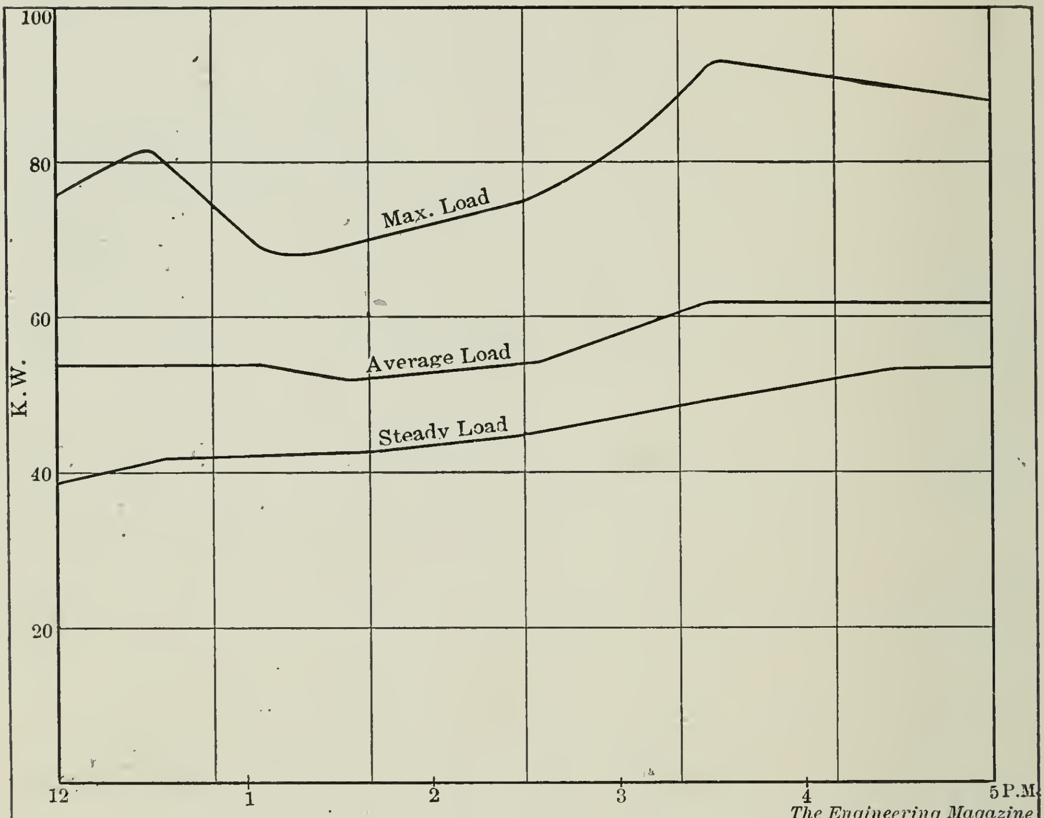


FIG. I. TYPICAL LOAD CURVES SHOWING DIFFERENCE BETWEEN MAXIMUM AND AVERAGE DEMAND.

demand may be fixed at the average requirement for a period of hours. Curves given in Figures 1, 2, and 3 show the average load and maximum demand in the case of some elevator and other installations. The ratio may be as much as 1 to 10 in the case of two high-speed elevators and a small lighting load. In such a case with a battery the maximum demand could be fixed at 6 kilowatts, costing $180 per year; while, without the battery, it might have to be fixed, to take care of all possibilities, at 60 kilowatts costing $1,800 per year. The greater the number of elevators or of other motors, the greater proportion the average load will be of the maximum demand, and the less valuable will the battery be for the purpose mentioned.

An analysis of the basis of the charge of $30 per kilowatt maximum demand, is illuminating. A maximum demand of 1 kilowatt by a stated installation, requires an investment in power house and equipment, in mains, feeders and ducts in street, in metering appliances, and in franchise and patent rights, and in taxes; all of which are additional to the actual cost of manufacturing the current. This investment, allowing for the installation at the station of one-third of a kilowatt for every kilowatt connected in the consumers' premises, amounted to about $200, on which 10 per cent may be allowed for fixed charges, or $20 per kilowatt, leaving $10 for manufacturing $30 worth of electricity, equivalent at current rates to about 400 kilowatt hours, or 2½ cents per kilowatt hour; that is to say, of a total cost for current, two-thirds was chargeable to investment and one-third to manufacturing cost, and this, notwithstanding the fact that the central station, because of its many customers operating under varying conditions, only needs to install less than one-third of the capacity which would be required if all the installations used their maximum requirements at one time.

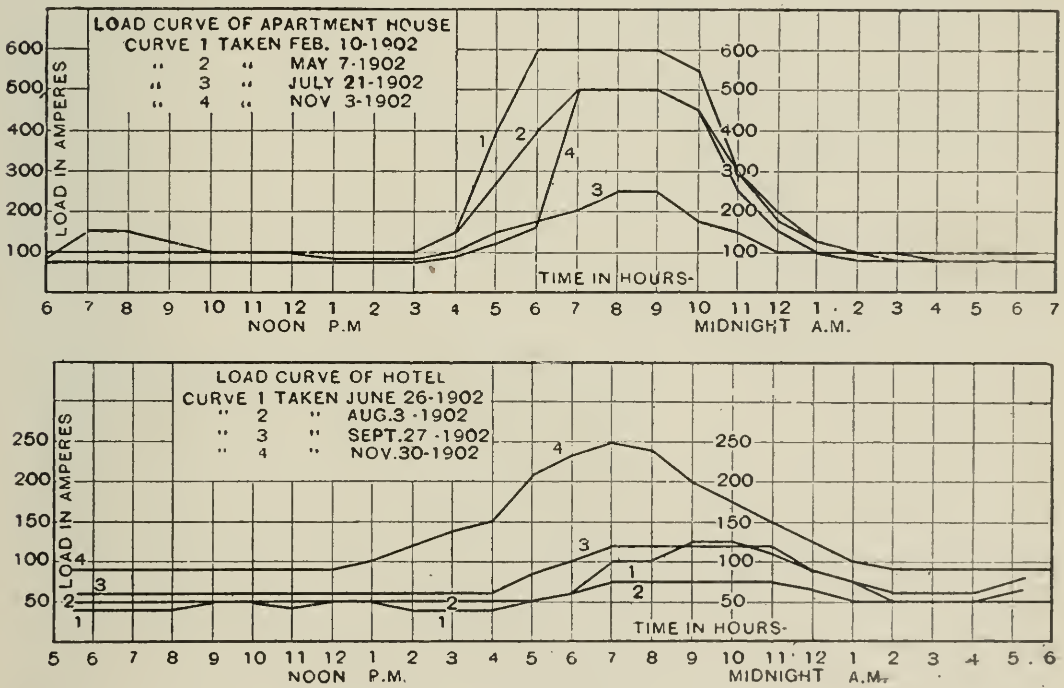


FIG. 2. TYPICAL LOAD CURVES OF A HOTEL AND OF AN APARTMENT HOUSE.

The use of a storage battery in an isolated plant in connection with a central-station auxiliary service, and a charge on basis of maximum demand, has been described, notwithstanding its limited application, because it points out clearly and definitely the main function of a battery in all isolated-plant installations. Such a plant does not have any expenditure for street mains, feeders, franchises, taxes.

etc., but the plant installation must be at least equal to the maximum demand, and usually because of need of a spare unit, from ¼ to ½ more than the maximum. Therefore, for a maximum demand of one kilowatt, the plant installation will be from one to one-and-one-half kilowatts, costing from $100 to $150, on which the fixed charges will be from $10 to $15 per annum. This should be compared with the $20 allowed the central-service company for maintaining its service in readiness.

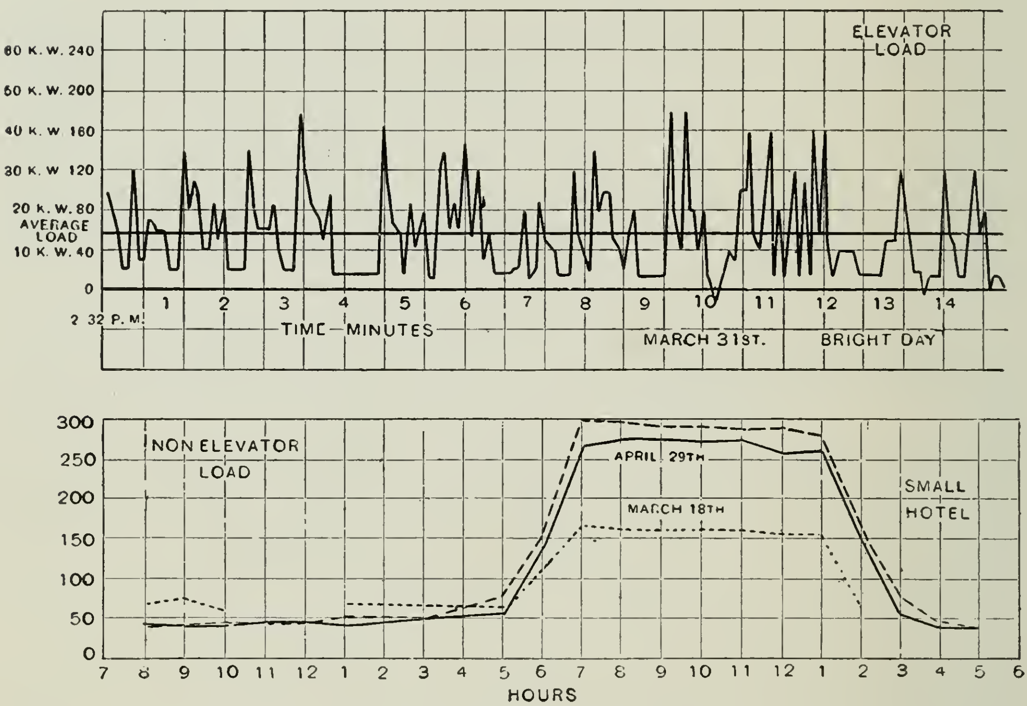


FIG. 3. LOAD CURVE OF A BUILDING WITHOUT ELEVATOR, AND A TYPICAL ELEVATOR LOAD CURVE.

From the foregoing, it follows that for every kilowatt of maximum demand in a private plant, the owner of such a plant has to charge the operation with from $10 to $15, or an average of about $12.50, per year for fixed charges alone, and if he can reduce the maximum demand by some system of energy storage to something approximating the average demand, he can reduce the total operating cost by the difference between the fixed charges on a plant big enough for the maximum demand, and one big enough for the average demand including the storage system.

In the case cited, of the elevator system of two elevators with a maximum demand of 60 kilowatts and an average of 6 kilowatts, the fixed charges in one case would be about $750 per year, and in the other $75; and the purchaser could afford to pay $6,750 (the differ-

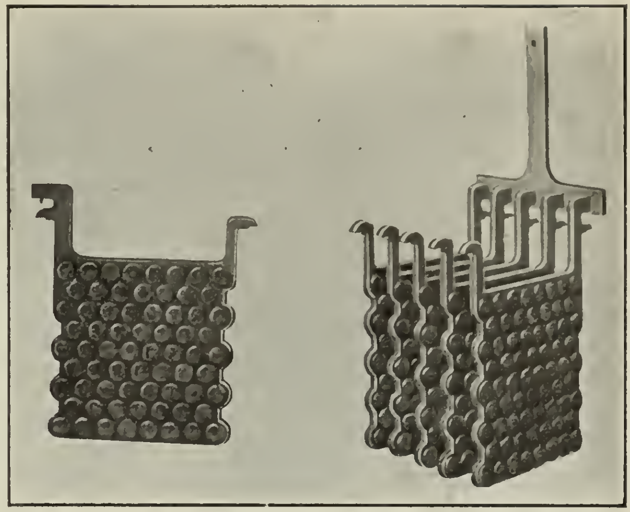


FIG. 4. POSITIVE PLATES, ELECTRIC STORAGE BATTERY CO.

ence in fixed charges capitalized at 10 per cent) for an energy-storage system, leaving out of consideration any question of operating expenses. This case, of course, is one especially favorable to a storage system, but it represents the conditions existing in a number of actual installations.

In so far as operating expense is concerned, on one hand there is the cost of maintaining and renewing the energy-storage system; and on the other hand, the savings due to decrease in use of fuel, oil, machinery repairs, and labor. It is hard to fix definitely the saving in fuel, oil, and repairs, due to a storage system; each plant has different conditions, and the question of the amount of low-pressure steam required for heating and hot water has an important bearing on the fuel question. It is evident that, omitting the question of steam for heating, etc., it is much cheaper to run a 100 horse-power boiler and 60-kilowatt unit under a steady load of nearly full capacity than to run a 160 horse-power boiler with a 100-kilowatt unit with a rapidly varying load of from 50 to 100 kilowatts, and it is equally evident that the strain on the engines and dynamos must be far greater in the second case than in the first. In several instances in my practice, only one unit is running now during the great part of the operating period where two operated before the storage system was installed.

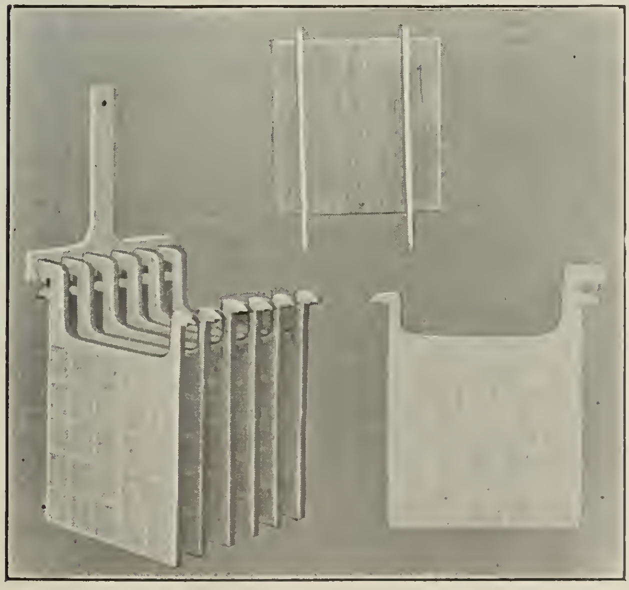


FIG. 5. NEGATIVE PLATES, ELECTRIC STORAGE BATTERY CO.

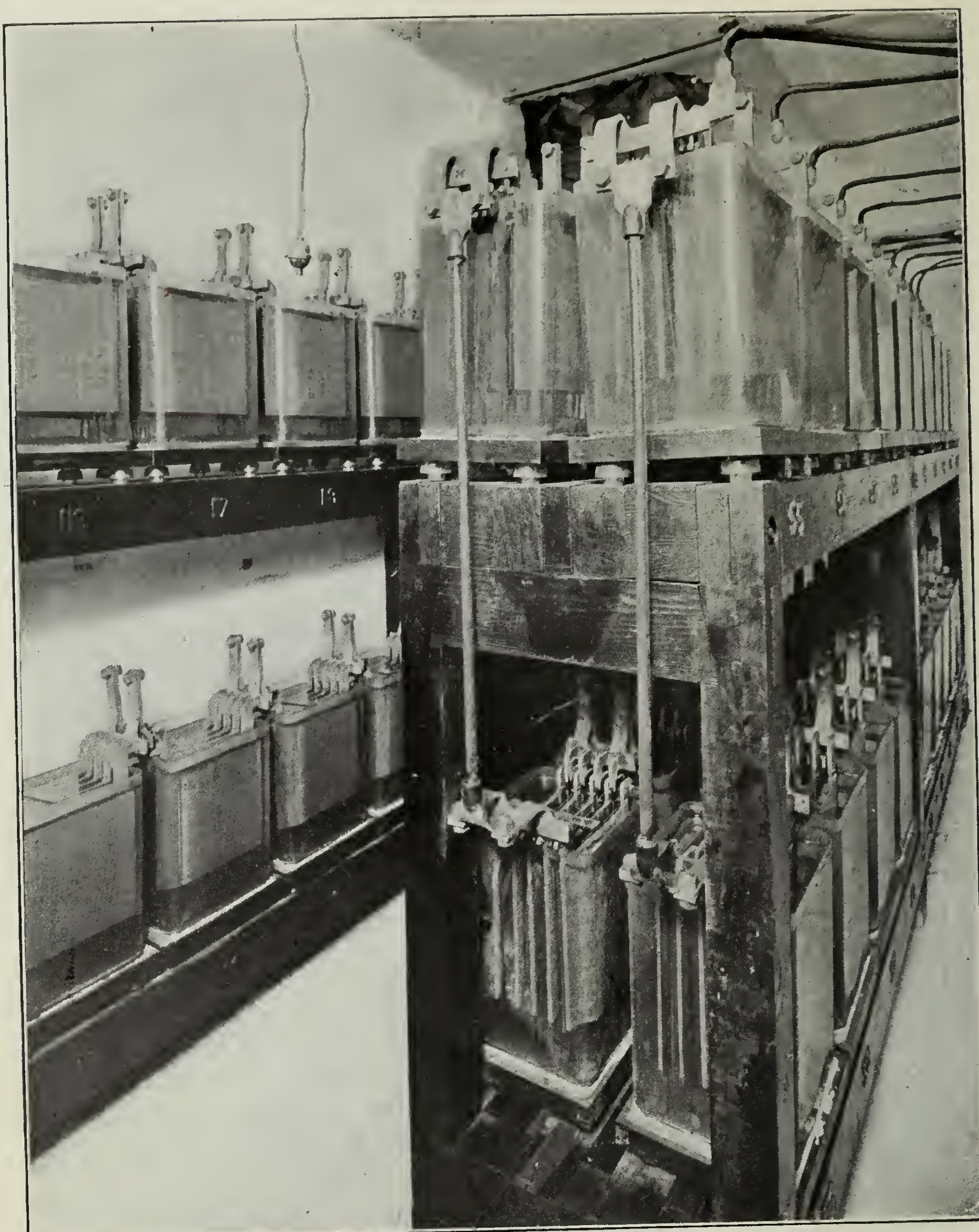


FIG. 6. BATTERY ROOM, VANDYCK AND SEVERN APARTMENT HOUSES.
Electric Storage Battery Co.

As to the labor, where a plant is operated 24 hours a day for other purposes than generating electricity, there will probably be no saving in labor, except in maintenance of engines, but where a plant need operate only part of the 24 hours, and can then be shut down, leaving the storage system to supply the energy the rest of the period, the reduction in labor may become the most important saving obtained by the installation of the storage system.

So far in this discussion the term "Storage System" has been used because the results mentioned, with the exception of the labor-saving item, would apply to any system of storing energy.

There have been other systems proposed, such as storage of hot water under pressure to supplement the boilers at peak-load periods. This system is not practical, and would not equalize the load on the engine and dynamo, nor would it take care of the short period in fluctuation of motor loads.

Another system, which is now being used in rolling-mill work, consists of a motor-generator connected to and revolving an enormously heavy flywheel, the flywheel supplying the energy necessary to care for the sudden fluctuations of elevator and rolling-mill work. This system might be arranged to take care of such momentary fluctuations, but it would be of no value in connection with the heavy short-period increase due to sudden lighting loads on dark days, nor as a reserve. Its main value is to avoid overload of the motor and

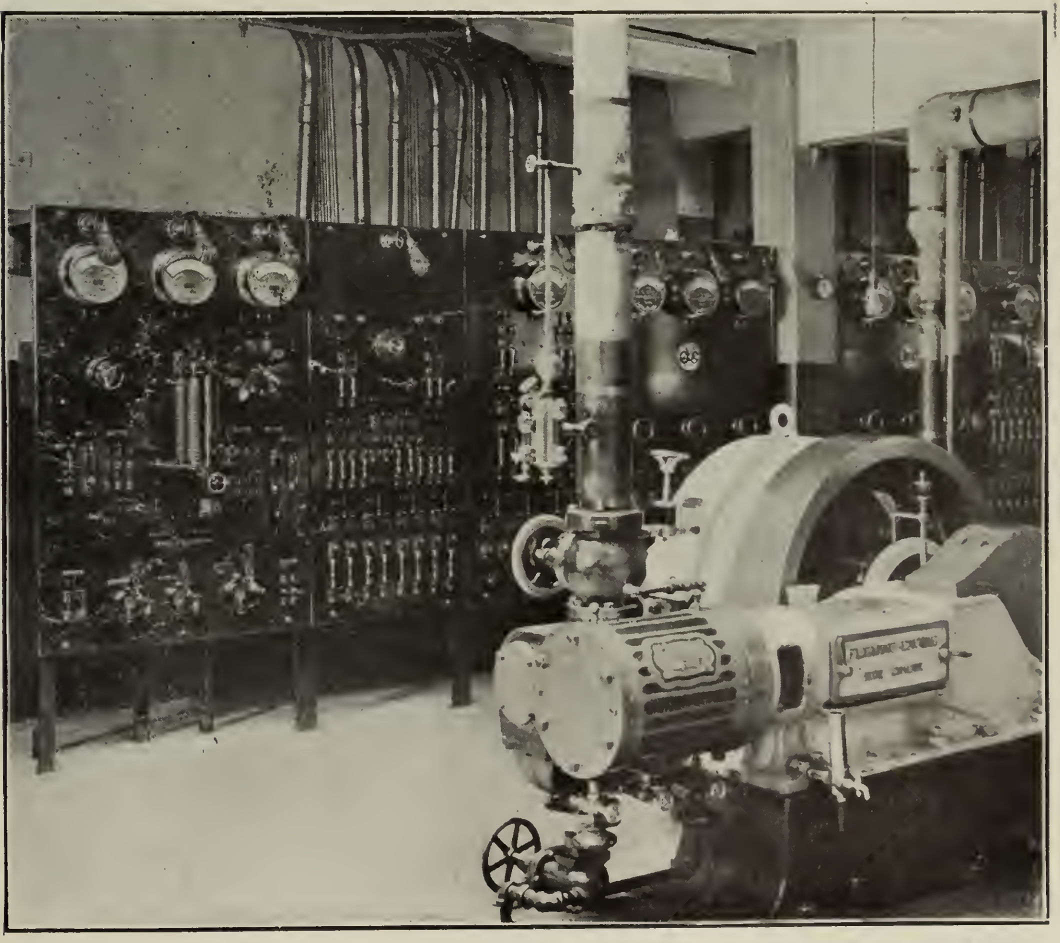


FIG. 7. SWITCHBOARD AND ENGINE ROOM, VANDYCK AND SEVERN APARTMENT HOUSES, NEW YORK.

Showing regulator and end-cell switch on switchboard.

prevent stoppage of the mechanical operation because of such overload. The reserve capacity for breakdowns and light-load periods is of great importance, even if it is only sufficient to supply a small portion of the total equipment for a few hours; as for example, a fire pump, an elevator motor, a printing-press motor, or a hundred or so lights at night after regular operating time. It is mainly for this reserve capacity in emergency that the large central-station companies maintain their large battery plants, and they have proved a "friend in need" on several occasions when feed or steam pipes burst.

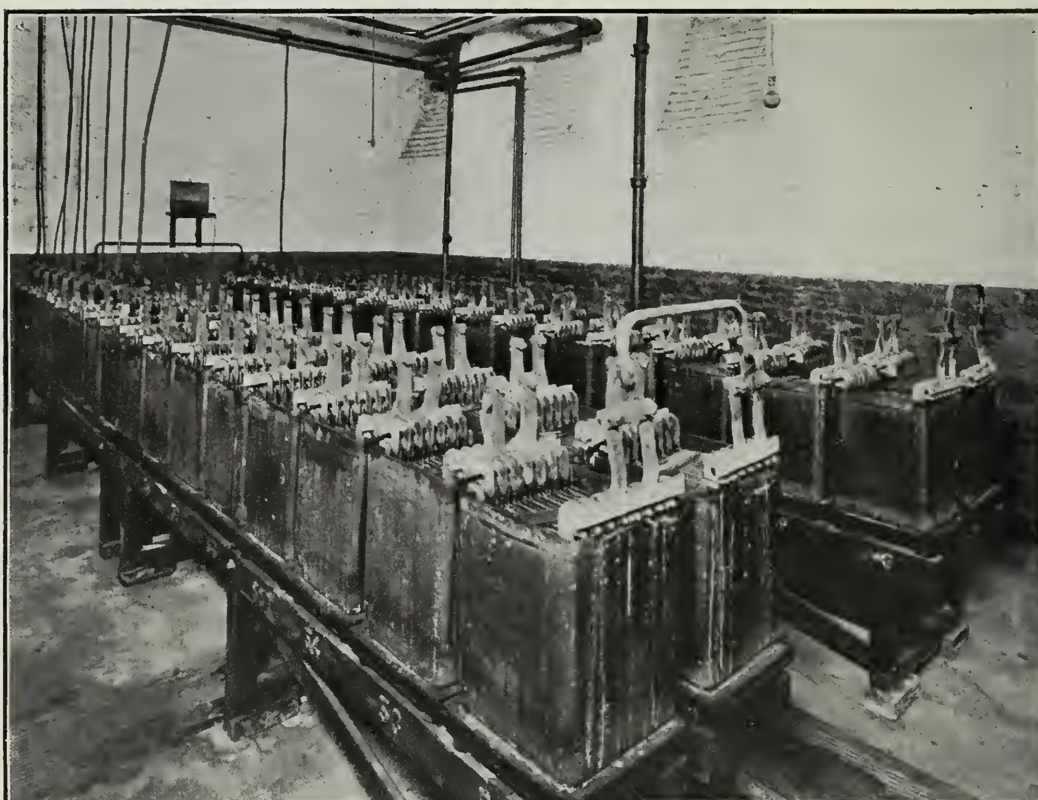


FIG. 8. BATTERY ROOM, CHATSWORTH APARTMENT HOUSE, NEW YORK.
Electric Storage Battery Co.

Another feature of an energy-storage system is avoidance of the fluctuations in voltage, and hence in lights, as heavy loads go on and off the system. Such variations are partly absorbed in plants without batteries by heavy flywheels and mechanical governors, and may be stopped entirely by electrical governors operating on the dynamo field. It is, therefore, not necessary to install a battery to take care of these fluctuations, but if a battery is otherwise advisable, the governing problem is simple, as the load change never reaches the engine and dynamo.

The function of a battery is exactly that of a gas tank in the manufacture of gas, or a reservoir in the supply of water. It is a reservoir of electrical energy, and it is the purpose of this paper to describe simply the various forms of batteries in use, some of the methods adopted for automatically charging (*i. e.*, filling up) and discharging (*i. e.*, emptying) the battery.

Storage batteries in connection with electric plants always consist of lead plates submerged in dilute sulphuric acid contained in glass jars or lead-lined wooden tanks. Each jar contains a number of these lead plates divided into two sets known as positive plates and negative plates; all the plates of one set are connected together by burning to a strip of lead, and this strip of lead is connected to the strip of the next jar. The positive strip of one jar is connected to the negative strip of the next in order, to add the voltage of one jar to the voltage of the next. In this way, by the installation of a number of cells in series, any desired voltage may be built up, each cell giving about 2 volts on discharge, so that for 120 volts, a battery of 60 cells is required.

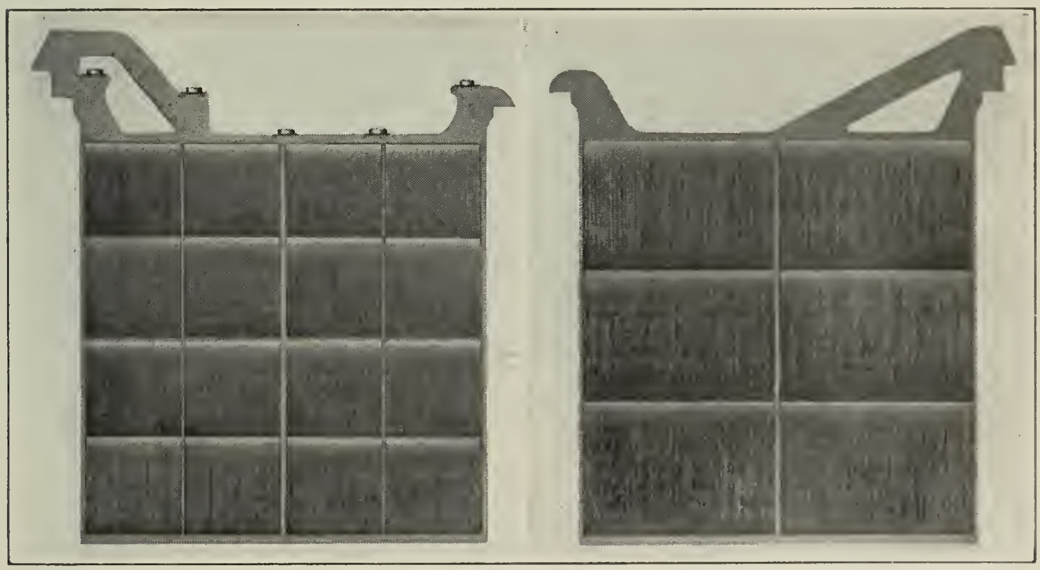


FIG. 9. POSITIVE AND NEGATIVE TYPE "S" PLATES, GOULD STORAGE BATTERY CO.

The method of storing electrical energy is simple, and depends upon the fact that the passage of electricity from one plate of lead oxide to another plate of lead oxide, when these plates are immersed in dilute sulphuric acid, changes the lead oxide of one plate to sponge lead, and the lead oxide of the other plate to peroxide of lead. This is the process through which the battery goes on charge. When it is desired to obtain electricity from the battery, it is only necessary to connect the terminals to some channel which will allow electricity to flow, such as a lighting system, or a motor, and the lead peroxide plate will begin to lose its oxygen and the sponge lead to take on oxygen again, and the result of this chemical action is to generate an electric pressure of about 2 volts which causes electricity to flow.

This is briefly the story of battery operation; charging is the rusting of the positive plate and the de-rusting of the negative, and discharging is the partial de-rusting, or reduction, of the positive plate, and the rusting or oxidation of the negative.

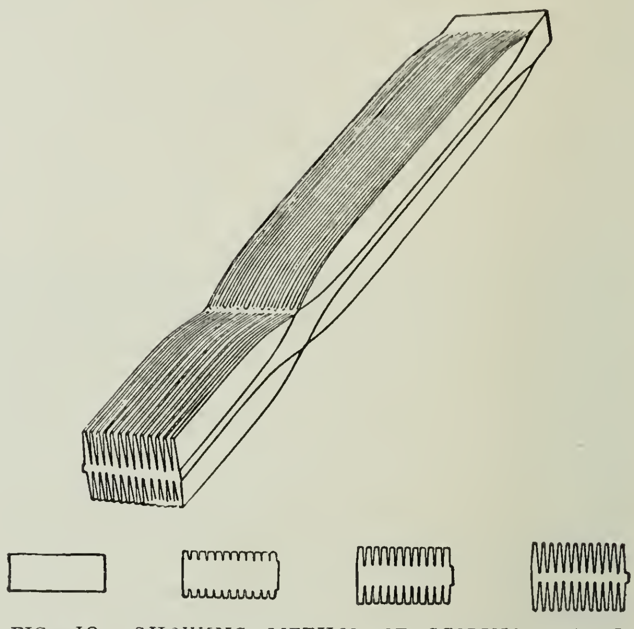


FIG. 10. SHOWING METHOD OF SCORING PLATES FROM LEAD SHEETS BY "SPINNING" ROLLS.
Gould Storage Battery Co.

If the chemical reaction stopped at this, and if lead were a substantial material and not given to expansion on rusting, the storage-battery problem would not have required the expenditure of money and brains, but, unfortunately, the chemical reaction does not stop but continues, and the lead oxide takes on sulphate and becomes lead sulphate, and this lead sulphate has the objectionable property of being an insulator and almost impervious to the passage of electricity; the lead oxide, instead of being strong and stable, is brittle and expansive on peroxidization, and these two facts are the cause of almost all the battery difficulties. The sulphating of the lead plates is not a serious trouble, with correctly designed plates, if the discharge is not carried too far. If the discharge is kept within well defined limits, as evidenced by the specific gravity of the solution and the voltage of the cells, the sulphating does not proceed sufficiently far over the active surface of the plates to prevent the passage of sufficient current on charge to regenerate the battery and drive the sulphate back into solution. It is the removal of the sulphate from the acid on discharge that reduces the specific gravity of the solution, and it is for this reason that the specific gravity is used as an index to the battery's condition. The expansion of the lead peroxide, or lead sulphate, and its brittle quality are two of the principal causes of the variety of forms of plates. All these plates have for objective the offering of the greatest amount of lead oxide or active material to the action of the acid solution consistent with maintaining a close contact (to reduce resistance) between the active material and the supporting surface or plate and, at the same time, giving room for expansion of the active material as it changes to lead sulphate or peroxide.

In one form of plate, the Manchester, made by the Electric Storage Battery Co. of Philadelphia, these results are obtained by forming the original lead oxide in a strip with corrugations on one side (see Figure 4). This strip is wound into a button and pressed into circular openings in the plate. The expansion of this button is then resisted radially, and incidentally the expansion tends to make the contact between active material and plate more perfect. Figure 5 shows the negative plate of this company known as box negative because active material is held in what is really a perforated lead box.

FIG. 11. BATTERY INSTALLATION, GOULD STORAGE BATTERY CO.

Another company, the Gould Co., forms its active material on leaves scored from the lead sheet (see Figure 10). These leaves are vertical and thicker at the base than at the ends, the space between being allowed for expansion of material.

A third form of plate, the Bijur plate made by the General Storage Battery Co., uses a grid with horizontal heavy bars and vertical cross

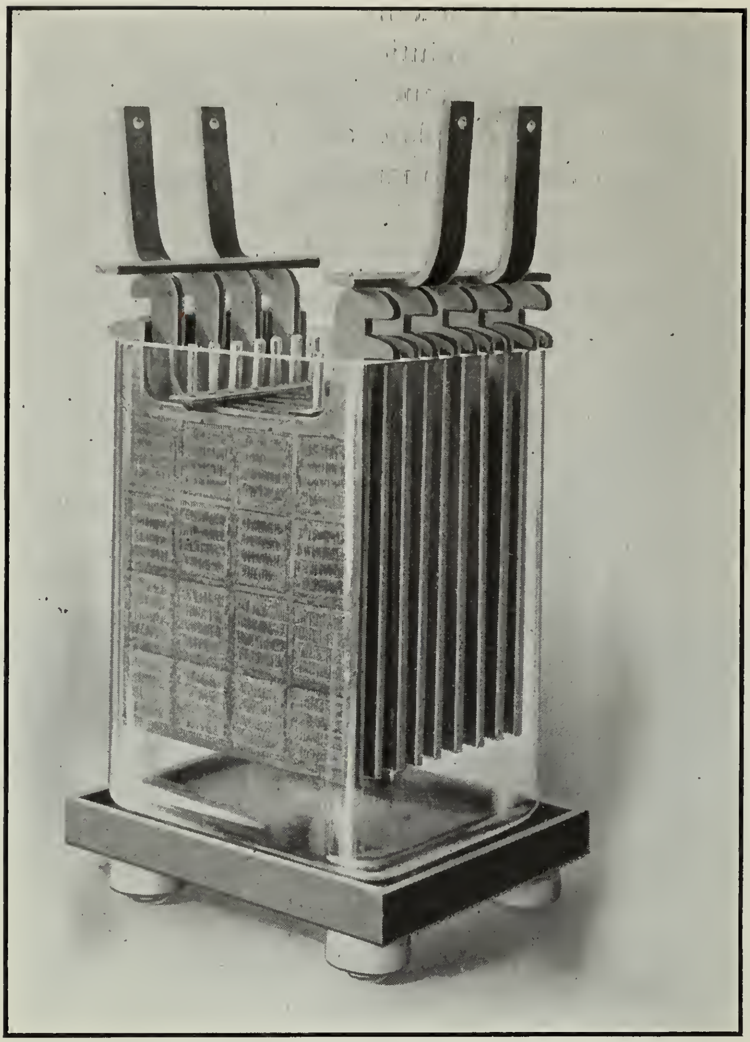


FIG. 12. CELL AND PLATES, GENERAL STORAGE BATTERY CO.

bars (see Figure 12), the oxide forming on these bars, and the expansion being taken care of by space left between the body of the plate and the grids.

In both the Electric Storage Battery and the General Storage Battery plate, the frame work is of lead mixed with antimony, this being stronger than pure lead and less easily attacked by acid. The Gould plate is all lead without alloy.

It may be well to state that although sponge lead and pure lead are apparently the same chemically, they do not act in the same way, as the pure lead is hardly affected by the passage of electric current from one plate to another, while the sponge lead is at once oxidized. It is this fact that makes it necessary in the first manufacture of the active material on the plates to do the preliminary oxidization of the plates by some acid such as nitric acid, and it is of the greatest importance that this acid be entirely removed before the plates are put into service, or the process of forming, *i. e.,* oxidation, will go on until the plates are destroyed.

The life of the plates, which are the only perishable parts of the battery (except for minor matters, such as separators and acid), depends almost wholly on the number of charges and discharges, *i. e.,* the amount of oxidization which has taken place. The oxidization, like the rusting of iron, is progressive; first the outer layer, then deeper and deeper until the whole of the available material, whether corrugated ribbon, grid, or leaf, is oxidized. As regards this progressive rusting, there are two theories; the one advocates arrangement to allow dropping off of the particles as new oxide forms, the other advocates the holding of as much oxide as possible with the idea that the capacity depends on the quantity of material, and the more oxide the more capacity. The latter theory seems the better grounded, as it is well known that the capacity of the negative plates decreases because of the gradual falling off of the active material, and as the oxidization is not progressive on these plates, due to the continued de-rusting on discharge, the capacity of the negative plates decreases.

The falling off of the active material results in a deposit in the bottom of the jar or tanks, which must be cleaned out before it reaches the plates and forms a short circuit. For this reason the jars should be from 2 to 3 inches longer than the plates. The oxide also forms trees and growths on side of plates, and these must be prevented from growing to the next plate. One method is that of using glass separators, the other that of using porous wooden separators. The latter plan has the added advantage of making the discharge

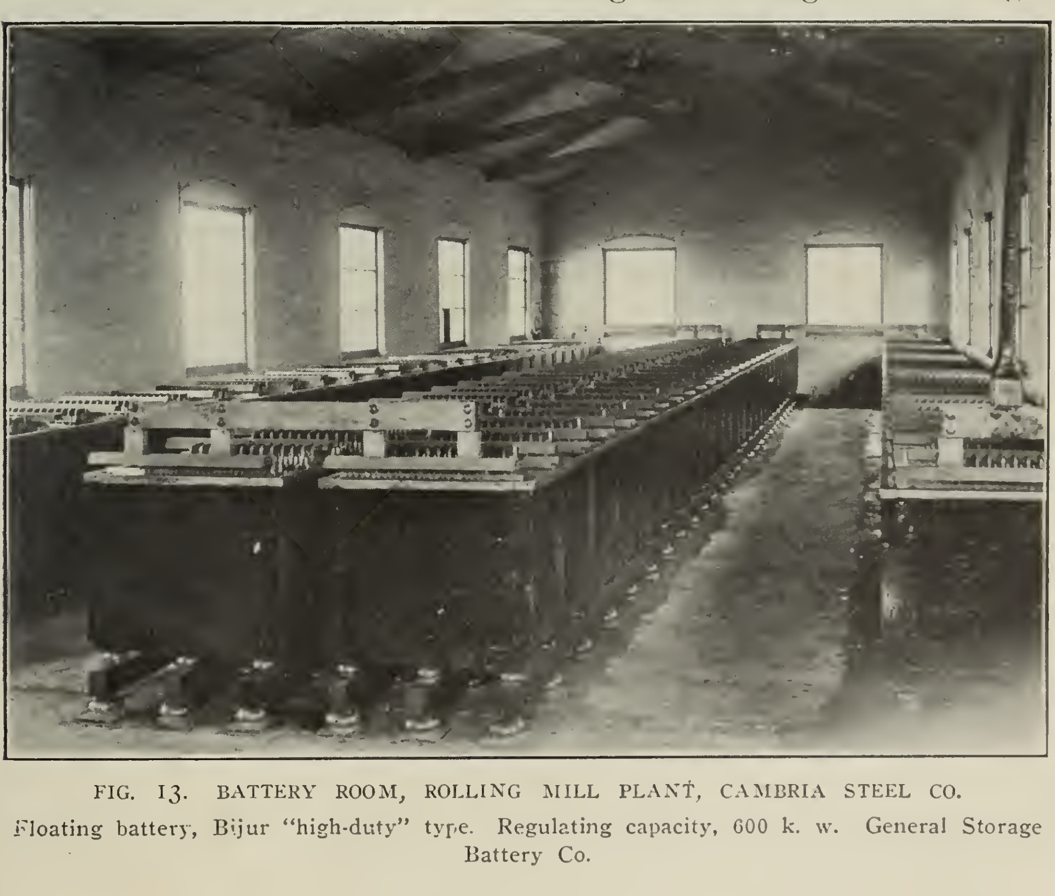


FIG. 13. BATTERY ROOM, ROLLING MILL PLANT, CAMBRIA STEEL CO.
Floating battery, Bijur "high-duty" type. Regulating capacity, 600 k. w. General Storage Battery Co.

from one plate to the next more uniform than it would be without the diffusing separator.

It is not possible to touch on the various minor matters entering into manufacture of batteries—this is properly the province of the writer of a book on the manufacture, but the essential simplicity of the battery has been shown, and the matters noted in which care should be exercised, are well known and recognized by successful battery manufacturers.

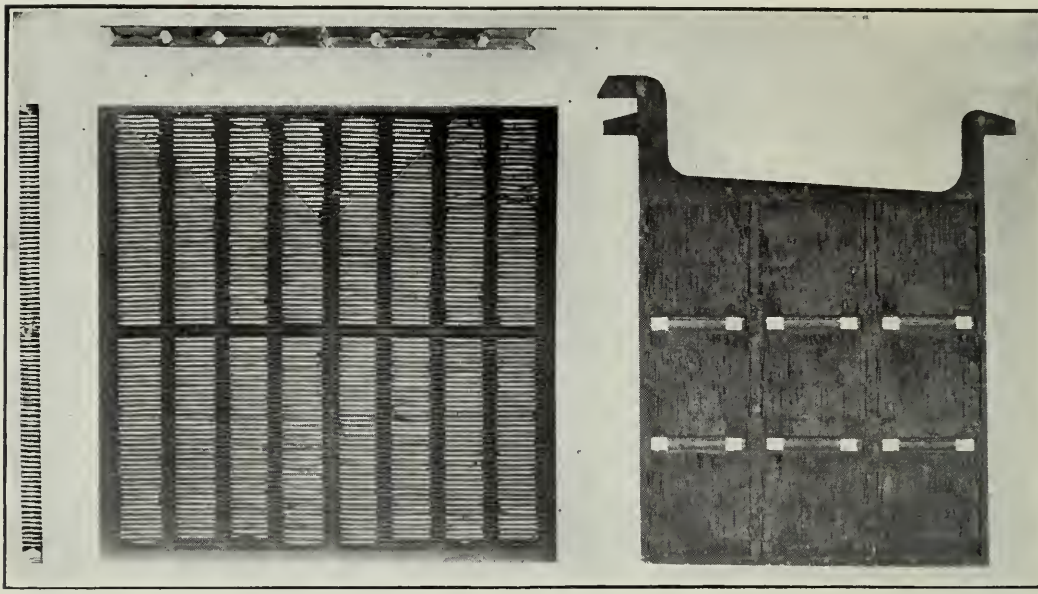


FIG. 14. WESTINGHOUSE STORAGE BATTERY PLATE, BEFORE AND AFTER CHARGING.

In the operation of batteries, the only thing necessary is intelligent inspection; the battery companies provide blanks showing advisable specific gravity readings and voltmeter readings, and if these be taken regularly, and the results be watched intelligently, no trouble need be feared, provided the manufacture has been carried out under careful inspection and supervision, and the battery is designed large enough for the work. There is one important point which should not be overlooked; viz., no foreign gas or substance must be allowed to enter into the solution. The batteries when fully charged give off sulphuric acid vapor which is extremely corrosive; hence any iron in the room is liable to corrosion, and the presence of iron in the acid would be fatal to the cell in which it appeared. Salt or ammonia would be equally objectionable, hence brine or ammonia pipes should be kept out of battery rooms; and any pipes necessarily in the rooms should be heavily protected with non-corrosive paint. Excessive temperature, *i. e.*, over 100 degrees Fahrenheit, is also objectionable, as tendency to internal chemical action increases.

MODERN DEVELOPMENTS IN THE METALLURGY OF LEAD AND ZINC.

By A. Selwyn-Brown.

One of the most salient features of modern practice is the successful handling of low-grade materials from which the value could not be profitably extracted by older methods. While the following review deals primarily with base metals, the author leads up to the important conclusion that as these almost always carry recoverable amounts of gold and silver, we have here a further important activity at work multiplying the world's store of the precious metals and hastening the economic effects which such an increase must produce.—THE EDITORS.

IN order to meet the demands of the world's markets for lead and zinc, in recent years, mine owners have been compelled to develop low-grade deposits. This, in its turn, has demanded improved methods in mining and metallurgy. The demands have been well met, and as a result we have witnessed, in a comparatively short time, the invention of entirely new and efficient processes for dealing with lead and zinc ores, either singly or combined, which have revolutionized the metallurgical practices for handling those metals.

The chief incentives to the introduction of improvements in the metallurgical treatment of mixed ores of lead and zinc were perhaps, the rewards offered some years ago by the mining companies operating on the Broken Hill field, New South Wales. For many years the principal mines on that great silver field had put aside ore too rich in zinc to be treated in the blast furnaces, and also collected immense tailing heaps carrying good values in silver, lead, and zinc. These by-products as the values of the metals advanced represented a great amount of tied up cash. According to conservative estimates made in 1905, the zinc-lead tailings in the dumps at the various mines at Broken Hill amounted to 5,700,000 tons, valued at $57,000,000. At the same time there were 10,000,000 tons of ore developed in the mines and valued at $200,000,000. This ore contained too much zinc to permit its treatment in the blast furnaces without a preceding process to separate or reduce the zinc contents and form a smeltable ore. With the view of obtaining a process capable of dealing with the refractory ores and tailings, the various companies offered large monetary rewards. These set metallurgists all the world over to work experimenting. It was not long, however, before a promising process was brought forward. Messrs. Huntington and Heberlein, while experimenting at a lead smelter in Italy with a modification of an old lead-smelting process that had been employed for many generations in Flintshire, England, found that the premature matting of sulphides in the blast furnace could be reduced, or prevented, by mixing lime with the charge. This appeared to be a simple invention, but its development has led to the introduction into recent metallurgical works of some of the most brilliant conceptions in the history of metallurgy. These inventions apply not only to the metallurgy of lead and zinc, but also, in many instances, they may be successfully applied to the treatment of copper, iron, antimony, arsenic, and other ores.

The Huntington and Heberlein Process.

This process consists of two distinct operations: (1), heating the finely divided ore mixed with a small quantity of burnt lime in a furnace with free access of air at a temperature of about 700 degrees Centigrade, and then cooling off to about 500 degrees Centigrade, when a further oxidation occurs; (2), conveying the roasted ore while still hot to a converter. The hot blast of the converter almost completely removes the sulphur. Towards the end of the blowing the temperature of the charge is raised sufficiently to agglomerate the ore in order to facilitate its treatment in the blast furnace.

The chemical reactions which take place during treatment have not been completely determined. The inventors believed that during the lime-roasting the lime is converted partly into sulphate, while the lead is partly changed to sulphate and partly to oxide. But according to the experiments of F. O. Doeltz, the lime is partly converted into sulphate and later is changed to calcium silicate by the combined influences of the roasting and silicic acid from the silica of the ore.

Carmichael-Bradford Process.

This is an Australian invention devised by the metallurgists at the Broken Hill Proprietary mine. It consists, essentially, in charging a mixture of the lead-sulphide ore with from 10 to 30 per cent of dehydrated gypsum into a converter without a preliminary roast. The operations then are similar to those in the Huntington-Heberlein process excepting that the converter gases are collected and converted into sulphuric acid.

The gypsum is mixed with the ore and water in a pug mill. The mixture is then spread out on a brick floor and sun-dried. When ready for the converter, the latter is prepared by charging the bottom with a layer of glowing coal which forms a bed for the charge of the ore and gypsum mixture and starts oxidation. The inventors worked on the theory that calcium sulphate, or gypsum, played an important part during the oxidation of the roasting charge. But recent investigations suggest that gypsum plays no such part in the chemical reactions in the converter. On heating a mixture of galena and gypsum in contact with air, lead sulphate will be formed along with some lead oxide. The lead is oxidized and then converted to sulphate by sulphuric acid by a reaction which may be formulated thus:

$$PbO + SO_2 + O = PbSO_4.$$

The results obtained from the operation of the large plant on the Broken Hill Proprietary Mine during the past four years have been so satisfactory that the company is at present completing arrangements for the erection of another Carmichael-Bradford plant on a much larger scale at its works at Port Pirie, South Australia, to deal with customs ore from all parts of Australia. The principal improvements in the designs of this plant are mainly in matters of automatically handling the materials during the progress of the operations. The fundamental features of the process will not be modified.

The Savelsberg Process.

An improvement on the two preceding lime-roasting processes was introduced into the Ramsbeck smelting works, near Aix-la-Chapelle, Germany in 1904 by Adolph Savelsberg. In this process a preliminary roast is made in revolving furnaces 20 to 26 feet in diameter having capacities varying from 25 to 60 tons of ore per 24 hours. The zinc from the ore passes into the fumes and is collected in the dust chambers. The converter bed is covered with a layer of crushed limestone which protects the ironwork. A layer of glowing coke is then forced over the limestone and on this is placed the mixture of ore and powdered limestone. When the blast is raised to a sufficient pressure, desulphurization commences and when completed the temperature is raised somewhat further so that agglomeration takes place. When the sulphurous fumes cease to be evolved and the charge commences to harden, the converter is tilted to dump the charge.

Savelsberg now omits the preliminary roasting when handling ordinary lead ores; he states in his United States patent specification:

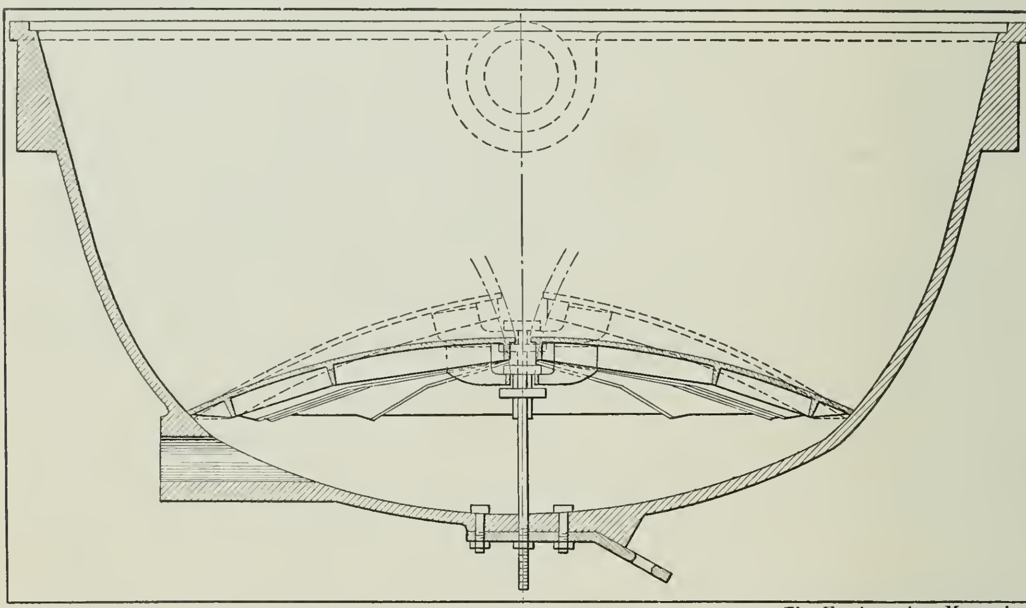
"I have observed that if lead ores which are to be desulphurized contain a sufficient quantity of limestone, it is possible, by observing certain precautions, to dispense entirely with the preliminary roasting furnace, and to desulphurize in one operation by blowing a current of air through the heated charge.

"The particles of limestone do not exert a chemical but a mechanical influence on the ore particles. They separate the mineral particles in the ore from one another in such a way as to prevent premature agglomeration. The whole mass is loosened and rendered accessible to air. The limestone, furthermore, moderates the high reaction temperature resulting from the burning of the sulphur, so that the liquefaction of the galena, the sublimation of the lead sulphide, and the separation of metallic lead are avoided."

The limestone is, nevertheless, decomposed by the process. Lime is formed and partly converted into a sulphate. When scorification takes place the lime sulphate is converted into calcium silicate by the silicic acid present, while sulphuric acid is liberated with the fumes. This process is carried out in a plant exactly similar to that employed in the two preceding processes.

Pot Roasting.

A modification of the lime-roasting processes above described has been introduced by the metallurgists of the American Smelting and Refining Company. It was discovered during the progress of some experiments at the company's smelter at Murray, Utah, that desulphurization of lead ores may be promoted without mechanical assistance of lime or any other refractory substances. All that is necessary is to attend to the proper distribution of the blast air throughout the charge. At the Murray smelter twenty-five pots are required to handle the roasted ore from five Heberlein cylinder roasters



POT BOTTOM, FOR POT ROASTING PROCESS.
As used at the Murray Smelter, Utah. The hood is removed.

The pots employed in this process resemble sugar boilers in appearance. They are from 8 to 10 feet in diameter, and are furnished with a detachable hood connected by a movable take-off with the dust flue leading to the dust chambers. A cast-iron grate, and a baffle plate, placed within the pot enable the air blast to be distributed in even streams throughout the charge. These pots differ only in minor details from the converters employed in the Huntington-Heberlein process, and pot roasting may be described as the Huntington-Heberlein process modified by the omission of lime from the charges.

The ore to be treated undergoes a preliminary roasting which reduces the sulphur contents from 20 or 25 per cent to 12 or 14 per cent.

Each pot carries an 8-ton charge. The charge is moistened before it is run into the pot. When a pot is charged and ready to be blown, the hood is adjusted and the blast is gradually increased from 1 to 4-ounces pressure. At Murray, the ore is galena which is comparatively free from lime. The average contents of the ore treated is about 8 per cent lead, 30 per cent silica and 20 per cent sulphur. The principal weakness of this process is the time occupied in treating the ore, and also the large amount of handling the ore undergoes.

Briquetting.

In some smelting works the fine sulphides are prepared for the blast furnaces by briquetting processes. At Broken Hill, silver-lead concentrates have been successfully briquetted by:

1. Mixing the concentrates and fines with newly slacked lime and water in a pug mill.
2. Pressing the mixture into briquettes.
3. Stacking the briquettes in roasting kilns.
4. Burning the briquettes to harden them.

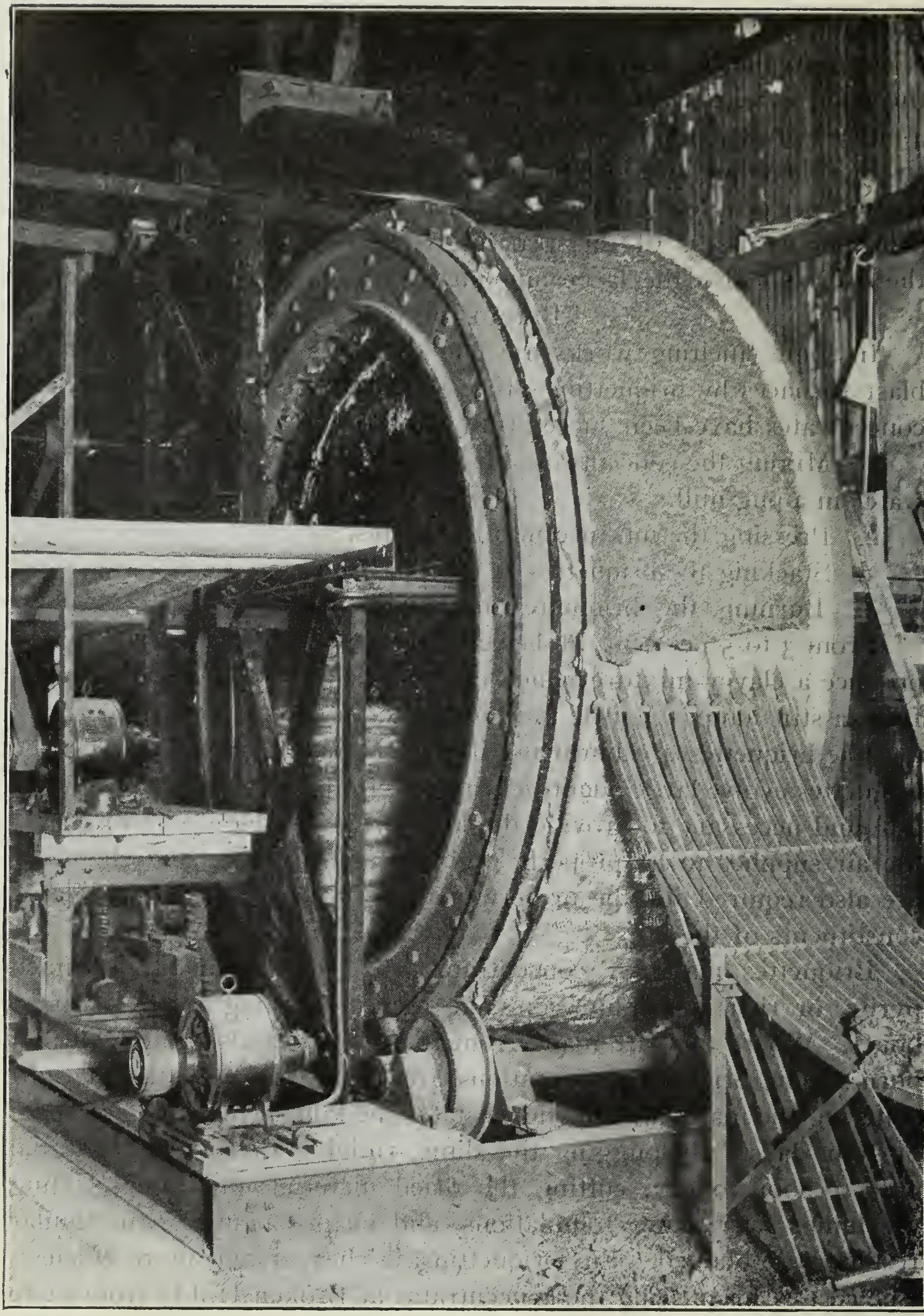
From 3 to 5 per cent of slacked lime is used and enough water to produce a clayey mixture which on being squeezed in the hands will form a stiff lump. A little sand is then added to act as a binder.

The briquettes are burnt in kilns like orinary bricks. But as the briquettes evolve large quantities of deleterious fumes while burning it is found necessary to provide the kilns with suitable doors to enable the air supplies to be properly regulated. Dust flues and chambers are also required for the preservation of the zinc and other volatile constituents of the ore.

Briquettes made of concentrates and slimes containing much pyrite, or rich in sulphur contents, require burning from 10 to 20 hours. Where they are made from roasted materials, which will not burn freely, briquetting operations are carried on with the view of sintering the material. This necessitates the kilns being fired for three or four days. By pugging the slime, running the pugged material onto a floor to dry, cutting the dried material into lumps, piling the lumps over firing foundations, and heap-roasting them, similar results are obtained. But briquetting is cheaper and more efficient. The cost of briquetting the concentrates at Broken Hill is from $1 to $1.50 per ton.

The Dwight and Lloyd Sintering Process.

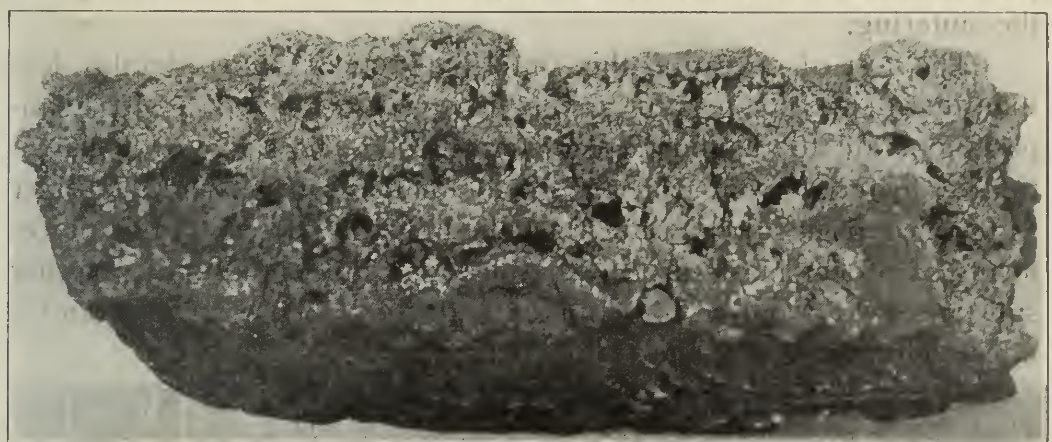
As a result of investigations relating to the conditions affecting the sintering of the charges in the blast pot, Messrs. Dwight and Lloyd found that better results are obtainable when operations are conducted so that: (1), treatment is made continuous; (2), the material is kept



DWIGHT & LLOYD SINTERING MACHINE, DRUM TYPE, SHOWING STRIPPING GRIZZLY.

in a quiescent condition; (3), a thin layer, charge or succession of charges is employed.

The maintenance of the charge in a state of complete quiescence is essential to good sintering. It appears that to obtain the best results all the ore particles must remain in practically the same relative position, in close contact with their neighbors, and subject to similar thermal reactions, during the period of maximum temperature at the end of the operations.



SINTER MADE FROM CONCENTRATES AND FLUE DUST.

With the view of treating ores which were not well suited to treatment by the pot-roast process Messrs. Dwight and Lloyd designed the machine shown on page 862. It consists of a revolving drum resting on rollers like a copper converter. This drum is caused to revolve slowly about its axis by the friction of the drive rollers. It acts as a conveyor of the ore as well as a roaster. Inside the drum there is a suction chamber which is connected with a suction fan. The moving rims form an air-tight joint with the edges of the stationary suction box which occupies the top quadrant of the circle inside the drum. The material to be sintered is fed in a thin layer upon the grated face of the drum from an overhead ore-hopper. Immediately the ore reaches the drum surface it comes in contact with the igniter. This is either a series of gasoline or gas jets, an oil flame, charcoal brazier, hot roasted ore, hot sinter, or anything capable of promoting the oxidation of the charge. The ignition medium acts downwards on the charge in such a way as to kindle the ore stream uniformly across the whole width of the conveyor. The roasting action started by the igniter is augmented and maintained by the steadily flowing airstreams that are sucked down through the ore layer by the suction fan as the ore drum slowly revolves across the suction box placed within the top quadrant of the drum. The ore layer is usually about 4 inches in thickness and requires about 20 minutes for the sintering action to be completed. The speed of the drum is regulated in such a way as to enable the whole layer to be completely sintered down by the time it reaches the far end of the suction box. The sintered ore is stripped from the drum and automatically discharged by the pointed grizzly.

The drum type of machine has been found in practice to be one of the most convenient for ordinary ores, but the same sequence of operations may be accomplished in other ways. The inventors of the process have used various other mechanical means for carrying out the sintering.

The cost of operating this sintering process is considerably less than that of the pot-roasting it was designed to supersede. It is simple to operate and is under complete control. The range of composition of material from which a suitable sinter can be made is wider as to silica, iron, sulphur, etc., than the limits imposed by the requirements of proper blast-furnace charges. No lime, limestone, or other substances are required to be mixed with the ore to be treated and it effectively handles the finest slime materials.

SINTER CARRYING 50 PER CENT. LEAD, MADE FROM GALENA CONCENTRATES WITHOUT LIME.

This process converts fine ore and slime into hard sintered masses suitable for smelting in blast furnaces. It also promotes economy in blast-furnace fuel, and largely increases the capacity of the blast furnace by such reduction in fuel. The sintering of the ore reduces the loss of metals by limiting the amount of flue dust. This method of sintering enables fine ores suitable for pyritic smelting to be successfully treated in isolated districts in which many of the older processes could not be utilized on account of the cost of the plant and other conditions.

The sulphur gases evolved from the ore treated on the drum are highly concentrated and can be easily controlled. It is consequently possible to utilize them for conversion into acids and other chemical compounds or to render them innocuous.

The process readily lends itself to the solution of many chemical and metallurgical problems and is capable of rendering valuable assistance in special concentrating and smelting operations. It has been successfully employed on a commercial scale for some time treating copper ores at Cananea, Mexico, and in handling other classes of ore at Perth Amboy, N. J., Baltimore, Md., and elsewhere.

Flotation Process.

Not only have the methods of smelting and of preparing ore for smelting been improved as was shown above, but the processes of ore concentration have been revolutionized also within the past few years.

When it was found that electrostatic concentrators were inefficient in dealing with the Broken Hill silver-lead-zinc ores, experiments were carried out with the view of improving wet methods of concentration. It was discovered that by using certain chemical means the well-known tendency of minutely divided mineral particles to float on the surface of water could be utilized in effecting a separation of the mineral matter from its gangue.

Potter discovered that a 3 per cent solution of sulphuric acid would so promote flotation that an efficient separation could be easily made in one operation. In his early experiments he simply ran the ore and water into long troughs, made from an alloy of zinc and antimony to withstand this acid, and drew off the floating ore in the overflow into settling pans. The concentration is now effected in specially designed Delprat pans. The ore to be treated is sized and fed into the pans with properly acidulated water. The amount of acid required varies as the zinc contents of the ore. For an ore running 20 per cent in zinc, about 40 pounds of sulphuric acid per ton of ore are required. The extraction amounts to about 95 per cent.

Delprat adds sodium sulphate to the sulphuric acid solution with the view of densifying the concentrating medium. De Bavay gasifies the ore particles by carbon dioxide obtained from furnace gases. Elmore replaces the water by oil. All these processes are now in successful operation at Broken Hill and employed in conjunction with one or other of the sintering processes described in this article they have solved the principal metallurgical problems relating to the utilization of refractory silver-lead-zinc ores. Since the installation of a Potter concentrating plant and a Carmichael-Bradford sinterer on the Broken Hill Proprietary mine in 1904, the company has been able to utilize 691,373 tons of zinc tailings which were previously of no commercial value.

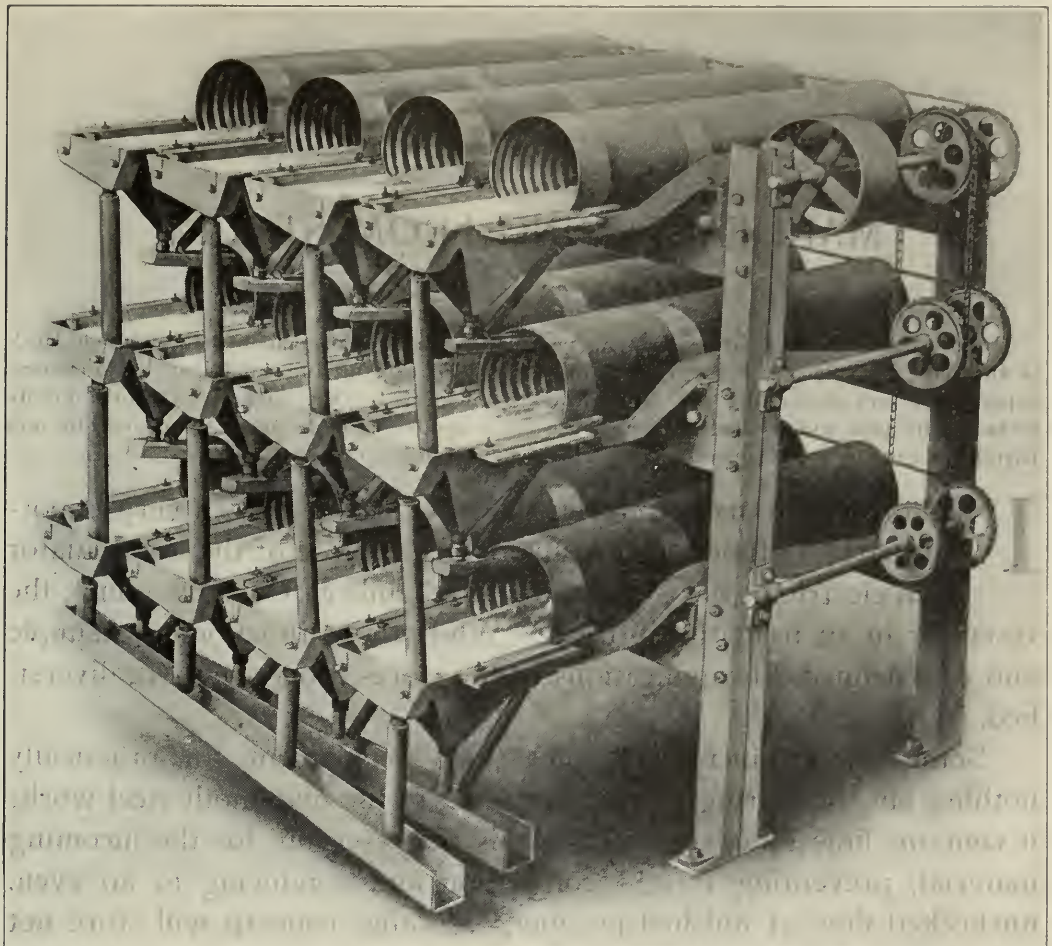
THE MACQUISTEN PROCESS.

A recent invention by Macquisten, of Glasgow, Scotland, reduces the flotation processes to their simplest form. No chemicals are employed as in the Potter, Delprat, De Bavay and Elmore processes. The sulphide particles of ores are separated from the accompanying gangue materials through the medium of water by utilizing the surface tension of water by a simple mechanical device. The invention is based on the observation that sulphide minerals are positively affected by the surface tension of water while the rock constituents are not so affected. The surface tension of the water spreads around each sulphide particle like an envelope leaving, probably, a bubble of air between the surfaces of the water and the mineral large enough to float the sulphide. No envelope is formed around silicates. The water appears to penetrate them and causes them to sink.

The process is carried out in a concentrator composed of a simple cast-iron tube about 6 feet in length and 1 foot in diameter which weighs about 450 pounds. Near each end, externally, the tubes are cast with two tires resting on supporting rollers to enable the tubes to be revolved with the least amount of friction. Internally there is a helical groove with an inch and a half pitch running from end to end as in a bolt nut. The tube is charged from an ordinary square wooden launder and it discharges into an ordinary separating box from which the floating ore particles are flowed over an apron on the upper rim opposite the discharging end of the tube. The gangue matter is drawn off from the bottom of the box from a bung hole.

The tube is revolved at the rate of about 30 revolutions per minute. The pulp is screwed through the tube and is so guided by the helical screw groove as to give the mineral particles repeated opportunities to glide upon the surface of the water. It is found in practice that ordinarily a good concentration can be made in one tube. The inventor's experiments, however, showed that when four tubes were joined in series so that one fed into the next one following, some of the finest particles did not get properly started on the water's surface until they had nearly reached the discharging end of the fourth tube.

This process has been tried on a large scale at the Adelaide Mill, Nevada. It was run with an ore composed of chalcopyrite, pyrrhotite and pyrite with a little blende and galena which previous plants had failed to handle profitably. Each tube successfully treated from 5 to 6 tons of ore per 24 hours, concentrating in the ratio of 11 to 1.



THE MACQUISTEN MACHINE, SHOWING CONCENTRATORS ARRANGED IN SERIES OF THREE.

The top cylinder feeds into the one immediately below. American Direct Concentrating Co., Salt Lake City.

The benefits arising from the above described metallurgical inventions will not be restricted to the treatment of the ores they were specifically designed to deal with. Experience, doubtless, will show that some of them may be successfully utilized in many of the chemical and manufacturing industries. Many of the refractory zinc-lead-copper ores these new processes will be called upon to treat contain appreciable quantities of gold and silver, which they will concentrate and save. Their use, therefore, will assist in preserving the steady increase in the world's annual gold production which has been so noticeable in recent years. They will in this way become important factors in affecting the depreciation of gold and silver values, and in the consequent appreciation in the values of commercial commodities.

MANUFACTURING FROM STOCK.

By Clarence Hoyt Stilson.

It has been observed by experts in systematic works management that although stock is the most directly visible equivalent of money, its careful and intelligent maintenance, supervision, and accounting are often strangely neglected. Mr. Stilson sets forth briefly certain principles and methods which, consistently applied, will do much to reduce idle and barren investment and to increase promptness in the filling of orders.—THE EDITORS.

IN all organized manufactories the stores room plays a very important part; its functions are analogous to those of the accumulator in an electric power system, the air chamber of a force pump, the reservoir in an irrigation project. While these functions are simple and well defined, the applications of the stores room are more diversified.

Some establishments use the stores department for practically nothing but the storing of raw material; in the mammoth steel works it contains limestone, coke, ores—it is the reservoir for the incoming material, preventing freight congestion and conducing to an even, unchecked flow of finished product. Another concern will store not only the raw material but the finished product as well, and while the purpose is still the avoidance of congestion and shortage, it is with a wider significance. In the steel works, minimum cost of production is sought by assuring maximum output; in other lines of business low cost of production is not sufficient to insure a healthy volume of trade; quick delivery must also be assured. As a consequence, a considerable store of both raw and finished product is maintained, so that, when necessary to meet competition, very quick delivery can be made either from the stock of finished goods or by rushing manufacture, using material on hand in the stores.

This practice of making prompt shipment by the aid of stock carrying has grown until the trade have been literally trained to expect and often to demand it. Furthermore, the very nature of certain classes of manufactured articles necessitates exceedingly prompt shipments; the demand for certain novelties may last only sixty days, making it imperative to get the goods on the market inside of a week or two. At any rate, both through the demands of the trade and through the endeavor of manufacturers to outdo one another in offering inducements to buyers, the conditions above described have come and are apparently here to stay. Manufacturing concerns are helpless in this matter, and must submit to some loss due to investment in raw material and finished goods, as a necessary contingency.

Brass Rod — ½" diameter								
				Temper-soft				
					AVAILABLE		Min. 4500	
							Max. 9000	
RECEIVED				WITHDRAWN				IN STOCK
Date	Order	Amount	Total	Date	Order	Amount	Total	
3/8/08	18786	9000	9000					9000
				3/10	E 23478	750	750	8250
				3/18	E 24176	2300	3050	5950

The Engineering Magazine

FIG. I. SIMPLE FORM FOR STOCK RECORD.

There are some factories where practically every order received entails only the assembling and finishing of standard parts made up in advance and stored in stock, which process we may call "manufacturing from stock." Manufactories of screws, shoes, metal buttons, etc., are organized to operate along this principle. Orders for these goods are received in great quantities, each of comparatively small value financially, and to attempt to put each lot separately through the works from raw state to completion would result in excessive high cost of production, great delay, and costly clerical work. This method, though proper and necessary in a machine-tool works, is entirely wrong in a shop manufacturing from stock.

Maximum ______
Minimum ______

Ordered				Applied				Available	Received				Withdrawn				In Stock
Date	Order	Amount	Total	Date	Order	Amount	Total		Date	Order	Amount	Total	Date	Order	Amount	Total	

The Engineering Magazine

FIG. 2. MORE COMPLETE FORM FOR DETAILED RECORD OF STOCK.

Although the practice of carrying a large stock is conducive to economy and to the profitable transaction of certain lines of business, yet in careless hands it is as dangerous as the steam boiler, in which the pressure may rise to dangerous limits or fall until the machinery comes to a standstill. On the other hand, under efficient management the investment can be kept normal and the amount of staple materials and goods be kept from either excess or depletion.

The principles governing the care of such varied and extensive stores as we have described are the same in most concerns, although the record forms vary with each specific class of manufactured goods. Figures 1 and 2 vary considerably in the volume and detail of the data recorded. Either form, however, gives a rather complete history of each specific lot of goods that is or ever has been in the storehouse. Without some such record it is impracticable to keep stores in the safe, economical manner referred to above With such records, the problem resolves itself into something which may be organized to run almost automatically, requiring but a light touch on the brake or throttle from time to time, with perhaps a general readjustment once a year or when abnormal conditions present themselves.

Turn to Figure 2. This gives total quantities received, withdrawn, and left in stock. More than this—it shows the quantities ordered to replenish stock but not yet received, also every customer's order on which any stock goods have been applied. From this a moment's study will give a complete story of the past and present business on any type of product. In the upper portion appear the Stock Limits, which are the "indicators" by which the condition of the stock may be judged and by the help of which the amount of stock on hand is kept within bounds. The figures appear insignificant and of no especial value to the layman, but they should represent not a little sober thought and an analysis of market conditions both conservative and progressive.

When the amount in stock drops to the minimum stock limit, orders are to be entered at once to replenish the stock; the amounts of these orders should be such that at no time does the total quantity of unapplied goods in stock exceed the maximum limit.

The limits themselves are based first on the present and past demand, and second on the time required to obtain or to manufacture the goods necessary to replenish the depleted stock. If the rate of consumption, as indicated by the records, of a certain size of brass rivet rod is 3,000 pounds per month, and six weeks are required to obtain any of this material after placing an order with the mills, then a minimum stock limit of 4,500 pounds is absolutely necessary; likewise a maximum limit of 9,000 pounds would seem quite safe. By placing an order for the maximum limit the very day the minimum is reached, we should receive 9,000 pounds on the date on which the stock would theoretically be entirely consumed.

Using these methods, the stores keeper is supplied with a list of goods to be carried in stock and is authorized to maintain this stock within the limits set, which renders unnecessary much anxiety on the part of the management as to the handling of future business and does away with the disorganization accompanying the fulfilment of rush orders for which otherwise the factory would be unprepared.

There still remains on the shoulders of the factory management one duty which must not be neglected, and that duty consists of a constant censorship of all orders for replenishing the stock. As a part of this duty may be considered the periodical study of the entire stock, a thing that may be done very quickly and comprehensively by means of charts such as are shown in Figure 3. (Page 872.)

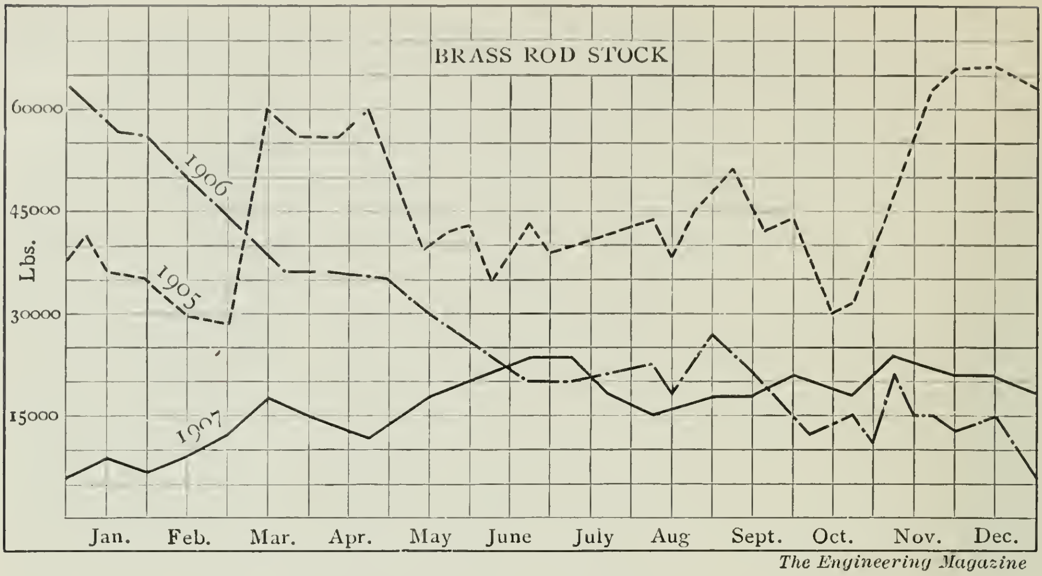


FIG. 3. GRAPHIC RECORD OF BRASS ROD IN STOCK.

The curve indicates that throughout the year 1905 an average of about 40,000 pounds of screws was maintained. In April and December the stock increased very noticeably, the rise in December being rather unfortunate in view of the imminent January inventory. The following year (1906) under systematic organization of the store-house records, the stock was rapidly reduced and held in good control all through 1907.

These charts are taken from the stores-room records, the totals of all classes of goods being taken every Monday morning and plotted as indicated. For purposes of comparison there is nothing more satisfactory than such charts, a number of things being indicated by the simple curves. They give present investment as compared with that of preceding years and months; they indicate in what lines business is the heaviest; and they give a history of the fluctuations in supply and demand for the past few years. But their chief use is the control of investment in stock, and with intelligent use they should permit the present-day manufacturer to practice "stock carrying" more extensively than ever before, with the consequent benefit of being able to make prompt shipments and the freedom from the danger of excessive accumulations of material and goods.

In other words, the stores room, instead of becoming simply a "catch-all" for defective work, useless goods from cancelled orders, and all such odds and ends, can be made a most efficient tool and a powerful resource for profitable manufacturing.

ALCOHOL AS A FUEL FOR INTERNAL-COMBUSTION ENGINES.

By Thos. L. White.

Mr. White's first paper was published in the August issue of THE ENGINEERING MAGAZINE, and was devoted to a review of the present state of the production of industrial alcohol and to a very interesting proposition for its manufacture at low cost and on a large scale from sources of almost unlimited abundance. This concluding paper examines the differences between alcohol and gasoline as combustion-motor fuels, the changes in design or practice necessary to adapt alcohol to general use in this field, and the advantages which may be thus secured.—THE EDITORS.

IN a preceding article the practicability of obtaining commercially ample supplies of fuel alcohol was examined, and the apparently sufficient answer afforded by the Lagerheim-Frestadius process was presented. On the principle that when the problem of catching the hare has been solved, there remains the problem of cooking it, we now come to consider the suitability of alcohol as a gasoline substitute. As there are many types of engine designed to fill widely varying needs, the subject is one which has many sides and may easily be made confusing or misleading unless the issue under discussion is very clearly defined. As an example of the kind of argument which too often passes current, and by causing motor users to expect the impossible does the prospects of fuel alcohol endless harm, we quote the following, which formed part of a paper read at a scientific meeting, and which, besides exemplifying the class of fallacy to be guarded against, will also serve to put on record the principal data of the fuel question so far as alcohol and gasoline are concerned.

"Comparing denatured alcohol and gasoline as at present in use:—

Gasoline, specific gravity, 0.72; net British thermal units per pound, 19,600.
Alcohol, specific gravity, 0.82; net British thermal units per pound, 10,600.

The heat units converted into work, taking the efficiency of the alcohol engine to be 35 per cent, and that of the gasoline engine to be 20 per cent, would be:—

Gasoline; useful British thermal units, 3,920.
Alcohol; useful British thermal units, 3,710.

Allowing for the difference in specific gravity, we find that the useful numbers of British thermal units per gallon are:—

$$3{,}920 \times 0.72 \times 8.3 = 23{,}246 \text{ for gasoline.}$$
$$3{,}710 \times 0.82 \times 8.3 = 25{,}259 \text{ for alcohol.}$$

Taking the price of gasoline at 15 cents per gallon, we could even pay 16 cents per gallon for alcohol, and obtain an equal amount of energy for the same expenditure. Or, we may say that it is possible to get with a properly designed alcohol engine a greater mileage per gallon of alcohol than with gasoline in the best designed engine."

From a logical point of view, or as regards the data and the calculations based on them, there is no fault to find with the foregoing argument. It is the underlying assumption that is misleading. What is not stated is that the alcohol motor for which an efficiency of 35 per cent is quoted is of a heavy stationary type, having a rate of only one hundred revolutions a minute, a ratio of stroke to bore of over two to one, and an initial compression in the neighborhood of 200 pounds to the square inch. Now, no such engine ever has been, or probably ever will be, put into an automobile, and to claim a greater mileage per gallon for alcohol than for gasoline on the strength of such a record, made it may be said under laboratory conditions, is very much the same thing as claiming that because the Diesel motor will burn crude petroleum and render an efficiency of 36 per cent, therefore crude petroleum is a better fuel for the automobile than gasoline.

In considering the difficult matter of changing over from gasoline to alcohol, it is important to remember that the two fuels differ in a dozen essential particulars; that the current type of motor is a gasoline instrument evolved under gasoline conditions; and that the greatest variety of opinion exists as to how far the accepted rules of construction will have to be modified to suit the change. Moreover, there is the important economic fact to be considered that some millions of gasoline motors are at present in use, and that it is not only a sound but a necessary policy to try to maintain their constructional features as far as possible, changing nothing unless there is a distinct necessity for each change, or a distinct advantage resulting from it. That there are to be had special alcohol machines, which are excellent for certain purposes, is beside the real issue which is concerned with using alcohol in the high-speed, low-compression engine.

We are all familiar with the fact that in the courts very little importance is attached to expert testimony, for the reason that for every eminent expert who can be brought to prove that A is B, another slightly more or less eminent expert can be brought to prove that it is nothing of the kind. While conceding that the chief offenders seems to be the medicals, and that mechanical engineering is less elastic in its conclusions than medicine (possibly because the engineer's failures remain to reproach him, while the doctor's do not) it is nevertheless astonishing how difficult it is to get a definite, clear-cut decision on a debatable point when we come to collate the conclusions of the different committees that have examined the fuel question. And on no issue, judging by the following extracts from the reports of several recent investigations, is there more variety of opinion than on the question of using alcohol in the gasoline motor.

As has been previously published, alcohol can be used with more or less satisfaction in stationary or marine gasoline engines, and these engines will use from one and one-half to twice as much alcohol as gasoline when operating under the same conditions. The possibilities, however, of altering the ordinary gasoline engine as required to obtain the best economies with alcohol are very limited, for the amount that the compression can be raised without entirely redesigning the cylinder head and valve arrangement is ordinarily not sufficient nor the gasoline engine usually built heavy enough to stand the maximum explosive pressures, which often reach 600 and 700 pounds per square inch.—*Report of the Technologic Branch of the U. S. Geological Survey.*

From the previous argument it will be seen that, in order to utilise alcohol in an internal combustion engine, certain modifications in the engine itself become necessary, but it is quite reasonable to expect that such alterations would become unnecessary if a proportion of tar benzol, acetylene, or other hydrocarbon, containing a high percentage of carbon were mixed with the alcohol. Owing to this high percentage of carbon present, the chemical composition of the mixture will be brought more nearly to resemble those of petroleum products. As to the most suitable relative proportions, experiment only will determine these, but such a fuel as is here suggested has the advantage that it can be used without material alteration to the engine.—*Report of the Fuels Committee of the Motor Union of Great Britain and Ireland.*

As for the difficulty of starting from cold, it will be probable that alcohol as a fuel will almost always have a greater or less quantity of benzol mixed with it, in which case this difficulty entirely disappears. Even without the addition of benzol there is little doubt that the question of starting from cold will be almost entirely overcome by the use of a suitable carburettor.—*From the same Report.*

Any gasoline engine of the ordinary types can be run on alcohol fuel without any material change in the construction of the engine. The only difficulties likely to be encountered are in starting and in supplying a sufficient quantity of fuel, a quantity which must be considerably greater than the quantity of gasoline required.—*Report of the Office of Experimental Stations of the U. S. Department of Agriculture.*

It will be seen that inferentially three distinct views can be based on the above findings:

1.—Material structural changes are necessary.

2.—Material structural changes are unnecessary if the alcohol is blended.

3.—Material structural changes are unnecessary.

Which view is adopted depends a good deal on the importance attached to the superior economies obtainable by high compressions. Viewed from a practical standpoint, such gains are capable of being much overrated. In the first place high compressions can rarely be maintained under ordinary working conditions. In the laboratory or the shop, where expert attention is always available, a high-pressure engine can be continuously operated at its top notch of efficiency; but in daily use in the factory, on the farm, or on the road, from the lack of constant skilled supervision, the compression will be gradually lost owing to the heavy duty imposed on the piston rings and valves. When this occurs the result is simply a low-compression engine having all the extra weight and unhandiness of a more complex type. Then, again, as has lately been pointed out by Mr. Sidney A. Reeve, the evolution of engine types in the past has not been so much along the lines indicated by considerations of fuel economy as along the lines indicated by considerations of handiness, reliability, and flexibility. If alcohol possesses advantages of this character, when burned in the present type of gasoline motor, and if any operative disadvantages incidental to its use (such as difficulties of starting up) can be eliminated, and some increase of efficiency attained by recourse to less radical means than high compressions, then there will be no need to consign the present engine to the scrap-heap in order to be able to burn alcohol. It is the opinion held in this article that alcohol has several such advantages, and that its efficiency in the gasoline motor can be increased without virtual reconstruction, and the grounds for this belief will now be set out. Incidentally, it is well to remember that in the matter of compression there is no golden mean. The gasoline engine compresses to 80 pounds at most, and till this is increased to over 130 pounds, the gain in thermal efficiency resulting is not worth the trouble of the alteration.

While it has always been the aim of designers to make the gasoline motor as flexible as the steam engine, the narrow range within which a charge of gasoline and air can vary in composition and yet remain explosive has always prevented any regulation of the power by the manipulation of the mixture. In the case of alcohol and air, however, the variation of the proportions compatible with perfect combustion is four times as great, and it has been determined by experiment that the specific power of the working stroke of an alcohol engine can be reduced to 25 per cent of maximum, by the operation of an auxiliary air throttle. In automobile practice this means that the adoption of alcohol would tend towards fewer cylinders and simpler gears. The actual limits within which alcohol and gasoline mixtures are respectively explosives are 4 per cent to 14 per cent, and 2 per cent to 5 per cent, tested at atmospheric temperatures and pressures.

When one pound of absolute alcohol and one pound of gasoline (hexane) are completely burned, each in a suitable motor, the following numerical relations are independent of the type of motor used, and consequently have the character of constants.

ALCOHOL.

Minimum sufficient amount of air .	= 9 lb.	
	= 117 cub. ft. at 15 C. and 760 m.m.	
Carbon dioxide in the exhaust . . .	= 1.9 lb.	
	= 15.9 cub. ft. at	do.
Nitrogen in the exhaust	= 6.9 lb.	
	= 90.6 cub. ft. at	do.
Water condensed from the exhaust .	= 1.2 lb.	

GASOLINE.

Minimum sufficient amount of air .	= 15.3 lb.	
	= 198.9 cub. ft. at 15 C. and 760 m.m.	
Carbon dioxide in the exhaust . . .	= 3 lb.	
	= 25.1 cub. ft. at	do.
Nitrogen in the exhaust	= 11.8 lb.	
	= 155 cub. ft. at	do.
Water condensed from the exhaust .	= 1.5 lb.	

Of course in ordinary practice more air than the theoretical minimum is admitted with the fuel, but taking such excess of air as pro rata in either case, the most noticeable feature in the above figures is the relatively greater amount of nitrogen per pound of fuel which passes through the gasoline motor. The exact effect of this extra dilution, amounting to at least five pounds of inert nitrogen to every pound of gasoline burned, is somewhat obscure; but so much at least is clear—that its presence means additional loss of heat at the exhaust, and has a tendency to cause incomplete combustion, besides thermodynamically lowering the efficiency of the cycle. The obnoxious smell from the exhaust of a gasoline motor, due to the escape into the atmosphere of unburned hydrocarbons, is largely an effect of its retarding action during combustion; while on the other hand, the odorless character of the products of combustion of an alcohol motor points to the absence of the damping effect of an excess of inert nitrogen in the mixture. The fact that deposits of soot in the cylinder are the rule with the gasoline motor and the exception with the alcohol motor may be similarly explained, for although it is true that there is more carbon in gasoline to be deposited, yet analyses of the exhaust gases from gasoline motors made by Sorel in Paris in 1903 show that the proportion of unburned carbon is no greater than the proportion of unburned hydrogen, the inference being that if the hydrogen was completely burned, as is the case in the alcohol motor, the carbon would be burned as well, and the fact that neither is completely burned points to the action of some retarding influence during the period of inflammation in the cylinder, which is present in the gasoline motor but absent in the alcohol motor.

The alcohol motor has been freely criticized because of the alleged difficulty in the matter of carburation which is occasioned by the high latent heat of the alcohol. It is difficult to see wherein the drawback from this cause exactly lies, and as far as one can tell the criticism seems to arise from the widespread notion that all preheating of the in-going charge is prejudicial to the efficiency of the motor. The fact is that preheating the mixture *after* the fuel is in a state of vapor is harmful in two ways:—

1.—The whole body of the ingoing mixture being thereby expanded, the actual weight of mixture that enters the cylinder during the suction stroke is decreased, so that the specific power of the motor is lessened.

2.—The efficiency of the motor is reduced, for while there is no lessening of the negative work done during the compression stroke, the energy of the succeeding expansion stroke on which it is a pro rata tax is less, there being less fuel present.

Preheating the mixture, however, or its constituents separately, within limits and before the fuel (in this case alcohol) has become converted into vapor, has no tendency whatever to rarefy the charge, and is consequently without effect, at any rate on that score, on either the specific power or the efficiency of the motor.

The amount of heat necessary to convert 90 per cent alcohol into vapor is nearly 6 per cent of the total amount of heat liberated by the alcohol when it is burned, and the lowest temperature at which the vaporisation çan be completely effected is somewhere in the neighborhood of 75 degrees Fahrenheit, the exact figure depending on the amount of moisture in the atmosphere at the time. Now, assuming, which is the general estimate, that 30 per cent of the energy liberated in the explosion of a gas engine escapes as heat through the exhaust, we have a fund of waste heat, 20 per cent of which can be returned to the motor in a latent state with the in-going charge, without sensible rise of the temperature, once the alcohol is vaporised, and without the weight per volume of the mixture being any more affected than in the carburation of air with gasoline. What may be the exact function of this latent energy of separation of the alcohol particles thus introduced into the motor it is difficult to surmise, but on no hypothesis can its presence be construed as harmful.

To the question of carburation is closely related the question of starting up from cold. The alcohol motor has been widely attacked in this connection and as widely defended, and the only satisfactory course seems to be to disregard all evidence of a merely general character. Even specific cases cannot be regarded as having much weight, unless the accompanying conditions were normal, for the pertinent issue is not whether a start can be made from cold under the most favorable conditions, but whether a start can be made under any conditions that are likely to occur in practice. The question also seems to be a separate one for each type of motor, technically, because the character of the difficulty to be overcome varies with different constructions, practically because the matter is of more importance in the case of the automobile engine than in the case of the stationary engine.

As they constitute a class in themselves, being unsuited to burn gasoline, the high-pressure German motors may be considered separately. According to the principle adopted in vaporising the fuel, they fall naturally for the present purpose into two divisions respectively typified by the Durr motor, in which preheat is relied on, and by the Deutz motor, in which the alcohol is sprayed into the ingoing air, vaporisation being effected by the aid of the heat generated during the compression stroke. In neither case can a start be made from cold, for in the one the necessary preheat is wanting, while in the other the compression by hand is too slow to volatilise the alcohol in the mixture.

In the case of the low-pressure or gasoline motor, it is impossible to make any accurate subdivision, the type varying all the way from the farm motor with a rate of 100 revolutions per minute and a ratio of stroke to bore of two to one, to the fastest automobile motor with a rate of 2,000 revolutions and a ratio of stroke to bore of one to one. Carefully conducted experiments go to show that when the speed is moderate and a good expansion is provided for, the gasoline motor will start up from cold on alcohol under laboratory conditions, but there is little evidence to prove that any gasoline motor can be set in operation with alcohol when the circumstances are unfavorable, as for instance in moderately cold weather. So far as the fast-running type is particularly concerned, the problem is not so much to be able to start up at all times and under all conditions on alcohol, as to be able to run at all on this fuel with any show of efficiency, and there are many reasons for agreeing with the conclusion of the Fuels Committee of the Motor Union, quoted above, that the solution lies in blending the alcohol with benzol or acetylene, not merely to facilitate starting up, which is regarded as an incidental gain, but to bring the alcohol nearer in character to gasoline so that it can be used under the gasoline conditions by which the limitations of the ordinary motor are determined.

The principal difficulties experienced when alcohol is used in the high-speed motor arise from the fact that this fuel ignites slowly, compared with gasoline, and that, when ignited, the propagation of the flame throughout the mixture is not sufficiently rapid to suit a piston velocity of over 12 feet per second, and a piston travel which, at any rate in the case of the automobile motor, is strictly limited in range. The disadvantages, direct and indirect, which result from this sluggish ignition and tardy inflammation are several, and all important.

1.—Combustion, instead of being completed when the compression and temperature are greatest, is continuous during the entire expansion. From a thermodynamical standpoint this means that a portion of the heat units contained in the alcohol are not being liberated to the best advantage. Let T be the absolute temperature of the burning mixture at the beginning of the expansion stroke when combustion is well under way, and let T′ be the absolute temperature when the exhaust valve opens. Then the theoretical efficiency for that part of the fuel which is burned at temperature T is $(T—T') \div T$. The theoretical efficiency corresponding to heat subsequently liberated during the expansion, say at a temperature T″, which is necessarily less than T and greater than T′, is $(T''—T') \div T''$. As this quantity is always less than $(T — T') \div T$, and diminishes continuously with T″, it follows, assuming the combustion to be continuous throughout the stroke, that the thermal efficiency with which the successive portions of alcohol are burned declines all the way from maximum when combustion begins to zero when the expansion is complete.

It has been claimed for the alcohol motor that this phenomenon of delayed combustion is a positive advantage, giving a smooth, even thrust on the piston and a high mean pressure. That such an effect has been observed in alcohol motors is beyond doubt, but it must be attributed, not to the sustained inflammation, since it is most noticeable in very slow-running motors in which combustion is completed during the early portion of the expansion stroke, but to the presence of steam produced from the burning of the alcohol and from the water with which this fuel is always diluted. Provided that this steam (which is of course superheated almost up to the dissociation point) receives its heat content at the maximum temperature of the expansion, its presence and action is in every way an advantage, for it represents internal as against external cooling of the cylinder walls, and the retention of heat units in the working fluid, which would otherwise pass into the water jacket. If, however, the superheat of the steam is regenerated as the expansion proceeds by the continued burning of the fuel, this regeneration is effected at the cost of the thermodynamic loss stated above, a loss which is avoided if the steam receives its whole energy at the beginning of the expansion.

2.—The imperfect combustion of alcohol under the conditions which obtain in a high-speed motor is favorable to the formation of compounds deleterious to the cylinder walls and valve seats. In America, as in most countries, fuel alcohol is methylated, and methylated alcohol, besides usually containing acetone, has a tendency during the compression stroke to form this compound, which during the expansion stroke is partially oxydized to acetic acid. The extent to which acid by-products may increase by their corrosive action the wear and tear of the moving parts of the motor has been the subject of some dispute, but in any case it can be shown that the amount of acid that is formed is proportional to the amount of acetone present in the unburned mixture.

3.—To the credit of delayed combustion must be laid not only work losses due to a portion of the fuel being burned to a disadvantage, but also losses due to a portion of the fuel being only partially burned or not burned at all. The exhaust is found to be contaminated with products of combustion other than water and carbon dioxide, and ceases to be odorless and unobjectionable.

Once it is clear that the problem of substituting alcohol for gasoline as a fuel in the high-speed motor reduces itself to seeking a more vigorous ignition and a more speedy inflammation, and conceded that these desirable ends can be attained by the addition to the alcohol of some compound which will generally accelerate its action in the motor, the natural suitability of acetylene as a corrective can hardly be overlooked. This gas, which has the same formula of composition as tar benzol, has the further property which is shared by no other fuel, that it is an endothermic compound. In its formation heat is absorbed, and there resides in the acetylene molecule the power of spontaneously decomposing and liberating this heat, if it is subjected to a temperature or pressure beyond the capacity of its unstable nature to withstand.

If the liberation as heat of the reserve energy of acetylene (which, it should be noted, is an operation quite distinct from combustion, in that it can take place in the absence of oxygen) is effected when the acetylene is diffused throughout the body of an inflammable mixture, it is found that each detonating molecule of acetylene becomes a center of inflammation and the whole mass is burned with a speed and vigor which is only limited by the proportion of acetylene present. In the case of alcohol the practical question is whether the conditions favorable to the spontaneous decomposition of acetylene are induced, when air carburated with alcohol and acetylene is compressed and ignited in the motor in the usual way; and the experimental answer is that they do. The rise of pressure set up in the mixture when the ignition takes place is accelerated by the detonation of the successive portions of acetylene as they are involved in the advancing pressure wave, and it is found that the ignition line in a pressure-volume diagram taken on a motor burning a mixture of alcohol and acetylene is even at 2,000 revolutions as vertical as the corresponding line in a pressure-volume diagram taken on the same motor when it is burning gasoline.

Mention has already been made of the fact that acetylene and tar benzol have the same empirical formula, viz., C_6H_6, and in the recommendation of the fuels committee quoted above they are coupled together as equally suitable fuels to mix with alcohol, on the common ground that their calorific value is high and that they are rich in carbon. Now, although the admixture of benzol with alcohol makes a true gasoline substitute, and although as an ingredient in *alcool carburé* benzol has been tried out with considerable success in France, the fact that it is not an endothermic compound, and that consequently it has no effect on the combustion of the alcohol with which it is mixed similar to the detonating action of acetylene, renders it inferior to that gas as a corrective for alcohol; and that there are limits to its usefulness in this capacity is plainly stated in the following extract from a paper by Herr Fehrmann, one of the leading German authorities on the alcohol motor.

> Other means for rendering alcohol suitable for use in vehicle motors consist in the admixture with the alcohol of other fuels which are calculated to overcome the difficulty of ignition. It has often been proposed to mix alcohol with other fuels of high calorific value, as, for instance, benzol or ergin, and thus to increase its heating value, and above all its inflammability. With slow-speed motors good results have been obtained in this manner, but with high-speed motors new difficulties arose as a result of the impossibility of completely burning these mixtures, so that there was a great deposit of soot in consequence of the admixtures.

Another trouble is that the amount of benzol necessary to change the character of the alcohol materially is very considerable, amounting in the case of *alcool carburé* to 50 per cent, a proportion doubly objectionable because the cleanly properties of the alcohol are entirely lost and because benzol is a product of which the sources of supply are too limited and the minimum possible price of production too high for it to come into extensive use.

The depositing of soot, mentioned by Herr Fehrmann, never occurs when acetylene is substituted for benzol, for in the first place the necessary amount of this gas to secure a quick ignition and a rapid inflammation is small, and in the second place even if this were not so, the latent energy of the acetylene would ensure the complete combustion of both itself and the alcohol in spite of the necessity for more air in the mixture due to the extra carbon in the acetylene. In the case of benzol it is the presence of this additional but necessary air that causes the combustion to be incomplete, for reasons that were explained in the early part of the article, when it was shown that the introduction of an excess of nitrogen in the motor leads to the undesirable effects mentioned by Herr Fehrmann.

Acetylene, as is evident from its formula, is a reducing agent, and its presence during the combustion of alcohol will either prevent any acetone present from forming acetic acid, or if the acid is formed, instantly reduces it to carbon dioxide and water.

All denatured alcohol contains a percentage of water, and it is a fact that alcohol containing from 10 to 15 per cent of water is in every respect a better fuel than pure alcohol. The action of the water is very obscure, and it has not been satisfactorily determined how far the percentage can be increased without the consequent lowering of the calorific value of the mixture more than offsetting the benefit in the motor. What is relevant here is that the advantages derived from the presence of comparatively large percentages have been principally experienced in connection with high compressions, and to get similar results in the low-compression high-speed motor, the damping effect of a large admixture of water calls especially for the accelerative action of acetylene on the inflammation and ignition.

In conclusion, if we consider that the automobile motor is an instrument in which power must be sought by high piston velocities, and that starting with Daimler's motor this condition has been accepted without question as the basic canon of construction of this class of engine, it seems almost inevitable that the use of alcohol, in the automobile field at any rate, will continue along the lines of carburating the alcohol, of which the French *alcool carburé* is an example and a step. Of the two ways of bringing Mahomet and the mountain together it is the best way in the end to transport Mahomet, even if the road be somewhat difficult and a little preliminary exploration be called for.

THE FEED-WATER SYSTEM FOR THE POWER PLANT.

By Charles A. Howard.

Mr. Howard's summary includes broadly all the more important elements of boiler-feed practice—supply, economy, appliances and lay-out. Following it very soon we shall present a full discussion of the subject of feed-water heating, by Reginald Pelham Bolton, in which the various methods of heating by hot gases, live steam and waste steam are carefully worked out and the heat balance is exhaustively studied.—The Editors.

ONE of the most important considerations, if not a vital one in the steam-power plant, is the system for supplying feed water to the boilers. A supply of reasonably clean water must be available at all times, and the system should be so designed that the failure of some piece of pipe or apparatus will not shut down the whole plant.

The fundamental point in the design of such a system, and one too frequently neglected, is the supply of water to the station itself. It is not uncommon to find a power plant equipped with the most up-to-date apparatus and the most carefully designed duplicate systems inside of the station, but with the sole water supply coming through a single line of pipe. There are, of course, cases where the single line is all that can be obtained; but there are many more where additional sources of supply could have been provided at a slight expense. Plants running condensing sometimes use the same source of water for circulating purposes as for the boilers, but when the circulating water is unfit for boiler use on account of salt or otherwise, and the feed water is taken from elsewhere, a connection should always be made so that in cases of emergency the kind of water used for circulating purposes can be used to feed the boilers.

After having made sure that the supply of feed water is adequate and certain, attention can be turned to the design and layout of the piping and apparatus inside of the station. At the very start, there are several fundamenal questions to be settled, each involving a careful study of the existing conditions, not only as they are at present but also as they will be in the future. There is the question of economizers; shall we install them or shall we not? Shall we use heaters, and if so are they to be open or closed? Are our auxiliaries to be steam or electrically driven, and if steam-driven shall we take any pains to secure especially good steam economy? The conditions of the individual problem are the governing factors in all these questions, and it can not be stated in general that one side of any of them is the better.

Let us first consider the economizer question. On looking over some of our largest plants designed by the most capable engineers, we find economizers installed; in other plants, which are the work of equally good men, no provision is made for them. There is a great diversity of opinion in regard to the maintenance of economizers; some who have had a large experience with them consider that the maintenance costs are very low, while others find them extremely excessive. I find pretty generally that the cases where the cost of upkeep has been high are in plants where the load factor is low. In looking over existing plants, it will be noticed that the economizer is very popular in mill plants and manufacturing plants, less so in railway work where the load factor is lower, and still less in lighting plants which have in general even a lower load factor than the railway plants.

In plants where the main generating units are run condensing, and where there is a demand for the exhaust steam of the auxiliaries for heating, drying, or other purposes, or where the auxiliaries are electrically driven, an economizer is a practical necessity for heating the feed water. Under other conditions than these just given, it is doubtful if any better results can be secured by an economizer than can be produced by a well designed system of auxiliaries and heaters making all together an installation of less first cost and less maintenance, and taking up less space, not to mention the effect of the economizers on the chimney draft. This last matter is no small item, especially where the tubes of the economizer are staggered. If the plant is operated by induced draft, it is a simple matter to speed up the fan and obtain the required draft provided the fan has sufficient capacity; but when forced or natural draft is in use this cannot be done, as if the forced draft fan is speeded up to any extent it will produce a pressure over the fires on account of the reduction of draft by the economizers making it impossible to take the volume of gases away. This pressure will very soon cause the boiler fronts to be burned. This is frequently the reason for the capacity of the boilers falling very materially after economizers have been installed.

When it comes to the question of choosing the type of auxiliary heater, there is some difference of opinion. In general, however, it may be safely stated that except in very unusual circumstances, the open heater shows up more favorably than the closed tubular heater for the following reasons.

First: The open heater saves the substance and heat of the condensed exhaust steam which amounts to as much as one-seventh of the total boiler-feed supply. The tubular heater throws this water and its sensible heat away, amounting to as much as 130 B. t. u. per pound above water at 70 degrees F.

Second: The capacity of the open heater is always the same; but the closed heater, after it has been in operation for some time, is sure to have its capacity reduced by the deposit of oil on the steam side of the tubes and the collection of scale on the water side.

Third: The open heater is usually operated under a very slight pressure, generally less than two pounds, while the tubular heater is subjected to a greater pressure than the boiler itself.

Fourth: The salts in solution in the water have each a temperature at which it is deposited, and this temperature is reached in the open heater while the water is dropping down from one tray to another, while in the tubular heater it takes place in the tubes, causing heavy scale deposits.

Fifth: The open heater has a large settling chamber and filter which catch the mud and floating impurities that would otherwise pass on to the boilers were a closed heater used.

The open heater, however, must be equipped with an effective oil eliminator, as practically no oil should be allowed to pass into the boilers. There are several good makes of these separators which prevent the passage of any appreciable amount of oil through them.

In selecting pumps and engines for the station auxiliaries, the condition rarely occurs in which it is worth while to strive for any great steam economy. The upkeep and first cost on simple engines and pumps are much less than on compound; in some cases the extra cost of maintenance of the latter will make up for the steam saved over the former where the exhaust is not used for feed heating. When the exhaust is used for feed heating and there is need for the extra steam, it is bad policy to install high-efficiency auxiliaries where these involve added complexity of parts. Recently, turbine-driven centrifugal pumps have been very successfully applied as boiler-feed pumps and condensed water pumps, and their low cost of maintenance and the fact that they need practically no attention ensure for them a large increase in their use. The pressure in the feed lines fed by centrifugal pumps is practically constant, while with direct-acting pumps, when several of them get into unison and a large number of the feed valves of the boilers are closed, the variations in pressure are very large. In one case, I have noted a differnce of 85 pounds between the maximum and minimum for five minutes.

Most of the advocates of driving the auxiliaries by electricity use the very plain and simple argument that the electricity is generated by an engine which uses say 12 pounds of steam per horse-power hour, while the auxiliaries will consume from 20 to 60 pounds per horse-power hour; and as the efficiencies of the motors and generators are each 85 per cent or more, and the transmission losses small, they figure a large saving for the electrically driven machines. Plant economy in pounds of steam not only means nothing but is in general very deceptive, giving on the surface results which are greatly in error, as this instance will show.

In an economical condensing engine running at 12 pounds per horse-power hour at 175-pounds absolute steam pressure, 17.7 per cent of the heat in the steam is delivered by the engine, the remainder being rejected to the condenser or otherwise lost. With the steam-driven auxiliaries exhausting into an open heater, the only loss of heat, and hence of energy in the system, is that due to friction and radiation from the piping, which if covered will total less than 10 per cent. This leaves 90 per cent of the heat utilized as against 17.7 per cent with the electric auxiliaries, making a loss of 82.3 per cent in one case and 10 per cent in the other. This would allow of a steam consumption by the auxiliary machinery roughly of 82.3 ÷ 10 or 8.23 times that of the main engines for equal economy, other things being equal.

To show this point up a little more plainly, let us take a concrete case. Say the auxiliaries of a given plant whose main engines run condensing require 300 horse power to drive them. Let the steam consumption of the main units be 12 pounds of steam per horse-power hour at 175-pounds absolute, and take the average consumption of the auxiliaries, both pumps and engines, at 60 pounds of steam per horse-power hour, which is a very high figure. Which is the more economical, to drive by electricity or steam when the exhaust from the auxiliaries passes into an open heater, allowing a loss of 10 per cent in friction and radiation, which is ample in most circumstances?

ELECTRIC AUXILIARIES:

Heat in 1 pound steam at 175 pounds absolute = ...	1,195 B. t. u.
Heat supplied main engine for auxiliaries for one hour, 1195 x 12 x 300 = ...	4,302,000 B. t. u.
Heat delivered as power by the engine, 42.42 x 60 x 300 =	763,600 B. t. u.
Heat rejected to condenser and lost from system......	3,538,400 B. t. u.

Steam-Driven Auxiliaries:

Heat supplied auxiliaries = 1195 x 60 x 300 = ...	21,510,000	B. t. u.
Heat delivered as power by the auxiliaries............	763,600	
Heat rejected from auxiliaries........................	20,746,400	
Lost by friction and radiation in piping, 10 per cent.....	2,074,640	
Heat returned to feed water..........................	18,671,760	B. t. u.
Heat supplied, total..................................	21,510,000	B. t. u.
Heat returned to feed water...........................	18,671,760	B. t. u.
Heat lost and used by auxiliaries......................	2,838,240	B. t. u.
or		
Net heat supplied auxiliaries per hour.................	2,838,240	B. t. u.

To run the auxiliaries of this plant for one hour by electricity therefore will require the work equivalent of 4,302,000 B. t. u. without making any addition for the losses in the generators, motors, and transmission, while if the steam-driven system is used these auxiliaries will be run for the same length of time with an expenditure of only 2,838,240 B. t. u.

There is also another very important consideration in connection with this question of the means of driving the auxiliaries, and that is that in general principle it is undesirable to use the finished product for a purpose for which this product partially manufactured will answer just as well. Power in the form of steam, of course, is cheaper than in the form of electricity which requires further manufacture. Besides the extra running plant cost of converting steam to electrical energy, there are the fixed charges on the whole engine room and electrical apparatus; these charges often amount to 30 per per cent of the total cost of producing current, and sometimes more in plants where the load factor is very low. In making calculations to determine whether the steam or electrically driven auxiliaries are the more suitable for a given condition, this matter of fixed charges on the engine room and electrical apparatus should always be carefully considered.

With stations whose prime movers run condensing, there are three general arrangements which may be used for heating the feed water, though, of course, there are several combinations of these arrangements used to a greater or lesser extent.

First: The auxiliary machinery may all be electrically driven and the feed water heated by an economizer, with sometimes the aid of a primary heater. If the condenser returns are being used for feed, their temperature is generally so high that a primary heater is of little or no value.

Second: The auxiliaries may be all driven by steam, and exhaust into a secondary heater of the open or closed type, this exhaust generally being sufficient to heat the feed to 200 degrees F. or slightly more. If warmer feed than this is considered advisable, the water is frequently passed from the heater to an economizer which will raise its temperature still further, to a point depending on the amount of its surface. Sometimes primary heaters are installed in the exhausts of the main engines, but with this system of auxiliaries they are seldom necessary or advisable.

Third: Part of the auxiliaries may be steam-driven and part electrically driven, and in this case almost every combination of the feed-heating devices is used.

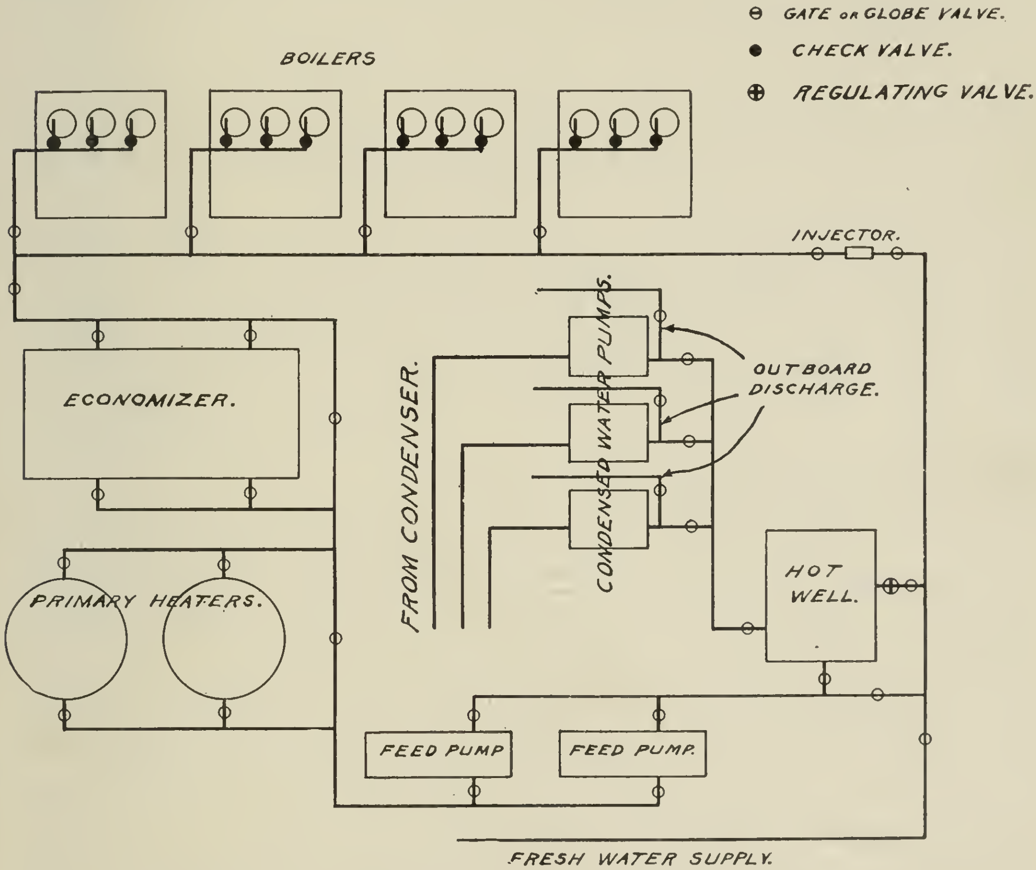


FIG. I. FEED-WATER INSTALLATION WITH ELECTRICALLY DRIVEN AUXILIARIES.

In Figure 1 is shown the diagrammatic layout of the piping and apparatus of a plant whose auxiliary machinery is driven electrically. Primary heaters are included in this sketch merely to show how they are connected into the system when installed, but as has been previously stated, their use under the most usual circumstances is not found necessary.

Figure 2 illustrates also in diagrammatic form the layout of the feed system for a plant whose auxiliaries are steam-driven An open heater is shown in this diagram, but if a closed heater were installed, the only difference in the layout would be that the closed heater would be placed on the discharge side of the feed pumps instead of on the suction side as shown.

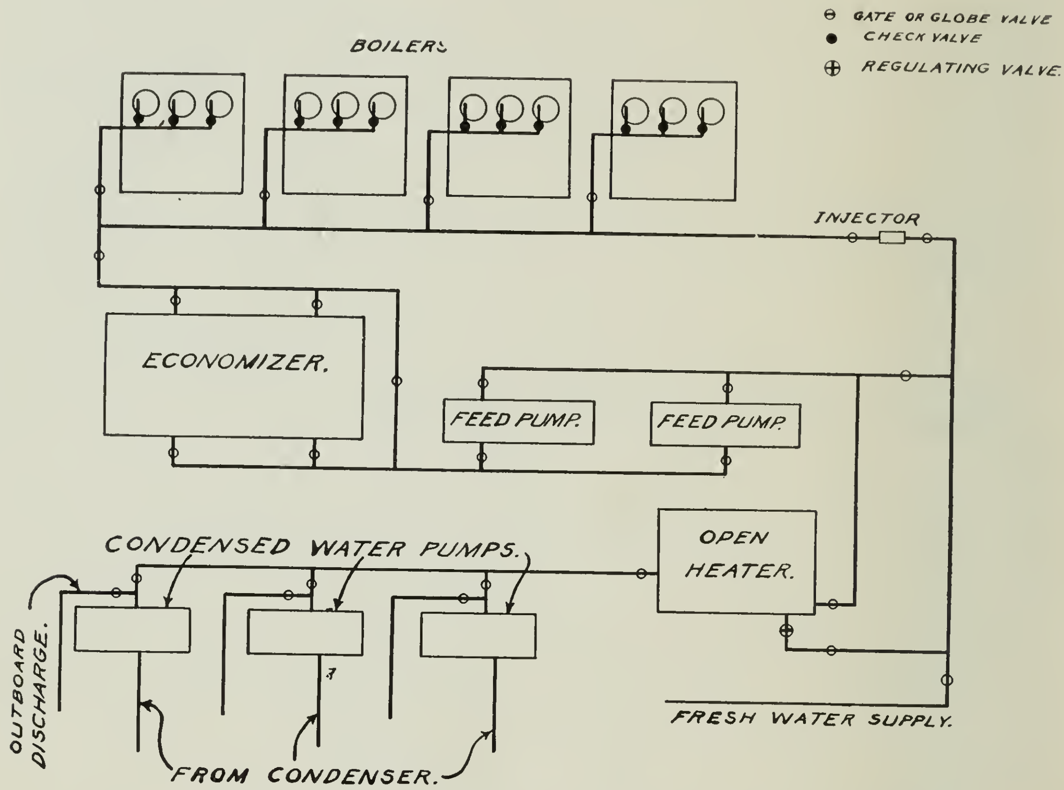


FIG. 2. FEED-WATER INSTALLATION WITH STEAM-DRIVEN AUXILIARIES.

In plants running non-condensing, the exhausts from the main engines are much more than sufficient to heat the feed water to 210 degrees F. so that no secondary heaters are necessary. These primary heaters, as they may be called in this case, may be either of the open or closed type as in a condensing plant. The motive power for the auxiliaries to give best results will generally be electric motors as there is no use for the exhaust steam. In case, however, steam-driven auxiliaries are installed, it will be found advisable, under most circumstances, to put in the most economical types as the exhaust steam from them will go to waste.

After the final layout of the system has been settled, then comes the determination of the sizes of the pumps, heaters, and piping. Open heaters are generally bought on a guarantee by the manufacturers to raise the temperature of the feed a specified number of degrees when supplied with sufficient exhaust steam at substantially atmospheric pressure. In purchasing closed heaters, the surface required may be figured by allowing 220 B.t.u. transmitted per square foot per degree difference in temperature per hour, and specified in asking the heater manufacturers for bids; but it is better in most cases not to specify the surface as this relieves the manufacturer from responsibility as to the operation of the heater. When he is asked to give a heater which will raise a given amount of feed water a definite number of degrees in temperature when supplied with a specified amount of exhaust steam at substantially atmospheric pressure, the amount of surface required is up to the contractor or manufacturer, and he can be held to his guarantee, whereas if the surface is specified by the engineer, and the heater falls down for any reason, the manufacturer can claim that the surface as specified by the engineer is too small and he stands safe.

In deciding upon the capacity of feed pumps to be installed, the size of the units should be so chosen that if one pump, or in fairly large plants, two pumps, be laid off for repairs, the remainder will be able to supply the station at full load. The most desirable type of direct-acting pump for feeding and the one in most general use is the outside end-packed duplex type. Compound cylinders are not necessary or desirable when exhausting into a heater, as steam economy is of no object and the maintenance is necessarily greater on the compound pumps.

In the past few years, a number of the largest stations in the United States have been equipped with turbine-driven multi-stage centrifugal pumps for boiler feeding, and their use is rapidly extending to the smaller plants. The steam economy of this unit is very much less than of the direct-acting type, they produce a more steady pressure, and require practically no attention or repairs.

When it comes to the design of the piping, the critical point is in the velocity of the water in the different parts of the system. This velocity should be kept as low as is consistent with the cost of the piping, but in general should not run over 15 feet per second in the main lines, above say 6 inches in diameter, and not over 8 feet per second in the smaller pipes. It is better to run lower velocities than these when practicable, and it should be considered that the head lost in friction increases very closely with the square of the velocity. Long-radius bends will reduce the friction by a very large amount, as the resistance of a right-angle elbow to the flow is very high. It has been said that "three elbows equal a plug", and while this is somewhat exaggerated, it rather pointedly illustrates the effect of right-angle bends.

GENERAL VIEW OF N. Y. O. & W. DOCKS AT GUTTENBERG.
Showing pusher engine placing cars to be unloaded.

THE COAL INDUSTRY OF GREATER NEW YORK.

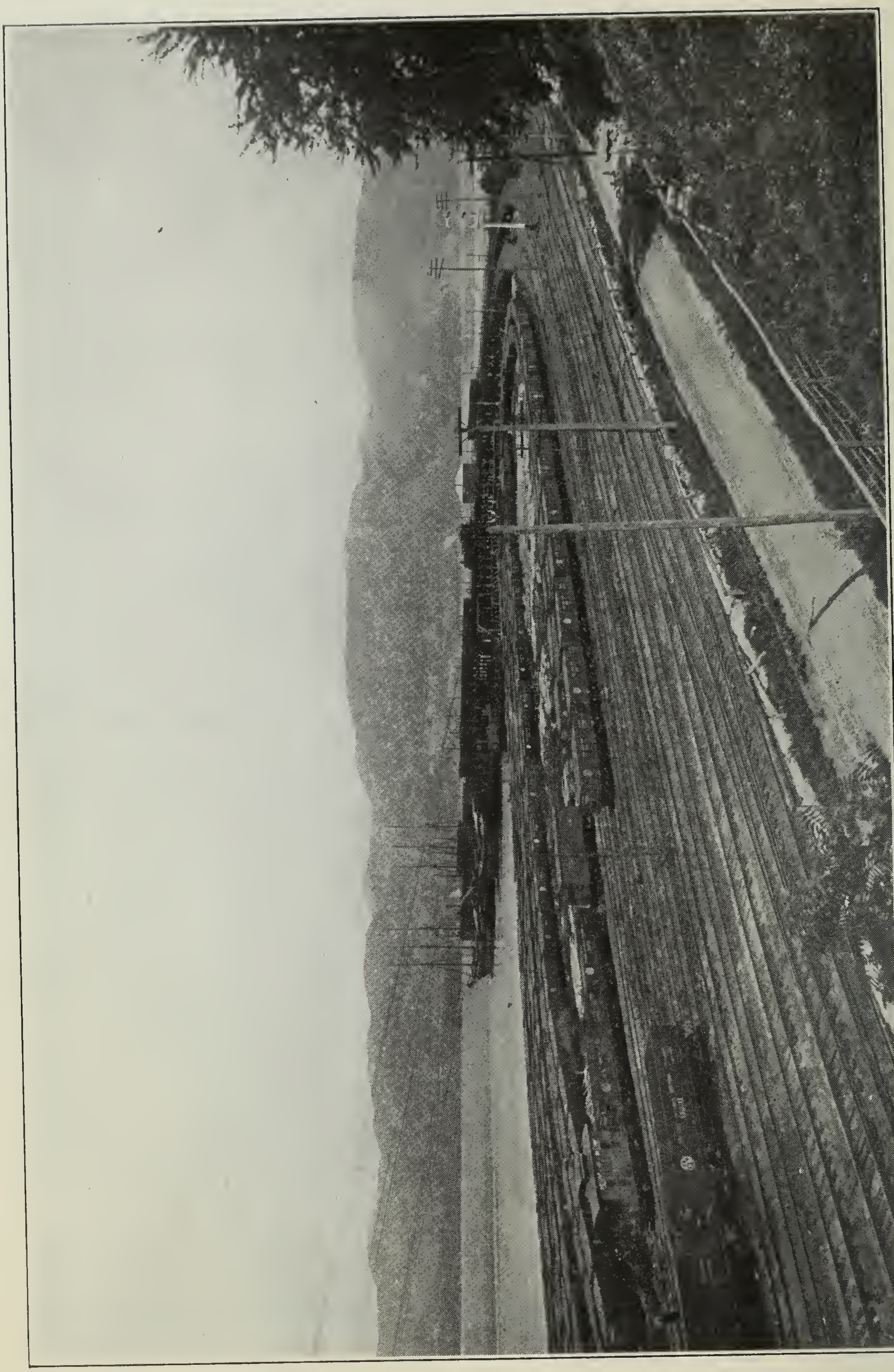
By Werner Boecklin.

NO city in the world does a business in coal equal to that of New York, for in addition to the great numbers of consumers on land, from the giant power house down to the smallest store, there is the tremendous foreign and domestic floating equipment taking its supply from the city's coaling ports.

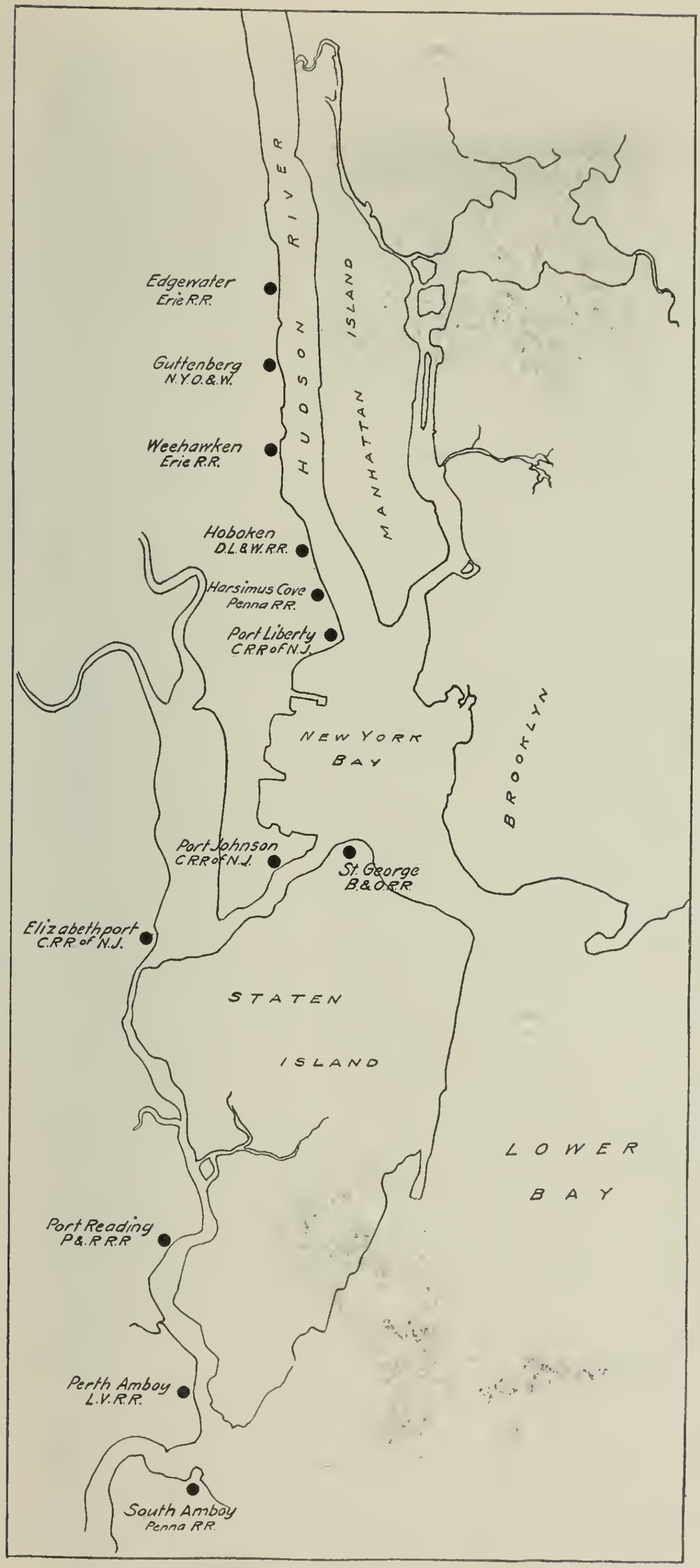
The thirty million tons of coal shipped annually to the New York seaboard come in greater part by rail, consigned to the various ports located within the coal-handling zone. These ports are the centers of distribution whence radiate the main supply arteries, leading either to other small centers for redistribution to large and small consumers, or to large consumers direct. Of these main centers of distribution, there are thirteen within the towing limits. Unloading docks are located at each one of them, and two have facilities for storing large quantities of unloaded coal. Only certain salient features in connection with these ports will be touched upon.

At Edgewater the Erie has two unloading docks; both are double or four track, with chutes on either side for delivery to boats and a return gravity track for the empties. The storage yard being considerably below the level of the top of docks, two incline-cable hoisting engines are employed to elevate the loaded cars. A boiler plant furnishes steam for the operation of the hoisting engines, for thawing sheds, and for general heating purposes. The difficulties which the company has had in the past on account of the freezing of the wet coal led the management to construct a series of frame sheds with just sufficient inside clearance to receive the largest cars. These are lined with tar paper and sheathed, and have a set of 4-inch steam coils placed on the floor between the rails. The plan is experimental, but it is hoped it will prove effective for the work required of it.

The Guttenberg plant of the New York, Ontario & Western consists of two piers which carry a 1,500-ton storage for a Manhattan dealer, for team deliveries, the balance of the piers being constructed with hoppers and side chutes in the usual manner. The approach grades are light, allowing the use of yard engines, thus obviating



GENERAL VIEW OF THE N. Y. O. & W. COAL TERMINAL AT CORNWALL ON THE HUDSON.



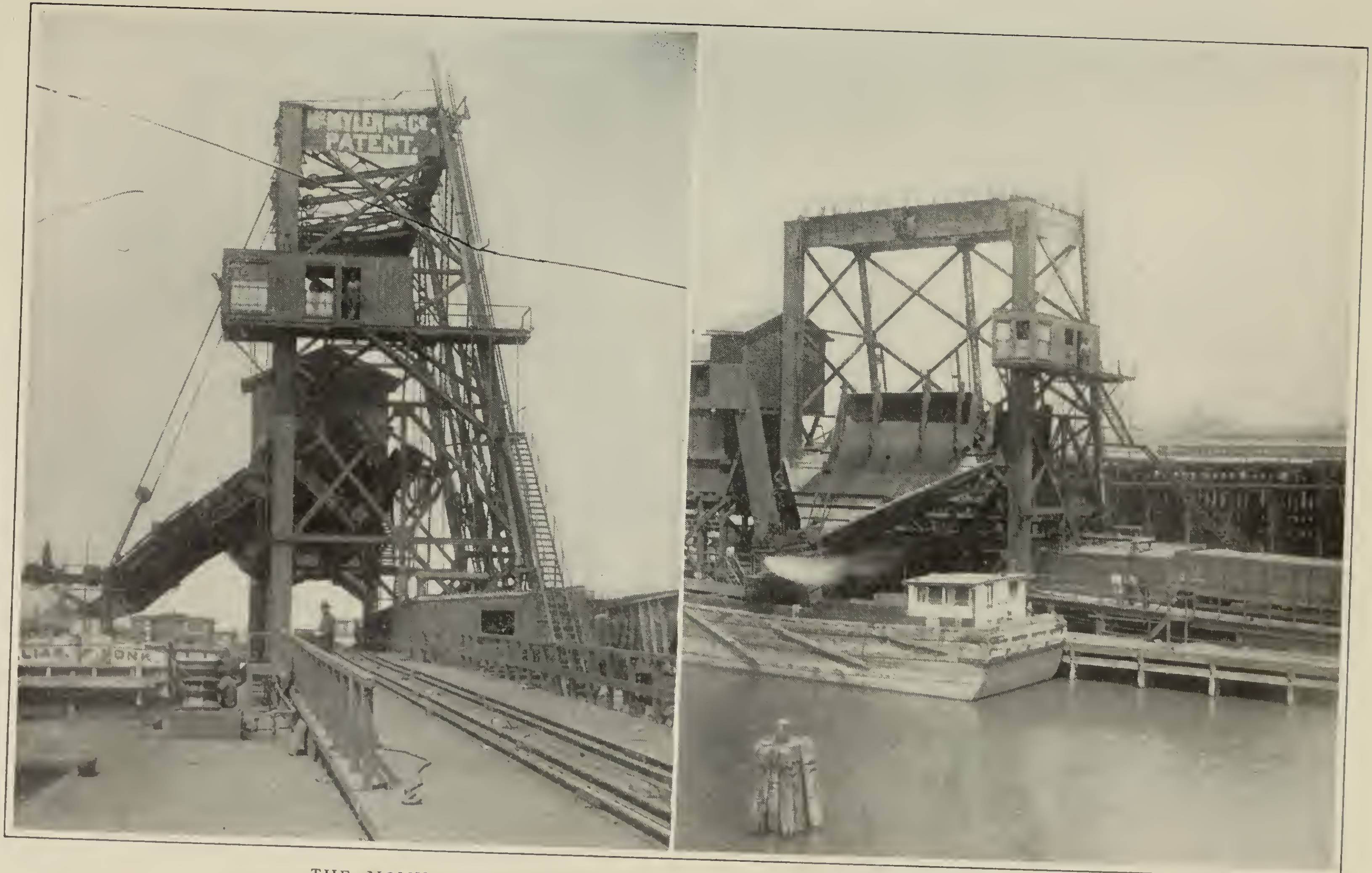
MAP SHOWING LOCATION OF COAL PORTS ABOUT NEW YORK CITY.

the necessity for installing hoisting machinery required in other docks of this type. There is a boiler plant for thawing purposes and for heating the office building. In 1907 these two docks with the one owned by the company at Cornwall handled 33,000 cars averaging 30 net tons each.

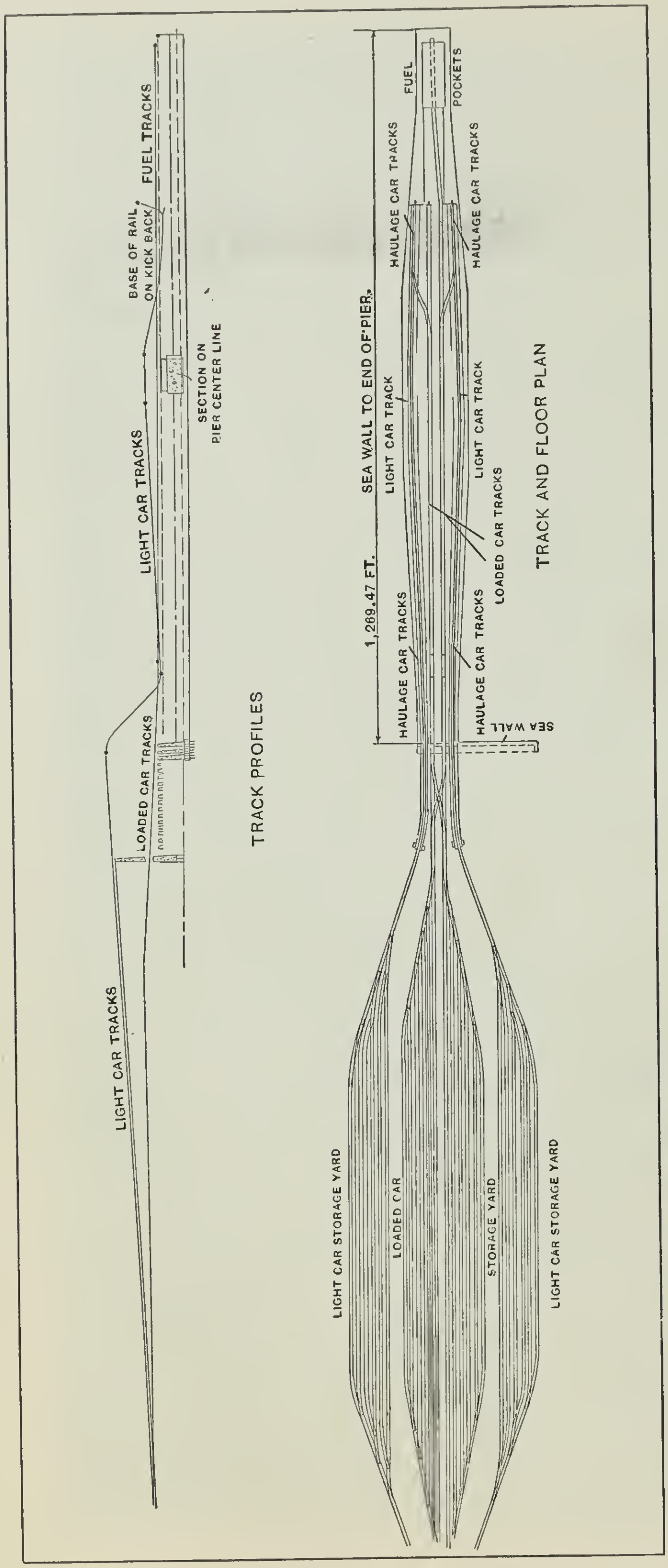
At the docks of the Delaware, Lackawanna & Western R. R. in Hoboken there are two McMyler dumping machines operating, and there is also one on the docks of the Baltimore & Ohio R. R. at St. George. A description of the D. L. & W. plant will prove of interest, typifying as it does an up-to-date installation managed and operated according to modern business principles. The complete plant consists of two McMyler dumps, one 1,000-foot single trestle pier, boilers

BALTIMORE & OHIO RAILROAD STORAGE YARD AT ST. GEORGE.

Bituminous coal only is handled at this point.



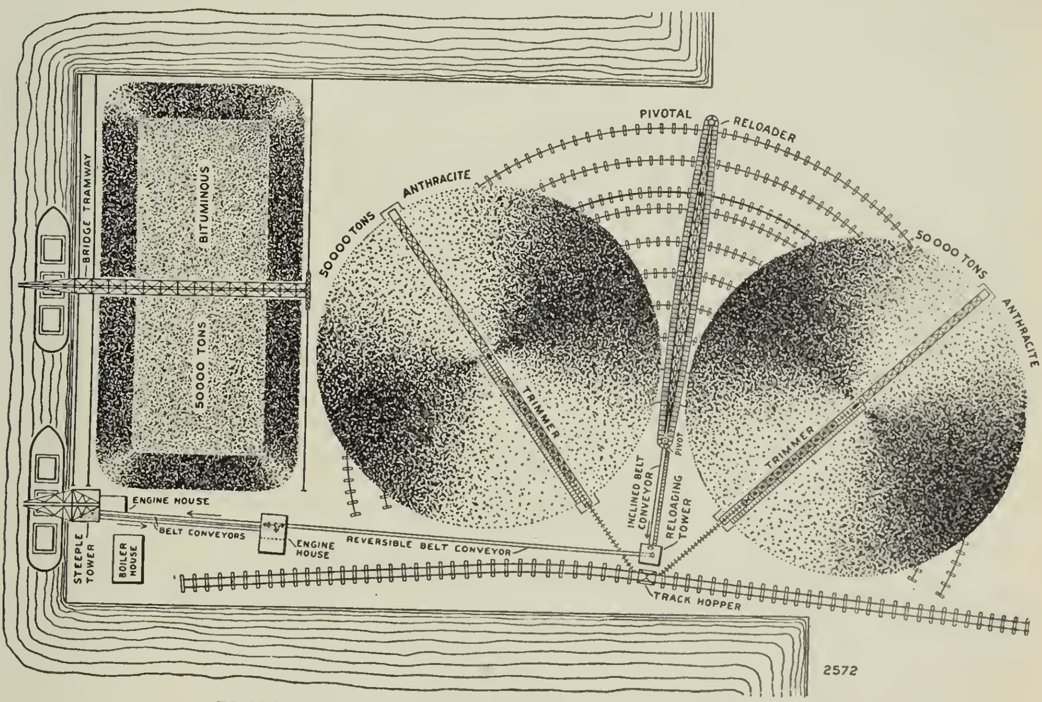
THE MCMYLER DUMPER, HOBOKEN DOCKS, LACKAWANNA RAILWAY.



GENERAL PLAN OF TRACNS, HOBOKEN TERMINAL, D. L. & W. R. R.

of 1,800 horse power, engines and dynamo for generating current for power and lighting, fire pumps, steam piping, and auxiliary machinery. There is a complete fire-alarm system with all necessary apparatus for emergency work. One pump is in continuous operation maintaining a pressure of 100 pounds throughout the salt-water system. A pipe line carrying live steam is located in the storage yard, which is capable of holding 400 cars, with convenient connections for flexible hose and "points" for insertion into the coal in freezing weather; 125 cars can be treated overnight without shifting, and by employing two gangs 300 cars can be treated in 24 hours. A gravity yard system is used both for the timber dock and for the two dumpers. The dumpers have a maximum capacity of about 420 cars in 11 hours, and the timber unloading dock can take care of about 200 cars in the same time. For the operation of the complete plant about 80 men are employed, including the office force. This is a hard-coal dock, whereas the St. George dumper handles bituminous coal exclusively.

At Perth Amboy there are two docks of the usual type owned and operated by the Lehigh Valley R. R. Co. The storage plant located here is probably the oldest in New York harbor. It was erected in 1884 and since that time has been practically rebuilt. The tracks are laid out to cover about 350 bins having a total capacity of over 200,000 tons. Under the bins are nine standard-gauge tracks running in tunnels, and coal is drawn off through suitable gates of which there are three for each bin. In addition to the bin storage the tracks in yards and on wharves have a capacity of 1100 cars. The approximate annual tonnage is 2,000,000 tons.



PLAN OF COAL-STORAGE PLANT AT SHADYSIDE.

Installed by the Dodge Coal Storage Co. for the New York Edison Co. Capacity 100,000 tons anthracite, 50,000 tons run-of-mine bituminous. Unloading from boats is by 1½ or 2 ton self-filling buckets operated from steeple tower. Reloading by pivotal reloader.

The Pennsylvania R. R. has four docks at South Amboy where both anthracite and bituminous coal are discharged into boats. Anthracite coal is stored on these docks and rehandled by wheelbarrows, but the larger amount is placed in piles by means of sixteen Dodge machines, with a total capacity of over 300,000 tons. Fully 4,000,000 tons pass through the two Amboy terminals annually.

The plant owned by the New York Edison Co. at Shady Side is, within the area under consideration, the only industrial installation comparing in size with those owned by the various railroads. This plant consists of two Dodge storage systems with a total capacity of over 100,000 tons of anthracite, and a 200-foot span bridge tramway with a capacity of 50,000 tons of bituminous coal. This storage point has connection with the New York, Susquehanna & Western R. R. and with other roads, and has full equipment for unloading from boats, thus placing the owners in a strong position as concerns their fuel supply.

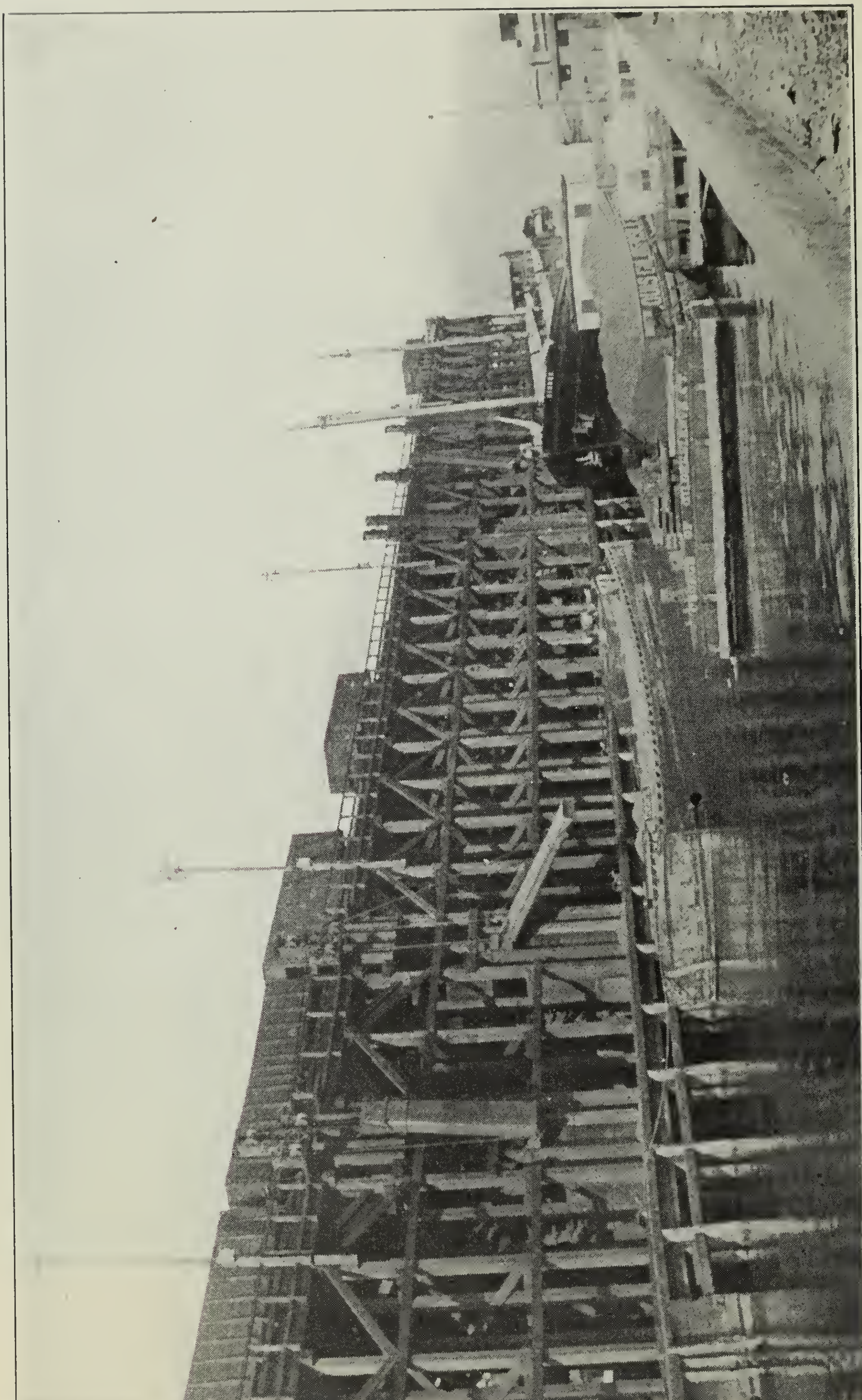
The distribution of supply from the main centers to smaller centers and to consumers direct is carried on by the towing and lighterage companies, or by the railroads employing large fleets of barges, sailing craft, and tugs. Coal furnished to local consumers, and that part transferred by water from the loading ports, is towed in barges holding from 350 to 1,500 tons of coal, which are filled at the loading docks and placed alongside of the unloading dock.

Business conditions affecting the secondary centers, which are owned and operated by the dealers, have been very much modified in the past decade. The *Coal Trade Journal* has found, by a systematic canvass of the field, that since 1890, two hundred and twenty-five concerns owning yards in New York have been forced to retire from business. Increased land values and restricted dock facilities are the factors mainly responsible for the large decrease in the number of coal dealers. These factors together with increased demands of single users and sharp competition in securing trade, have brought the plants now in operation to a degree of efficiency never before realized. In Manhattan, Brooklyn and the Bronx there remain some one hundred and fifty dealers, a small number when the immense population served by them is considered. This concentration of the trade has naturally resulted in the development of a few large plants, so that it is not strange to find one company handling 1,000,000 tons annually, another over 750,000 tons, and several doing a business as high as 1,000 tons in a single day. Dealers located on the water are fortunate in that the cost of one haul is eliminated from their operating charges, and the volume of business is larger than can be handled by an inland dealer. There are less than fifty dealers having plants on the water front, these being on the Hudson, East, and Harlem Rivers and on Mott Haven Canal.

The largest single customer purchasing coal from the dealer is the municipal government. In 1905 the twenty odd departments of the city government consumed more than 350,000 tons. The addition of

COAL-STORAGE SYSTEMS, N. Y. EDISON CO. AT SHADYSIDE, AND PENNSYLVANIA R. R., SOUTH AMBOY.

The Shadyside plant, above, shows part of the anthracite storage, the hoisting tower for anthracite, and bridge tramway for bituminous coal. The Penna. plant is an extension of an older 100,000-ton storage; it consists of six 15,000 ton piles with three reloaders. All by the Dodge Coal Storage Co.



A TYPICAL COAL-UNLOADING PIER, SHOWING SIDE CHUTES FOR DELIVERING COAL TO BOATS.

the municipal ferry system between Staten Island and Manhattan, together with new school houses and other structures, brought the total to 444,000 tons in 1906 and to 511,000 tons in 1907. Most of this coal is hauled to its destination, but the Staten Island ferries, which used more than 87,853 tons last year, have convenient coaling facilities at St. George for unloading and storing. The six city departments which are the largest users are: Water Supply, Gas and Electricity, 135,000 tons; Education, 100,600 tons; Charities, 40,000 tons; Fire, 19,000 tons; Corrections, 18,000 tons; Docks and Ferries, 94,000 tons. Of the entire amount of coal purchased by the city 23 per cent is consumed in the schools. Only 11 per cent of the total is bituminous.

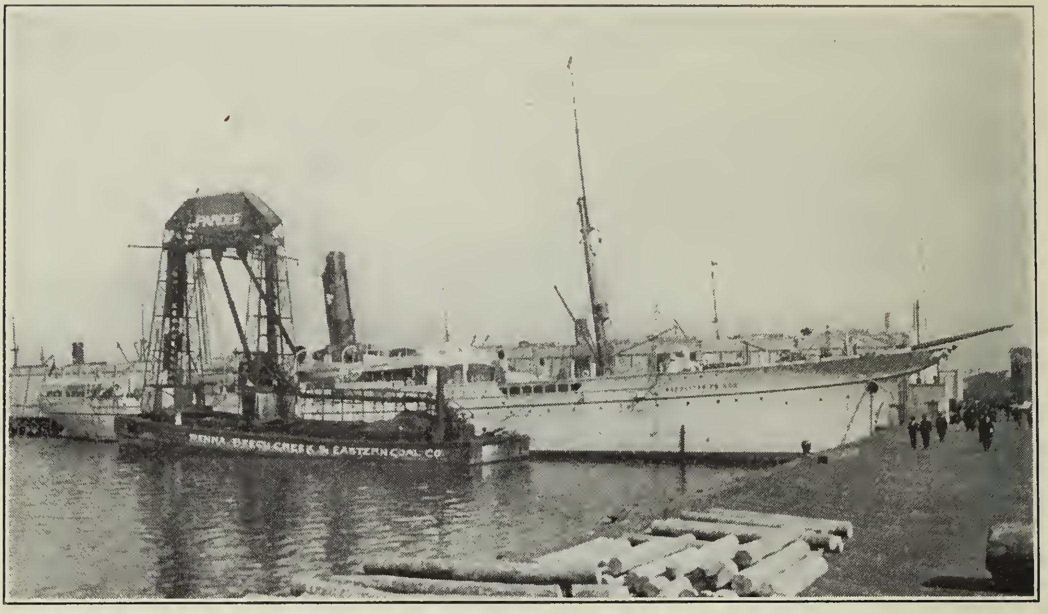
Buildings using large quantities of coal are hotels, large office buildings, high-grade apartment houses, department stores, loft buildings used for manufacturing purposes, and factories. In addition there are such buildings as colleges, hospitals and other institutions. The list gives some of the prominent buildings with the amounts of coal consumed per day.

HOTELS:—		
Waldorf-Astoria	100	tons
Hotel Astor	35	"
St. Regis	50	"
Plaza	30	"
Hotel Knickerbocker	30	"
Hotel Belmont	35	"
OFFICE BUILDINGS:—		
Singer	38	"
Park Row	26	"
Broad Exchange	26	"
Western Union	15	"
St. Paul	10	"
DEPARTMENT STORES:—		
Macy's	38	"
Siegel-Cooper	38	"
Altman's	25	"
Bloomingdale's	15	"

The larger apartment houses consume from 6 to 8 tons a day. Columbia University burns 20,000 tons annually, the new Custom House uses 6,000 tons for heating only, the main Post Office uses 12,000 tons a year for heat, light and power, St. Luke's Hospital consumes 6,500 tons for all purposes.

Another class of consumers contract directly with the coal companies for their annual supply. The New York Edison Co., with its 50,000 horse power in boiler installation; the New York Central, with a 30,000-kilowatt plant at Port Morris; the Pennsylvania Railroad, with its Long Island power station having a total capacity of 66,000 kilowatts; the Metropolitan Street Railway Co., the Interborough

Rapid Transit Co., the Brooklyn Rapid Transit Co. and the Brooklyn Edison Co., aggregating upwards of 400,00-kilowatts capactiy, all take their supply from the main centers and are all equipped for unloading at a minimum cost. The plants named consume from 6,000 to 8,000 tons of coal every day throughout the year.



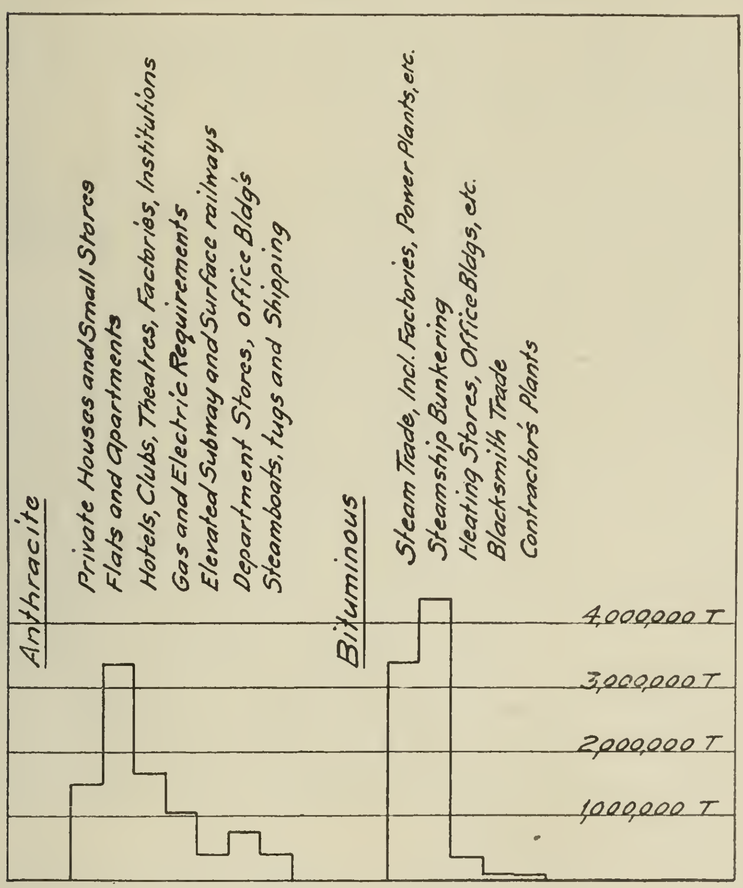
AUTOMATIC BARGE COALING A PRINCE-LINE STEAMER.
Coal-handling machinery installed by John A. Mead & Co.

With such large power plants no question is of more vital importance than that of storage, and this has received due consideration by the management in all these cases. Take for example the Waterside Stations of the New York Edison Co. The old station has a bunker capacity of 10,000 tons; the new has a capacity of 18,000 tons of anthracite and 1,600 tons of bituminous coal, or a total for the two stations of 30,000 tons. For this type of storage the limit has about been reached, and to increase the reserve other means must be resorted to. This is accomplished by providing an auxiliary storage entirely separate from the bunker storage. Where such large interests are dependent upon continuous service, an interruption of such service becomes a real catastrophe. The coal strike of 1903 demonstrated beyond doubt the need for such a reserve; and the Edison Company, which at that time imported large shipments of coal, set about securing a location for such a storage. The result was that the Shadyside plant, already briefly described, was installed.

There is but one large power plant in Greater New York which has, in addition to its bunker storage, an auxiliary storage adjacent to the plant and with necessary equipment for rehandling. This is the Central Station of the Brooklyn Rapid Transit Co. where 100,000 tons may be stored and where coal can be taken out of storage and delivered to bunkers at a minimum cost.

The United States Government took 38,000 tons through the Brooklyn Navy Yard dock in 1907. This dock has a storage capacity of 10,000 tons and every precaution is taken for the prevention of fires, since only bituminous coal is handled at this point.

Another large user in this class is the Consolidated Gas Co. This company has nine plants in Manhattan, the Bronx, and at Astoria. These plants hold in storage 80,000 to 100,000 tons coal the year round, or about a 90-days supply, and consume 800,000 tons of anthracite and bituminous coal.



TONNAGE, NEW YORK CITY COAL TRADE.

From statistical data published in *The Coal Trade* for 1908 is prepared the diagram showing tonnage used in city trade in the year 1907. The shipments at New York harbor points in 1907 amounted to 28,444,000 tons, of which 16,753,000 were anthracite and 11,691,000 bituminous. Of the total shipment 50 per cent is consumed locally, not counting the 4,391,767 tons placed in steamer bunkers.

But a small percentage of this enormous bunker tonnage is handled automatically. Some 20,000 tons per month of bituminous coal are transferred to ships by two automatic machines owned by a leading coal company. These machines, comprising a barge holding 1,000 tons of coal and a gravity bucket conveyor elevating the coal to sufficient height to discharge into the ship's bunkers, have been in operation for a number of years. The efficiency of this method is controlled only by the ship's facilities for rapidly stowing the coal.

A SUPERINTENDENT'S VIEWS OF AMERICAN SHOP AND LABOR CONDITIONS.

By John Geo. Niederer.

In the following pages, Mr. Niederer gives his views of the discussion begun by a New England Machinist in our April issue, and continued by Mr. C. R. McGahey in June. His estimate of conditions will be read with interest on account of his evident optimism and strong belief in steady improvement.—The Editors.

An experience of thirty-nine years at bench and lathe has made an impression upon me widely different from that received either by Mr. McGahey, or by the New England Machinist, whose views were recently expressed in this Magazine.

I was sent out to begin my fight for a place in old New York as a graduate of Grammar School No. 13, at thirteen years of age. On account of my German extraction I had to fight every boy of my years in the first shop I entered (a printing establishment) and life, indeed, has been a fight ever since to obtain bread, clothing and comfort for my family. It has been a gradual working up from lathe and bench to inspector, foreman, assistant superintendent, general works superintendent—a rise from $3 a week to $8,000 a year; but at this moment, though out of a job and out of money, I want to profess unwavering belief that the United States and its sons have a future greater and grander than any past, and that at this day to those who are willing to take hold opportunities are offered such as we in our earlier days I am sure never had.

The New England Machinist speaks of apprentices in the iron trade receiving 65 and 85 cents per day, and then being taught nothing. I had a like experience in New York at fourteen years of age—but I did not stay; I got another job, where I was treated more fairly. I know boys today—many of them—who work all day and go to school at night to study mechanical drawing. I have known apprentices to do this ever since I have been connected in any way with manufacturing concerns. You can lay a heavy wager that if boys really have the ambition in them they are going to win. You can't take the ambition out of a boy of this kind; if he does not get fair treatment at the machinist's trade he will turn to dentistry or some other better field, for he is bound to win and to make the coin to raise another American family.

It is my conviction that apprentices nowadays serve their full time just about as they did when I was young; a great many did not do so then. My experience as superintendent covers a period of twenty-five years. As I recall it, the boys of American birth whom I have had as apprentices either served their full time or went elsewhere because they received higher salary and better opportunities to learn; as I remember, also, they have been as worthy and industrious as boys of any other nationality that I have employed, and far more ambitious. A great many naturally find that the factory is not the best field for a bright man who desires independence and fortune.

In all the years of my factory management I never had any trouble with unions. We had our differences, the walking delegate and I, but with a little "you tickle me and I will tickle you" we would part the best of friends. Judging from what I have been told by men who had been taught under the old system, (I heard this from journeymen with whom I worked when I was an apprentice) the manufacturer in the old days was a positive slave-driver. The effort of the bosses then was to get the boys to live with them, and it is a generally accepted fact that the treatment received by the boy apprentice was as a rule not the kindliest, but far removed from it. Of course there were exceptions, as there were in the days of slavery.

No; there was no talk of unions then, further than that one would occasionally hear that a union was to be started; but this was because the world generally, and the States in particular, had not yet made the progress in the social evolution which is gradually proceeding, and in which the American boy is going to be a great factor. I do not belong, and I never have belonged, to any union. Labor and capital will go hand-and-hand when the millennium is established. The workman in the average is not intelligent, but he is becoming more and more so. I believe the workman thinks he is the only tax payer—but so does the boss. If the New England Machinist can really convince the corporations that they have inflated values, he should be equally able to convince the average workman that his estimate of himself is far in excess of his actual worth.

The New England Machinist ought to be thankful to think that his boys desired to be draftsmen, engineers, and dentists rather than simple machinists, leaving this work for the sons of the foreigners who are now taking their places in the shops—these coming sons of foreigners who will some day be proud American mechanics.

It seems to me it was a mistake for the boy not to take the position offered him at $1.40 per day, for this appears to have been his opportunity to show the people what was in him; very possibly before a year had passed his salary would have reached a much higher figure. I think, however, all will agree that he is better off as a dentist, for no doubt he will soon be able to start his own business, while as a machinist he might never have done so.

The manufacturers do, indeed, employ the best legal talent, but not always, and some of the lawyers in the service of the unions are just as able. The New England Machinist says: "The laborer is sure of nothing;" he never was, outside of his industry. Again he says, "the mechanic can not water his stock." Well, I have engaged many a one who had watered his stock to such an extent that the excessive valuation was many times greater than his actual worth.

Now for Mr. McGahey and the spoiled boy. I must honestly say that throughout New York, New Jersey, and Pennsylvania I see no difference at all. In fact I think the boys are brighter, and it seems to me that we boys in our time gave our bosses more trouble than ever the boys gave me. In my many years' experience as factory executive I have had no trouble with my boys as regards union cards, and I am sure that many large concerns, like Baldwins of Philadelphia for instance, have no such trouble with their host of youngsters. I know when I was an apprentice at Tiffany's I hustled out a lot of work and one of the men objected saying: "There are others who want some work;" so this is an old failing and did not find life first in unionism. I have noticed no change in the conduct of the young people and they seem to me as well behaved today as they ever were in my youth. Every young man who shows ability receives recognition—if not in one shop then in another; the young people know this and why should they not move? I do not believe it would benefit any one if we asked all men to carry certificates as to where they worked previously. This is additional red tape, heavy to bear and of no good. When I want men I advertise and then pick out those I think will suit. I don't care whether they are union men or not; if they are capable and industrious they remain— if not, they go out.

Our scarcity of American mechanics, in my opinion, is due only to the fact that the American youngster of the second generation desires to go higher up. He does not want to be a machinist, humble and passive, keeping his head bowed down over his bench from 7 o'clock in the morning until 6 o'clock at night. Can you blame him?

I have found that most American apprentices are from the country. City boys are full of ambition for other things than factory life, and I think their efforts as a rule are crowned by their success in becoming engaged in pursuits which offer greater independence and larger earning capacity.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

III. THE STRENGTH AND WEAKNESS OF EXISTING SYSTEMS OF ORGANIZATION.

The two instalments of Mr. Emerson's series already published, in our issues for July and August, dealt with, respectively, typical inefficiencies and their significance, and the tendencies and influence of national efficiencies. In the part now presented he illustrates strikingly the differences between line and staff systems of organization, the limitations of each and the possibility of effective combination of the two, and applies the principles dominating the most efficient organizations, natural or artificial, from which he draws his illustrations, to the practical problems connected with the operation of an industrial concern. Next month Mr. Emerson will discuss the averages attained in standard practice, and in November, the methods of establishing standards for the introduction of the efficiency system as a basis for operation and wages.—The Editors.

IT is notorious that great aggregations of wealth and power usually do not operate as efficiently as smaller concerns. The various operations of a railroad or of a manufacturing concern are performed far less economically and efficiently than similar operations in smaller and more compact industrial organizations. Also nothing is so gigantically inefficient in view of its power and opportunities as such an organization as the United States Government. In what it does, it cannot compare relatively with the comfort, security and hygienic conditions supplied by a large, modern American office building.

The ten-million-dollar and upwards company ought to be able to supplement every dollar-a-day worker with a $200,000 a year staff of assistants, thereby making the worker four times as effective and gaining a crushing advantage over the smaller concern which cannot afford the same aggregation of specialized knowledge. The great concerns, however, have conspicuously failed to develop this advantage even if they do have a large staff of experts, a very different thing from a staff organization which gives the least worker the needed direction, stimulus and advice. A $200,000 staff for a dollar-a-day man is neither utopian nor expensive. On the contrary it is to the highest degree economical, if almost infinitesimal attention from a very high priced man will make, as to his specialty, one thousand or twenty thousand low-priced men four times as effective.

To preserve the adult individual, Nature uses staff organization; to preserve the race, nature uses line organization. Both are necessary and they may operate separately, they may alternate, they may work in parallel; but always and everywhere it is one or the other or a blending of both. Man, the individual, is fitted out with a number of aids, each far superior to him, each knowing what to do and how to do it, knowing how to respond to his every call to the extent of its ability. His lungs, his heart, his stomach, his nervous system, how instantaneously they come to his rescue in an emergency! On the other hand a father is succeeded in time by his son, one generation gives way to another, "the king is dead, long live the king!" This is line organization.

The strength of line organization lies in its indestructibility. A company cannot be destroyed as long as two men are left. The captain is succeeded by the lieutenant, and if this one falls, a petty officer takes command. There is always some one in authority. The weakness of line organization is that no one man knows much more than any other, that promotion is by seniority and not by merit. If a company loses its way in the woods it is all lost together. The captain has no special knowledge to meet the emergency. The weakness of staff organization is that if one member of the staff collapses, the whole organization goes to pieces, as when the heart stops beating or the lungs fail to find air. The strength of staff organization lies in its ability to multiply many fold the effectiveness of other staff members, all co-operating to make possible such a wonderful thing as a man, a humming bird, a midge or a yellow-fever microbe.

Organization may be conscious or unconscious. The authority in charge, whether individual or intangible, whether one or many, may know how to do the work or may not know how to do it. In the first case performance may be delegated to subordinates; in the second case it must be, if the work is to be well done, the actual worker, as far as the work is concerned, being a subordinated superior. The most perfectly organized entity in the universe is the living thing. There is an unconscious, unseen authority over it, not in the theological sense, but in the instincts with which it is endowed.

Passing from the single body to a community or family, we find similar organization, a central authority supported and supplemented by special staffs. Isms fail—individualism, communism, socialism, despotism—not because there is not serviceable value in each, but because form of organization counts for more than theoretical ism, and the highest organization relies on and utilizes all. Institutions have evolved from the primitive family and tribal life of birds and mammals, and birds and mammals, notably man, have evolved, molded by forms of organization.

There is always line and staff in organic nature. Line organization developed in its specially human form not in the family or tribe, but when men gathered in bands, generally for mischief or damage either to animals or to others of their own kind. The experienced hunter led a band on a hunting expedition or the fisher led a company to fish. As the hunters developed into maurauders, as the fishermen developed into buccaneers there was pure line organization and very little, if any, staff. The hunter and war captain had himself been hunter and warrior, the captain of the boat had been fisher and fighter. Because he was older and stronger or more experienced he commanded other men, none of whom knew more than he did. When the medicine man or priest accepted a disciple there was even less chance for staff, since the adept knew far more than the neophyte. Thus all through the development of army, or navy, or church, we find line organization, whose unit is the company, headed by a captain. This kind of organization is at the opposite extreme from pure staff organization found in the living body, and it is also distinct from the mixed line and staff found in primitive family life. The shops and schools adopted line organization almost without modification. There was indeed subdivision of labor, since all foremen did not direct similar activities nor all teachers teach the same branches, but these differentiations were not into staff functions.

Some modern organizations of tremendous strength are those in which staff alternates with line, as in a base-ball team. The ins play in line organization, all subject to the captain, each passing through exactly the same round, since a part of the play, as to its entirety, is handled by each. The outs, also subject to the captain, play distinctly in staff organization, the pitcher, singly, doing all the pitching against each of the ins, the catcher, singly, doing all the catching against each of the ins. The whole inning is played by each. It is because the staff specialists, the pitcher, the catcher, etc., are superior to the average skill of the ins and combine against each one separately that in the best games there is no score.

In all organizations line and staff have their place. Organization has always been a means to an end, and it has therefore always been an evolution rather than a creation, generally lagging behind requirements. Long after the time when staff should have come to the rescue of line, line traditions and line prejudices have continued to prevail, each line officer trying to create a staff of his own. In the navy a strong staff has by a process of compulsion been added to the line. Supreme as he was, no sea captain quite dared to claim that he knew all about furnaces and boilers, engines and propellers, refrigerating and illuminating accessories, so there have been developed in marine organization very strong staffs. There was not the same compulsion in the army. It is von Moltke's greatest claim to fame that he perceived the deficiency of line organization in the army and supplemented it with the general staff which made the Prussian army the marvelously supreme organization it became shortly after 1860. The theory of a general staff is that each topic that may be of use to an army shall be studied to perfection by a separate specialist and that the combined wisdom of these specialists shall emanate from a supreme staff. The specialist knows more about his one subject than all the rest of the army put together, but the whole army is to profit by his knowledge. One man may be the authority on military maps, another on balloons, another on roads and road making, another on sanitation, another on explosives or rapid-fire guns, an ever widening list Nothing is to be left to chance, or to individual ignorance or brilliancy. The North Germans were not more courageous, not better individual fighters than the South Germans, the Austrians, the Hungarians or the French. Napoleon in 1806 had had no difficulty in defeating the military organization of Prussia, inherited from Frederick the Great, and it took nearly ten years of European coalition, all of Russia, all of Austria, all of Germany, all of Great Britain, to overthrow the French. The Prussian army in the decade 1860-70 became what it was, not on account of men or arms, but through the supreme genius of one man whose creation, the general staff, used the line organization as one of the means or implements to the all-important end. If a man has special military aptitudes, special genius, the staff is the place for its opportunity and development. In the line special genius only makes trouble. Grant deprived General Butler of his command because Butler did not know how to obey. Nominally, under von Moltke's plan, the line remained supreme, the highest command being vested in the King of Prussia, though he was merely the spokesman for staff plans, even as in England the monarchical line is supreme with its personal staff of earl marshals, etc., yet all the real power lies with the cabinet, a staff organization. It was owing to staff knowledge and staff plans that in 1866, the Prussian army, two weeks after the outbreak of hostilities, overthrew the combined armies of Austria and of South

Germany. It was owing to staff organization that the united German army of 1870 decided the war against France, declared July 14, at Sedan on September 2. The French plans for mobilization required 19 days but von Moltke's plan for German mobilization required 18 days, and it was strictly carried out in neither more nor less days than the 18. The French mobilization took 21 days and this delay placed the seat of war in France instead of along the frontier or in Germany. French officers were not even provided with maps of French territory. The French plan of campaign failed before it was even tried, because of the fatal three-days' delay. On August 6, only 23 days after the outbreak of hostilities, one of the bloodiest battles of the war occurred.

Napoleon I was a marvelous genius, but, working through line organization against line organization, he had to get rid of all his rivals, make himself ruler, dictator, emperor, before he could carry out his plans. Von Moltke left the line undisturbed, gathered his eminent military contemporaries into the general staff with him, and through the staff gave his king, the head of the line, an organization before which all the military power of Europe crumbled. It was King William's great merit that he had the good sense to listen to the staff advice of such specialists as von Moltke for war, Bismarck for diplomacy. The Japanese, seeking the best there was in western organization, adopted and perfected in their army the Prussian staff system. At the relief of Pekin they proved themselves in all staff matters superior to any of the allies, the Germans included. Their maps, their Red Cross, their commissariat, their discipline, their humanity were all better. Before and during the war with Russia it was Japanese staff knowledge and staff skill even more than the high ideals and bravery of the individual soldiers and sailors that brought about the final victory.

Yet even von Moltke's marvelous combination of old line and modern staff could not be adapted without change to railroad or manufacturing activities. Its deficiency lies in the fact that the members of the line, who are many, are excluded from intimate relations with the staff, which is numerically so weak. When the line is supreme there is a great deficiency of special knowledge. When the staff is supreme there is a great deficiency of personal fructifying experience. In last analysis the man in the line, the man down at the bottom of the line, meets the difficulties, and he is the one who most needs staff assistance for his special case. He is the one who should be able to call on the very highest special talent to solve his $0.10

difficulty. He finds this assistance outside of his daily work far more than within its limits. If, for instance, in New York city he wishes to transport himself from the north end of the city to the south end, he offers a five-cent piece and finds at his disposal a fifty-million-dollar subway. In his daily work, however, there is no assistance. For his bread and butter task, which alone makes him of value to others, there is no assistance of this kind.

What is needed in organization is complete parallelism between line and staff, so that every member of the line can at any time have the benefit of staff knowledge and staff assistance. This kind of organization does not exist in perfected form to-day. Modern organizations are defective because they individualize instead of generalize their staffs. The president of a railroad or of a manufacturing plant apportions duties among several vice-presidents, each one of whom takes up a line of duties. This is necessary, but in the old days in the palace of Pharaoh it is not stated that the chief butler organized a staff with a head baker or that the chief baker organized a staff with a head butler. Each vice-president of course requires a staff of his own for his special line of duties, but there are general needs which are the very fundamentals of strong organization and these needs should be under general staff officers, all of whose aggregated wisdom should be available to guide, not only the president and the vice-presidents, but also each subordinate official down to the lowest man in the line. Because there is no general staff of this kind each official down to the worker attempts, more or less awkwardly, to create his own general, as well as his particular, staff. There is specialization of line activity, which is always advantageous, but there is also multiplicity of different kinds of general control, which is wholly bad. Imagine an army to which each soldier came with his own individual rifle and ammunition and kit, in which each captain had his own system of tactics, in which each general had his own special plan of campaign! Yet this is virtually the condition of railroad and manufacturing-plant organization to-day. Much of the time and energy of each official is taken up with keeping in order and adjusting to the whole his unregulated staff activities and eccentricities. One of the defects of this kind of organization is that the staffs of the different officials are not correlated. It makes no difference whether the head of a company is an individual or a commission, the organization is that of the line, the old military line, which at best has progressed as far as monarchy with a monarch's staff.

With full understanding of the strength of line organization, of staff organization, and of their mutual advantage to each other, and with a general comprehension of what both have accomplished in the past, it becomes possible to devise and outline a modern line and staff organization suited to the largest industrial concerns. The task would be hopeless if it were necessary to displace or even to modify existing line organization, since scarcely anything is as tenacious of life as institutions. But happily this is not necessary. Von Moltke added staff to line without a jar. A perfect staff could be added to modern line and be self-supporting from its inception without a jar.

A modern company, whether railroad or industrial, is organized for a specific purpose which is secured by an interplay of men, machines, materials and methods. The specific purpose is the end in view, but the interplay is the all important means. Whatever the vice-president's department, he has men, equipment, supplies and conditions to deal with. Whatever the manager's duties, he also has men equipment, materials and conditions to adjust to one another. Whatever the superintendent's duties he also is confronted with the same general problems as to men, machines or locomotives, materials and methods. The foreman meets the same problems of men, materials, machines and methods, and even the individual worker has also his problems of man, of machine, of materials and of methods. It is evident that the most philosophic way to meet general and universal problems is by general and universal solution. That is the solution offered by Nature. We have hands, feet, a head and various other bodily parts, each doing various work, but there is only one heart, one set of lungs, one stomach, one telephone system, each doing specific work. The general problems, therefore, appertaining to men, to materials, to machines or equipment and to methods or conditions, can be initially divided into four groups. All four groups, which more or less interweave, should come under one chief of staff. Under him should be various heads of staff. The subdivisions of the staff depend on the particular business, but a general scheme, modified to meet special conditions, would be that of the four groups mentioned.

As to Men.

1.—A head of staff to plan, direct and advise as to everything appertaining to the well-being of the employees. This is in itself a very extensive and important department of staff activity. Men should not be able to connect themselves with a company except after examination as to their moral, physical and professional fitness. Everybody knows that one quality of steel will cut four or five times faster than some other quality, and a modern tool is selected not because it has the shape of a drill but because it is of a composition that can be made into a good drill or into any other good tool. Men are still selected not on account of qualities that would make them good in any particular direction, but because at the moment they call themselves this or that. Having entered the service of a company with difficulty, it ought to be a catastrophe for a man to leave it, because, while with it, so much appertaining to his physical, financial and professional welfare was provided, so much he could not by any possibility provide for himself.

The line organization of a staff head in charge of welfare would extend down to where it was available with its advice and help to the humblest worker. There is no reason, for instance, why a watchman, whose business it is to look for bad conditions, should not combine the duties of a watchman with those of welfare work and advice. He would meet special cases that would otherwise escape observation and report, and carry them up to his staff superiors, but he would also have been instructed by his staff superiors and given standards by them as to all usual conditions, so that he would have at his fingers' ends standards for the use of the workers, standards evolved by specialists of the highest rank.

As to Equipment.

2.—A head of staff to plan, direct and advise as to everything appertaining to the adjustment of structures, machines, tools and other equipment to the work in hand. There is very little difference between good handling of equipment and good handling of men. The rules that apply to the one case will generally apply to the other. Much has been learned about the proper care of men from methods evolved for the care of equipment, and much has to be learned about the care of equipment from methods evolved for the guidance of men. It is not to be forgotten that in the human organism the whole is incapacitated by a seemingly slight injury to a single part. No man will work efficiently with a cinder in his eye, or a splinter under his nail. Neither will a plant work efficiently if little things go wrong. Single items of equipment are often of very great perfection, whether a Corliss engine or a twist drill, but from twist drill to general design and equipment of plant everything is usually wholly out of relation and balance. Recently, in consequence of staff organization, it was found necessary to relocate over three-quarters of all the machines in two large and fairly modern plants. Each machine had been doing good work by itself and no one looked further, but the moment its relation to other machines or to the progress of the work was investigated, the conditions at once appeared impossible and unbearable. It is expected that this relocation of machines, together with other staff reforms, will result in an increase of output of 40 per cent. without additional men or equipment. The high officials of every railroad point out the glaring defects of early location or equipment—the fact, for instance, that out of 600 locomotives there were 550 different types, instead of 6. The earlier builders had no staff advice.

This staff line in charge of the use of equipment also extends down until it is within reach of the worker. An example will show both the nature and the effects of staff organization. A staff was organized on a transcontinental railroad to advise generally as to the care and operation of shop machinery and tools. The duties of the staff, which extended from the vice-president's office downwards, were:

a. To secure suitable machines and equipment;

b. To give them the best possible care; and

c. To give the workers advice and directions as to how to use the equipment most efficiently.

The expense of maintaining shop machinery and tools, on this railroad for the year 1903-4 was $487,171; the unit cost in relation to output was $10.31. On a competing and largely parallel railroad, working under similar conditions, the cost in the same year was $487,150, and the unit cost, $9.55. As a result of staff activity and control on the first road, by the year 1906-7 total costs had fallen to $315,844, and unit costs to $4.89, but on the other road, where line organization was not supplemented by staff organization, the total costs rose to $638,193, unit costs remaining virtually constant at $9.81. This saving in expenses of $322,000 was brought about by a staff costing less than $10,000 and the $10,000 is included in the $315,844.

One subdivision of this maintenance problem was the care of belting. This had cost (for maintenance and renewals) at one of the main shops about $12,000 a year, and it was so poorly installed and supervised that there was an average of twelve breakdowns every working day, each involving more or less disorganization of the plant in its parts or as a whole. With the authority of the vice-president and in conjunction with the general purchasing agent, the whole subject of belting was taken up. A few general rules were laid down:

a. That the quality of the belts should be the best obtainable;

b. That the installation and care of belting should be put under the care of one competent man; and

c. That he should so maintain belts as to prevent breakdowns. The worker in actual charge of belts, a promoted day laborer, was given standards, took his directions from a special staff foreman, only one of whose duties was knowledge as to belts. The foreman had received his knowledge and ideals from the general chief of staff, who had made belts a special study, and this general chief of staff was in the first place inspired and directed by a man who had made a nine-years' special study of belts and who was the greatest authority in the world on the subject. The belt foreman had as much of this knowledge at his call as he desired to absorb, but he in turn was in immediate contact with each individual belt, with the machine it was on and with the worker using the machine. The chief of staff learned as much from the belt foreman as the belt foreman learned from the chief of staff. The cost of maintaining belts fell from $1,000 a month to $300 a month, the number of breakdowns declined from twelve each working day to an average of two a day, not one of them serious, and even the few breakdowns were due almost wholly to defective installations, such as narrow pulleys, which it was impossible to remedy without unjustifiable expense.

As to Materials.

3.—A head of staff as to materials, their purchase, custody, issue and handling. Subsidiary materials are only too often purchased on the basis of price per pound rather than on basis of cost per unit. This is inevitable, since no one is able to give the purchasing agent any standard as to cost per unit. After materials are purchased they are frequently given such poor custody that they deteriorate or disappear before being used. They are still more often issued for extravagant and wasteful use. The economical handling of materials is a special art. In a large steel plant, staff control of handling material reduced the cost of handling per ton from $0.072 to $0.033, and increased the number of tons handled per man per day from 16 to 57. Here again was the same kind of staff organization, calling down from the top all the most valuable knowledge in the world as to this one subject, working up from the bottom from actual daily contact with changing conditions.

As to Methods and Conditions.

4.—A staff head as to conditions and methods, including standards, records and accounting. It has been found practically impossible either to maintain standards or records unless they are tied into the accounting. This is because there are standards as to money entries and none as to times or performances. This does not imply that records or standards shall be an outgrowth of accounting. Either is quite as important as accounting, and if a choice had to be made between good accounting coupled with bad practice and good practice coupled with bad accounting, most practical men would choose good practice. It is because at the present time good accounting is unrelated to good practice that extensive accounting is viewed with such extreme disfavor by the practical man. Standards are wholly distinct from accounting, records are wholly distinct from accounting, but all three gain greatly when tied in together. It is virtually impossible to maintain records unless there are standards of performance, but these can never be evolved from either records or accounting. The determination and establishment of standards is a peculiar art, yet one of fundamental importance, for, without a sea level from which to start there is no measuring of mountains or of absolute heights. Railroads and industrial plants have systems of accounting based on the same general plan, but their records are not similar, so that it is difficult, if not impossible, to compare performances on one railroad with those on another railroad. There are certain records at the top, there is occasionally a certain semblance of a record at the bottom, but between the bottom record, on which, after all, everything rests, and the top record which is supposed to reveal the condition of the company, everything is vague and disconnected. It is astonishing, almost pathetic, that presidents' reports and Wall Street publications solemnly print costs per locomotive mile or cost of fuel per 1,000 ton miles when the initial records out of which the final reports are built up are wholly unreliable.

With a staff specialist on records, with record specialists under him reaching down into intimate, hourly and departmental touch with the worker, every gang boss, every worker could confide to him his desires and his needs. A good record may increase the output of a machinist quite as effectively as a good belt or tool, as good material, and when the worker needs help of this kind he should have it at hand. The writer knew a worker on time allowance for every job. The company was satisfied with 100 per cent. efficiency, but this particular worker had set himself a standard of 120 per cent., his earnings depending on his monthly efficiency. To attain this he could not afford to lose track as to any single day; he had to know, in fact, how he stood as to every job during the day. He therefore needed a record of both his standard and actual time. An ambition of this kind is of extreme value to the company, not only because it decreases the cost and increases the output and reliability of the man, but because of its effect on all the other workers. This man made out his own records, on awkward and unsuitable blanks, and they were kept in such a way as not to fit in with or be of any value to the general scheme. Here was a case where the desire of the worker could well have been assisted by the skill of the specialist, each learning much from the other and together evolving a form of record of universal, optional use. Had any question come up beyond the skill or the authority of the local record man, he could have taken it up with his superiors until it had met and been solved by the grade of talent required.

Standards of performance are not less of a general character than records. In railroad operation the only work which is accomplished in a definite predetermined time is the running of the passenger trains. The Pennsylvania Railroad, for instance, reports that it ran its 18-hour train from New York to Chicago 312 days out of 366 exactly on time, an arrival efficiency of 85.24 per cent. In April the Chicago train arrived in New York 28 days out of 30, or 93.33 per cent. on time, being on one of the two days only 1 minute late. Probably this train runs with a time accuracy of 99.9 per cent. if one should add up all the standard time minutes in the year and divide by the actual time taken. Perhaps the Pennsylvania Railroad keeps similar efficiency check on other passenger trains, but how about all its other items of expense incurred for either material or time? Do they also show 99 per cent. efficiency or would they show about 60 per cent. efficiency? If standards were established, if records were kept, it would be possible soon to attain almost automatically the same high efficiency as is now shown in the 18-hour train. It has cost money, a great deal of money, to run the 18-hour train as efficiently as it runs. It would save money, a great deal of money, to run other operations on a 100 per cent. schedule.

Both accounting and records are very greatly simplified when connected up with standards. When the housewife buys a pound of tea or of meat she hands over the money and she receives in return a definite and agreed-upon equivalent in weight. This is exactly what the railroad company or the manufacturing concern does not do when it pays for services. The company does not even know what it ought to receive as service in return for the money paid, and so it accepts, not what it ought to receive, but what the payee gives, generally much less than it is entitled to.

The result of perfected staff organization is that everything is well and quickly done when and where wanted, that all costs are predetermined, that the responsibility for any deviation is immediately located, that the heads of both line and staff can direct far better than they are now able to, that costs of performance decrease, and that output from the same equipment and men increases. The staff is to the line what the good road is to the automobile. Without it neither speed nor smooth running nor economy is attainable.

Editorial Comment

Who Pays the Freight?

IN a plausible little "Freight Rate Primer" circulated in support of the railways' argument for a 10 per-cent increase of rates, the effect of such advance is made to appear insignificant, so far as the shipper or the consignee may be concerned, by the method of assuming figures for a single unit of product. In the case of a $50 dining-room suite shipped from Grand Rapids to Chicago, for instance, the additional cost imposed by the higher rate appears to be 16 cents. On a reaper shipped from Chicago to a point 100 miles west of the Mississippi, it is stated, it would be 17½ cents. The thinly disguised fallacy of this demonstration, apart from the special distances and conditions assumed, is that it regards but one of the very great number of movements of material which must take place between the ore in the ground and the timber on the stump, and the delivery of the finished work to the user. Every pound of steel, every foot of lumber, every gallon of paint, every nail and bolt, every machine on which the materials are worked, every ton of coal burned in mills and factories, will have paid their tribute—some of them again and again, as they are moved from place to place in various stages of manufacture—before the furniture or the agricultural machinery can be placed on the cars at the assumed points of origin. This part of the influence of increased freight rates, far the largest part, and one which would be expressed in an increase of price at the point of shipment, the Primer overlooks. And we cannot finish the argument more forcibly than by quoting the very words of the eloquent plea for the railroads advanced by William C. Brown, senior vice-president of the New York Central:

"The whole fabric of freight rates, from the first shipment of raw material, is simply a transfer or carrying forward of freight charges, until it reaches the final purchaser or consumer, *and he pays the freight.* When the New York Central lines paid the various locomotive and car manufacturing companies approximately $31,000,000 for equipment and material furnished in the year 1907, the railroad paid every farthing of freight that had accrued on every pound of iron and steel from the time the first pick was struck into the ground that mined the ore; it paid the freight on every foot of lumber from the time the axe was struck into the tree from which the lumber was cut, and it paid the freight on every dollar's worth of provisions used and clothing worn by the employes of these companies and their families while working on this equipment."

This is as absolutely true of the housekeeper in Chicago or the farmer 100 miles west of the Mississippi as it is of the New York Central lines. An increase that will add half a billion dollars a year to the income of the railroads can not be made without effect upon the men who pay the freight, and the logic which makes this effect seemingly vanish is false. As well argue that reduction of wages would not be felt because, for an hour's time of a cheap man, it would amount to but a fraction of a cent.

Salvation for the Railways.

IT is most strange that in almost all the discussion of this vital question, attention has been focussed upon only two ways of forcing into parallel what Mr. Brown strikingly terms "the converging lines of cost and compensation in railroad operation." These two ways are paying less to employees, and exacting more for service performed. Little has been said of the third, and by far the greatest, way of remedying the case — the way which would be at once sought by a manufacturer paying standard wages and making standard goods in a competitive market, if he found his balance sheet evidencing similar trouble. This way is the systematic, thorough-going reduction of "costs of production" by the policies and methods that have been made familiar practice in industrial engineering. The opportunities for such betterment in railway operation are suggested in Harrington Emerson's article, in this issue, and were amplified by further instances in his interview recently published in the New York *Times*. Examples of an enlightened spirit and an active reform, such as are afforded by the Santa Fe, by their rarity and the brilliance of their results prove the generality of the rule and the vastness of the opportunity. The narrow income of railroads throughout the country is to a very great extent due to ignorance of, or indifference to, efficient methods of handling business and administering their property. They have wasted their substance by spendthrift ways, and now, finding their pockets empty, they wish to put their hands into the pockets of shippers or employees. If they secured an increase of gross income, they would promptly dissipate it. A spendthrift can not be cured by giving him money. The reform must be in the methods of handling the money he has. Higher economy — wholly feasible increase in efficiency—in railway management and operation has possibilities vastly greater than anything yet advanced in conferences between shippers and railway officials. It would probably mean increase in wages of employees. It might possibly mean reduction of freight rates. It would certainly mean that the "lines of cost and compensation" for the roads themselves would become divergent, instead of convergent; and the future of expansion and prosperity which such lines would embrace is incalculable.

A Nation of Spendthrifts.

IT needs a shock, and sometimes a severe one, to waken the prodigal to his folly in wasting his substance. Too often he comes to himself only after the substance is all gone. It may be so with us nationally, so far as concerns our forests and the water resources closely dependent upon them. The wiser example of our older brothers in Europe we hold in light esteem, and to the increasing warnings of flood waste and water famine we blind our eyes, and go on elsewhere with the same policy of destruction. But it is hopeful that public interest is centering on the questions of forest and water conservation, and even more hopeful that strong, organized interests may be enlisted on that side. The enormous importance of the question has perhaps never been better exhibited than in the group of articles by Mr. von Schon now appearing in this Magazine. To an able and authoritative demonstration of the practical results attainable, and an impressive exhibit of the quantities and unit costs involved, he adds proof of the absolute interdependence of the great propositions — forest conservation, water supply, flood prevention, power development, and navigation; and with all he offers constructive criticism in the form of a definite proposal for ready means of solution.

THE GEORGIAN BAY CANAL.

A SUMMARY OF THE OFFICIAL REPORT RECENTLY PRESENTED TO THE CANADIAN PARLIAMENT.

Engineering News.

THE first official report on the Georgian Bay Ship Canal project which, though first promoted as a private enterprise, has been under careful examination by the Canadian Government for a number of years, was presented to Parliament on July 6. It proposes a waterway at least 22 feet in depth for the "dam and lock" system of navigation, the whole being so designed as to enable boats 600 feet long, 60 feet wide, and 20 feet draft to pass from Lake Huron to Montreal, advantage being taken of the natural channels which can be made to form 80 per cent. of the distance. The report embodies the results of careful surveys and estimates made on this basis. The following details of the scheme are taken from a summary report which appeared in *Engineering News* for July 16.

"Of the 440 miles of projected navigation between the above-mentioned points, from 410 to 420 miles follow the course of some river or lake. For that part of the route from Georgian Bay to the Height of Land separating the Great sheds of the Ottawa River and the Great Lakes, a distance of 81 miles, the French and Pickerel rivers and Lake Nipissing are utilized. From Lake Nipissing through the Height of Land, for a distance of 3½ miles, the route is an artificial waterway, with the exception of a few small lakes through which it is located. This artificial cut leads into Trout Lake, the Little Mattawa River and Talon Lake, which is utilized as far as Sand Bay at its southern end, a distance altogether of 21 miles, Trout and Talon lakes referred to above being very deep and fairly large bodies of water.

"From Sand Bay there is a canal for 3 miles to the Mattawa River, which is utilized as far as the town of Mattawa, a distance of 13 miles, where another canal cut of ¾ mile in length makes an entrance into the Ottawa River. This river, which expends into large and deep lakes in many places, is followed all the way down to the foot of the Lake of Two Mountains, a distance of 293 miles.

"From the foot of the Lake of Two Mountains to Montreal, a distance of 25 miles, either the St. Lawrence River or the Ottawa River, called Rivière des Prairies, flowing north of the Island of Montreal, may be utilized. The former route is five miles of artificial waterway and the latter about eleven miles. By the first route the canal enters Montreal Harbor at its upper end. By the second route the St. Lawrence Ship Canal is joined at Bout de l'Ile, some eleven miles below the eastern boundary of Montreal Harbor, or seventeen miles below the city Custom House."

The distance from Fort William to Montreal by this route will be 934 miles, a saving of 282 miles over the Lake Erie and Welland Canal route, and 424 miles shorter than the distance to tide water at New York via. the Erie Canal. The distance from Fort William to Liverpool via the Georgian Bay Canal will be 4,123 miles, 806 miles shorter than by the New York route. It is estimated that the time of passage from Georgian Bay to Montreal will be 70 hours, 1 3/5 to 2 days shorter than the time of transit from the Great Lakes to an ocean port by any existing route. It is probable, however, that practically the same time could be made by the St. Lawrence route if the latter were improved to a depth of 22 feet, assuming that the number of locks would be greatly reduced thereby.

"The total length of what may be termed canal cutting for the entire route is about 28 miles, by the project connecting the St. Lawrence River above Montreal, through Lake St. Louis, and 34 miles should the Rivière des Prairies route be selected. The length of submerged channels to be excavated is about 60 miles in stretches of varying lengths. Apart from this there is an aggregate of 14¼ miles where obstructions such as shoals, sharp bends, etc., have only to be removed to form very wide channels. Therefore, of the 440 miles constituting the waterway, 108 miles will require excavation work for locks, approaches, canals, submerged channels, etc., leaving 332 miles of natural river or lake channels, which will not require any improvement beyond the raising of the water surface as recommended in connection with the project. Taking into account the 14½ miles of obstructions which, after removal, will leave wide, free channels, the route may be subdivided as follows, in relation to width:

	Miles.
Canal cuts, 200 to 300 feet wide, including necessary restrictions at locks	28
Improved channels, submerged sides, 300 feet wide	66
Free channels, 300 to 1,000 feet wide and over	346
Total	440

The relative length of canals and submerged channels may be varied slightly as it is an open question as to the exact point where the one ends and the other begins.

"The sides of all submerged cuts will be shown by piers or clusters of piles at suitable distances to indicate the channel, and to aid the vessels in navigating. Along curves these piers will be provided and each different course will be defined by ranges. The restricted channels are widened at all ends, and conditions for navigation in these restricted parts will be as good, it is expected, as on the St. Mary's River or the St. Clair and Detroit River channels. The depth of 22 feet selected for the waterway will more than equal the conditions as they exist to-day in the channels connecting the waters of the Great Lakes, the St. Mary's River, Hay Lake, St. Clair Flats Canal, and the Detroit River.

"The mileage of excavation in canals and channels for the route may be subdivided as follows for each class of material encountered:

"Dry Excavation — Rock, about 25 miles; earth, about 13 miles; mixed earth and rock, about 20 miles; total, about 58 miles.

"Wet Excavation — Rock, about 18 miles; earth, 16 miles; mixed earth and rock, 16 miles; total, 50 miles; grand total, 108 miles.

"This mileage includes all points which are to be dredged or excavated, whether canal cuts, submerged channels or shoals. A small percentage of the excavation given as submarine rock work might possibly be done in the dry, and the cost, therefore, reduced. In the estimates, when doubt existed, the rock excavation has been invariably classified as wet rock.

"The summit level embraces Lake Talon, the Little Mattawan River, Turtle and Trout Lakes, their present surfaces being raised to elevation 677. Talon Lake will be raised 41 feet and Trout and Turtle about 15 feet above their present level. The locks at both ends of the summit are designed to allow of the large lake thus created, being lowered to elevation 671, without interfering with navigation. In fact, besides affording a wide and unobstructed route for shipping in transit, the lake will have two important duties; to absorb part of the excess in floods and to store the reserves for the months of deficient water supply.

"From the careful hydraulic investigations made, the available supply from the summit watershed, with the storage provided, will be 540 cubic feet per second throughout the season of navigation, which will allow of an average of 24 passages per day or 5,040 passages for the navigation season, estimated to average 210 days per year. As the traffic develops, in the event of this supply being insufficient to meet the demand upon the summit, the supply can be augmented by 700 cubic feet per second by creating storage reserves at the head of the Amable du Fond River, and diverting it from the present outlet into the Summit Lake. This can be accomplished at an expenditure of $900,000. These two sources of supply will more than meet the requirements at the Summit, should the waterway ever be worked to its full commercial capacity.

"The difference in elevation of 659 feet between Montreal and the summit level, and of 99 feet between the summit and Georgian Bay is overcome by 27 locks ranging in lift from 5 to 50 feet. By the Rivière des Prairies route, however, this number is reduced to 26. All locks are designed to be built of concrete. Regarding their size, lake boats have attained a length of over 600 feet, and the minimum dimensions of lock chamber should not be less than 650 feet in length by 65 feet in width. The estimated cost of the locks is based on these dimensions, but in the final report the additional cost of building these locks 800 feet in length by 75 feet in width, should it be found desirable, will be given. In all cases the depth of water on the sills will be 22 feet at extreme low stage.

"The navigation scheme requires the building of 45 dams of various sizes, not including those which will be required in connection with the system of storage reservoirs. Generally, where the quantity of water is much above the canal requirements, the rock-filled type of dam has been adopted. Where, however, it is important to economize water for lockages, concrete dams have been designed. The estimated cost is based on these two kinds of dams and the stop log system of regulation of sluices has been adopted throughout, with the exception of a few locations where Stoney sluices are deemed necessary."

It is intended, in connection with the navigation project, to create large storage reservoirs to control the flood waters of the Ottawa River. These reservoirs will have an important effect on the development of water powers also. It is expected that the concentration of fall and other improvements will render possible the development of at least a million horse power along the Ottawa and French rivers. Under present conditions it is not likely that more than 150,000 horse power could be developed at minimum flow. A certain sum has been placed in the estimates to cover claims for damages to the power concessions already granted and the cost of permanently flooded ground.

"A careful analysis of the work to be performed, shows that it would take from three to five years to develop all contracts and place the whole route under active construction. Some of the sections where heavy submarine excavation is encountered would require at least five years to complete under the best conditions of labor and equipment. It may be fairly stated, therefore, that a period of ten years from inception would be necessary to open the waterway to navigation. This would mean an average expenditure of about ten million dollars per year.

"The cost of the canal is estimated at $99,689,000 if the route via Ste. Anne de Bellevue, Lake St. Louis and the St. Lawrence River is followed to Montreal. If, however, the other mouth of the Ottawa River known as Rivière des Prairies is followed, the cost is estimated at $93,890.000. In either case $900,000 will have to be spent for a feeder at the summit of the canal, when this is required.

"The land damages are partly covered by the estimate and partly by contingencies. In most cases of undeveloped water powers it has been assumed that owners could be compensated by being granted power privileges at the nearest dam. The cost of damages cannot, however, be well defined. In ten years from now it is likely that the damages to pay would be much larger, as conditions on the river would be much more involved. This amount cannot be well foreseen. It might be larger than estimated by one or two millions, according to conditions at the time of construction and the legal view taken of some of the claims.

"The geology of the lower 200 miles of the Ottawa River creates seven main steps, at each one of which one or more locks are required. The estimated cost of the Montreal reach from the Custom House to Verdun is $3,859,000, including the lock at Montreal costing $1,090,700. The Lake St. Louis reach from Verdun to Ste. Anne's, a distance of 19 miles, is estimated at $12,553,000, of which $1,093,000 is set down at Verdun to gain the level of Laké St. Louis. The impounded basin from Point St. Charles westward afford an upper harbor five miles in length. The western part of Montreal above Victoria Bridge would be protected from high water by the Verdun dyke. The new lock would have to be built at Ste. Anne, costing $784,800. The cost of the section from Ste. Anne to Port Fortune, 25 miles, is estimated at $2,334,000. Locks at Port Fortune and Hawkesbury furnish the means of rising over the Vaudreuil ridge from Oka Lake to the long reach below Ottawa, a distance of 60 miles. The ten-mile stretch past the Long Sault Rapids would cost with the locks $3,860,880."

BRIDGE ERECTION BY THE END-LAUNCHING METHOD.

A DESCRIPTION OF THE ERECTION OF THE FRENCH RIVER BRIDGE BY THE LITTLE USED PROTRUSION METHOD.

C. N. Monsarrat—Canadian Society of Civil Engineers.

THE little used protrusion method of bridge erection was employed by the Canadian Pacific Railway during the past year in the construction of a single-track span, 412 feet 8 inches long, over the French River, at a point where the depth of water prohibited the erection of false work. As this is one of the longest spans ever erected in this way, the following details of the method employed, taken from a paper read by Mr. C. N. Monsarrat before the Canadian Society of Civil Engineers on April 16, will be found of great interest.

"On account of the great depth of water, it was not possible to build falsework and erect the span in its proper place, so after due consideration of several possible schemes of erection it was decided to erect the span on the north approach embankment, on the centre line of the bridge (produced) and launch it forward by supporting the forward end on a large scow, and sliding the rear or north end on a skidway of greased rails. The embankment immediately north of the north abutment was a new fill consisting mainly of boulders, coarse gravel and sand, with a maximum height of about 25 feet against the abutment, running out to the natural surface of the ground about 100 feet north. The width of the embankment at subgrade was 16 feet, and in order to provide a proper bearing for the skidway, it had to be widened to 26 feet. On this specially prepared roadbed two parallel skidways, about 316 feet long, were built, 10 feet center to center, each consisting of railway ties about 15 inches on centers, with a 12 by 12-inch timber, 16 feet long, every 10 feet to tie the two skidways together. On these ties were laid five lines of 12 by 12-inch longitudinal timbers, over which was laid a flooring of 3 by 12-inch planks, supporting seven lines of 80-pound rails, laid with joints staggered and securely spiked and bolted together.

"The steel work was accordingly erected on the embankment, using a specially designed traveler consisting of two 60-feet boom derricks of ten tons capacity each, mounted upon a timber framework designed to travel on rails gauged 14 feet centers, the platform of the traveler being placed 12 feet 7 inches above top of rail so that lorry cars loaded with bridge material could readily pass underneath on standard gauge railway track and the material be picked up by the traveler booms. Each of the 60-feet boom derricks was handled by separate double-drum engines placed at the rear end of the traveler and forming part of the 20 tons of counterweight on each side required to provide for the uplift due to loading the boom derricks. The assembling of the span on the embankment was, in itself, quite a difficult operation, on account of the large size of the members to be handled, some of them weighing as much as 40 tons. Before any work was started, the order in which each member was to be erected was fixed and clearly shown on the erection diagram. In order to permit of supporting the forward end of the span by the scow, it was necessary to erect it with its south end projecting over the water about 103 feet. The bottom chord and floor systems, excepting that portion overhanging the water, were first placed in position by means of a self-propelling derrick car, ties were then laid for temporary track on the steel stringers, and the traveler erected with which the balance of the span was assembled.

"In order to place the scow at the proper elevation under the projecting end of the large span, it was necessary to depress it about 4 feet by pumping in water. As this water ballast would render the scow unstable transversely until it took a bearing under the 415-foot span, it was necessary to use a small balancing scow, which was placed at the north side of the large scow and secured to the latter and the stiffening span, by means of diagonal and horizontal struts, and was equipped with counterweight and adjusting screws to provide for any raising or lowering of the large scow. The general dimensions of the large scow, referred to, which was built at the site, were: Length, 155 feet; 33 feet beam, and 12 feet deep; made in two sections for convenience in launching. It was built of 12 by 12-inch timbers for the ends; bulkheads and intermediate frames, 6 by 12 inch sheathing on the sides, 4 by 12 inch for the bottom, with joints staggered and secured to the framing with ⅝ by 12-inch lag screws. The bulkheads were spaced 22 feet 1 inch center to center to conform with the panel points of the 150-foot through riveted truss span, which was erected on the scow as a supporting span, each panel point being blocked on a cross bulkhead. All seams in the sheeting, up to about 2 feet above load water line, were calked with oakum.

"On the completion of the assembling of the large span, the traveler was taken down, the ties used as temporary floor removed, and all field connections excepting end portals and sway bracing, were riveted before launching was started. The ⅞-inch field rivets, of which there were approximately 60,000, were driven by means of pneumatic riveting hammers, a compressed air plant having been installed for the purpose.

"The scow was equipped with boiler and double-drum hoisting engine, as well as a centrifugal pump with 8-inch suction and 6-inch discharge pipes, and a sluice arrangement located over the double bulkhead forming the ends of the two component parts of the scow by which the water pumped in could be controlled and directed into either half of the scow. Each intermediate bulkhead had an 8 by 8-inch hole near the bottom so as to equalize the water in each compartment.

The load from the south end of the 415-foot span, and the 150-foot stiffening truss supported by the scow, was about 1,000 tons. The load from the north end of the span, amounting to about 640 tons, was transmitted to the skidway through two large fixed end cast-iron shoes (used temporarily for the purpose), placed 10 feet center to center, under the end floor beam, which had been designed with a special view to such use. This arrangement of the castings left a clear space under the truss bearings for landing of the span on oak blocking over the bridge seats preparatory to its being jacked down to its bearings. The oak blocking was required for the temporary support of the span at an elevation about 8 feet 5¼ inches higher than its final position, this height being necessary to permit the skidway to pass over the parapet wall of the abutment. Between the aforementioned cast-iron shoes and the skidway rails was placed a ⅞-inch steel plate, large enough to include both castings, with strips riveted to its under side to form guides to engage the rails on the skidway.

"When the scow was in position under the overhanging end of the main span, in front of the north abutment and transverse to the center line of the bridge, two guide anchors were located on the opposite shore at an angle of 45 degrees. Holes were drilled in the rock and 3½-inch steel bars were grouted in a vertical position. To each of these anchors was secured a two-sheave steel block carrying four lines of ⅝-inch wire cable, forming the forward guy lines which were wound up simultaneously on the drums of the hoisting engine on the scow, as the span moved forward, steadying the floating end from any effect of wind or current.

"The tackle used to haul the 415-foot span into position consisted of two specially-constructed steel pulley blocks, having 14 sheaves each, through which was reeved a ⅝-inch diameter steel wire cable 1,000 feet long, with a fall line leading back to the drum of a hoisting engine located on the land at the north end of the skidway. This engine was a 32 horse-power double-drum hoisting engine, with two cylinders 8 by 12 inches, boiler 41 inches in diameter by 108 inches high, and capable of pulling 8,000 pounds on a single line.

"One of the large blocks was secured to the skidding plate under the castings, and the other to the rear end of a string of bottom laterals—belonging to a 250-foot through span designed for the crossing of the Pickerel River, a short distance south of the French—consisting of two angles 6 by 4 by ½ inch each, used as pulling links. These were in turn secured by a pin to a box girder supported by struts in front of the north abutment. Each section of these laterals was about 30 feet long, and when the two large blocks were brought together one or two sets of lateral links were removed and the blocks overhauled. When the last section was reached it was removed, and the forward block secured by the pin direct to the box girder.

"When everything was in readiness, on the evening of October 27, 1907, the scow was pumped out by means of the centrifugal pump, until the span was raised off the blocking. When this occurred it was found that there still remained a foot of water in the scow, showing that an ample margin of buoyancy had been allowed. At 8 a. m. on the 28th, the engine was started, and with the assistance of a slight shove from two 40-ton hydraulic jacks, the large span started on its way, moving on the well greased skidding rails at the rate of 4 to 6 feet per minute. Considerable time was lost owing to the inability of the small boiler of the hoisting engine to keep up sufficient steam pressure and also in the overhauling of the very heavy tackle.

"The actual time occupied in moving the span was 3 hours, and in overhauling tackle, etc., 4 hours. The span was landed on its blocking at 4:05 p. m., without a hitch of any kind.

"Trouble had been anticipated with settlement of the skidway on the new dump in view of the 640-ton concentrated moving load passing over it, but in no case was the settlement over six inches, and it was uniform at both sides, the greatest variation of the span from the level being about ⅛ inch in its width. So smoothly did the span move that it was possible to set it in its final location with the engine alone, without the assistance of jacks, and by means of the steering control afforded by the forward guy lines the span was within ¾ inch of its proper alinement when landed on the main pier on the south side of the river.

"The lowering of the span to its final bearings on the bridge seats was accomplished by means of two specially-constructed 500-ton hydraulic jacks. After the span was landed on the wooden blocking, the skidway, castings, and skidding plate were removed and cast-steel cap plates were bolted to the under side of the floor beam, these plates being turned out to fit over a cast-steel disk plate 23 inches diameter by 3½ inches thick, placed on top of the plunger of each jack; between the bottom edges of these disks and the shoulders of the jack cylinders were placed a number of ¼-inch steel plate half-ring shims, as a safety precaution against accident should anything go wrong with the jacks; in which event the weight would be transferred to the massive jack cylinders.

"The jacks were each placed on blocking consisting of three super-imposed steel cylinders filled with concrete, over which were placed a number of cast-iron cellular blocks 2 feet 10 inches in diameter by 3½ inches thick. The ¼-inch shim plates were removed one at a time as the span was lowered so that in no case was there left a space greater than ¼-inch between the under side of the disk and the jack shoulders. Before the last of these shims was removed the span was landed on the oak blocking, the jacks released and one or more sections of cast-iron blocking removed, the jacks pumped up, shims replaced, and the operation repeated until all the cast-iron blocking had been removed, when one of the concrete-filled cylinders was taken out, the casting and shims replaced, and so on until the span was landed on its permanent shoes. The oak blocking was also removed as the span was lowered, the top of it being kept high enough to free the jacks while shims were being adjusted.

"When the span had been lowered about 4 feet at one end, the jacks were transferred to the other and similar operations carried out there. That end, however, was lowered right down to the shoes before the jacks were returned to the end first lowered."

THE CO-OPERATIVE COURSE AT CINCINNATI.

AN OUTLINE OF THE RESULTS AND LESSONS OF TWO YEARS' EXPERIENCE.

Herman Schneider—Society for the Promotion of Engineering Education.

THE discussion on Mr. M. W. Alexander's paper outlining a proposed coöperative system for teaching electrical engineering, read before the recent convention of the American Institute of Electrical Engineers and reviewed in these columns last month, disclosed the fact that nearly every college professor and a number of representatives of large manufacturing companies present at the meeting doubt that the system would be successful in producing the highest type of thoroughly trained engineer. In this connection it is interesting to read the testimony of Prof. Herman Schneider as to the results and lessons of two years' experience with the coöperative system in mechanical engineering at the University of Cincinnati, contained in his recent paper before the Society for the Promotion of Engineering Education. It will be remembered that at Cincinnati the students in the coöperative course spend alternate weeks in college and shop, the whole course covering six years. According to Prof. Schneider, the manufacturers of Cincinnati have taken very kindly to the plan and have lent the college authorities most cordial support and assistance. Their advice has been particularly valuable in selecting from the hundreds of applicants the men best suited to the profession of engineering. In a sense the students in the coöperative course are picked men but the results outlined by Prof. Schneider are none the less interesting and valuable on that account. He says in part:

"It is hard to make an accurate determination of the relative efficiency of instruction in the four-year and the coöperative courses. The records in one or two subjects, however, will indicate about what this would be. In calculus, for instance, not one of the coöperative students failed. The lowest grade received by any coöperative student was 73 (60 being the passing grade and 100 the maximum), and fifty per cent. of the class received over 90. In the regular four-year engineering course, on the contrary, about twenty per cent. of our students failed in calculus and few received a grade above 90. In this connection the fact should be noted that the examination given to coöperative students was harder than that given to the regular students. In chemistry the coöperative students and the regular students have exactly the same examination. Ninety per cent. of the coöperative students passed and about eighty per cent. of the regular students. This need not be astonishing, for, with few exceptions, the coöperative course is not carrying any dead wood. It will be seen, therefore, that since the efficiency of the instructor depends primarily upon the amount of actual substance absorbed by the class, it is increased very considerably in the coöperative courses.

"When this system was started two years ago many questions of detail arose. For instance, the matter of the rearrangement of the college courses was taken up. It was concluded, however, that the best thing for us to do would be to learn by experience. We are happily being driven from traditional methods by the students themselves. Here is a sample of what happens:

"The instructor in mathematics covers the blackboard with the demonstration of a long formula, and when he has finished it he turns to the class and asks, 'Do you understand that?' The class replies that it does, but inquires seriously, 'What shall we do with it?' This has happened a number of times, and at first caused much annoyance to the instructor; but when it was pointed out to him that if a thing had no use it was useless and should not be taught in an engineering college, light dawned on him, and he now spends much of his time hunting practical exemplifications of theory.

"This is the characteristic attitude of the coöperative student, and it is not surprising. Our four-year students are accustomed to being handed a formula which they hold, until examination time, when they hand it back. The coöperative student in the shop is handed a tool and is instructed how to use it. He uses it, hands it back to the tool-room, and thereafter knows where to find the tool and how to use it. When he is handed a formula or a theory at the university it is a matter of second nature to him to expect to be shown how to use that formula or theory prior to his handing it back. Thereafter, as with the tool, he knows where to find it and how to use it.

"We have inaugurated what we call the 'reverse quiz' in class. Toward the end of the hour students are given permission to ask any questions that have a bearing upon the subject, and this has been perhaps the most valuable addition to our system. It is, of course, uncomfortable for a young instructor, but if he is the kind of a teacher our engineering college ought to have, he will work to meet the situation. The shop knowledge of the student has demonstrated to us the fact that some of the instruction in our colleges is not only frequently out of date, but also that it is as often absolutely wrong. You will observe that there is a check upon the instructor's work which cannot be had in any other way except through this practical knowledge of the student.

"The questions of these young men have caused us to change our courses and will cause many more changes as the work advances. Mathematics, for instance, is taught as one subject, the fundamental principles of university algebra, trigonometry, analytical geometry, and calculus being given during the first part of the freshman year; and thereafter any one formula is derived by the different methods. The course in mechanics is taught as part of the course in calculus. Descriptive geometry and machine drawing will hereafter be given as one subject, because when a student was given a problem in descriptive geometry he wanted to know its application, and when told the application, wanted to know whether he could not put it at once on the same sheet.

"It will be seen, therefore, that while we simply took the four-year course at the beginning and spread it over a period of six years, we are changing it considerably by reason of the experiences which we have in every day class work.

"It has become evident also that it will be necessary to bring some of the engineering work down into the earlier years. As a counterbalance to the essentially practical attitude of the student we have inaugurated a broadening course in the social, economic, industrial and political development of the human race, together with courses in biology and geology. It was originally intended that this course should cover a period of three years, but we are now inclined to give it through the entire six years.

"The alternating periods were fixed at one week tentatively, and this has proven very satisfactory. A vote of the students was recently taken, and they were unanimously in favor of the one-week period as giving them the proper alternation of mental and physical work. They also state that absence from the shop for more than a week allows their muscles to become soft, and for this reason they prefer to continue on the week system. The shop also desires to keep this period of one week, because if the period were made longer at the university the student would lose some of his skill by the time he returned to the shop. It has been definitely concluded, however, that when the young men go into the designing and sales offices — which will be about the fifth year—the alteration will be semesters. It will be impossible for a young man to work in a designing or sales office with any benefit to himself or to the firm for a shorter period than six months. The students in the coöperative course will then enter the regular classes at the university, when a better comparison of the work of the two classes of men can be made.

"Since the coöperative student is at the university for a period of three years, as compared with four years of the regular student, it became evident, of course, that he would be required to do more actual class and laboratory work per week than our regular students. Additional hours were given to him during his alternate week at the university, and the roster was considered by some of our faculty to be too heavy. At the end of the first year, however, the students finished without any seeming effort and with much better records than did our regular students. This year a further experiment was tried by the writer on the freshman coöperative class by giving them work every period of the day from 8:30 until 5 o'clock, with one-half hour for lunch, except on Saturday morning, when they work from 8:30 until 10:30 o'clock. This, it will seem, is about the heaviest roster the student can possibly carry. At the end of the year the men were more vigorous, mentally and physically, than they were in September. They were more active in university social affairs, athletics, and general student life than the regular students, and they had made much better scholastic records.

"The fundamental principle underlying this course is based upon the rational assumption that the proper way and the only way for a young man to learn the practical side of his profession, together with business details and an intimate knowledge of the labor problem, is by working as a regular employee in a commercial shop; and further, that the only place where he can learn properly the scientific and the cultural subjects is at a school under trained teachers. This further implies that the school work and the practical work should, as far as possible, go hand in hand, so that the young man may step from school to business just as readily as he does from one promotion to another in after life. The writer believes this principle to be all-important and to apply to all engineering and industrial education."

THE QUEBEC BRIDGE DESIGN.

EDITORIAL COMMENT ON MR. C. C. SCHNEIDER'S REPORT TO THE CANADIAN GOVERNMENT.

Engineering News.

To supplement the exhaustive investigation of the causes of the collapse of the Quebec Bridge carried out by the Royal Commission of Inquiry, a summary of whose report was published in these columns in April, the Canadian Government caused to be made a full investigation of the Phoenix Bridge Company's design. This work was intrusted to Mr. C. C. Schneider and his report has recently been made available by the publication of a blue book containing the reports of both inquiries. Mr. Schneider's report is abstracted in *Engineering News* for Aug. 6. We present below the editorial comment on his findings contained in the same issue, which enumerates and discusses the main points dealt with by Mr. Schneider.

"Mr. C. C. Schneider's report on the design of the Quebec Bridge amply confirms the general opinion with which that ill-fated structure has been regarded since the searching investigations of the Canadian Government's commission of inquiry. The Commission found that the bridge had turned out to be some 20 per cent. heavier than was contemplated by the stress-sheets. Although the collapse was shown to be due to quite another cause, such an overrun of dead weight, in a structure whose own weight constitutes by far the largest part of the load it has to carry, is unavoidably fatal. With the bridge fully completed and in service, the stresses would have risen to the limit of strength of the members, and if it did not at once fall, it could at best stand trembling on the verge of collapse.

"The computed percentages of excess stress from Mr. Schneider's report reveal this clearly enough, though the actual stress figures themselves are rather more striking. In this place we may present as typical illustrations two selected examples, a compression and a tension member, respectively. One of these is the famous lower-chord member in the ninth panel from the anchorage (second panel of the anchor arm counting from the main pier), the member whose failure by buckling brought about the fall of the bridge. The other is the top chord of the cantilever arm directly adjoining the main pier. The figures of total stress give a picture of the relative importance of dead and live-load, while the unit-stress figures represent directly the tax on the metal. In considering the latter, it is convenient to remember that the elastic limit of the steel—its real or virtual failure point—is not far from 30,000 pounds per square inch. But the figures below, while they do not quite reach this point, really exceed it because they contain no allowance for the numerous minor effects, the so-called secondary stresses.

	Anchor Arm Lower Chord, Panel 9.	Cantilever Arm Lower Chord, Panel 10.
Section, sq. ins.	781	669
l/r	42.2	...
Total stresses, thousands of pounds:		
Dead-load	—13,690	+11,950
Live-load	+43 / —4,021	+3,760
Snow	—1,025	+930
Wind	—7,370	+1,140
Unit stresses, pounds per square inch:		
D + L + S	—24,000 (21,200)	+24,900 (21,100)
D + 1½ L + S + 1/3 W	—29,700 (24,000)	+28,300 (24,000)
Erection, Aug. 29, 1907	—16,800	+17,500

"The figures in parentheses are the stresses which were permitted in these members for the respective load-combinations, under Mr. Cooper's specifications. Mr. Schneider's estimate of the highest stress intensity compatible with bare safety is not far different from these specified stresses, in the case of the eyebar chord; but for the compression chord his values are lower by some 4,000 pounds per square inch.

"We need do no more than point to the fact that in the eyebar chord the stress even under the working load, and without wind, is higher by 1,000 pounds per square inch than the extreme or emergency strength estimated by Mr. Schneider. Still worse, in the compression chord, whose emergency strength is valued at slightly less than 20,000 pounds per square inch, the working load causes a stress of no less than 24,000 pounds, and the stress under extreme load rises practically to 30,000 pounds per square inch, fully one-half higher than the extreme assignable strength.

"Let it be remembered that Mr. Schneider's figures for limits of permissible stress are intended as real limits, and would by no means be defensible or admissible in the design of a bridge. '*The writer does not advocate these high unit-strains,*' we read in the report. And while this warning is unobtrusive, we conceive it worthy of very strong emphasis. Tendencies in recent years toward the regular use of very high unit-stresses in design, even in cases where economy of weight is of no particular importance, receive a sharp but needed rebuke in this brief sentence.

"Under the circumstances as revealed by the stress analysis, there will be few to raise objection to Mr. Schneider's statement that none of the material which has been fabricated for the north half of the bridge can be used in rebuilding the structure. The strengthening which would be necessary if the trusses were to be rebuilt on the same outline, but with adequate cross-sections, would have to extend to virtually every part except floor and bracing. Even this extensive work—if it is to be considered feasible at all—would involve so many difficulties that the result could but be an unsatisfactory patchwork. And if patchwork and halfway measures are ever justified, assuredly they must be kept out of the rebuilding of the Quebec bridge. The engineering world can hardly afford to contemplate the chance of a second Quebec disaster.

"The most difficult subject which the eminent bridge engineer who wrote the report had to deal with is, curiously enough, the one which he treats most briefly: the suggestion for a new design. It may be premature to ask for anything very specific in this matter at the present stage, or in any case without giving time and opportunity for exhaustive studies. But the existing design, originated both in general outline and in details by the Phoenix Bridge Company, stands criticized, and one looks very naturally for justification of the criticism in the shape of suggestions for better design. Yet we find hardly more than a single suggestion in the report.

"An explanation for this which has some force is to be found in the fact that so huge an undertaking as this bridge is by no means susceptible of systematic and progressive designing. The design must, in a sense, be evolved by a process of development, a sort of trial and error method. In a structure of ordinary dimensions the engineer knows in advance all of the limitations which will affect his work, and can allow for them in his planning in advance. But in the present case the limitations appear only as the design unfolds. The necessary arrangement of the details, the limits of manufacturing tools and processes, the shipping limits of weight and bulk, the erection problems, etc., have an influence even on the choice of outline that is easily underestimated; yet their full bearing cannot appear until an outline is adopted and has been elaborated to an advanced stage. The testimony of the Phoenix Bridge Company's designers before the Commission gives some idea of these conditions. It seems idle, therefore, to seek a very full statement of governing features as a matter of abstract deduction.

"The recommendation of straight chords must enlist general approval, as being unexceptionable in its general reasoning. But it fixes a principle hard to adapt to the original requirement that the maximum under clearance is to be maintained over so great a width as 1,200 feet, two-thirds the span. The two conditions together would produce a remarkably radical design indeed, unless perhaps the changes were begun still farther back and the railway approaches raised to a much higher elevation. If this is true for the present clearance of 150 feet, still more so will it hold if the recent clamor of St. Lawrence shipping interests for increased clearance—to nearly 200 feet, if we recall correctly—is heard with approval. In fact, it is not too much to say that, just as the determinative features of the Phoenix design were fixed by the adoption of sharply-curved chords to meet the clearance requirement, so the principle of straight chords in conjunction with the same requirement would establish the chief characteristics of the new bridge. The single suggestion, therefore, may well appear complete and sufficient for present purposes.

"There should be joined to this, we believe, another principle which is clearly inculcated by the report, though Mr. Schneider makes no explicit mention of it. This has for its object the reduction of the high secondary stresses. The calculations show that these stresses attain alarming values — alarming when we consider how destructive they are to economical, and therefore practicable and safe, design. In a bridge of such proportion that each pound of useless metal requires three or four pounds of effective metal for its support, it cannot be tolerated that even 5 per cent. of the useful metal should be put out of service by being appropriated for secondary stresses, if this be at all avoidable.

"It is true that secondary stresses are inseparable from bridge construction, especially when continuously riveted chords are employed; and the unfortunate fact is that any attempt to make the members stronger to resist the secondary bending, by making them stiffer, defeats its own purpose and actually increases the secondary stress. How high they will be, in proportion to the main stresses, depends, however, to a large extent on the truss outline or network. We believe it may be said broadly that two things are most influential in contributing to high secondary bending stresses: flexibility of the truss system as a whole, and short length of panel. The former creates large angular distortion, while the latter concentrates the distortions. Relief from high secondary stress may therefore be sought by making the truss system rigid and by employing long panels. The former is promoted to some extent by straight chords, still more by increased truss depth; and the profile of the Quebec Bridge clearly evidences that the shallow depth of the structure causes relatively high flexibility. The effect of long panels is obvious.

"Secondary stresses of the intensities as existing in the original Quebec design must, in our opinion, be eliminated in a new design. To this end the two expedients of (1) increasing the depth of truss, and (2) employing larger panels —in the trusses, not necessarily in the floor-system—must receive primary attention in outlining the new bridge."

FLYWHEELS VERSUS STORAGE BATTERIES FOR EQUALIZING FLUCTUATING LOADS.

A COMPARISON OF THE TWO SYSTEMS AND AN OUTLINE OF THE CONDITIONS TO WHICH EACH IS SUITED.

G. C. Allingham—The Electrician.

ON another page of this issue Mr. Percival R. Moses refers briefly to the limitations of the flywheel system of energy storage and finds that it can compete with the storage battery only under very special conditions. A more extended comparison of the two systems is given by Mr. G. C. Allingham in *The Electrician* for July 10, from which we take the following extracts. Mr. Allingham's discussion refers principally to mining work, but the principles he lays down are applicable to any problem involving the choice of a system of energy storage.

"The duty for which flywheel storage is best adapted is that of equalising the power demand of an individual machine, such as a winding engine or a rolling mill, which goes through a definite cycle of operations, repeated throughout the period of working, so that very short periods of heavy and of light load recur alternately in regular succession. In such cases the actual amount of *energy* that has to be stored is very small (although the *power* to be dealt with may be large) and it has to be kept stored up for a very short space of time. Again, the amount of energy to be stored can be calculated fairly closely, and the flywheel equaliser can be designed to suit the load-curve of the machine, so that it is storing and giving out energy alternately almost all the time, and running idle as little as possible. In other words, it is possible to arrange to work the flywheel equaliser at a comparatively high load-factor.

"On the other hand, in cases where the overloads are irregular in frequency and amount; where they may last for longer periods or occur in rapid succession, and may also be separated sometimes by comparatively long periods of low load, flywheel equalisers are not suitable, on account of the small amount of energy they are capable of storing, and their heavy no-load running losses. In such cases, the load-factor on the equalising plant is of necessity low, and the constant running loss being high, the working efficiency must consequently be low. A haulage gear is an instance of a machine whose load-curve is usually extremely irregular, and for which fly-wheel storage would, therefore, not be well adapted; a coal-cutter is another.

"In the case of a coal-cutter, for example, the load-curve shows successions of heavy peaks, alternating with intervals of no load varying from a few minutes to half an hour or more while the cutter is being shifted. Consider what occurs in one of these intervals. Within a minute or two the flywheel is brought up to full speed, by which time it has taken up all the energy it is capable of storing, and afterwards current has to be wasted to keep it turning round at full speed churning the air until a heavy load comes on again.

"If, on the other hand, an attempt is made to save no-load running losses by shutting down the flywheel set during a period of low load, all the energy stored in the flywheel has to be thrown away, and it will also take a considerable time to get the wheel started up again, so that if a sudden overload comes on there is a risk of being caught unprepared.

"Again, when the peaks are liable to endure for some time, or to come on in rapid succession, the flywheel equaliser is handicapped by its small storage capacity; and if an attempt were made to overcome this drawback by increasing the size of the flywheel, the fixed running losses due to friction and windage would be correspondingly increased, and the efficiency of working would be greatly reduced. The amount of energy which would have to be expended every time the flywheel was started up would also be increased. For these reasons, not to mention the practical difficulties in the way of making flywheels of enormous size, and their prohibitive cost it is impossible to construct flywheel equalisers having any considerable storage capacity combined with a high working efficiency.

"From the foregoing considerations, flywheel storage would appear to be unsuited for equalising the load on a power station supplying a number of motors, since the fluctuations of the power demand on such a station are always quite irregular. Attempts are being made to apply flywheel storage to power plants for electric traction, but, for the reasons given above, the author does not consider them likely to meet with success.

"The alternative to flywheel storage is the use of a storage battery, preferably in combination with an automatic reversible booster. In special cases, such as those mentioned in the second paragraph of this article, where the storage capacity required is very small, a flywheel is of course a cheaper means of storage than a battery. But where the power demand to be dealt with is irregular, the battery equalising plant has the advantage, for, firstly, it has sufficient storage capacity to deal with any combination of peaks and depressions in the load-curve that could possibly occur; and secondly, its no-load running loss is quite insignificant compared with that of a flywheel equaliser, so that the working efficiency of the battery plant is almost independent of load-factor.

"As a matter of fact, there is of course no such load loss in the battery itself, the only such loss being that involved in keeping the automatic booster running, and at times when the load is not heavy enough to make it worth while to run the booster, the latter can be shut down, without any waste of stored energy, and the battery alone will still have a considerable steadying effect.

"A storage battery has the further incidental advantages that it serves as a standby which is capable of supplying power for a considerable time in case of a breakdown, or of an unusually heavy load on the generating plant, and that it often enables the generating plant to be shut down entirely at times of light load, as at nights or over week-ends.

"The point is often raised that storage batteries can only be used on direct-current systems, whereas a large proportion of power plants are three-phase. But it should be borne in mind that most systems of flywheel storage involve conversion to direct current, and that such conversion can be carried out equally well in connection with storage batteries.

"It may be pointed out that, when a storage battery is employed for equalising an alternating power load, it is not necessary to convert the whole of the power load to direct current, but only that portion of it which has to be stored in the battery, so that it is only on that fraction that conversion losses are incurred. An automatic reversible motor-generator or rotary converter may be connected across the three-phase mains, and arranged to keep the three-phase load constant by alternately charging and discharging the battery which is connected to its direct-current end. In the case of most flywheel storage systems, on the other hand, the whole of the fluctuating power load which is to be dealt with by the flywheel has to be converted into direct current; this is notably the case with the Ilgner system."

THE MARINE GAS ENGINE.

A REVIEW OF THE ADVANTAGES AND DIFFICULTIES OF GAS PROPULSION FOR LARGE SHIPS.

Engineering.

CONSIDERABLE interest has been aroused by reports lately published in English newspapers that the Admiralty are contemplating the adoption of gas engines for a battleship soon to be laid down, and, more recently, by a prediction made by one of the fuel experts of the United States Geological Survey that in the near future the ships of the United States navy will be driven by gas power. *Engineering,* in an editorial review of the situation in the issue of July 3, admits that in the past year great progress has been made, but believes that the introduction of gas propulsion on a large scale will be delayed for some time to come, at least until careful and exhaustive experiments have been made on small units. From this article we reproduce the following outline of the advantages and difficulties of the marine gas engine.

"The advantages to be obtained from an installation of large size for marine propulsion are a saving of one-third of the space occupied by machinery, and a reduction of the total weight of machinery of possibly one-fourth. While the engine itself would have to be much heavier than a steam-engine of the same power, the necessary gas-producers would be much lighter than the steam boilers. As the gas-engine and producer have a thermal efficiency about double that of the combined thermal efficiency of the steam-engine and boiler, it should be possible to get a horse-power at the propeller for 1 pound of coal per hour, and also to obtain it from a cheaper grade of fuel than can be used to advantage in a boiler. The last-named advantage will appeal strongly to owners in the mercantile marine, as it will enable the fuel cost of transport per ton-mile to be considerably reduced. Gas-producers, when once charged, will go on making gas for several hours without further attention. In Beardmore's tests on board ship the producer, once charged, runs for ten hours without attention. The same large force of stokers needed for a steam installation of any size will not therefore be required. Where there are many producers they would be charged in succession, and not more than two or three in any one watch. There would be considerably less than one-quarter the amount of ashes to handle in a given time, and there should be no clinker at all. There would be no smoke, and, therefore, the large funnels, with their wind resistance, would not be present. The space usually occupied by uptakes would also be saved. This advantage would be of considerable value to naval vessels by enabling them to almost get into range before their presence could be detected. It must be remembered that each and every cylinder in a gas-engine is a complete engine in itself, and should one or more break down, the disabled cylinder could be put out of operation, and the propeller turned as long as there was a single cylinder left in working order. It is only necessary to remove the connecting-rod, and the rollers that are operated on by the cams, in order to disconnect a cylinder—a much lighter job than would be required in the case of a steam-engine, though the weight to be handled might be greater.

"The disadvantages of gas propulsion for marine use, though many in number, are not by any means insurmountable. The chief objection seems to be the very high temperature that obtains in the cylinders when they are of large size, and the consequent liability of the valves to score and give trouble, finally resulting in a complete temporary stoppage, which would be exceedingly inconvenient, if not dangerous, at sea. There are several methods of reducing this excessive temperature, such as making the engine of relatively long stroke, diluting the charge with a surplus of air or some of the exhaust gases, increasing the volume of water circulating in the jackets and pistons, or injecting water into the cylinder during the combustion, etc. Valves, if of large size, can readily be waterjacketed. They can also be double-seated, and thus cause the speed of the hot gas through them to be reduced, and the work required to lift them to be lessened. Another objection has been the great size and weight of the crank-shafts and connecting-rods, framing, etc., in order to withstand the heavy and violent shocks incidental to all gas-engines. Here again the relatively long-stroke engine will score, and by adopting a cycle of operations in which heat is added at constant pressure rather than at constant volume, the violence of the shocks can be reduced, and a lower temperature of combustion obtained at the same time. It has been considered a disadvantage that most gas-engines are fitted with trunk-pistons, and that therefore the connecting-rod pin is inaccessible, and the piston, when worn, has to be entirely renewed. But when gas-engines are built specially for marine use, they will be of such a size that they will have thin water-cooled pistons, be double-acting, and be fitted with the ordinary crossheads and slides used upon steam-engines; or if trunk pistons are used, they will be fitted with adjustable shoes to take the wear in the wake of the connecting-rod pin.

"It is generally considered to be a difficult matter to make a gas-engine reversible, but this is only because it has generally been attempted with the usual revolving cam-gear, and on engines of comparatively small size. On large engines, oscillating instead of revolving cams can be used with advantage, and these can be operated by the well-known Stevenson link motion or by the Joy, Marshall, or other radial reversing valve motion, worked by compressed air when the engines are very large.

"A special compressor, driven by an independent gas-engine, will always form part of a marine gas-engine installation, because compressed air will be required for starting the main propelling engines, blowing the whistle and syren, working the reversing engine, circulating and other pumps, steering-engine, capstan, deck-winches, ash-hoists, etc., which are now part of the recognised outfit of the modern steamship. Under certain circumstances, all this work might be done by electricity, in which case a separately driven electrical generator would take the place of the air-compressor. A disadvantage of the gas-engine for marine propulsion is its want of flexibility in the rate of revolution at which it can be driven, but there are several ways in which this can be met, such as cutting off the gas supply to one or more cylinders, building the engine in two or more distinct units which can be readily connected up or disconnected, applying the total power on three or more shafts, so that one may run ahead and two astern, or *vice versâ*, so that a ship of large total power may be run at very slow speed when necessary.

"A mechanical disadvantage of the gas-engine, when used for marine propulsion, is the uneven turning moment, especially when run on the four-stroke cycle. It is, of course much better on the two-stroke cycle, but as in the latter case twice the amount of hot gas has to pass through the exhaust-valve in a given time, special provision has to be made to meet and overcome this difficulty. Three double-acting cylinders, acting on cranks at 120 degrees apart, is probably the smallest unit that can be relied upon to work satisfactorily, and even then it would be necessary to employ a fly-wheel. Another mechanical difficulty is in so regulating the power that it shall follow the sudden variation in the resistance, due to the propeller being partially lifted out of the water when the vessel pitches; but some form of high-speed centrifugal governor arranged to cut out or throttle the gas supply, relieve the pressure in the cylinders, cut out the ignition, or a combination of two or more of these methods, should be able to meet the difficulty.

"What to do with the exhaust from the marine gas engine is also quite a difficult problem to settle, but as the object sought to be attained is both to cool and reduce the volume of the exhaust gases as rapidly as possible, some form of surface condenser, in combination with an injection of part of the cooling water into the exhaust pipe, ought to meet the case. The cooled gases could also be afterwards discharged overboard below the surface, and thus secure perfect silence. Objection has been made to the gas producer on board ship that poisonous gases are liable to leak out and either kill the crew or cause disastrous explosions, but if operated under the suction system this does not hold, since any leak would be into, and not out of, the producer. If the producers are operated on the pressure system, it is only necessary to surround the producers and all the gas pipes with an outer air-tight shell, and force the supply of air through the intervening space on its way to the producers. In this way any leak that could occur would be pure air, either into the ship or into the producers or gas pipes. If more than one producer were in use, it would be the duty of the attendants to regulate the amount of gas furnished by each, in accordance with the reading of a pyrometer fitted to each one, so that the temperature of combustion in each was the same. This would not be any more difficult than the work of regulating the feed water to a battery of steam boilers."

THE USE OF EXPLOSIVES IN COLLIERIES.

A DISCUSSION OF THE DANGERS INVOLVED AND THE MEANS OF MINIMIZING THE RISKS.

Wm. Maurice—The Electrician.

A SPECIAL mining number of *The Electrician,* published July 10, contains an interesting article by Mr. William Maurice on the risks attending the use of explosives in collieries, due to the presence of firedamp and coal dust. Little attention has been given in the United States to the regulation by the government of the materials and methods of blasting in coal mines but, as Messrs. Hall and Snelling pointed out in THE ENGINEERING MAGAZINE for February last, one of the most potent causes of colliery explosions can be removed by the strict enforcement of regulations based on careful investigation of the nature and behavior of explosives and the characteristics of explosive mixtures of gas, dust, and air. We present below Mr. Maurice's brief outline of the regulations in force in European countries and the results of the researches on which they are based.

"Twenty years ago gunpowder and dynamite were almost the only explosives used in mines, although it had even then been more or less generally recognised that gunpowder was a dangerous agent to use in the presence of firedamp and coal dust. After many disasters had been traced to the use or misuse of explosives, the Secretary of State of the United Kingdom availed himself of Sec. 6 of the Coal Mines Regulation Act, 1896, to issue an order making it unlawful to use any explosive other than a 'permitted' explosive under certain specified conditions on and after July 1, 1897. Concurrently a testing station was erected at Woolwich, following on the report of a Departmental Committee appointed 'to inquire into the testing of explosives for use in coal mines.'

"Explosives to be tested are sent by the manufacturers to this testing station, and if 20 charges of any sample are fired into an explosive mixture of gas and air, under certain specified conditions as to weight and stemming, without causing ignition, the explosive is then entitled to be placed on the 'permitted list.'

"As it is to be feared that many workmen regard the fact of an explosive being 'permitted' as being somewhat in the nature of an official certificate of safety, the following remarks of the officers in charge of the testing station cannot be too often repeated. 'There is not a single explosive on the permitted list which has not at some time or other caused an explosion of gas at the testing station when fired without stemming. It is impossible to get an explosive which will be absolutely safe under all conditions. The safety of any particular explosive depends not only upon its composition and physical characteristics, but even in a more marked degree upon the conditions under which it is used. There must be:

1. Complete and immediate detonation of the charge.

2. Correct proportioning of the charge to the work to be done, and avoiding the use of unnecessarily heavy charges.

3. Careful stemming to ensure that there should be sufficient length, firmness, moisture and closeness of consistency.'

"Thus the only difference as regards safety from mine explosion risks between one explosive and another is the difference in degree; the most that can be said is that one explosive is less dangerous under certain conditions than another. Modern explosives are divided into five principal groups:—

1. Nitro-glycerine explosives, which are relatively easy to detonate under normal conditions.

2. Ammonium nitrate explosives, which occupy an intermediate position between the dynamites and the carbonites.

3. Nitro-glycerine and ammonium nitrate explosives, which detonate more freely than class 2.

4. Non-detonating mechanical mixtures, mainly represented by Bobbinite, which is a high-grade gunpowder mixed with starch and paraffin wax; and

5. Gunpowder, the principal characteristic of which is its low velocity of explosion, rendering it very suitable for work where a slow heaving action is required. All these classes are represented on the permitted list with the exception of gunpowder, which will not pass either the Continental or Woolwich tests.

"The time occupied in detonating a given quantity of an explosive is determinable, and is known as its rate of detonation. All explosives on detonation develop flame, of different extent and duration. M. Bichel, the inventor of carbonite, has conducted elaborate and extensive experiments to ascertain the determining factors in the ignition of firedamp, and finds them in a comparison of the ratios of the safest and least safe explosives as to rate of detonation, length and duration of flame, after-flame ratio, and temperature. M. Bichel has shown that the flame of all explosives outlasts the time of detonation, but that of the 'safe' explosives does so in a much less degree than in the contrary case. 'In general,' he says, 'safety explosives should show a minimum rate of detonation and a minimum of length and duration of flame at a given pressure; none of these should exceed certain limits, as the detrimental effect of one of them cannot be counterbalanced by the others, however favourable. Thus it is the long contact between flame and gas mixture which is fatal to gunpowder in spite of its low calorific value. The heated gases remain too long in contact with the inflammable gas mixture, and thus, even at low temperature, ignition is unavoidable.'

The importance of coal dust as a factor in mine explosion is not yet generally recognized but "experiment has shown that as little as 1/3 ounce of coal dust per 35 cubic feet of air will suffice for the production of an explosion, and that it is more a question of fineness of division of dust than the weight. In addition to fineness of subdivision the percentage of volatile matter in the coal dust has an important influence on its inflammability, and the same also applies to the ease with which these volatile matters are disengaged by heat.

"The Commission appointed by the Société de l'Industrie Minérale to investigate the causes of coal-dust explosions have pointed out that the great danger of explosion presented by floating coal dust is evident from the fact that a mixture containing 111 grammes of dust per cubic metre of air (*i. e.*, in the proportion furnishing carbon dioxide on combustion) develops a pressure of 15.5 atmospheres on ignition, as compared with the pressure of 8.9 atmospheres produced by the combustion of an explosive mixture of firedamp and air. Even when the amount of coal dust is double the above figure, so that carbon monoxide is produced, the pressure generated amounts to 6.7 atmospheres. The fact, moreover, should not be lost sight of that the dust danger is by no means eliminated merely by removing coal dust. Any powdered substance in a state of suspension as fine dust may, by occluding, and so acting as a substitute for, air or oxygen, cause an atmosphere to become explosive. Dust from oil-bearing shales might be especially dangerous.

"Having regard to the facts now known concerning the use of explosives in dangerous atmospheres, the Commission above referred to have suggested that non-fiery mines should be divided into safe and dangerous according to their condition as regards dust, the dangerous class being subdivided into damp and dry mines. In Great Britain the present alternative to watering lies in the conditional use of a permitted explosive. The French Commission approve of local, but not of general watering, and recommend that shot-firing be allowed in coal up to charges of 13½ ounces without previously laying or removing the dust. Watering may be dispensed with by using explosives (in the coal) with a detonation temperature not exceeding 1,500 degrees C., in charges of not more than 4 ounces, this being permissibly increased to 13½ ounces if covered with clay stemming to a depth of 8 inches

"There is nearly always a certain amount of coal dust left in holes bored in coal, the amount depending on the hardness of the coal, the inclination of the hole, and the care bestowed on cleaning it out. According to some tests carried out by the French Commission the conclusions were drawn that the contents of blasting cartridges may become mixed with coal dust in shot holes bored in coal and that miss-fires under these conditions may cause the deflagration of the mixture, in which case any firedamp present is certain to be ignited. This danger is also present to a smaller extent in the case of complete detonation, the carbon present increasing the temperature of detonation and producing carbon monoxide, thereby facilitating the ignition of firedamp. In view of the probability of accidents arising from this cause, the Commission recommend that shot holes bored in the standing coal should be carefully cleared of dust; that the practice of ramming the cartridges so hard as to break the envelopes and mix the contents with coal dust should be abandoned, and that the size of the detonators should be increased.

"The risk of causing an explosion by the use of permitted explosives is practically confined to the use of blown-out or improperly stemmed shots. Experiments made in Austria show that a vacuum resulting from a blown-out shot may amount to as much as ½ inch of mercury, which is equivalent to 8 pounds to 9 pounds to the square foot. This reduction of pressure creates an increase in the flow of firedamp in the ratio of 235 to 100, so that a blown-out shot may itself be the means of furnishing a considerable amount of gas that otherwise would not have escaped from the coal. A blown-out shot also, of course, produces an immense volume of flame, which, coming into contact with the coal dust on the roof, floor and sides of the road, is liable to raise and ignite it, and so bring about a disastrous explosion.

"Such safety as is at present obtainable appears to lie in entrusting the charging, stemming and firing of shots to selected men, insisting on the use of a sufficient length of proper stemming and of efficient detonators."

PEAT COAL.

A DESCRIPTION OF THE NEW EKENBERG PROCESS FOR THE MANUFACTURE OF PEAT FUEL BRIQUETTES.

Iron and Coal Trades Review.

REVIEWS in these columns of THE ENGINEERING MAGAZINE for December, 1907, and February, 1908, have already described the successful Frank-Caro process for the utilization of peat in gas producers with recovery of by-products and the Ziegler system of by-product coking. Attention was turned to the problem of the utilization of peat, first in by-product coke ovens, and then in gas producers when after a half-century of experiment it seemed impossible to devise a successful process for converting peat into a satisfactory commercial fuel for domestic and power-producing purposes. According to an article published in the *Iron and Coal Trades Review* for July 17, however, the latter problem has been satisfactorily solved by Dr. Martin Ekenberg, whose process is described in the following abstract.

The cause of the failure of the many attempts made to produce peat in a form that would equal coal in utility lay in the difficulty of getting rid of the large quantity of water invariably contained in raw peat. The consistency of the material is such that only a small proportion of the water can be got rid of by mechanical means, and the cost of artificially drying a material containing normally about 87½ per cent. of water is prohibitive. The only alternative has been to allow the peat to dry in the air, but this apparently simple process has many drawbacks. The production is entirely dependent on climate and season, and the qualities of fuel produced also are influenced by these factors to a certain extent. The manual labor connected with air drying makes the apparently cheap process a very expensive one, and coal made from air-dried peat is dearer than ordinary coal with the additional disadvantage that, weight for weight, its bulk is four to five times as great. It appears, then, that the two requirements which must be satisfactorily fulfilled to bring the peat-fuel industry into such a position that it can supply fuel for general use are, first, that the process should render the manufacture independent of the weather, and, second, that the product should have a heating value approaching that of ordinary coal with an equally-high specific gravity. It is claimed that Dr. Ekenberg has discovered the means of overcoming the difficulties, and has evolved a process fulfilling the requirements mentioned.

"His process is based on the discovery that when wet peat is subjected to a temperature of over 150 degrees C. in a closed vessel it is charred, more or less, depending upon the temperature used, thereby losing its property of retaining the water, the bulk of which can then readily, and at a low cost, be pressed out by mechanical means.

"In charring air-dried peat, retorts heated from the outside, without the presence of water, have hitherto been used. As gases are bad conductors of heat, this charring is a time-consuming operation, and generally it is very difficult to get the peat in the middle of the retort charred without overcharring the peat near the walls. In the wet carbonising process, the large quantity of water serves as a heat-conducting medium, allowing a short and sharply defined charring with a uniform effect which corresponds to the temperature used. The charring is thorough, and every particle of peat is exposed to the heat. A further effect is that paraffin substances are liberated, which serve to bind the mass together in the subsequent process of briquetting, thus giving the product a proper consistency and making it impervious to rain or moisture. Great loss of tar and gaseous hydrocarbons cannot be avoided in the old charring process, but it is claimed that no such loss occurs in the wet process.

"Shortly described, the operations are as follows:—The wet peat is taken from the bog by any of the usual methods, and passed through a specially-constructed cutting machine, which reduces it to a homogeneous pulp. By means of specially designed pumps, it is then forced in a continuous stream through the carbonising oven, which is heated to a moderate temperature. Here the peat pulp is subjected to the requisite temperature and pressure. The oven is constructed on a recuperative principle, so that variation of the percentage of water in the peat is practically immaterial. The pressure maintained in the oven is about 200 to 320 pounds per square inch, and at the corresponding temperature a partial carbonisation takes place which, as before mentioned, has the effect of so altering the properties of the material that the water can be pressed out. All the valuable volatile constituents of the peat are retained in the product, thus making it a fuel equal to coal. It is a noticeable feature of this treatment that the original quality of the peat has little or no influence on the finished product, except in yield, so that the age or ripeness of the bog is immaterial. From the oven the wet carbonised pulp passes direct to a press, where the water is pressed out.

"After the carbonising and pressing operations are completed, the mass contains only 8 to 14 per cent. of the water originally absorbed in it. This water is evaporated by a final drying by means of the waste heat from the carbonising oven. The peat is then ready for briquetting, which process is carried out in the ordinary and well-known briquetting presses.

"The finished peat briquettes have a black glossy appearance. They have a heating value of 6,000 to 6,800 calories per kilogram (about 10,200 to 12,500 B.T.U. per pound), or very nearly equal to that of ordinary coal. The specific gravity of the briquettes is 1.32 to 1.35 and one hectolitre weighs 85 to 100 kilograms, subject to the shape of the briquettes. The weight of one hectolitre of ordinary coal is about 78 kilograms with an average specific gravity of 1.31. These figures appear to show that the above-mentioned requirements of good peat fuel are fulfilled by the briquettes of peat coal made by the 'Ekenberg' process.

"On burning, the peat briquettes retain their form until consumed, give a long clear flame, and are stated to have proved equal to coal in all instances where they have been tried. They possess the important advantage of containing practically no sulphur, which might injure metals with which the flame comes into contact. Submitted to dry distillation, a good-burning coal-gas evolves, and a hard coke suitable for metallurgical purposes is left.

"At a locomotive trial of the new fuel, it was found to be smokeless and without cinders, which specially meets one of the requirements for naval purposes. An interesting point is that the coal produced by the process is obtained in very much the same way as by Nature's own process, viz., that the substance is exposed to the influence of heat in the presence of water under pressure, ordinary coal having probably been produced from plants under very much the same conditions.

"The cost of production of peat coal by the 'wet carbonising' process will be 4s. to 7s. 3d. per ton, according to local conditions. To these figures the expenses for briquetting have to be added. On a basis of 12½ per cent. of the water in the raw peat being left in the peat coal, to be evaporated by surplus heat from the carbonising oven, the following estimate gives the total manufacturing cost of the briquettes at the factory:—

	s.	d.
Raw peat in the bog (including fuel used in the factory)	0	8
Wages for excavation and transport of the raw peat to the factory	2	0
Wages in the factory	2	3
Depreciation and maintenance of plant	2	6
Administration and sundry expenses	1	4
Total cost of briquettes per ton	8	9

"These figures will, it is believed, be reduced considerably, especially the wages for excavation, by using modern excavating machinery.

"It remains to be noted that an experimental plant for working the process has been installed at Stafsjö in Sweden, and has been in operation for some time. Based upon his experience in connection with the process, Mr. Alf. Larson, who superintended the Stafsjö plant during its construction, puts the total cost of a factory to produce 100 tons of briquettes per day at about £27,500."

MOTOR CABS IN PARIS

TECHNICAL NOTES ON THE CONDITIONS NECESSARY FOR THEIR SUCCESSFUL OPERATION.

L. Périssé—Société des Ingenieurs Civils de France.

A VERY comprehensive paper on the subject of motor cabs in Paris, read by M. L. Périssé before the Société des Ingenieurs Civils de France on April 3, is published in the *Mémoires* for March. This type of vehicle has come into such extensive use in the larger and more important cities of both Europe and America that the following technical notes from M. Périssé's paper on the conditions governing successful operation in Paris will be of interest.

After outlining the development of traffic and transit facilities in Paris, M. Périssé gives detailed statistics of the increase in the number of motor cabs during the last ten years. In 1898 the first 22 cabs were placed in service and the number at the end of 1907 was 2,359, the greatest increase having taken place since 1904. The vehicles are of many different types and there is no standardization of tariffs, though several of the more powerful companies have established a rate of one-third franc per kilometre, equivalent to 10¾ cents per mile. The average number of fares per day is 8 to 9 and the average distance traveled is about 75 kilometres, of which 15 to 20 are unremunerative. The averages of horse cabs are 14 fares for 30 kilometres.

An important difference between horse and motor cabs lies in the fact that the operating cost of the former is practically independent of the distance travelled, while in the case of motor vehicles every additional kilometre means a relatively high charge to cover fuel, maintenance and depreciation expenses. The motor-cab industry depends for its success on the attitude of the public and will be a success only when the public becomes more accustomed to the use of the passenger automobile. The pressing need in Paris is a unification of tariffs, or the adoption of three fixed tariffs according to the type of motor used, four-cylinder, three- and two-cylinder, and single-cylinder vehicles corresponding to a degree of comfort and speed justifying a difference in rate.

The chief items of expense connected with the operation of motor cabs are those for maintenance and repair of tires, fuel and lubricants, repairs, and amortization. After a review of the various types of tires on the market, M. Périssé concludes that under present conditions the pneumatic tire is the only one which will give satisfactory service. For their proper maintenance two conditions must be fulfilled; the tire should be subjected to a rigid examination at frequent intervals and repairs should be made before an irremediable accident ends the tire's usefulness prematurely; and the mechanism of the car should be so designed as to make sudden jerks impossible. It is necessary that the operation of the motor should be such that the driver cannot make mistakes in handling the levers and it is desirable that the rapidity with which the motor is thrown in and out of gear should be susceptible of control by the foot. Brake bars could be improved so that a more gradual braking action could be obtained and the steering gear should be so designed that in braking the play of the wheels would be taken up almost automatically, thus preventing the abnormal wear of the tires of the forward wheels when an undulating motion of the wheels is permitted.

The speed and weight of the vehicle should also be limited. A maximum speed of 35 kilometres an hour should be sufficient for cabs operating only within the city limits and this limitation would contribute also to lessening the number of accidents. As to the limitation of weight it is necessary to consider that the vehicle must be rigid and that the maximum of comfort is incompatible with light weight. The use of air-cooled motors, a return to tubular frames or the use of the new aluminium frames are means of reducing the weight without loss of rigidity.

The question of fuel is an important one. A fuel not subject to duty should be used and alcohol, benzol, and a mixture of equal parts of these two are possible substitutes for gasoline. Alcohol will not come into general use until a stable level of price has been reached. Next to fuel, the question of the carburetter is of first importance. The motor should start instantaneously from the cold and should work economically through a wide range of conditions. M. Périssé believes that best results would be obtained with a carburetter permitting the driver to admit a supplementary supply of air. As to lubrication no system has as yet given entire satisfaction and many improvements must be introduced to do away with smoking and other inconveniences.

It is necessary to distinguish between two distinct classes of repairs, those due to normal wear of the machines and others due to accident. Repairs of the first class should be made annually in slack seasons. In repairing or replacing parts damaged by accident it is important that the period of idleness of the vehicle should be reduced to a minimum. Manufacturers can assist materially by supplying interchangeable and duplicate parts.

According to M. Périssé, the future of the motor cab in Paris depends on the following conditions:

1. Distinction between the cab for city use and that for use in the suburbs or for short tours.

2. In the case of the city cab the weight should not exceed 1,000 to 1,100 kilometres with three passengers and driver, to secure greatest economy in tires and fuel. A tariff should be adopted close to that of horse-drawn vehicles.

3. Lower speeds and limitation of speed by the use of small motors.

4. The use of alcohol or benzol as fuel.

5. The encouragement of the adoption of special means of lowering wear and maintenance costs.

6. Establishment by cab companies of their own repair shops to diminish idle time.

7. The introduction of comfortable vehicles with four-cylinder motors for use outside Paris and the adoption of a tariff of one-half franc per kilometre for cabs of this class. The tariff of one-third franc is remunerative only under certain conditions and it would seem necessary that to give the cab companies reasonable security this should be raised to two-fifths franc.

RAIL CORRUGATION.

A THEORY BASED ON OBSERVATION OF THE GRINDING OF THE WHEEL FLANGE AGAINST THE RAIL HEAD AND THE EFFECT OF DUST.

C. A. Carus-Wilson — Tramways and Light Railways Association.

A NEW theory of the causes of the corrugation of tramway rails was added to the already-long list by Prof. C. A. Carus-Wilson at the meeting of the Tramways and Light Railways Association held at the Franco-British Exhibition on July 10. The theory propounded by Prof. Carus-Wilson was suggested to him by the fact that corrugations on grooved rails are very often accompanied by a cutting of the check of the rail immediately opposite. When rails and wheels are new there is generally about ¼-inch clearance between the flange and the check on both sides. But after a certain amount of wear has taken place the flange may bear against the check. Instances of check cut tires are very common. Prof. Carus-Wilson does not propose to examine the causes of this wear, but, taking into account the fact that check cutting generally accompanies corrugation, to discover the connection between the two. The following is an abstract of his paper.

In his investigations Prof. Carus-Wilson uses a model consisting of a small four-wheeled truck with brass wheels 2½ inches in diameter, placed 4¼ inches center to center. The two wheels on one side were keyed to the axles; those on the other were allowed to run loose. One wheel of the latter pair was arranged so that it might be coupled to the axle by means of a rigid or an elastic plate fitting into slots in the end of the axle and in a stud on the rim of the wheel. The truck ran on brass rails 3 1/16 inches wide and 3 9/16 inches apart. The track was so arranged as to permit the passage between the rails of a weight hung from a central support and distributed equally over the four wheels by means of an equaliser suspension.

When the truck was loaded with a weight of fourteen pounds, a rigid coupler inserted in the loose wheel, and the truck pushed from end to end of the track with the flange of the coupled wheel pressed hard against the rail, it was found that the length of track covered in three complete revolutions of the coupled wheel was about 2 per cent. longer than the distance covered when the truck was allowed to move freely without lateral pressure on the flange. Owing to this side pressure the flange bit the rail on a line of contact whose diameter was greater than that of the tread of the wheel; the wheel tended to run on this line of contact and the tread was forced to skid on the head of the rail in consequence. The result was a motion combining roll and skid, the skidding, however, being continuous.

By this it appeared that when the flange is forced against the side of the rail the wheels are made to skid a certain percentage of the distance traveled. Investigations were then undertaken at Croydon to determine whether such skidding takes place on an actual tramway track. A four-wheeled car, weighing 7.8 tons and equipped with apparatus for counting the revolutions of the axles, was run over a stretch of straight and nearly level track, badly corrugated for the greater part of the distance. The diameter of the car wheels was carefully measured and a distance amounting to 1581 times the diameter of the wheel was carefully chained along the track. The car was run over the distance at constant speed, and the time and revolutions were carefully taken. Two trips were made each way with the track very dry, and two trips each way after a heavy rainstorm. The results of the tests are given in the following table:

	Condition of Track.	Mean Counter-Revolutions.	Skid in Counter-Revolutions.	Skid in per Cent. of Distance Covered.	Mean Speed, Miles per Hour.
Down trip	Dry	1516	65	4.1	11.2
" "	Wet	1535	46	2.9	11.1
Up trip	Dry	1522	59	3.7	14.4
" "	Wet	1547	34	2.1	14

From these results it appeared that car wheels skid on a tramway track in the same way as they did in the model.

Further experiments were then undertaken with the model to determine in what way the skidding could produce corrugation. In order to get a definite amount of skid, independent of possible variations in the side pressure exerted, a metal fillet was inserted against one of the rails in such a way as to lift the keyed wheels off the rail and force them to roll on the outside of their flanges. When the loose wheel was fitted with a rigid coupler the motion of the coupled wheel was a roll and a skid, and that of the keyed wheel a roll and a slip, the skidding, however, remaining quite uniform and continuous. When an elastic coupler of the nature of a stiff spring was inserted in place of the rigid plate, it was found that the spring was bent, no matter in which direction the truck was pushed. This indicated a tendency to twist the coupled wheel relatively to the axle, the angle through which the spring was bent representing the torsion required to overcome the adhesion between the tread of the wheel and the rail.

It was evident, therefore, that when the flange of a car wheel grinds against the rail in such a way as to cause skidding the axle will be twisted until the turn is sufficient to make the tread of the mate wheel skid on the rail, the elastic twist of the axle representing the bending of the spring in the model. So far the skidding was quite continuous, and there was no indication of an intermittent action such as could produce corrugation. When, however, fine sand was sprinkled on the rails, the difference in behavior of the coupled wheel was at once apparent; instead of moving uniformly as before it advanced with a series of jerks at regular intervals.

"The action is as follows:—When the torque on the spring has increased to a certain amount, the force of adhesion is overcome, and the wheel skids, turning meanwhile about its own axis, so that the whole force of the skid is concentrated over a limited area on the rail surface. In skidding, the wheel grinds through the grit on the surface of the rail, and comes into contact with clean metal: there is thus a large and sudden reduction in the coefficient of friction, and the wheel flies back under the influence of the spring through a considerable angle. The result is that the subsequent motion of the wheel upon the rail will be a pure roll while the spring is being again deflected. When the limit of adhesion is reached, the wheel again skids, and the process is repeated, the motion thus consisting of alternate rolling and skidding. The addition of the grit has made the skid intermittent, whereas formerly it was continuous. When the surface of the rail is clean, there is no sudden breaking down of the adhesion which is required to make the skid intermittent. This effect is not due to the increased torsion on the spring consequent on the increase in the coefficient of friction; for the same torsion can be obtained with a clean rail by increasing the weight, when the skid remains continuous. . . . . .

"The experiments on the model afford an explanation of the connection between check-cutting and corrugation. The flange of one of the two wheels on an axle grinds against the rail on a line of contact having a diameter greater than that of the tread, causing both wheels to skid. The skidding on the one side, where the flange is grinding, will be uniform, but on the other side, owing to the twist of the axle, the skidding will be intermittent, provided the rail surface be sufficiently rough, and the motion will be an alternate rolling and skidding. This explains why, as a rule, corrugations appear on one rail only: both wheels are skidding, but, owing to the twist of the axle, one skids uniformly and the other intermittently, the intermittent skidding taking place on the rail opposite to that where the flange is grinding. Observation shows that the rail opposite the corrugated rail is generally scored uniformly, though often with a slight wavy appearance which is caused by the sudden release of the twist on the axle affecting the motion of the non-corrugating wheel."

In tramway practice the gritty material necessary to produce corrugation is furnished by dust and particularly by the sand which is put on the rail. Prof. Carus-Wilson believes that the presence of sharp grit on the rail surface is a prime factor in the production of corrugation, and he notes several cases in which badly corrugated stretches of track are found in close proximity to supplies of hard sand. The other factor in producing corrugations, the side pressure of the flange on the rail, is caused on the straight by irregularities of gauge and level, which make the car lunge from side to side and bear over against one rail or the other. This accounts for the irregular distribution of corrugations along the track. On curves the centrifugal force tends to press the flanges outward. On curves of large radius the speed will be practically the same as on the straight, and the conditions under which corrugations may be produced will be similar, except that the pressure is constant and always in one direction. For this reason corrugations on large radius curves will appear on the outer rail, accompanied by cutting of the check of the inner rail. On curves of small radius the difference in length between the inner and outer rail gives rise to a skidding apart from that due to the grinding of the flange on the rail and the conditions of corrugation become very complex. As a rule, however, the speed on small radius curves is too low to admit of corrugations being formed.

While Prof. Carus-Wilson is convinced that corrugations are usually caused by the grinding of the flange on the rail, he admits that they may be produced in other ways. A similar action may be set up, if for any reason the wheel should be forced to run on its flange. This may happen at points and crossings where the rail is badly worn and the flange actually touches the bottom of the groove, or, more commonly, in cases where the groove is allowed to get full of dirt. Flange riding on a packed groove is responsible for some of the most perplexing vagaries of corrugation. Unless both grooves are packed to the same height and with materials of equal hardness, corrugations are bound to appear on the rail opposite to that in which the groove packing is the lower or softer.

"The investigations outlined above appear to show that the following conditions are necessary for the formation of corrugations on grooved rails: (1) As regards the track:—(*a*) Irregularities in gauge or level, (*b*) Curvature, or (*c*) A packed groove; (2) As regards the rails:—(*d*) Surface rough with sand or gritty dust; (3) As regards the rolling-stock:—(*e*) Wheels with check-cutting flanges; (4) As regards traffic:—(*f*) A critical speed.

"Corrugations cannot be formed unless conditions (1), (2), (3), and (4) are all present at the same time—that is, peculiar conditions must exist simultaneously in the track, the rails, the rolling-stock, and the speed, and the absence of any one of these conditions will prevent corrugations being formed."

THE ENGINEERING INDEX

THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

CIVIL ENGINEERING

BRIDGES.

Arches.

The Diminishing-Curve Masonry Arch (Le Arcate in Muratura a Monta ribassata). Carlo S. Rivera. Begins an exhaustive theoretical discussion. Ills. 2400 w. Serial, 1st part. Monit Tech—June 10, 1908. No. 93630 D.

Rigid Bow-string Arches (Etude des Arcs à Tirant rigide). C. Birault. A mathematical discussion of the effect of vertically applied loads and changes of temperature. Ills. 3000 w. Génie Civil —June 20, 1908. No. 93627 D.

A Note on the Calculation of Concrete and Reinforced-Concrete Hingeless Circular Arches and Vaults (Ein Beitrag zur Berechnung von Bögen und Gewölben mit kreisförmiger Achse ohne Gelenke in Beton und Eisenbeton). J. B. Bosch. Mathematical. Ills. Serial, 1st part. 3000 w. Deutsche Bau—June 13, 1908. No. 93648 D.

Bascule.

The Franklin Street Bascule Bridge, Michigan City, Indiana. Illustrated description of a single-leaf bascule recently built to replace a swing span of a deck highway bridge. 1200 w. Eng Rec—July 25, 1908. No. 93919.

See also Steel, under BRIDGES.

Blackwell's Island.

See Testing Materials, under MEASUREMENT.

Compression Members.

See Testing Materials, under MEASUREMENT.

Drawbridges.

The Drawbridge Over the Libau Harbor Canal (Die Drehbrücke über den grossen Hafenkanal in Libau). Harold Hall. The two halves of the swing span give a total clear opening of about 217 feet. Ills. Serial, 1st part. 2700 w. Zeitschr d Ver Deutscher Ing—June 6, 1908. No. 93683 D.

End Launching.

See Steel, under BRIDGES.

Foundations.

Concrete Pile Foundations for a Paris Railway Bridge. Illustrates and describes the construction of a new bridge over the Seine, Asnieres, France. 1000 w. Eng News—July 23, 1908. No. 93944.

Raising.

Raising the Broadway Bridge, Boston. Illustrates and describes methods of carrying out difficult work without interrupting heavy navigation. 1200 w. Eng Rec—July 18, 1908. No. 93811.

Reinforced Concrete.

Methods and Some Costs of Constructing a Reinforced-Concrete Arch Bridge. John Harms. Illustrated description of this bridge and the method of construction, with itemized costs. 2500 w. Engng-Con—July 22, 1908. No. 93907.

Steel.

The Wrought Compressive Member for Bridge Trusses. H. E. Horton. Discusses the limitations and relation of parts forming a member; their design, specifications, etc. General discussion. Ills. 5500 w. Jour W Soc of Engrs—June, 1908. No. 94019 D.

Railway Bridges of Moderate Span. Conrad Gribble. Shows how modern bridges have been gradually evolved, and how the investigation of stresses in materials has brought about the evolution of the modern steel girder. Ills. 4500 w. Cassier's Mag—July, 1908. Serial, 1st part. No. 93443 B.

Viaduct Over Walney Channel at Barrow-in-Furness. Illustrated description of a recently completed bridge with a bascule span, and the method of construction. Plates. 5000 w. Engng—July 17, 1908. Serial, 1st part. No. 93982 A.

The Erection of Long Span Trusses by the End-Launching Method.—The French River Bridge, Canadian Pacific Ry. An illustrated account of the erection of this bridge by the method named. 2500 w. Eng News—July 23, 1908. No. 93942.

The Replacement of Steel Trusses in a Railway Bridge Over the Elbe, Near Magdebourg (Le Remplacement des Travées métalliques d'un Pont de Chemin de Fer sur l'Elbe, près de Magdebourg). A. Bidault des Chaumes. Illustrated description of the work. Plate. 1700 w. Génie Civil—June 6, 1908. No. 93622 D.

See also Raising, under BRIDGES.

Timber.

Highway Bridge Across the Kansas River at Fort Riley, Kansas, Capt. P. S. Bond. Describes a bridge erected by enlisted men of the U. S. Army, which is unique in design and construction. 3500 w. Eng Rec—July 11, 1908. Serial, 1st part. No. 93707.

Viaducts.

Progress on the Queens Approach Viaduct on the Blackwell's Island Bridge. Illustrated description of work in progress on this steel structure. 1200 w. Eng Rec—July 18, 1908. No. 93817.

The Stony Brook Glen Viaduct. Illustrates and describes a single-track plate-girder structure, said to be the highest bridge in the State of New York. 3000 w. Eng Rec—July 4, 1908. No. 93526.

CONSTRUCTION.

Beams.

On the Determination of the Bending Moments at the Points of Support of Continuous Beams. Prof. J. H. Smith. Gives a method that will enable one to obtain the bending-moment diagrams for all possible cases of continuous beams in which the load and cross-section vary, the supports are at any given levels, and the ends fixed at given inclinations. 1500 w. Engng—June 26, 1908. No. 93561 A.

See also Concrete, under MATERIALS OF CONSTRUCTION.

Boring.

Testing Diamond Drill Borings at the Site of the Olive Bridge Dam, Ashokan Reservoir. Illustrates and describes the apparatus used and method of testing. 1200 w. Eng Rec—July 4, 1908. No. 93528.

Contractors' Plants.

Contractor's Plant for the Sewage Purification Works of Washington, Pa. R. F. Proctor. General plan and description. 2000 w. Eng News—July 16, 1908. No. 93791.

Excavation.

Cost of Excavating Earth with an Electrically Equipped Shovel. Report of work in Canada with a Thew shovel, operated by electrical power. 700 w. Engng-Con—July 22, 1908. No. 93908.

Examples of High and Low Cost of Wheel Scraper Work, with Comments on the Efficiency of Work Done. Gives two examples illustrating how work can cost much more than it should, and showing the need of good foremanship. 1300 w. Engng-Con—July 22, 1908. No. 93909.

Foundations.

Pneumatic Caisson Foundations for the Lighthouse at the Elbow of Cross Ledge, Delaware Bay. Describes the conditions and the method of carrying out the work. 2500 w. Eng Rec—July 25, 1908. No. 93917.

Reinforced Wall Foundations on Yielding Subsoil. Gunvald Aus. Illustrated description of steel beam reinforcement used successfully for massive buildings. 700 w. Eng News—July 2, 1908. No. 93482.

Piling.

Column Action in Piles. Editorial discussion of problems in marine piling, the possibility of buckling, considering two interesting failures of pile foundations. 2800 w. Eng News—July 2, 1908. No. 93486.

Steel Sheet Piling for Retaining Earth Under Spread Footings. Illustrates and describes work in connection with the reconstruction of the old Custom House building in New York City. 900 w. Eng Rec—July 4, 1908. No. 93524.

See also Foundations, under BRIDGES.

Reinforced Concrete.

Some Phases of the Building Situation in San Francisco. An interesting account of the changes in architecture introduced since the earthquake, and the conditions that have affected the construction. Ills. 4500 w. Eng Rec—July 18, 1908. No. 93814.

Reinforced Concrete in Engineering Structures. C. S. Meik. Read at meeting of the Inst. of Munic. & Co. Engrs. Describes some of the systems in use, discussing the designing, materials, and matters requiring care in various kinds of work. Ills. 7500 w. Surveyor—July 10, 1908. No. 93857 A.

The New Orleans Court House: A Reinforced Concrete Public Building. Illustrated description of a large public building of reinforced-concrete frame, with exterior of marble and tile. 1200 w. Eng News—July 2, 1908. No. 93481.

See also Tanks, under WATER SUPPLY; and Conduits, under ELECTRICAL ENGINEERING, TRANSMISSION.

Retaining Walls.

See Ferry Approach, under WATERWAYS AND HARBORS.

Roofs.

Analytical Design of Vaulted Roofs (Analytische Berechnung von Kuppelgewölben). O. Gottschalk. Discusses both spherical and conical types. Ills. 3300 w. Beton u Eisen—June 10, 1908. No. 93659 F.

Steel Buildings.

American Steel Frame Buildings Abroad. An illustrated account of the achievements of the United States Steel Products Export Co. 1800 w. Ir Age—July 16, 1908. No. 93773.

Tall-Building Construction in New York. C. H. Hughes. Illustrated descriptions of recent examples of business structures and their construction, equipment, etc. 4000 w. Cassier's Mag—July, 1908. No. 93447 B.

See Wind Bracing, under CONSTRUCTION.

Tall Buildings.

Limit of Height for Tall Buildings. Interesting illustrations and information concerning the limit under present restrictions of the Building Code of the City of New York. 1200 w. Sci Am—July 25, 1908. No. 93926.

Tunnel Lining.

Examples of Labor Saving Machinery and Methods for Placing Concrete Tunnel Lining. Shows a variety of such machinery and plant, designed under the direction of E. C. Williams. 1500 w. Engng-Con—July 1, 1908. No. 93577.

Tunnels.

The Cost of Driving an Earth Tunnel for a Railroad. Gives itemized costs of the work. 2000 w. Engng-Con—July 1, 1908. No. 93578.

Tunnel Driving at Low Cost. Walter H. Bunce. Brief account of the methods employed in driving the Chipeta adit at Ouray, Colo. 900 w. Min & Sci Pr—July 11, 1908. No. 93808.

The Tunnels of the Franklin & Clearfield Railroad. H. M. North. Illustrated outline of construction work on the L. S. & M. S. Ry. 1500 w. Transit, Univ of Iowa—Vol. XIII, 1908. No. 93764 N.

The Rotherhithe Tunnel. Editorial, describing this recently completed tunnel under the Thames, the thirteenth, and the largest that has been driven. 1500 w. Engng—June 19, 1908. No. 93430 A.

New York Tunnel Extension of the Pennsylvania Railroad System. William Couper. Gives the schedule of engineering organization for constructing this extension, and the personnel of the management. Map. 1500 w. Bul Am Inst of Min Engrs—July, 1908. No. 94025 C.

Wind Bracing.

Wind Bracing in Buildings. Arthur L. Bobbs. Brief paper on methods used, followed by discussion. 2500 w. Pro Engrs' Soc of W Penn—June, 1908. No. 93760 D.

A Theoretical Discussion of the Knee Brace Design of Wind Bracing in Steel

Frame Buildings. R. B. Woodworth. Ills. 2500 w. Pro Engrs' Soc of W Penn —June, 1908. No. 93761 D.

MATERIALS OF CONSTRUCTION.

Cement.

The Effect of Alkali on Portland Cement. Information from a paper by J. Y. Jewett, before the Am. Soc. for Test. Mats. 2300 w. Eng Rec—July 25, 1908. No. 93923.

Standards for Portland Cement. W. W. Maclay. Read before the Am. Soc. for Test. Materials. A plea for conservatism in standards, especially for the tensile strength. 2500 w. Cement Age—July, 1908. No. 93997.

The Influence of Fine Grinding on the Physical Properties of Portland Cement. Richard K. Meade. Read before the Am. Soc. for Test. Materials. Gives results of experiments made to determine the actual commercial value of fine grinding. 3000 w. Cement Age—July, 1908. No. 93996.

The Addition of Pozzolane to Hydraulic Cements for Use in Sea Water (Additions de Pouzzolanes aux Mortiers en Prise à l'Eau de Mer). H. Vetillart and R. Feret. A general discussion of their value in preventing decomposition. Ills. 4200 w. Ann d Ponts et Chaussées—1908 —I. No. 93610 E + F.

See also Cement Testing, under Measurement.

Cement Paste.

A Cement Paste for Protecting Steelwork from Locomotive Gases. Reports concerning an efficient, durable and economical coating and the method of application. 900 w. Eng Rec—July 18, 1908. No. 93813.

Concrete.

Tests of Plain Concrete Beams at St. Louis. Richard L. Humphrey. A report of tests made at the laboratories of the U. S. Geol. Survey in St. Louis. 1500 w. Eng Rec—July 11, 1908. No. 93709.

The Strength of Concrete Beams. Richard L. Humphrey. Report of investigations made at the structural materials testing laboratories, giving results of tests of 108 beams. 11500 w. U S Geol Survey—Bul. 344. No. 93755 N.

Some Tests of Concrete Beams Under Oft Repeated Loading. H. C. Berry. Read before the Am. Soc. for Test. Mat. Illustrates and describes the apparatus used, and reports tests made. 2000 w. Eng Rec—July 25, 1908. No. 93918.

The Effect of Alkali Soils on Concrete. Reviews the preliminary report of investigations carried out by the Montana State Agricultural College, investigations by the U. S. Reclamation Service, and others. Also editorial. 4000 w. Eng News—July 23, 1908. No. 93948.

Sands: Their Relation to Mortar and Concrete. Henry S. Spackman and Robert W. Lesley. Shows that their strength is as dependent on the sand as the cement, the necessity of inspection and testing of the sand, and the desirability of standard specifications for and standard methods of testing. 2500 w. Cement Age—July, 1908. Serial, 1st part. No. 93995.

See also Stone, under Materials of Construction.

Crushed Stone.

Voids, Settlement and Weight of Crushed Stone. Ira O. Baker. Gives results of tests made under a variety of conditions. 5500 w. Univ of Ill, Bul 23 —May 6, 1908. No. 93776 N.

Mortar.

See Concrete, under Materials of Construction.

Steel.

The Wasting of Iron. Thomas Holgate. A study of waste through rusting, corrosion and decay, giving examples from practical experience. 2500 w. Builder—July 4, 1908. Serial, 1st part. No. 93781 A.

Stone.

Shearing Values of Stone and Concrete. Henry H. Quimby. Read before the Am. Soc. for Test. Mat. Considers shearing tests and the manner of making them. 2000 w. Eng Rec—July 18, 1908. No. 93815.

Timber.

Southern Yellow Pine. Arthur J. Cox. The manufacture and supply for construction work is discussed. Ills. 3500 w. Transit, Univ of Iowa—Vol. XIII, 1908. No. 93768 N.

Timber Preservation.

The Economic Aspects of Wood Preservation for Structural Purposes. Carlile P. Winslow. Gives data of costs, results, and savings effected. 4000 w. Engineering Magazine—Aug., 1908. No. 94013 B.

See also Pavements, under Municipal.

MEASUREMENT.

Cement Testing.

A Rapid Method for Comparing the Liability of Hydraulic Cements to Decomposition by Sea Water (Une Méthode accélérée pour Comparer l'Aptitude des Liants hydrauliques à la Decomposition par l'Eau de Mer). R. Feret. Describes a method for use in the laboratory. 4500 w. Ann d Ponts et Chaussées—1908—I. No. 93609 E + F.

Hydrographic Surveying.

The Long Wire Drag or Sweep for

Subaqueous Charting. Describes methods used by the U. S. Geodetic and Coast Survey for determining shoals and rocks. 2000 w. Eng Rec—July 18, 1908. No. 93816.

Stream Gauging.

Recent Changes of Methods and Equipment in the Water Resources Work of the United States Geological Survey. John C. Hoyt. Illustrates and describes recent changes in instruments and methods used in stream gaging. 1000 w. Eng News—July 2, 1908. No. 93485.

Testing Materials.

A Ready Means of Making Compression Tests on Large Size Compression Members with Special Reference to the Blackwell's Island Bridge. A letter from Gustav Lindenthal referring to a method proposed by Col. Henry Flad for the St. Louis steel arch bridge in 1872. 500 w. Eng News—July 30, 1908. No. 94046.

See also Concrete, under Materials of Construction; and Fuel Testing, under MECHANICAL ENGINEERING, Steam Engineering.

MUNICIPAL.

Drainage.

See Sewage Disposal, under Municipal.

Dunoon.

Municipal Engineering Works at Dunoon, with Special Reference to the Working of Mechanical Filters. James Andrew. Read at Scot. Dist. Meeting of Assn. of Munic. & Co. Engrs. Description and discussion. Ills. 12000 w. Surveyor—June 26, 1908. No. 93553 A.

Garbage Disposal.

City Refuse and Its Disposal. H. de B. Parsons. An illustrated article dealing with the disposal of New York City refuse. 2500 w. Sci Am Sup—July 4, 1908. No. 93490.

Utilization of Residuals from Refuse Destructors. H. Percy Boulnois. Discusses uses of destructor clinker, different kinds of metal in home refuse, etc. 2500 w. Surveyor—July 17, 1908. No. 93973 A.

The Chicago Underground Railway System of Refuse Disposal. Frank C. Perkins. Describes the disposal station and method of moving the material. 900 w. Munic Engng—July, 1908. No. 93763 C.

Pavements.

Creosoted Wood Block Paving. H. C. Innes. A short description of the preparation of the material and the construction of the pavement. 1400 w. Munic Engng—July, 1908. No. 93762 C.

Roads.

Road Making in Relation to Street Cleaning. H. Percy Boulnois. Read before the Inst. of Cleans. Supts. A general discussion of this subject, stating the requirements of an ideal road. 2500 w. Surveyor—July 10, 1908. No. 93858 A.

Engineering Problems in Road Construction. Joseph W. Hunter. An illustrated account of the work of the Penna. State Highway Department and the difficulties encountered. General discussion. 7000 w. Pro Engrs' Club of Phila—April, 1908. No. 94003 D.

The Acceptance of Stone for Use on Roads, Based on Standard Tests. R. S. Greenman. Read before the Am. Soc. for Test. Mat. Considers problems of road construction and the requirements to select suitable stone. 1700 w. Eng Rec—July 11, 1908. No. 93706.

New Methods of Road Maintenance (Neuere Bestrebungen auf dem Gebiete der Strassenpflege). Jakob Bacher. Discusses the changes made necessary by the advent of automobiles and various new methods and materials for road construction and maintenance. Ills. 3000 w. Oest Wochenschr f d Oeffent Baudienst—June 13, 1908. No. 93662 D.

Sewage Disposal.

Sewerage and Drainage of New Orleans. An illustrated general description. 1800 w. Munic Jour & Engr—July 1, 1908. No. 93497.

Sewage Disposal at Burslem. F. Bettany. Brief description of new works for treatment of domestic sewage. 1500 w. Surveyor—July 3, 1908. No. 93723 A.

Sewage Purification at Washington, Pa. R. Winthrop Pratt. Illustrated detailed description of a new plant for a manufacturing town near Pittsburg, costing about $100,000. 6500 w. Eng News—July 16, 1908. No. 93790.

Main Sewerage and Sewage Disposal. T. Aird Murray. Aims to describe the leading features of an up-to-date disposal plant, and the subject of sewerage. 2500 w. Can Engr—July 17, 1908. Serial, 1st part. No. 93797.

Hydrolytic Sewage Tanks. Illustrated description of the tanks and the theory of operation. 2500 w. Munic Jour & Engr—July 1, 1908. No. 93495.

The Travis Hydrolytic Sewage Tanks at Norwich, England. From a paper by Arthur E. Collins, recently read before the Inst. of Munic. & Co. Engrs., describing the principles on which the works have been based and their operation. 3500 w. Eng Rec—July 25, 1908. No. 93921.

The Hampton Doctrine in Relation to Sewage Purification. W. Owen Travis. An explanation and discussion of the Hampton doctrine, applying it to actual operation. 5000 w. Surveyor—July 10, 1908. No. 93859 A.

Studies of the Physiological Control of Sewage Filters, at New Britain, Conn. Milton W. Davenport. Describes the filtration plant and records the organisms which have been found in water more or less polluted, giving conclusions and suggestions. 2000 w. Eng News—July 30, 1908. No. 94043.

See also Purification, under WATER SUPPLY.

Sewage Sampling.

An Automatic Device for Sampling the Flow in Combined Sewers at Any Desired Dilution. G. S. Coleman. Illustrates and describes the device, explaining method of taking samples. 1000 w. Eng News—July 2, 1908. No. 93484.

Sewers.

The Harlem Creek Sewer and Its Steel Centering: St. Louis, Mo. Describes what is believed to be the largest concrete sewer in the United States. Ills. 2200 w. Eng News—July 30, 1908. No. 94047.

Sewerage of Queens Borough. Alberto Schreiner. Abstract of paper read before the Munic. Engrs. of City of N. Y. An explanation of conditions and the work in progress. Ills. 2500 w. Munic Jour & Engr—July 1, 1908. No. 93494.

WATER SUPPLY.

Baltimore.

Baltimore's Pressing Need of More Water. Map showing the present, proposed, and possible supply, with explanation of the proposed improvements. 3000 w. Mfrs' Rec—July 16, 1908. No. 93782.

Dams.

Planning the Execution of a Contract for a Dam, the Methods Used, Together with Some Notes and Comments on the Plant Needed and the Life of Such a Plant. Relates to the construction of the Cross River dam for the additional supply of New York City. 4500 w. Engng-Con—July 15, 1908. No. 93819.

The Great Roosevelt Irrigation Dam. Day Allen Willey. An illustrated description of this great undertaking which will provide water for irrigating more than a quarter of a million acres of arid land in Arizona. 1400 w. Sci Am—July 4, 1908. No. 93488.

See also Reservoirs, under WATER SUPPLY.

Filtration.

See Dunoon, under MUNICIPAL; and Oakland, Cal., and Springfield, Mass., under WATER SUPPLY.

Fire Protection.

Successful Test of New York's New High-Pressure Fire Service. An illustrated account of a test demonstrating the success of the system, with information relating to the plant. 1800 w. Sci Am—July 11, 1908. No. 93596.

Recent Developments in Fire Protection Devices. Gorham Dana. Discusses automatic sprinklers and their working, alarm service, fire doors, shutters, etc. Ills. 6000 w. Tech Qr—June, 1908. No. 93769 E.

Automatic Fire Protection. W. A. Neracher. Brief review of the history and development of automatic systems, describing the sprinkler equipments. Discussion. 6000 w. Pro Engrs' Soc of W Penn—July, 1908. No. 94024 D.

Irrigation.

The Nile Irrigation Question. C. O. Burge. Brief account of what has been done and is proposed in Egypt and the Soudan by means of irrigation. 2200 w. Eng Rec—July 18, 1908. No. 93810.

The Irrigation of Egypt and the Success of the Aswan Dam. Editorial on the official report for 1907, and remarks on other irrigation works in progress. 1000 w. Sci Am—July 4, 1908. No. 93487.

The Mexican National Irrigation Law. Arturo Reyes Temple. Explains the great need of irrigation in Mexico, and gives the law as passed by the National Congress. 1700 w. Eng Rec—July 25, 1908. No. 93922.

See also Dams, under WATER SUPPLY.

Oakland, Cal.

The Testing Station and Filter Plant Improvement of the People's Water Co., Oakland, Cal. W. W. De Berard and Langdon Pearse. Explains the conditions and describes the scheme for providing adequate water supply, illustrating the works named. 3500 w. Eng Rec—July 25, 1908. No. 93920.

Orifices.

Coefficients of Discharge Through Circular Orifices. Extracts from a paper describing experiments made in Australia, by H. J. I. Bilton, and the conclusions reached. 1500 w. Eng News—July 9, 1908. No. 93595.

Pipe Flow.

Loss of Pressure in the Transmission of Liquids and Gases (Der Druckhöhenverlust bei der Fortleitung tropfbarer und gasförmiger Flüssigkeiten). R. Biel. Derives a new general formula. Ills. Serial, 1st part. 2500 w. Zeitschr d Ver Deutscher Ing—June 27, 1908. No. 93-688 D.

Pipe Lines.

The Design of Pipe Lines of Small Diameter (Calcul des Conduites d'Eau de petit Diamètre). M. Dariès. Discussion of the piping of buildings to secure the best results, giving tables showing piping discharges under various conditions and according to various formulæ. Rev de Mécan—June, 1908. No. 93612 E + F.

Pipe Tests.

Tests of Cast Iron and Reinforced Concrete Culvert Pipe. Arthur N. Talbot. Results of tests at the University of Illinois. Ills. 20000 w. Jour W Soc of Engrs—June, 1908. No. 94021 D.

Purification.

Ohio Water and Sewage Purification. R. Winthrop Pratt. Reports the results of investigating all the plants in the State. 2000 w. Munic Jour & Engr—July 1, 1908. No. 93496.

Ozone Water Treatment (Ueber Ozonewasserwerke). Dr. Gg. Erlwein. Illustrates and describes various systems of ozone purification treatment and gives the results of three years' operation of the Paderborn plant. 2000 w. Gesundheits-Ing—June 6, 1908. No. 93600 D.

Reservoirs.

The Santo Amaro Reservoir and Hydraulic-Fill Dam, Brazil. Thomas Berry. Illustrates and describes interesting features of construction. 4000 w. Eng Rec—July 4, 1908. No. 93522.

The Design and Construction of Impounding Reservoirs. William Watts. A summary of the writer's experience, including the construction of 18 reservoirs for the water supplies of large corporations, and also smaller ones. Also discussion. 4500 w. Surveyor—July 3, 1908. No. 93722 A.

The Vingeanne Reservoir (Le Réservoir de la Vingeanne). M. Jacquinot. Describes the construction of one of the large regulating reservoirs of the Marne-Saône canal. Ills. Plates. 11000 w. Ann d Ponts et Chaussées—1908—I. No. 93607 E + F.

Springfield, Mass.

The Little River Water Supply for Springfield, Mass. Illustrated description of the filter plant, sand washers, and other features. 3500 w. Eng Rec—July 11, 1908. No. 93705.

Tanks.

Layout and Construction of a Large Water Tank. Illustrated detailed description of tower and tank erected at Louisville, Ky. 1500 w. Boiler Maker—July, 1908. No. 93466.

Reinforced Concrete Tanks. L. Mess. Illustrates and describes interesting structures in Europe and America. 800 w. Min & Sci Pr—July 25, 1908. No. 94049.

Testing Plants.

See Oakland, Cal., under Water Supply.

Water Works.

A Tropical Water-Works. Henry A. Young. Describes conditions in Cuba from a water-works standpoint, and the works for the city of Camagüey. 2500 w. Eng Rec—July 4, 1908. No. 93525.

Water Service Plant for the Delaware Water Company at Christiania Creek. Illustrated description of a new pumping station and water service plant which will supply the P. B. & W. Ry. 1200 w. R R Age Gaz—July 24, 1908. No. 93939.

Wells.

Wells and Boreholes for Town Water Supply. H. Ashton Hill. Read before the Assn. of Water Engrs. Discusses the legal right to take underground water, the analytical conditions, relative merits of wells and boreholes, construction, etc. General discussion. 8500 w. Surveyor—July 17, 1908. No. 93972 A.

WATERWAYS AND HARBORS.

Canals.

The Widening of the Suez Canal. An illustrated account of work in progress and the difficulties encountered. 1700 w. Sci Am—July 25, 1908. No. 93927.

The Newark Ship Canal. Discusses the project for making Newark, N. J., an important port, outlining the character of the problem. 3000 w. Eng Rec—July 4, 1908. No. 93523.

The Break in the Cornwall, Ont., Canal and the Consequent Drawbridge Collapse. An illustrated account of the collapse and repairs. 3000 w. Eng News—July 9, 1908. No. 93593.

See also Columbia River, and Newark, N. J., under Waterways and Harbors.

Columbia River.

U. S. Improvements of the Columbia River, Oregon and Washington. W. P. Hardesty. Describes the jetty at the mouth of the river, and the Celilo-Dalles canal, around rapids in the river. Ills. 9000 w. Eng News—July 30, 1908. No. 94042.

Docks.

Royal Edward Dock at Avonmouth, Bristol. Gives plan and illustrated detailed description of this great engineering project, costing 2½ millions sterling. 3000 w. Engng—June 26, 1908. Serial, 1st part. No. 93565 A.

See also Newark, N. J., under Waterways and Harbors.

Ferry Approach.

The St. George Ferry Approach Improvements, New York City. An illustrated account of improvements on Staten Island, to cost about $1,000,000. The construction of a reinforced-concrete retaining wall is described. 4500 w. Eng Rec—July 11, 1908. No. 93704.

Floods.

Flood Damage at the Great Falls Smelter, Montana. F. S. Shewell. An illustrated account of recent floods in the valleys of the Missouri and Sun rivers. 600 w. Min & Sci Pr—July 11, 1908. No. 93807.

French Ports.

The Transformation and Autonomy of the Great French Ports (Les grands Ports français, leur Transformation et leur Autonomie). Georges Hersent. Discusses the growth in the size of vessels, the accommodations demanded in harbors, the condition of French ports, etc. Ills. 20000 w. Mem Soc Ing Civ de France—March, 1908. No. 93605 G.

Georgian Bay Canal.

The Official Report on the Georgian Bay Ship Canal. A summary of the report as published in the Ottawa *Evening Journal* of July 6. 3000 w. Eng News—July 16, 1908. No. 93793.

Jetties.

See Columbia Rivers, under WATERWAYS AND HARBORS.

Lighthouses.

See Foundations, under CONSTRUCTION.

Lock Gates.

The Lock Gates at the Charles River Dam, Boston and Cambridge, Mass. Edward C. Sherman. Illustrated description of the type adopted, and the methods of supporting and moving them. 3000 w. Eng News—July 9, 1908. No. 93592.

Mechanical Locks.

The Transverse Inclined Plane Type of Ship Lift (Das Schiffshebewerk mit Schraubenführung auf schiefer Ebene mit Querneigung). Fr. Jebens. A general discussion of the design of this type. Ills. 4000 w. Glasers Ann—June 15, 1908. No. 93657 D.

Newark, N. J.

A Proposed Land Reclamation and Dock Scheme for Newark, N. J. Plan, and information concerning the proposed canal harbor and municipal docks, with reclamation of a large area of meadow land. 2500 w. Eng News—July 23, 1908. No. 93947.

Ohio River.

The Ohio River. J. W. Arras. A brief description of its principal navigation improvements, with mention of some of its characteristics. Ills. Discussion. 11000 w. Pro Engrs' Soc of W Penn—June, 1908. No. 93759 D.

Panama Canal.

Progress at Panama. The present number is mainly a review of the history and outline of the project, with maps and sections. 5000 w. Engr, Lond—July 3, 1908. Serial, 1st part. No. 93733 A.

River Improvement.

River Canalization. C. E. Gordon. An outline of the principal features requiring consideration in this work. 4000 w. Transit, Univ of Iowa—Vol. XIII, 1908. No. 93765 N.

Sea Walls.

An Extensive Sea Wall at Coronado Beach, California. Illustrated description of the construction of a loose-rock-fill wall to protect the fore-shore. 2000 w. Eng Rec—July 18, 1908. No. 93812.

MISCELLANY.

Roebling.

A Monument to a Famous Engineer. Illustration, with an interesting review of the life of John A. Roebling, as given by Henry D. Estabrook in address at the unveiling of the statue at Trenton, N. J. 3000 w. Eng News—July 16, 1908. No. 93789.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

The Resistance Equivalent of Electromagnetic Radiation from a Linear Oscillator. Oscar C. Roos. Analytical study. 4000 w. Elec Rev, N Y—July 4, 1908. No. 93537.

The Ducretet Radio-Telegraphic Apparatus (Communication de E. Ducretet, sur ses Appareils de Télègraphie sans Fils). An illustrated detailed description. 2800 w. Bul Soc d'Encour—May, 1908. No. 93614 G.

See also A. C. Dynamos, under DYNAMOS AND MOTORS.

Telephone Cables.

Notes on Recent Submarine Telephone Cables (Neuere Beobachtungen an unterseeischen Fernsprechkabeln). F. Breisig. Describes two cables recently laid between Denmark and the German coast and shows their importance as marking progress in this field. Ills. 2000 w. Elektrotech Zeitschr—June 11, 1908. No. 93691 D.

Tele-Photography.

Korn's New Telephotographic System. An illustrated account of the method of sending pictures by wire from Paris to London. 1800 w. Sci Am Sup—July 4, 1908. Serial, 1st part. No. 93491.

DISTRIBUTION.

Circuit Breakers.

Fuses and Automatic Circuit-Breakers. W. B. Kouwenhoven. Explains their use, describing types. 2000 w. Ry & Loc Engng—July, 1908. No. 93512 C.

Fuses.

See Circuit Breakers, under DISTRIBUTION.

Insulation.

Rubber Insulation. Describes the preparation, manufacture and application of the material. 1400 w. Elec Wld—July 25, 1908. No. 93914.

Receiving Stations.

Receiving Stations Operated from High-Tension Transmission Lines. Considers the suitable equipment for such stations. 4000 w. Elec Age—July, 1908. No. 93472.

Wire Heating.

Heating of Conductors by Electric Currents. Sydney F. Walker. Gives formulæ for the heating effect, with notes. 700 w. Eng & Min Jour—July 25, 1908. No. 93955.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Portable Type of High-Frequency Alternator. R. A. Fessenden. Illustrates and describes a high-frequency alternator driven by a small steam turbine for use in wireless telegraphy. 3000 w. Elect'n, Lond—July 3, 1908. No. 93727 A.

Alternators in Parallel. Morgan Brooks. Considers the influence and relative importance of the circumstances controlling the successful operation. Discussion. 7000 w. Jour W Soc of Engrs —June, 1908. No. 94022 D.

Practical and Theoretical Notes on the Parallel Operation of A. C. Machines (Praktisches und Theoretisches über den Parallelbetrieb von Drehstrommaschinen). O. Weisshaar. The first part is mathematical and theoretical. Ills. Serial, 1st part. 4500 w. Elektrotech u Maschinenbau—June 28, 1908. No. 93-680 D.

A. C. Motors.

Alternating-Current Motors and Lamps for Industrial Plants. Warren H. Miller. An explanation of the possibilities of the alternating-current system. 3500 w. Elec Wld—July 4, 1908. No. 93477.

Armatures.

See Windings, under Dynamos and Motors.

Commutation.

Demonstration Apparatus for Illustrating Commutation. Harrison W. Smith. Illustrated description of two pieces of apparatus used at the Mass. Inst. of Tech. 1200 w. Tech Qr—June, 1908. No. 93-770 E.

D. C. Dynamos.

The Operation of Electrical Machinery. Norman G. Meade. Gives a classification of direct-current generators, explaining how connections are made, the effects of residual magnetism, etc. Ills. 2000 w. Power—July 21, 1908. Serial, 1st part. No. 93845.

Induction Motors.

The Induction Motor—Its Characteristics in Their Relation to Industrial Applications. A. M. Dudley. Discusses performance curves and typical applications. 7500 w. Elec Jour—July, 1908. No. 93756.

The Exact Circular Current-Locus of the Induction Motor. K. J. Laurell. Explains an interesting method of determining the correct locus of the primary current. Also editorial. 2000 w. Elec Wld —July 11, 1908. No. 93590.

Polyphase Induction Motors: The Choice of Type. G. Stevenson. Abstract of paper read before the Glasgow Sec. of Inst. of Elec. Engrs. Describes the characteristics of squirrel-cage and slip-ring induction motors, showing that in most cases the former can be satisfactorily installed. 3500 w. Elect'n, Lond—June 19, 1908. No. 93419 A.

Standards.

A Comparison of American and German Standards for Electrical Machinery (Vergleich der amerikanischen und deutschen Maschinennormalien). Georg Stern. Discusses principally dynamos. 3000 w. Elektrotech Zeitschr—June 4, 1908. No. 93689 D.

Windings.

Relation Between Number of Turns and Resistance of Magnet Spool Windings. Paul M. Rainey. The method described treats only of magnets having circular cores and conductors of circular cross-section. 1200 w. Elec Wld—July 11, 1908. No. 93591.

Wave Winding for Direct-Current Armatures. George T. Hanchett. Gives a rule devised by the writer explaining its application. 600 w. Elec Wld—July 4, 1908. No. 93479.

ELECTRO-CHEMISTRY.

Cells.

On the Free Energy of Nickel Chloride. M. de Kay Thompson and M. W. Sage. An investigation and measurement of the electromotive force of a nickel-chloride cell. 2500 w. Tech Qr—June, 1908. No. 93771 E.

Electro-Metallurgy.

Progress in the Application of Large Electric Furnaces to the Production of Calcium Carbide and High-Percentage Ferro-Silicon (Ueber die Fortschritte in der Verwendung grosser elektrischer Oefen zur Fabrikation von Kalziumkarbid und hochprozentigem Ferrosilizium). Walter Conrad. A review of the technology of these processes. Ills. Serial, 1st part. 2800 w. Stahl u Eisen—June 3, 1908. No. 93633 D.

Electro-Plating.

Buck's Method of Producing an Extra

Heavy Deposit of Silver Upon the Wearing Parts of Flat Ware. Illustrated detailed description. 900 w. Brass Wld—July, 1908. No. 93848.

A New Process of Producing Dead Black Nickel Deposits, and the Method of Using Black Nickel Solutions. Describes the various operations, explaining difficulties and their causes. 2500 w. Brass Wld—July, 1908. No. 93847.

ELECTRO-PHYSICS.

Radio-Activity.

On the Emission of Electricity from the Induced Activity of Radium. William Duane. Reports investigations made in the radium laboratory of the University of Paris, and states conclusions. 4000 w. Am Jour of Sci—July, 1908. No. 93449 D.

GENERATING STATIONS.

Accumulators.

"A. C." Accumulator Sub-Stations and the Use of Accumulators for Peak Loads. A. M. Taylor. Abstract of a paper read before the Incor. Munic. Elec. Assn. Considers the possibility of putting in accumulators instead of generating plant to deal with the peak load of a station as the output increases. Discussion. 8000 w. Elect'n, Lond—July 10, 1908. No. 93865 A.

Central Stations.

Equipment of a Modern Central Station. Osborne Monnett. Illustrated description of the apparatus and operating features of the steam hydro-electric plant of the People's Power Company, Moline. Ills. 2500 w. Power—July 28, 1908. No. 93989.

The Reconstruction of an Electric Lighting Scheme with Observations on the Working of a Combined Steam and Water Power Plant. C. M. Shaw. Abstract of a paper read before the Incor. Munic. Elec. Assn. Describes the Worcester electricity supply scheme. 1800 w. Elect'n, Lond—July 3, 1908. No. 93726 A.

Chignecto Electric Plant. H. Mortimer Lamb, and W. J. B. Drew. Describes a steam power plant at the mouth of a coal mine to deliver electric power 6½ miles to the city of Amherst, N. S. 2000 w. Mines & Min—July, 1908. No. 93-518 C.

The Castelnuovo-Valdarno Power Station of the Società Mineraria ed Elettrica del Valdarno (Das Kraftwerk Castelnuovo-Valdarno der Società Mineraria ed Elettrica del Valdarno). L. Pasching. Illustrates and describes a large plant situated at a lignite mine and supplying power to Florence, Siena, and other cities of Northern Italy. Serial, 1st part. 2000 w. Elektrotech u Maschinenbau—June 14, 1908. No. 93678 D.

See also Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Design.

Some Considerations on the Design of a Generating Station. H. Richardson. Slightly abbreviated paper read before the Incor. Munic. Elec. Assn. Mainly discusses a steam turbo-alternator system with extra-high-pressure alternating supply. 5500 w. Elect'n, Lond—July 3, 1908. No. 93728 A.

Economics.

Method of Investigating the Cost of Producing Electrical Energy. Edwin D. Dreyfus. Outlines the procedure to be followed by the consideration of a concrete case. 1500 w. Elec Wld—July 4, 1908. No. 93478.

Hydro-Electric.

The Wreck of the Cazadero Hydro-Electric Power Plant on the Clackmas River, near Portland, Ore. An authentic account of the accident, though not official. 800 w. Eng News—July 23, 1908. No. 93949.

Hydraulic Power Development by the Town of Kenora. Illustrated description of a new hydro-electric plant on the Winnipeg River, Ontario. 2500 w. Eng Rec—July 18, 1908. No. 93809.

Water Power for Iron Mining. Thomas W. Orbison and Frank H. Armstrong. Illustrated description of the hydro-electric plant of the Penn Iron Mining Co., at Vulcan, Mich. 3500 w. Ir Age—July 16, 1908. No. 93774.

The Brusio Power Plant, Campocologno (Die "Kraftwerk Brusio" in Campocologno). A profusely illustrated description of this large plant. Serial, 1st part. 2500 w. Die Turbine—June 5, 1908. No. 93670 D.

The Uppenborn Power Plant (Das Uppenbornkraftwerk). S. Meyer, H. Nietz, and K. Dantscher. A very thorough illustrated description of this large plant on the Isar which supplies power to Munich. Serial, 1st part. 2000 w. Elek Kraft u Bahnen—June 4, 1908. No. 93-930 D.

Switchgear.

The Reyrolle Extra High-Tension Switchgear. Illustrated detailed description of switchgear of the iron-clad solid system. 2000 w. Elec Engr, Lond—June 26, 1908. Serial, 1st part. No. 93554 A.

Switching Apparatus and Its Practical Operation in Large Hydro-Electric Stations. Frank E. Conrad. An account of the design and operation of what has proved to be a simple and efficient switching apparatus and its practical operation. 3000 w. Elec Wld—July 25, 1908. No. 93913.

LIGHTING.

Alternating Current.

See A. C. Motors, under Dynamos and Motors.

Arc Lamps.

Recent Developments in Electric Lamps. Maurice Solomon. A general survey of the present position and prospects in both incandescent and arc lamps. 4000 w. Nature—June 25, 1908. No. 93-549 A.

Government Control.

State Regulation of Lighting Enterprises. H. L. Doherty. An address at the meeting of the Wisconsin Gas Assn. 10500 w. Am Gas Light Jour—July 20, 1908. No. 93796.

Hygiene.

A Study of the Principal Sources of Light from the Point of View of Eye Hygiene (Etude des principales Sources de Lumière au Point de Vue de l'Hygiène de l'Oeil). André Broca and F. Laporte. Includes incandescent arc, and mercury-vapor lamps. Ills. 9500 w. Bul Soc Int d'Elecns—June, 1908. No. 93-611 F.

Illumination.

The Lighting of the Washington Union Station, Washington, D. C. Illustrated description of methods employed. 2500 w. Eng News—July 30, 1908. No. 94044.

Electrical Contractors' Opportunities in the Illuminating Field. George Loring. Abstract of a paper read before the Nat. Elec. Contr. Assn. Gives suggestions for the lighting of houses and stores, and matters related. Ills. 3500 w. Elec Rev, N Y—July 25, 1908. No. 93911.

Incandescent Lamps.

Tungsten Lamp Fallacies. H. Thurston Owens. Discusses the comparative cost of tungsten and inverted mantle gas lamps. Ills. 1500 w. Am Gas Lgt Jour —July 20, 1908. No. 93795.

The Tungsten Lamp. E. F. Tweedy. Briefly describes the more important methods of manufacturing a lamp filament from the metal tungsten and its electrical and physical properties. 4000 w. Cent Sta—July, 1908. No. 93739.

The Coming Development of the One-Watt Lamp and Electric Lighting (Beitrag zur Klärung der Frage betreffend die künftige Entwicklung der einwattigen Lampe und der elektrischen Beleuchtung). H. Remané. An economic discussion of high-efficiency lamps. 3500 w. Elektrotech Zeitschr—June 11, 1908. No. 93690 D.

See also Arc Lamps, under Lighting.

Photometry.

A Selenium Photometer. Describes an ingenious photometer patented by William J. Hammer, in which the sensitivity of selenium to light is practically applied. Ills. 1200 w. Sci Am—July 18, 1908. No. 93799.

MEASUREMENT.

Cable Testing.

The Testing of High-Tension Cables. C. Feldmann and J. Herzog. Abstract translation from *Elek. Zeit.* Discusses the advantages of grading the insulation of cables. In testing, prolonged application of excessive voltage is considered harmful. 1500 w. Elect'n, Lond—July 17, 1908. No. 93967 A.

Capacity.

On Some Methods of Measuring Capacity with Alternating Currents of Complex Wave Form. Robert Beattie. Points out the error in the "direct" method of measuring capacity by alternating current, and describes how this may be overcome. 2800 w. Elect'n, Lond—July 17, 1908. No. 93968 A.

Dynamo Testing.

The Determination of the Efficiency of Electric Machines (Sulla Determinazione del Rendimento delle Machine elettriche). Salvatore Spera. Outlines a method of determining the heat and leakage losses. Ills. 3000 w. L'Indus—June 14, 1908. No. 93629 D.

Galvanometers.

The Duddell Thermo-Galvanometer. A. Frederick Collins. Illustrated description of a device for measuring extremely small currents. 1000 w. Sci Am Sup—July 18, 1908. No. 93802.

Laboratories.

The Work and Equipment of a Testing and Standardizing Department. H. A. Ratcliff. Abstract of a paper read before the Incor. Munic. Elec. Assn. Notes on various features of practical interest. 2500 w. Prac Engr—July 3, 1908. Serial, 1st part. No. 93720 A.

Meters.

The Intermediate Resistance Between Commutator and Brushes in D. C. Ampere-Hour Meters and Recent Types of the Allgemeine Elektricitäts-Gesellschaft (Ueber den Uebergangswiderstand zwischen Kommutator und Bürsten bei Amperestundenzählern für Gleichstrom und die Neukonstruktionen der Allgemeinen Elektricitäts-Gesellschaft). Ills. 2400 w. Elektrotech Zeitschr—June 18, 1908. No. 93694 D.

TRANSMISSION.

Cables.

Notes Upon Mining Cables. J. H. C. Brooking. Discusses the requirements for mining cables, their protection, etc., and illustrates and describes cables and cable accessories for mines. 6500 w. Elect'n, Lond—July 10, 1908. No. 93-875 A.

Conduits.

Reinforced-Concrete Conduits for Electric Cables; Long Island R. R. Frederick Aueryansen. Brief illustrated description of unusual conduit construction recently built in the new North Shore Freight Yard at Long Island City. 800 w. Eng News—July 3, 1908. No. 93943.

Excess Voltages.

The Cause, Effect and Control of Excess Voltages (Ursache, Wirkung und Bekämpfung von Ueberspannungen). C. Feldmann. Considers excess voltages to arise, in the main, from five types of oscillations, and discusses each. Ills. Serial, 1st part. 3600 w. Elektrotech Zeitschr—June 18, 1908. No. 93693 D.

Line Design.

Determining the Sizes of Alternating Current Line Wires. N. A. Carle. Gives charts and explanation of their use. 1200 w. Power—July 28, 1908. No. 93991.

Long-Distance Electric Transmission of Power. L. S. Bruner. Considers the design and location of the line, method of turning angles, etc., as used on the lines of the Niagara, Lockport, and Ontario Power Co. 3000 w. Pro Engrs' Club of Phila—April, 1908. No. 94006 D.

A Graphical Method for the Design of Three-Phase Transmission Lines (Método gráfico para el Cálculo de las Líneas de Transporte de Energía Eléctrica por Corrientes trifásicas). Enrique Campdera. A complete theoretical discussion. Ills. 5500 w. Rev Tech Indus—May, 1908. No. 93631 D.

The Various Methods of Designing Electrical Transmission Networks and Their Combinations (Ueber die verschiedenen Methoden zur Berechnung elektrischer Leitungsnetze und ihre Combinationen). G. Mattausch. Discusses the methods of Herzog, Coltri, Teichmüller, Frick and Kenelly. Ills. Serial, 1st part. 1400 w. Elektrotech Rundschau—June 19, 1908. No. 93676 D.

Rotary Converters.

The Voltage Regulation of Rotary Converters. 2000 w. Elec Rev, Lond—June 26, 1908. No. 93556 A.

Substations.

The Central Station Distributing System. H. B. Gear and P. F. Williams. Describes transmission and conversion systems, referring particularly to the location and design of substations. 4000 w. Elec Age—July, 1908. No. 93471.

See also Accumulators, under GENERATING STATIONS.

Transformers.

What Is the Ratio of a Transformer? Morton G. Lloyd. A criticism of the loose way in which the term "ratio" is used. 1000 w. Elec Wld—July 11, 1908. No. 93589.

Parallel Operation of Transformers. E. G. Reed. Discusses the distribution of the load current and the satisfactory parallel operation. 2500 w. Elec Wld—July 18, 1908. No. 93778.

Voltage Regulation.

Applications of the Thury Regulator (Applications du Regulateur Thury). J. A. Montpellier. Outlines its principal applications in the regulation of voltage of direct and alternating current generators. Ills. Serial, 1st part. 1200 w. L'Elecn—June 6, 1908. No. 93621 D.

MISCELLANY.

A. C. Waves.

Wave Form Analysis. P. M. Lincoln. A description of the Fischer-Hinnen method and its adaptation, with editorial comment. 3000 w. Elec Jour—July, 1908. No. 93757.

Farm Work.

The Equipment of Farms and Country Houses with Electricity. Putnam A. Bates. A résumé of what has been accomplished in applying electricity for lighting and power. Ills. 6000 w. Jour Fr Inst—July, 1908. No. 93998 D.

Resistances.

The Design of a Continuously Adjustable Resistance. J. T. Morris, R. Milward Ellis, and F. Stroude. Describes the various arrangements tried, the difficulties met, and the arrangement finally adopted. Ills. 2000 w. Elect'n, Lond—June 26, 1908. No. 93557 A.

INDUSTRIAL ECONOMY

Cost Systems.

Obtaining Actual Knowledge of the Costs of Production. This fourth article of a series discusses the use and abuse of mechanical aids in cost finding. 1800 w. Engineering Magazine—Aug., 1908. No. 94017 B.

Accounting and Cost Systems (Kalkulations- und Selbstkostenwesen). H. Meltzer. The first part discusses the importance and general principles of systematic accountancy. Forms. Serial, 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—June 20, 1908. No. 93685 D.

See also Management, under INDUSTRIAL ECONOMY.

Education.

A Justification of the Technical School. Stanley G. Harwood. A reply to the paper by Frank Foster, on "The Un-Academic Side of Engineering." 2000 w. Ry & Engng Rev—July 25, 1908. No. 93962.

Two Years of the Coöperative Engineering Courses at the University of Cincinnati. Herman Schneider. Read before the Soc for Pro of Engng. Ed. Also editorial. Describes the system inaugurated in Cincinnati and its working. 5800 w. Eng News—July 9, 1908. No. 93594.

Labor.

Industrial Politics in England. Discusses the labor movement. 3500 w. Ir Age—July 16, 1908. No. 93775.

Japanese Factory Hands and Labor Conditions. M. Kawara. A brief review of changes due to the introduction of western ideas. 1200 w. Engineering Magazine—Aug., 1908. No. 94018 B.

Management.

The General Principles of Cost Accounting. Oscar E. Perrigo. Tenth of a series of articles on shop management and cost keeping. 5500 w. Ir Trd Rev —July 2, 1908. No. 93513.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This second article of a series discusses national efficiencies; their tendencies and influence. 5500 w. Engineering Magazine—Aug., 1908. No. 94010 B.

Patents.

Some Features of the German Patent Laws. Henry E. Schmidt. Facts relating to German patent and trade-mark legislation. 1500 w. Am Mach—Vol. 31, No. 29. No. 93788.

Production Census.

The Census of Production. An account of the steps taken by the United Kingdom, British Colonies and the United States to ascertain the extent of their own manufacturing industries. 2000 w. Engr, Lond—June 26, 1908. Serial, 1st part. No. 93718 A.

Stores Keeping.

Foundry Warehouse Methods. F. C. Everitt. Read before the Am. Found. Assn. Considers the arrangement of floors and a practical system for keeping records of stock and shipments. 1500 w. Foundry—July, 1908. No. 93572.

See also same title, under RAILWAY ENGINEERING, Motive Power and Equipment.

Sweden.

Mining and Industrial Progress in Sweden. John Geo. Leigh. This second article deals chiefly with the character and equipment of the leading industrial works. Ills. 6500 w. Engineering Magazine—Aug., 1908. No. 94012 B.

Wages.

The Various Plans for Payment of Wages. Harrington Emerson. A discussion of Forrest E. Cardullo's article on the system of diminishing and increasing premiums for the purpose of increasing the efficiency of employees. 3500 w. Ir Trd Rev—July 23, 1908. No. 93933.

MARINE AND NAVAL ENGINEERING

Ash Ejectors.

Schäffer & Budenberg's Patent Automatic Ash Ejector. Illustrates and describes this appliance for removing ashes from the stokeholds of steamships at sea, explaining its advantages. 1300 w. Mech Engr—July 3, 1908. No. 93725 A.

Barges.

Steam-Winch Coaling-Barge. Illustrated description of a barge constructed by Thomas White. 600 w. Engng—June 26, 1908. No. 93564 A.

Battleships.

U. S. S. New Hampshire. William Ashley Leavitt, Jr. Illustrated description and report of official trials. 13000 w. Jour Am Soc of Nav Engrs—May, 1908. No. 93999 H.

Progress of Warships and Machinery Under Construction in England. A review of ships under construction and their equipment. 2500 w. Engr, Lond—July 10, 1908. No. 93896 A.

Cruisers.

Description and Trials of U. S. S. Chester. A. F. H. Yates. Ills. 10000 w. Jour Am Soc of Nav Engrs—May, 1908. No. 94001 H.

The Trials of the Scout Cruiser "Salem." An illustrated account of the trials of a cruiser equipped with Curtis turbines. 2500 w. Sci Am—July 11, 1908. No. 93597.

The Indian Pilot Cruiser "Lady Fraser." Illustrated description by a twin-screw steamer designed to be a floating home for pilots. 1200 w. Engng—July 17, 1908. No. 93985 A.

Electric Power.

Electrical Equipment of Ships. W. D. Kirkpatrick. Read before the Liverpool Engng. Soc. Considers the applications made and the advantages secured by the use of electricity on shipboard. 2500 w. Mech Wld—June 26, 1908. Serial, 1st part. No. 93548 A.

Explosives.

Smokeless Powders. Editorial on the explosion on board the Jena, and the reports investigating the causes of the disaster. 2200 w. Engng—July 10, 1908. No. 93892 A.

Fire Boats.

Fire Fighting Equipment for Tugboats. R. H. Newbern. Read before the Nat. Fire Protection Assn. Describes the equipment of tug-boats with fire-fighting appliances. 1800 w. R R Age Gaz—July 24, 1908. No. 93940.

Lusitania.

Speed Trials and Service Performance of the Cunard Turbine Steamer Lusitania. Thomas Bell. Read before the Inst. of Nav. Archts. Describes the turbine machinery and its running, reporting the various trials made. Ills. 3000 w. Engr, Lond—July 10, 1908. No. 93898 A.

Mauretania.

The Recent Runs of the "Mauretania." Editorial discussion of recent trans-Atlantic records and the conditions under which the runs were made. 1200 w. Engng—June 19, 1908. No. 93429 A.

Oil Fuel.

Oil Fuel for Ships. Reviews the progress made in the application to the vessels in the merchant service, illustrating types of burners, and describing the Körting system. 2500 w. Engng—June 19, 1908. No. 93425 A.

Pinnaces.

Steam-Pinnaces for Naval Service. Illustrates and describes 12 steam-pinnaces built in England for the Argentine navy. 500 w. Engng—July 10, 1908. No. 93-891 A.

Propellers.

A Comparison of Propeller Theories (Vergleichung von Propeller Theorien). Rudolf Mewes. A mathematical paper. Serial, 1st part. 2000 w. Die Turbine—June 20, 1908. No. 93672 D.

Resistance.

A Comparative Criticism of Formulæ for the Determination of Ship Resistance and Their Utility (Vergleichende Kritik der Formeln zur Bestimmung des Schiffswiederstandes und ihre Brauchbarkeit). Albert Achenbach. Mathematical and theoretical. Ills. 3500 w. Serial, 1st part. Die Turbine—June 5, 1908. No. 93667 D.

Shipbuilding.

Harland and Wolff's Works at Southampton. Illustrated detailed description of new shipbuilding works and their equipment. Plates. 3500 w. Engr, Lond —July 17, 1908. No. 93979 A.

Ship Design.

A New System of Ship Construction. J. W. Isherwood. Read before the Inst. of Nav. Archts. Illustrated detailed description of the arrangement of the framework, and information concerning stresses, erection, etc. 4500 w. Engng—June 19, 1908. No. 93433 A.

Framing of Vessels. E. Hall Craggs. A review of such structures and systems as have come within the writer's experience, and description of the longitudinal system with which Mr. Isherwood's name is associated. Discussion. 11 plates. 6000 w. Trans N-E Coast Inst of Engrs & Shipbldrs—June, 1908. No. 93452 N.

Steamboats.

New Southern Steamers. Illustrated description of the steamboat John W. Callahan, steamboat Lucille, and tug Cuba, with notes on other craft. 1500 w. Naut Gaz—July 23, 1908. No. 93906.

Steam Boilers.

Hints on the Construction of Water-Tube Boilers (Winke für die Konstruktion von Wasserrohrkesseln). Köhn v. Jaski. Discusses recent types for marine purposes. Ills. 3000 w. Schiffbau—June 10, 1908. No. 93660 D.

Steam Engines.

A Practical Comparison of the Advantages of Higher Cylinder Ratios. C. S. Root. Gives an account of two moderately long runs with the same vessel with different cylinder ratios. 1800 w. Jour Am Soc of Nav Engrs—May, 1908. No. 94002 H.

Steam Turbines.

The Weight of Marine Turbines. Discusses the tendency to increase in weight, the causes, and means whereby the weight can be safely reduced. 2200 w. Engr, Lond—June 19, 1908. No. 93434 A.

Steering Gear.

The Continuous Indication of the Work of Steering Engines During Operation (Die fortlaufende indikatorische Untersuchung von Rudermaschinen während der Rudermanöver). Herr Praetorius. Describes a method and illustrates results obtained. Serial, 1st part. 3000 w. Schiffbau—June 24, 1908. No. 93-661 D.

Superheaters.

Recent Designs of Superheaters for Marine Boilers (Konstruktive Neuerungen an Ueberhitzern für Schiffskessel). Carl Züblin. Illustrates and describes a number of types. 2000 w. Serial, 1st part. Die Turbine—June 5, 1908. No. 93669 D.

The Design of Recent Superheaters for Marine Boilers (Berechnung neuerer auch für Schiffskessel verwendbarer Ueberhitzer). P. Brauser. The first part discusses mathematically the Jacobi superheater. Ills. Serial, 1st part. 1500 w. Die Turbine—June 5, 1908. No. 93671 D.

AUTOMOBILES.

Cabs.

Motor Cabs in Paris (Les Fiacres automobiles à Paris). L. Périssé. Discusses the Paris traffic problem, the economic importance of the motor-cab service, with notes on the technical details of their operation and maintenance. Ills. 12000 w. Mem Soc Ing Civ de France—March, 1908. No. 93606 G.

Commercial Vehicles.

Motor Turntable Fire Escape for Shanghai. Illustrated description of a petrol motor turntable fire escape. 700 w. Engr, Lond—July 3, 1908. No. 93735 A.

The Commercial Vehicle Exhibit (Concours de Véhicules industriels). E. Girardault. A general discussion of the models shown at a show held in Paris, May, 1908. Ills. 4000 w. Génie Civil—June 13, 1908. No. 93624 D.

Notes of an Electric Vehicle Expert on the Results of Herr Reichel's Tests in the Berlin Fire Department (Bemerkungen eines Elektromobil-Fachmannes zu den Ergebnissen der Berliner Versuche des Branddirektors Reichel). Carl Schirmbeck. Criticizes some of Herr Reichel's conclusions on electric vehicles. 3600 w. Zeitschr d Mit Motorwagen-Ver—June 30, 1908. No. 93674 D.

Construction.

See Foundries, Machine Tools, and Shops, under MACHINE WORKS AND FOUNDRIES.

Dentz.

The 40-60 Horse Power Deutz Car (Der 40-60 pferdige Motorwagen der Gasmotoren-Fabrik Deutz, Cöln-Deutz). A. Heller. Illustrated detailed description. 2400 w. Zeitschr d Ver Deutscher Ing—June 6, 1908. No. 93684 D.

Electric.

Power Calculations for Electric Vehicles. W. J. Aitken. Reports the results of over 150 tests under different conditions. 1200 w. Am Mach—July 16, 1908. No. 93786.

See Storage Batteries, under AUTOMOBILES.

E-M-F.

Details of the E-M-F "30" '09 Model A. Illustrated description of a new medium-priced car. 2000 w. Automobile—July 30, 1908. No. 94053.

Fuels.

Comparison Between Benzol and Gasoline for Automobiles (Comparaison entre le Benzol et l'Essence pour les Automobiles). A. Grebel. Gives particular attention to the properties of benzol. Ills. 4000 w. Génie Civil—June 13, 1908. No. 93625 D.

Garages.

The Marché Saint-Honoré Garage and Its Automobile Hoist (Garage avec Monte-automobile installé dans le Marché Saint-Honoré, à Paris). G. Leroux. Devoted principally to a description of the mechanism of the elevator. Ills. Plate. 2800 w. Génie Civil—June 20, 1908. No. 93626 D.

Ignition.

Recent Developments in Magneto Ignition. Otto Heins. Illustrates and describes devices and improvements of the Bosch Magneto Co. 2500 w. Automobile—July 2, 1908. No. 93492.

Motors.

Motor Engine Design. The discussion is confined to petrol engines applied to motor vehicles. 1800 w. Prac Engr—July 3, 1908. Serial, 1st part. No. 93-719 A.

Napier.

The Napier Grand Prix Cars. Illustrations and brief description of one of the six-cylinder Napier cars built for this race. 1400 w. Autocar—July 18, 1908. No. 93965 A.

Peerless.

Peerless Models 19 and 25 for the Season of 1909. Illustrated detailed description of a 4-cylinder 30 horse power car and a 6-cylinder 50 horse power car. 2000 w. Automobile—July 16, 1908. No. 93818.

Racing Cars.

The British Racing Cars for the Grand Prix. Illustrates and describes the Austin cars, and the Weigel cars. The latter are of the live-axle type. 3000 w. Auto Jour—July 4, 1908. No. 93717 A.

Steam.

Steam from a Petrol Standpoint. A summary of knowledge gained by running a 30 h.p. White car. Ills. 3000 w. Auto Jour—July 18, 1908. Serial, 1st part. No. 93964 A.

Storage Batteries.

The Storage Battery in Automobile Work. Bruce Ford. Considers the Faure or Brush type of battery only, discussing the various uses in an automobile. 3500 w. Automobile—July 9, 1908. No. 93584.

Tires.

Points in the Tyre Problem. Goeffrey de Holden-Stone. Presents the advantages of the Victoria suspension system as a solution of the tyre problem. 2500 w. Autocar—July 4, 1908. No. 93716 A.

The Making of G. & J. Tires. Illustrated description of stages in the process of manufacturing tire casing at an Indianapolis factory. 1500 w. Automobile—July 2, 1908. No. 93493.

COMBUSTION MOTORS.

Fuels.

Alcohol as a Fuel for Internal-Combustion Engines. Thomas L. White. Discusses the sources of a cheap and ample supply of fuel alcohol. 4000 w. Engineering Magazine—Aug., 1908. Serial, 1st part. No. 94016 B.

Gas Engine Ignition.

Induction Coils for Gas Engines. Eric J. Edwards. Deals only with the "make-and-break" or "touch-spark" method of ignition. 4000 w. Transit, Univ of Iowa—Vol. XIII, 1908. No. 93766 N.

Gas Engine Indicators.

Defects in an Indicator Reducing Motion. Walter H. Adams. Explanation of the defect and method of correcting it. 1200 w. Power—July 14, 1908. No. 93753.

Gas Engines.

800-B.-H.-P. Twin Cylinder Two-Cycle Gas-Engine with Electric Generator. Illustration, with description, of an engine at the Franco-British Exhibition. 1700 w. Engng—June 19, 1908. No. 93432 A.

No Load Gas-Engine Tests (Leergangversuche an Gasmaschinen). R. Schöttler. Gives the results of tests on four four-cycle engines. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—June 20, 1908. No. 93686 D.

Gasoline Engines.

Adams-Farwell Aeronautic Gasoline Motor. Illustrated description. 1600 w. Mach, N Y—July, 1908. No. 93458 C.

New 5-Cylinder Aeronautical Motor. Illustrated description of the Adams-Farwell motor, which is of exceedingly light weight per h. p. 2000 w. Am Mach—Vol. 31, No. 27. No. 93475.

See also Motors, under AUTOMOBILES.

Gas Power Plants.

An Interurban Railway Gas Power Station. Cecil P. Poole. Illustrated description of the Western New York & Penn. Traction Co.'s power plant and its performance. 2000 w. Power—July 14, 1908. No. 93748.

Gas Producers.

Why Gas Producers Are Not More Successful. T. F. Christopher. Describes the three types in general use, discussing the difficulties common to each. 3000 w. Power—June 30, 1908. No. 93438.

The Carbon-Monoxide Gas Producer. W. Y. Lewis. Illustrated description of the plant installed in the works of the John Thomson Press Co., in Long Island City, stating the advantages of this process. 4000 w. Cassier's Mag—July, 1908. No. 93444 B.

HEATING AND COOLING.

Cooling Sprays.

Cooling Condensing Water by Means of Spray Nozzles. Illustrated description of this system. 1500 w. Power—July 14, 1908. No. 93754.

Electric Heating.

Heating and Ventilating by Electricity (Le Chauffage et la Ventilation par l'Electricité). R. Périssé. A review of methods and appliances. Ills. 2800 w. Bul Soc d'Encour—May, 1908. No. 93-615 G.

Hot-Air Heating.

Cast-Iron Heaters for Hot-Blast Work. Theodore Weinshank. Read before the Am. Soc. of Heat. & Vent. Engrs. Reports problems that developed in the course of tests made of a heater for the hot-blast system. Ills. 2500 w. Heat & Vent Mag—July, 1908. No. 93992.

Refrigeration.

The Absorption System Made Simple. Lewis C. Reynolds. An explanation of the heat-unit theory and its application. 1200 w. Power—June 30, 1908. No. 93437.

Management of an Absorption Plant. W. S. Luckenbach. Discusses some of the causes of breakdowns, their prevention and repair. 2500 w. Cold Storage & Ice—July, 1908. Serial, 1st part. No. 93794 C.

Compression vs. Absorption Plants. Thomas Shipley. Discusses recent claims made as to the remarkable performances of absorption, or of combined plants. 4500 w. Ice & Refrig—July, 1908. No. 93574 C.

A Novel Cooling Installation. Dr. A. Gradenwitz. Illustrates and describes a plant designed by Prof. Linde, of Munich, for the hospital at Togo, in German West Africa. 900 w. Sci Am Sup—July 11, 1908. No. 93700.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

School Buildings.

Simplifying the Installation and Operation of School Heating and Ventilating Apparatus. S. R. Lewis. Read before the Am. Soc. of Heat. & Vent. Engrs. Gives a description of a typical plan of heating and ventilating apparatus of the simplest steam plant; also furnaces with fans. 1400 w. Heat & Vent Mag—July, 1908. No. 93993.

Steam Heating.

The Movement of Damp Steam in Long Pipe Lines (Ueber die strömende Bewegung nasser Dämpfe in langen Leitungen). R. Trautmann. A mathematical discussion of some steam-heating problems. Ills. 5000 w. Gesundheits-Ing—June 20, 1908. No. 93663 D.

Theatres.

Heating and Ventilating of the Brooklyn Academy of Music. A monumental structure of composite design, most completely equipped for ample ventilation and heating, and the apparatus installed is described. Ills. 4500 w. Eng Rec—July 25, 1908. Serial, 1st part. No. 93924.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Centrifugal Pumps. Ezra E. Clark. Describes their operation in the field of fire pumps. Ills. 4500 w. Ins Engng—July, 1908. No. 94007 C.

Electric Pumping.

See Pumping, under MINING AND METALLURGY, PUMPING.

Hydraulic Plants.

A Large Hydraulic Development and Wood Pulp Mill in Canada. Illustrated detailed description of the engineering and hydraulic development of the pulp mill at Espanola, Ontario. 5500 w. Eng Rec—July 11, 1908. No. 93702.

Pumping Engines.

Tests of Pumping-Engines of the Rand Water Board, Zwaart-Kopjes Station. Describes the engines and gives results of tests. 700 w. Engng—July 10, 1908. No. 93889 A.

Pumps.

Locating Defects in Steam Pumps. W. H. Wakeman. An account of troubles and their cause. Ills. 900 w. Power—July 14, 1908. No. 93752.

Proper Thickness of a Valve Deck in a Pump. William F. Fisher. Methods of calculating are given. 700 w. Power—July 7, 1908. No. 93532.

Turbine Plants.

Large Modern Turbine Plants (Grosse moderne Turbinenanlagen). L. Zodel. The first part is a general introduction to a series of descriptions of large water-power plants in Europe. Ills. Serial. 1st part. 1500 w. Schweiz Bau—June 13, 1908. No. 93649 I.

The "La Dernier" Hydraulic Power Plant on the Orbe (Wasserkraftanlagen "La Dernier" am Orbe). A. Stoll. An illustrated detailed description of this Swiss plant. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—June 10, 1908. No. 93664 D.

Turbines.

Turbine Blades (Die Schaufelenden der Kreiselräder). Dr. H. Lorenz. A mathematical discussion of their design. Ills. 3500 w. Zeitschr f d Gesamte Turbinenwesen—June 30, 1908. No. 93666 D.

Series Construction of High-Speed Compound Turbines (Construction en Série des Turbines mixtes à grande Vitesse). J. Lafitte. A discussion of the type with notes on the design. Ills. 2200 w. Génie Civil—June 6, 1908. No. 93623 D.

Notes on the Design and Construction of Turbine Machinery (Beiträge zur Berechnung und konstruktion der Turbomaschinen). W. Wagenbach. Discusses principally the design of the rotor of hydraulic turbines. Ills. Serial. 1st part. 1100 w. Zeitschr f d Gesamte Turbinenwesen—June 20, 1908. No. 93665 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

See same title, under MACHINE WORKS AND FOUNDRIES.

Cams.

Cam Applications. George W. Armstrong. Illustrates and describes various mechanisms employed in connection with cams. 2500 w. Mach, N Y—July, 1908. No. 93457 C.

Couplings.

The New Coupling of the Berlin-Anhaltischen Maschinenbau-A.-G. (Die neue Kraftmaschinenkupplung der Berlin-Anhaltischen Maschinenbau-A.-G.) O. Ohnesorge. Illustrated detailed description. 4500 w. Zeitschr d Ver Deutscher Ing—June 27, 1908. No. 93687 D.

Crossheads.

See Engine Design, under STEAM ENGINEERING.

Gears.

Direction of Rotation of Epicyclic Gears. Reprint of an article by A. T. Woods, which appeared in 1889, with remarks on its value, by Oscar J. Beale. 2200 w. Am Mach—Vol. 31. No. 28. No. 93586.

The Safe Working Loads for Gear Teeth. Charles H. Logue. Gives charts for designing teeth for wear, and taking into consideration hardness, and elastic limit of material, etc. 1000 w. Am Mach—Vol. 31. No. 30. No. 93916.

Graphics.

A New Development in Cross-Section Paper. Henry Hess. Presents an improvement in cross-section paper, explaining its advantages and use in the graphic derivation of an expression, law or formula defining the quantitative relationship of plotted observations. 6800 w. Pro Engrs' Club of Phila—April, 1908. No. 94005 D.

Mechanics.

A Revision of the Fundamental Laws of Matter and Energy. Gilbert N. Lewis. Aims to show that a simple system of mechanics may be constructed, which is consistent with all known experimental facts. 3500 w. Tech Qr—June, 1908. No. 93772 E.

Mensuration.

The Guldin Theorems (Les Théorèmes de Guldin). M. Nachtergal. Shows the derivation of various formulae in mensuration and the application of the method to finding the volume of machine parts. Ills. 3000 w. All Indus—June, 1908. No. 93620 D.

Riveted Joints.

Calculating the Strength of Riveted Joints. S. F. Jetter. Showing how such calculations can be made by simple arithmetic. 4500 w. Power—July 7, 1908. No. 93536.

Speed Changing.

A Speed-Changing Mechanism Without Gears. H. M. Russell, Jr. Brief description of a novel differential movement. Ills. 800 w. Am Mach—Vol. 31. No. 29. No. 93787.

Stresses.

Guest's Law on Combined Stresses. C. A. Smith. Discusses instances illustrating combined stresses, giving results of calculations and describing difficult experiments which have led to the acceptance of Guest's law. Ills. 3500 w. Engng—July 10, 1908. No. 93887 A.

Wheels.

Designing Wheels for Corliss Engines. L. L. Willard. Gives directions for determining the required diameter and face, and for finding the proper weight of wheels for various cases. 2000 w. Power—July 21, 1908. No. 93844.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

Method of Making Aluminum Castings in a Connecticut Foundry. Illustrates and describes methods used at Fairfield, Conn. 2400 w. Brass Wld—July, 1908. No. 93846.

Annealing.

See Furnaces, under MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

The Production of Ball Bearings (Die Herstellung der Kugellager). Fritz Huth. Describes the machines used. Ills. 1500 w. Serial. 1st part. Zeitschr f Werkzeng—June 15, 1908. No. 93653 D.

Boiler Making.

Building the Modern High Power Boiler. Discusses rivet and plate heating practice and effect of high altitudes on stack draft. 2500 w. Ir Trd Rev—July 30, 1908. No. 94052.

Design and Construction of a Marine Boiler. Describes some of the difficulties met in the shop in building a boiler of the water-back marine type. 3300 w. Boiler Maker—July, 1908. No. 93468.

Flanging Boiler Plates. Frank B. Kleinhans. The present number illustrates and describes early methods of flanging. 1200 w. Boiler Maker—July, 1908. Serial. 1st part. No. 93469.

Boring Mills.

Vertical Turning and Boring Mill at the Franco-British Exhibition. Joseph Horner. Illustrates and describes a 4 ft. mill having novel features; notably a chain-drive to a worm which turns the table. 1500 w. Engng—July 17, 1908. No. 93983 A.

Brass Founding.

The Leakage of Castings Under Pressure. Considers some of the causes of leakage and the best methods of remedying the trouble. Ills. 1400 w. Brass Wld—July, 1908. No. 93849.

Improving the Appearance of Cheap Brass. Walter J. May. Helpful suggestions for the treatment of castings. 900 w. Prac Engr—July 17, 1908. No. 93971 A.

Prolonging the Life of Crucibles. Dudley A. Johnson. Read before the Am. Brass Found. Assn. Suggestions for improvement in crucible manufacture and use. 2000 w. Foundry—July, 1908. No. 93575.

See also Electro-Plating, under ELECTRICAL ENGINEERING, ELECTRO-CHEMISTRY.

Brazing.

Brazing (Das Hartlöten). August Bauschlicher. Discusses applications, methods and appliances. Ills. 3500 w. Zeitschr f Werkzeng—June 15, 1908. No. 93654 D.

Castings.

Large Castings (Grosse Guszstücke). C. Irresberger. A discussion of difficulties in their production and means of overcoming them. Ills. Serial. 1st part. 1800 w. Stahl u Eisen—June 3, 1908. No. 93634 D.

Hard Spots in Steel Castings, with an Account of Certain Diffusion Phenomena. Arthur P. Scott. Detailed account of an investigation made of a hard spot encountered in a steel roll. Ills. 5000 w. Elec-Chem & Met Ind—July, 1908. Serial. 1st part. No. 93456 C.

Chain Making.

Making Weldless Chains by the Annular Rolling Method (La Fabrication des Chaînes sans Soudure par le Procédé du Laminage annulaire). Eng. François. Discusses the process and the product. Ills. Serial. 1st part. 5500 w. All Indus—June, 1908. No. 93619 D.

Core Boxes.

See Molding, under MACHINE WORKS AND FOUNDRIES.

Drawing Presses.

See Sheet-Metal Working, under MACHINE WORKS AND FOUNDRIES.

Straight Floor Car Wheel Foundry. Illustrated description of the operating methods of the Dickson Car Wheel Co., Houston, Texas. 1200 w. Foundry—July, 1908. No. 93570.

Foundries.

Foundry Plants and Machines for Automobile Construction (Giesserei-Anlagen und Maschinen für den Automobilbau). Illustrates and describes many types of molding machines and the arrangement of a typical foundry for the production of automobile castings. 4000 w. Zeitschr f Werkzeug—June 25, 1908. No. 93655 D.

Foundry Materials.

Ferro-Alloys in the Foundry. W. M. Saunders. Read before the Am. Found. Assn. Discusses the use of various alloys and the properties they impart to cast iron. 2000 w. Foundry—July, 1908. No. 93576.

Furnaces.

Small Annealing Furnaces and Muffles. Walter J. May. Suggestions for their construction and use. Ills. 700 w. Prac Engr—July 3, 1908. No. 93721 A.

A Twin Chambered High-Speed Furnace. S. N. Brayshaw. A new patented furnace for hardening high-speed steel, using either gas or oil for fuel, is illustrated and described. 2500 w. Am Mach—Vol. 31, No. 31. No. 94039.

Grinding.

Emery Wheels and Their Uses. Hints on the situation, use, and application of emery wheels. Ills. 2500 w. Mech Engr—July 10, 1908. Serial. 1st part. No. 93863 A.

Grinding Disk Tests. Illustrated account of tests made by the Gardner Machine Co., Beloit, Wis., to determine the comparative efficiency of different kinds of abrasive disks. 1500 w. Ir Age—July 30, 1908. No. 94037.

Grinding Machines.

See Shop Appliances, under Machine Works and Foundries.

Guns.

Vickers Ordnance at the Franco-British Exhibition. Illustrates and describes improvements represented by these exhibits. Plate. 3500 w. Engng—June 26, 1908. No. 93560 A.

Lathes.

9¼-In. High-Speed All-Geared Lathe. Illustrated description of a lathe shown by the Colchester Lathe Co., at the Franco-British exhibition. 1500 w. Engng—June 19, 1908. No. 93427 A.

Sliding, Surfacing, and Screw-Cutting Lathe; Franco-British Exhibition. Illustrated description of a lathe of this type exhibited by M. Emile Chonânard. 500 w. Engng—June 19, 1908. No. 93426 A.

Machine Tools.

The Franco-British Exhibition. Calls attention to some interesting exhibits in the British machinery section. 3300 w. Engng—July 17, 1908. No. 93980 A.

Some Interesting German Machine Tools. J. W. Carrel. Illustrates and describes tools showing originality of design. 2000 w. Am Mach—Vol. 31. No. 31. No. 94041.

A Noteworthy Combination Machine Tool. Illustrates and describes a machine capable of a great variety of work on heavy castings. 1200 w. Am Mach—Vol. 31. No. 28. No. 93585.

All-Gear Drives for Machine Tools. Thomas R. Shaw. Illustrates and describes some of the most recent examples of this style of drive. 1500 w. Mech Engr—July 10, 1908. Serial. 1st part. No. 93861 A.

Special Machines and Tools Used in Upright Drill Manufacture. Illustrates and describes interesting special tools used in a shop at Rockford. Ill. 3500 w. Mach, N Y—July, 1908. No. 93460 C.

Special Tools and Appliances for the Manufacture of Automobile Parts (Spezial Maschinen und Vorrichtungen für die Herstellung von Automobilteilen). Ernst Valentin. A profusely illustrated article describing European machines and methods. Serial. 1st part. 4000 w. Zeitschr f Werkzeng—June 15, 1908. No. 93652 D.

Milling Machines.

The Milwaukee High Power Miller. Illustrated description of the Milwaukee No. 3-B universal milling machine. 3500 w. Ir Age—July 30, 1908. No. 94035.

An English Milling Machine with Independent Belt Feed. I. W. Chubb. Illustrated description. 700 w. Am Mach—Vol. 31. No. 29. No. 93785.

A design for a Plain Milling Machine. H. F. Noyes. Illustrates a machine with a constant belt speed with sixteen changes and all gears in oil. 1200 w. Am Mach—Vol. 31. No. 29. No. 93784.

A Double-Spindle Spline Milling Machine. Illustrated description of a novel machine with two cam-controlled spindles and reciprocating table for feeding the work between the cutters. 2000 w. Am Mach—Vol. 31. No. 27. No. 93473.

Molding.

All-Core Molding of Turbine Rings. Joseph Horner. Illustrated description of the design and construction of core boxes and methods of molding. 1200 w. Am Mach—Vol. 31. No. 28. No. 93588.

Molding Machines.

A Multiple Molding Machine. James Cooke Mills. Illustrates and describes the invention of John A. Rathbone. 700 w. Sci Am—July 18, 1908. No. 93798.

Bonvillian & Ronceray Molding Machines (Ein neues Formverfahren und seine Maschinen Patent Bonvillian & Ronceray). A. F. Hager. Illustrated description of various machines. 3000 w. Zeitschr d Oest Ing u Arch Ver—June 26, 1908. No. 93658 D.

See also Foundries, under MACHINE WORKS AND FOUNDRIES.

Molding Sands.

Relative Values of the Physical and Chemical Examinations of Molding Sands. Heinrich Ries. Read before the Am. Brass Found. Assn. Gives evidence leading to the conclusion that the physical tests are far more important. 2500 w. Foundry—July, 1908. No. 93573.

Pattern Making.

Patterns for Twin Locomotive Cylinders. C. Patton. Illustrates and describes methods used. 1000 w. Am Mach--Vol. 31. No. 31. No. 94040.

Pipe Founding.

Progress in Pipe Founding (Neuerungen in Röhrengiessereien). Oskar Simmersbach. A review of recently introduced processes and appliances. Ills. 3500 w. Stahl u Eisen—June 17, 1908. No. 93636 D.

Saws.

The Teeth of Circular Saws (Ueber die Zahnung von Kreissägen). D. Dominicus. Illustrates many tooth forms and discusses their efficiency and application to various classes of work. 2000 w. Zeitschr f Werkzeng—June 5, 1908. No. 93650 D.

Sheet-Metal Working.

Sheet-Metal-Working Tools at the Franco-British Exhibition. Joseph Horner. Illustrated description of interesting exhibits. 3000 w. Engng—July 10, 1908. No. 93888 A.

Shop Appliances.

Some Special Tools Used in Italian Shops. E. Domon. Illustrates and describes ingenious fixtures used in machining carburetters, etc. 1400 w. Am Mach —Vol. 31. No. 28. No. 93587.

Tools and Equipment in Structural Shops. George P. Thomas. Suggestions of value. Also general discussion. 6500 w. Pro Engrs' Soc of W Penn—July, 1908. No. 94023 D.

The Aerochuck and a Few of Its Many Uses. E. F. Lake. Illustrated descriptions of chucks and clamps which are opened and closed by compressed air, explaining their usefulness. 2000 w. Am Mach—Vol. 31. No. 30. No. 93915.

Tools and Methods of the E. Howard Watch Co. F. A. Stanley. Illustrates and describes grinding machine and miller attachments and some bench lathe and other appliances used in connection with accurate watch work. 3000 w. Am Mach—Vol. 31. No. 29. Serial. 1st part. No. 93783.

See also Machine Tools, under MACHINE WORKS AND FOUNDRIES.

Shop Hygiene.

The Idea of Personal Hygiene in Industry (La Notion de l'Hygiène individuelle dans l'Industrie). A. Beauquis. Discusses the moral obligation on employers to secure sanitary surroundings for workmen and the economic effects of industrial betterment. 4500 w. Rev d'Econ Indus—June, 1908. No. 93602 D.

Shop Practice.

Machining a Crankshaft for a Three-Throw Pump. S. Laurence. Prize paper. Illustrated detailed description of the work. 1200 w. Mech Wld—July 10, 1908. No. 93860 A.

The Development of Mechanical Movements. J. G. Vincent. Describes the laying out of metal parts accurately by means of master plates bored to centers corresponding to those found in the machine frames. 2000 w. Am Mach—Vol. 31. No. 27. No. 93476.

The Product and Methods of European Locomotive Works. Charles R. King. This third and concluding article of a series considers principally the machine tools and shop methods in practice in Italy and on the Continent. Ills. 3500 w. Engineering Magazine—Aug., 1908. No. 94014 B.

Shops.

The New Works of Messrs. Peter Brotherhood, Ltd. Illustrated description of the new works at Peterborough, for the manufacture of engines, air compressors, etc. Plate. 3000 w. Engng—July 17, 1908. No. 93981 A.

Automobile Shops (Automobil-Fabrikanlagen). Ernst Valentin. Enumerates and discusses the various departments of an automobile works and comments on the organization necessary. Ills. 2500 w. Zeitschr f Werkzeng—June 15, 1908. No. 93651 D.

Shop Ventilation.

Purity of Air in Factories (La bonne Aération des Ateliers). M. Perbost. A discussion of ventilation problems in relation to the effect of impure air on workmen. 3500 w. Serial. 1st part. Rev d'Econ Indus—June, 1908. No. 93603 D.

Taps.

Special and Adjustable Taps. Erik Oberg. Illustrates and describes a number of forms. 2500 w. Mach, N Y—July, 1908. No. 93461 C.

Tempering.

Hardening High-Speed Steel Tools by the Barium-Chloride Process. O. M. Becker. A working description of the operations and appliances needed. Ills.

3000 w. Engineering Magazine—Aug., 1908. No. 94015 B.

Tools.

Making and Using of High-Speed Steel Tools. A. L. Valentine. Discusses the composition of the metal, results of practical work, and other matters relating to this material. 4000 w. Am Mach—Vol. 31. No. 93474.

Wire Drawing.

A New Friction Block for Wire Drawing Frames. Illustrated description of the Carroll friction block which has a friction clutch of the coil type designed to meet the requirements of wire-drawing. 2500 w. Ir Age—July 30, 1908. No. 94036.

Woodworking Machines.

Machines for Making Slack-Barrels. Illustrated description of special machinery for making barrels for Portland cement. 1500 w. Engng—June 26, 1908. No. 93562 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Magnalium. Notes on the valuable characteristics of this aluminum alloy. 1300 w. Mach, N Y—July, 1908. No. 93459 C.

New Applications of Electro-Metallurgical Alloys. Ad. Jouve. Abstract of a paper read before the Faraday Soc. Concerning the production of material capable of resisting acids. 700 w. Ir & Coal Trds Rev—June 26, 1908. No. 93568 A.

Alloy Steels.

The Static and Dynamic Properties of Steels. W. L. Turner. On the need of thorough investigation of different alloy steels, reporting test results obtained by the writer. 4000 w. Ir Age—July 2, 1908. No. 93465.

Aluminium.

See Aluminium Founding, under Machine Work and Foundries.

Bronze.

The Metallurgy of the Bronze Age. W. M. Corse. Read before the Am. Brass Found. Assn. A discussion of the bronze age in Europe, including a reference to early practice and mixtures. 3000 w. Foundry—July, 1908. No. 93571.

Heat Insulation.

The Conductivity of Heat Insulating Materials (Die Wärmeleitfähigkeit von Wärmeisolierstoffen). Wilhelm Nusselt. Gives the results of tests on a number of materials. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—June 6, 1908. No. 93682 D.

Manganese Bronze.

Manganese Bronze. C. R. Spare. From a paper read before the Am. Soc. for Test Materials. Concerning the value of this metal, the testing methods, use and demands. 1200 w. Ir Age—July 30, 1908. No. 94038.

Metallography.

Note on the Structure of a Brittle Sheet of Very Low Carbon Steel. Albert Sauveur. Illustrated description of a peculiar structure. 400 w. Elec-Chem & Met Ind —July, 1908. No. 93453 C.

A Laboratory Experiment to Illustrate the Changes in Magnetic Properties Occurring at the Thermal Critical Points in Steel. H. M. Boylston. Describes the method and apparatus used, giving suggestions for the practical application of the principle involved. 1300 w. Elec-Chem & Met Ind—July, 1908. No. 93454 C.

The Carbon-Iron Diagram. Henry M. Howe. Gives the reasons which led to Roozeboom's form of the diagram, and those that led to the replacing it with the double diagram. Also considers the graphite-iron diagram and related matters. 21000 w. Bul Am Inst of Min Engrs—July, 1908. No. 94026 E.

A Contribution to the Study of Steels Containing Phosphorus (Contribution à l'Etude des Aciers Phosphoreux). M. J. de Kryloff. A metallographic study of the effects of various amounts of phosphorus on the properties of steel. Ills. 1300 w. Rev de Métal—June, 1908. No. 93697 E + F.

Steel.

Loop Eyes and Upset Ends on Steel Rods. Malverd A. Howe. A report of tests made to get information as to causes of failure. 800 w. R R Age Gaz—July 31, 1908. No. 94054.

Wood.

Tests of Vehicle and Implement Woods. H. B. Holroyd and H. S. Betts. Gives results of tests made to obtain a better knowledge of their mechanical properties. Ills. 5600 w. U S Dept of Agri—Circ 142—No. 93758 N.

MEASUREMENT.

Dynamometers.

The Rotation Dynamometer (Dinanmómetre de Rotacion sistema M. Donat Banki). César Serano. Illustrates and gives a mathematical analysis of the design. 3000 w. Energia Elec—June 25, 1908. No. 93632 D.

Hardness.

Notes on the Rebounds of a Ball and the Information They May Give as to the Hardness and Elasticity of Bodies (Remarques sur les Rebondissements d'une Bille et les Renseignements qu'ils peuvent donner sur la Dureté et l'Elasticité des Corps). M. de Fréminville. Refers to the Shore sclerometer. Also discussion by M. M. Breuil, Mauer, and Mesnager. 9000 w. Rev de Métal—June, 1908. No. 93699 E + F.

Testing Materials.

The Testing of Alloys. W. B. Parker. Read before the British Found. Assn. A general survey of the subject with illustrations from the writer's experience. Ils. 6000 w. Engng—July 10, 1908. No. 93894 A.

Notched-Bar Impact Tests. Deals with a report presented by Dr. Ing. Ehrensberger, of Essen, to the Deutsche Verband für Material-prüfungen. Ills. 2000 w. Engng—June 19, 1908. No. 93424 A.

Board of Trade Rules for Boiler Materials. A copy of circular, No. 1443, dealing with the manufacture and testing of steel material intended for boiler and machinery under Board of Trade Survey. 3000 w. Mech Engr—July 10, 1908. No. 93862 A.

Instructions to Surveyors. Circular, No. 1443, issued by the Marine Department of the Board of Trade, dealing with the manufacturing and testing of steel material intended for boilers and machinery. 2200 w. Engr, Lond—July 3, 1908. No. 93734 A.

POWER AND TRANSMISSION.

Air Compressors.

Compressing Air by an Improved Method. Jos. H. Hart. Information concerning the bucket pumps system of compressing air for mining work. 2200 w. Min Wld—July 25, 1908. No. 93957.

Compressed Air.

See Pipe Flow, under CIVIL ENGINEERING, WATER SUPPLY.

Costs.

The Cost of Power. W. N. Polakow. Discusses the correct method of determination and what it must show. 1500 w. Power—July 14, 1908. No. 93749.

Electricity in a Belgian Steel Works. Illustrated description of the equipment of extensive steel works of Tilleur, Belgium. 2500 w. Elec Wld—July 25, 1908. No. 93912.

Electric Driving.

Converting Hand-Blown Organs. J. W. Warr. Sketches and description of methods used in adapting hand-worked organs to use electric motors. 1500 w. Elec Rev, Lond—June 26, 1908. No. 93555 A.

Flywheels *versus* Storage Batteries for Equalizing Fluctuating Loads. G. C. Allingham. Shows the limitations of flywheel storage, and the advantage of employing storage batteries. 1300 w. Elect'n, Lond—July 10, 1908. No. 93873 A.

Gas Power.

Power Transmission. Prof. C. A. Smith. A comparative study of the merits of gas and electricity as applied to modern problems. 3000 w. Cassier's Mag—July, 1908. No. 93448 B.

Gearing.

See Machine Tools, under MACHINE WORKS AND FOUNDRIES.

Power Plants.

Works Engine Houses. Arthur Titley. An illustrated discussion of power-plant design for manufacturing and engineering plants. 2000 w. Cassier's Mag—July, 1908. No. 93441 B.

Building a Power Plant. John H. Ryan. Describes a concrete example; the building and equipment. Ills. 4500 w. Power —July, 1908. Serial. 1st part. No. 93851.

Power Plant of the Bryant Paper Company. George H. Chandler. Outline description of the steam plant of a large mill in Michigan. Ills. 1000 w. Power—July 21, 1908. No. 93842.

See also Coal Handling, under POWER AND TRANSMISSION.

Shafting.

Sizes of Shafts Without Mathematics. John H. Barr. Gives a chart for rapidly solving problems involved in designing or checking shafts, explaining its use. 3000 w. Power—June 30, 1908. No. 93439.

STEAM ENGINEERING.

Boiler Cleaning.

Cleaning Water-tube Boilers. Maurice W. Campbell. Directions for cleaning. 1200 w. Power—July 21, 1908. No. 93843.

Boiler Efficiency.

Boiler Efficiency. Walter Jones. From a paper before the (British) Inst. of Heat. & Vent. Engrs. An analysis of the ratings of house-heating boilers. 2500 w. Heat & Vent Mag—July, 1908. No. 93994.

See also Smoke Prevention, under STEAM ENGINEERING.

Boiler Feeding.

Automatic Boiler-Feed Controlling Apparatus. Illustrated description of an appliance recently shown at Olympia. 1000 w. Engng—July 10, 1908. No. 93893 A.

Boiler Furnaces.

See Fuels, under STEAM ENGINEERING.

Boiler Management.

See Fuels, under STEAM ENGINEERING.

Boiler Repairs.

Some Boiler Troubles and Their Remedies. Frank Collins. Discusses various troubles, suggesting remedies. 2500 w. Boiler Maker—July, 1908. No. 93467.

Boiler Settings.

Cement and Concrete for Boiler Setting. R. I. Blakney. Directions for the work with suggestions. Ills. 800 w. Power—July, 1908. No. 93850.

Boiler Tubes.

Bursting and Collapsing Pressures of Boiler Tubes. Ulrich Peters. Gives formulæ, illustrating their use by examples. 500 w. Power—June 30, 1908. No. 93440.

Condenser Water.

See Cooling Sprays, and Cooling Towers, under HEATING AND COOLING.

Engine Design.

Design of Corliss Engine Crossheads. L. L. Willard. Illustrates and describes different types, commenting on the merits of each. 1000 w. Power—July 7, 1908. No. 93533.

See also Wheels, under MACHINE ELEMENTS AND DESIGN.

Engine Erection.

Lining-up a Horizontal Engine. C. R. Strother. Explains methods. Ills. 1500 w. Power—July 7, 1908. No. 93535.

Engines.

The Lentz Compound Engine. Illustrated detailed description of a compound drop valve steam engine. 1000 w. Engr, Lond—July 10, 1908. No. 93897 A.

Fuels.

Chemistry of Combustion. Charles F. Mabery. Read before the Int. Assn. for the Prevention of Smoke. Discusses the transformation of energy, as related to combustion. 4000 w. Ind Wld—July 13, 1908. No. 93737.

Fuel and Boiler Room Economics. C. H. Benjamin. Abstract of a paper before the Int. Assn. for the Prevention of Smoke. Suggestions on the installation of the plant, purchase and burning of fuel, etc. 2000 w. Power—July 28, 1908. No. 93990.

The Heat of Fuels and Furnace Efficiency. William D. Ennis. Defines heat, explaining how chemical composition determines heating value, and discusses other factors of combustion. 5000 w. Power—July 14, 1908. No. 93750.

Specifications for Steam Coal. A. C. Cunningham. Gives a specification believed to be reasonable and just, with explanation of the requirements, and the writer's experience. 3000 w. Jour Am Soc of Nav Engrs—May, 1908. No. 94000 H.

Use of Wood as Fuel for Steam Boilers. J. A. Johnston. Discusses the calorific value of various woods, the kind of furnace required, the size of chimney, and other conditions forming good practice. 2500 w. Power—June 30, 1908. No. 93436.

Fuel and Its Future. Vivian B. Lewis. This first lecture gives an outline of the fuels used and their development, and information relating to them. 4400 w. Jour Soc of Arts. July 17, 1908. Serial. 1st part. No. 93963 A.

Fuel Testing.

The Investigations of Fuels and Structural Materials by the Technologic Branch of the United States Geological Survey. Joseph A. Holmes. A report and historical sketch. 8000 w. Bul Am Inst of Min Engrs—July, 1908. No. 94027 D.

Smoke Prevention.

City Supervision of New Boiler Plants. A discussion of Robert H. Kuss at the convention of the Int. Assn. for the Prevention of Smoke. 4000 w. Eng Rec—July 11, 1908. No. 93703.

Steam Jets and Their Uses. A. W Puddington. Read before the Int. Assn. for the Prevention of Smoke. Considers the use of the steam jet blast to secure perfect combination and prevent smoke. 3500 w. Ind Wld—July 13, 1908. No. 93738.

Steam Generation.

Modern Steam: Its Generation and Uses. Robert Bailie. Presents facts and suggestions from recent experience. Ills. 3000 w. Jour W of Scotland Ir & St Inst—March, 1908. No. 94008 N.

Steam Pipes.

Emergency Repairs to Steam Pipes. William Kavanagh. Devices for stopping leaks in pipes are illustrated and described. 1000 w. Elec Wld—July 4, 1908. No. 93480.

Superheating.

Effects on Superheating Moist Steam. J. C. William Greth. Gives reasons why boilers must deliver dry steam to obtain the best results from superheating. 4500 w. Power—July 7, 1908. No. 93534.

See also Superheaters, under MARINE AND NAVAL ENGINEERING; and Superheating, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Thermic Accumulators.

The Halpin Thermic Accumulator and Its Applications (L'Accumulateur Thermique Halpin et ses Applications). M. Izart. A discussion of the practical results obtained by its use. Ills. 2500 w. Rev de Mécan—June, 1908. No. 93613 E + F.

Turbine Auxiliaries.

Troubles with Steam Turbine Auxiliaries. Walter B. Gump. Describes a case where the circulating pump failed to meet the guarantee, the investigation and changes. 2000 w. Power—July 14, 1908. No. 93751.

Turbines.

Some Points to Be Considered in the Purchase of Steam Turbines. John Hays Smith. Brief consideration of features that assist in selection. 1600 w. Elec Age—July, 1908. No. 93470.

Centrifugal Force on Steam in Turbine Blading. Frank Foster. Investigates the nature of these centrifugal forces, considering their probable effects on the flow of steam through the blading. 800 w. Engr, Lond—July 17, 1908. No. 93978 A.

The Zoelly Steam-Turbine. Illustrated detailed description of this turbine and information relating to it. Plates. 6000 w. Engng—July 3, 1908. No. 93731 A.

The Development of the Zoelly Turbine (Die Entwicklung des "Zoelly"-Dampfturbinenbaues). Illustrates and describes a number of installations. 2500 w. Die Turbine—June 5, 1908. No. 93668 D.

Steam Turbines (Dampfturbinen). Wilhelm H. Eyermann. The first part gives a general discussion of the various types. Ills. Serial. 1st part. 3000 w. Elektrotech Zeitschr—June 11, 1908. No. 93692 D.

Valve Setting.

Setting the Valves of the Wright Steam Engine. Hubert E. Collins. Directions for setting the gridiron valves. Ills. 3000 w. Power—July 7, 1908. No. 93531.

TRANSPORTING AND CONVEYING.

Ash Handling.

See Coal Handling, under POWER AND TRANSMISSION.

Coal Handling.

The Storage and Handling of Coal and Ashes in Power Plants. Werner Boecklin. Illustrates and describes mechanical appliances substituted for manual labor, and discusses requirements of storage. 2500 w. Cassier's Mag—July, 1908. No. 93445 B.

Cranes.

The Design of a Foundry Crane (Berechnung eines Giessereikranes). Adolf Knelles. Gives a complete mathematical demonstration of the method of designing a jib crane for heavy service. Ills. Serial. 1st part. 1200 w. Elektrotech. Rundschau—June 4, 1908. No. 93675 D.

Flange Friction in Hoisting Machinery (Die Spurkranzreibung bei Hebezeugen). E. Hillbrand. Discusses mathematically the friction due to the flanges of the wheels on which revolving and traveling cranes run. Ills. 2000 w. Elektrotech u Maschinenbau — June 21, 1908. No 93679 D.

Dock Machinery.

New Hydraulic Equipment for the Albert Dock, Hull. Illustrates and describes a new hydraulic 25-ton coal hoist and a 40-ton hydraulic coaling crane recently introduced. 1200 w. Engr, Lond—June 19, 1908. No. 93435 A.

Elevators.

Electric Elevators for High Buildings. John D. Ihlder. Illustrates and describes a new type of elevator, especially suited for high rises and great speeds. General discussion. 7000 w. Jour W Soc of Engrs—June, 1908. No. 94020 D.

See also Garages, under AUTOMOBILES.

Escalators.

A Moving Stairway in the Quai d'Orsay Station (Installation d'un Escalier à Marches Mobiles dans la Gare du Quai d'Orsay). Ch. Jullien. Illustrated description of the mechanism. Plates. 2200 w. Rev Gen d Chemins de Fer—June, 1908. No. 93616 G.

MISCELLANY.

Aeronautics.

Flying Machines for Warfare. Editorial discussion of their value, concluding that it is exceedingly doubtful. 1500 w. Eng News—July 30, 1908. No. 94045.

First Successful Flights of Bleriot's No. 8 Monoplane. Brief illustrated account. 500 w. Sci Am—July 18, 1908. No. 93800.

Experiments with a Helicopter. Otto G. Luyties. An illustrated description of experiments made to collect data for the construction of rotary flying machines. 2000 w. Sci Am—July 11, 1908. No. 93598.

Helicopter and Aeroplane. Otto G. Luyties. Aims to present the advantages of rotary machines, and to show the mechanical efficiency is higher than that of the aeroplane. 3500 w. Sci Am Sup—July 11, 1908. No. 93701.

The Speed of an Aeroplane. Dr. A. F. Zahm. Explains how it may be determined. 1000 w. Sci Am Sup—July 18, 1908. No. 93803.

The "June Bug" Aeroplane—A Competitor for the Scientific American Trophy. Brief illustrated description of the third aeroplane of Dr. Bell's Aerial Experiment Association. 800 w. Sci Am—July 4, 1908. No. 93489.

The Winning Flight of the "June Bug" Aeroplane for the Scientific American Trophy. An illustrated account of the recent competition and the successful flight made by Glenn H. Curtiss. 1200 w. Sci Am—July 18, 1908. No. 93801.

The Soaring Flight of Birds Attained Mechanically. Jacques Boyer. Explains the solution of the problem as shown by Prof. Marcell Deprez. Ills. 1000 w. Sci Am—July 25, 1908. No. 93928.

Flying Machines and Dirigible Balloons (Flugmaschinen und Lenkballons). Herr Hildebrandt. A general review of progress in aeronautics. Ills. 3500 w. Serial, 1st part. Glasers Ann—June 1, 1908. No. 93656 D.

Dirigible Aerostats (Les Aérostats dirigeables). Paul Renard. The first part of the serial gives a general discussion of the problem of controlling the direction of flight. Ills. Serial. 1st part. 15000 w. Rev Gen Sci—June 15, 1908. No. 93618 D.

Progress in Aeronautics, Particularly the Construction of Air Ships (Fortschitte in der Luftschiffahrt, insbesondere im Luftschiffbau). Hermann W. L. Moedebeck. A review of recent developments. Ills. 3000 w. Zeitschr d Ver Deutscher Ing—June 6, 1908. No. 93681 D.

Aeroplanes, Screw and Wing Machines (Drachen-, Schrauben- oder Schwingenflieger). Ansbert Vorreiter. Illustrates and describes the designs and discusses the performances, of various aeroplanes. 5000 w. Zeitschr d Mit Motorwagen-Ver—June 15, 1908. No. 93673 D.

Agricultural Machinery.

The Royal Agricultural Society's Show. Illustrates and describes the exhibits. 5000 w. Engng—July 3, 1908. Serial. 1st part. No. 93732 A.

Gyroscopes.

Some Interesting Features Concerning Gyroscopes. George T. Hanchett. On the law of gyroscopic action and its applications. 1200 w. Elec Wld—July 18, 1908. No. 93777.

MINING AND METALLURGY

COAL AND COKE.

Coal Cutting.

A New Machine for Use in Room-and-Pillar Work. Illustrated description of the Jeffrey Shortwall Machine. 900 w. Eng & Min Jour—July 4, 1908. No. 93543.

Electrical Coal-Cutting Machines. F. W. Hurd. Presents the advantages claimed, illustrating and describing well-known coal cutters. 9500 w. Elect'n, Lond—July 10, 1908. No. 93871 A.

Coke Ovens.

An Improved German Coke Oven System. A description of the von Bauer type, which avoids reversals in currents and the use of large regenerative chambers. Ills. 3000 w. Ir Trd Rev—July 30, 1908. No. 94051.

Electric Power.

Is the Electric Current Safe in Coal Mines? Rush N. Hosler. Read before the Y. M. C. A. Dist. Min. Inst. Shows the results of investigations in Europe, and discusses the dangers. 3000 w. Eng & Min Jour—July 4, 1908. No. 93545.

Switchgear for Mines. H. W. Clothier. Explains the requirements and gives illustrated descriptions of lay-outs and switchgear construction. 11000 w. Elect'n, Lond—July 10, 1908. No. 93874 A.

The Employment of Storage Batteries in Colliery Power Stations. William Maurice. Explains the advantages gained by applying accumulators for equalizing the demand. Ills. 3500 w. Elect'n, Lond—July 10, 1908. No. 93872 A.

Explosions.

Effect of Humidity on Mine-Explosions. Carl Scholz. Gives results of observations of conditions noticed during 15 years connection with coal-mines. 3300 w. Bul Am Inst of Min Engrs—July, 1908. No. 94028 C.

Recent Mine Explosions and Their Lessons. Thomas K. Adams. Read before the Coal Min. Inst. of America. Deals with the Naomi, the Monongah, and Darr explosions and their probable causes. 6500 w. Ind Wld—July 27, 1908. No. 93959.

The Ignition of Fire-damp by Sparks Struck from Rock and the Influence of Free Hydrogen on Mine Gases (Ueber die Entzündlichkeit der Schlagwetter durch Stahl und Steinfunken und den Einfluss des freien Wasserstoffes auf die Grubengase). L. Volf. 2700 w. Oest Zeitschr f Berg- u Huttenwesen—June 27, 1908. No. 93640 D.

Explosives.

Government Tests of Mine Explosions. An account of an experimental station to be erected in the United States for the testing of explosives used in coal mines. Ills. 2500 w. Sci Am—July 11, 1908. No. 93599.

The Use of Explosives in Collieries. William Maurice. Improvements in explosives and the determining factors in the ignition of firedamp are discussed, and blasting in the presence of coal dust. 2200 w. Elect'n, Lond—July 10, 1908. No. 93878 A.

Formation.

The Origin of Coal. H. M. Chance. Discusses some of the fallacies of accepted theories. 2000 w. Eng & Min Jour—July 4, 1908. No. 93544.

Mine Fires.

Fighting Fire in an Anthracite Coal Mine. P. H. Devers. An account of problems met in fighting a mine fire in the Wyoming Valley, Penn. 3500 w. Eng & Min Jour—July 11, 1908. No. 93715.

Ignition Points of Wood and Coal. Henry Hall. Brief discussion on the question of what heat is required to set wood or coal on fire, reporting tests. 1800 w. Col Guard—July 10, 1908. No. 93856 A.

Mine Locomotives.

Tests of a Benzine Locomotive Motor in Fire Damp and Protective Devices Against Danger of Fire and Explosion in the Use of Such Motors (Versuche mit einem Benzinlokomotivmotor in Schlagwettern und Erprobung von Schutzvorrichtungen gegen die Feuers- und Explosionsgefahr beim Betriebe solcher Motoren). Herr Beyling. Ills. 4200 w. Glückauf—June 13, 1908. No. 93644 D.

Mine Management.

The Supervision of Mine Workers and Means for Ensuring Eight Hours of Actual Work (Einrichtung zur Ueberwachung der Arbeiter in der Grube und Kontrollmassnahmen zur Gewährleistung einer achtstündigen Ruhezeit). F. Baum. Describes the methods of superintendence in vogue at several German collieries. Ills. 3500 w. Glückauf—June 20, 1908. No. 93645 D.

Mining.

Mining in Flat Coal Seams Under Heavy Cover. Audley H. Stow. Considers costs and details of operation. 5500 w. Eng & Min Jour—July 18, 1908. No. 93839.

Longwall Methods of Mining a Coal Seam. Lucius W. Mayer. Discusses features of this system and its advantages. 4500 w. Eng & Min Jour—July 4, 1908. No. 93542.

Coal Mining by the Retreating Room-and-Pillar System. Harvey J. Nelms. Plan of development with description. 800 w. Eng & Min Jour—July 4, 1908. No. 93541.

A Method for Working a Thick Coal Seam. Granville Poole. Describes the difficulties, and method of working under unfavorable conditions. 1500 w. Eng & Min Jour—July 4, 1908. No. 93540.

The Advantages of Flushing in Coal Mining. Lucius W. Mayer. Discusses the value of the system, and practice in the United States and Europe. Ills. 3000 w. Eng & Min Jour—July 4, 1908. No. 93538.

Mining Legislation.

Protection of Mines and Miners. James C. Beebe. Aims to give an idea of what is necessary in the way of legislation to protect the lives of the men and the property of the operator. 4000 w. Mines & Min—July, 1908. No. 93517 C.

Missouri.

Coal Mining Methods in Randolph County, Mo. J. J. Rutledge. Describes the deposits and details of methods of working. Ills. 1800 w. Eng & Min Jour —July 4, 1908. No. 93539.

Peat.

Electricity from Peat Gas. An illustrated account of a scheme being projected in Ireland. 1500 w. Sci Am Sup—July 25, 1908. No. 93929.

Peat Coal. Remarks on the efforts to develop a means of utilizing peat and lignite and the requirements, giving an illustrated description of the "Ekenberg" process which claims to have solved the problem. 3500 w. Ir & Coal Trds Rev—July 17, 1908. No. 93988 A.

Rescue Appliances.

Requirements of a Breathing-Apparatus for Use in Mines. Walter E. Mingramm. Illustrates and describes the Draeger apparatus, and its use. 2000 w. Bul Am Inst of Min Engrs—July, 1908. No. 94029 C.

The Rescue Brigade and Service Wagon of the Hibernia Company (Truppe und Gerätewagen der Bergwerksgesellschaft Hibernia für den Rettungsdienst). F. Hajemann. Gives very detailed lists of the tools, chemicals, and appliances kept on hand. Ills. 2100 w. Glückauf—June 6, 1908. No. 93643 D.

The Combined Volunteer Fire and Rescue Brigade of the Rheinpreussen Mine at Homberg (Die vereinigte Berufsfeuerwehr und freiwillige Rettungstruppe der Zeche Rheinpreussen bei Homberg a. Rhein). O. Dobbelstein. Describes the organization, station and appliances, giving the cost. Ills. 2200 w. Glückauf—June 6, 1908. No. 93642 D.

The Central Rescue Station at Beuthen, Upper Silesia, and the Development of Rescue Methods in this District (Die Zentralstelle für Grubenrettungswesen in Beuthen O. S. mit besonderer Berücksichtigung der Entwicklung des Grubenrettungswesens im oberschlesischen Industriebezirk). Herr Mandel. Describes the station, organization, rescue apparatus, training methods, etc. Ills. 4200 w. Glückauf—June 6, 1908. No. 93641 D.

Screening.

New Screening Plant at Crigglestone Collieries. Illustrated description of a new installation at these English collieries. 1500 w. Ir & Coal Trds Rev—July 3, 1908. No. 93736 A.

COPPER.

Alloys.

See same title, under MISCELLANY.

Bolivia.

Some Special Features of Practice at the Corocoro Copper Mines, Bolivia. G. Preumont. Explains the use of dry-wall masonry for underground mining works, and other unusual practices due to the absence of timber and of mineral fuel. 1500 w. Min Jour—June 20, 1908. No. 93423 A.

Costs.

The Cost of Producing Copper in Arizona. James Ralph Finlay. Shows low costs in chief districts due to richness of ore. 1500 w. Eng & Min Jour —July 4, 1908. No. 93547.

Cost of Producing the World's Supply of Copper. James Ralph Finlay. Divides the mines into three classes, and compares the costs per pound of metal for each class. 4000 w. Eng & Min Jour—July 25, 1908. No. 93951.

Idaho.

See same title, under Gold and Silver.

Mexico.

See same title, under Gold and Silver.

Montana.

Extensions of the Butte Copper Camp. Horace J. Stevens. Information concerning the Butte and Buxton tract. 1500 w. Min Jour—July 11, 1908. No. 93884 A.

Production

The World's Copper Supplies in 1907. John B. C. Kershaw. Gives the present state of the copper-producing industry in various parts of the world, and reviews its past growth and fluctuations. 1200 w. Cassier's Mag—July, 1908. No. 93442 B.

Queensland.

The Many Peaks Mine. J. Bowie Wilson. An account of this copper mine which has recently come into prominence. 2500 w. Aust Min Stand—June 3, 1908. No. 93552 B.

Smelter Contracts.

Ore Contracts from the Smelter's Standpoint. Clarence A. Grabill. Shows that smelting involves many items of cost which cannot be apportioned under a flat rate. 4500 w. Eng & Min Jour—July 11, 1908. No. 93712.

Smelter Smoke.

Smoke in Smelting Works. E. H. Messiter. A discussion of the causes, and methods of disposing of it. 1600 w. Min & Sci Pr—July 4, 1908. No. 93581.

GOLD AND SILVER.

Alaska.

Mining the Treadwell Lode. T. A. Rickard. An account of the methods adopted in the mining of wide ore bodies without the aid of timbers. An unusually large low-grade deposit of gold ore. Ills. 2000 w. Min & Sci Pr—July 18, 1908. No. 93903.

Australia.

See Tellurium, under Minor Minerals; and Zinc Milling, under Ore Dressing and Concentration.

Cobalt.

Cobalt, Ontario. H. B. Smith. An illustrated article describing methods of prospecting, mining, etc. 1200 w. Min & Sci Pr—June 27, 1908. No. 93499.

Ores and Rocks of the Cobalt Region. R. E. Hore. Gives results of field and laboratory study. 1800 w. Can Min Jour —July 1, 1908. No. 93514.

Production and Dividends of the Cobalt Mines. Alex. Gray. Information in regard to output, dividends, etc., of the various producing companies. 2200 w. Min Wld—July 18, 1908. No. 93834.

Cobalt Mines of To-day. Alexander Gray. Gives a brief account of a number of mining properties and general conclusions. Map. 3000 w. Min Jour—June 27, 1908. No. 93559 A.

See also Nickel, under Minor Minerals.

Colorado.

Treasure Mountain, Colorado. C. W. Purington. Interesting description of the characteristics of the quartz-filled veins in the Silverton region. Ills. 2500 w. Min & Sci Pr—July 4, 1908. No. 93580.

See also Dredging, under Gold and Silver.

Cyaniding.

Veta Colorado Cyanide Mill, Parral, Mexico. Claude T. Rice. Describes treatment by cyanidation of silicious silver ores, using fine grinding, agitation, and filtration. Ills. 2500 w. Eng & Min Jour—July 18, 1908. No. 93837.

Cyanidation in the Malay States. H. F. Lofts. An account of the plant of the Raub Pahang mine, at Raub Pahang, F. M. S. 1300 w. Jour Chem, Met & Min Soc of S Africa—May, 1908. No. 93853 E.

Dredging.

Dredging Placer Gravels at Breckenridge, Colorado. Arthur Lakes, Sr. Illustrates and describes the ground worked and the construction and operation of the dredges. 5000 w. Mines & Min—July, 1908. No. 93520 C.

Idaho.

Atlanta Gold District, Idaho. Robert N. Bell. Brief report of this district and its mines. Ills. 1000 w. Eng & Min Jour—July 25, 1908. No. 93954.

The North Side of the Coeur d'Alene District. Herbert S. Auerbach. Information concerning the deposits of lead, silver, and gold in this region of Idaho. Ills. 4000 w. Eng & Min Jour—July 11, 1908. No. 93710.

Mining in the Coeur d'Alene District, Idaho. J. P. Rowe. Map and description of this district, discussing its lead-silver and copper deposits. 2800 w. Mines & Min—July, 1908. No. 93516 C.

Mexico.

On Horseback in Western Chihuahua. Mark R. Lamb. An account of travels among mining camps where sectionalized machinery is the rule. Ills. 5000 w. Eng & Min Jour—July 25, 1908. No. 93950.

The Mines of Northwestern Altar, Sonora, Mexico. George W. Maynard. A review of the mining development and prospects. Ores of lead, silver, gold and copper. 2000 w. Eng & Min Jour—July 11, 1908. No. 93711.

El Rayo Gold Mine, Near Santa Barbara, Mex. Claude T. Rice. The veins are developed from adit levels and the ore is treated by cyanidation and zinc-dust precipitation. Ills. 2000 w. Eng & Min Jour—July 11, 1908. No. 93713.

Mining and Transportation at Santa Eulalia. Claude T. Rice. An illustrated account of the ore deposits, mining methods and general conditions. 2500 w. Eng & Min Jour—July 4, 1908. No. 93546.

New Mexico.

The Cachiti Mining District, New Mexico. Percy E. Barbour. A low-grade gold-silver camp is described, which has a reputation for failure, but possesses many promising veins. Ills. 1500 w. Eng & Min Jour—July 25, 1908. No. 93953.

New Zealand.

The Genesis of Bendigo and Carrick Lodes, Otago, New Zealand. James Park. Describes the deposits and gives conclusions as to their origin. 1200 w. Min & Sci Pr—July 25, 1908. No. 94048.

The Tairna Goldfield (N. Z.) J. M. Bell. Describes the geography, geology, principal mines, and metallurgical treatment of the ores. 2500 w. Aust Min Stand—June 10, 1908. No. 93899 B.

Porto Rico.

Gold Mining in Porto Rico. William B. McKinlay. An interesting review of the early history of gold discovery in America. 2500 w. Min & Sci Pr—July 18, 1908. Serial. 1st part. No. 93905.

Rand.

Notes on Hand Stoping and Underground Management on the Rand. J. A. Wickes. Discusses methods of working, timbering, and organization. 2700 w. Min Jour—June 20, 1908. No. 93421 A.

Silver Refining.

The Silver Refinery of the New Addition to the Raritan Copper Works. Frank D. Easterbrooks. Outlines the process for smelting and refining, describing apparatus used. 2000 w. Elec-Chem & Met Ind—July, 1908. No. 93455 C.

South Dakota.

South Extension Homestake Mineral Formations. Francis C. Nicholas. Illustrates and describes peculiar features in the mineral formation. 2200 w. Min Wld—July 25, 1908. No. 93958.

IRON AND STEEL.

Assaying.

The Estimation of Iron and Vanadium in the Presence of One Another. Graham Edgar. Presents a successful method of estimation under stated conditions. 1300 w. Am Jour of Sci—July, 1908. No. 93450 D.

Blast-Furnace Practice.

Recent Progress and Present Problems in the Blast-Furnace Industry. John J. Porter. Lecture before the Cincinnati Sec. of the Am. Chem Soc. Deals especially with the work of the metallurgist in increasing the production and economy in fuel. 3500 w. Mech Engr—July 10, 1908. Serial. 1st part. No. 93864 A.

Briquetting.

The Briquetting of Iron Ores (Die Brikettierung der Eisenerze). R. Goebel. Discusses especially binding materials. 1500 w. Glückauf—June 20, 1908. No. 93646 D.

Chemical Engineering.

The Chemist in the Iron Trade. George Auchy. A criticism of the methods and scope of training given by the colleges for work in analytical chemistry and chemical engineering. 3000 w. Ir Age—July 2, 1908. No. 93463.

Electro-Metallurgy.

Recent Developments of the "Rjellin" and "Rochling-Rodenhauser" Electric Induction Furnaces. J. Harden. Considers the "pinch" effect of an electric current, and discusses the rapid development, during the last two years, of the electric induction furnace. 3000 w. Ir & Coal Trds Rev—June 26, 1908. No. 93569 A.

The Elimination of Sulphur in the Héroult Process (Ueber die Entschwefeiung im Héroult-Verfahren). Th. Geilenkirchen. An explanation of the total elimination of sulphur in the Héroult furnace. 2600 w. Stahl u Eisen—June 17, 1908. No. 93637 D.

Ferro-Alloys.

The Manufacture and Use of Ferro Alloys. John B. Kershaw. A discussion of the methods adopted abroad in connection with the electric furnace, and notes on the properties and applications of the alloys. 4500 w. Ir Trd Rev—July 16, 1908. No. 93779.

See also Electro-Metallurgy, under ELECTRICAL ENGINEERING, Electro-Chemistry; and Foundry Materials, under MECHANICAL ENGINEERING, Machine Works and Foundries.

Germany.

See Trade, under Iron and Steel.

Rolling Mills.

Improvements in Plate Rolling-Mills. Andrew Lamberton. Read before the Ir & St. Inst. An account of recent improvements, largely in details of machinery, which have greatly increased the capacity of mills. 2500 w. Eng News—July 2, 1908. No. 93483.

The Power Required in Rolling Steels. J. A. Knesche. Aims to show a more scientific way of determining the power required under any existing conditions, and the direction along which improvements of such method should progress. 4500 w. Ir Age—July 23, 1908. No. 93910.

Steel Works.

La Belle Iron Works Improvements. Plans and illustrated description of the new 72-in. plate and jobbing and sheet mills recently added. 3500 w. Ir Age—July 2, 1908. No. 93462.

Trade.

The German Iron and Steel Industry. T. Good. German competition in this industry is discussed from the British viewpoint. 3000 w. Cassier's Mag—July, 1908. No. 93446 B.

Warehouses.

The Ryerson Iron and Steel Warehouses. Illustrated description of new warehouses and general office buildings in Chicago. 2200 w. Ir Age—July 9, 1908. No. 93579.

LEAD AND ZINC.

Australia.

Broken Hill Mining Industry. G. D. Delprat. Urges economy in mine development, discussing the manufacture of spelter. 2500 w. Aust Min Stand—June 10, 1908. No. 93900 B.

See also Zinc Milling, under ORE DRESSING AND CONCENTRATION.

England.

Teesdale District. H. L. Terry. An account of the efforts being made to keep alive the traditions of this lead-mining district. 2000 w. Min Jour—June 27, 1908. No. 93558 A.

Idaho.

See same title, under GOLD AND SILVER.

Lead Assaying.

Determination of Lead in Spelter and in Ores. Eric John Ericson. Describes a new method for the wet assay of lead by means of a hydrogen peroxide reaction with potassium permanganate titration. 2500 w. Eng & Min Jour—July 25, 1908. No. 93956.

Lead Smelting.

Handling Blast Furnace Bullion at the Selby Smelting Works. James C. Bennett. Drawings and description of the method used. 1500 w. Eng & Min Jour—July 11, 1908. No. 93714.

Missouri.

Mining and Milling Methods at Granby, Missouri. Evans W. Buskett. Illustrated account of the discovery of lead and zinc, and of the methods of acquiring and working the mineral land. 1500 w. Min Wld—July 11, 1908. No. 93742.

Prussia.

Lead Mining at Mechernich, Prussia. Lucius W. Mayer. Describes the deposits which occur as fine grains in flat beds of sandstone, and are mined without the use of timber. Ills. 2500 w. Eng & Min Jour—July 25, 1908. No. 93952.

MINOR MINERALS.

Asbestos.

Asbestos: Its Occurrence and Economic Value. J. S. Diller. Describes the varieties and characteristics, method of mining, etc. 2000 w. Min Wld—July 11, 1908. No. 93743.

Cement.

Cement Works at Irthlingborough. Illustrated description of the works, their equipment, and methods of manufacture. 3000 w. Engr, Lond—July 10, 1908. No. 93895 A.

See also Limestone, under MINOR MINERALS.

Diamonds.

Recovering Diamonds from the Far North. Alex Gray. Discusses a reported discovery of diamonds in Quebec. 1200 w. Min Wld—July 11, 1908. No. 93741.

Limestone.

The Constitution of Limestone for the Manufacture of Cement and Lime (Sulla Costituzione intima dei Calcari da Cemento e da Calce). Shows the necessity for careful chemical and physical tests to secure the best results. Serial. 1st part. 2700 w. Il Cemento—May, 1908. No. 93628 D.

Manganese.

The Indian Manganese Industry. Extract from the *Madras Mail,* dealing with the present position of the manganese industry. 1800 w. Min Jour—June 20, 1908. No. 93422 A.

Supplies of Manganese Ore (Zur Deckung des Bedarfes an Manganerzen). Wilhelm Venator. A review of the manganese mining industry in all parts of the world. 4900 w. Stahl u Eisen—June 17, 1908. No. 93638 D.

Nickel.

Winnings and Wastings of Canadian Minerals. Alex. Gray. Mainly a discussion of the opposition to the nickel trust, and what the question means to Cobalt. 4500 w. Min Jour—July 11, 1908. No. 93883 A.

Potassium Chloride.

Potassium Chloride of the Upeo Plateau, Chile. Julio Schneider. Describes the plateau and the deposits, and gives information of interest. 1800 w. Min Jour—July 11, 1908. No. 93880 A.

Salt.

Salt-Making by Fusion. Information concerning the process evolved by Robert Tee. 1000 w. Sci Am Sup—July 25, 1908. No. 93932.

Tellurium.

Tellurides of Kalgoorlie. Donald Clark. Notes on tellurium and its properties, compounds of tellurium, tests, etc. 2000 w.. Aust Min Stand—June 10, 1908. Serial, 1st part. No. 93901 B.

Tin.

The Mines of Montebras. Brief illustrated account of the present condition of this tin-mining district in France. 2000 w. Min Jour—July 4, 1908. No. 93729 A.

The Tin Deposits of Bolivia. Eduardo A. L. de Romaña. Brief account of the history, geography and geology of the region, and the characteristics of the deposits. 2000 w. Min Jour—July 11, 1908. Serial. 1st part. No. 93881 A.

The South African Tin-Deposits. William R. Rumbold. An account of three fields being developed in 1904, describing the deposits, and giving conclusions. 2000 w. Bul Am Inst of Min Engrs—July, 1908. No. 94033 C.

See also same title, under ORE DRESSING AND CONCENTRATION.

Vanadium.

See Assaying, under IRON AND STEEL.

MINING.

Automobiles.

The Introduction of Automobiles for Mining Work (Ueber die Einführung von Kraftlastwagen in bergbauliche Betriebe). Herr Sorg. Discusses the possibility of replacing horse-drawn vehicles by automobiles for ore transport and other purposes, giving comparison of costs. Ills. 8500 w. Glückauf—June 27, 1908. No. 93647 D.

Costs.

Variations in Mining Costs. T. A. Rickard. Gives detailed data of the cost of operations at the Bunker Hill and Sullivan mine, with discussion of the record. 1500 w. Min & Sci Pr—July 4, 1908. No. 93582.

Drills.

Rules Relating to the Transvaal Stope Drill Competition, 1909. 2500 w. Jour Chem, Met & Min Soc of S Africa—May, 1908. No. 93854 E.

The Banka Prospecting Drill. E. Middleberg. Explains the principle of the drill, and describes special features of the tools. Ills. 3000 w. Min Jour—June 20, 1908. Serial. 1st part. No. 93420 A.

Electric Hoisting.

Electric Winding. T. Campbell Futers. Discusses the subject in all its bearings, the advantages, and the conditions that will render it profitable. 6000 w. Elect'n, Lond—July 10, 1908. No. 93868 A.

Energy Calculations in Coal Winding. R. Livingstone. Notes applying particularly to the Thury System, where the winding motor is supplied by a motor generator fitted with a heavy fly-wheel, though the methods for calculating the h.p. are applicable to any system. Also illustrates and describes electric winding plant. 6500 w. Elect'n, Lond—July 10, 1908. No. 93869 A.

Electric Power.

General Survey of Electric Power Applied to Mining. W. S. Taplis. Considers the use of gas engines, turbines, and power house auxiliaries, the application of motors, etc. 4800 w. Elect'n, Lond—July 10, 1908. No. 93866 A.

Employing Electric Power in Joplin District. Doss Brittain. Describes the construction and equipment of buildings of the Spring River Power Co. Ills. 1800 w. Min Wld—July 18, 1908. No. 93832.

See also same title, under COAL AND COKE; and Cables, under ELECTRICAL ENGINEERING, TRANSMISSION.

Geology.

Dip and Pitch. R. W. Raymond. A correction or explanation of Prof. Louis' definition of "pitch" as given in a previous paper. Also reply from Prof. Henry Louis. 2000 w. Bul Am Inst of Min Engrs—July, 1908. No. 94034 C.

Haulage.

Electricity in Mine Transportation. Briefly considers the four kinds of motive power used in mines, especially the application of electricity. 2000 w. Sci Am Sup—July 25, 1908. No. 93931.

Electric Haulage in Mines. W. C. Mountain. Detailed discussion of the four systems upon which haulage in collieries is mainly effected, the power required, apparatus used, etc. Ills. 12000 w. Elect'n, Lond—July 10, 1908. No. 93870 A.

Construction of Haulage Mechanism So as to Preserve Ropes and Chains. E. Heckel, in *Stahl und Eisen*. On defects in haulage mechanism and the causes of breakage of ropes, etc. Ills. 2000 w. Col Guard—July 17, 1908. No. 93976 A.

The Preservation of the Life of Driving Ropes and Chains (Wie sollen Seil- und Kettentriebe mit Rücksicht auf die Haltbarkeit des Zugorgans construiert sein?). Discusses the stresses to which ropes and chains are subjected and the design of driving systems. Ills. 3000 w. Stahl u Eisen—June 10, 1908. No. 93635 D.

Hoisting.

See Haulage, under MINING.

Locomotives.

Development of Electric Mine Locomotive. Frank C. Perkins. On the advantages of and improvements in various types of mine locomotives. Ills. 4000 w. Min Wld—July 4, 1908. No. 93529.

See also Mine Locomotives, under COAL AND COKE.

Management.

See Rand, under GOLD AND SILVER.

Pumping.

Electric Pumping. Dr. R. Herzfeld. Reviews the development of pumping machinery for mining plants, giving reasons for favoring electrical pumping plants. Also illustrated descriptions of examples of electric pumps. 6500 w. Elect'n, Lond—July 10, 1908. No. 93867 A.

Quarrying.

The Penrhyn Quarry. Henry Briggs. Illustrates and describes the method of working and the arrangement of labor in the largest quarry in the world, Wales. 3000 w. Mines & Min—July, 1908. No. 93515 C.

Signalling.

Electrical Signalling in Mines. F. Hird. Considers the applications made to hauling, hoisting, etc., the principles to be observed, and gives a description of a system extensively applied in Germany and Belgium. Ills. 4000 w. Elect'n, Lond—July 10, 1908. No. 93876 A.

Stoping.

See Rand, under Gold and Silver.

Surveying.

Mine Surveying. Charles W. Helmick. Suggestions helpful in surveying in mining work. 3500 w. Transit, Univ of Iowa —Vol. XIII, 1908. No. 93767 N.

Tunneling.

See Tunnels, under CIVIL ENGINEERING, Construction.

Valuation.

Valuation of Mining Properties. George H. Gillespie. Discusses problems of mine valuation. 2000 w. Can-Min Jour—July 15, 1908. Serial, 1st part. No. 93820.

Ventilation.

Ventilation of Mines by Electric Fans. J. W. Gibson. Illustrates and describes several installations, and examples of ventilating machinery. 3500 w. Elect'n, Lond—July 10, 1908. No. 93877 A.

The Ventilation of Metalliferous Mines Henry Briggs. A letter discussing this question, especially the gaseous impurities detrimental to the health of miners. Also editorial. 4500 w. Min Jour—July 18, 1908. No. 93974 A.

ORE DRESSING AND CONCENTRATION.

Briquetting.

See same title, under Iron and Steel.

Copper.

Experimental Mill of the Nevada Consolidated Copper Company. M. L. Requa. Illustrated description of a small concentrating mill and the tests made to justify a large investment. Details of tests and general information. 2500 w. Min & Sci Pr—July 18, 1908. No. 93904.

Filters.

The Butters Vacuum Filter. G. Howell Clevenger. Considers the treatment of slimes, discussing pressure filters and vacuum filters, and describing the Butters filter in detail. 3000 w. Mines & Min—July, 1908. No. 93519 C.

Gold Milling.

Milling and Cyanide Practice, San Prospero Mill, Guanajuato. J. S. Butler. Describes the mill and methods of ore treatment. 1800 w. Min & Sci Pr—July 25, 1908. No. 94050.

Treatment of Gold-Ores in New Zealand, South Africa, America, and Queensland. G. E. Bray. Abstracts from paper read before the N. Queensland Min. & Mill-Mgrs.' Assn. describing recent practice in the countries named. 2300 w. N Z Mines Rec—April 16, 1908. No. 93550 B.

See also Slimes Treatment, under Ore Dressing and Concentration.

Magnetic Separation.

Magnetic Separation and Its Application to Roasted Siderite at Siegen (Die magnetische Aufbereitung und ihre Anwendung für gerösteten Spateisenstein im Siegerlande). Herr Horel. Ills. 3200 w. Oest Zeitschr f Berg- u Hüttenwesen—June 27, 1908. No. 93639 D.

Sampling.

Ore Sampling by Machines. John A. Church. Discusses conditions necessary to accurate sampling, suggesting improvements. 3000 w. Eng & Min Jour—July 18, 1908. No. 93836.

Silver Milling.

See Cyaniding, under Gold and Silver.

Slimes.

Theory of the Settlement of Slime. H. S. Nichols. Discusses factors affecting the settlement of slimes, giving results of tests and conclusions. 1200 w. Min & Sci Pr—July 11, 1908. No. 93806.

Slimes Treatment.

The Adair-Usher Process. Alfred Adair. An account of the experiments, and the ideas which they suggested, giving diagrams showing results, describing the washing apparatus and giving notes on the assay of slimes. 6500 w. Jour Chem, Met & Min Soc of S Africa—May, 1908. No. 93852 E.

Tin.

New Methods of Concentrating Alluvial Tin. Harry D. Griffiths. An account of new methods introduced at Cape Colony, consisting in effecting a coarse concentration of the wash by means of a rotary pan, and then cleaning in a hydraulic separator to the grade required. 1200 w. Min Jour—July 11, 1908. No. 93885 A.

Tube Mills.

The Hardinge Conical Pebble-Mill. H. W. Hardinge. Illustration and information concerning this mill. 1500 w. Bul Am Inst of Min Engrs—July, 1908. No. 94031 C.

Zinc Milling.

The Metallurgy of Broken Hill. Gerard W. Williams. Describes the methods in vogue at the different mines. 3000 w. Aust Min Stand—May 27, 1908. Serial, 1st part. No. 93551 B.

Mill Construction in the Joplin District. Otto Ruhl. Discusses changes in practice due to increase in capacity, the cost of mill construction, etc. 2200 w. Eng & Min Jour—July 18, 1908. No. 93838.

MISCELLANY.

Alloys.

The Alloys of Copper (Les Alliages de Cuivre). M. A. Portevin. Summarizes the results of Prof. Tammann's researches on the alloys of copper with gold, aluminium, bismuth, calcium, cadmium, cobalt, iron, magnesium, manganese, nickel, phosphorus, palladium, platinum, silicon, tellurium and thallium. Ills. 7500 w. Rev de Métal—June, 1908. No. 93698 E + F.

Argentina.

Natural Soda and Other Deposits of the Atacama Desert, Argentine-Chilian Andes. Dr. Fritz Reichert. Information concerning deposits of soda, sulphur, gold, alum, and pyrites. 2000 w. Min Jour—July 11, 1908. No. 93882 A.

Australasia.

Mining in Australasia in 1908. F. S. Mance. Reviews the progress of the industry and the returns of gold, silver, lead, copper, tin and zinc. 2500 w. Eng & Min Jour—July 18, 1908. No. 93840.

Australia.

Mining Prospects in Commonwealth of Australia. John Plummer. Discusses the increased cost of mining and ore treatment and the effects, considering the prospects encouraging. Ills. 1000 w. Min Wld—July 18, 1908. No. 93833.

Bolivia.

See Burma, under MISCELLANY.

Burma.

Recent Mining Wanderings in Burma, Chile, and Bolivia. J. H. Curle. An interesting account of travels through mining regions, with critical remarks on things observed. 3500 w. Min & Sci Pr —June 27, 1908. No. 93500.

Chile.

See Burma, under MISCELLANY.

Exhibitions.

The Mining Exhibition. An illustrated description of the interesting exhibits at Olympia. 32000 w. Ir & Coal Trds Rev —July 17, 1908. No. 93987 A.

The World's Great Mining Exhibition. An illustrated account of the exhibition recently opened at Olympia, the exhibits, etc. 6000 w. Col Guard—July 17, 1908. Serial, 1st part. No. 93975 A.

Great Britain.

Twenty-five Years of Mining. Edward Ashmead. A retrospective review, 1880-1904, of mining companies registered in Great Britain, with notes and comments, and the names and capitals of the principal registrations. 5800 w. Min Jour—July 4, 1908. Serial, 1st part. No. 93-730 A.

Herculaneum.

The Excavation of Herculaneum by Mining Methods. Alex. Del Mar. An outline of the proposed method and its possible results. 2500 w. Engineering Magazine—Aug., 1908. No. 94011 B.

Honduras.

Some Notes on Honduras. C. F. Spalding. Information relating to the rich mineral deposits, the conditions, etc. 1200 w. Min Wld—July 4, 1908. No. 93530.

Korea.

The Mineral Resources of Korea. Hallet R. Robbins. An account of foreign mining enterprises, and the native methods of mining and metallurgical operations. Ills. 4000 w. Bul Am Inst of Min Engrs—July, 1908. No. 94032 C.

Ore Deposits.

Rock Oxidation at Cripple Creek. Philip Argall. Description of the volcanic action and rock oxidation on Globe hill. 3300 w. Min & Sci Pr—June 27, 1908. No. 93501.

Waters, Meteoric and Magmatic. T. A. Rickard. Discusses the effect of ground-water on ore deposition. 3000 w. Min & Sci Pr—June 27, 1908. No. 93498.

Peru.

The Physical Features and Mining Industry of Peru. George I. Adams. Describes the physical and climatic divisions, the commercial features, etc. Maps. 3000 w. Bul Am Inst of Min Engrs—July, 1908. No. 94030 C.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Derailments.

The Wreck of the White Mountain Express. Editorial criticism of the design of electric locomotives, claiming this to be the cause of this wreck. 1000 w. Sci Am—July 25, 1908. No. 93925.

Signals.

A. H. Johnson's Electric Switch and Signal Apparatus. Guy W. Wyles. Illustrated description of a system of electric interlocking. 1500 w. R R Age Gaz —July 10, 1908. No. 93745.

Automatic Block Signals on the Long Island. Diagrams and description of recently installed signals between Glendale Junction and Jamaica. 800 w. R R Age Gaz—July 17, 1908. No. 93829.

Electric Signaling at the New Victoria Station, London. Illustrated description of signaling carried out on the Sykes Electro-Mechanical System. 2500 w. Elect'n, Lond—July 17, 1908. No. 93966 A.

The Storage Battery in Signal Service.—Restoration of Low Cells. H. M. Beck. Discusses the mechanical and electrical restoration of the cells, the impurities in the electrolyte, and the determination of the cause of trouble. 3500 w. Jour Ry Sig Assn—July, 1908. No. 94009 F.

Trains.

Corridor Train for South Indian Railway. Plans and description of a train, showing the requirements of service in India. 1300 w. R R Age Gaz—July 17, 1908. No. 93828.

The Maritime Express. An account of the principal express train on the Intercolonial Railway of Canada, illustrating the country through which it passes. 1200 w. Ry & Loc Engng—July, 1908. No. 93510 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Wrongly Used Triple Valves. Remarks on wrong applications and the effects. 700 w. Ry & Loc Engng—July, 1908. No. 93511 C.

Car Heating.

Ventilating and Heating of Coaches and Sleeping Cars. From the report of a committee to the Master Car Bldrs.' Assn. Outlines the various systems used and describes the present standard arrangements of the Pennsylvania R. R., the Pullman system, and others, discussing proposed improvements. Ills. 8500 w. Ry & Engng Rev—July 18, 1908. Serial, 1st part. No. 93835.

Cars.

New Rolling Stock, Shanghai-Nankin Railroad. Illustrates and describes luxurious new cars built in England. 1600 w. R R Age Gaz—July 17, 1908. No. 93824.

See also Trains, under CONDUCTING TRANSPORTATION.

Car Ventilation.

See Car Heating, under MOTIVE POWER AND EQUIPMENT.

Draft-Gear.

Draft Rigging. Editorial review of opinions set forth in recent papers regarding the proper methods to be pursued to relieve the car shock. 1500 w. R R Age Gaz—July 24, 1908. No. 93934.

Electrification.

Railway Electrification Plans on the Continent. Editorial review of what is being done in the various countries. 2500 w. Engng—July 17, 1908. No. 93984 A.

Locomotives.

American Locomotives for Export. Illustrates and describes types sent to many different countries. 2000 w. Engr, Lond—June 26, 1908. No. 93567 A.

Recent American Ten-Wheeled Locomotives. Illustrated detailed description of three recent types of 4-6-0 engines. 3000 w. Mech Engr—July 3, 1908. No. 93724 A.

Prairie Locomotive for the Wabash. Illustrated detailed description of 2-6-2 locomotives intended for freight service. 1200 w. R R Age Gaz—July 17, 1908. No. 93830.

Ten-Wheel, Oil-Burning Locomotive for the Southern Pacific Co. Illustrated description. 800 w. Ry & Engng Rev—July 25, 1908. No. 93960.

Consolidation Locomotive; Chesapeake & Ohio. Illustrated description of engines used for hauling coal trains. 300 w. R R Age Gaz—July 31, 1908. No. 94057.

Consolidation Locomotive for the Southern Railway. Illustrated description of engines for fast freight service. 600 w. Ry & Engng Rev—July 11, 1908. No. 93740.

Four-Coupled Eight-Wheeled Side-Tank Locomotive; Egyptian Delta Light Railways, Ltd. Illustrated detailed description. Plate. 500 w. Engng—July 10, 1908. No. 93890 A.

New Pacific Type Locomotive—Western Railway of France. Illustrated detailed description of engines designed for hauling heavy and fast trains. Plate. 3000 w. Engr, Lond—July 17, 1908. No. 93977 A.

The British Locomotive. A. W. S. Graeme. From a paper before the Rugby Engng. Soc. Describes British practice and its adaptation to the requirements, giving British views on compounding. 5000 w. R R Age Gaz—July 17, 1908. No. 93825.

An Abt Rack Locomotive for the Transandine Railroad. Photographs and drawings, with description of engines for steep grades. 1500 w. R R Age Gaz—July 10, 1908. No. 93746.

Mallet Type Articulated Locomotives. Grafton Greenough. An interesting illustrated discussion of the development of this type, reviewing the better known designs of double truck and articulated locomotives. General discussion. 7000 w. Pro Engrs' Club of Phila—April, 1908. No. 94004 D.

Twelve-Wheel Mallet-Compound Locomotive; Central Railway of Brazil. Illustrated description of engines built by the American Locomotive Co. 1000 w. Engng—June 19, 1908. No. 93428 A.

Locomotive Trucks.

Evolution of the Locomotive Truck. S. A. Bullock. Historical review, with illustrations. 2500 w. R R Age Gaz—July 24, 1908. No. 93936.

Motor Cars.

A Steam Motor Car: Chicago, Rock Island & Pacific R. R. Illustrated description of a 250 H.P., oil-burning, compound, steam motor car. 1500 w. Eng News—July 16, 1908. No. 93792.

Rail Motor Cars in Wisconsin. Reports the case of Colin W. Wright vs. Illinois Central R. R. Co. before the Railroad Commission of Wisconsin, the complaint in which alleged inadequacy of passenger service. 2000 w. R R Age Gaz—July 24, 1908. No. 93938.

Refrigeration.

The Absorption Machine in Railroad Refrigeration. Joseph H. Hart. Discusses the application of refrigeration to railroad work and the advantages of the absorption system. 2800 w. R R Age Gaz—July 31, 1908. No. 94056.

Springs.

Experimental Determination of the Coefficient of Friction of Spring Plates (La Determination expérimentale du Coefficient de Frottement des Lames de Ressorts). M. Hallard. Describes the method employed and gives the results. Ills. 2200 w. Rev Gen d Chemins de Fer—June, 1908. No. 93617 G.

Stores Keeping.

Economical Care of Material. Frank H. Crump. Explains a practical and efficient system that has been thoroughly tested. 1500 w. R R Age Gaz—July 24, 1908. No. 93935.

Superheating.

The Use of Superheated Steam in Locomotives. Dr. Wilhelm Schmidt. Shows what can be gained by the use of superheated steam, and the rules that govern the design of an economical locomotive superheater. 3000 w. R R Age Gaz—July 17, 1908. Serial, 1st part. No. 93822.

Train Lighting.

The Electric Train-Lighting System of the Gesellschaft für Zugbeleuchtung. Illustrates and describes this system of a Berlin company. 4000 w. Engng—June 26, 1908. No. 93563 A.

PERMANENT WAY AND BUILDINGS.

Crossings.

Road, Canal, and Rail; Joint Crossing. W. B. Paley. Illustrates and describes Windmill Lane bridge, in England, where a highroad, a canal, and a railroad cross at the same point. 700 w. R R Age Gaz—July 17, 1908. No. 93827.

Abolishment of Grade Crossings on the Philadelphia & Reading Railway in Philadelphia. Brief illustrated description of the work. 1200 w. Eng Rec—July 11, 1908. No. 93708.

Elevated Railroads.

Philadelphia Track Elevation of the Reading. Illustrates and describes proposed work. 1000 w. R R Age Gaz—July 31, 1908. No. 94055.

Freight Sheds.

See Yards, under Permanent Way and Buildings.

Rails.

The Latest Results with Steel Rails. E. F. Kenney. Report of results of investigations by Pennsylvania Railroad interests. 2500 w. Ir Age—July 2, 1908. No. 93464.

Some Features of the Present Steel-Rail Situation. Charles B. Dudley. Presidential address before the American Society for Testing Materials. 7500 w. Eng News—July 2, 1908. No. 93841.

A Microscopic Investigation of Broken Steel Rails: Manganese Sulphide as a Source of Danger. Henry Fay. Read before the Am. Soc. for Test. Materials. Reports results of investigations made of broken rails from various sources. Ills. 4000 w. Eng News—July 23, 1908. No. 93946.

Reconstruction.

Double-Tracking of the Southern Railway Between Greensboro and Spencer, N. C. George H. Gilbert. Illustrated detailed description of the work. 2500 w. Eng Rec—July 4, 1908. No. 93527.

Switches.

See Signals, under Conducting Transportation.

Ties.

Novel Design of Steel Tie and Railway Appliances. Information concerning a design to be tested by the Pennsylvania R. R. Co. Ills. 1500 w. Ir Trd Rev—July 16, 1908. No. 93780.

Track Construction.

The Theory and Construction of the Railways of the Future (Théorie et Pratique des Voies ferrées futures). L. Schlüssel. Discusses the need for greater solidity and rigidity of track construction and means of securing them. Ills. 10500 w. Mem Soc Ing Civ de France—Mar., 1908. No. 93604 G.

Train Sheds.

Removing the Grand Central Train Shed. Brief illustrated description of methods used in removing this large shed in New York City. 500 w. R R Age Gaz—July 31, 1908. No. 94058.

Yards.

New Goods Yard and Warehouse at Glasgow. Plans and illustrated description of extensive improvements by the North British Ry. Co. 4000 w. Engr, Lond—June 26, 1908. No. 93566 A.

TRAFFIC.

Bills of Lading.

Uniform Bill of Lading. Discusses the bill recommended for adoption, September 1 next, by the Interstate Commerce Commission. 2500 w. R R Age Gaz—July 17, 1908. No. 93831.

Demurrage.

The Hay Traffic in New York City Freight Yards. Gives the decision of the Interstate Commerce Commission concerning demurrage rates on car loads of hay, with details of this business in New York City. 2000 w. R R Age Gaz—July 17, 1908. No. 93826.

Freight Rates.

W. C. Brown on Proposed Rate Increase. An argument for the general increase of freight rates. 2300 w. R R Age Gaz—July 17, 1908. No. 93823.

STREET AND ELECTRIC RAILWAYS

Adhesion System.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Car Records.

The Car Defect Record System of the Elevated Division, Boston Elevated Railway Company. Describes the system of defect records adapted to the handling of heavy traffic by multiple-unit trains. 2000 w. Elec Ry Jour—July 18, 1908. No. 93805.

Conductors.

Track Return. E. Goolding. Considers the conditions influencing the drop in volts on track rails. 2000 w. Tram & Ry Wld—July 2, 1908. No. 93856 B.

Hamburg.

The History of the Establishment of the Hamburg City and Suburban Railways (Zur Entstehungsgeschichte der Stadt- und Vorortbahnen in Hamburg). Ed. Vermehren. Reviews the various projects which have culminated in the present extensive construction. 2500 w. Glasers Ann—June 1, 1908. No. 93601 D.

History.

Tramways of the World. Sir J. Clifton Robinson. Slightly condensed address before the Tram & Light Ry's Assn. Gives a résumé of the early days of tramway enterprise, British electric tramways, etc. 4500 w. Elec Engng—July 16, 1908. No. 93969 A.

Instruction Schools.

Chicago City Railway School of Instruction. An illustrated description of the equipment and course of instruction. 2200 w. Elec Ry Jour—July 18, 1908. No. 93804.

Locomotives.

Single-Phase Locomotive of the Windsor, Essex & Lake Shore Railway of Canada. S. C. Dewitt. Illustrated description of a locomotive built for pulling gravel cars for ballasting, handling general freight, and handling excursion trains. 1200 w. Elec Ry Jour—July 25, 1908. No. 93902.

The Fireless Locomotive. Illustrated description of a German storage battery locomotive used for switching service. 600 w. R R Age Gaz—July 10, 1908. No. 93744.

The Storage-Battery Switching Locomotive in the Yards of the Imperial Railroad Shops at Tempelhof, near Berlin (Die Akkumulatoren - Verschiebelokomotive der Königlichen Eisenbahn-Werkstätten-Inspektion in Tempelhof bei Berlin). Alfred Strauss. Illustrated description. Serial, 1st part. 1200 w. Elektrotech Zeitschr—June 25, 1908. No. 93-695 D.

See also Derailments, under RAILWAY ENGINEERING, CONDUCTING TRANSPORTATION.

London.

The Metropolitan Electric Tramways. Illustrates and describes an extensive system in the northern part of London. 4500 w. Tram & Ry Wld—July 2, 1908. No. 93855 B.

Rack Railways.

See Switzerland, under STREET AND ELECTRIC RAILWAYS.

Rail Corrugation.

Rail Corrugation. C. A. Carus-Wilson. Lecture before the Tram. Cong. An investigation of the causes. 3000 w. Engng—July 17, 1908. No. 93986 A.

Preliminary Report on Rail Corrugation (Voorloopig Rapport betreffende de Golfslijlage der Rails). A report of investigations made by a committee of the Royal Institute of Engineers of Holland. Ills. 2500 w. De Ingenieur—June 6, 1908. No. 93696 D.

Rail Joints.

Tramway Rail Joints. Alfred H. Gibbings. Read before the Tram. & Light Rys. Assn. The ordinary concrete track used in England is discussed with special reference to types of joints. Discussion. Ills. 5400 w. Elec Engng—July 16, 1908. No. 93970 A.

Shops.

Special Tools at the Shops of the Chicago City Railway Company. Brief illustrated descriptions of devices for facilitating repair work. 2500 w. Elec Ry Jour—July 11, 1908. No. 93583.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Fôrderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

Current Record of New Books

NOTE—*Our readers may order through us any book here mentioned, remitting the publisher's price as given in each notice. Checks, Drafts, and Post Office Orders, home and foreign, should be made payable to* THE ENGINEERING MAGAZINE.

BOOKS RECEIVED.

Autogenous Welding of Metals. By L. L. Bernier. Size, 6½ by 4½ in.; pp., 45. Ills. Price, $1. New York: The Boiler Maker.

Bulletins 9 to 17, University of Illinois, Engineering Experiment Station. Size, 9 by 6 in. Ills. Urbana, Ill.: University of Illinois.

Forest Products of the United States, 1906. Size, 9 by 6 in.; pp., 99. Washington, D. C.: United States Department of Agriculture.

Conversations on Electricity. By Joseph G. Branch. 8 by 5½ in.; pp., 282. Ills. Price, $2. Chicago and New York: Rand, McNally & Company.

Main Sewerage and Sewage Disposal. By T. Aird Murray. Size, 9 by 6 in.; pp., 46. Ills. Price, 25 cents. Toronto, Ont.: The Canadian Engineer.

Report of the Commissioner of Public Roads, State of New Jersey, 1907. Size, 9 by 6 in.; pp., 209. Ills. Trenton, N. J.: Commissioner of Roads.

Annual Report of the City Engineer of the City of Halifax, N. S., for the Civic Year 1905-6. Size, 8½ by 6 in.; pp., 203. Halifax, N. S.: City Works Department.

General Index to Reports, 1885-1906, Geological Survey of Canada. Compiled by F. J. Nicolas. Size, 9½ by 6½ in.; pp., 1014. Ottawa, Canada: Geological Survey.

Sixteenth Annual Report of the Sewerage and Water Board of New Orleans. Size, 9 by 6 in.; pp., 61. Ills. Maps. New Orleans, La.: Sewerage and Water Board.

Report of the United States Fuel-Testing Plant, at St. Louis, Mo., January 1, 1906, to June 30, 1907. Size, 9 by 6 in.; pp., 299. Washington, D. C.: United States Geological Survey.

Report of the State Engineer and Surveyor, State of New York, 1906. Two Volumes. Size, 9 by 6 in.; pp., 555, 378. Ills. Albany, N. Y.: Office of the State Engineer and Surveyor.

Physical Geography of the Evanston-Waukegon Region. By Wallace A. Atwood and James Walter Goldthwait. Size, 9 by 6 in.; pp., 104. Ills. Urbana, Ill.: State Geological Survey.

A Vest-Pocket Handbook of Mathematics for Engineers. By L. A. Waterbury. Size, 5½ by 3 in.; pp., 91. Ills. Price, $1, 4/6. New York: John Wiley and Sons; London: Chapman & Hall, Ltd.

Diamond Bars for Concrete-Steel Construction: Reasons and Rules for Proper Design. By Edwin Thacher. Size, 9 by 6 in.; pp., 4. Ills. Price, $1. New York: Concrete-Steel Engineering Company.

The Standard Handbook for Electrical Engineers. Written and Compiled by a Staff of Specialists. Second Edition. Size, 6¾ by 4 in.; pp., 1285. Ills. Price, $4. New York: McGraw Publishing Company.

Organization, Equipment and Operation of the Structural-Materials Testing Laboratories at St. Louis, Mo. By Richard L. Humphrey and Joseph A. Holmes. Size, 9 by 6 in.; pp., 84. Ills. Washington, D. C.: United States Geological Survey.

Slow Burning or Mill Construction. Report No. V, Insurance Engineering Experiment Station. Third Edition. Size, 11 by 9 in.; pp., 28. Ills. Plates, 9. Price, 25 cents. Boston, Mass.: Boston Manufacturers' Mutual Fire Insurance Co.

Proceedings of the Seventeenth Annual Convention of the Association of Railway Superintendents of Bridges and Buildings held in Milwaukee, Wis., October 15, 16, and 17, 1907. Size, 9 by 6 in.; pp., 316. Ills. Concord, N. H.: Secretary of the Association.

Accidents, Their Causes and Remedies. A Treatise of the Development of Care and Faithfulness to Aid the Safeguarding of Life and Property. By Thomas D. West. Size, 7¾ by 5½ in.; pp., 95. Ills. Price, 25 cents. Greenville, Pa.: Beaver Printing Co.

Annual Report of the Minister of Mines for the Year Ending 31st December, 1907, being an Account of Mining Operations for Gold, Coal, etc., in the Province of British Columbia. Size, 10½ by 7½ in.; pp., 235. Ills. Maps. Victoria, B. C.: Department of Mines.

Stationary Engineering. By Joseph G. Branch. In Three Volumes: Vol. I, Steam Boilers and Attachments; Vol. II, Steam Engines, Heating and Electricity; Vol. III, Mechanical Refrigeration, Elevators and Steam Turbines. Size, 8 by 5½ in.; pp., 393, 370, 267. Ills. Price, $7; each volume, $2.50. New York and Chicago: Rand, McNally and Company.

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LEADING ARTICLES.

REVIEWS. INDEX, AND EDITORIALS.