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TABLE OF CONTENTS.

THE FIRST-CLASS BATTLESHIP "ALABAMA," which was launched at the Cramps yard in Philadelphia this week, has the following dimensions and armament: Length on load-water line, 368 ft.; extreme beam, 72 ft. 2½ ins.; mean draft, 23½ ft.; displacement, 11,525 tons; gross tonnage, 6,802 tons; net tonnage, 5,546 tons; twin-screw vertical triple-expansion engines of 10,000 I. HP.; contract speed, 16 knots; normal coal capacity, 800 tons, and 1,200 tons bunker capacity. She has two military masts. The main battery will include four 13-in. guns., and sixteen 6-in. rapid-fire guns; the secondary battery will have sixteen 6-pdrs. and four 1-pdr. rapid-fire guns, one Colt and two field guns, and four long Whitehead torpedo tubes. The side armor will be 16½ ins. thick tapering to 9½ ins., with 13¾ ins. at water line; the turrets will be 17 and 15 ins. thick, and the barbettes, 15 and 10 ins.; the protective deck will be 3 and 4 ins. thick on slopes and 2¾ ins. on flat; there is a capacity for 12,464 cu. ft. of corn-pith water-line obturating material. The crew will include 40 officers and 449 men. The "Alabama" was authorized on June 10, 1896, and the keel was laid on Dec. 1, 1896; the contract date of completion is Sept. 24, 1899, but this will be much shortened. The contract cost of hull and machinery is $2,650,000.

BIDS FOR 16 TORPEDO-BOAT DESTROYERS and 12 torpedo boats are asked for by the U. S. Navy Department. The destroyers will have a displacement of 400 to 435 tons; have a coal capacity of 100 tons, equal to a steaming radius of 2,000 miles; have a minimum speed of 28 knots, and carry two 3-in. rapid-fire guns, five 6-pdrs. and two torpedo tubes. They are to be completed in 18 months and to cost not more than $300,000 each. The 12 torpedo boats will be from 150 to 170 tons in size; have a minimum speed of 26 knots; a coal capacity of 40 tons, or a steaming radius of 1,200 miles; carry a battery of three 3-pdr. rapid-fire guns, and have three torpedo tubes. They are to be completed in 12 months, and not to cost more than $170,000 each. The designs for the three new battleships authorized are also about complete, and they will be almost identical with the "Alabama" class, with the addition of two submerged torpedo tubes and some other improvements.

THE FIVE NEW DRY-DOCKS for the U. S. Navy, ordered by Congress, are now being planned by the Bureau of Yards and Docks. The dock at Boston will probably be made of concrete; the three timber docks will be located at League Island, Portsmouth, N. H., and Mare Island, Cal. The steel floating dock will probably be located at Algiers, on the Mississippi River, opposite New Orleans. These new docks will be over 700 ft. long by about 90 ft. wide, and they must have at least 30 ft. of water over the sill.

THE LARGE SEARCHLIGHT recently placed at the Golden Gate, the entrance to San Francisco Bay, to prevent surprises from Spanish vessels, is one of the largest in existence. Since the World's Fair it has been at Mont Lowe, California. The body of this lamp is 6 ft. long and 5 ft. in diameter, and when mounted upon its standards the top is 10 ft. above the foundation. The parabolic glass reflector is 5 ft. in diameter and weighs 800 lbs. It is 3¼ ins. thick at the outside and something less than an inch at the center, and is mounted in a metal ring which weighs 750 lbs. This great mirror is at one end of the drum mentioned, while at the other is a glass door made of strips of glass 5-16 x 6 ins., mounted in a frame. Inside is the automatic arc lamp, which is about 6 ft. long and weighs fully 400 lbs. The carbons are 1½ ins. in diameter and require about 200 amperes when the intensity of the arc light alone is between 90,000 and 100,000 candle power. The reflector concentrates the light and throws a beam, whose luminous intensity is approximately 375,000,000 candle power, to a distance of between 20 and 30 miles.

SCARCITY OF WATER AT KEY WEST, FLA., is reported in press dispatches. A public water-works plant was built in 1895, taking a supply from an artesian well, or wells, but it appears that the water is not fresh. Reliance seems to be placed largely in rain-water cisterns and the like, which are always more or less uncertain, and are now overtaxed with the heavy demands upon them. A government condensing boat, with a contract capacity of 40,000 gallons a day, is said to be at the port, but continued delays have been experienced in getting it into operation.

RUSSIA'S NAVAL PROGRAM, for which $68,000,000 were lately appropriated, includes the building of the following warships: Four first-class battle-ships, of which three are to be built on the Neva, and one in Philadelphia. They are to be over 12,500 tons each; armed with four 10 or 12-in. guns; sheathed with wood and copper for those built on the Baltic, and have enormous coal carrying capacity. One armored cruiser of 6,000 tons is also to be built in the United States. In addition, the Russian yards are about completing six first-class battleships, one second-class battle-ship, one large and four smaller armored cruisers, one coast-defence iron-clad, three gunboats, 17 torpedo boat destroyers and ten torpedo boats. The contract for the two vessels to be built in the United States has been let to Wm. Cramp & Sons, of Philadelphia.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Missouri Pacific Ry., about four miles east of Jefferson City on May 13. A passenger train running on schedule time was run into head-on by a light engine, which, it is said, did not stop when ordered. One engineer was fatally injured and several persons were injured more or less seriously.

STEAMBOAT AND OTHER ACCIDENTS on the waters of the Mississippi and its tributaries for the year 1897 numbered 22 serious disasters, involving 10 deaths and a loss of $330,000.

A FATAL TIDAL WAVE is reported from Yokohama, Japan, on May 14. It is supposed to have occurred at a place called Swate, and resulted in the destruction of 200 fishing boats and the death of 1,500 persons.

1,100,000 BUSHELS OF GRAIN and a large quantity of lumber were destroyed in a fire which originated in the great Armour & Co. "D" elevator, at Chicago, Ill., on May 13, from an unknown cause. Fifty fire engines and three fireboats succeeded in subduing the flames after six acres of elevator and lumber district had been swept over.

THE EXPLOSION OF MARSH GAS in the new water-works tunnel at Cleveland, O., on May 11, resulted in the death of four men and the serious injury of five others. The men were working in the heading fully 6,300 ft. from the shore, when, according to report, a gas pocket was struck. The cause of the explosion is unknown. The statement is made, however, that either the electric light wires or a spark caused by a pick striking a stone is responsible for the accident.

THE GREATER NEW YORK CONSTITUTIONAL debt limit has been made the subject of another opinion by the Corporation Counsel, and he now holds that the awards for street and park openings, to the amount of about $20,000,000, are not a part of this alleged debt. This decision will enable a number of contractors and workmen to be paid. Mr. A. P. Fitch, the former Controller of New York, contends that no former Corporation Counsel ever included in the debt statement contracts running through many years to come and dependent on unknown quantities, or the purchase by the city of lands to be paid for by assessment on private property and protected by a fund replenished from the proceeds of the tax levy. If these are left out, the old city, on Dec. 31, 1897, was inside the debt limit by $39,863,317.

THE NEW EAST RIVER BRIDGE COMMISSION has been awarded $200,000 by the Board of Estimate. But it seems that the Commission owes the Degnon-McLean Construction Co. $80,000 on the Brooklyn foundation, and Mr. P. H. Flynn $80,000 for work at the New York end. When the salaries for the Commissioners, engineering staff, etc., are deducted, it is evident that there is little or nothing left out of the $200,000 to protect the work already done against damage. Though the contrary statement was made, it now seems that the sum named was simply to meet debts incurred, and no provision is made for carrying on the work or taking precautions against damage to the portions of the work completed.

THE JOINT COMMITTEE ON NEW BUILDING CODE of New York city, represented by a sub-committee, called upon Mayor Van Wyck on May 16 to urge the necessity of preparing a new building code, as provided in the new city charter. The need of impartial disinterested experts to prepare the new code was fully set forth by the committee. In reply the Mayor urged that all possible influence be brought to bear upon the municipal council to induce it to pass a satisfactory bill, and in case of failure to accomplish this, advised the committee to report to him again.

THE RIGHTS OF THE MORRIS CANAL CO. to the water in all the streams along its line is causing trouble between the prospective bidders for the permanent water supply of Jersey City. The East New Jersey Water Co., and its ally, the Morris Canal Co., say that no contract can be made except with them. The Delaware & Hudson Co. claims that the canal company cannot interfere with its proposals, and the O'Brien, Sheehan, McBean & Rodgers Co. maintain the same. The courts may have to decide the contentions.

MEMPHIS, TENN., MAY BE LEFT 3 MILES EAST of the Mississippi River, say the citizens, if the St. Francis Levee Board concludes to adopt the lines laid down for the levees along Four-Mile Bayou. This bayou runs due south, from above Memphis, and connects with the river below; there is a tendency for the river to enter this bayou, and in the high water of 1897 the bayou channel was both widened and deepened, and recent high water has increased both depth and width. If the levee is built on the west bank of this bayou, as proposed, the river men fear that the Mississippi will be encouraged to take the shorter course, and they ask careful consideration before any work is done.

A TIMBER RAFT, of 4,000,000 ft. B. M., is being built at Portland, Oregon, to be floated to San Francisco, Cal. It will be cigar-shaped, 400 ft. long, 53 ft. wide and 24 ft. above water, with a draft of 17 ft. It is an experiment of a kind that were generally costly failures when tried on the Atlantic coast.

THE PURCHASE OF A DREDGE for the improvement of the harbor of Port Arthur is contemplated by the Russian Navy Department. According to information received from Mr. D. T. Mertvago, Naval Attache Imperial Russian Embassy, Washington, D. C., the Department wishes to purchase completed or on the stocks a ladder dredge 162 ft. long, 33 ft. wide and 9 ft. load draft at the middle, with a free board of 12½ ft., capable of excavating 250 cubic meters of material per hour. In case it is impossible to purchase a dredge of these dimensions ready for work or under construction the Department desires to obtain information in regard to the shortest time in which such a dredge can be built and delivered in full working order at Port Arthur, together with an estimate of its cost. Information should be sent to Mr. Mertvago, Washington, D. C.

THE EXCESS VALUE OF U. S. EXPORTS over imports, for ten months of the present fiscal year, is $514,245,495; the highest on record, as the previous largest excess was $287,613,144 in 1897. For the ten months in question the total merchandise exports were valued at $1,025,426,681, while the imports were worth $511,181,186. In the 85 years prior to 1876, there were only 16 years in which exports exceeded imports; and since 1876 there have been only three such years. The export of agricultural products alone, in the present fiscal year, have exceeded by more than $100,000,000 those of the corresponding ten months of 1897.

A PHILADELPHIA ELECTRICAL EXHIBITION will open at 818-820 Chestnut St., Philadelphia, Pa., on June 6, and continue until the 10th.

CONGO RAILWAY PROJECTS, in the Independent Congo State, are thus noted in the "Praktische Maschinen Constructeur" for April 14. The plans cover two systems; one is a line connecting Acetawa and the Upper Oubenghi, or Nile, in the north of the Congo State, and for which construction was decreed on Jan. 6, 1898. The other system would run through the center and south of the State and reach the sea by way of Bona and Leopoldville, on the navigable waters of the Congo River. On the east this line would reach Lake Tanganika. The completion of this project for supplementing the natural navigable ways would afford abundant means for exploiting the products of this rich country.

THE TRIANGULATION OF BRONX BOROUGH, NEW YORK CITY.

By Wm. S. Dalrymple, Assistant Engineer, Board of Public Improvements.

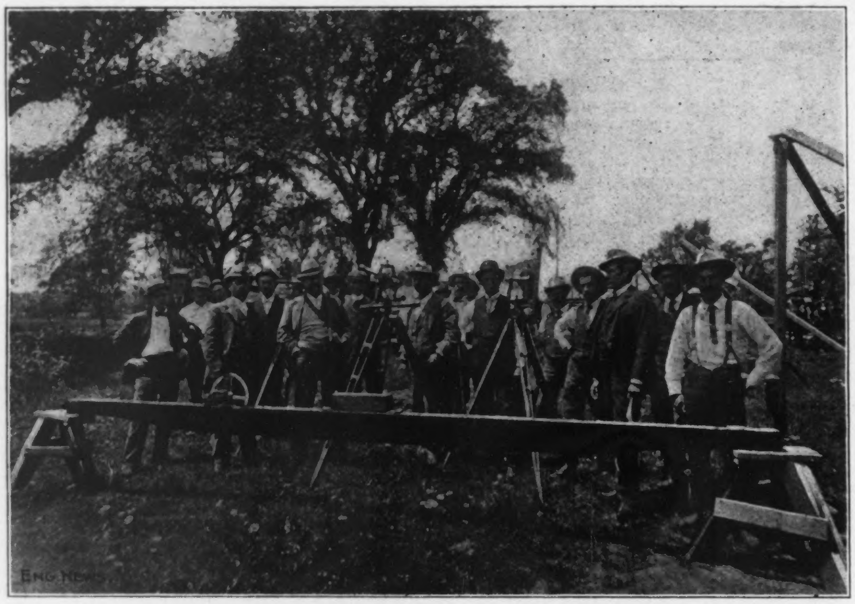
By the authority of Chapter 937 of the laws of 1895, the district east of the Bronx River, and south of the extension easterly of the northerly boundary of the city of New York, was made a part of what, under the new charter, now constitutes the Borough of the Bronx. The then Commissioner of Street Improvements, Hon. L. F. Haffen, and his chief engineer, L. A. Risse, determined upon a thorough triangulation of this newly-acquired territory.

This work is being extended throughout Greater New York, under the supervision of the president of the Board of Public Improvements.

A preliminary reconnoissance, made during the spring of 1896, developed the fact that a base-line of over 10,000 ft. could be measured on the salt meadow extending from Eastchester to Baychester, and another of about equal length was practicable over the Eastern Boulevard in Unionport. A quadrilateral was selected as the controlling polygon for the primary triangulation, made up of the following stations: Highbridge Water Tower, the central dome of St. Joseph Seminary at Dunwoodie, the mansion on the highest point of Hunter Island, and Jackson's brick water tower on the Fort Schuyler road, near Throgg's Neck. These enclose about 33 sq. miles of the Borough of the Bronx, and constitute a well-conditioned figure.

The line of Eastern Boulevard, at Unionport, was extended easterly to near its intersection with Fort Schuyler Road, and westerly across the salt meadows to its intersection with the Clauson's Point Road. This Unionport base-line, where necessary, was cleared for a width of nearly 30 ft., and during the summer of 1896 was alined, divided into sections and marked by stakes, and then accurately measured with a spring-balance compensating chain, 50 ft. long. The Eastchester base-line extends southerly from Station Maguire, the cupola of a house near the intersection of Old Boston Post Road and Hutchinson River, to a point about 1,500 ft. south of the N. Y., N. H. & H. R. R., and near the margin of a salt meadow just west of Baychester. During the fall of 1896 this line was also accurately measured with the chain.

The conventional meridian to which are referred the rectangular co-ordinates of the fixed points of the Borough of the Bronx, is the easterly line of 10th Ave., prolonged northerly from the southeast corner of 10th Ave. and 155th St.; and the origin of distances is the intersection at right angles with the above line, of the northerly line of 225th St. The party to whom the field-work was assigned at various times during the spring and summer of 1896 was divided, part measuring the line above referred to, and part measuring the center line of 10th Ave., from 175th south to 98th St. Furthermore, during the period noted, over 10,000 angles were read from preliminary stations, co-ordinates derived and plotted on a map to a suitable scale, to determine the relative locations of selected points. For the purpose of properly orienting the map, a "center line," assumed to be parallel to 10th Ave., and distant therefrom easterly about 16,000 ft., was measured from the easterly extension of the northerly city boundary southerly to its intersection with Whittier St., near Hunt's Point.



A FIELD PARTY ON BASE LINE MEASUREMENT.
Topographical Survey of Bronx Borough, New York City.

For the final work, nine towers, varying in height from 20 ft. to 75 ft., were erected where necessary. The north terminus of the Eastchester base-line is the cupola of the Maguire house, to which allusion has heretofore been made. The south terminus of said line is a tower about 40 ft. high. The whole extent of the line is visible from either terminal point, and the triangulation monuments, when set, were each readily centered from one terminal station, and tested afterward from the other. Each of the base-lines is marked by five granite monuments, bedded in concrete and capped with a suitable iron cover. In the center of each monument is a copper bolt about 1 in. in diameter and 4 ins. long. The intersection at right angles of two finely-cut lines on the smooth bolt head is the point in the base-line to which distances have been measured.

About Dec. 10, 1896, the staking of the Eastchester base-line was begun. Starting from the monument Maguire[2], about 112 ft. south of Station Maguire[1], chestnut or spruce stakes, 4 × 4 ins. by 14 ft. long, were sawed into appropriate lengths determined by the contour and nature of the surface, and driven down to a given grade, and at intervals of 16 ft. Where necessary these stakes were stay-lathed with spruce 1¼ × 4 ins. by 18 ft., and in the case where a slough or stream was staked, double lines of galvanized steel wire were stapled to the stakes, carried to firm ground and securely anchored to a heavy stone buried 2½ ft. deep. The line so constructed was perfectly rigid. To cross the narrow streams and long sloughs, nineteen foot-bridges, varying in length from 30 ft. to 320 ft., were built. This base-line contained 695 stakes. In like manner the Unionport base was staked out, requiring 748 stakes.

On April 6, 1897, the exact measurement of the Eastchester base-line was begun from the monument Maguire[2], southerly to monument Town Dock Road, to a monument on Cactus Knoll in the meadow, to a monument on the Pelham Bay Parkway, then to the last monument, about 32 ft. north of the south terminus, namely, station Red Oak. The line was prepared for measurement by nailing a table of spruce 8 × 15 ins. on the top of each stake. The same tables were used over and over again, those in the rear of the line, after duplicate measurements had been taken, being removed and renailed on the stakes in advance of the line.

Four bars were made by F. E. Brandis Sons & Co. for the Department, according to a design furnished by Mr. E. Ankener, Asst. Engr. in charge of the field work. Each of these bars carried a battery for making electrical contact. They are made of straight-grained, specially-prepared white pine, trussed longitudinally to eliminate the least disposition to sag, carefully oiled, shellacked and painted, so as not to absorb moisture, and capped at one end with a brass frustum of a cone, tipped with hardened steel having a polished surface. The other end carried a micrometer screw capable of expressing a length of 1-5,000 of an inch, as shown by the silvered scale of one inch divided into fifty equal parts; one revolution of the wheel passed over one space of the scale, the circumference of the wheel itself being divided into 100 equal parts. This micrometer wheel was moved by a milled edge hard rubber wheel of about 2 ins. diameter. The micrometer screw and wheel responded so delicately and accurately that it was not considered worth while to calculate for the "run of the micrometer."

One of these bars was sent to the U. S. Coast and Geodetic Survey office, at Washington, for standardizing. The bar, afterwards called "Comparator D," has then a determined length between the cone edge of one end and the zero point of the micrometer at the other end; it also has a coefficient of expansion, and it is known at what temperature the standardizing was made. The three other bars, marked A, B, and C, and painted, one red, another white, and the third blue, were compared by Messrs. Brandis.

As before mentioned, on April 6, 1897, the accurate measurement of the Eastchester base-line was begun. First, the line of the base was projected on the tables capping the stakes, by means of a transit at an average distance of 500 ft. in advance of the bars. The three bars being successively alined, the electrical contact was made, the micrometer of each bar read, first by the writer, then by an assistant, the reading noted on an appropriate printed form, and then called out, and checked. On the said form were spaces ruled for time, whole number of bars, letter of bar, temperature, inclination plus or minus, correction for inclination, plus for micrometer, and remarks. A clinometer, reading to minutes, was placed successively on each bar, leveled by tangent screw, and read by two observers, then entered on the record, duplicate records being kept, one by each observer. At intervals of from five to ten bars the temperature was read and also entered. To protect the bars against extreme and sudden changes of temperature, each was "jacketed" with a covering of hair felt enclosed between two thicknesses of heavy drilling, so that but three or four inches of the extremes of the bars were exposed. Where the grade was 3° or more, and fortunately this did not often occur, the series of three bars was held steady by a transit set up at right angles, one (transit) at each terminus, the vertical thread set on a fine needle placed one at each extremity of the series. On this base 695 bars were measured in duplicate, and in a similar manner 743 bars were measured on the Unionport base-line. The exact measurement was finished June 29, 1897.

Mr. Ankener, provided with a new, improved theodolite, occupied the various stations for reading the final angles. The preliminary observations amounted to a reading of 10,000 single angles. In the final observations, a systematic method of reading in series was observed, and the repetitions so extensive that the discrepancies were reduced to a minimum. He kept the writer supplied with angles as they were required in the subsequent mathematical investigations.

About the middle of July, 1897, the calculations on the base-lines were commenced. This was systematized thoroughly as follows: The forms used by the U. S. Coast and Geodetic Survey are such models of neatness and simplicity that they were adapted to our use. After the filed records of base measurement were finished, they were neatly copied in ink. These records and the notes taken in the field are the data for the subsequent computation. Tables of temperature changes, of corrections for inclination, and of multiple bars, were calculated and used. Thus the calculation on the direct measurement became mechanical. The problem for the interpolation of a base was used three times. A modification of that problem was used twice.

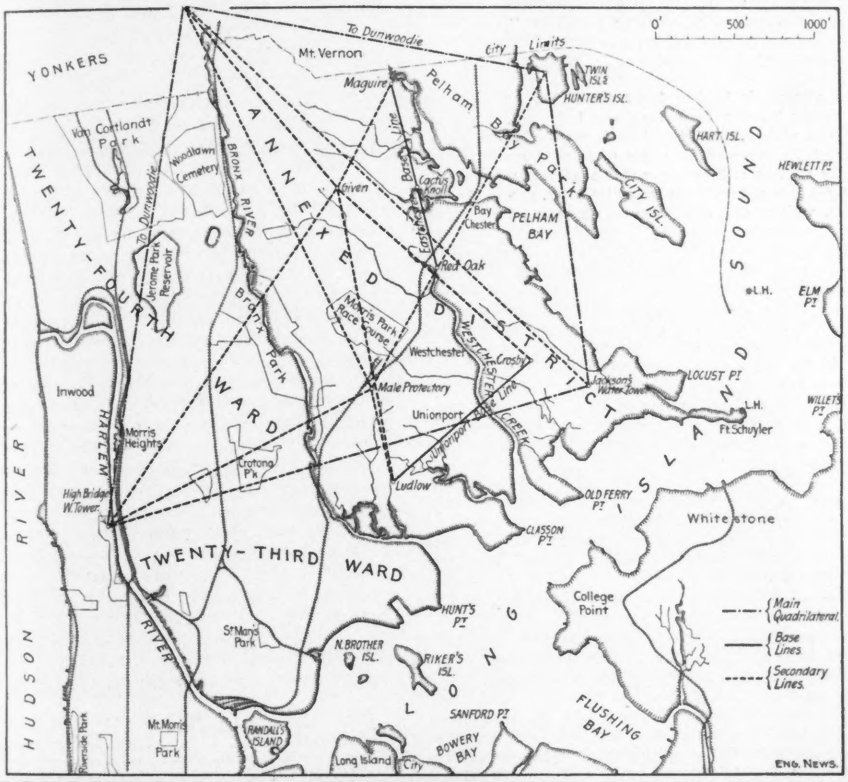
The horizontal angles at the station were read in series, thus reducing errors of graduation to a minimum. The angles to a station were repeated from 40 to 100 times. The local adjustment was effected by Least Squares, using the Gauss' algorithms for the general work, and Dienger's method of treatment for a check. In the formation and solution of the normal equations, whether derived from the "Beobachtungs gleichungen" or from the "Bedingungs gleichungun," to use the German expressions for "Observation Equations" and "Conditional Equations." In the solution of the normal equations, this tedious operation was materially shortened by using logarithms, and carrying along a "check equation."

In the adjustment of the triangulation net, involved in passing from one base to the other, and also in connecting stations to the rigid quadrilateral previously formed, the writer used the admirable method of the U. S. Coast and Geodetic Survey, as elaborated in the Report of 1894. The resulting sides in a net of 30 triangles show a discrepancy of not more than 0.04 ft. in a distance of about 26,000 ft. In fact, no methods treated in the German or French works on geodesy were more concise and satisfactory than those to be found in our Coast Survey Reports from 1854 to 1896. The writer has not had the time to calculate the probable error of many sets of observations, as the requirements of the work did not permit much digression from the main subject. But an exhaustive examination of the directly measured part of the Eastchester base gave an error of 0.007 ft. in 11,000 ft.—a degree of exactness high enough for all practical purposes. Coefficients for the chain measurements are as low as 1.00005, and none higher than 1.00012.

Taking the Coast Survey distance, Ferber to Memorial Church, the geodetic co-ordinates of Highbridge Tower were checked. Then the co-ordinates of Dunwoodie, Hunter Island, Jackson, Given, and the Protectory were derived directly from Highbridge; those of Hunter Island, Jackson, Given and Protectory again derived from Dunwoodie; those of Jackson, Given and Protectory from Hunter Island; those of Given and Protectory from Jackson, and finally those of Protectory from Given. The greatest discrepancy was 0.004". One very satisfactory connection has been made with the Coast Survey distance Memorial Church—Highbridge tower, and others will be made as early as practicable.

To the rigid polygon of control will be connected a sufficient number of secondary stations; and to these in turn will be tied crucial points in the perimeter of the local surveys of the subdivisions of the district. All the various stations of the interior surveys will then be calculated in a single system of rectangular co-ordinates.

The obligations of the writer are due to the U. S. Coast and Geodetic Survey office for unvarying courtesy and a prompt response to all requests for reports and other valuable information.



MAP OF PART OF THE BOROUGH OF THE BRONX, NEW YORK CITY, SHOWING TRIANGULATION IN CONNECTION WITH TOPOGRAPHICAL SURVEY.

EARLY MARINE ENGINEERING IN THE UNITED STATES.*

By Charles H. Haswell, M. Am. Soc. M. E.

Marine steam engines of the primitive construction, were, down to 1822, of the vertical crosshead type, connected with sliding clutches directly to the water-wheel shafts, and also geared to a shaft with a fly-wheel at each end of it; the object of the connection was to enable the water-wheels to be disconnected, and the engine to be operated independently and solely, to feed the boiler and operate the bilge pump when the vessel was at a pier or anchored, as independent steam, feed, bilge, and fire pumps were then unknown. The steam and exhaust valves, if puppet, were operated by the band gear of Beighton; when otherwise, the long slide valve was used.

This type of engine, with the crosshead, connecting-rods, cranks and shafts of cast iron, the key, crank, and pin holes cored and cast in, was wholly used until about 1822, when the vertical overhead beam was introduced; where the horizontal or inclined engine was introduced, the short slide valve was resorted to, except in the Southern and Western waters, where the level puppet, operated by a cam, was wholly used.

The boilers, with the exception of the very first few, which were plain cylindrical, set in masonry, were of copper plates of the design termed "D. and Kidney Flue," having but one furnace full width of the inner space of the front, the flame and gases of combustion leading through a flue of about two-thirds width of furnace into a back connection, and from thence into a return flue, which, from the outlines of its transverse section, was termed a "kidney flue," and from thence to a short vertical flue at the back of the furnace, and then extending up to the shell of the boiler, in a short shoulder of which the base of the smoke pipe was set. The cause of this convexity to the inner side of the main flue, and the indentation given to the inner side of the other, was that the curved surfaces rendered socket bolts less necessary, with the limited steam pressure of 15 lbs. or less per square inch.

On Southern and Western waters, where non-condensing engines were alone resorted to in consequence of the waters of the rivers being too turbid for the continuous operation of a condenser, wrought-iron cylindrical boilers alone were used, and the character of the iron was such that the plates were cold riveted; the boilers were generally internally fired in some cases externally, and it was not until about 1820 that marine boilers were constructed of iron in Eastern waters.

Boiler plates were punched manually by the aid of a long wooden lever, on which four men exerted their force, and as the location for the punch was directed only by the eye of the operator, the spaces were frequently irregular, involving pinning, in order to bring the holes as nearly opposite as practicable, and hence the plates were frequently strained and the rivets set at an inclination; all rivets were hand-made, but at the East were driven hot.

Blow-offs were not attached to boilers until steam navigation was well advanced. The exact period is not now ascertainable; probably about 1822. The boilers of steamboats on the bay and river routes, with the low pressure of steam with which they were operated, and the consequent temperature of it, did not involve the necessity of the frequent blowing off of saturated water from their boilers, and the water was let run out of them at the end of each passage, and they were then refilled with fresh water. In consequence of this neglect of blowing off, and the imperfect manner in which the plates of a boiler were riveted, a boiler at the end of a trip in wholly, or even partinlly salt water, would be loaded in its seams and joints, with incrustations and stalactites of salt, to an extent that involved the hammering and scraping off of them at the termination of the trip. Felting of a boiler waa unknown.

Cranks and Crankpins.—The shaft hole of cranks was octagonal, and they were secured to the shaft with flat keys, the interspaces fitted with a cement of iron borings and sal ammoniac; and as the distance between the centers of the crank, from the varying shrinking of the metal and the casual settling of the cores, would vary from that of the exact required length of half-stroke of the piston, the pin was forged with two longitudinal centers, one for the hub and the other for the eye of the crank, and when the pin was fitted and seated, it was held in position by a key in its end, which protruded beyond the eye of the crank.

Finishing.—So deficient were the facilities of lathes, planers, slotters, and drills, that "black work" of engines, as it was termed, was the prevailing finish. The connecting-rod of a large vertical beam engine in the "Victory" was wholly finished in the smith's shop, the body of it after forging being dressed by swageing, the key holes drifted, and the ends and straps dressed with a flatter on an anvil, and a horse file.

Cylinder-piston packing consisted of hemp gaskets, and if the safety valve of the boiler was not raised during the initial raising of steam, the steam around the chimney flue would become so dry as to char the wood blocking between the ribs of the piston, and also the piston packing; hence lead pipes through which the gaskets were drawn was resorted to.

Counters, indicators, salinometers, brine pumps, steam and vacuum gages, metallic packing, whistles and oil cups, other than the one in the cylinder head, by which the piston was lubricated on its exhaust side, were unknown.

Cut-offs were operated by a cam on the water-wheel shaft; hence, upon the closing of the cut-off valve, all the steam in the pipe between the valve and in the side pipe up to the steam valve, was added to that expended without any effect that compensated for its flow, and, as a result, it was sought to save this expense, and Robert L. Stevens, of Hoboken, N. J., designed and successfully introduced the cutting off of the steam directly by the steam valve.

Compound or Woolf Engine.—About 1824 James P. Allaire constructed the steamboat "Henry Eckford" with a vertical crosshead compound engine, the center shafts geared to the water-wheel shafts, but in the absence of a receiver the mutual operations of the cylinders were only at the extreme of the opposite strokes of their pistons. Soon after and up to 1828 he constructed five other boats, namely the "Sun," "Commerce," "Swiftsure" and "Pilot Boy," with like engines, and the "Post Boy" with an overhead beam engine, the cylinders being set at opposite ends of it; but as this type of compound engine operated at the moderate pressure of but 25 lbs. per sq. in. it did not attain such an effect as to justify the increased cost and weight of two cylinders and their connection, and the further construction of it was abandoned.

Steam Chimney.—In 1827, James P. Allaire, of New York, invented the steam chimney; the original design being that of two cylinders of boiler plate, one within the other, connected and closed at both ends, the interspace being about 5 ins. in width, with a vertical diaphgram, connected near its upper end to the outer shell above where steam was admitted from the boiler, through two or more connecting pipes, which served also as fastenings and to

*A paper read April 1, 1898, before the Institution of Naval Architects, being reminiscences of early marine steam engine construction and steam navigation in the United States of America from 1807 to 1850.

hold the chimney in position. This diaphragm led down to within a few inches of the bottom of the chimney, and the steam was inducted down and under it, then up and around the inner cylinder, and from thence to the steam pipe opening in the top; thus the steam deposited its contained water in the chimney, to be vaporised by the heat at the base of it, and received also heat from that ascending the chimney, hence a material economy of fuel was attained with the advantage of obtaining dry steam. Boilers at this period did not foam (prime); the great proportionate volume of water, its area at the water-line, and the moderate heat in the furnace from wood, with but a natural draught, precluded it.

In 1828, the engine of a large steamboat, the "Chief Justice Marshall," on the route from New York to Albany, broke down by the breaking of the head of her piston-rod at its insertion into the crosshead socket, the crosshead, both connecting-rods, and a center crank were broken, and in four days new castings from the builder's patterns were made, the piston-rod repaired, all fitted, and the engine ready for operation.

In this connection, it is to be considered that neither the eye of the crank was reamed nor the keyholes of the rods slotted; they, the crank eye, and the ends of the rods, were submitted only to the operation of a coarse file.

In the attachments to engines and boilers the steam gages were constructed in the smith's shop, consisting of an iron tube ½ in. in diameter and 4 ft. in length, bent, with one of its legs 15 ins. in the clear length, and the other the balance of its length filled with mercury, on which was placed a light pine rod, the rise and fall of which, shown on a tin plate divided and numbered in inches, designated the pressure of the steam in pounds per square inch.

Steam navigation, up to the latter part of 1829, was confined to Long Island Sound, the Southern and Western rivers, and Canadian lakes and rivers, with a single passage of a steamboat from New York to Philadelphia, the "Phoenix," in 1807, and one on the route from Havana to Matanzas, and one from Charleston to Savannah. In 1819 the auxiliary steamer "Savannah," of 380 tons, steamed and sailed from Savannah to Liverpool, she being the first steamer to cross the Atlantic Ocean.

In 1825, Mowatt Brothers, of New York, owners of the steamboat "Henry Eckford," attached a loaded barge to her, and transported it from New York to Albany; this was the first essay of steam towing, and although insufficiency and impracticability were generally predicted, the enterprise proved to be a great and lasting success.

In 1826 a fan-blower was first introduced under the grates of the boilers in the steamboat "North America" of the Messrs. John C. and Robert L. Stevens.

In 1828-9 the rivalry for speed between the steamboats plying on the route from New York to Albany was so great that in the design of the boats, their beam was so disproportionate to the weight of the engine, boilers and deck-houses above, that they proved unstable, and, in order to reduce this condition, large logs of light pine wood with sharp ends were firmly suspended under their after wheel-guards and depressed for half their diameter below the water-line, and in operation they measurably improved the stability of the boat.

In 1830, the patent of the steam chimney of Mr. Allaire was invaded, and the operation of it simplified by making the double cylinder an integral part of the boiler, open at its lower end, and extending to such a height above the boiler as to give the necessary surface to superheat the steam, and the required height and volume of steam space measurably to arrest foaming by admitting the subsidence of the water, physically borne with the steam in its flow to the steam pipe.

Gongs for the engine-room were unknown, and in many of the boats, when the pilot was in his house, if there was one, or on the deck over the engine-room, he would signal to the engineer by the strokes of a stick or cane upon the floor of the house or deck. All boats, of course, carried bells, and by them all notices of departure and of arriving were made known, and all salutes between boats were given by their bells. To blow steam, as is now done by a whistle, was intended and held to be a challenge or an insult.

Fuel, up to the year 1836, was wholly of pine wood, at which period some owners of steamboats commenced experimenting upon the practicability of using anthracite coal. A steamboat, on her route of six or more hours, could not have the capacity in her fire-room to contain all the wood required, and was compelled to pile it upon her side houses, and such boats as were on a long route, as from New York to Providence, were compelled to invade their upper deck with wood, and upon leaving the city had somewhat the semblance of a floating wood yard.

In 1836 James P. Allaire commenced the running of a steamboat, the "David Brown," a light-built river boat with deck-houses and promenade deck, from New York to Charleston and return, the enterprise being almost universally held to be utterly impracticable. It was successful, however, and soon afterwards he built two other and larger boats for the same route, and from that period coastwise steam navigation was held to be so practicable that various lines to other ports were established. The "David Brown" was fitted for this service with planking under her water-wheel guards closely joined and caulked, extending from the inside of string piece to the light water-line, which shielded the guards from being forced up by a sea. This device, after several essays at a proper term, is now known as the sponson. In some cases on coast routes, instead of a closed shield, open slatting was resorted to.

1837.—The first propeller steamer was introduced.

1838.—Phineas Bennett designed, patented and introduced in the steamboat "Novelty," plying on the Hudson River, a vertical cylindrical boiler in which a hermetically-closed furnace was supplied with air by a pump, and all the gaseous products of combustion of the fuel were driven into the steam-room of the boiler; the object of this design was to increase the generation of steam and reduce the proportionate area of heating service. The boiler after a short period of service was removed.

Soon afterwards he introduced the design into a vessel built to ply between New York and Liverpool, under the conditions with her builder that, if the design proved to be acceptably successful, he was to be paid for the entire plant of engines and boilers and his services; but if not successful he was to remove the entire plant, and at his own expense, without any remuneration whatever. The engines and boilers were completed and operated, but they were not paid for by the builder of the vessel, and the boilers were soon afterward removed and replaced with others. In consequence of the ashes borne into the valve chests and cylinders, and the evaporation of the oil of lubrication by the dry heat of the steam, the valves were rapidly worn, and the cylinder pistons shrieked to a degree that would have rendered the design very objectionable, even if it had been successful in other points.

Captain John Erricson arrived in New York in this year, and in 1842, he designed and directed the construction of the engines and propeller for the United States auxiliary bark-rigged steamer "Princeton."

1839.—Anthracite coal was introduced as fuel for steamboats, and, to aid its combustion when a high pressure of steam was required, a fan-blower, driven by a belt from the water-wheel shaft, was first resorted to, but soon afterwards a small independent engine was resorted to, connected by a belt to the blower. Anthracite coal was soon afterwards first burned without auxiliary draught in the open furnace of a steam boiler.

1840. — Wrought-iron shafts were first made, the construction varying wholly from that of the present period; thus, iron bars from 2.5 in. to 3 in. square, and of the greatest attainable length were laid up with a square section, the abut ends breaking joints with the other bars; hence the solidity of a section of the mass was only subjected to any imperfection arising from their ends not being wholly welded, by the percentage of the section of one bar to the whole number, and of all the shafts made up to the period included in this paper but one was broken; and that in consequence of its being insufficient in diameter for the stress to which it was subjected, and this result was foretold when the diameter of the shaft was reduced from that given in the specifications for it.

1842.—The first steam frigates for the United States were constructed.

1846.—Captain John Ericsson applied a surface condenser to the engine of a revenue cutter, and in 1848 Pierson designed an improvement which was further improved by Chief Engineer William Sewell, of the Navy, and the perfected instrument is now in general if not in universal use.

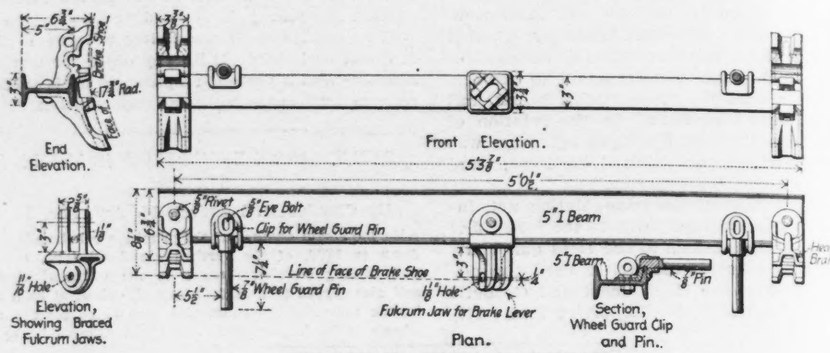
1848.—The "Atlantic" and "Pacific" of the New York & Liverpool Steamship Co., "Collins Line," were constructed in this year, and in July, 1850, the "Atlantic" made the then quickest passage between New York and Liverpool, it being but 10 days 15 hours. The "Arctic" and "Baltic" of the same line were launched.

1850.—It is wholly impracticable to obtain the consumption of fuel per horse-power in early steam engineering, as engines were not fitted with counters or indicators, and the wood was not weighed. In 1840, with auxiliary or blower draft, and in the absence of counters and indicators, it was computed by weighing the coal consumed, and held to be about 5 lbs., and the velocity of the river boats from 8½ statute miles in 1816, increased to 19 miles.

A NEW METAL BRAKEBEAM.

The advantages of metal brakebeams as compared with trussed wooden brakebeams in point of life, efficiency, cost of maintenance, and even first cost, are being very generally recognized, and are leading to the rapid introduction of such brakebeams. One of the latest forms of metal brakebeam is the "Solid" beam, which is manufactured by the Monarch Brakebeam Co., of Detroit, Mich., the special claims for which are lightness, stiffness and cheapness.

It consists of a 5-in. Carnegie steel I-beam, 3 ins. wide over the flanges, and 5 ft. 3⅞ ins. long,



THE "SOLID" METAL BRAKEBEAM.
Monarch Brakebeam Co., Makers.

riveted to each end of which is a malleable iron head, to receive the brakeshoe, and a malleable iron clip for the wheel guard pin. At the middle is a fulcrum jaw, also of malleable iron, and as this grips the flange of the beam and is riveted to its web, the attachment is very secure. Each wheel guard clip is secured by one ⅝-in. eye bolt, and by loosening this the ⅞-in. pin, which fits in a notch in the front flange of the beam, can be readily removed for renewal. The weight of this beam is 80 lbs., all complete, and the simplicity is shown by the drawing and the list of parts given below.

The same company also manufactures the Monarch brakebeam, which consists of a 2⅜-in. steel tube, bent to an arc with a rise of 7½ ins., and trussed horizontally by a 1-in. rod attached to the malleable castings at the ends of the tube and passing over a malleable iron strut or fulcrum at the center, this rod being bent to a curve with a rise of 3⅛ ins., so that the horizontal truss depth of the beam at the middle is 10⅝ ins. To the strut is attached the jaw for the brake lever. For the following table of the detail list of weights of parts of the two beams we are indebted to Mr. Harry W. Frost, General Sales Agent of the company, Old Colony Building, Chicago:

Solid Brakebeam.

		Lbs.
1	beam, 5 × 3 ins. × 5 ft. 3⅞ ins.	50
2	⅝-in. eyebolts and 2 nuts	1
2	wheel-guard pins	2½
2	brake heads	17
2	wheel-guard clips	3
1	fulcrum jaw	5½
3	⅝-in. rivets	¾
15	Total	79¾

Monarch Brakebeam.

		Lbs.
1	center fulcrum	10
2	brake heads	19½
2	wheel-guard clips	4½
2	wheel-guard pins	2¾
2	⅝-in. eyebolts with 4 nuts	1¾
1	truss rod, 1-in., with 2 nuts	16
1	hard pipe	10
2	split cotters, ¼ × 1½	..
19	Total	73½

SPECIAL BRILL TRUCK FOR A 96,000-LB. LOCOMOTIVE PASSENGER CAR.

The accompanying cut shows a special truck built by the J. G. Brill Co., of Philadelphia, Pa., upon the general model of the well-known "Perfect" truck, for a 96,000-lb. locomotive passenger car now being constructed in France for high-speed electric railway service. Briefly stated, what the French engineers propose to do is to build a double truck passenger coach weighing 96,000 lbs., and to provide it with sufficient motive power to utilize the adhesion obtained by this weight. As the body for this car was built in

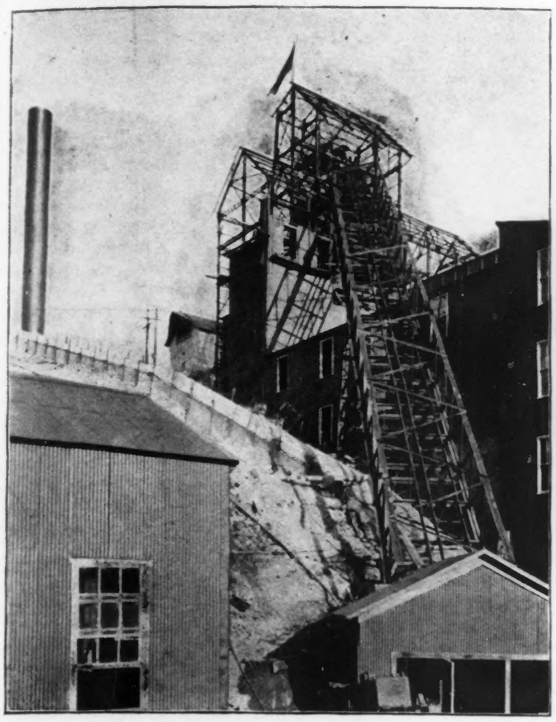


FIG. 2. 160-FT. STEEL INCLINE FROM MOUTH OF MINE SHAFT.

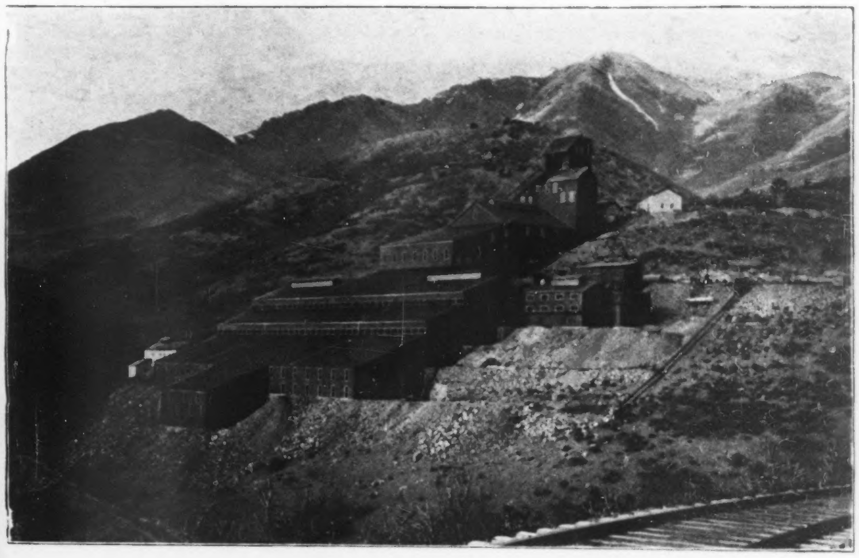


FIG. 1. GENERAL VIEW OF COMPLETED MILL.

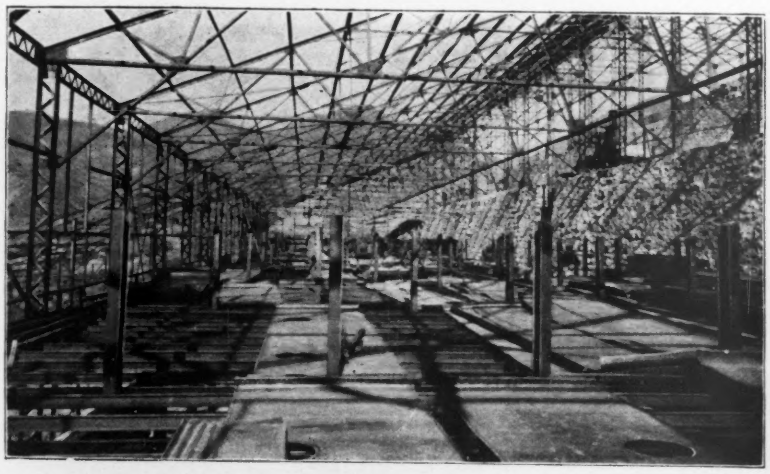


FIG. 4. ROOF TRUSSES OVER TANK ROOM.

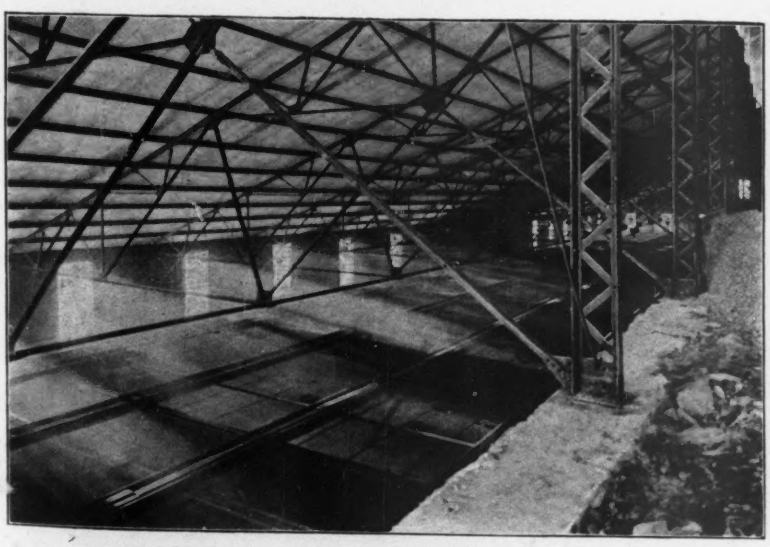


FIG. 5. TANK ROOM, SHOWING EMPTY TANKS.

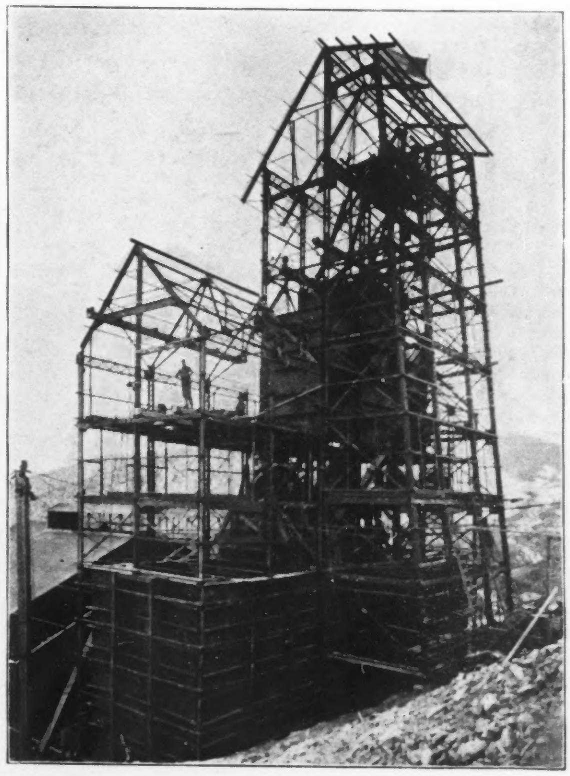


FIG. 3. UPPER SECTION OF MILL UNDER CONSTRUCTION.

GOLDEN GATE MILL OF THE DE LA MAR'S MERCUR MINES CO., MERCUR, UTAH.

D. C. Jackling, Superintendent and Designing Engineer.

The Gillette-Herzog Mfg. Co., Minneapolis, Minn., Contractors for Steel Construction.

France only a few details are available in regard to its construction. It is stated to be 36 ft. 9 ins. long, and 6 ft. 9 ins. wide. The floor frame is of channel bars apparently about 10 ins. deep. There are six cross sills, also channel bars, spaced so that the outer ones are 5 ft. 10 ins. from the ends of the car. No details whatever are available in regard to the construction of the car body proper. This locomotive car, it is stated, will operate on a line 200 miles long at express train speed.

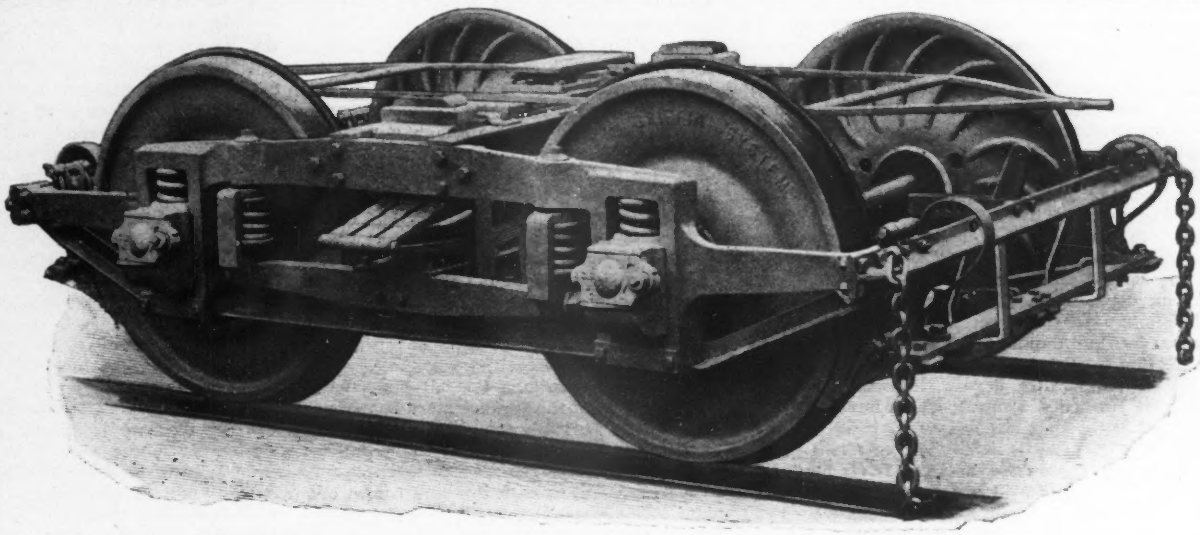
The trucks, which are of special design, have two distinct functions to perform; the first being that of a locomotive engine, and, the second, that of a carriage supporting the car body. To meet the requirements of the locomotive the trucks were built in the most substantial manner. The side frames, which also form the jaws for the journal boxes, are massive forgings nearly as large as the bars of a steam locomotive frame. The end pieces of the frame are T-irons carried by palms worked upon the side pieces. The seats in these palms are finished, and the holes are reamed for taper-bolts. In fact, locomotive practice is followed throughout in constructing these trucks, and wherever bolts are used they are made taper and the holes are reamed. The swing bolster is held between a pair of angle iron transoms which are bolted to the side frames of the truck, the ends of the angle being cut out and bent so as to form brackets for the purpose. The wheels are of unusual size, being 45 ins. in diameter. They are of cast-iron and are mounted upon axles 7 ft. 6 ins. long, and 5 ins. in diameter at the wheel fit. The journals are 4½ × 8 ins.

Each truck is furnished with a pair of 150-HP. motors, thus giving the car 600 HP. The trucks weigh 11,080 lbs. each, the motors 10,000 lbs. per pair, and the car body 24,000 lbs. This brings the weight, without passengers, up to a little more than 66,000 lbs. Lead or iron ballast will be used to get the required load of 96,000 lbs.

In the production of an easy riding carriage the initial step was the introduction of journal springs over the boxes. The first advantage of this is the reduction of the weight not carried by springs, which now consists of wheels, axles and boxes only. The heavy equalizer, instead of resting directly on the boxes, is carried by the open links in which another set of springs are introduced. The latter have the same capacity as those on the journal boxes, and have a double function, cushioning the equalizing movement when the wheel rises, and cushioning the swing motion when the trucks move sidewise.

The equalizing bar forms a part of the swing motion, and is firmly attached at its center to the spring plank. The links by which it is carried are attached to the wheel piece a short distance from the centers of the journal boxes. The hanging of these links is peculiar. It consists of a large bar carrying a spring seat upon the lower end while the upper post terminates in a square head under which a ball or hemisphere is finished forming, with a hemispherical cup in the solid frame, a ball and socket joint. The hole beneath is made sufficiently large to allow the bar the required swing. This construction gives an extra long link, as no room is taken up by the hinge. Upon the spring plank there are two sets of triple elliptics. Quadruple springs would have been preferable, but in this case the contract limited the wheel base to 6 ft., and there was only room for the triple springs.

As shown in the engraving, this truck is substantially the form of "Perfect" truck which the J. G. Brill Co. recommend for passenger service on steam roads. It is fitted with the M. C. B. standard box, and in other respects would conform to the standard. The brake rigging is nearly the same as that used on heavy steam car work. The brake beam in this case is a heavy flat bar trussed for strength, but the brake hangers, springs, straps, etc., are like those used on steam road trucks. It should be noted that the double brake rod shown in the cut is a feature introduced for the purpose of clearing the motors which come up very high. The brake levers could not be inclined because the French guard rails are high, and fill the whole space between the rails, except a small opening in the center, which was the only place for the lower rod. By using pipe the double rod was made quite light.



SPECIAL MOTOR TRUCK FOR A 96,000-LB. LOCOMOTIVE PASSENGER CAR.
The J. G. Brill Co., Philadelphia, Pa., Builders.

We are indebted to the J. G. Brill Co., of Philadelphia, Pa., for the information from which this description has been prepared.

THE LARGEST CYANIDE GOLD REDUCTION WORKS IN THE WORLD.

By W. P. Hardesty, C. E.*

(With full-page plate.)

The discovery that cyanide of potassium in the form of a weak solution is a perfect solvent of gold has increased enormously the production of gold in South Africa, Australia and New Zealand, and more recently in America. The existence of the pure metallic gold in small masses or veins, generally visible to the naked eye, or what is usually known as "quartz gold," was formerly the only form known except "placer gold." But of late years gold has been discovered in ore where its presence was never suspected before, it not being found by the usual tests.

The Camp Floyd mining district in Utah is a notable example of this, and here during the past four years has been built up a substantial and flourishing gold mining camp. The gold here is usually found in a soft, easily-pulverized rock, mostly decomposed quartz, approaching earth in its nature. Just what form the gold is in is not definitely settled. The most powerful microscopes fail to reveal any granules, but the weight of evidence is that it exists in an extremely finely-divided or amorphous state, and not as a compound, as some assert.

The McArthur-Forrest process, the right to use which is owned by the African Gold Recovery Co., Ltd., involves the use of cyanide of potassium, and the courts have usually upheld the validity of the patents. By this process ores of very low value have been successfully treated, and many mines in Africa and Australia that had previously been able to save only 20% to 40% of the gold, on account of its fineness or association with other minerals, now use the cyanide process and save nearly all. The process is not applicable to free-milling ore, except where fine, as it takes a month or even several months to dissolve nuggets of gold with the cyanide.

The town of Mercur is the business center of the Camp Floyd mining district, and the now famous Mercur mine and mill were the first to demonstrate the value of the ore-bodies here. In fact the Mercur mill was the first in the world to treat the raw ore by the cyanide process, which was used only on tailings before, and the Mercur camp is the only one in which gold in the state invisible to microscopes has been found. The development of the process at the Mercur mill was made without reference to the patented process.

Mercur is 60 miles by rail from Salt Lake City, and at the terminus of the Salt Lake & Mercur R. R. Some three years ago Capt. J. R. De La Mar, the French-Hollander, whose mining properties in Idaho, Utah and Nevada have secured for him such a fortune and caused him to become so well known, secured the ground which was the beginning of the Golden Gate mine, the area of which has since been enormously extended. A serious objection to most of the ores of this mine was found to be in the presence of arsenic, which defeated the application of the ordinary cyanide process. An experimental plant was erected and an exhaustive series of experimental researches was gone through by which it was satisfactorily demonstrated that the ore would be fitted for cyanide process if first roasted so as to expel the arsenic. So in July, 1897, work was begun on the Golden Gate mill, which forms the subject of this article.

The mill is situated on the west slope of the hill of the same name. Advantage was taken of the hillside location to have different levels for the different steps of the process, allowing the ore to start at the top of the mill and proceed by gravitation from one level to the next below, all the operations being automatic.

The mill is 294 ft. in length along the side of the hill by 379½ ft. in width up and down the hill. The arrangement is the same each side of the center line running up and down the hill, except for a small compartment at the lower end. There are eight different levels, and there is a range in elevation of 145 ft. from the top of the lowest foundation wall to that of the highest. The different levels were blasted out of the mountain side, the stone serving for building the masonry foundation or retaining walls. The walls are 2 ft. wide at the top, battering down 1 in. to 1 ft., and some of them are 40 ft. high. They are of rubble masonry laid in lime mortar, and contain over 5,000 cu. yds. The excavation and masonry work were done by Rhodes & Thompson, of Salt Lake City, who also graded for a 4,000-ft. extension of the Salt Lake and Mercur R. R., to reach the hill.

Work was rapidly prosecuted on the excavation and masonry. One notable blast was made when about 200 holes, 22 ft. deep and extending in a line for about 300 ft., were exploded by giant powder; the chambers so formed were filled with 6,500 lbs. of black powder, which, when exploded, threw loose 5,000 cu. yds. of rock, a large part of which fell within a few feet of where it was wanted for a masonry wall. The contract prices were 93 cts. per cu. yd for the rock excavation and

*Room 612 Progress Building, Salt Lake City, Utah.

95 cts. for the rubble masonry, for the latter, however, the company furnishing all materials, except the rock, which was on the ground. The mill building is entirely of steel construction, except the window frames, and contains about 1,500 tons of metal. It was built by the Gillette-Herzog Mfg. Co., of Minneapolis, Minn.

The eight different levels or sections and their uses are as follows: The first, or top level, is for coarse crushing of ore, and is 25 × 75 × 100 ft. high. It is divided into three stories, the upper one comprising receiving bins for ore from the mine, the middle one being the crusher room and the lower one having storage bins of 2,000 tons capacity. Section 1 is also divided into three vertical chutes or compartments, one for the silicious ores, one for the base, talcy ores, and one for the arsenical ores. By means of chutes, etc., these ores are kept separate through the mill until finally mixed ready for the leaching tanks. In the crusher-room are two Gates gyratory ore-crushers with a combined capacity of 1,500 tons per day. They weigh 20 tons each.

The second section is the ore-drying and conveying department. The ore from the storage bins is fed to the dryers, through which it is passed by the rabbling machinery and discharged to Section 3. Section 2 is 75 × 82¼ ft., and now contains two Brown dryers (invented and patented by Horace F. Brown), which have a capacity for 500 tons per day, room being left for another dryer when the capacity of the mill is increased. The dryers are each 80 × 16 ft., having a hearth 60 × 12 ft., and are connected by a flue 4½ × 6 ft., with the main flue. The ore is worked over the floors of the dryer by rabbling devices, operated by endless cables, and is subjected to the furnace heat for about 2½ hours.

Section 3 comprises the fine crushing and ore-sizing department, and is 90 × 68 ft. The machinery consists of four sets of 26-in. and three of 36-in. Gates improved Cornish rolls, with a maximum crushing capacity of 1,000 tons per day, Berthelet separators for sizing, and a duplicate system of elevators for raising the crushed product to the separators. There are six elevators, two to each of the three different classes of ore, and their lift is 60 ft. There are three separators for each class, that which is fine enough passing through to the next section, while that which is still coarse is passed through the crushers until fine enough. The finely crusher product is discharged into an ore bin 25 × 84 ft. and holding 2,000 tons. Under this ore bin is the dust chamber, 10 × 11 × 100 ft. long. It is connected directly with the main flue, and is provided with hoppers spaced 12 ft. apart. The floor is so arranged that the dust collects at the mouths of these hoppers, to be drawn off into cars below.

Sections 4, 5 and 6 comprise the ore-roasting department. The roasting plant consists of four Brown straight furnaces. Each has an effective roasting hearth 12 ft. wide by 100 ft. long, with a cooling floor 12 × 100 ft. attached. The arsenical ores are crushed about 10-mesh, and are discharged into two of the roasting furnaces; the base, talcy ores are crushed to about 4-mesh and are fed to the other two furnaces, while the silicious ores are not roasted, but are emptied directly into the receiving hoppers below the roasters and mixed in the required proportion with the other two classes for the leaching tanks. Each of sections 4, 5 and 6 is 298 × 33⅓ ft. The four roasters are in sections 4 and 5, No. 6 being reserved for additional furnaces when needed. The two furnaces used for the arsenical ores have a daily capacity of 75 tons each; those for the base, talcy ores of about 150 tons each.

The furnaces have their roasting hearths directly on the foundations, the calcined ore being elevated to the cooling floors above. The furnaces are of fire-brick masonry backed by vertical I-beams 4 ft. apart, the skewbacks for the arch being longitudinal channel beams.

The ore is stirred during roasting by means of V-shaped plows or scoops attached to rabbling carriages. These consist of heavy I-beams mounted on wheeled carriers which run on tracks at either side of the furnace hearth. The tracks and wheeled carriers are protected from the furnace heat by means of a low wall extending the length of the hearth on either side, which is the distinctive feature in the Brown system of furnaces. The carriages are driven by endless cables, and are spaced 75 ft. apart, the cables having transmission stamps which work in sprocket wheels journaled on suitable cross shafting at either end of the furnaces, the ore being stirred and advanced once each minute. Each carriage on its return plows through the roasted ore on the cooling floor above the furnace to cool it, the two being separated by mineral wool. The attention of but one man is required for each pair of furnaces.

Under the furnaces are flues, 75 ft. long and 6 × 8 ft. inside, which carry their gases into the main dust chamber which starts here and runs up hill to a point above the building, discharging its smoke, dust and gases through a vertical sheet steel stack 8 ft. diameter and 85 ft. high, the top of which is 275 ft. above the lower level of the building. The main flue is 7 × 9 ft. It receives the discharge of the branch flues and dust chambers from the roasting furnaces, the dryers and the fine crushers, there being altogether about 400 ft. of the branches built behind the various retaining walls. All the flues and chambers are of the best brick, with arched tops. On account of its incline the main flue tunnels through the retaining walls.

Having gone through the "dry" portion of the treatment, from the furnace store hoppers the ore now passes through the "wet" portion. These hoppers are excavated out of the fifth level and are connected with the seventh level by a tunnel. The ore passes through this and comes out at a point above the tanks on the seventh level.

This, the tank or leaching department, is 60 × 294 ft. It has two floors, the main floor containing the leaching tanks, ten in number, and each 25 × 50 × 5 ft. deep, and also the three solution tanks—20 ft. diameter × 12 ft. high. Here it is that the cyanide process is applied to the dissolving of the gold in the ore. The tanks are supported by a retaining wall and by 230 piers of masonry, each 2 ft. square at the top, and battering 1 to 12 on each face.

Until the leaching department is reached, the operations are entirely automatic. The ore from the tunnel is received in cars and run out by hand over the tanks and dumped. Four lines of tracks are used. Each tank has a filter bottom through which the solutions filter, passing out as a clear liquor to the precipitating tanks on the eighth level. Each of the ten tanks has a holding capacity of 200 tons. The bottom floor of Section 7 has four tracks for tramming out the tailings from the tanks above when the liquor has been drawn off and carrying them to the waste dumps.

The 8th and lowest section is 50 × 70 ft., and is two stories in height. There are three precipitation tanks, 14 ft. diameter by 8 ft. high, where the gold is precipitated from its solution. On the floor below these, called the press sump room, are two sump tanks of 20 ft. diameter by 12 ft. high. These pressure sump tanks are operated by compressed air.

The mill is fully equipped with chutes and gates for feeding and regulating the passage of the ore from one part to another, and the operation is entirely automatic, except where noted. The mill is also equipped with a complete system of exhaust fans for collecting dust from every point where made, it being recovered in chambers by straining the air forced in by the exhausters through fabric, the dust automatically falling into the store bins, to be mixed with the ore. Notwithstanding this, it is found, in operating the mill, that the dust is very plentiful and disagreeable.

The intention was to use no wood in the equipment of the mill except for the supports of the Gates rolls, where it was used on account of its greater elasticity, but by change of plans and for other reasons a good deal of wood has been used in the interior.

To the south of the fourth level is the gas producing plant, a two-story building, 32 × 62 ft. It contains a duplicate system of Loomis gas machinery, consisting of four generators 9 ft. in diameter by 23 ft. high, exhaust fans, engine, scrubbers, etc. Connected with the plant is a gas receiver, 30 ft. in diameter by 30 ft. high, with a capacity of 10,000 cu. ft. All the gas for roasting and drying the ores is produced here. Slack coal is used, and the plant has a capacity of consuming 40 to 50 tons per day. Steam is used to secure a mixture of gas free from soot and tar.

On the north of Section 3 is a machine shop 30 × 60 ft., and a warehouse 30 × 40 ft., and north of Section 7 is a large brick assay office, refinery and chemical laboratory.

An incline from the main working shaft of the mine, and starting about 60 ft. below the surface of the ground, has been brought up to the surface and thence continued on as a steel bridge supported by a steel trestle on up to the top of the upper story of Section 1. This bridge is 160 ft. in length, and is shown in Fig. 1. The total length of incline and steel extension is about 600 ft., the vertical shaft being the same length. The incline is equipped with tilting skips, for working on both the vertical and the incline. These skips are loaded from the mule tram cars at the bottom of the shaft and discharged into the hoppers above the crushers. The shaft has three compartments, one being the manway and two for the ore.

Above the mill, about 100 ft., is the shaft-house or power-house, a one-story brick building, 25 × 70 ft. Here are located the electric motors for operating the hoist, and air compressors for the machine drills in the mine below. An electric hoist of 200 HP. operates the cages for the ore in the two compartments, and one of 75 HP. operates the cage in the manway. A Nordberg compressor of 100 HP. supplies the air. There are 11 motors used in the operations at the power-house and in the mill, with a total capacity of 600 HP. The motors are so located that each section can be run entirely independent of the others. All the motors were furnished by the Westinghouse Electric Co.

The electric power is supplied by the Telluride Power Transmission Co., from their plant in Provo canon, 35 miles distant, and on the east side of Utah Lake. The line transmission is at 35,000 volts. The terminal building is between the shaft-house and the mill, and has necessary step-down transformers, etc., for distributing the current to various motors throughout the mill. By a contract made with Capt. De La Mar and the power company, a minumum of 300 HP., or a maximum of 500 HP. per year is to be delivered at $60 per HP. It requires about 500 HP. for operating the plant at full capacity.

The usual process in cyanide reduction is as follows: After the fine crushing the ore is put into the leaching tanks, and water in which about ¼% of cyanide of potassium is dissolved is turned in. It takes about ½-lb. of the cyanide to one ton of ore, the cyanide costing about 30 cts. per lb. at the present time. When the gold is dissolved out the solution is passed into the precipitation tanks, wherein are placed zinc shavings for the gold to deposit on. The action of the cyanide rots or crumbles the zinc, but it can be restored afterward. The zinc shavings are turned by lathes located at the mill. The final product, averaging in value $14.00 to $16.00 per lb., is precipitated in the precipitation tanks, dried in furnaces and sent to the refinery. For most of the mills in this country the product is sent to the refineries at Omaha, Neb., or Argentine, Kan. The Golden Gate mill has its own refinery.

The cost of the mill and equipment was between $300,000 and $400,000. The total value of the property in the Mercur camp of the De La Mar's Mercur Mines Co., which is a close corporation—Capt. De La Mar owning about all the stock—is probably $1,500,000. Of course, the working capacity of a mine to feed such a mill as this (requiring about 800 tons of ore per day) must be enormous.

Before deciding on the mill a long campaign of exploration and development had been carried on in the original Golden Gate mine, miles of drift having been run and over 8,000 assays made. The ore runs in value from $3 to $100 per ton, with an average of $12 to $15. By acquirement of adjoining property the Golden Gate group now covers about 200 acres, and has four shafts. For one piece of ground of only 6 9-10 acres extent was paid the sum of $237,500, partly on account of its intrinsic value and partly on account of its dovetailing into and breaking the continuity of the main body. Other distant groups owned by the company bring the total area up to about 700 acres.

The presence of the arsenic seems to be mostly confined to the original Golden Gate mine. The Brickyard group, which is connected with the main Golden Gate shaft by a tunnel one-half mile long, has only oxidized ores. This group covers 140 acres.

The superintendent of the mines, Mr. Duncan McVichie, has adopted the "cave-in" system of working the ore-bodies (which is used in the iron mines of Michigan), in place of the usual method of timbering, by which the ore is all stoped out and then the roof allowed a gradually collapse, without disturbing the surface improvements.

A number of parties have assisted in the construction of the Golden Gate mill. The contractors for the masonry foundation and structural work have already been named. The Gillette-Herzog Mfg. Co. also built the storage bins, all the steel tanks, the sheet steel stack, and, in fact, supplied all the iron work except that connected with the machinery for the different processes. The contractor for the Brown dryers and roasters was Horace F. Brown, the inventor. The Gates crushers and rolls, the six elevators and the nine sizing screens or separators (with all shafting, pulleys, belting, etc.), in Section 3, the three-drum hoist of 275 HP. and the air compressor in the shaft-house were all supplied by L. C. & S. V. Trent, of Salt Lake City.

The mill and its general arrangement and equipment were designed by Mr. D. C. Jackling, who is also Superintendent of the mill.

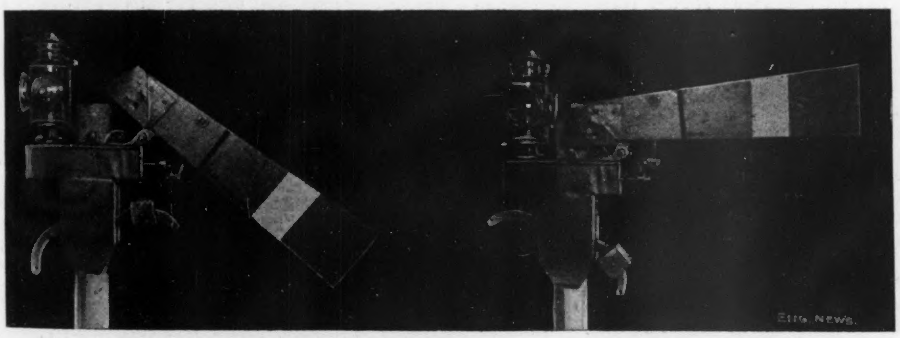
The head office of the company is at Salt Lake City, with Mr. H. A. Cohen as general manager of all the properties.

A NEW FORM OF RAILWAY NIGHT SIGNAL.

A new railway semaphore signal has been devised, which substitutes a revolving lamp for the old form of colored glass disk or spectacle attached to the swinging arm. The advantages claimed are, that the revolving lamp is positive in its safety or danger signal. With the common semaphore, if the red spectacle is broken, a white light may be shown when a red light is intended; but with this lamp should the red lens be broken, the light would either be blown out, or if it kept burning would be practically invisible. Another important advantage is that when the signal is in the danger position, with the red lens facing the track, and the blade horizontal, the white light illuminates this blade, makes it plainer and actually serves as a double signal. Experience shows that in winter time the heat of the lamp keeps the lenses clear of snow and ice, and the lamp always gives a direct and clear light; while the spectacle on the ordinary semaphore arm is often obscured in a driving snow storm.

The illustration sufficiently shows the appearance of the apparatus; but its working may be described as follows: The movement is affected by cams acting on a vibrating arm, pivoted at the lower end and having a toothed portion at the top which meshes with the lower teeth of a double gear-wheel, which is keyed to a central shaft. This vertical shaft is connected with the main frame above and rests on a bridge connected with the frame below. The upper teeth of the double gear mesh with a bevel gear, which is keyed to a horizontal shaft, which has at its end a jointed rod that lifts or lowers the semaphore arm. The lamp is revolved one-quarter turn by a rod and cranks, connected with the central shaft. The signal is set by releasing one of the arms connected with the cams, the other cam-arm being weighted; this action moves the vibrating arm and the gear mechanism. The device, which has been patented by R. T. Kanski, 704 E. 137th St., New York city, has been satisfactorily tested for over a year in the Mott Haven yard of the New York Central & Hudson River R. R.

While the apparatus by which this signal is operated appears to be needlessly complicated and might well be redesigned with a view to greater simplicity, the idea of dispensing with the spectacle glasses and revolving the lamp itself appears to be an excellent one.



Safety Position. Danger Position.

A NEW RAILWAY SEMAPHORE SIGNAL WITHOUT SPECTACLE GLASSES.

MANGANESE MINING IN NEW BRUNSWICK.

A recent report by Mr. Gustave Benteispacher, U. S. Commercial Agent at Moncton, N. B., describes the manganese mines of New Brunswick. Wad or bog manganese ore is found in two places in the form of large beds from 5 to 30 ft. in thickness, lying immediately under the turf or first layer of soil. This soft ore cannot be treated like hard ore in the blast furnace for the production of ferro-manganese, and an attempt is now being made by the Mineral Products Co., of New York, of which Hon. F. C. Sayles, of Pawtucket, R. I., is president, and Dr. Edwin F. Ward, of New York, is secretary, to treat the ore by mixing it with a binder in such a manner that it will stand the operation of the blast furnace. The company has now spent about $50,000 in purchase of land at Dawson Settlement, near Hilisboro, Albert Co., N. B., and in erecting a plant. It owns 400 acres of land, on 17 of which the ore is found. It can be got out by merely shoveling it into the cars. The bog ore in its natural state contains about 50% of water. When this is extracted the ore is a black powder, as fine as flour. It is compressed after mixing with the binder, a secret composition, into blocks 3 ins. diameter, 2½ ins. long. The process of handling the ore is thus described:

The ore is brought in tram cars from the ore bed, a distance of 600 to 1,000 ft., and, running into the building, is dumped on a platform on a level with the feeding hopper of a revolving drier. It is shoveled into this hopper, and the drier, which is kept heated by wood or coal fires, carries it to the back end of a brick chamber, where it drops into a spiral conveyor, which carries it out of the chamber to the boot of a bucket elevator, by which it is raised to the top of the building, where it passes through a revolving screen. The fine ore sifts through the screen into the dry-ore bin. The coarser part goes out of the farther end of the screen, and thence into a grinder, which powders it, and it is then carried back to the revolving screen, through which this time it sifts without difficulty into the dry-ore bin.

Above the drier is a dust chamber with a V-shaped bottom, provided with a spiral conveyor. Any fine ore passing off from the drier along with the steam or gases settles in the bottom of the dust chamber and is carried into the dry-ore bin.

The ore from the dry-ore bin is drawn into a mixer, where it is united with a suitable "binder," the purpose of which is to cement the powder together. The mixed material is then carried up to a sufficient height to pass in at the top of the briquetting machine, a very complicated piece of mechanism, from the bottom of which the ore comes out in hard, cylindrical bricks or briquettes. These briquettes are carried to a pocket on the level of the railway, which has capacity to store 250 tons, and from which the ore is shipped on cars to be taken to the company's blast furnace at Bridgeville, Nova Scotia, and converted into ferro-manganese, which from there can be shipped to steel works in any part of the world.

The company has had the property examined and reported on by seven of the best experts in the United States and Canada, and the ore analyzed by ten of the principal steel makers and prominent chemists of the United States; and the result shows that the ore deposit is a valuable one. The analysis of the ore dried at 212° is as follows:

	Per cent.
Metallic manganese	48.24
Metallic iron	5.70
Sulphur	0.086
Phosphorus	Trace.
Silica	1.88

COURT DECISIONS IN AIR BRAKE PATENT CASES.

The air brake patent suit of the Westinghouse Air Brake Co. vs. the Boyden Brake Co., of Baltimore, has reached a final decision in the U. S. Supreme Court, which last week by a vote of 5 to 4 affirmed the decision of the Circuit Court of Appeals, which was rendered on Nov. 11, 1895, at Richmond, Va., and which was in favor of the Boyden Co. The Boyden Co. was sued by the Westinghouse Co. for infringement of Claims 1, 2 and 4 of the latter's patent No. 360,070. The Circuit Court on March 11, 1895, decided that the Boyden Co. had infringed Claim 2, but not Claims 1 and 4. Claim 2 is as follows:

In a brake mechanism, the combination of a main air pipe, an auxiliary reservoir, a brake-cylinder and a triple-valve having a piston whose preliminary traverse admits air from the auxiliary reservoir to the brake-cylinder, and which by a further traverse admits air directly from the main air pipe to the brake-cylinder, substantially as set forth.

The case was appealed, and on Nov. 11, 1895, the Court of Appeals handed down a decision reversing the decision of the lower court as to the infringement of Claim 2. The Westinghouse Co. carried the case to the Supreme Court on a writ of certiorari, and its final decision has just been rendered, as above stated.

The triple valve of the Boyden Co., over which the above long legal battle was fought, is what is known as Valve No. 1 of that company's manufacture. The passage from the auxiliary reservoir to the brake cylinder is controlled by a hollow piston valve. It is illustrated and described in the 1894 report of the M. C. B. Association, p. 33. According to the Interstate Commerce Commission's statistics, in 1893 the Boyden brake was in use on 796 cars. In 1896 it was in use on only 439 cars. The Boyden Co. in 1893 brought out another triple-valve having a slide-valve between the auxiliary reservoir and the brake cylinder, and it was tested by a committee of the M. C. B. Association. So far as we are aware, however, this valve has never been put in service, and we believe it is also claimed to infringe the Westinghouse patents and it now in litigation.

As our readers will recall, the Westinghouse company has also carried on a long series of suits against the New York Air Brake Co. for infringement of the Westinghouse patents. The New York Co. has at different times placed four different triple-valves on the market in its endeavor to evade the Westinghouse patents. Three of these valves have been declared infringements and their further manufacture and use have been prohibited by the courts. The fourth of these valves is now in litigation, and on May 9 the Circuit Court rendered a decision that it does not infringe the patents on which the Westinghouse company brought suit. The case will, of course, be carried to the Court of Appeals. This latest New York valve obtains its quick action by venting the train pipe to the outside air instead of into the brake cylinder, and would naturally be expected, therefore, to produce a lower final pressure in the brake cylinder than the Westinghouse valve.

PAPER FLOORS are becoming popular in Germany, as the absence of joints does away with the accumulation of dust, vermin or hurtful fungi; they are bad conductors of heat and sound, and though really hard they feel soft under the feet. The paper mass, with a small addition of cement as a binder, is shipped in bags in the form of a powder. This mass is made into a stiff paste, spread on the floor, rolled with heavy rollers and then painted after it is dry. These paper floors are cheaper than hard wood in Germany.

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The automatic stop-valve for steam boilers, which is illustrated and described in another column, deserves the examination of every engineer interested in any way in steam generating plants. Most up-to-date engineers are familiar with the automatic stop-valves which are now generally specified when a number of boilers are set in a battery, and which are really check-valves, their purpose being to prevent a flow of steam into the boiler from all the others in the battery in case the collapse of a flue or the failure of a tube or furnace or other accident should permit the escape of steam from the boiler. The English device we illustrate is designed to not only do this, but also to close automatically the stop-valve in the boiler in case the breakage of a steam pipe should occur. If this device can be made to operate satisfactorily—and we see no reason why it should not—it would take away practically all the danger from steam-pipe failures, which are now only less dreaded than actual boiler explosions by those in charge of large steam plants.

We wonder why it is that so little use is made of mineral wool in building construction. Probably the chief reason is that most architects and engineers have an erroneous impression that it is too expensive for use in ordinary structures. This impression probably owes its origin to the early use of mineral wool, when it was applied in places where it competed with other high-priced non-conducting materials, and when a fancy price was, therefore, placed upon it. As a matter of fact, however, mineral wool is made from a waste product, blast furnace slag; its process of manufacture is inexpensive, and it is now sold in such quantities as are required for building construction at a price of only about 12 cts. per cu. ft., according to a recent quotation by one of the principal manufacturers. It will be readily seen that the advantage in warmth and saving of fuel due to filling the space between the studding with this material will amply repay its cost. Its absolute cleanliness, and the fact that no vermin of any sort will live in it, make it an ideal material for this purpose, while its value in preventing the spread of fire through hollow walls, floors and partitions is also a reason for its use throughout all frame buildings.

One reason why mineral wool has not had the popularity it deserves, is that it was first used largely for steam pipe coverings, and this is a field to which it is least adapted. The jarring to which most steam pipes are subjected packs the material about the lower part of the pipe, and when mineral wool is in contact with iron and is wet, the sulphur it generally contains is apt to cause rapid corrosion. In frame building construction, however, neither of the above objections to its use obtain; and engineers and architects will do well to post themselves and their clients upon its advantages.

A movement to adopt certain standard forms for cranks, compensators, pole fittings, bracket castings, and other details of interlocking and block signaling apparatus, has recently been started by the Railway Signaling Club, but is meeting with some opposition, mainly from the representatives of roads which already have organized signal departments. The principal arguments of the opponents of this movement are that the results aimed at would not warrant the time and labor involved, and that railways would not be likely to change from their own standards already in use to those recommended by the club. The advocates of standardization, however, refer to the well-known difficulties and complications incident to the use of various devices which are intended for the same purposes, but which yet differ sufficiently in detail as to be non-interchangeable, necessitating the manufacture and keeping in stock by the signal companies of a great number of patterns of articles which are often almost identical. This necessarily increases the cost of manufacture, and often causes delay in filling orders through some one special device not being in stock at the time it is required. Another point which might well have been brought out more strongly in the recent discussion of this matter by the Railway Signaling Club, is that the railways which have not yet adopted standards will be more likely to follow standards approved by an independent body like the Signaling Club than to adopt the standards of some other railway or those of some signal manufacturer.

The formal adoption of standards of good practice by the Signaling Club will, therefore, tend to discourage the further multiplication of designs of signal apparatus, even if the railways now having standards should refuse to change them. We referred to this matter in our issue of Jan. 20, in connection with the lack of uniformity at an interlocking plant where different roads demanded the use of their own specialties for the signaling of their own tracks; and we then pointed out that "pet ideas," a little different from those of other people, are entirely out of place in the signaling department of railway service. The fact that so many varying designs have been adopted as individual standards by several of the leading railway companies should be a strong argument in favor of the adoption of uniform standards, in order to check further increase of such individual standards. It is to be hoped that the Railway Signaling Club will recognize the real meaning and importance of its proposed adoption of standards, and will vigorously support the present movement.

An example of the advantage of rigid tests over a manufacturer's reputation as a guarantee of the quality of engineering materials is furnished by a correspondent of the Rensselaer "Polytechnic." A large steel structure was to be painted, and the specifications called for a coat of red lead and linseed oil, in such details as to ensure a pure article thoroughly applied. The story continues as follows:

> Soon after the frame work was ready for the first coat of paint, a sales agent of an old and reputable manufacturing firm presented to the superintending engineer a "ready-mixed red lead" as being superior to the ordinary painter's mixture; he urged that a paint compounded by the manufacturer would be more uniform in proportion of oil and pigment and the ingredients more completely intermixed than if mixed by the painter himself; he also adroitly gave impression that this compound consisted almost entirely of linseed oil and red lead, each pure and of the best quality. To enforce his statements he referred to several users of his paint.
>
> One of these references was carefully verified. A long line of elevated railroad had been painted with the compound, and the engineer in charge freely commended its quality, giving an analysis, made at his request by a somewhat noted firm of commercial chemists. This certified that the sample submitted contained about 80% of linseed oil and 20% of pigment, there being over 99% of pure red lead. Favorable opinions were obtained from other parties referred to, including one from the management of a prominent steam railroad based upon an analysis by its chemist, the results of which were similar to those above cited. In consequence, these statements of analyses and opinions being accepted, the "Ready Mixed Red Lead" was substituted at the shops for the mixture previously used.
>
> In due course complaint was made that the prepared compound was unsatisfactory; when dried it became upon exposure more white than red, and it tended to flake off or exhibit on the painted surface a loose powder of apparently solid substance.
>
> Two analyses of the prepared paint were then made, not by a commercial chemist but by one whose competence, impartiality and professional standing are beyond question. The first sample submitted to him was from the painter's bucket, and accepting the possibility that this might have been "doused" by the painter himself; the second was from the package as delivered from the manufacturers. The relative proportion in bulk so determined were, per first analysis, 57% of linseed oil, 20% of turpentine, 11% of red lead and 12% of chalk; and per second analysis, 65% of linseed oil, 14% of turpentine, 8% of red lead and 13% of chalk. These analyses showed that the painter had not "doused" the contents of his bucket, that the mixtures were not uniform in composition and that turpentine and chalk had been in large proportions added as adulterants.
>
> So soon as reports of these results were obtained the use of the mixture was stopped, and a paint of oil and red lead, as prescribed by the specifications, was thereafter applied. Some time later the plausible vendor substantially admitted that the two analyses last mentioned were in the main correct.

There are two remedies which may be employed to guard against fraudulent adulteration of paints and other manufactured compounds, such as that described in the above extract. One is that the consumer shall have his own chemical and physical testing laboratory, in which samples of the goods he wishes to purchase shall be tested. Such laboratories are maintained by some of our largest railroads and manufacturing companies. The other is that the public conscience shall be awakened to the fact that adulteration of a compound and selling it under the pretense that it is unadulterated, is a crime, and should carry with it the same penalty as any other attempt to obtain money by fraud or false pretense. It may be the duty of a purchaser to know what he buys—let the buyer beware—but every consumer of paint cannot have a chemical laboratory, and it is the duty of the state to define and punish crime. If the legislature should pass a law providing that every compounded substance like paint must be sold under a label which should give its analysis for chalk, barytes, turpentine, and other adulterants, just as in some states fertilizers are sold, and providing for analyses by public chemists, and prosecution of adulterations by the public prosecutor, such fraudulent practices as those described above would be made so dangerous that they would soon be almost entirely done away with.

The superiority of English over American municipal government is continually urged by reformers on this side of the water, and with no little reason. But our English engineering exchanges bear almost weekly evidence that perfection has by no means been attained in England in this particular department. The London "Surveyor" of April 15 states that there has recently been

> a grave scandal in connection with the Corporation of the City of London, though subsequent reports proved to be of a less exaggerated character. The charges, however, are quite serious enough, if true.

After an investigation to ascertain the truth of the assertion that certain officers of the Public Health Department, formerly the City Commission of Sewers, had for years been receiving bribes from contractors, the committee found "the charges of so serious a nature that they suspended ten officers, some of whom have been in their service for ten years." Recently, the "Surveyor" states, it was learned that a common councilman of the City of London had "accepted £50 for using his influence in that capacity to obtain a highly-paid appointment for a certain person." The comment made by the "Surveyor" on these incidents tends to show that they are far less common than similar occurrences here, but that they are rather more than the proverbial exceptions that prove the rule. This will be seen from the following extract from the journal named:

> We are accustomed to pride ourselves—and not without cause—on the purity of our local administration, as

compared with American local government, for example, and if we are to maintain this high standard of good and honest administration it is absolutely necessary that the detection of dishonorable practices should be followed by swift and adequate punishment. There are those who prophesy that as political conditions in this country approximate more nearly to those now prevailing in the United States we shall experience much the same deterioration and corruption in matters of government and administration which we find in the United States and France, generally understood to be the two most democratic and politically advanced countries in the world. We are not prepared to accept so sweeping a conclusion, for, after all, the character of a people must count for a great deal, and we believe that in this country public opinion will be sufficiently strong to prevent any widespread demoralization such as that indicated.

We have not alluded to these incidents to disparage English municipal government, nor to make out that American misgovernment is any blacker than it has been painted. Our desire is first to warn some American writers that in their unqualified praise of English administration they have sometimes given only partial truths, and in their enthusiasm left the impression that their statements were "too good to be true;" and second, to show by the comments of our contemporary that incidents which would in some cities here be considered almost too trifling, in comparison with other scandals, to be noticed make a great stir in a country where a municipal office is generally considered by the holder as a public honor instead of a private sinecure.

It is also to be said that much of our American city government is not corrupt, and that in point of engineering capacity we yield the palm to no country, wherever politicians give our engineers a fair chance to do their best.

In our review of the battle of Manila in our last week's issue an error was made in stating the tonnage of the vessels of the American fleet. The gross tonnage was given for these, while the tonnage given for the Spanish vessels was their displacement. The displacement of the vessels of the American fleet was as follows: "Olympia," 5,870; "Baltimore," 4,413; "Raleigh," 3,213; "Concord," 1,710; "Boston," 3,000; "Petrel," 892; total, 19,098, or slightly over 1,000 tons in excess of the combined displacement of the Spanish fleet.

THE M. C. B. STANDARD FOR AIR BRAKES.

At the semi-annual meeting of the American Railway Association at Louisville last month, a very energetic debate occurred over the matter of the application of air-brakes to freight cars. The Association, unfortunately, got into a tangle over questions of parliamentary procedure, and the time was mainly consumed in debating questions apart from the one really at issue. The net result was the postponement of action until the fall meeting, which is to be held in New York city Oct. 12. To understand clearly just what is the significance of the proposed action by the Association, it will be necessary to review past history a little.

In our issue of May 5 we told the story of how the Master Car Builders' Association finally adopted a standard automatic car coupler in 1887, after several years of investigation, and of pulling and hauling by the powerful rival interests backing the different coupler companies. For three years following this action by the M. C. B. Association, however, little progress was made by the railways in the equipment of cars with M. C. B. couplers. A few progressive companies adopted the practice of equipping all new cars and all old cars going through the shop for general repairs; but most of the railways let the automatic coupler question drop, and some of those which had most strongly opposed the adoption of the Janney type of coupler as standard, exerted all their influence against its use and took such measures as were in their power to bring about a reconsideraion by the M. C. B. Association of its action in adopting the Janney type as the standard. Fortunately, their efforts proved ineffectual. By 1890 about 100,000 cars were in service equipped with M. C. B. couplers, and it became clear that it was to be the coupler of the future. To definitely settle this matter in the minds of some railway officials who were still opposing the M. C. B. coupler, the American Railway Association (then known as the General Time Convention) at its meeting in the fall of 1890 adopted the M. C. B. type of automatic coupler as the standard of its members.

The history of the use of the air-brake on railway freight trains has been closely associated with that of the M. C. B. coupler. The quick-action brake which first made possible the use of air-brakes on long freight trains was perfected by George Westinghouse at about the same time that the M. C. B. Association adopted the Janney coupler as the standard. In the years from 1887 to 1890 the equipment of freight cars with air-brakes proceeded more rapidly than their equipment with couplers. The reason for this was that the air-brake, though a considerably more costly appliance, was at once put into use, so that immediate benefit from it was obtained. For fast freight service and for use on railways having long and steep grades the demand for air-brakes was a large one. The M. C. B. coupler, on the other hand, was of little benefit to any railway purchasing it for many years, or until the proportion of cars equipped with similar couplers became great enough to permit them to couple automatically.

We have already seen how the adoption of a standard coupler was an absolute prerequisite to the introduction of any automatic coupler on American railways. But similar action was not necessary in the case of the air-brakes. There were thousands of couplers, but only one quick-action air-brake, the Westinghouse. That was covered by patents, of course, so that the M. C. B. Association could not have adopted it as a standard even had they been disposed.

As for the adoption of standards of excellence to which the various parts of the brake apparatus must conform, that was not considered, since so long as the brake apparatus was controlled by a single manufacturer, the railways had to take what it furnished, and further, no railway officer had enough experience in the use of the air-brake in freight service to be able to say what qualities in the apparatus were essential to its safe and satisfactory service and long life.

It was not to be expected, however, that so valuable an invention as the quick-action triple valve would remain an unchallenged monopoly. In the years from 1888 to 1893, a large number of inventors were at work striving to produce devices which would evade the Westinghouse patents, and companies were organized to market several of these devices. Of these various concerns, the only ones which actually put their devices into service were the New York, Boyden, Lansberg and Crane companies. Of these, the Interstate Commerce returns for 1893 showed about 7,000 of the New York, 800 Boyden, and 700 Lansberg brakes in use, and 288,000 of the Westinghouse. But while these competing brakes were thus few in number, the mechanical officers of the railway companies, as soon as the introduction of these brakes began, awoke to the fact that the interests of the railway companies demanded that vigorous steps should be taken to prevent the introduction of defective brake appliances upon freight cars used in general interchange. Tests of some of the apparatus offered by these rival brake manufacturers showed that while it was designed to operate in the same manner as the Westinghouse, the variations in design, which had been adopted to evade the Westinghouse patents, had seriously affected its interchangeability, and that its use in trains involved danger, not only to the car to which this brake was applied, but to the successful working of the other brakes in the train.

This led to the appointment of a committee of the ablest members of the Master Car Builders' Association to report what tests were necessary to determine the fitness of air-brake apparatus for service. The reports of this committee, based on extended study of the behavior of various makes of brakes, both on the testing rack and in actual service, were made in 1894 and 1895, and the code of tests which it recommended was adopted by the Association as part of its "Recommended Practice" in the latter year.

Now at the recent meeting of the American Railway Association, to which we referred above, the Committee on Safety Appliances presented a report in which they recommended the adoption by the Association of the following resolutions:

Whereas, The Safety Appliance Act of Congress of March 2, 1893, Section 3, provides not only that the cars engaged in interstate commerce shall be equipped sufficiently with power brakes to meet the requirements of the act, but further that if such brakes shall not work and readily interchange with those on the cars of any road to which they may be offered, they may be lawfully refused; and

Whereas, In order to comply with the spirit of the act, it is important that any power brake applied in the future shall be such as "will work and readily interchange with" the 500,000 or 600,000 cars running in interstate service, now equipped with air brakes; and

Whereas, The Master Car Builders' Association, after extensive experience and abundant consideration, has announced the principles and set forth the essentials of air-brake apparatus, and has prepared itself for tests of the same; therefore be it

Resolved, That this Association recommends to its members that they shall not apply or use any air-brake apparatus that has not been submitted to such tests.

Doubtless the committee supposed that the wisdom of the resolution was so apparent that it would be adopted without question; but, on the contrary, it aroused decided opposition, and it was finally voted to postpone its consideration till the November meeting. It seems certain that the real meaning and significance of the resolution were not fairly understood by the members, or instead of postponing action, the resolution would have been unanimously adopted.

The air-brake situation is now about as follows: Of the total freight cars in service, about 1,150,000 in number, something over 500,000 are fitted with air-brakes, of which all but a scattering 15,000 to 20,000 were made by the Westinghouse Co. These air-brakes are in use already to a very large extent in the operation of trains, and 18 months hence it will be contrary to law to run trains without air-brakes enough for their control. Further, every railway company is given by the law express permission to refuse to receive any car not equipped with such brakes as "will work and readily interchange with the brakes in use on its own cars." Thus both the law and the interests of the railway companies demand that the standard set by the brakes already applied to a half million freight cars shall be strictly adhered to in the equipment of the remaining cars. But this is exactly what the Code of air-brake tests of the M. C. B. Association is designed to effect. It asks no questions as to the origin of a brake apparatus, or as to what patents it may or may not infringe. It simply lays down certain simple tests which determine whether the brake apparatus will so operate as to be safe and efficient when used in connection with the Westinghouse apparatus. The necessity for doing this ought to be self-evident to every railway officer. It certainly is to every one in charge of the railway mechanical departments.

It is to be especially noted, moreover, that this resolution does not, as seems to have been imagined by some of the members of the American Railway Association, shut out competition in air-brake manufacture. The M. C. B. committee which framed the tests expressly stated in presenting them that their object was not to cut off but to foster competition. They aimed to admit every triple-valve which showed evidence that it would or could be made to operate correctly, and to "outlaw" only such as were so defective in design as to cause real danger when applied in railway service.

This proposed action by the American Railway Association has especial interest now by reason of the recent change in air-brake litigation, which is noted elsewhere in this issue. For many years the Westinghouse company has been successful in its suits against infringers of its patents, and the standard for air-brakes which the M. C. B. Association adopted has been of much less actual use than was expected by many, because the expected competition did not materialize. Now, however, the court of last resort has decided that the original form of Boyden triple-valve is not an infringement, and the lowest court has decided against the Westinghouse Co. in its suit against the latest New York triple-valve. It would be premature to say that this means the active pushing upon the market of either of these devices. Perhaps the further decision may be adverse to the New York valve, and other patents may be brought up by the Westinghouse company against the Boyden valve. If, however, these or any other devices are offered to the railway companies as interchangeable with the Westinghouse, the need of some system of tests to determine whether such interchangeability actually exists is evident.

In the American Railway Association's discussion one member said:

We have 650,000 cars in the United States to equip with air-brakes in the next few years, and to a road with six or seven thousand cars, it means a good many dollars whether it is to buy a certain device at six dollars more than another.

But it would mean a good many more dollars to a railway company if it were to equip a lot of its cars with a brake because it was six dollars cheaper than the standard, and should then find that its failure to operate successfully with the brakes already in use would compel the refusal of all the cars so equipped by other roads at points of interchange.

As we have often had occasion to point out, while the ownership of freight cars is vested in different companies, they are practically used in common by all the railways of the country, and the railways as a whole are even more interested in the soundness and safety and correct design of a freight car than is its owner. On a matter of such vital relation to the safe movement of the trains as the braking facilities, it is emphatically proper that the associated railways should take such action as is necessary to ensure that no unsafe or defective apparatus shall anywhere be put in service.

CAUSES OF THE FAILURE OF COPPER STEAM PIPES.

On June 19, 1897, the brazed main steam pipe of the British steamer "Prodano" burst while under a pressure of 130 lbs. per sq. in., killing two engineers and two firemen. If such an accident had happened on an American merchant vessel, there might have been a perfunctory examination by the local U. S. Inspectors of steam vessels and an inconclusive verdict rendered, and then the matter would be forgotten by the public. But in Great Britain they have a much better plan. When an explosion of a boiler or steam pipe takes place, it must be investigated by the Board of Trade, under the Boiler Explosion Acts of 1882 and 1890. The investigation so made usually goes further than merely fixing the responsibility upon some person or persons, and it includes scientific research of the most elaborate nature into the physical, chemical or electrical causes which may have produced the accident, and concludes with recommendations as to provisions for avoiding similar accidents in future. It is greatly to be regretted that in this country we have not an equally good system of investigating the cause of accidents. The case of the bursting of the steam pipe of the "Prodano" was thus made the subject of a most thorough investigation, both by a court composed of three commissioners appointed by the Board of Trade, and afterwards by Prof. J. O. Arnold, Professor of Metallurgy in University College, Sheffield, acting for Lloyd's Register of British and Foreign Shipping. The report of the court and that of Prof. Arnold differ as to the cause of the accident, the former attributing it to defective brazing of the pipe, and the latter to deterioration of the brazing, which was originally sound. Both reports, however, contain most valuable suggestions in regard to copper steam pipes. Prof. Arnold's report is a model of close reasoning from the results of chemical and microscopical research to his conclusions as to the cause of the accident, and his work is a fine example of scientific research in accident cases. From "The Engineer" of April 15 we take the following extract from remarks of the chief engineer surveyor of Lloyd's register concerning the opinions of the court and of Prof. Arnold in regard to the failure of the steam pipe:

From an examination of the exploded pipe it appeared to us that the brazing solder forming the seam had considerably deteriorated at the exploded part, and it had also deteriorated in the fellow pipe, which, however, had not exploded, and we expressed the opinion to the Court that the explosion had occurred through deterioration of the brazing, which had originally been sound. We based our conclusions as to the original soundness of the brazing mainly on the fact that both pipes had been first made in straight lengths, and had afterwards been bent while cold to a sharp curve. Unsound brazing would not withstand such treatment. The finding of the Court, however, was that the explosion was caused by original defective brazing of the pipe.

The Court also expressed the following views and opinions: The pipe had not been subjected to any hydraulic test since 1890. Since that date it should have been, in their judgment, subjected to a suitable hydraulic test, as by no other process could its condition have been ascertained. In view of the high steam pressures now in use, which will probably still further increase in the near future, lap-welded wrought iron pipes or seamless steel pipes as now manufactured are distinctly preferable to either brazed or seamless copper pipes. Brazed copper steam pipes 3½ ins. in internal diameter and over should be examined periodically with their lagging removed, and tested by hydraulic pressure, and that they should be subjected to this examination and test at intervals not exceeding about four years. The test pressure should be such as would subject the material of the pipe to a stress of 2½ tons per square inch on the sectional area of the material. The risk of explosion of copper steam pipes would be materially reduced by hooping them with wrought iron or steel bands, or by serving them with wire. Owners and users should be urged to carry out reasonably frequent examinations and testing of existing copper steam pipes exposed to high steam pressure; and that, in the case of new work, they should be recommended to adopt lap-welded wrought iron or seamless steel pipes, properly arranged with carefully designed expansion joints, and with means to prevent such joints from blowing out. It was felt that in view of such strongly expressed opinions as to frequent examination and testing of pipes, grave responsibility would be incurred in cases of similar accident, if these recommendations were disregarded.

The whole of the cases of steam pipe explosions which had been investigated by the Board of Trade under the Boiler Explosion Acts had been previously studied, and in only one of them, viz., that of the steamship "Vulcan," inquiry No. 578, were the circumstances at all similar to that of the "Prodano." This latter case, therefore, appeared to be so exceptional that, before making any recommendation on the subject to the committee, it was deemed advisable to endeavor to ascertain the cause of the deterioration of the brazing in this instance, and for this purpose Prof. Arnold's assistance was requested, he being acknowledged to be one of the most skilful investigators in metallurgical matters. His report is absolutely conclusive, not only that the brazing had been originally sound, and that the deterioration had been gradual, but also as to the actual cause of the deterioration.

For the purpose of Prof. Arnold's investigation he was supplied with samples as follows:

1. Two pieces of the unruptured portion of the exploded pipe of the "Prodano," one of which had been tested by Messrs. Kirkaldy, and had burst at a pressure of 890 lbs. per sq. in. 2. A brazed strip of the unexploded fellow pipe to that which burst. 3. About an ounce of a brown incrustation scraped from the inside of the fellow pipe. 4. A sample of the cylinder oil said to have been used on the "Prodano." 5. A sample of "Zynkara," an anti-corrosive fluid said to have been regularly used in the "Prodano's" boilers. 6. Portions of a copper main steam pipe taken from another vessel, one of the pieces containing a brass drainage boss which had been brazed in with a considerable amount of solder, and three pipes in which the brazed seams had been well loaded. This pipe will be referred to as pipe A. 7. Typical samples of brazing solder as cast by representative firms. 8. Samples of new yellow or Muntz metal, and of yellow metal bolts which had broken off after long exposure to the action of bilge water.

Prof. Arnold's research included the following: 1. Micrographic analysis of a deteriorated yellow metal bolt, of the brazing of the unruptured "Prodano" pipe and of portions of exploded pipe tested by Messrs. Kirkaldy. 2. Micro-chemical examination of the seam loading and the brazing around the drainage boss of pipe A. 3. Analysis of the incrustation in the "Prodano's" pipes. 4. Analysis of "Zynkara." This was found to be a solution of hydroxide of zinc in caustic soda. 5. Analysis of a sample of mineral oil supposed to be identical with that supplied for use in the "Prodano's" cylinders. In this no traces of fatty acid were found. 6. Further analysis of the deteriorated pipe A. The analysis of the brazing of this pipe gave a most remarkable result, viz.: Metallic copper, 76.8; oxide of zinc, 22.5; fatty acids, in terms of oleic acid, 1.4; showing that all of the metallic zinc originally in the brazing had disappeared, and had been converted into oxide. The report of Prof. Arnold is very complete, and is accompanied by micro-drawings and sections, which are reproduced in "The Engineer." His conclusions are summarized as follows:

Summary.—I consider that the correlation of the evidence, chemical, physical and microscopical, obtained during the investigation detailed in this report, justifies the following conclusions: 1. That the brazing of the "Prodano" pipe was originally sound, of good workmanship, and composed of a suitable alloy. 2. That the explosion was due to a gradual removal from the greater part of the brazing of about half its zinc, the remainder being converted into oxide, and thus leaving a spongy and hence brittle mass of metallic copper possessing little cohesion. 3. That the disintegration described in the last paragraph was electrolytically brought about by the presence in the pipe of water containing small quantities of fatty acids which formed organic salts of zinc, either fusible at the temperature of the pipe or soluble in hot water. 4. That the fatty organic acids must have reached the main steam pipe via the piston rods, cylinders, condensers and boilers, and that fatty oils must have been employed either inadvertently as adulterations in mineral oil or deliberately in the form of lubricants, such as tallow or castor oil.

LETTERS TO THE EDITOR.

The Difference Between the Astronomical and Geodetic Latitude at Albany, N. Y.—Correction.

Sir: In a foot-note on p. 294 of the Engineering News of May 5, 1898, the following statement is made: "The astronomical latitude is here (Albany, N. Y.) about 1.4 minutes less than the geodetic, the zenith being locally deflected to the south by this amount. See report of the C. & G. Survey for 1897, p. 110." One and four-tenths minutes is an impossible value for the local deflection. So large a value surely does not exist anywhere on the surface of the earth. Moreover, the reference to the Coast & Geodetic Survey Report for 1897 is evidently an error, for said report for 1897 has not yet been put in the hands of the printer.

Yours respectfully,

John F. Hayford, Computer, Coast & Geodetic Survey.

Washington, D. C., May 10, 1898.

(The difference should have been stated as 1.4 sec., instead of 1.4 min., and the date of the report as 1879 instead of 1897.—Ed.)

A Theory for Spacing Stiffeners in Plate Girders.

Sir: I have not been able to find in the authorities at my command, a rational theory for the spacing of stiffeners in plate girders. Mr. C. W. Bryan, in Prof. Johnson's work on framed structures (p. 297), says there is no rational theory, and that the column formula cannot be applied. Others apply the Gordon formula for the full compression strains, using l = depth of girder × sec. 45°, which certainly gives excessive stiffening.

Having lately had occasion to design several plate girder bridges, under varying conditions, and finding little help in this particular in the works at hand, I have been led to reason out a theory of my own, which I formulate below, and respectfully ask your criticism, or, if you think it worth while, to publish it that others may criticise it. My conclusions are as follows:

1. A plate girder web is properly treated as a simple rectangular beam when it is not stiffened.

2. When stiffeners are introduced at intervals not exceeding the depth of the girder, the conditions are changed to those of a truss composed of posts and tension web members, similar to the Pratt truss.

3. As the load is applied to the posts at short intervals throughout its whole length instead of at the extreme ends, it seems safe to take the length of column at two-thirds the unsupported depth of web.

4. As the column, formed by the stiffeners, fillers and the part of the web covered by the stiffeners, is supported by the web, preventing deflection in the plane of the web, the radius of gyration should be taken with the center of the web as the axis.

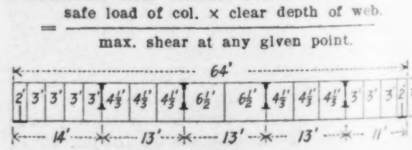
5. With l = ⅔ the clear distance between the flange angles (in inches) and r calculated as above indicated; the safe load of the column per sq. in. is given by the formula.

$$\text{Safe load per sq. in.} = \frac{\text{bearing value}}{1 + \dfrac{l^2}{36,000\, r^2}}.$$

This multiplied by the cross-section gives the total safe bearing load of the column.

6. Maximum clear distance between stiffeners.

$$= \frac{\text{safe load of col.} \times \text{clear depth of web.}}{\text{max. shear at any given point.}}$$



Proposed Spacing of Stiffeners on a Plate Girder.

The accompanying sketch shows the result of the application of the above reasoning to a recent design for one of our city bridges. The eccentric location of the panel points is occasioned by the skew of the bridge, and the theoretic spacing of stiffeners is modified by the length of panels.

Yours respectfully,

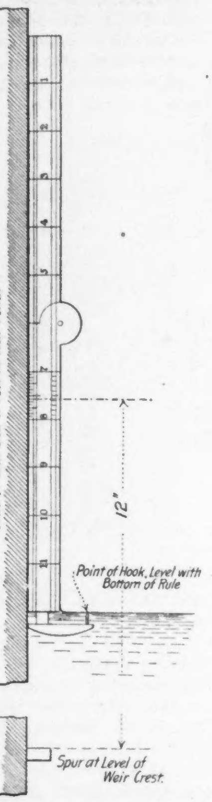
H. T. Beach.

City Hall, Syracuse, N. Y., April 23, 1898.

A Pocket Hook-Gage.

Sir: Throughout the irrigated portions of the United States, weirs are generally used for measuring water, and observations of the heads on weirs are very frequently taken by hydraulic engineers, zanjeros (water-masters), and the consumers.

The ordinary method is to have a spur set in the side of the still-box or weir pond at the level of the crest. The depth of water is taken by a rule thrust down through the water and resting upon this spur. In a vast number of instances it would be desirable to eliminate the uncertainty regarding the true water level caused by the rise of water on the rule, due to surface tension, but without introducing the refinements of the regular hook-gage. The following is a description of a simple and inexpensive device which has proved satisfactory to the writer and to other engineers who have seen it.



Any sort of a folding caliper rule is transformed into a pocket hook-gage by setting a sharp point near the outer end of the caliper bar, and extending up parallel with the slide. A hole is drilled in the opposite end of the rule into which the point disappears when the rule is folded and the caliper pushed home.

For making a measurement it is convenient to set a mark or spur on the side of the still-box at the length of the rule above the weir crest. The point of the hook is adjusted to the level of the foot of the rule by contact with the free end of the rule when the latter is slightly open. When the point is at the water surface the depth of water is read down from the top of the rule to the mark.

In this manner reliable observations can be readily taken to the nearest 1-16-in., or a limit of error of about 0.0025-ft. This reading is as close as the conditions usually met with would permit, even if the expensive and cumbersome regular hook-gage were used.

Thus far it has been impossible to find on the market a rule suitable for this purpose in which the foot is divided decimally. Were some maker to put out such an article it would doubtless find extensive sale in the West. The accompanying sketch shows both the construction and use of the rule to better advantage than a description.

Very respectfully, Edward M. Boggs,
Civil and Hydraulic Engineer.

Redlands, Cal., April 15, 1898.

A Water "Spy-Glass."

Sir: Having recently had occasion to examine the bottom of a stream of muddy water, I made use of the expedient described below, and as it served my purpose admirably, I offer it to engineers with the hope that it may prove useful to them under similar circumstances.

A wide-mouthed bottle, a cork, a candle and a piece of ½-in. gas-pipe comprised the outfit necessary, and the only other accessories used were a jack-knife, with a corkscrew in it, an old tin pail and a clean pocket handkerchief. These were employed as follows: A pailful of the muddy water was first drawn and set aside; a hole was then made in the cork of a "vaseline" bottle with the corkscrew and reamed out with the knife-blade, and the cork was then forced on the end of the ½-in. pipe, which had been heated in the camp fire so that the hole was burned to exact size. The cork was next forced into the bottle, with the top of the cork slightly below the glass, and the hot grease from the lighted candle was allowed to run into this space, and a large mass of the grease was run about the rod and the neck of the bottle.

A funnel was now made, out of a leaf of a field-book, and lined with the handkerchief, and enough water was decanted from the pail—which meanwhile had been acting as a settling basin—to fill the bottle and about 1 ft. of the pipe; as this pipe was lowered into the water more water was poured in to equalize the pressure.

This outfit formed the "spy-glass," and objects were to be observed through it. Without the "spy-glass" white objects, 6 ins. square, could barely be seen through the muddy water at one foot depth; with it stones of any size and color could be seen 3 ft. below the surface, and small stones at 6 ft. below. The only distinguishing colors, however, were black and white. Shining objects, such as brass or polished steel, could be very plainly observed. At a depth of 7 ft. it seemed about the same as if making observations in the open on a starlight night; and the work strained the eyes much as if one were picking his way on such a night. With another "spy-glass," made on similar lines, but filled with clear spring-water, it was easy to see 16 ft. into water in which, without the glass, the white page of a field-book could only be dimly seen at a depth of 5 to 6 ft.

By using a sphere, or a clear bottle with a rounded base, a magnifying glass of small power could be made and the range of observation be increased. Such a glass could be used to considerable depths, and as long as the balance is kept up between internal and external pressure there can be no destructive strains, tending to destroy the apparatus. A duplicate glass, with a mirror arranged to throw a beam of light down the tube, would add largely to its efficiency; and an electric light, when it could be obtained, would still further extend its usefulness.

Yours truly,
A. McL. Hawks,
Chief Engineer Chilkoot R'd. & Transport Co.

Dyea, Alaska, May 4, 1898.

Experiments Upon Water Ram.

Sir: The conclusions concerning water-ram in pipe-systems, published in your issue of March 24, need a little explanation, as some of your readers are asking for more light. A brief statement of the conditions under which the work was done* may remove misunderstanding.

A main line, 2½ miles of 12-in. pipe. About five miles of distribution system in 10, 8, 6 and 4-in. pipe, mostly in closed circuits, but with two dead ends which were believed to have a decided effect upon some of the results. Static head from 155 to 235 ft. Some small-scale experiments under 30-ft. head, from a large tank, 1-in. main and Newport quarter-turn valve, with nozzles varying from ⅛ to ⅝-in. All discharges measured in a large gaged brick tank. The large-scale experiments were made at street hydrants, with 6-in. connections to 10-in. and 6-in. street mains, one being on a dead end under a static head of 235 ft. In these cases the water was measured by using previously gaged nozzles. The pressure gages were of the Crosby, Bristol and Woodman makes, tested at night by the known static head. Many experiments were made at night when the pipes were nearly free from movement of the water.

In the tank experiments the stop-valve was closed in about one-tenth of a second. The weight of water in motion was varied by connecting in a coil of pipe, about 80 ft. in all. About 250 observations were made, and results plotted in curves for comparison and discussion. In the hydrant experiments the same discharge piece with quarter-turn valve was used, and nozzles varying from ⅛ to 2 5-32 ins. diameter. Another series gave the results of shutting a 3½-in. Ludlow gate-valve at different speeds.

In the last-mentioned series autographic records of the water-hammer were obtained. These showed that the maximum pressure or limit was not reached directly, but by a series of very rapid and increasing intermediate pulsations, or secondary maxims. The maximum effect was always followed by diminishing pulsations at increasing intervals. The apparatus simply magnified and defined the waves which anybody can observe by watching a Bristol or Crosby recording gage, on a water-works system when the water-ram is produced. The effects are similar to the very numerous pulsations revealed in Prof. Langley's observations of velocity and pressure of air (wind)—the secondary contributing movements which escape the notice of the ordinary observer. We must conclude that the considerable elasticity of cast-iron pipe and the compressibility of water have much to do with these effects.

The conclusions which appear to be warranted from the results, under the conditions stated, are as follows:

With slow-motion valves worked by a screw the force of the ram varies inversely as the time of operating or directly as the speed of closing; in some cases the pressure is greater for smaller than for larger velocities of flow, and large rams are equally liable to occur in closing partial or full openings of the valve; obviously the result depends upon the acceleration and rapidity of closing at the last stage.

In a simple open system the pressure in pounds per square inch corresponds approximately with the theoretical expression $W v \div a g t$; in which W represents the entire weight in motion in the pipe system, v the velocity of the water in the pipes in feet per second, a the area of cross-section of the pipe or pipes in square inches, g the acceleration of gravity, and t the time, which varies from the total time of closing the valve to some fraction thereof. This fraction decreases as the time of closing increases, but when the time of closing is as short as 0.1 sec., this may be taken as the value of t with sufficient accuracy.

According to the formula, the force of the ram varies directly as the velocity and volume of the water in the pipe system.

Dead ends in the vicinity of the point of discharge greatly increase the pressure effect.

In a large closed system (one having one or more loops or circuits) pressure effects are not as great as theory requires; the absolute pressure depends upon the relative arrangement and number of lines of lesser resistance which the wave or pulsation may follow.

*Experiments conducted under direction of the writer by Messrs. S. A. McCoy and H. N. Chase.

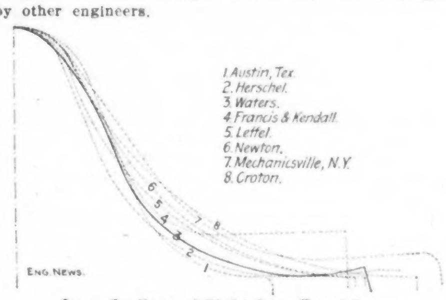
The use of quarter-turn quick-closing stop-valves on any pipe system should be prohibited. The usual addition of 100 lbs. per sq. in. to the static head, to allow for water-ram, is ample, provided slow-motion screw valves are used and closed slowly at the last stage. Dead ends should be avoided if possible. Relief valves should be introduced in all systems where the static pressure exceeds 100 lbs. per sq. in.

Robert Fletcher.

Thayer School of Civil Engineering,
Hanover, N. H., May 13, 1898.

Ogee-Faced Dams Again.

Sir: Notwithstanding my denial contained in my letter to you of April 18, Mr. Herschel still unmistakably claims that I borrowed my design for the Holyoke dam from discarded plans or studies that he had made, and, to prove the truth of his charges, he shows his design superimposed over mine. I admitted what all engineers must know, that all ogee-faced dams have a family resemblance, and in confirmation of that fact I herewith show the profile of different ogee-faced dams, built or designed by other engineers.



Cross-Sections of Eight Ogee-Faced Dams.

The Croton dam is 38 ft. high, the Mechanicsville concrete dam but 15 ft., the Leffel dam of unknown height, the Austin dam 60 ft., while the Herschel, Francis-Kendall, Newton and Waters are all 30 ft. high. It has not seemed to me improper to so change the scale of some of these designs which vary in height, for the reason that the face is mainly determined by the designer as the proper form to carry over the water as smoothly as possible, according to the depth of the flowing water. The family resemblance crops out in every design. I might have shown in like manner many other profiles, but the multiplicity of lines would be confusing.

Would not I have been justly criticised as grossly unprofessional had I rushed into print and charged Mr. Herschel with having copied, borrowed, or adapted the design for the Croton dam, planned about 1839; the Leffel dam shown in his book on Mill dams, published in 1881; the Vyrnwy dam, commenced in 1882; the dam shown in Weisbach's Mechanics, Vo. 2, page 111, edition of 1849, or the dam designed by James B. Francis and Jonas Kendall, for the identical situation that his plan or study for a plan was intended for?

He tells the public that he knows that his plan was had in mind by me, and that I had the use of all the plans, models, etc., left by him at Holyoke, and he goes still further and avers that I had especially sent for and had studied the American Soc. C. E. paper in 1887 or 1888. I am sorry to be obliged once more to state that Mr. Herschel is mistaken. I never studied his plans or his models for any such purpose. I had not seen either his plans or his models for years when I drew the plan for the dam that I am now building.

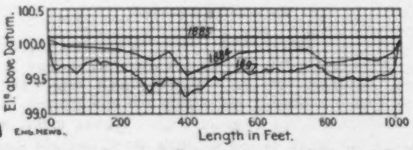
I never did, so far as I can recollect, send to any one for that report to the society. I was chosen Treasurer of the Holyoke Water Power Co. in 1887. Mr. Herschel had been the Hydraulic Engineer of that company for seven years, and in 1885 had expended a large amount of money on the Holyoke dam, stopping leaks, filling it with gravel and restoring the crest to its original height, and had written a long paper concerning the work done by him, which I had never seen. I asked Mr. Herschel, as a favor, if he could furnish me a copy of that paper and as he told me that he could not, I received one from a director of our company. I read the paper with much interest, but could not agree with many of his conclusions. I was pleased, I admit, with the section of dam recommended by him, for it resembled the typical form that I had considered years before.

As to the very costly experiment of filling the old timber dam back of his sheet piling with gravel, I did not then agree with his conclusions, nor do I now. I reported to the directors that, in my opinion, a great mistake had been committed, and said, furthermore, that if Mr. Herschel had really succeeded in making that portion of the work behind his sheet piling perfectly tight, he had doomed the old dam to quick destruction, and that its only chance for life was that sufficient leakage might occur to thoroughly soak the timbers in front.

Quite a leak occurred in 1889, and two leaks of about 4 or 5 ft. by 6 ft. have happened since. Though these later breaks were under water some 10 or 12 ft., we experienced but little difficulty in closing them at a cost not exceeding $20. He still claims great credit for saving the old wooden dam from destruction for the last 13 years.

He could have saved this company many thousand dollars and the old dam would still be here and probably in better condition than it is to-day.

He now thinks that the saving he estimated by not building the new stone dam was too low. The profile of the crest which I send you shows its condition in 1884; in 1885, after he had repaired it, and in 1897, and any engineer of standing will say that the time has come to replace the old dam by a new one. That being the case,



Profiles of the Crest of Holyoke Dam at Different Dates.

and a new dam necessary, Mr. Herschel must have contemplated building a new dam across the Connecticut River and giving it to our company, or else the dam that he could build for the company at a cost more than half a million less than the one we are at work upon would be the greatest wonder of the age.

I have no intention of decrying the value of his services to the company by the introduction of a good and proper system of water measurements, but one might suppose, after reading his letter, that this company would not now be having any income from the use of surplus water had the fates so decreed that any other man than he had been employed as Hydraulic Engineer in 1880. He did good work and deserves credit for it. He benefited the company and built for himself a reputation as an expert in hydraulic engineering that he might never otherwise have obtained. In time he may be willing to admit that others also have the "know how" and "a little executive ability."

My reputation as a Civil Engineer is as dear to me as Mr. Herschel's is to him. I have never received a diploma from any school of science or technology or from any German university, but I am a Civil Engineer nevertheless. My engineering education was commenced in 1848, in the office of Samuel Ashburner, of Boston, my fellow student being the late Gen. Theodore G. Ellis, of Hartford. I was brought up in the school of Ashburner, the Notts, Capt. Parrott, Appleton, Chesborough and others, and it was a hard school but a thorough one. I have a right, I think, to express an opinion as to dams, for in my fifty years of engineering experience I have designed some 14 dams of stone, frame or cribwork, and have built ten of them. I am sorry for Mr. Herschel's sake that only one of these dams reached the height of his magic number 30. I dimly recollect one that was but 28 ft. high and one but 26 ft. One of the dams was as long as this one at Holyoke, but it unfortunately was only from 16 to 20 ft. high.

Yours truly, Edward S. Waters.

Holyoke, Mass., May 2, 1898.

RECENT ELECTRIC MOTOR VEHICLES FOR CITY STREETS.

With this issue we illustrate four types of horseless vehicles which are in daily operation, successfully and economically meeting the requirements of city traffic in all its various phases of cobblestone pavements and crowded streets, requiring quick stops and starts and perfect control of steering.

Figs. 1 and 2 show in outline the style of hansom cab and brougham manufactured for the Electric Carriage & Wagon Co., of New York city, by Morris & Salom, of Philadelphia. Twelve of these cabs have been in constant operation for nearly a year in New York city, and in the near future 100 more, now in course of construction by the same company, will be put upon the streets.

The cab bodies are built by Chas. S. Caffrey Co., Philadelphia, and are excellent samples of carriage work. The wheels, four in number, are 36 ins. in diameter, and are of the usual tangent spoke bicycle type, of course being much heavier. The Hartford pneumatic tires are 5 ins. in diameter, and are pumped up to about 100 lbs. per sq. in. The complete cab, including batteries, weighs about 2,700 lbs. The operator and two passengers add about 445 lbs., making a total of 3,145 lbs. Of this two-thirds, or 2,096 lbs., rests upon the front wheels, each of which, therefore, supports 1,048 lbs., which necessitates between 8 and 10 sq. ins. of contact between wheel and road.

The steering is done by shifting a vertical lever, conveniently placed at the right side of the operator's seat, which in turn, through a system of levers, shifts the rear wheels much in the same way that the rudder of a boat turns. The motors are controlled by a small series parallel controller patterned after the usual street car controller. This is placed under the cabman's seat, and is also operated by a lever at the left of the seat within convenient reach of his left hand. The alarm or warning signal is a loud-ringing electric bell, to ring which a slight pressure of the foot suffices. A brake operated by foot power, not shown in the drawings, is also provided. Two iron-clad Lundell bipolar motors, with self-oiling ball bearings, are mounted under the cab body upon the axle with a form of spring suspension.

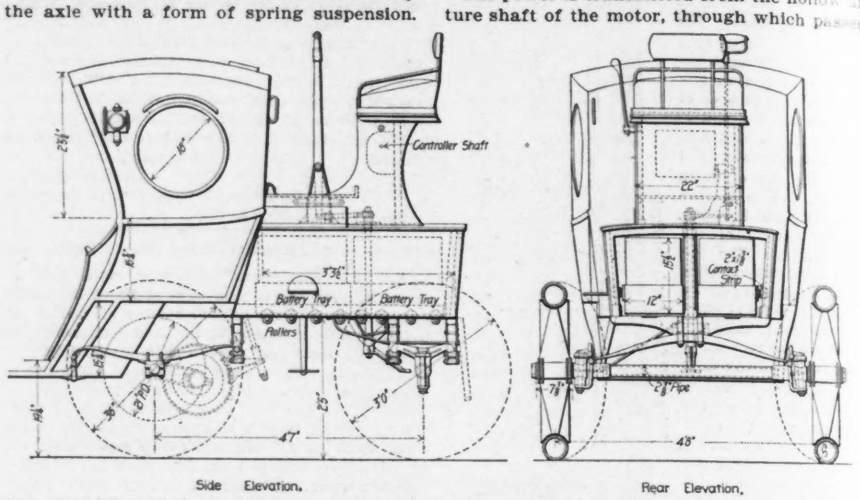


FIG. 1.—SIDE AND END ELEVATION OF THE ELECTRIC HANSOM CABS USED IN NEW YORK CITY. Morris & Salom, Philadelphia, Pa., Builders.

They weigh 172½ lbs. each, are rated at 1½-HP., and run at 1,350 revolutions per minute, with a voltage of 88. The small pinions on the motor shafts mesh into internal gears mounted upon each driving wheel, giving a reduction ratio of 8½ to 1.

The current for operating the motors is supplied by 44 storage cells of 100 ampere-hour capacity, manufactured by the Electric Storage Battery Co., of Philadelphia. These are arranged in four boxes or trays, each holding eleven cells; which in both types slide under the operator's seat. With this battery equipment, which adds between 900 and 1,000 lbs. to the weight of the cab, one charge is sufficient for an average run of 20 miles, although considerably more than this has been made. The controller provides three speeds: 4 to 5 miles, at which rate the cab can run about 25 miles; 7 to 9

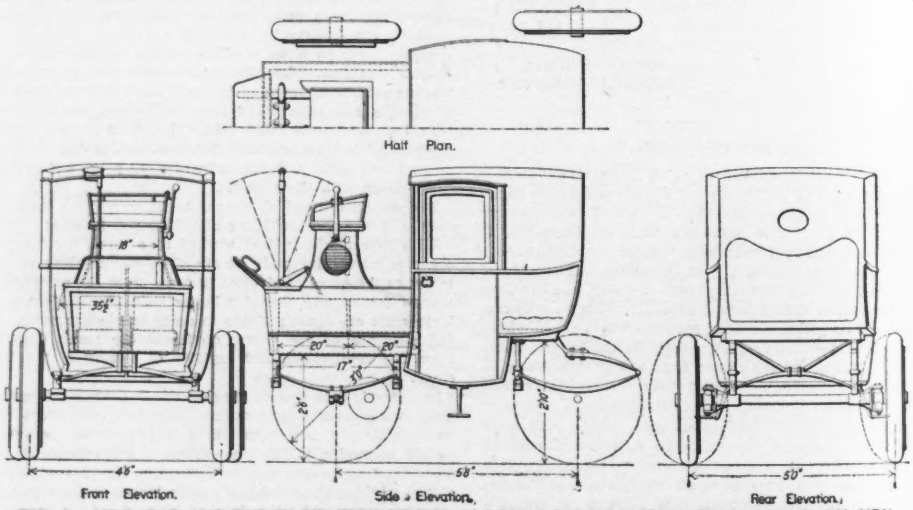


FIG. 2.—SIDE, TOP AND END ELEVATION OF THE ELECTRIC BROUGHAMS USED IN NEW YORK CITY. Morris & Salom, Philadelphia, Pa., Builders.

miles, with a travel of 20 miles; and 15 miles, with a travel of 13 miles. The complete cab, as described, costs about $2,500, of which amount about $400 must be charged to the batteries. For service, the usual city rate of $1 for the first two miles, and 50 cts. for each additional mile is charged, and at this rate the enterprise pays, as shown by the increase in the number of cabs contemplated.

The third type, Fig. 3, represents one of two electric wagons for city delivery service which are now being used by Charles A. Stevens & Bros., silk merchants, of Chicago. The wagon is of ordinary style, but has plate glass panels, which add about 225 lbs. to the total weight of 1,900 lbs. The body is mounted upon four 34-in. wheels with pneumatic tires, the distance between the axles being 4 ft. 4 ins. There is one 3½-HP. multipolar motor, of the builder's design and manufacture, which is dust and waterproof.

The power is transmitted from the hollow armature shaft of the motor, through which passes the driving shaft, on each end of which is a steel pinion engaging the large gun-metal gears attached to the rear hubs; these gears are covered, and run in oil. In the driving shaft is a differential gear which automatically adjusts the different speeds of the wheels in turning corners. At the maximum speed of 12 miles per hour the wagon requires about 15 amperes and 80 volts, which is about the normal discharge rate of the battery. At this speed the battery is calculated to run the wagon for five hours, or a distance of 60 miles, but at lower speeds the time and distances are greater. There are 40 cells, giving a capacity of 100 ampere-hours, which weigh 13 lbs. each, or a total of 520 lbs. The battery is of the usual lead type, with about 80% of the plates active. It was also designed and manufactured by the builders of the wagon.

By means of a series parallel controller various rates of speed are attained, ranging from two to twelve miles per hour. The steering is effected through a lever operating a short axle, which is pivoted in the center of the special hub, making the control easy and simple. There are two hand brakes on the driving shaft, operated by a foot lever; the brake firmly locks the rear wheels, and will hold the wagon on ascending or descending grades. The vehicles are operated by ordinary wagon drivers.

For the first two weeks these wagons were at work on the south side, each working an average run of about 30 miles per day, though a much greater distance could have been traveled if necessary.

The wagons cost about $1,650 each, and were built by the American Electric Vehicle Co., of Chicago. The builders inform us that these are the first electric delivery wagons they have built, but that they now have orders for similar vehicles, and have also sold a number of pleasure vehicles, including broughams and surreys.

Fig. 3.—Electric Delivery Wagon in Use in Chicago, Ill. American Electric Vehicle Co., Chicago, Ill.

The Pope Manufacturing Co., of Hartford, Conn., are now offering a very attractive electric motor carriage, a view of which is shown in Fig. 4, the result of a long and expensive series of experiments, begun in July, 1895. The carriage here illustrated, known by the trade name of "Mark III," weighs 1,000 lbs., to which the batteries add 800 lbs. The tread is 54 ins. c. to c., and the wheel base about 6 ft. The front wheels are 32 ins. in diameter, and the rear, 36 ins., both having 3-in. Hartford single tube tires, inflated ordinarily to about 120 lbs. per sq. in.

The frame is made of steel tubing, rigidly braced, yet so designed as to be simple and pleasing in appearance. The rear wheels, or drivers, are tight on the shaft, and are driven by a very compact enclosed motor mounted upon the shaft. The front wheels are on a frame free to rock so as to mount obstructions without straining the frame. The steering is accomplished by means of a simple series of levers and a bell crank arranged in such a manner that the two front wheels turn always tangent to the respective curves, on which they are moving. The batteries, 44 in number, in four sets of 11 each, are made by the Chloride Accumulator Co., of Philadelphia, Pa. They are placed in trays and slide into the carriage box over the rear wheels. The motor may be of any make, but is built from designs of the Pope Company. It is series wound, and has a normal full speed of 1,000 revolutions per minute, developing 2 HP. on about 20 amperes. For a short time a heavy overload can be maintained. Speed is controlled by a small switch placed under the seat and operated by a lever close against the side of the carriage. Three speeds are provided, 3, 6 and 12 miles per hour, accomplished by changing the grouping of the cells, the first putting 11 in series and 4 parallel sets; the second, 22 in series and 2 parallel sets, and the full speed with all 44 in series. For reversing, a small foot lever is provided, but this is so connected to the controller that all current must be cut off before the reversing lever can be moved. Current for charging the batteries can be taken directly from the 110-volt direct-current lighting circuits, such as are found in most cities and towns. The alarm is rung by pressing a button in the end of the controller handle, where it is always ready for use without changing the position of the hand of the driver. Four 6-c. p. electric lights are provided, two side lights, one front light and a pilot lamp on a long flexible cord which can be carried about the carriage for examination or hung up inside for reading. These are all controlled by separate switches, so any or all can be lighted. To let the operator know the exact condition of the batteries, a General Electric storage battery watt-meter (Eng. News, April 21, 1898), is placed under the seat within easy reach of the operator. The brake is a friction drum mounted upon the rear axle, and is applied by a foot lever projecting through the floor of the carriage. The general appearance of the rig is most attractive, the outline being graceful and the parts light, yet substantial. This is due somewhat to the curved dashboard, which gives an added finish, the relative size of the wheels and the attention to the proportions of the seat and box.

FIG 4.—AN ELECTRIC PHAETON. Pope Manufacturing Co., Hartford, Conn.

THE ULTIMATE AND THE RATIONAL ANALYSIS OF CLAYS AND THEIR RELATIVE ADVANTAGES.*

By Heinrich Ries, Ph. D.**

Pure clay or kaolin† is extremely refractory, possesses little plasticity, and usually shrinks and warps considerably in burning. Even the smallest proportion of impurities changes these properties, so that the kaolin exhibits variations in shrinkage, plasticity, tensile strength, fusibility, and often color when burned. The majority of nearly pure kaolins consist of kaolinite (Al_2O_3, $2SiO_2$, $2H_2O$), undecomposed feldspar, and quartz. The kaolinite generally forms the finest particles of the clay and is known as the clay-substance, while the rest of the clay-particles are collectively spoken of as sand.

In the ordinary or ultimate analysis, the substances generally determined are silica, alumina, ferric oxide, lime, magnesia, alkalies and water. An analysis of this type simply regards the clay as a mixture of elements or oxides, but gives no clue as to the actual condition in which these substances exist, i. e., whether as silicates, oxides or carbonates, etc., a point which it is of the highest importance to know; for the individual components of the clay influence its properties not only according to their quantity, but also according to their condition. Thus, lime, if present as a carbonate, may be extremely injurious, causing the clay to swell or burst during or after burning, while if present as a silicate (feldspar) it may form a desirable flux, serving to bind the burned clay-particles more firmly together.

Moreover, the ultimate analysis gives no clue to the condition in which silica is present in the clay. In the form of quartz it would serve to diminish the shrinkage, and (except at high temperatures) increase the refractoriness of the clay, but if combined with alumina and potash in feldspar it would act as a fluxing agent.

A high percentage of total silica in an ultimate analysis does not necessarily indicate the presence of much quartz, but may be due, on the contrary, to an excess of feldspar.

It frequently happens that two clays approach each other quite closely in their ultimate composition, and still exhibit an entirely different behavior when burned. The explanation which most quickly suggests itself is, that the elements present in the two clays are differently combined. Some method of resolving the clay into its mineral components, so as to indicate the condition in which the elements are present is therefore practically needed.

As kaolinite results from the decomposition of feldspar, the kaolin is quite sure to contain some undecomposed feldspar, and also some quartz, and (in smaller amounts) mica, since the two latter minerals are common associates of the feldspar.

If, now, we know the amount of feldspar, quartz and kaolinite or clay-substance in the kaolin, and the effect of these individual minerals, we can form a far better opinion of the probable behavior of the clay in burning.

The rational analysis, or method of separating kaolin into its mineralogical components, depends on the decomposition and solution of kaolinite by sulphuric acid and sodic hydrate, leaving the feldspar and quartz behind. *In this residue the alumina is determined; and from this the amount of feldspar in the residue can be calculated. The balance is quartz. When mica is present, it is dissolved out with the kaolinite and reckoned in as clay-substance, but it is rarely present in large amounts ,and may perhaps alter the character of the clay-substance but little, for finely ground white mica possesses plasticity, and can be formed and dried without cracking. It is more refractory than feldspar, and holds its form up to 1,400° C.**

The practical value of the rational analysis bears chiefly upon those branches of the clay-working industry, such as the manufacture of porcelain, white earthenware, fire-bricks, and glass-pots, which use materials with comparatively few fusible impurities (iron, lime, magnesia).

There is much concerning clays which still remains unexplained, but it seems probable that, other things being equal, two clays having the same rational composition will behave alike.

The application of the method of rational analysis to impure clays is not quite as satisfactory, but at the same time not as necessary. In the treatment, the iron, if present as oxide, and lime or magnesia, if carbonates, are dissolved out with the clay substance. The silicate minerals are grouped with the feldspar, and the clay thus becomes divided into clay-substance (kaolinite, ferric oxide, lime and magnesia carbonates), feld-spar or feldspathic detritus; and quartz. We still have, however, a far better idea of the structure of the clay than we should get from an ultimate analysis alone.

The importance of the rational method of analysis has been widely recognized in Europe, especially in Germany, and has been applied with great success; and it is hoped that its value will soon become more thoroughly appreciated in this country. The complete investigation of a clay in the laboratory should include not only an ultimate and a rational analysis, but also detailed physical investigation.

*Extracts from a paper read at the Atlantic City meeting of the Am. Inst. Mining Engineers, Feb., 1898.

** Columbia University, New York city.

† The term kaolinite refers to the mineral resulting from decomposition of feldspar, while kaolin is used to designate a mass of more or less pure kaolinite. The two names are sometimes confused.

* The rational analysis is in reality a simple operation, but still requires some little practice to ensure accurate results.

**G. Vogt, Chem. News, p. 315.

TUNNEL EXCAVATING MACHINE ON THE CENTRAL LONDON RAILWAY.

In carrying out their contract on the Central London Railway the contractors, Messrs. Walter Scott & Co., include in their plant a machine devised for excavating within the shield. This machine was built on the designs of Messrs. Scott's agents by Mr. Thomas Thomson, and is described as follows by London "Engineering," to which journal we are also indebted for the illustrations used:

The problem of extracting the earth from within a shield and depositing it in cars is more complicated than would at first appear to be the case; and previous machines constructed with rotary cutters failed in clay mixed with bowlders. In addition to the method of excavating employed, care must be taken that the machine itself does not block the tunnel section nor interfere with the placing of the iron segments. The difficulty in keeping the shield in alinement is also increased by the use of excavating devices.

The primal conditions in the machine here designed were as follows: It must be able to excavate, without injury to itself, in beds of hard clay mixed with septaria, and occasional bowlders up to 4 ft. diameter; it must deliver the earth at a height sufficient to drop it into cars; it must not form an obstacle to other tunnel-making processes, and be easily withdrawn, so that hand-work can be at once resumed where conditions demand this; and it must be so constructed that the direction of the shield can be controlled and lines and levels conveniently checked.

The machine built to meet these conditions consists of an under carriage with wheels running on a 6 ft. 3 in. gage track. This carriage has an opening beneath 5 ft. 8 ins. high and sufficiently wide to admit the usual 2 ft. gage cars underneath it. The top of this carriage is strongly braced and carries a short king-post on which an upper carriage revolves. This upper carriage has sides of plate iron, cross braced, and with a central casting revolving on the king-post; attached to the top of this carriage is an endless chain carrying excavating buckets. The frame which carries this chain is 17 ft. long and is held up by two chains passing to a winding-drum in the upper part of the carriage. The machine is driven electrically by a 100-ampere motor taking current at 200 volts. The current is supplied by a 20-HP. engine and dynamo, at the head-house. The motor is mounted on the back end of the carriage and drives a shaft, parallel to the carriage, by a two-thread worm and worm-wheel. This shaft also operates the revolving, the propelling and the raising and lowering gear, by suitable bevel pinions and wheels.

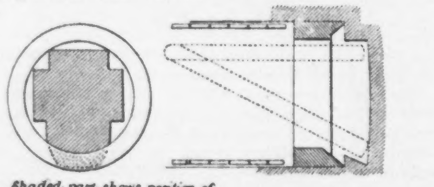
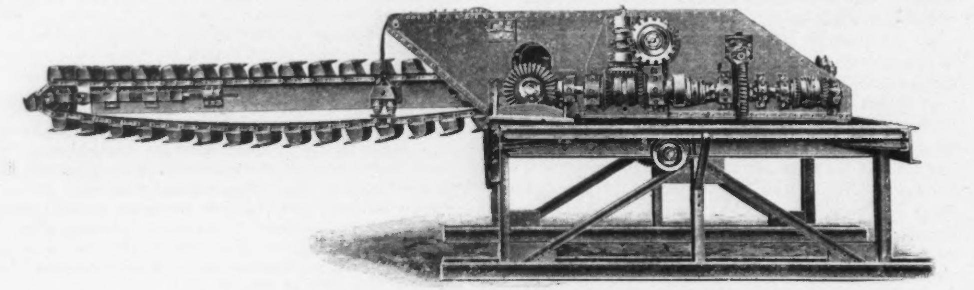


Diagram Illustrating Operation of Tunnel-Excavating Machine.

The revolving gear consists of a pair of friction cones and bevel wheels driving, through a worm-gear, a chain pulley with chains passing to the sides of the under frame. The raising and lowering of the bucket-ladder is also performed by a pair of friction cones and a worm-gear, and on the barrel of the latter the lifting chains are wound. The traveling-gear is worked from a pulley on the opposite end of the motor and belted to a pulley on a shaft over the king-post. From this latter shaft, by means again of friction cones, another shaft, leading down the king-post, is operated and drives, by a worm-gear, two spools placed on either side of the under frame. From these spools wire ropes are led and anchored to the sides of the tunnel, and by them the machine is moved.

As the excavating buckets are run at a higher speed than those used on dredges, especial care has to be given to the feed, and all levers and wheels for the control of the machine are within easy reach of the operator, who stands on a small platform on the left of the machine. The bucket-ladder is fitted with a screw extension device for tightening up the bucket-chain. The buckets are really scrapers, and each has four or five teeth, placed alternately, chisel-shaped and fitting into recesses cast in the back of the buckets. Cast steel was first used in these buckets; but as one or two were broken, gun-metal has since been employed with better results.



ENDLESS CHAIN EXCAVATING MACHINE USED IN THE TUNNEL FOR THE CENTRAL LONDON RY.

In operation, the excavator is brought up to the face and scrapes out all that it can reach in a space 18 ins. to 2 ft. beyond the front of the shield; the area covered being shown in the accompanying diagram. The machine is then run back 10 or 12 ft. clear of the face and the shield is pumped forward, the cutting-edge bringing down the earth not touched by the excavator. This insures a clean cut and no cavities. The iron lining is next erected and bolted up and the excavator is again set to work. While the machine is not as large or heavy as experience shows would be desirable, the only stoppages have been due to the breaking of buckets. As it is, the saving over hand-labor is very considerable, and an average advance of three 20-in. rings is made in ten hours, with eight men at the face, including the machine operator.

ROAD STATISTICS FOR THE UNITED STATES.

The following notes are taken from a paper upon "Various Phases of the Road Question" recently presented to the Engineers' Club of Philadelphia, by Gen. Roy Stone, Director of the Office of Road Inquiry in the U. S. Department of Agriculture. Over 10,000 letters of inquiry were sent out from this office, and from the data thus obtained Gen. Stone deduced certain figures which are here tabulated as follows; these figures refer to the average length of haul, from the farms to market or shipping points, the average weight of load hauled and the average cost per ton for the whole length of haul:

Group of States.	Average haul, miles.	Average weight, lbs.	Average cost per 2,000 lbs. per mile.	Total average cost per ton for whole length of haul.
Eastern	5.9	2,216	$0.32	$1.89
Northern	6.9	.....	.27	1.86
Middle	8.8	.....	.31*	2.72*
Cotton	12.6	1,397	.25	3.05
Prairie	8.8	2,409	.22	1.94
Pac. Coast & Mount'n.	23.3	2,197	.22	5.12
Whole United States...	12.3	2,002	.25	3.02

*Middle Southern States.

Assuming the correctness of these data, and using the census return of farm products and forest and mineral outputs, and estimating incidental traffic, Gen. Stone arrives at a total of 313,349,227 tons as representing the total annual movement over country roads. At the average cost of $3.02 per ton, the grand annual cost of haulage on public roads amounts to $946,414,665. Statistics of the cost of operating foreign highways, and the data obtained from the use of the few good roads existing in this country, would indicate that nearly two-thirds of the above cost is directly chargeable to bad roads. And this figure does not include the loss of perishable products for want of access to market, the failure to reach market when prices are good, and the uselessness of cultivating certain products which depend upon the markets being always accessible. The enforced idleness of men and horses during a large part of the year is another item which should be charged largely to bad roads.

Gen. Stone thinks that the chief obstacle to road improvements in this country is the negative or hostile attitude of the rural population towards all effective legislation in this direction. In parts of New Jersey, where the farmers are realizing the real benefit to them of such improvement, the actual progress is very rapid. Another obstacle is the general overestimate of the cost of such improvement. A few years ago the macadam roads of New Jersey cost $10,000 per mile; now, equally good roads are being built for $3,000, even where railway transportation of material is required; and in localities better supplied with road material and a narrower road is deemed sufficient $1,500, or even less, will make a mile of good stone road. Experience has demonstrated the fact that in most country districts, a single stone road, 8 or 10 ft. wide, with a good earth road on one or both sides, is more generally satisfactory than a wider road of macadam.

The only plan, says Gen. Stone, by which the help of cities and business corporations generally can be obtained for road building, is through State aid; based upon the principles of "helping those who will help themselves" and "first come first served." To be effective, State supervision of location and construction should be a ruling condition. Gen. Stone suggests as one method of obtaining government aid, the long-talked-of establishment of postal savings banks, with the investment made in road bonds. Among the advantages claimed are the safety of the investments, the home circulation, and the fact that the poor and sparsely settled district could obtain its road money at as low a rate of interest as the rich and populous country.

In speaking further of the postal savings bank road bonds, Gen. Stone says that the interest on such bonds would not increase taxation, as it could be paid out of funds already raised for road repairs, and still leave enough to keep a system of good roads in order. The present taxation for road repairs, in money and in labor throughout the United States, is estimated at $45,000,000 annually. One-third of this sum would be sufficient, under wise supervision, for the daily care of well-built roads; and the remaining $30,000,000, at 2% would pay the interest on $1,500,000,000. This latter sum would build one million miles of good country road. The government operates 276,000 miles of post roads; and it would save more by the improvement of these roads than the cost of handling the postal savings bank funds would amount to.

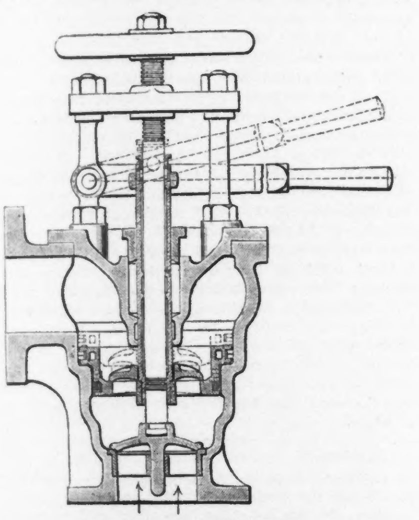
Gen. Stone believes in the future of automobile road wagons; provided, the roads be made fit to operate them economically. He notes that one of the latest electrical carriages, for two persons, weighs but a little over one ton, including passengers and electric storage; one horse-power will move this vehicle over a good stone road at the rate of 15 miles per hour, or 1,000 miles in a week, by daylight. From the experience of Augusta, Ga., in furnishing water power for $5.50 per horse-power per annum, he figures that, with the utmost deductions for transmutation, transmission and profit, electric power might be furnished along public roads at $1.00 per week per horse-power. On this basis the two persons would be transported 1,000 miles for $1.00; or about one-fourth the cost of railway travel; not counting wear and tear on vehicle and battery. He suggests national object-lesson roads, as interstate roads. An Atlantic and a Pacific coast-line road system connected by a continental highway, from Washington to San Francisco, could be built by the States and Federal Government; and it would furnish an invaluable lesson in the science of road building and the direct benefits to the users and to adjacent properties.

In the discussion following this paper the question of steel for highway construction was brought up. In answer to questions Gen. Stone said that the road proposed by the Department of Agriculture was to be made of longitudinal stringers with about 8 ins. of level surface with a 3-in flange to hold the ballast and a ½ × ¾-in. bead on the inside of the stringer to assist wheels in keeping the track. These stringers would rest on broken stone or gravel in a trench provided, and be tied together at intervals by rods. About 100 tons of steel per mile of single track would be required and he estimated the cost at about $3,500 per mile, at present prices for material. As yet the demand has not been sufficient to warrant the expense of preparing rolls for these special rails, or stringers. But experiments, on short lengths, had been made with the lightest kind of channel iron and with plates and angles, and the results had been very satisfactory in the decreased tractive power required and in the ability to resist wear and displacement.

A DOUBLE-ACTING AUTOMATIC STOP VALVE FOR STEAM BOILERS.

The accompanying illustration, which we take from "The Engineer" (London), shows an ingenious form of automatic steam stop valve, which will operate in either direction. When applied to a steam boiler it will close automatically whenever the pressure in the boiler is reduced below that in the steam main, and it will also close if the pressure in the main should be reduced considerably below that in the boiler, as in the case of the bursting of a steam pipe. The valve is manufactured by McFarland & Co., 58 Hyde Park St., Glasgow. The description of the valve is as follows:

These valves are fitted and worked like the ordinary stop valves now in use. There is on the outlet branch an ordinary screw-down valve operated by the hand-wheel. Above this, and mounted on an outer spindle or sleeve, is a loose, movable piston, having two surfaces, an upper and lower, on which the pressure of the steam acts. This



Automatic Steam Stop Valve, Manufactured by McFarlane & Co., Glasgow, Scotland.

piston, which is an easy fit in the chest, is provided, as shown, with Ramsbottom rings. In the bottom of the piston valve ports are formed, and on the inner ledge of the bottom of the piston sits a loose disk valve, which forms a steam-tight face over the ports in the piston. The outer sleeve or spindle is attached to a testing lever, so that by working the lever the piston is moved, and its good working conditions insured.

When the stop valve is opened the steam passes through the ports in the piston valve and lifts the non-return valve up against the end of the stuffing-box, holding it in that position, and at the same time exerting its pressure on the upper and lower surfaces of the piston valve when passing to the engine. In the event of a rupture to the surface pipe, and an outburst of steam, the pressure in the pipe and on the upper surface of the piston valve is released. The valve is instantly moved up against the non-return valve in its raised position, and the supply is shut off. The engraving shows the automatic piston valve in the open position, and the dotted lines in the closed position. While the steam is flowing to the engines the loose non-return valve mounted on the outer spindle is, of course, held up against the end of the stuffing-box. Should the pressure in any of the boilers be reduced, due to a burst tube or an explosion, the direction of the flow of steam is reversed, and the steam in seeking to pass from the other boilers into that which is damaged, acts on the back of the non-return valve and shuts it on its seat on the piston valve, thus isolating the damaged boilers from the remainder. The arrangement therefore acts both for a ruptured pipe and a damaged boiler, the automatic piston valve being moved up against the non-return valve and shutting off the supply when the pipe is ruptured, and the non-return valve is shut on its seat on the piston valve when any one boiler in a group is damaged.

INVESTIGATION OF AN ACETYLENE GAS EXPLOSION.

On Dec. 24, 1897, the works of the U. S. Acetylene Gas Liquefying and Distributing Co., in Jersey City, N. J., were destroyed by a fire succeeding an explosion. Two men were killed, one of them being the superintendent of the works, and a coroner's jury was convened to investigate the circumstances which led to and which accompanied the disaster. The "Progressive Age" of May 8 contains an elaborate illustrated description of the works, of the system of manufacture which was there carried on, and an account of the results of the investigation by the coroner's jury, from which we condense the following:

This is the second fire of this kind which has occurred in this country, the previous instance taking place on Jan. 21, 1895, at New Haven, Conn., and which likewise resulted in the death of two men. In this case negligence was shown on the part of the person handling a cylinder of liquefied acetylene.

The present instance seems somewhat similar as to cause. The gas will not burn unless ignited, and if it was ignited it was through the wilful negligence of the workmen in not following the rules of the establishment. Just what this negligence was, whether the workman charging the cylinder was smoking a pipe or cigar, or struck a match to light one, or whether the nearby gas jet had been ignited is not known.

In the regular routine, carbide was first put in two cylinders. Water was pumped into these cylinders after securely fastening the opening, and the gas passed over trays of carbide in a third cylinder in order to remove the moisture contained in the gas; from this dryer the pipes led to compressors where it was compressed in stages. The compressed gas passes to the cooling coils, which were surrounded by well water at about 50° F., contained in an elevated tank and thence to the charging rack where the workman charges the tanks or cylinders with liquid acetylene—rendered liquid by the combined effect of cold and pressure. A pipe leading from the dryer was first found to be frozen up on the morning of the fatal accident, and subsequently the same pipe, at a point nearer the compressor, was found choked. This was opened (contrary to orders) whilst the compressors were in operation, and air drawn into the apparatus, which mixed with gas, was forced into the attached cylinders, where it naturally formed a mixture explosive if ignited.

Ignition was in some way brought about by the workman, White, who disconnected one of the cylinders to blow out the mixture of air and gas contained therein. Instead of closing the tank valve, and thereby shutting off the burning mixture of air and gas, White apparently lost his head and ran to call the superintendent, Mr. Grimm, whose office was located above the shipping office, and upon being called he ran to a door at the top landing, down the stairs through the pipe shop to the rack holding the cylinder from which the mixture of burning gas and air was issuing, with the intention, no doubt, of closing the valve. He arrived too late, for by this time the pressure within the tank had been reduced sufficiently to enable the flame to strike back into the cylinder, thereby igniting the explosive mixture of air and gas contained therein.

A workman, who observed the burning gas and air escaping from the cylinder, testified that the flame differed from that obtained by igniting the gas from a cylinder full of gas alone; in the latter case the flame is slightly yellowish and it smokes; that which he saw was a bluish-white smokeless flame, such as is produced in an acetylene Bunsen burner, plainly indicating the presence of air in the cylinder. This was further indicated by the observation that the compressor worked unusually hard when up to full pressure, which never occurred with acetylene alone. There is one fact to be observed in handling acetylene, and that is, that a mixture of gas and air will explode and propagate through an orifice the size of which is much greater than possessed by an ordinary burner. This, however, will depend upon the pressure of the issuing gas, for this mixture will not strike back even with a relatively large orifice if the velocity is sufficient. Thus it was that a considerable space of time elapsed between the ignition of the gas and the explosion of the cylinder, a period during which the pressure was gradually being lowered to the required point, after which the flame struck back into the cylinder and it exploded.

Liquefied acetylene is converted into a gas at 98½° F. having a pressure of 65 atmospheres, thereafter its pressure, due to expansion by heat, follows the law of Guy Lussac, that is, for each degree of temperature a proportionate expansion of the gas and consequent increase in pressure results. At the boiling point of water the pressure of the gas will increase to about 200 atmospheres. In order to provide a safeguard for increased pressure or temperature, the cylinders containing the compressed or liquefied acetylene are supplied with safety diaphragms which rupture at 100 to 120 atmospheres, and melt at a temperature corresponding to this pressure, namely about 150° F. The cylinders themselves are all tested to 250 atmospheres and will stand a bursting strain of 400 atmospheres, the margin of safety being, therefore, greater than that of any other cylinder used for certain liquefied or compressed gases, for, the actual pressure at ordinary temperature, when the above flasks are in use, is but 40 atmospheres. The 5-in. cylinder contains 10 lbs. while the 8-in. contains 20 lbs. of liquefied acetylene.

As a result of the above, out of some 60 filled cylinders, which were exposed to the intense heat of the fire, 48 cylinders did not burst, but were prevented from so doing by by the rupture of the safety diaphragm which permitted the gas to escape and quietly burn at the valve orifice without explosive effect. The filled acetylene cylinders as well as those containing liquefied carbonic acid and ammonia which exploded were all supplied with safety diaphragms, and the failure of the latter to act, or possibly a stoppage in the escape openings therefrom, caused the pressure in the cylinders when exposed to the heat of the fire to rise above the the resisting power of the cylinders, namely 400 atmospheres.

The most disastrous of the several explosions was that produced by the tank of liquefied ammonia, which was much larger than any of the others and contained 100 lbs. of liquid ammonia. One volume of liquid ammonia generates about 1,000 volumes of ammonia gas, 1 lb. producing about 30 cu. ft., or about twice the quantity given off by liquid acetylene—hence its terrific explosive effect. Notwithstanding this it simply blew out the side of the building next the railway trestle, overturning the compressor which was upon the other side of the cylinder, but did not disturb the boiler or generator house. The force, however, of the exploding ammonia cylinder was tremendous, a fragment of the same being found a quarter of a mile away, while the earth vibration was felt as far as Staten Island. There is no evidence that the carbide ignited and burned of its own accord; on the contrary, most of the drums and their contents were not injured; a few which had been ruptured permitted the contact of water with the carbide, generating gas which thereby burned during the fire, and thus increased the conflagration so that they had to desist and let the fire burn out. Out of the total of 63 drums going through the fire 56 were returned to the carbide works in good condition, only 7 being damaged or pierced by flying fragments.

In view of the experience obtained from this fire, it would appear that the danger surrounding the manufacture of liquefied acetyleno is not so great as heretofore assumed if ordinary precautions are taken. In the proposed erection of a new acetylene liquefying plant at Lebanon, Pa., the several operations will be carried on in separate fireproof buildings, thereby preventing the spreading of fire and possibly danger to human life. In the present instance, it is apparent that the loss of life and damage by fire could have been largely avoided if there had been sufficient space to permit the generation of gas, its compression and liquefying, the charging of cylinders, their storage and the storage of carbide, to be carried on in buildings separated from each other. If such an arrangement had been possible, the disaster would probably have been confined to the bursting of one cylinder.

A NATIONAL EXPOSITION OF AMERICAN PRODucts and Manufactures is proposed in House Bill 8066 and favorably reported upon by the Committee on Interstate and Foreign Commerce. This bill proposes that such an Exposition should be held in Philadelphia in 1899, under the auspices of the Philadelphia Commercial Museum; permits free import of exhibits, and appropriates $50,000 for collecting samples in foreign markets for exhibition, to illustrate preparation, packing, etc. It also votes $300,000 to aid in providing a suitable building. The purpose is to encourage American industries and to expand present and to develop new markets for American products. The Philadelphia Commercial Museum, under whose auspices this Exposition would be held, is controlled by a board of trustees created by an ordinance of City Councils in 1894, and the city has appropriated $570,000 for its maintenance and equipment. It has extensive quarters at 233 S. 4th St., Philadelphia, and its bureau of commercial information is doing very good work in extending American commerce in South America, Africa and other neutral markets. For the purpose of the Exposition the Philadelphia Exposition Association was lately incorporated. The City of Philadelphia has assigned a central site for the permanent Exposition, covering several acres of valuable ground, and the appropriation for buildings, asked for from Congress, is conditional on securing at least an equal amount by private contributions and $200,000 from the City of Philadelphia, as authorized by a popular vote. The State of Pennsylvania has already appropriated $50,000 for this purpose, and more is expected. The Congressional Committee recommends the passage of the bill, as called for, to give that standing to the Exposition with foreign countries which its best interests demand.

THE OMAHA EXPOSITION, more formally known as the Trans-Mississippi & International Exhibition, will be opened with some ceremony on June 1, and remain open until Nov. 1. Its chief object is to show the resources and industrial development of the states west of the Mississippi River, representing a region with an area of about 2,500,000 sq. miles. Liberal support has been received in the way of cash donations, stock subscriptions, and exhibits, and the exhibition promises to be interesting and successful, though the war will unfortunately have a material influence in reducing the attendance below the estimated figures.

The site is north of the city, within the city limits, and covers a large area. Railway tracks, having connection with the numerous roads entering Omaha, will run into the grounds, where a large terminal station will be provided. These will carry a service of local trains as well as the special excursions from other cities, and in addition there are three electric railways from the city to the grounds. The general plan is based on that of the Columbian Exhibition, there being a central sheet of water—the Grand Canal—surrounded by a court, on which the main buildings will front. The buildings are of wood, with the "staff" covering and decorative work which is at once so cheap, easily handled and effective. Walker & Kimball, of Omaha, are the Architects-in-Chief, and the following is a list of the principal buildings and their architects:

Administration Building and Colonnade, Power House, Transportation Buildings, Girls' and Boys' Building, Restaurant, Viaducts, East Colonnade, Arch of the States, Lagoon Finish, etc., Walker & Kimball, Omaha, Neb.; Agricultural Building, Cass Gilbert, St. Paul, Minn.; Auditorium, Fisher & Laurie, Omaha, Neb.; Liberal Arts, Fisher & Laurie; Fine Arts, Eams & Young, St. Louis, Mo.; Horticultural, C. F. Beindorf, Omaha, Neb.; Machinery and Electricity, Dwight H. Perkins, Chicago, Ill.; Manufacturers, S. S. Beman, Chicago, Ill.; Mines and Mining, J. J. Humphreys, Denver, Colo.

The U. S. Government will have a special building and exhibits, Congress having appropriated $200,000 for these purposes. The building, 208 × 150 ft., was designed by the Supervising Architects, and exhibits will be made by all the executive departments, the U. S. Fish Commission, the Smithsonian Institute and the National Museum. A number of states have appointed special commissions and some will have their own state buildings. For these purposes appropriations have been made by the state legislatures, and large public subscriptions have been raised. Several foreign countries will also be represented.

The grounds have been laid out with a view to picturesque effect, and provision has been made for water supply, sewerage and proper maintenance. A variety of amusement features will be provided in one part of the grounds.

The management is in the hands of a company, the President of which is Mr. Gurdon W. Wattles, of Omaha. The executive committee is composed of the managers of the six departments, as follows: Zachary T. Lindsey, Ways and Means; Edward Rosewater, Publicity and Promotion; Freeman P. Kirkendall, Buildings and Grounds; Edward E. Bruce, Exhibits; Abram L. Reed, Concessions and Privileges; William N. Babcock, Transportation.

AMERICAN RAILS AND RAILJOINTS have been sold to the Government of Victoria in response to a call for 7,000 tons 80-lb. rails; 240 tons 95-lb. rails; 5,240 tons 110-lb. rails; 300 tons 115-lb. rails; 700 tons 80-lb. fish-plates; 550 tons 100-lb. fish-plates. The invitation for bids called for a delivery of 25% within six months, 25% in nine months and the other 50% in twelve months. The five tenders received were as follows: Messrs. Krupp, of Essen, f. o. b. Antwerp, instead of c. f. i. Melbourne, as stipulated, rails £56,610; fish-plates, £9,322; Pennsylvania & Maryland Co., £73,630 for all; C. Cammel & Co., England, £77,894; Bay & Co., England, £79,274; the Carnegie Co. tendered for the rails alone at £5 1s. 9d. per ton, c. f. i. Melbourne. The bid of the Pennsylvania & Maryland Co., which works out £4 18s. 9d. ($23.94) per ton, c. f. i. Melbourne, was accepted. Of this contract 2,000 tons have already been shipped to Melbourne from Sparrow Point, Baltimore. The same company is filling another large order for the Trans-Siberian railway, and shipments of steel rails are being made direct from Baltimore to Vladivostock, via Suez. A Norwegian steamer is also loading at the works with a portion of an order for 4,000 tons of steel rails for Jamaica, says the Baltimore "Herald."

MEXICAN RAILWAYS are referred to as follows in President Diaz's late message: From September, 1897, to May, 1898, a total length of 195.3 miles of railways were built. This included 64.5 miles on the Coahuila & Zacatecas Railway; 47 miles of private lines connecting federal lines; 13.6 miles on the Jalapa Electric Railway; about 10 miles on the Merida & Campeche Railway; 10.5 miles from Jalapa to Teocelo, and the remainder on the Merida-Peto, Hidalgo-Guanajuato-San Luis, Cazadero-Solis and Nautla-San Marcos lines. The Mexican railway system now aggregates 7,356 miles of track, not including some lines not now worked. Tramway lines, built under state authority, aggregate 145 miles in length. Since September 12 concessions for railways have been granted, including an amendment to the charter for a line connecting the Tehuantepec Railway with the general Mexican system.

THE TRAMWAYS OF PARIS are now operated by nine different systems of mechanical traction, as follows in chronological order: Rowan system of steam motors, 1889; Francq system of superheated water, 1889; cable traction, 1891; Serpollet system of instantaneous vaporization, 1892; accumulators with slow loading, 1893; compressed air, Mekarski system, 1895; electric traction by contact boxes, 1896; accumulators with quick loading, 1897; improved Serpollet system, 1897. The first regular system of mechanical traction, says the "Revue Generale des Chemins de Fer," was installed in Paris in 1889 by the Compagnie Generale des Omnibus on a special line to the exposition of that year. The compressed air system of Mekarski was first tried, in 1876, on the Courbevoie l'Etoile line of the North Tramway Co., and has been working in Nantes since 1878. In 1895 the Compagnie Generale applied it, first on the line from the Louvre to St. Cloud, Sevres and Versailles, and then to Vincennes. The electric system used is that of Claret Vuilleumier, and is operated on a line from the Place de la Republique to Romainville. The latest accumulator system is used on three lines starting from the Madeleine; and the perfected Serpollet steam type is employed on a line running from St. Ouen to the Bastile. On these lines, which have an aggregate length of 52 miles, 211 vehicles are used; the Paris tramway lines, operated by horses, have a total length of 129 miles and use 478 conveyances, not including those in reserve. It is estimated that an expenditure of about $18,000,000 would be required to transform all the lines to some system of mechanical traction; and the contention is made by those interested that this improvement would be sufficiently effective and vastly more economical than the Metropolitan rapid transit plan proposed, which would cost about $60,000,000 when completed.

WEATHER TABLE FOR APRIL, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation—rain or melted snow—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average.	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	38.8	67	6	61	—	35	NW	2.74	0.96	16
	Portland, Me.	41.2	70	17	53	8.6	29	NE	4.33	1.66	12
	New York City	46.8	74	25	49	14.2	38	N	3.23	1.29	12
	Pittsburg, Pa.	48.5	78	20	58	7.3	25	NW	1.60	.61	13
	Chicago, Ill.	44.4	76	19	57	18.7	48	NE	0.76	0.43	8
	Omaha, Neb.	51.2	88	26	62	9.1	30	NW	2.74	1.03	12
	St. Paul, Minn.	45.6	77	19	58	7.6	30	SE	1.22	0.52	9
	Duluth, Minn.	40.3	64	18	46	8.8	42	S	0.41	0.28	5
	Bismarck, N. Dak.	43.7	79	18	61	13.5	48	NW	1.12	0.39	5
	Average	44.5	75	19	56	11.0	36		2.02	0.80	10
Southern Cities.	Washington, D. C.	50.9	83	26	57	8.9	34	NW	2.36	0.54	14
	Louisville, Ky.	53.5	82	25	57	9.3	36	NE	2.80	0.73	10
	St. Louis, Mo.	54.4	82	29	53	11.0	47	W	3.85	1.11	15
	Savannah, Ga.	63.6	86	42	44	9.6	42	NW	2.46	1.13	7
	Kansas City, Mo.	53.3	85	31	54	9.1	39	NW	3.77	0.99	13
	Jacksonville, Fla.	66.7	86	42	44	7.6	36	SW	2.45	1.06	7
	Chattanooga, Tenn.	55.4	82	30	52	7.9	36	W	4.83	1.35	12
	New Orleans, La.	65.0	82	43	39	10.0	32	NW	2.80	1.28	6
	Memphis, Tenn.	58.7	84	35	49	10.7	54	NW	2.30	0.66	9
	Palestine, Tex.	64.2	83	39	44	7.9	25	SW	1.43	.88	6
	Average	58.6	84	34	49	9.2	38		2.90	0.97	10
Western Cities.	Helena, Mont.	45.4	80	14	66	8.7	38	SW	0.56	0.28	7
	Port Angeles, Wash.	45.2	67	30	37	6.4	24	W	0.80	0.21	10
	San Francisco, Cal.	54.4	87	44	43	12.3	42	W	0.19	0.19	1
	Salt Lake City, Utah.	54.0	83	27	56	7.0	38	W	1.30	0.71	5
	Santa Fe, N. Mex.	—	—	—	—	—	—	—	—	—	—
	Denver, Colo.	49.4	83	20	63	8.5	58	SW	1.20	0.60	10
	Yuma, Ariz.	73.5	107	44	63	—	44	W	0.01	0.01	1
	Average	53.6	84	30	55	8.6	41		0.68	0.34	6

THE FORMAL INAUGURATION OF THE BALTIMORE & Ohio R. R. occurred on July 4, 1828, and the official beginning was made by the laying of a corner stone in Baltimore by Charles Carroll, of Carrollton, the last surviving signer of the Declaration of Independence. This event of 70 years ago is brought to mind by the recent removal of the masons' tools and emblems used by Mr. Carroll from the vaults of the B. & O. Treasurer to the Masonic Temple in Baltimore. These relics include badges, a trowel, spade and stonecutter's hammer, and also the apron worn by Thomas Young Nichol, a working stonemason, who performed the actual labor of laying the stone.

THE ANNUAL REPORT OF THE GENERAL ELECTRIC Co. gives the gross earnings of the company for the year 1897 as $12,524,938, and the expenses as $10,727,692. While the gross earnings were $295,457 less than last year the expenses were $479,696 less. The assets include the items of patents, franchises, good will, etc., valued at $8,000,000; factories, including 1,600,000 sq. ft. of floor space, on land amounting to about 160 acres, all free from mortgages and valued at $3,400,002. Other real estate is listed at $586,528. Stocks and bonds owned by the company are placed at $7,455,872; cash on hand on Jan. 31, 1898, $1,425,874. Other items, such as notes and accounts, work in progress, inventories, etc., $8,681,686; charged to profit and loss, $11,725,561, or a total of $41,275,525. President Coffin thinks that at the final hearing the Van Depoele trolley patents will be upheld, but states that the rapid growth of underground conduit systems and the fact that nearly all roads in the country likely to use the overhead system are equipped, would prevent any but a slight effect upon the business of the company should an adverse decision be made. The revival of business throughout the country has been felt by the company, and at present there are a larger number of unfilled orders on hand than ever before. In the lighting department orders for 60,826 K-W. of arc and incandescent machines were received, this being an increase of 5.8% over the previous year. In the railway department orders for generators aggregating over 60,000 K-W. were received, and an increase of 33⅓% for all classes of railway apparatus is shown. In this connection it is interesting to note that the average size of railway motors has increased to 34.7 HP., while railway generators averaged 484.3 HP., against 356.3 HP. in 1896. Orders for direct current and induction motors increased from 15,171 HP. in 1896 to 19,531 during the past year. Orders for multiphase generators nearly doubled, increasing from 25,007 HP. in 1896 to 49,902 HP. during 1897. The supply department handled 114,229 separate orders, or 43 for each working hour during the year. The principal articles handled were 36,874 Watt meters, 3,369 measuring instruments, 11,499 transformers, 24,158 arc lamps and 2,357,629 lamp sockets and receptacles. There were also ordered 6,857,239 incandescent lamps. During the year 87 acres were added to the Schenectady plant, and buildings aggregating 130,000 sq. ft. of floor space were constructed or started. Under the head of patents or franchises $333,334 was expended in acquiring new patents and in patent litigation, $250,000 was set aside from the profits of last year for extensions of factory plant, meaning the new iron foundry and machine shop at Schenectady.

ARTIFICIAL BLACK MARBLE, says U. S. Consul L. H. Bruhl, of Catania, is made as follows in Sicily: The details are not made known, but soft white sandstone is cut into the desired form, smoothed and then boiled in coal-tar, which is gradually heated up to 700° C., controlled by a pyrometer. The oil penetrates nearly 8 ins., and large objects are made hollow. When these boiled blocks are broken they are as hard as granite and the broken surfaces glisten like coal. It is much cheaper than real marble, and the makers claim that it will resist heat, cold and rain and the action of the elements as well as actual marble. It is polished after treatment and is used for cemetery work, pedestals, columns, garden tables, mantels, flooring, etc. The prices depend on style of work, dimensions, etc., and the Sicilian prices would be no guide to its cost in America, owing to the low wages paid.

A METHOD OF OBTAINING CHLORINE BY ELECTROLYSIS is mentioned in a recent issue of "Paper Trade," of New York city. This is an English patent by E. J. Hunt and E. F. Watson, and is as follows: In a tank, either metallic or otherwise, a porous vessel is placed, or a tank may be used which is divided into two portions by a porous diaphragm. In the porous vessel is placed a carbon rod or plate and a strong solution of common salt. The tank is then filled with a solution of protochloride of iron. A direct electric current capable of being varied in intensity is then allowed to pass through the cell thus formed, entering at the carbon plate or anode, passing through the salt solution, through the porous partition, the iron solution and out at the other terminal, which may be either the vessel or an iron plate suspended in the solution. Chlorine is given off from the carbon, which may be collected and used for the manufacture of quick-lime or for any other purpose, and pure iron is deposited on the cathode. This also may be removed and used for chemical or other purposes where pure iron is desired. The process may be intermittent—that is, using a given quantity of solution until it is exhausted, or continuous by having the solutions flow slowly in and out.

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