ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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TABLE OF CONTENTS.

THE PROPOSED RAMAPO WATER SUPPLY is being investigated by the Merchants' Association of New York, under an agreement with the Board of Public Improvement to defer all action upon the Ramapo contract until Feb. 22, awaiting a report from the investigating committee appointed by the Association. This committee was organized on Dec. 4 and the work was subdivided as follows: Engineering Committee, to report on the past history and present condition of the water supply; the probable need of an increased supply and the available sources. The members of this committee are: Rudolph Hering, Chairman; E. P. North, T. C. Clarke. D. McN. Stauffer, H. G. Prout, Col. H. S. Haines, E. E. Olcott, D. Le Roy Dresser and F. W. Hinrichs. The Committee on Municipal Finance and Public Policy will examine into the financial ability of the city in this connection, and the general advisability of the city relying upon private companies supplying water to the city under any form of contract. The members are: Horace Deming, Chairman; Prof. F. J. Goodnow and R. R. Bowker. The Committee on Legislation will consider the effect of existing statutes governing the water supply, and prepare suitable amendments. The members of this committee are: Arthur J Baldwin, Henry W. Goodrich, Charles L. Guy, John M. Perry and Joseph G. Deane. The Committee on Fire Protection and insurance will report on the existing water supply with special reference to fire protection and the effect upon insurance rates. The members are: John R. Van Wormer, Chairman; W. A. Marble, R. W. G. Welling and W. C. Le Gendre. The Permanent Chairman of the General Committee is M. E. Baunin; Vice-Chairman, D. Le Roy Dresser; Secretary, S. C. Mead. The Merchants' Association authorizes these committees to secure the services of expert engineers, legal and professional assistance on the subjects to be investigated and all the clerical force required.

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WATER PURIFICATION EXPERIMENTS at Pittsburg, Pa., are being continued by the Department of Public Works since the Filtration Commission completed its studies. The aim is to secure more information regarding the character of the water, the effect of sedimentation and other factors entering into the design and operation of the works. Mr. E. M. Bigelow is Director of Public Works; Mr. A. B. Shepherd is Superintendent of Water-Works; and Mr. Wm. R. Copeland is Bacteriologist in charge of the experiments. A loan for improving the water supply was authorized by popular vote several months ago, but the bonds cannot be issued until the city council provides for the payment of the interest charges, and such action can be taken only at the February meeting of the council, when the yearly appropriations are made.

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A BITUMEN-LINED COVERED RESERVOIR is to be built at Warrington, England. It will be about 200 ft. sq., and contain about 20 ft. of water. It will be built of Portland cement concrete, with outside walls from 4 to 7 ft. thick, floor 20 ins. thick, and a roof of twelve arches, supported on 2-ft. walls, lightened by arched openings. There will be 2 ft. of soil over the tops of the arches. The lining will consist of "bitumen" ⅛-in. thick, with canvas embedded, laid on in sheets, jointed with hot irons, the bitumen being protected with a layer of blue vitrified bricks. We are indebted to Mr. Jas. Deas, Water and Sanitary Engineer of Warrington, for the information given.

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A WATERPROOF CEMENT COATING for brick and other masonry in architectural and engineering structures was described at the latest meeting of the Western Society of Engineers. The coating was invented by a Mr. Johnson, of Richmond, Va., and is composed of a fluid in which cement is mixed to any desired proportion, according to the purpose for which the coating is to be used and the conditions under which it is to be used. The composition of the fluid is kept secret for commercial reasons. It is thick, like soft soap, but is diluted with five parts of water for use as a paint or wash, or 16 parts for use as a mortar, the cement being added to give it the desired consistency. The waterproof coating has been used for the walls of a number of large office buildings in New York, including the Park Row Building, and has also been used in Boston, where it has been found to prevent the smell of ammonia in a stable from passing through the walls. The material has been used by the inventor for several years, and is now being introduced by companies organized for the purpose: the Johnson Cement Coating Co., of New York, Mr. George French, Vice-President; and the Chicago Cement Coating Co., 737 Monadnock Block, Chicago, of which Mr. C. E. Schauffler is General Manager.

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THE 3,000-FT. DEEP COMSTOCK SHAFT, filled with water to the 1,640-ft. level for 13 years past, is to be pumped out by the aid of electricity—if present plans succeed. The miners were originally driven out by the great heat and by the cost of lifting the water by old methods. Water power would be used for generating the electrical power, and the scheme has already been tried in emptying 500 ft. of the shaft, in the Consolidated California & Virginia Mine into the Sutro tunnel. For this purpose a 28-mile ditch was dug and a 12-in. steel pipe led the water 1,740 ft. below the surface. In the Comstock lode there are twenty rich mines now abandoned; and it is thought that by the use of electrical power for pumping and ventilating these can be again worked.

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A GRADED FARE SYSTEM on the street car lines of the Chicago General Railway Co. went into effect on Sept. 1, 1899. To secure its advantages tickets must be bought, all single fares being 5 cts. each, but with transfer privileges to any other line of the company. Six tickets are sold for 25 cts., good on all lines, with transfer to any other line. The most notable feature of the graded fare system is the selling of 12 tickets for 25 cts., good on three branch lines only, and carrying no transfer privileges. Of these three lines, the Stock Yards and Drainage Canal branches are a little less than three miles each, in length, and the Kedzie Ave. line is one mile long. The records for September and October of this year show a gain of 16% in gross receipts over the same months of last year and an increase of 23.4% of passengers carried. During October, 17% more passengers were carried than during the previous month, which is considered remarkable in view of the fact that surface travel normally falls off in October. On the 2-ct. lines a larger number of 5-ct. fares are collected now than before the reduction went into effect. For the information given above we are indebted to Mr. Chas. L. Bonney, Vice-President and General Counsel of the Chicago General Railway Co., 80 East 22d St., Chicago.

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THE TUNNEL AND VIADUCT PROJECTS for crossing the Chicago River to connect the boulevards of the North Side and the South Side have been reported upon by Mr. Ericson, City Engineer of Chicago. A single tunnel of the dimensions suggested by the promoters is considered impracticable, and plans have been submitted for single and double tunnels 31 ft. diameter, with roadway, sidewalks and bicycle paths. They would have cast-iron shells, lined with brick or concrete, the sides and crown being faced with enameled brick. Ventilation and electric lighting are provided for. The tunnel would extend from the Lake Front Park north to Ohio Boulevard, with branches east and west to the North Shore Drive and to St. Clair St. The total length would be 4,050 ft., of which 880 ft. at the south and 1,320 ft. at the north would be open cut approaches. The viaduct would have plate-girder approaches, and a truss drawspan of 185 ft. across the river. The estimates are as follows:

	Single.	Double.
Tunnel proper	$2,304,820	$4,365,009
Open cuts	300,934	324,689
Portals, dock walls, ventilation, drainage, etc.	159,225	214,907
Real estate	564,308	564,308
Total for tunnel	$3,329,287	$5,468,913
	With St. Ry.	Without St. Ry.
Viaduct and approaches	$801,120	$660,462
Street depressions	15,891	14,875
River bridge	371,100	325,000
Real estate	833,228	696,452
Total for viaduct	$2,041,339	$1,696,789

AN ELEVATED FOOTWAY in the center of the street is proposed by Mr. Banks Cregier, of Chicago, to relieve congestion on present sidewalks and to answer other purposes in that city. It would be an overhead, covered, heated and lighted structure, held up by single posts located between street car tracks. It would carry in the roof the smaller cables and conduits, and high-pressure water mains under the floor. The water in these pipes would be kept constantly moving, to prevent freezing, with steam pipes laid in the same conduit, as an additional precaution; and the posts would be provided with nozzles for fire purposes. As proposed the structure would be 16 ft. wide, and the posts 14 ft. high, so that the structure might pass below the existing elevated railways. Alongside the structure would be copper rails for the trolley surface system.

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THE POINT RICHMOND TUNNEL on the San Francisco extension of the San Francisco & San Joaquin Valley Ry. (now owned by the A., T. & S. F. Ry. as a part of its transcontinental line) will be, it is said, the largest tunnel on the Pacific slope. It is 830 ft. long, 30 × 26 ft. in section, being intended for double track. It has a timber lining, the posts and roof beams of which are 12 × 12 ins. and 10 × 16 ins., placed about 12 ins. apart. Mr. Wm. B. Storey is Chief Engineer, and the contractor is Mr. Egbert B. Stone, of Oakland, Cal.

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THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Paterson, N. J., on the line of the Delaware, Lackawanna & Western R. R., on Nov. 28. The eastbound Buffalo express, while standing at a crossing, was run into by a swiftly moving accommodation train. Seven persons were killed and about 20 injured.

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A FAST RUN on the Lake Shore & Michigan Southern Ry. was made Nov. 22 with the "Fast Mail" train hauled by one of the new ten-wheel engines described in our issue of Nov. 9. The run was from Buffalo to Cleveland, 183 miles, with stops at Dunkirk, Erie and Ashtabula. The train left Buffalo at 7.24 p. m., 59 minutes late, and reached Cleveland at 10.50 p. m., schedule time. The three stops aggregated 16 minutes, giving an average running speed of 57.8 miles per hour. The official record shows that the average speeds on the four divisions of the run were as follows: Buffalo to Dunkirk, 40 miles at 52 miles per hour; Dunkirk to Erie, 48 miles at 58¾ miles per hour; Erio to Ashtabula, 41 miles at 65 miles per hour; Ashtabula to Cleveland, 54 miles at 57 miles per hour. The record also shows that between Painesville and Mentor, 7 miles, the speed averaged 83.7 miles per hour. The train consisted of five mail cars, two sleeping cars, a combination car and one day car. The gross load, including engine and tender (142 tons) is estimated at 675 tons.

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THE BUREAU OF YARDS AND DOCKS through its chief, Rear Admiral M. T. Endicott, submits to Congress estimates for improvements in the various navy yards aggregating $14,756,439. Among the larger items are the following: For a new stone and concrete dock at the New York yard, $1,000,000; a similar dock at Norfolk, Va., $1,200,000; he also recommends that the large timber docks at League Island and Mare Island be changed to stone and concrete at an increased cost of $1,100,000 each; new barracks at Brooklyn, Boston, League Island, Norfolk and Mare Island, are recommended at a cost of $300,000 each. The estimates for the New York yard, for the next fiscal year, amount to $2,157,000, including a beginning on the new stone and concrete dock, repairs on dry-dock No. 2, new buildings, storehouses, barracks, etc.

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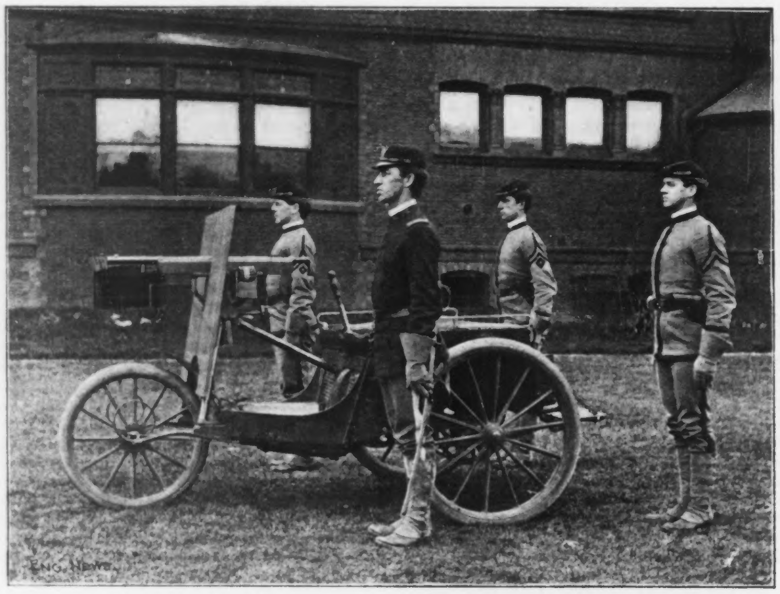
THE ARMOR CONTRACTS FOR WARSHIPS, says Secretary of the Navy Long, in his report to Congress, is the most important question pertaining to naval construction at the present time. The act of March 3, 1899, prohibits the Department from contracting for armor for the vessels authorized except at a price under $300 per ton. For this price even inferior armor can not be obtained. The situation is as follows: All the armor for the battleships "Kearsarge" and "Kentucky" has been delivered; and all the armor for the battleships "Alabama," "Illinois" and "Wisconsin" has been contracted for and deliveries will probably be completed by May, 1900. All this armor cost $400 per ton, plus a royalty for face-hardening of $11.20 per ton, payable under certain conditions. In August and September, 1899, contracts were made at $400 per ton for armor for the four monitors authorized on May 4, 1898, and for 116.6 tons of armor for the battleships "Maine," "Ohio" and "Missouri," this small amount being necessary in the early stages of construction. There still remains to be contracted for, for the last-named battleships, 7,358 tons of armor. These vessels are now building, and it is imperatively necessary that this armor be supplied early in 1900; and while under existing law $400 per ton may be paid for these ships, $400 will not buy the best armor—which is the only "suitable" armor for warships of this class. Secretary Long asks that Congress remove the restriction as to price for these ships.

A MILITARY MOTOR CARRIAGE.

The accompanying view shows a three-wheeled motor carriage for military use designed by Major R. P. Davidson, of the Northwestern Military Academy, Highland Park, Ill., and built for him (under the Duryea patents) by the Peoria Rubber & Motor Vehicle Mfg. Co., of Peoria, Ill. The use of a single wheel in front gives the operator more control over the machine and simplifies the construction.

The weight of the carriage without gun and with tank empty is about 900 lbs. In full working order, with gun, gasoline, and full equipment, the weight is about 1,100 lbs. The wheels are 36 ins. diameter, with wooden spokes, metal rims and pneumatic tires. The distance between the axles is 5 ft., and the width between rear wheels 4 ft. 6 ins. On the front of the frame is mounted a Colt automatic rapid-fire gun of 7 mm. caliber, firing 480 shots per minute as long as the trigger is held back and cartridge belts are attached. It has a range of 180° right and left, and an effective firing range of over 2,000 yds. The cartridges have smokeless powder and nickel-jacketed bullets, with a muzzle velocity of 2,200 ft. per second. A detachable bullet-proof shield protects the operator, and the tank and machinery are also made bullet-proof. The carriage seats four persons, with tents, blankets, and equipment, extra supplies, rations for 10 days, and from 3,000 to 5,000 rounds of ammunition. The tank holds enough gasoline for a run of 200 miles.



MILITARY MOTOR CARRIAGE.
Major R. P. Davidson, Designer.

The carriage is driven by a 6-HP. Duryea three-cylinder horizontal gasoline engine, with cylinders 4½ × 4½ ins., and a flywheel 16 ins. diameter. There is a single feed-pipe and exhaust pipe, and a single set of cam shaft gears operates all the valves and igniters. The engine has a windlass attachment, and by attaching a rope, having one end anchored ahead, the carriage can pull itself out of holes or up steep grades.

This carriage is now used at the Academy, being accompanied by the bicycle corps as a support. Major Davidson informs us that it is his intention to ascertain not only what the carriage can do on good roads, but just what it will stand in rough work, for which purpose experiments will be made over ploughed fields and in heavy country. It has already been used on heavy and muddy country roads. The designer is confident that it is perfectly practicable for street riot duty, but to what extent it will be practicable for military use in the field remains to be ascertained, by the several trials already planned. Next spring it will be taken to Washington, and exhibited to the Ordnance Bureau of the War Department. The machine is the outcome of five years' experience with military bicycling. In the photograph which we reproduce, the designer is standing at the left of the machine.

AN ALLEGED ELECTRICAL GAS PROCESS.

About ten years ago there was exploited in some of the Western cities a new gas process, patented by Thurston G. Hall, the peculiar feature of which was the passage of the gas through one or more chambers which were said to contain electric generators of the "thermopile" class. These were alleged to convert a weak water gas, made in a continuously operating producer, into a gas of high heating and illuminating power. Several stock companies, with large nominal capital and expectations, were organized during the next few years, and plants were built in several cities. All of these plants failed in a short time after they were erected. In 1898 the same process was revived in San Francisco, by a Dr. J. W. Chisholm, who organized there the Equitable Gas Lighting Co. This company built a plant in that city which has now been in operation for several months. The Equitable Co. has also erected a building in Oakland, Cal., and claims to be erecting a gas works there, but this claim is disputed. During the past month Dr. Chisholm has come East and has recently been trying to obtain a franchise to lay gas mains in the streets of Passaic, N. J., and also, we are informed, in Plainfield, N. J. He has met with considerable success in Passaic, having induced Mr. Andrew McLean, an ex-mayor of that city, to organize a company with $100,000 capital, and he has urged his claims before two public meetings of citizens, the first at a hearing given by a committee of the council, and the second at a public meeting of the Board of Trade. At both meetings his proposal to furnish gas at 50 cts. per thousand cubic feet, and his request for a franchise, met with almost unanimous approval from the citizens present. The committee of council postponed its decision, waiting for further information upon the subject, but the Board of Trade passed a resolution recommending to the council the granting of the franchise. At both of these meetings a member of the staff of Engineering News was present. From a stenographic report of the first meeting, and from several other sources, which will be mentioned later, we have been enabled to obtain considerable information concerning Dr. Chisholm and his process, which we have presented in condensed form below.

It will first be of interest to give the promoter's own description of his gas process, and we quote the following verbatim from Dr. Chisholm's address at the first public meeting in Passaic:

> Eight years ago the gas question was presented to me. For six months I took no heed of it, but I found that it had in it such a reality, if it could be brought out, that I took it up and have spent eight years, and hundreds of thousands of dollars of my own to bring it to its present state of perfection.
>
> Gas makers generally have experimented all these years in their attempts to break up the elements forming the gas and unite them together chemically if they could, but they never could do it. On this point we go a step further, and make use, in the field of electricity, which has been very little explored, of a thermo-pile, because our generator is really a thermo-pile, consisting of four, six, eight or ten chambers, according to the size of the plant that is built. These chambers are filled with material of opposite electric polarity, and separated from each other. These are acted upon by heat for a certain time, and as the thermo-pile produces an electric current the gases pass down and up through these chambers in a way, we believe (for we do not see it), that it reaches a great heat—and we believe these gases are broken up and united together into a burning gas.
>
> All our materials, coal, oil and steam, go into the blast furnace. There is a blast so as to put pressure behind all these, and they are forced into the chambers. When we take gas out of the first chamber, before it has been acted upon by what we call the electrical apparatus, the gas would not burn. It is simply furnace gas. When we take it out of the first chamber, before it is acted upon by the electric current, the gas will not burn. When we take it from the second chamber it will burn badly. When taken from the third chamber a trifle better, and when taken from the fourth it is still better, and so on for the fifth, sixth, seventh and eighth. When at the eighth it is in a fit state to use, to go through the cleaning and purifying process, and from the purifying process into the holders, and from the holders through the pipes and mains to the consumers.
>
> The new company supplies the best and cheapest fuel gas in the world. Through the Equitable Gas Light Co. it has been tested by some of the best gas experts in America, and compared with the gases made by all of the largest companies in Chicago, New York, Philadelphia, Washington and Baltimore; it has been proved over and over again to be incomparably the cheapest and best gas known. Citizens of San Francisco have many times been promised good and cheaper gas, and have been disappointed. They know the influences which have kept them back and denied them this great boon.

We regret that it is impossible to reproduce here the eloquence with which the "Doctor" delivered his address, over an hour long, from which the above is an extract. However absurd the above description of his process may sound to an engineer it fully satisfied his audience, and the popular sentiment in favor of granting a franchise to the "50-ct. gas company" was overwhelming.

Some engineers present, however, thought it worth while to extract some more information concerning this remarkable gas process, from its promoter, and the following shows the result of their cross-questioning:

Q. This is not your invention?

A. No, sir.

Q. How long have you had charge of it?

A. Eight years.

Q. How many cities and villages have you operated in?

A. I have operated in no cities or villages until I operated to serve the public in San Francisco.

Q. This is the first?

A. This was the first, and this will be the first plant in the East. We went on with the work of building the plant and the people who were in the business spread every kind of evil report about it, and the papers that they controlled, such as the "American Gas Light Journal" and the "Progressive Age," in order to save their patents; they spread abroad every kind of falsehood, every exaggeration, every untruth about it, although none of them knew anything about it.

Q. Is this the Hall process?

A. The foundation is the Hall process.

Q. In what does the difference consist?

A. In the apparatus which is used to bring out the merits of the Hall process. The Hall discovery is really the use of electricity in the way I have spoken of.

Q. The Hall process is the use of electricity to get gas out of coal?

A. Yes, his theory was that electricity being the power that built up and broke down everything in nature was the only power that could break up these elements into their nascent condition, and that that condition would be reproduced in the presence of the power that broke them up.

Q. The Hall patents are owned by your company?

A. So far as New Jersey is concerned, they are owned by me personally.

Q. What are the patents that are now being applied for to which you have referred?

A. You should not ask that question. You know that a man does not spread his inventions abroad.

Q. Then I cannot ask you what is the specific difference between the Chisholm process and the Hall process?

A. It is not yet divulged. I have gone so far as this, that I have had a gas plant with a flame 20 ft. high going out of the chimney, just like a natural gas plant, and they have said when they take up the analysis of the gas that it would not burn.

Q. You do not believe in chemists or engineers?

A. No, sir; I did not say that. They are men who have gotten into a rut, and if there is anything new invented they are the last to take it up.

Q. Have you any gas chemist who can instruct us in regard to the chemistry of this process?

A. I don't think I would allow them to do it.

Q. Have you any engineer?

A. No.

Q. Have you any report from any chemist in regard to the calometric power—the heating value of this gas?

A. I have just shown you a record from Kalamazoo, 336 heat units.

Q. Do you acknowledge that this analysis gotten by Mr. Goodwin from Kalamazoo is an analysis of the gas that you are now making?

A. No, sir.

Q. Is there any way known to man by which the quality of a gas can be determined other than by analysis, by burning in a calorimeter, or by a photometer?

A. The best test is to burn it.

Q. You have no other way to suggest, have you?

A. I have the way stated, the same as a man will test a pair of boots or a coat, put them on and use them. I stated at the beginning that this was not a process to be judged by the analysis of the old processes, which are [illegible] different. We treat the elements forming this gas in a different way, and with a different agent. We come to this city not to sell the people an analysis, but to sell them gas to work their factories, to cook their food, and to give them light, and the question of analysis that this gentleman asks us are altogether beyond the question I came here to answer you about to-night.

Q. What way would you suggest to a man by which he would find out the quality of that gas?

A. If he was an old gas man and tried in old gas ways, I would say that it is very hard to teach an old dog young tricks. You cannot analyze that gas by the laws and in the ways that you analyze the gas made by an entirely different process and broken up by an entirely different method. Therefore, I would say to you, if you are going to San Francisco to find out what the gas is in the interests of the people of Passaic, go to the same kind of people that are in Passaic, to store keepers, to hotel keepers, in large houses and dwellings and find what the gas does for them, and how much they pay for it, and you won't care a button, if you are not prejudiced, how the analysis comes out.

Q. Will you give us an explanation of the electrical part of your process?

A. It consists of about 6,000 Hessian crucibles. The outside one is for strength, being the heaviest to bear the superincumbent weight; after this, and above it, is a second one holding iron in small particles, and the third is imbedded in the iron and contains copper in small particles. There are two materials of different electric polarity. Now to excite them, we believe, we cannot see it—

Q. The copper and the iron are affected, and not the Hessian crucible?

A. Neither one.

Q. And there is electrical action going on?

A. First, there is heat. In order to heat them up at first and get them to a proper heat we take about three weeks heating, then when it is in condition we can begin to make gas, and we can go on making gas from the beginning of the year, until the end of the year, keeping a continuous heat. We do not let down our heats from one year to the next. We not only have the heat electrically, which you know by the disturbance of the molecules or atoms these things will give, but we have frictional electricity, made by the pressure pulling on say a small machine of a hundred thousand feet in all.

Q. How is the fact that there is an electrical current shown?

A. The only way is by a galvanometer.

Q. Is it like an electric light current?

A. Oh, no. It is of a very low intensity. There is a very slight current there.

One of the most "interesting, if true," statements made by Dr. Chisholm was that the nitrogen, which his gas contains, to the extent of 50% or more, is not the ordinary atmospheric nitrogen, but a compound consisting of several gases, and that it is combustible and has a heating value!

So much for the claims of Dr. Chisholm for his gas process. We need hardly say to our readers that these claims themselves are sufficient to condemn it. Any man who sets up claims that are contrary to established and universally accepted scientific facts, and who refuses to submit these claims to the tests and measurements in common use by scientific men, brands himself at once as a fraud. The maker of cloth, who should object to have his product measured by a yardstick, or the dealer in liquids who should protest that the quart and gallon measure could not determine the volume of his products would be no more absurd than this gas promoter, who claims that neither chemical analysis, calorimetric measurement or photo metric test of the light producing power, can determine the value of his products.

It may be of interest, however, to review briefly some of the past history of the Hall or Chisholm process, and especially its record in San Francisco. Space forbids us to give this in extenso. We can do little more than catalogue it.

We have, in the first place, a recent report made by Dr. Henry Morton, President of the Stevens Institute of Technology, upon the Hall patents, Nos. 494,198, 494,199 and 494,200. We quote from it as follows:

> The descriptions in these patents display an entire ignorance as to some of the simplest and most universally recognized facts in the sciences of electricity and chemistry. * * * * As to the statements of these patents, I would say briefly but emphatically, that what is true is not new, and what is new is not true.

"The American Gas Light Journal," of Sept. 21, 1891 (p. 398), contains a letter from a correspondent describing the operation of the Chicago Smokeless Fuel Gas Company, F. G. Hall, manager, in selling stock to the dear public. "The Hall process is the progeny of the well-known (and well-scored) 'Proctor Process' of a couple of years ago." The gas-making process is described. 'Electrodes' generate electrical energy by the passage of the gas over them." "A fit kinsman of electric sugar."

An account of the operations of this company or a near relative at Grand Rapids, Mich., in 1891, was given in a paper by Mr. F. H. Shelton, entitled "The Failure of the Commercial Attempts to Supply Fuel Gas in the United States," read at the annual meeting of the Western Gas Association in May, 1897, and reprinted in "Engineering News," of Aug. 12, 1897, p. 110.

We quote as follows:

> The process was the notorious "Hall," an outgrowth of the "Proctor." The machine consists of a generator with adjacent chambers through which air is blown. Oil is added and a little heat is used for propriety's sake and the amount of gas made is in direct proportion to the speed and efficiency of the blower! Some steam is introduced which is decomposed at a temperature of 800° by the action of a "new electric chemical," opportunely invented by Miss Proctor. In Grand Rapids they located alongside the Grand Rapids Electric Light & Power Co., and fed gas to that company's boilers, their one customer and their landlord. They never distributed gas beyond the above. The plant was levied on for rent.

"Progressive Age," Oct. 1, 1897, p. 436. Reprinted from "Progressive Age," of Jan. 15, 1895. Ridicules the claims for the Hall process.

"Progressive Age," Feb. 15, 1898, p. 79. Editorial on "Schemes of the Hall Process Schemers." Quotes from a pamphlet issued by the Cicero Gas Co., Oak Park, Ill., showing the absurdity of the claims made by the Hall people. (These claims are exactly the same, and almost in the same words, as those made by Dr. Chisholm.)

Records of failures of the Hall process are given as follows: (1.) Defiance, O., 1889. (2.) Maumee, O., 1889. (3.) Chicago, Ill., 1891, experimental plant. Company capitalized at $10,000,000. (4.) Chicago. Western Wheel Works. Spent $15,000 to $25,000 and failed. (5.) Grand Rapids, 1891. Capital stock $2,000,000. Plant built but failed to operate. (6.) Buffalo, 1895. Experimental plant. Made gas containing 55.6% nitrogen. (7.) Kalamazoo, Mich., 1896. Plant removed from Grand Rapids and put in operation in the spring of 1897. Ceased to furnish gas in January, 1898.

The editor discusses the claims made for the gas, and says: "That any person possessed of ordinary common sense could, after reading these 'claims, give the matter a second serious thought is almost beyond belief."

"Progressive Age," Feb. 1, 1899. Editorial, "The Hall Process in Court at Kalamazoo." Action brought by the city to have the court pass upon the ordinance granting the Hall people the right to use the streets, and to restrain the company from continuing to operate. A witness describes the Hall process at Maumee as a fake, and tells how he found that the company was introducing natural gas into its mains through a secret pipe.

"Progressive Age," April 1, 1899. Editorial on "The Hall Process in San Francisco." Describes a competitive test made on March 7, attended by the mayor, Board of Supervisors, gas experts and other interested parties. Dr. Chisholm was present, said to be the inventor of the new process. He admitted that the gas contained 75% nitrogen, but denied that it was non-combustible.

Same in "American Gas Light Journal," March 22, 1899, copied from the San Francisco report of March 8.

"Journal of Electricity," San Francisco, Feb., 1898, pp.93-101. Editorial commenting on a signed article by Sidney Sprout, entitled "A Fraud upon Electricity." Mr. Sprout describes the so-called electrical action claimed to be used by Dr. Chisholm, and says that it is spurious. He concludes by saying:

> It is in order that fraud may be exposed and in the hope that unsuspecting capital may not be sunk in spurious processes of a so-called electric nature, that I have concluded to contribute this article.

Finally, we have a luminous exposition of the operations of Dr. Chisholm and his associates in San Francisco, which we have received, Mr. E. C. Jones, Engineer of the San Francisco Gas & Electric Co., of San Francisco, and we print it in full as follows:

Sir: During the latter part of 1897 and the beginning of 1898, a company was organized in San Francisco called The Equitable Gas Light Co. This company issued a prospectus entitled "Dollar Gas," dated March 30, 1898. In this they stated that they were building the first section of a gas works having a capacity of 3,000,000 cu. ft., which would be finished within four months from date. Quoting from the prospectus:

> There is a space on the company's property for six sections, and the remaining five sections will each have a similar capacity for manufacturing 3,000,000 cu. ft. of gas daily. The plant will, therefore, be increased from time to time in sections of this capacity as quickly as the demand for cheap and good gas extends.

The company proceeded to construct a small gas works on the Hall system, which consists of a generator of the ordinary cupola type with a take off pipe half way up the height of the generator, while the remaining top section of the generator is of no use whatever. Next to the generator is what is known as the electric chamber, a large coffin shaped super-heater, lined with fire-brick and separated into compartments by partition walls and in these compartments are placed a large number of so-called electric batteries consisting of nests of three clay crucibles, the outer of which is 7 ins. high by 6 ins. in diameter, the other two being smaller and enclosed within the largest one. Between these crucibles are placed fragments of copper and iron which are supposed to form a galvanic pile. These so-called batteries are used to take the place of the ordinary brick in a water gas superheater and are heated by the gases passing over from the generator and burning in the presence of air among the crucibles.

From the "electric" chamber the gas passes into an ordinary seal pot, thence to scrubber, condenser and purifiers similar to those in use in ordinary gas works. The works consisted of a double set of generating apparatus, an air compressor for providing blast to the generator, and electric chamber and wind to pad out the gas, a set of very small scrubbers and condensers and small purifiers, no station meter and two steel tank gas holders of 160,000 cu. ft. capacity each.

During the early part of 1899 the company began laying mains from its works through Hyde St., in San Francisco, starting with a 20-in. main, then reducing to 16 and 8-in. The pipe was laid regardless of the grade of the street and no drip boxes were used, as one of the chief claims for the Hall gas was that it contained no condensible matter.

From April, 1899, to the present time the company extended its mains through some of the downtown streets of San Francisco, and took on a number of consumers from both the San Francisco Gas & Electric Co. and the Pacific Gas Improvement Co. The price of the gas was $1 per thousand. In the beginning no meters were used for measuring it and consumers were charged arbitrarily with no knowledge of the amount of gas consumed. The gas was made from bituminous coal and oil, the bituminous coal being placed in the generator, and blasted up with air from the air compressor for periods ranging from 40 minutes to two hours.

Then air and steam is turned in under the coal, and oil admitted over the coal, together passing down through the superheater. The air in passing through the bituminous coal gave up its oxygen for combustion, leaving the nitrogen of the air mixed with a quantity of water gas from the decomposed steam as the diluent gases.

On Feb. 1, 1899, the first service was laid on Stockton St., and from Feb. 13, to March 24, inclusive, the amount of gas made was 1,716,000 cu. ft. or 42,900 cu. ft. per day. To make this gas there was used 18,337 gallons of oil equal to 10.66 gallons per thousand cu. ft. and 275,520 lbs. of coal equal to 160.5 lbs. per thousand cu. ft. The composition of this first gas made is shown by the following analysis of gas taken at the Equitable gas works Wednesday, Dec. 21, 1898:

Carbonic acid	5.4
Illuminants	7.6
Oxygen	.4
Carbonic oxide	11.4
Hydrogen	11.53
Marsh gas	12.03
Nitrogen	51.64
Total	100.00

This gas contained 2% of hydrocarbon vapor held in suspension.

The gas was delivered to the city under a pressure of about 5.8 ins. and the gas was used exclusively through Welsbach burners. The gas was so poor in combustible material that it would not light in an open flame burner under a pressure exceeding 1 in., and then would give only a bluish colored flame. The gas would not light in any of the ordinary Bunsen burners of gas cooking or heating stoves with the air shutter open at all, and enough air leaked around the air shutters of ordinary Bunsen burners to prevent ignition of the gas, making the gas practically valueless for fuel purposes with ordinary gas appliances.

In order to determine exactly the quality of the gas being made, and the conditions under which it was being distributed, we opened a laboratory on Stockton St., during January, 1899, supplied with Equitable gas. At this laboratory, daily tests of candle power of the gas used through Welsbach burners, as well as analyses of the gas and a determination of the heat units by a Junker's calorimeter, tests of pressure and many other experiments were made. This laboratory was continued in operation until August, 1899. The composition of the gas remained fairly constant; that is, it remained constantly poor from the start, and though it was claimed by the promoters that the electric furnace used in the Hall process acted in a mysterious way on the nitrogen of the air forced through the coal so as to break it up and make it combustible, yet this same old incombustible nitrogen existed in the gas in amounts always above 50% of its volume. It soon became evident to consumers that they were paying two-thirds as much money for a gas of less than half the value. The fact was forcibly brought to the minds of the sensible men connected with the company that the Hall process was a fake of the worst kind; that the electric chamber contained no electricity; that the batteries themselves did not constitute galvanic piles, as the metals were not in contact and the first dash of tar and oil from the generator would completely coat every particle of the metal and the crucibles in which they were contained, and the succeeding blast would bake this tar into a crust of carbon. Thus the most expensive part of the Hall process, and the part for which the most was claimed was inoperative from the first, and its failure to work became evident to the men who were trying to run the works.

Soon after starting an ordinary blower was substituted for the expensive air compressor, and one by one the main features of the works were eliminated, leaving the Hall process nothing but a badly constructed cupola generator with the worst kind of a superheater filled with a lot of flower pots, and all a dismal failure. At this point the men who had brought the process to San Francisco departed for new fields, leaving this dilapidated plant on the hands of the investors in San Francisco.

A small business had grown up and the price of gas was reduced from $1 to 65c., and every effort was made to try and make a Commercial Gas Company at the Equitable gas works. The electric chamber was used as a poor makeshift for a superheater, the methods of blasting and running were changed so as to get less air mixed with the gas and to try to bring up its illuminating power, so that it might be burned through large open flame tips. The Equitable gas at present sold in San Francisco has the following composition:

Carbonic acid	7.6
Illuminants	11.8
Oxygen	.4
Carbonic oxide	7.3
Hydrogen	11.9
Marsh gas	15.8
Nitrogen	45.2
Total	100.0

From the first the gas has been imperfectly purified, and for weeks at a time a test for sulphuretted hydrogen would show a black stain on acetate of lead paper. To make the gas at present, the length of the blast has been cut down and after the blasting process a quantity of Kentucky shale is dumped in on top of the fire in order to try and get some rich coal gas mixed with the other stuff.

From October 18 to 30, 1899, inclusive, the amount of gas made was 2,893,700 cu. ft. and to make this gas 8.38 gallons of oil and 65.8 lbs. of coal was used per 1,000 cu. ft.

This coal consisted of 168,000 lbs. of Comox bituminous coal and 22,400 lbs. of Kentucky shale, and a deduction from these figures shows that the material used in every thousand cubic feet of the gas cost 54.95 cts.

It seems a pity that there cannot be some sort of quarantine in force to protect cities against the inroads of diseases like the Hall process, which leave scars upon the city streets and menace healthy investments in legitimate gas companies.

E. C. Jones.

San Francisco, Nov. 18, 1899.

The only quarantine provision we know of which will prevent people or municipalities from being swindled by smooth-tongued promoters is the equipment of common-sense and intelligence which was bestowed on mankind for practical use. Those who take leave of this safeguard will find gold bricks awaiting them on every street corner. Certainly Dr. Chisholm's claims for his alleged "process," with its past history set forth above, should be sufficient warning to any municipality to have nothing whatever to do with it.

RAIL SAWING AND DRILLING CAR; CHICAGO, ST. PAUL, MINNEAPOLIS & OMAHA RY.

The great cost of steel rails, the necessity of introducing heavier rails, and the comparatively small amount of wear which rails sustain before becoming unfit for main track service (owing largely to the battering and wear at the joints), make it imperatively necessary to utilize the rails taken out of main track for secondary lines, sidings, etc. In many cases the rails are re-laid in their new position without any treatment whatever, beyond a more or less careful sorting, badly-worn rails being rejected and sent to the scrap heap. Re-rolled rails have been tried to a small extent, and three important lines have adopted a method of measuring and matching the rails as to height, cutting off the battered ends, and drilling fresh bolt holes, the rails thus treated making a very good track, hardly inferior to main track.

In order to avoid the trouble and expense of shipping all the rails to a mill, or of installing special equipment at all large divisional shops, the work is usually done by a portable plant which can be sent from one division to another, as required. Fig. 1 shows the most recent of these portable plants, built for the Chicago, St. Paul, Minneapolis & Omaha Ry. (Chicago & Northwestern Ry. system). It consists of a steel-framed flat car, mounted on a pair of heavy steel trucks with diamond frames. On this is mounted a complete power and machinery equipment for sawing, drilling and straightening rails.

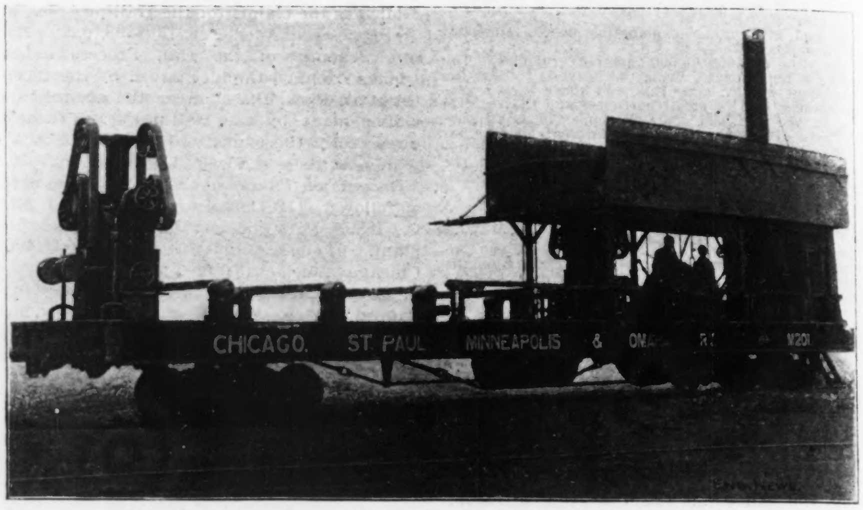


FIG. 1.—RAIL-SAWING CAR FOR THE C., ST. P., M. & O. RY.
Industrial Works, Builders.

The car is 61 ft. long over all and 10 ft. 4 ins. wide, with a framing built up of 20-in. steel I-beams and channels, and stiffened by two truss rods. All the machinery is driven by a double-cylinder horizontal engine, specially designed for high speed, having cylinders 12 × 14 ins., and running at a speed of 300 revolutions per minute. Steam is supplied by a vertical, submerged-flue boiler, 10 ft. high and 5 ft. 3 ins. diameter. The shell is of ½-in. steel, and the tubes are 2 ins. diameter, with copper ferules in the crown sheet end. The circular saw is 42 ins. diameter, and is run at a speed of 1,800 revolutions per minute, requiring about 150 HP. The equipment includes also the saw feed tables, straightener, and two double rail drills, 34 ft. apart, c. to c., with suitable skids, beds and rollers. Fig. 2 is a plan of the car.

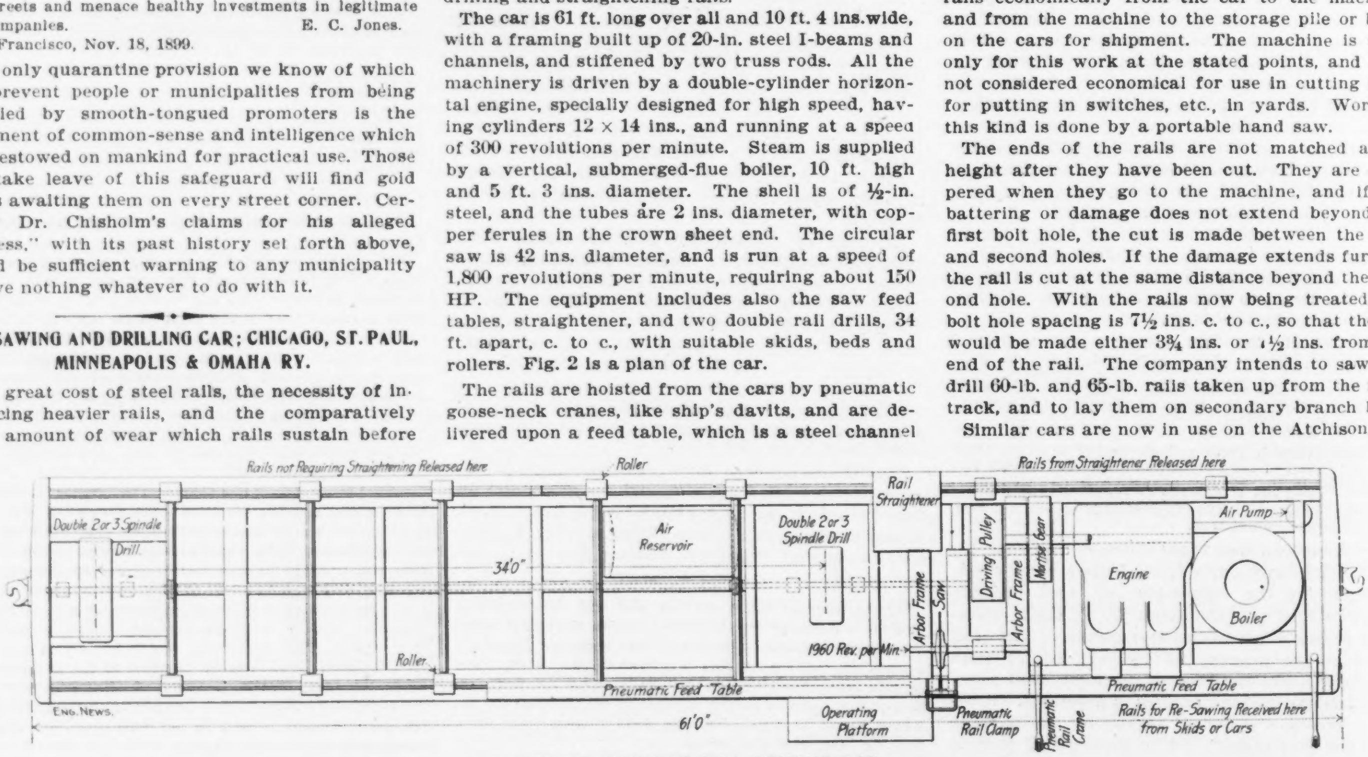


FIG. 2.—PLAN OF RAIL-SAWING CAR.

The rails are hoisted from the cars by pneumatic goose-neck cranes, like ship's davits, and are delivered upon a feed table, which is a steel channel with rollers in the bottom. While being cut, the rail is held by a pneumatic clamp, and it is then run up to the drills. If it is straight, it is then passed across and loaded directly onto the cars on the other side of the machine. Otherwise, it is passed across and then run back to the straightening press, from which it goes direct to the cars.

The drills are independent, and are conn by friction clutches to the main countershaft. ther machines of this class have only one dril s, and can saw about twice as many rails as be drilled in the same time. As the C., St. P., M. O. Ry. desired to fully utilize the saw capacity, ad an extra drill press put on, so that eight es (two rails) can be drilled at one time, thus k-ing the drilling capacity equal to the sawin a-pacity.

With this machine, over 400 rails have en sawed and drilled in ten hours. During one rt, the crew succeeded in sawing the ends off and drilling new holes in 67 rails in 64 minutes. In ordinary service, from 450 to 500 rails can be treated in a working day of ten hours.

All rails to be sawed are collected at one central point on each division. Runways, skids, etc., have been constructed at moderate cost to handle the rails economically from the car to the machine, and from the machine to the storage pile or back on the cars for shipment. The machine is used only for this work at the stated points, and it is not considered economical for use in cutting rails for putting in switches, etc., in yards. Work of this kind is done by a portable hand saw.

The ends of the rails are not matched as to height after they have been cut. They are calipered when they go to the machine, and if the battering or damage does not extend beyond the first bolt hole, the cut is made between the first and second holes. If the damage extends further, the rail is cut at the same distance beyond the second hole. With the rails now being treated, the bolt hole spacing is 7½ ins. c. to c., so that the cut would be made either 3¾ ins. or ı½ ins. from the end of the rail. The company intends to saw and drill 60-lb. and 65-lb. rails taken up from the main track, and to lay them on secondary branch lines.

Similar cars are now in use on the Atchison, Topeka & Santa Fe Ry. and the Michigan Central R. R. The former is 46 × 10 ft., and as there is only one drill press, it has a turntable at the front end to swing the rail round when one end has b n drilled. The total weight is about 57 tons. The cost of labor, repairs, coal, etc., for sawing, drilling and handling 6,500 tons of 61-lb. rails was about 77 cts. per ton, or $5,000, while the 500 tons of crop ends realized about $7.60 per ton, or $3,800. On the Michigan Central R. R., the cost of handling, sawing, drilling and matching the rails is about 75 cts. per gross ton. The system used on this road for matching and calipering the old rails, as devised by Mr. A. Torrey, M. Am. Soc. C. E., Chief Engineer, was described in our issue of Aug. 18, 1898, and Fig. 3 shows the arrangement of the rail-sawing machine, skidways, receiving and loading tracks, etc. In this case an overhead pneumatic trolley is used for handling the rails.

For photographs, blue prints, etc., of these rail-sawing machines we are indebted to Mr. W. L. Clements, President of the Industrial Works, of Bay City, Mich., which firm has built all those described. For particulars of the work of the latest machine we are indebted to Mr. J. C. Stuart, General Superintendent of the Chicago, St. Paul, Minneapolis & Omaha Ry.

THE EDUCATION OF MACHINISTS, FOREMEN AND MECHANICAL ENGINEERS.*

By M. P. Higgins,† M. Am. Soc. M. E.

The central object of this paper is to outline a special school for the training of boys to fill the successive grades of mechanics from machinists to engineers, and which shall be adapted to train each boy for each successive grade until his particular career is determined by natural selection and he goes out fitted for that career.

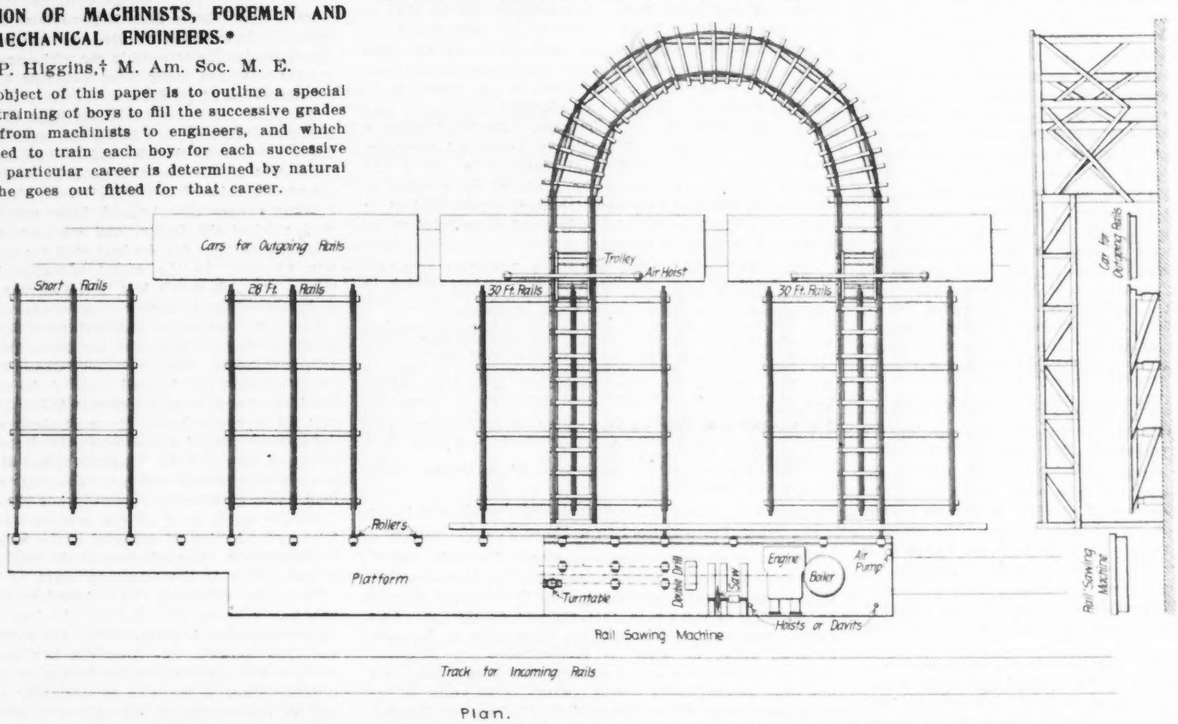


FIG. 3.—PLAN OF RAIL-SAWING PLANT FITTED UP FOR OPERATION; MICHIGAN CENTRAL R. R.

Demand for Trained Mechanics.

While it must be admitted that during the past 25 years most gratifying progress has been made in American mechanical engineering and in the education of mechanical engineers, yet it is evident to the managers of our mechanical establishments that there is a great lack of competent mechanics below the grade of the mechanical engineer to take the increasing demands and responsibility of the work and properly carry it out.

The standard of the work of the machinist has rapidly moved forward in refinements and complications. He is called upon to read and understand intricate drawings, and to make quickly and with certainty very exact measurements and computations in the shop. He must deal with tempered steel for almost numberless uses and for the severest requirements. Hardened steel parts must be fitted to an extent and with a precision never thought of 25 years ago. This practice of machine construction will be introduced to an unlimited extent in the future, necessarily making many changes in methods, as, for example, the substitution of grinding for filing, which will secure so much better results. This introduces the modern machinist to a field of unlimited possibility requiring most exact knowledge of new and constantly changing methods; and the experience of all employers testifies to the difficulty, if not the impossibility, of securing the requisite knowledge and skill in the machinists of to-day.

If the position of machinist is a hard one to fill, what is to be said of that of foremen? At a recent meeting of managers it was stated that 200 young men suitable for foremen for foundries could be placed at once. Nothing is more difficult than to find men capable of filling such positions. Indeed, I have expressed the opinion, and I believe it will be confirmed by others, that the most difficult position to fill when a machine business is to be orgsnized is that of shop foreman. The positions of president, treasurer, mechanical engineer, salesman, etc., need not wait a day for applicants, but the man who is fitted to manage the practical details of a machine shop successfully is a rare man, and there is no scientific or professional man whose services are in surer demand than his.

Is it not wise, economical shop management which is giving us the leading position in the machine markets at home and abroad? This is what we expect the good foreman to exhibit. The ability to produce a very fine and exact piece of work in a machine shop, regardless of time or method, will not insure success, but, on the other hand, will be most apt to induce failure. It is the shop which can build the best machinery at a less cost than others which is sure to be successful; and to secure this the management must depend upon no man more than the shop foreman. He must ascertain all possible legitimate ways and means for reducing shop costs, stopping leaks and losses, without reducing the manliness of the men and the standard of the work. How many men of this kind do we get, and what opportunity is there to-day for training for such positions?

With this great and growing demand of the profession, and with the splendid opportunities open to young men who will fit themselves to be mechanics, and who in turn are demanding of the profession the chance to fit themselves, the question is forced to our attention: How are these needs being met?

Failure of the Technical Schools to Reach this Class.

Never was there a national movement more timely or more successful in its introduction than the movement looking toward the establishment of technical schools 35 years ago in this country, supplemented as it was by the educational land grant act in 1862. We naturally expected at that time that this movement would meet not only the higher education of engineers, but the needs of mechanics, which this paper emphasizes. Perhaps, however, it was too much to expect that these schools, under the management of professional educators, the most able and suitable that could be selected at that time, could have accomplished so much or covered more ground than they have. It is most natural that each technical school management should be greatly influenced by the college education and academic profesionalism of the men who conduct it, to whom were entrusted the relations of academic and practical departments and those of theory and practice. This has resulted in a tendency to produce scientists and not mechanics.

It is not the policy and intention of engineering schools to put sufficient time and stress on shopwork to allow the student to attain thorough practical skill. He very readily receives the impression that an engineer need not work with his own hands, though he admits that he should know how the work should be done by others. To be a thorough mechanic, which he ought to be before he can be a well-trained mechanical engineer, he must be able to do the work, and this the present technical school does not teach thoroughly.

The gulf between the work of the schools and the shops has sometimes been called a difference between theory and practice; but the real variance in educational attempts is between men, between the mechanic and the schoolman, between the machinist and the engineer. Brave attempts have been made to bring the two together, but with partial success only. In one of our most prominent and practical engineering schools a professor has designed a commutator which required sections cut from a metal ring. The professor ordered two rings, so that a piece from the second could be used to make up for the loss in cutting up the first. The machinist said: "Let me make one ring only, somewhat larger than you want, cut it up, and then turn it to the exact size, and thus save the cost of the second ring." "No," answered the professor, "I am doing the engineering, I want you to do the work." I state this actual occurrence, as one of many illustrations which might be given, to show that the two have not yet joined work even in the technical schools. It is not always an easy matter to secure this necessary union, and even where it seems to be attained it is not always complete. It can be secured by having both vital parts in one and the same man. And it is exactly this union that the proposed system for training mechanics is designed to secure.

The very surprising fact that the total number of students in technical colleges in this country is at present on the decrease, may suggest that some changes in the engineering courses would better meet the needs of a larger class.

This unexpected falling off in the number of engineering students is greater than can be readily accounted for in these prosperous times, amounting to 15% from 1894 to 1897. These facts were first shown by Dr. Wadsworth, President of the Michigan College of Mines, and since verified by Mr. William Barclay Parsons, Trustee of Columbia University.

Raising of Standards of Admission.

I would also mention that with the tendency toward the abstract and scientific which has been referred to, has come the raising of standarda for admission from year to year, so that the Technical School has become more nearly on a par with the college than it was when it started, and this puts the school beyond the reach of boys who are to make workmen and also beyond the reach of many who would make engineers.

Prof. R. H. Thurston, in a thorough treatise on this subject, says:

> In the opinion of many of the ablest and most authoritative members of the profession, the process of raising entrance requirements has already gone too far, and the result of carrying the process further, for purely sentimental reasons which do not appeal to the people who desire to send their sons to such schools, will be seriously to cripple institutions of this kind in the work of aiding the industrial classes.

Thus, whatever the advantages of the technical school and college, which I would not for a moment belittle or decry, they do not meet the needs for which they were founded, but leave the uncovered field as large as ever.

Another Unfortunate Result of the Technical School—the Amount of Discarded Material.

As a result of the technical school overlooking the needs of the large body of mechanics and devoting themselves

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*Extract from a paper presented at the New York meeting of the American Society of Mechanical Engineers.

†President Norton Emery Wheel Co., Worcester, Mass.

to the production of scientific professionalists, they produce an enormous amount of discarded material, men who are neither fit for workmen nor engineers, men who are not at the start fit to become successful engineers.

In a class of 100 in an engineering college, if only 5 make engineers such as the course is aimed to produce, the 95 others bave not, in all probability, received a course of training well fitted for their special needs and capacities. Further than this, the large portion of the class who are, to some extent, failures are also frequently disappointed men.

There are many reasons why the young man who enters an engineering school is allowed to get false ideas regarding his future. He understands that there is a lively demand in the active world for technically trained young men. He likes the idea of being an "engineer," and he knows that all the leading technical schools have high-grade engineering courses, the requirements are up to the colleges, and he expects when he graduates he will be able to engage in engineering work. When he finds that he either cannot do engineering work at all, or that there are ten engineer graduates to one position of that particular kind, and that every year the demand for professional engineers grows less and the graduates more numerous, he turns his attention reluctantly to a lower grade of work, and is never quite satisfied or happy in it. He feels that he was born and educated for something better. But was he? No. He only thought he was. His failure would be no fault of the school, however, if he had not been, in a sense, educated away from the work that he is obliged to undertake. These "culls" from an engineering class are not first-class material for workmen in any department below the engineer. Such a man is a disappointment to himself and to his employer. And though we may be able to show that every graduate in a class has been greatly benefited and developed during the course of study, yet that is not a sufficient reason for a course fitted only to the very few and which allows the large majority to come to their disappointment through the general understanding that, if they were graduated, they would be engineers because they were graduates. Consider, also, what a fearfully expensive system this is, with its large percentage of failures or partial failures, to educate the few of which there is already a larger number than can secure positions as professional engineers.

Over-Supply of Polytechnic Engineers.

We must remember that mechanical progress is very dependent upon the capitalist. The proprietor who stands behind the work is more and more inclined to trust his engineering to his own men who have grown up in the works and have, in some way or other, picked up science enough to get on with considerable success. The proprietor is not inclined to put his work into the hands of a professional engineer who works on the same problem for other clients, and he is less and less inclined to employ special engineers. When this is done at all, one engineer is employed by several concerns, and his time divided up among them.

This lessened demand for polytechnic graduates was recognized several years ago in Europe, and some slight attempts were made to remedy the evil. As early as 1885 the British commissioners found in Germany an excess over the demand of 1,000 well-trained polytechnic graduates, and they were informed that the manager of a large engineering works had been so importuned by these young men for employment that he put a notice in his window, "No polytechnic student need apply." The Baron von Eybesfeld, Austrian Minister of Instruction, stated that the most serious problem in education in that country is to reduce the number of theoretical engineers (who, after their long course of study, find themselves not wanted) and to increase the number of men in whose training theory and practice had been so combined that they could meet the great demand for those who can put theory and practice together. This statement, taken from a report of "Technical Instruction in Europe," by the late C. O. Thompson, formerly President of the Rose Polytechnic Institute, and published by the United States Bureau of Education, is followed by another statement which shows that the tendency of the technical schools toward a par with the college, referred to above, was fully recognized and admitted at that time. This statement says:

> There is a constant and apparently irresistible tendency in all the lower schools to pass up into the higher by imperceptible advances. For example, at Chemnitz what used to be the Gewerbeschule has ranked since 1879 as a polytechnic school. But so true is it that a school of higher education never loses or departs from the cast it receives in the first ten years of its existence, that the old polytechnics, modeled largely after the Ecole Polytechnique of Paris, have so steadily held to the theoretical training of engineers that the times have swept past them. The efforts now making in Austria to remedy this evil are more to the point than any others in Europe, but they are directed towards the artisan rather than the engineer.

Tendency of Technical Schools.

As a single instance from many that might be cited illustrating the tendency of technical schools in America as well as in Europe to drift more and more out of the reach of the boy who wishes to educate himself as a mechanic, I refer to the history of the Worcester Polytechnic Institute. In 1884 the full course for a mechanical engineer was 3½ years. In 1896 it was 4 years. In 1884 the shop practice for the 3½ years' course was 2,376 hours. In 1896, even with the 4 years' course, the shop practice was only 1,709 hours, a reduction of over 28%, and an increase of time and consequent expense to the student of 14%. In 1884 a year's school work consisted of 42 weeks. In 1896 there were only 36 weeks, a loss of time of 14%. The productive activity of the school shops has been reduced from $109,027.78 in 1896 to only $20,801.82 in 1898.

Since 1889 the tuition has been raised from $100 to $150, an increase of 50%. In 1873 this institution was able to advertise that the total expenses of a member of the school, including tuition, utensils and board, need not exceed $380 per year. The present advertised estimate is $450 per year, an increase of over 19%.

Proposed Solution of the Problem.

The proposed solution of the problem lies in the answer to the question: "How can we give our boys a chance to learn a trade without being deprived of a good common school education and at the same time secure a foundation upon which to build a higher education if capacity and circumstances permit?"

The half-time school, established upon the plan outlined below, will, it is believed, answer this question and solve the problem.

This school is aimed to fit each boy for the successive grades of mechanics from the machinist up, so that at any time he will be fitted to take up his work outside as a well-trained mechanic in the grade which he has completed, and be prepared to enter the training of the next grade. In other words, the object of the school is to produce many well-trained and educated machinists, and from these machinists some foremen, from the foremen a few superintendents, and finally an occasional engineer. The character of the individual material in ability and natural aptitude determines the grade of the product of the school, whether workman, foreman, superintendent or engineer. The plan will be understood by a brief statement of its prominent features:

1. A school which shall include a first-class commercially successful and productive machine-shop, which is a department co-ordinate in importance, influence and educational value with the academic department.
2. A school in which the pupils are to have instruction and practice in this shop during half the working hours in five days of each week for a period of four years.
3. Instruction in the public schools during a portion of the other half of the time, equivalent to a high school course, restricted, abridged and improved to meet the needs of these pupils.
4. Special care and method of selection of pupils who have finished the grammar school course and who have special aptness for mechanical work.
5. Management under a corporation whose trustees shall be practical business men.

How Much Can Be Accomplished for Students in the Half-Time School in a Four Years' Course.

We can confidently assure a more thorough expert knowledge of the machinist's trade, and a more practical skill in its various departments, than is generally secured by any apprenticeship in this country or Europe. This rather large expectation is based upon quite a thorough personal study of what is accomplished in England, France, Switzerland and Germany, and also upon what has been accomplished during twenty-eight years at the Washburn shops of the Polytechnic Institute of Worcester, Mass.

In this school, where a 3½ years' course included only 2,376 hours of shop practice, or, in other words, less than one-third of a 3 years' apprenticeship, the graduates have always enjoyed a high reputation for practical skill and shop experience. And it has been claimed throughout the history of the school that its graduates are as skilful and effective practical machinists as those who have served a 3 years' apprenticeship to learn the machinist's trade. This is a very bold claim, when it is remembered that together with this attainment of practical skill the graduate has obtained a thorough technical and scientific education. After a very thorough experience and after employing large numbers of these graduates in all capacities in machine shops, I think the claim is well sustained.

In the half-time school actual shop practice in the various departments would cover a much longer time, and under circumstances more favorable, because the attainment of a thorough machinist's trade is confessedly the central point from which the future engineering work is to emanate.

2. These pupils will receive, as a part of their shop practice, a much larger amount of time in lectures and instruction upon the technical part of the machinist's business than is given in the technical school.

3. It is proposed to train every pupil in the general knowledge and practice of drawing and machine design, and any one having particular taste in this direction can have special and advanced instruction, the object being to make draftsmen superior to engineering school graduates in the following particulars:

(a) More expert in execution of drawing and lettering.
(b) Much more thoroughly familiar with all the shop knowledge affecting the efficiency of a draftsman on simple every day work.
(c) A more ready, reliable and precise use of arithmetic.

4. It is proposed to train every pupil in a general knowledge and practice of pattern making and foundry molding, and in special cases give advanced instruction and practice in pattern making. In all cases, however, the machinist's trade will be taught as the basis of any sp line of mechanical work.

5. Pupils who exhibit suitable qualifications as work and as directors of men, will have special opportu to become fitted for responsible positions, as work machine-shop foremen. Such pupils, among other qu fications necessary for foremen, would be required to s general ability in drawing, pattern making, and sp accuracy and reliability in arithmetic.

6. If any one from the above-mentioned classes of exhibits taste and natural abilities for high-grade e neering work, requiring the highest mathematical scientific knowledge, he will be encouraged and aide take a course to meet his special requirements i engineering school.

The Importance of Good Material and the Sel tion of Students.

Do we get the best stock for engineers? We have sons of engineers who stand first in the great indus enterprises. The young men coming to the engineer schools are generally the best in many ways. They usually well born; they do not often come from p homes, where work, stern effort, and self denial keep h out of reach of the thorough systematic mental trai which fits them for entrance examinations. If such a from the poor home finds it possible to enter, the coll life is rather out of his line and out of his reach, a the funds for the term bills are still more impossible. B in this class are many who should be fitted for the different grades of mechanics.

It is well to remember, in the light of all history, that the revolutions of fate bring the submerged to the top, and after a while the child of fortune becomes enervated by advantageous ease and good keeping, and frequently the son, in spite of the father's determination to give him a better chance than he had, lacks something which has distinguished the father, and we may, after all, search this class in vain for the best stuff for engineers. It cannot, however, be the wisest educational scheme which allows the rich man's boy to degenerate, or merit to go undiscovered in the poorer classes, wherever it may exist.

There are marvellous possibilities of skill and invention among a class of boys who are never thought of as possible engineers, boys who sometimes make themselves leaders among the favored ones of the earth. In one of the largest and most prosperous industries nearby I find that the man who knows the most about a very important department carried a hod when the factory was building ten years ago; and the responsible head of another department was snagging castings eight years ago. One of the fond hopes of the half-time school is that it will pan out the pure metal by a sifting process which is true and fair; and selection of material is the first important step in the process. The selection of the pupils is only second in importance to the schooling itself.

The proper education of the American mechanic will not necessarily be sought after by the boy who is best capable to become the mechanic. He must be sought out and then trained. The American boy needs to be awakened to the inducements for becoming an educated mechanic. Many a boy who is splendidly suited by nature and by inheritance to this calling is allowed by outside influences to drift into some other calling to which he is not adapted, all for the lack of a little guidance or some circumstance having no connection with his fitness or aptitude for mechanics, and thus is lost to the profession which needs him.

The hindrance to the best results in engineering schools, which has come from the imperfect and unfair method of selection in making up or enlisting its classes, has already been mentioned. Under the present system it is a boy's business to spend several years of cramming for examinations after he decides upon going to a polytechnic school or college. His whole aim and the aim of his teacher is to prepare for the examinations. The fitting school develops an astonishing ability to pass examinations which are not a true or adequate test of a boy's fitness to make a mechanic or a mechanical engineer. Therefore the entering class of the polytechnic Institute consists of a body of experts at examinations, while the boys all through the country who ought to be trained for manufacturing and mechanical industry are overlooked and passed by.

Vacations.

There is a great opportunity for improvement in the education of the boy offered by a radical change in the matter of vacations. The present method is to crowd the work of the week into five days, and the work of the year into 35 or 37 weeks, making it as intense as possible for awhile and then letting up entirely.

It is certainly not impossible to arrange a course of education and training of a boy with hard work so judiciously distributed and so interspersed with healthful, easy and enjoyable exercises and so intermingled with daily (not quarterly or yearly) recreation, that he will never need or require entire or complete relief from duty. Nothing is so dangerous or so trying to a boy's nervous, mental and physical constitution as the method of suddenly applied load and long intervals of total relief. Six days' work in a week, with sufficient variety, recreation and healthful exercise distributed throughout each day, and with Sunday properly spent, will, I think, assure much better and more enjoyable effort on each following Monday than is possible where all the students' work is dropped for two days every week.

The same gain may be obtained by distributing the work throughout the eleven or twelve months of the year. I must not be understood as recommending harder or more work. I would make an easier course for boys, not a harder one, by having a better arrangement and distribution of an ample amount of daily work, rest and recreation, and then instead of the present vacation, which is frequently harmful instead of helpful, I would grant furloughs to any student who needed or desired it. Such furloughs are not impossible or impracticable, and would be, in my judgment, much better and more effective than the present vacation seasons. Let it be understood that this presupposes a school organized for the good of the pupils and not for the convenience of the teachers.

Is there a Danger of Making the School Course Too Severe?

It seems to me that this danger is very great, a danger that has already been realized, from time to time, in almost every institution of learning. Many methods have been resorted to, to avert the danger, such as shortening terms of study, which necessarily make them more condensed, the introduction of athletics, etc., which is apt to absorb enthusiasm needed for the work; and when I have suggested continuous school work, less vacations and less interruptions, I insist that I do not believe in harder work but easier work for students, and I believe that a four years' course can be so arranged, with such interesting and profitable variety of occupation alternating between the recitation room, the drafting room, the pattern-making room, the machine shop, the shop lecture room, and with the requisite amount of exercise and recreation, not at long intervals, but in every half-day, that a boy's life from 15 to 19 would be a joy and not a burden.

How Shall We Successfully Meet Our Foreign Competitors.

America has made a strong beginning as an export nation of high-grade machinery. There are many evidences of the keen interest, amounting to surprise and alarm, on the part of our European rivals. It is interesting to note their efforts to discover the causes of this sudden uprising of a new and evidently powerful rival in a field heretofore all their own.

The cause of our supremacy has not been altogether the superiority of our engineers, for foreign nations also have highly educated engineers. But it has largely resulted from the superior character and make-up of our mechanics, which has come from the chance which America gives the workman, and in the liberal and wise provisions to train free-born American boys, giving each a fair field and open path to rise from one plane to a higher one, as his abilities and circumstances may warrant.

We must not allow ourselves to rest secure in the belief that our Old World competitors will be slow to discern this cause or slow to profit by the example. Therefore, what more potent steps can we take for our protection than to keep this path open from the bottom and to better our methods all the way up through the successive steps?

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A SPANISH STEEL TRACKWAY FOR COMMON ROADS.

The use of steel rails or trackways on country roads has been tried experimentally in this country on a very limited scale, but we illustrate herewith a form of construction which has been in use for seven years on the road between Valencia and Grao, in Spain, a distance of two miles. The road is 39.36 ft. wide between ditches, and has two steel trackways with a gage of 4.07 ft. c. to c. of rails. The distance between these trackways is 22.69 ft., c. to c. of rails, and this middle space is macadamized.

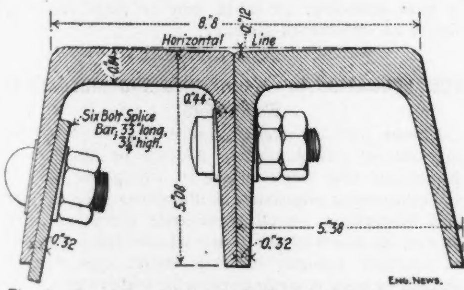

Fig. 1.—Section of Wagon Rails Used in the Valencia and Grao Road in Spain.

Each rail is built up of two inverted channels, with flaring outer flanges, and bolted together through the middle flanges, as shown in Fig. 1. The width on top is 8¾ ins., with a depression of 0.12-in. from the sides to the center, forming a slightly concave surface. The depth is 5 ins., and the width over the base 10⅜ ins. The opposite rails break joint by 13.12 ft., and the two channels of each rail break joint by 6.56 ft. The joints are spliced by single inside flat plates 33 ins. long, with six bolts. The bolts through the middle flanges are spaced 4 ins. apart. At intervals of 6.56 ft. are flat tie bars, 4½ ins. deep, 9-32-in. thick and 5 ft. 5 ins. long, with slots 2 ins. deep to receive the three webs or flanges of the rail. Fig. 2 shows this arrangement, and it will be seen that the outer slots are made wide enough to receive a key or wedge. The thickness of the rail is 0.84-in. on top, and tapers from 0.44-in. to 0.32-in. in the flanges.

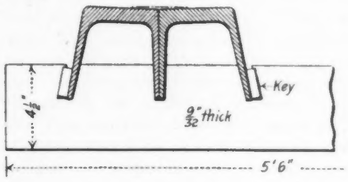

Fig. 2.—Attachment of Rail and Tie-Bar.

The space between the rails is paved with stone blocks about 12½ × 7 ins., 8 ins. deep, which project about ⅝-in. above the rails. Similar blocks are laid outside the rails, but two of these blocks laid as stretchers alternate with two blocks 15 ins. long laid as headers, or parallel with the rails. The blocks are bedded on sand and the joints are filled with the material. Outside of this paving is a sort of rubble paving which is carried down into the trench or ditch, as shown in Fig. 3, which is a partial cross-section of the road.

The cost per mile of double track is given as follows:

Steel construction	$11,113
Transporting and laying steel construction	817
Paving	3,400
Total	$15,330

The steel trackway was designed by Mr. Meseguer, the municipal architect of Valencia, but while the road is interesting as an example, the system of construction is far too complicated for economical considerations. The number of parts is something appalling. With bolts 4 ins. apart through the central web of each rail, we have 31,680 bolts per mile, to which must be added about 3,960 for the joints in the outer webs, or say 35,640 bolts per mile of single track, with nuts, washers and other accessories in addition. A triple-web trough section of this kind can be rolled in one piece, and has been employed for longitudinal bearings for rails in Germany and Austria. The general design is an example of Spanish engineering, and a total disregard of economical considerations. The steel-work was made in Belgium.

The traffic on this road is said to be about 3,200 vehicles per day, and the cost of maintenance until 1892 was about $,470 per year. Since the opening of the steel trackway, the cost of maintenance of the central portion of macadamized road is but $380 per year. The wear of the rails is said to be very slight, and no renewals have yet been required.

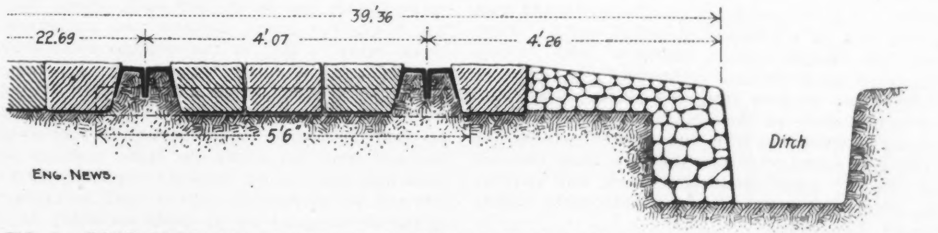

FIG. 3.—PART CROSS-SECTION OF ROAD WITH STEEL RAIL WAGON-WAY; VALENCIA AND GRAO ROAD, SPAIN.

The road was described in a recent report from Mr. Horace L. Washington, United States Consul at Valencia, who sent blue prints with his report. For the loan of these we are indebted to Gen. Roy Stone, Chief of the Road Enquiry Office, U. S. Department of Agriculture, Washington, D. C.

COLORS OF HEATED STEEL CORRESPONDING TO DIFFERENT TEMPERATURES.*

By Maunsel White and F. W. Taylor, Members Am. Soc. M. E.†

There is, perhaps, nothing more indefinite in the industrial treatment of steel, than the so-called color temperatures, and as they are daily used by thousands of steel workers, it would seem that a few notes on the subject would prove of general interest.

The temperatures corresponding to the colors commonly used to express different heats, as published in various text books, hand books, etc., are so widely different as given by different authorities that it is imposible to draw any definite or reliable conclusion. The main trouble seems to have been in the defective apparatus used for determining the higher temperatures. The introduction of the Le Chatelier pyrometer within the last few years, has placed in the hands of the scientific investigator an instrument of extreme delicacy and accuracy, which has enabled him to determine the temperatures through the whole practical range of influence, and led to the establishment of new melting and freezing points of various metals and salts, which are now accepted as the standard in all scientific investigation. There has not, however, been published any results with the Le Chatelier pyrometer seeking to establish a correspondence of temperatures with color heats.

The first work done in this line, of which we are aware, is that of Dr. H. M. Howe, some eight or nine years ago. His results, however, have not been published, and with his kind permission we are enabled to give them here:

	Centigrade.	Fahrenheit.
Dull red	625° to 550°	1,022° to 1,157°
Full cherry	700°	1,292°
Light red	850°	1,562°
Full yellow	950° to 1,000°	1,742° to 1,832°
Light yellow	1,050°	1,922°
Very light yellow	1,100°	2,012°
White	1,150°	2,102°

The nomenclature used for color heats differs with different operators, but in our investigation we have adopted that which seems more nearly to represent the actual color corresponding to the heat sought to be represented. We have found that different observers have quite a different eye for color, which leads to quite a range of temperatures covering the same color. Further, we have found that the quality or intensity of light in which color heats are observed—that is, a bright sunny day, or cloudy day, or the time of day, such as morning, afternoon or evening, with their varying light—influence to a greater or less degree the determination of temperatures by eye.

After many tests with the Le Chatelier pyrometer, and different skilled observers working in all kinds of intensity of light, we have adopted the following nomenclature of color scale with the corresponding determined values in degrees Fahr. as best suited to the ordinary conditions met with in the majority of smith shops:

	Degrees.
Dark blood red, black red	990
Dark red, blood red, low red	1,050
Dark cherry red	1,175
Medium cherry red	1,250
Cherry, full red	1,375
Light cherry, bright cherry, scaling heat,* light red	1,550
Salmon, orange, free scaling heat	1,650
Light salmon, light orange	1,725
Yellow	1,825
Light yellow	1,975
White	2,200

With the advancing knowledge of, and interest in, the heat treatment of steel, the foregoing notes, it is hoped, may prove of some value to those engaged in the handling of steel at various temperatures, and lead to further and wider discussion of the subject, with a view to the better understanding and more accurate knowledge of the correct temperatures. The importance of knowing with close approximation the temperatures used in the treatment of steel cannot be over-estimated, as it holds out the surest promise of success in obtaining desired results.

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*A paper presented at the New York meeting of the American Society of Mechanical Engineers.

†Bethlehem Steel Co., Bethlehem, Pa.

*Heat at which scale forms and adheres; i. e., does not fall away from the piece when allowed to cool in air.

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ADVERTISING RATES. 20 cents a line. Want notices, special rates, see page XXII. Changes in standing advertisements must be received by Monday morning: new advertisements, Tuesday morning: transient advertisements by Wednesday morning.

It seems beyond belief; but it is nevertheless true. An official body of the City of Chicago has publicly and strenuously protested against a certain estimate of that city's population as being much too large. It appears that the Commission appointed by the Governor of Illinois to pass upon the sufficiency of the new drainage channel has through its engineer, a resident of far away and conservative Boston, reached the conclusion, after thorough investigation, "that there are at least 1,800,000 inhabitants in the Sanitary District of Chicago."

Judging by past history, one might have supposed that this announcement would have been greeted with trumpets and drums. Chicago's count of its own noses has long been received with incredulity by a cold and skeptical world. When she has offered "police censuses" and "school censuses" and "official estimates," the dwellers outside her borders have smiled an unbelieving smile and gone on their way unconvinced. Chicago's belief in her own numerical greatness has remained unshaken; but she has long yearned for the day when proud New York, and envious St. Louis and even eclipsed Philadelphia should concede her claims.

At last, from an unexpected source, comes just the testimony she has desired. An engineer from Boston, eminent for conservatism and scientific accuracy, as the result of an official and thorough investigation, declares that the population of the Chicago Sanitary District is "at least 1,800,000;" and how much more it may possibly be, he does not trust himself to say.

And now, as Chicago's own Mr. Dooley would say, what do they do? Do they send the news broadcast over the wires? Do they hang Fitzgerald's portrait in the City Hall? No. The Trustees of the Sanitary District actually find fault with this estimate. They go back to that very fountain of authority which Chicago has so long discredited, the United States Census, and declare that the entire population of the Sanitary District is only a trifle of a hundred thousand or less over a million. We have always understood that this Board of Trustees was an unpopular body in Chicago, and now we do not wonder. As we go to press our Chicago correspondent wires that a vigilance committee is searching for the Trustees. When found they are to make public recantation as the alternative to burial alive in a hole dug in the waters of the Chicago River.

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In our issue of Aug. 17 we discussed the "Proper Size for Septic Sewage Tanks," and suggested that a capacity equal to from four to six hours' flow (from a separate system of sewerage) might prove on investigation, to be sufficient, and that if the large capacities indicated by English practice were necessary to the success of the process, some other method of treatment might be preferable. We now wish to go one step further and ask: Is it necessary to provide an air-tight cover, or any cover, for sewage tanks in order to secure a sufficient amount of anaerobic action? So far as the exclusion of air is concerned, it would seem that if the tank units were small enough to prevent wave-action the air-penetration would be quite small. Light would reach deeper at the start, but would there not soon be a collection of scum so opaque as to exclude most of the light? In any event, the tanks are supposed to be large enough to give ample time for sedimentation. The sludge remains in the tank indefinitely, and certainly neither light nor air would penetrate to where the bulk of it lies, at the bottom of the tank. The principal effect of omitting the covering from tanks would therefore seem to be upon the tank effluent. If the omission of the tank covering resulted in a poorer tank effluent a part of the saving effected by the omission could be put into the capital and maintenance accounts of a larger filter area, with good reasons to believe that there would still remain a large margin over the cost of covered tanks. If investigations should prove that the exclusion of light was a more important factor than the absence of air, light roofs for that purpose could be provided at much less cost than the air-tight roofs now advised.

The omission of roofs from septic or anaerobic tanks is well worth careful consideration in view of the saving it possibly might effect and of the fact that many cities have been deterred from building water filter plants and from covering water reservoirs on account of the cost of masonry roofs.

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In his annual report to the Secretary of the Navy, Admiral Endicott, as Chief of the Bureau of Yards and Docks, makes an able argument in favor of substituting stone and concrete for timber in naval dry dock construction. The only arguments advanced in favor of the latter material, that are worth considering, are cheapness in first cost and speed of execution. But the experience gathered since 1889, when the first of the navy timber dry docks was built, shows that in ten years the repair account has amounted in some cases to 50% of the original cost; though the replacing of rotten timbers with concrete, in the upper portions of the altar system, will probably reduce the cost of maintenance in the future. In connection with the comparison in cost of timber and stone dry docks, the stone docks at New York and Mare Island, costing respectively $2,000,000 and $2,750,000, are usually cited as examples of the extravagant outlay made necessary by the use of stone. But these advocates of timber generally omit any mention of the stone docks at Boston and Norfolk that each cost less than a million. and they also fail to say that day's work, piecemeal contracts and intermittent Congressional appropriations were largely responsible for the large amount of money expended on the New York and Mare Island structures. Admiral Endicott, in his report, gives us a much fairer basis of comparison as deduced from very recent experience. The stone and concrete docks, at Boston and at Portsmouth, N. H., have been let upon conditions very similar to those under which the timber dry docks were constructed; competitive bids were invited upon complete plans covering the whole dock, and they were to be finished in 2½ years under a continuous appropriation by Congress. These docks are among the largest in the world and among the best and most substantial in fittings and construction. One was for $1,013,00 and the other for $1,089,000. If we compare this cost with the recent bids for the timber docks at Philadelphia and Mare Island—[illegible] and $782,600 respectively—we have a more accurate means of rating the comparative values of the two types of construction; especially as the four contracts all specify the same period of time for completion.

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As Admiral Endicott says, the conditions affecting the stability of the dock are practically the same in the two classes; the ability to sustain the weight is the same, though the masonry dock is superior in this respect, as it distributes the weight over a larger area; and in resisting the destructive upward pressure of the soil water the dead weight of the stone dock has great advantages over timber, which can only be held down by being pinned down to piles. Further, the timber dock depends largely for its tightness and life upon the character and integrity of the soil surrounding it; deep leaks are especially dangerous in such docks, as they carry soil and may eventually undermine and cause the collapse of the structure, and such leaks caused a repair bill of $300,000 on a timber structure originally costing $500,000, at the Brooklyn Dock No. 3 On the other hand, in masonry docks, leaks from faulty joints may cause some extra pumping, but they do not impair the stability or usefulness of the dock. In a word, the report of Admiral Endicott plainly shows that the masonry dock is in every way better adapted for its purpose than a timber dock, it is immeasurably safer, it can be built in the same space of time, and its first cost is only about 25% in excess of that of the timber dock. And against this excess in first cost we have a vastly increased cost of maintenance and the comparatively short life of the wooden structure. The report shows that the stone docks average a cost of $14 to $58 per year for repairs; though it should be said that these average the cost of repairs for 66 years, in the case of the Boston dock, as against ten years or less for the timber docks. But in these ten years these latter docks have cost from $5,304 to $16,800 each—and they are not reliable docks now.

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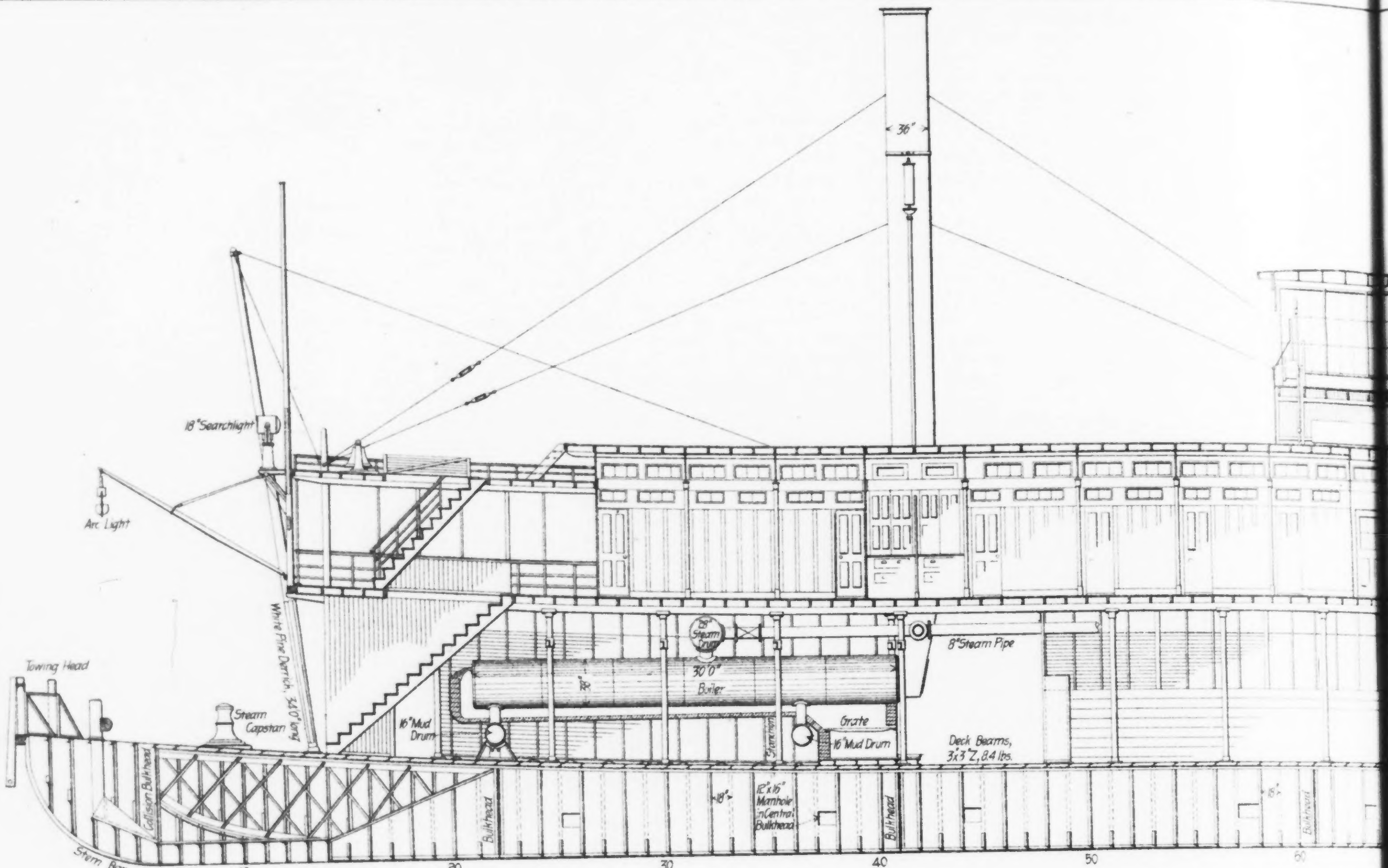
It cannot but be believed that these arguments will be sufficient to cause Congress to rescind its action in the case of the two timber dry docks first let The timber docks served a purpose in the beginning of our era of naval expansion; but the navy we now possess is of such character and volume that it demands only the best in dry-dock construction, and it would be a waste of public funds to supply anything else. A naval dry dock is too vitally important as a tool in peace or war to be dealt with lightly or cheaply; and the loss through the wreck of a single battleship—such as might easily have occurred in connection with Dry Dock No. 3, in Brooklyn—would amount to a sum sufficient to build two or three masonry docks of undoubted stablity.

THE EDUCATION OF MACHINISTS AND MECHANICAL ENGINEERS.

Among the excellent papers presented at the meeting of the American Society of Mechanical Engineers this week is one in which the subject of engineering education is discussed with a vigor and originality which commands attention. We reprint as much of the paper as our space permits in another column of this issue; but we are obliged to omit a large portion in which the author explains in much detail his plan for a "Half-Time School"; and we urge those of our readers who are interested to obtain from the Society or from the author copies of the complete paper and examine carefully the proposals which the author makes.

The over-supply of engineering graduates is far from being a novel subject. Just now, we are happy to say, it is of less pressing importance than it has been for many years. Especially in the field of mechanical engineering, one would



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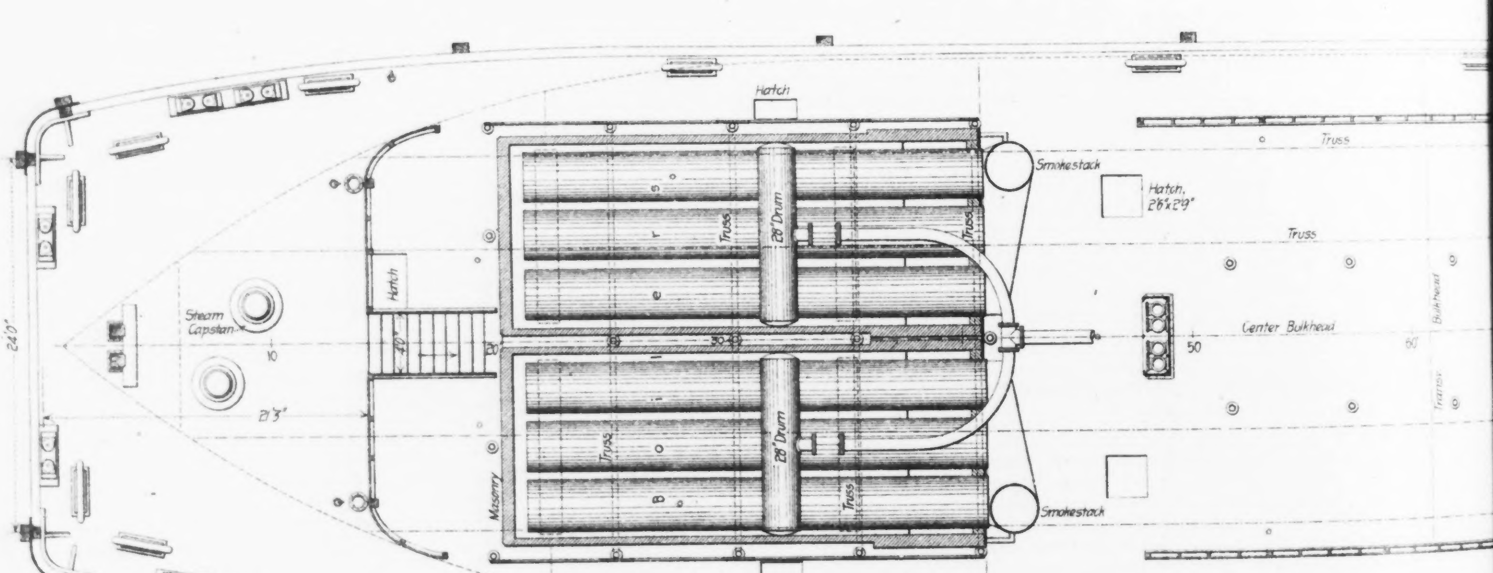
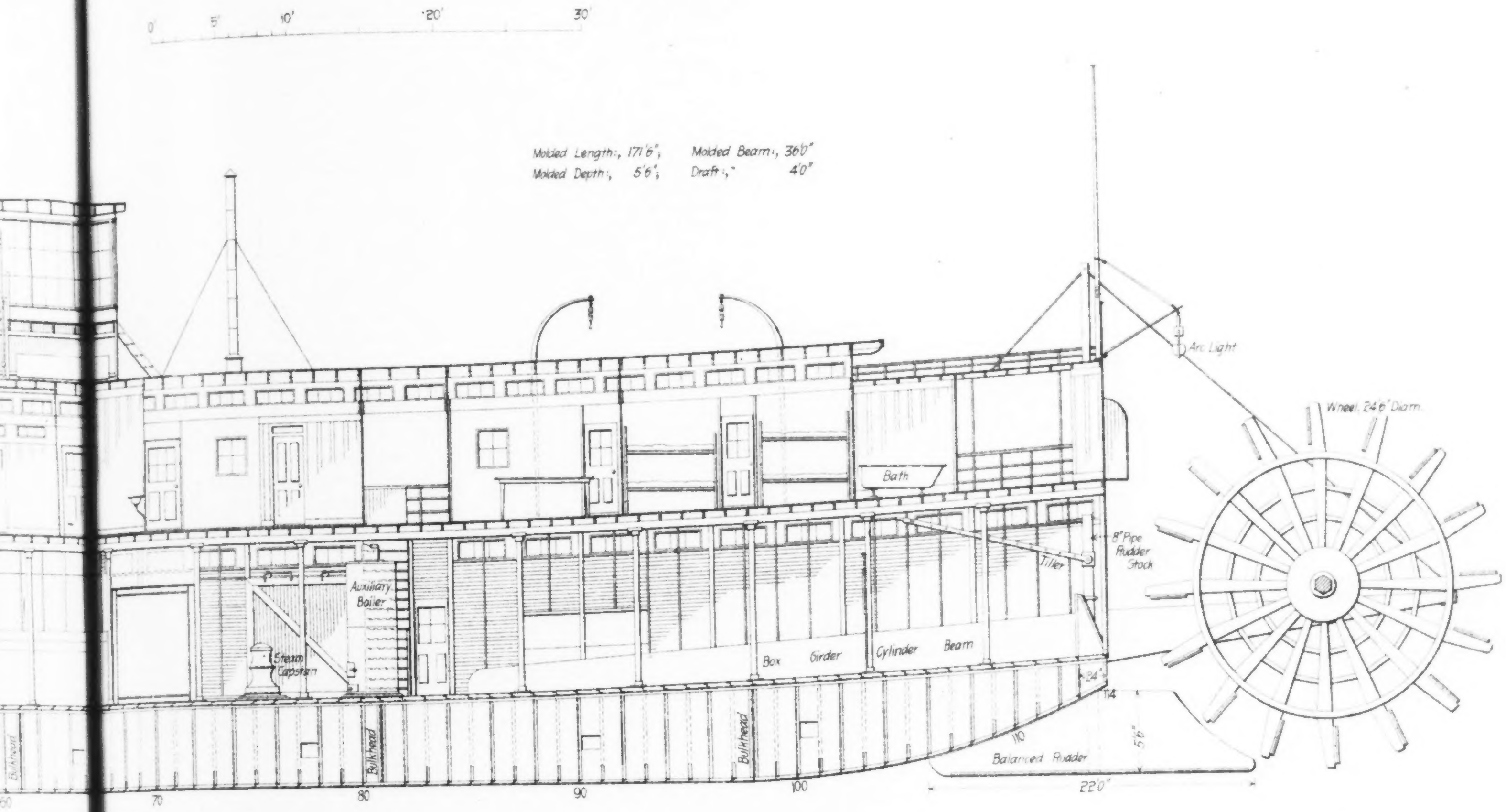


FIG. 2. MAI DECK

STEAM TENDER FOR HANDLING D EDGE

Capt. Mason H. Patrick. U. S. Engineers, Secretary of the Mississip River

Iowa Iron W ks, B



G 1. LONGIT INAL SECTION.

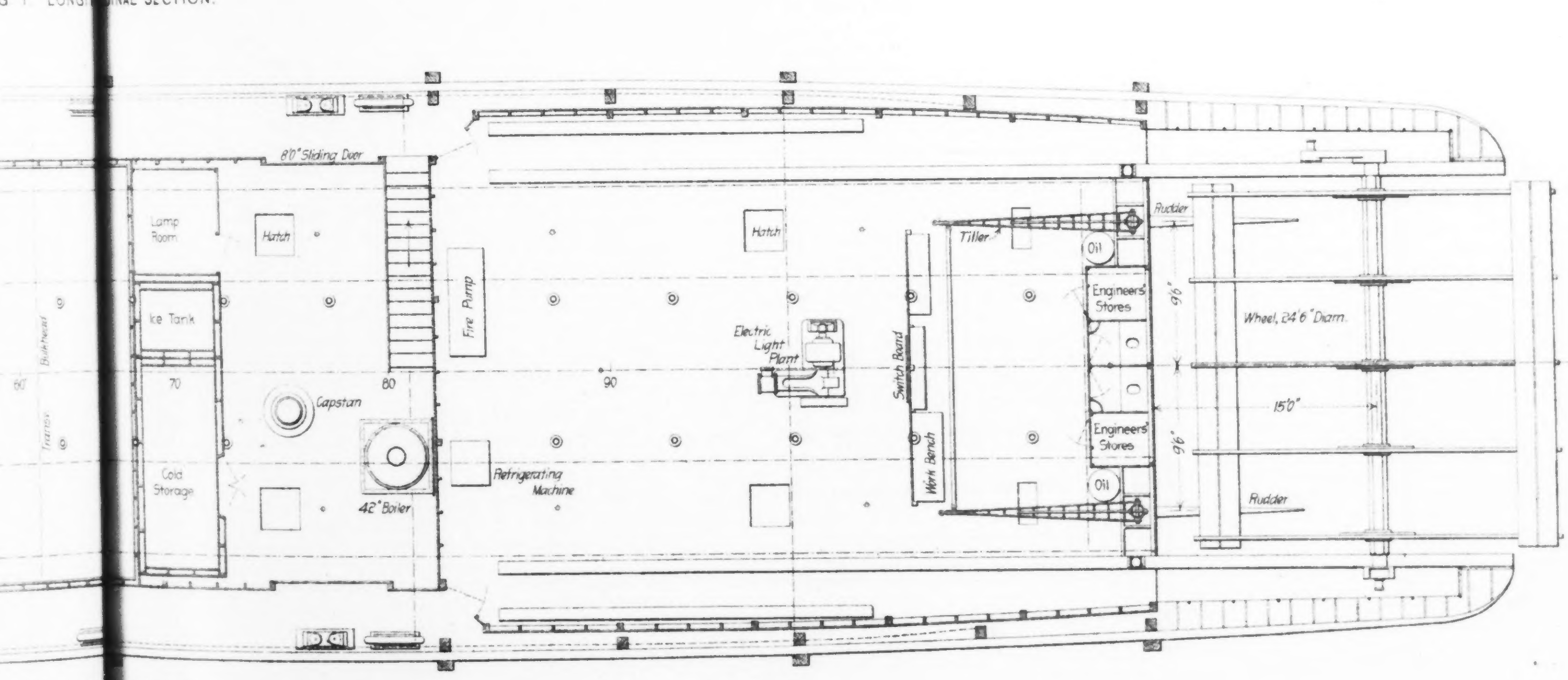


FIG. 2. MAI ECK PLAN

NDLING D EDGES ON THE MISSISSIPPI RIVER.

the Mississip River Commission. Mr. Percy H. Middleton, Assistant Engineer.

Iowa Iron W ks, Builders.

CHAS. HART, LITH., 36 VESEY ST., N. Y.

have to go back many years to find a time when the demand has been greater for thoroughly competent and experienced mechanical engineers of all grades, than at the present time. And yet, we are strongly of the belief that any one who wants an engineer for any grade of service, from draftsman to manager, and is willing to pay a good salary and to offer a position of some permanence, will have no lack of applications if he will make his wants known through our advertising columns. The demand is large, it is true, but, with the possible exception of a few limited fields, it does not equal the supply.

We are aware that the common answer to any such statement as this is the trite saying that "There's plenty of room at the top." This means, properly interpreted, that the man who stands head and shoulders above his fellows in practical ability and all around intelligence, who unites genius, talent and address, and who can perform any task from lowest to highest in a manner that leaves nothing to be desired—such a man is always in demand. But the average output of the engineering schools cannot fill such a specification and cannot be expected to. There are a hundred places to be filled requiring only ordinary ability to every one that calls for such a perfect being as that just described.

We cannot draw the contrast more effectively, we believe, between supply and demand in the engineering field than by comparison with the medical profession. The last report of the Commissioner of Education shows 150 medical schools of all classes in the United States, with a total attendance of 24,377 students, and a total value of "plant," including grounds, buildings and endowment funds of $7,919,000.

Unfortunately, the statistics are not given in the Commissioner's report in such a manner that direct comparison of engineering schools with medical schools is possible. The institutions giving instruction in engineering are classified under (1) "Schools of Technology," (2) "Agricultural and Mechanical Colleges" and (3) "Universities and Colleges." The "Schools of Technology" number 48, with 9,734 students, of whom about 7,000 are studying engineering, and a total investment in buildings, grounds, equipment and endowment funds of over $24,000,000. The "Agricultural and Mechanical Colleges," excluding those devoted to colored education, number 50, with 25,069 students, of whom about 6,000 are studying engineering. The endowment of these institutions is not summarized, but they received from the state and national governments during the year $1,859,000. In the "Universities and Colleges," the number of students pursuing engineering studies is about 15,000, including in this number those who are pursuing courses leading to the degree of "B. S."

From these figures it would appear that the number of students pursuing engineering studies in the United States is in excess of the number pursuing the study of medicine. If the reader will now contrast the number of physicians whose services are needed in the average community and the amount of high class engineering work required in the same community, he can form some idea of the relative overcrowding in the two professions.

And yet, in the face of these facts, we have new engineering and technical schools springing up all the time, while the older ones are enlarging their field and increasing their endowments; and old-time institutions, which have adhered to the traditional course of classical study from their foundation, think it necessary to join the procession and establish engineering departments.

It is said, and with entire truth, that the new education is taking the place of the old; that the youth who takes a thorough course in engineering has as good or better a general training for any career than the one who pursues the old-time course of classical study. If this were clearly understood by the boys who enter college there would be no cause for criticism. The trouble is, however, that in the scramble to secure students in which the schools engage, youths are brought to the schools who ought not to afford the investment and the sacrifices required for a four-year college course unless they have some certainty of earning a living at its close, and such a living as their college life has accustomed them to. The increasing expense of an engineering training is a matter of importance in this connection. What shall we say to the youth who desires to study engineering but who must do it on borrowed capital, and is without friends or influence to aid him in getting a start when he completes his preparation for active work? Is it really a blessing to a man to train his abilities in a certain direction and then deny him the opportunity to make use of them? How many men know the trial of heart that comes from the knowledge of the ability to do good and useful work coupled with the failure to secure any chance to prove their abilities and receive just recognition? The man who is capable of filling a responsible position and who has to get along in a menial one will never be a very contented or useful member of society.

As we said in these columns not long ago, the philanthropic men who have endowed so munificently our engineering schools have had in mind, we believe, the benefaction of just the class of students that finds entrance to the schools more and more difficult year by year. Of course the boys who come from homes of the wealthy or the well-to-do deserve consideration; but they do not need help nearly so much as the sons of the men who carry the dinner pails. Mr. Higgins pleads that these boys also deserve a chance. "There are marvellous possibilities of skill and invention," says he, "among a class of boys who are never thought of as possible engineers." He urges for his "Half-Time" school that it will give boys of this class an opportunity to show their abilities, and to enter the race for the "survival of the fittest" with at least some show of overcoming their handicap as compared with their comrades in more fortunate circumstances.

Much more might be said of Mr. Higgins' proposal from the standpoint of the students which it is intended to benefit; but the commercial aspect of the case also deserves consideration. The money which is being spent on technical education is given in the belief that a need is being supplied. Neither philanthropists nor state legislatures want to spend money in training men to do work that nobody wants done. There is an unquestioned demand, however, and one that is certain to prove permanent for the highest grades of skilled labor. It is true that automatic machinery and the producion of machines by manufacturing on a large scale instead of building to order has made possible the employment of unskilled labor in the machine shop; but it has at the same time wiped out the manufacturing establishment as a school for the production of expert machinists. The all-around training that a workman received in the old time "general jobbing shop" grows year by year harder and harder to obtain. For this reason the graduate of Mr. Higgins' proposed "half-time" school could feel certain of earning a good living as a journeyman mechanic on the completion of his course of study, and he would have at the same time a foundation on which to build that would make pretty sure his advancement to a higher position as he proved his competence to fill it.

No argument is needed to show the necessity of skilled mechanics to the success of any manufacturing enterprise at the present day. There are signs in abundance that the old happy-go-lucky methods of obtaining them will not serve in the future as they have in the past. Mr. Higgins' proposal for solving this problem seems to us the most practical and meritorious that has ever been made.

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LETTERS TO THE EDITOR.

Has Cameron's Septic Tank Patent Been Antedated in America?

Sir: I send you an article brought forth by the account of the Exeter Septic Tank in your issue of Oct. 26, and the fact that Mr. Cameron has taken out a patent in the United States which conflicts with those owned by the American Sewage Disposal Co., of Boston. Americans have some rights which Englishmen are bound to respect. The printed matter in the article is plate proof of a catalogue, which will be published in a few days.

Yours truly, John M. McClintock,
Gen. Mgr. American Sewage Disposal Co.
89 State St., Boston, Oct. 31, 1899.

(We suggest that those interested in the details of Mr. McClintock's claims obtain from him a copy of the catalogue which he mentions. If they wish to go further, they may secure from Washington copies of the patents granted to Amasa S. Glover, on an apparatus for the disposal of sewage, Nos. 258,744 (May 30, 1882), and 559,522 (May 5, 1896); also the patent granted to Donald Cameron, F. J. Commin and A. J. Martin, of Exeter, Eng., on Oct. 3, 1899, No. 634,423. Mr. Glover's patents are now owned by the American Sewage Disposal Co. and the one granted to the three Englishmen is commonly known as the Septic Tank Patent. The Glover patents neither describe nor claim any of the special features included in the septic tank patent. In fact, the two systems of sewage treatment are apparently at variance in that the American proposes to ventilate the tanks through a central shaft, whereas the Englishmen exclude the air from their tank as fully as possible. Notwithstanding this divergence in descriptions and claims, it seems probable that tanks constructed in accordance with the description in the first Glover patent might be so operated as to bring about a large amount of anaerobic action; but might not the same be true of any other sewage tanks constructed on the continuous flow principle? This raises an interesting question regarding the design of septic tanks, which, being of a general character, we have discussed in our editorial pages.—Ed.)

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The Granting of Degrees by Engineering Schools.

Sir: In your issue of Nov. 16 is an article stating that the Armour Institute of Technology, of Chicago, is considering a change in the system of giving degrees in Civil Engineering, and that they ask for information and assistance in this respect.

As the subject is of interest to the engineering profession in Canada, I take the occasion to briefly point out that the course observed in this country by the Canadian Society of Civil Engineers is, generally speaking, parallel with that of the Institution of Civil Engineers of Great Britain, and of the American Society of Civil Engineers.

I may also mention that the University of Toronto does not now give the degree of C. E. as a result of mere class attendance and theoretical work. A graduate of the School of Practical Science receives the degree of B. A. Sc. He then goes out into the world and practices, and in the course of a few years thereafter, if his practice and the results warrant it, and he so desires, he makes an application to the Registrar of the University for permission to write for the degree of C. E. The Registrar thereupon sends a form of application to be filled up by the applicant. This form must contain particulars of the applicant's scholastic course and career as a Civil Engineer. The applicant also states the branch of engineering on which he prefers to be examined.

The Registrar of the University then submits the application to the examiner, who, if satisfied of the applicant's experience and worth, advises that the candidate be allowed to write. The Registrar informs the candidate as to his mode of procedure.

In due course his thesis is received by the Registrar, who thereupon transfers it to the examiner, who, if satisfied of the ability of the applicant, so intimates to the Registrar; should, however, the candidate's thesis be not fully satisfactory to the examiner, the latter may call upon the candidate to appear and answer such questions as may seem necessary to enable him to finally determine on the candidate's fitness for the title. The successful candidate then receives his degree at the next ensuing "commencement" proceedings of the University.

Many students in attendance at the School of Practical Science in connection with Toronto University, and at the School of Applied Science in connection with the McGill University of Montreal, are enrolled as students in the membership of the Canadian Society of Civil Engineers, and they remain as students until at least two years subsequent to the receipt of their degree of B. A. Sc.

Even after receiving the degree of C. E. from the Toronto University, a Civil Engineer of that Institution of learning remains an associate member of the Canadian Society of Civil Engineers until his experience and attainments in the profession qualify him for full membership.

Prof. J. Galbraith, Principal of the School of Practical Science, Toronto, Ont., will, I am sure, on application, gladly furnish to the Armour Institute of Technology detailed information in connection with the course of study and mode of procedure adopted in his department.

I am, dear sir, Yours truly,
W. T. Jennings,
Prest. Can. Soc. C. E.
Examiner in Civil Engineering.
Toronto, Nov. 28, 1899. Toronto University.

The Comparative Cost of Mixing Concrete by Hand and by Machine.

Sir: Having recently heen in local charge of mixing concrete upon quite a large scale, both hy hand and machine, in the same locality, and under practically the same conditions, except as to the manner of mixing and handling, I am enabled to offer the following figures, giving the cost of mixing and placing hy each method. These may prove of interest to some of your readers. The work waa upon fortifications, huilt for the U. S. Government.

Hand Mixing and Laying.—This work was done hy contract, and showa fairly what may be done by the hand method. Almost identical results have been obtained hy day labor. The following force was required for one mixing gang, heing the force at each mixing hoard:

1 foreman at $2.00 per day	$2.00
6 laborers bringing material to board at $1.25	7.50
8 " mixing concrete at $1.25	10.00
8 " wheeling away concrete at $1.25	10.00
6 " placing and ramming concrete at $1.25	7.50
1 pump man	1.25
1 water boy	1.00
	$39.25

The rate of wages paid to laborera is assumed, for comparison, to he the same aa that paid in the machine mixing.

The ahove gang will mix, place, and ram eight to nine batches per hour, and will easily place eight hatches per hour continuously. The batches measure, after ramming, 0.75 cu. yds. per hatch, as determined from a measurement of ahout 9,000 cu. yds. in place.

Cost of one day's work (8 hours) of above gang	$39.25
Numher of batches mixed per day	64
Numher of cuhic yards in each hatch	0.75
Numher of cuhic yards mixed per day	48
Cost per cu. yd. for mixing and placing by hand	$0.81¾

The proportions were: natural cement, 1; sand, 2; pehhles, 2; stone, 3.

The concrete was well mixed, being turned four times; and it was well rammed with heavy rammers. All handling of concrete was done in harrows. The only machinery employed was a small steam pump to furnish water for mixing. The entire cost of tools, pump and hoiler, hoards, etc., prohahly did not exceed $500. A board large enough for three batches at a time was used. One hatch was heing mixed while another was being removed, and a third was heing placed on the hoard at the same time, so that the mixers moved without an interval from one batch to tho other. Usually two gangs like the above were employed.

Mixing and Placing by Machinery.—This work was done by day lahor. The total force required was as follows:

1 foreman	$2.88
1 engineman	1.70
1 engineman	1.50
1 derrick tender	1.50
32 laborers at $1.25	40.00
1 pumpman at $1.25	1.25
1 teamster and horse for moving cars	2.00
2 water hoys at $1.00	2.00
	$52.83
Fuel and oil (approximate)	1.25
	$54.08

Cement barrels were largely used for fuel, hence the small expenditure on this account.

A day's work for this force was the mixing, placing, and ramming of 160 to 190 batches of concrete in 8 hours. In one day over 200 hatchea were mixed. Twenty-one batches per hour, or 168 batches per day of 8 hours is a low rate under ordinary conditions. The same proportions were employed as for the hand-mixed concrete, hut the place measurement of the batches, determined from ahout 4,000 cu. yds., was 0.70 p. batch; probably because the measurement of material in the cars from the hins was not quite so accurate as with the barrow.

Cost of mixing and placing, with above force, one day (exclusive of wear and tear, depreciation, interest on plant, etc.)	$54.08
Numher of batches mixed per day	168
Numher of cuhic yards per batch	0.70
Numher of cuhic yards mixed and placed, per day	117.6
Cost of moving and placing per cubic yard	$0.46
Net cost of concrete per cubic yard for material and labor only	$3.63

The concrete was thoroughly mixed. There was no difference in this respect in the two methods, and the appearance of the concrete from the two processes was identical. In both cases the concrete was rammed in layers 6 ins. thick. It was found to be a good rule to employ one rammer for each 20 batches mixed per day, in addition to the spreaders.

The plant employed was a 4-ft. cubical mixer, operated hy an engine of about 12 HP. The same engine hoisted the loaded material cars up the incline to the mixer. These cars passed hy a double track under a hin containing the different materials, which were admitted to the proper compartments of the cars hy trap doors. After passing the cement house, where the cement was placed upon the load, they were pulled up the incline to the mixer, and when dumped were lowered hy way of a similiar incline on the opposite side. Seven revolutions of the mixer sufficed for a good mixture. The concrete was then dumped into an iron dumping tub resting on a car. This was hauled hy a horse to a point in reach of one of two derricka with 80 ft. booms, so placed as to cover almost the entire area of construction. These derricks were each operated hy a hoisting engine. These turned the masts hy means of bull-wheels, as well as hoisting the buckets and operating the booms. A boiler and pump for the water supply, with tank and necessary pipe, was included in the plant.

As most of the plant was on hand from previous operationa, its entire cost is difficult to determine, hut it was prohahly not less than $5,000 in position. Deducting from this $500 as the probahle cost of equipment for hand mixing, the difference in cost of plant is ahout $4,500. The cost of mixing and placing hy machine is 35¾ cts. per cu. yd. less than by hand. From this it is evident that ahout 12,500 cuhic yards would have to be mixed in order to pay for the first cost and erection of a similar plant.

L. R. Grahill, Civil Engineer.

55 Quincy St., N. E., Washington, D. C.
Nov. 17, 1899.

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Concerning Roof Truss Design.

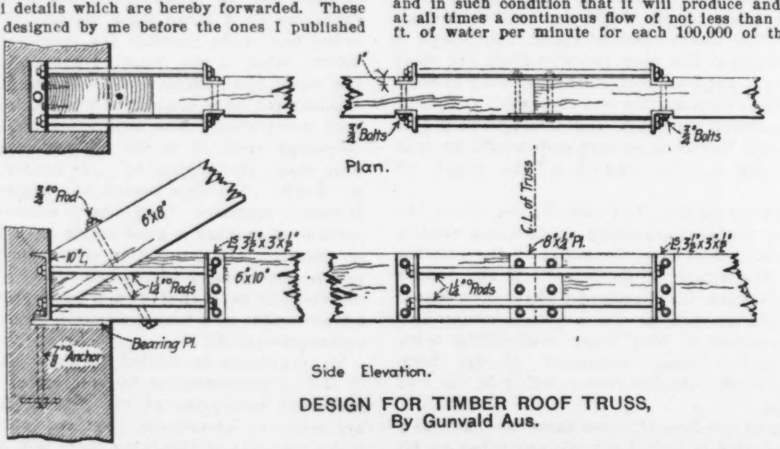
Sir: In the issue of Engineering News of Nov. 9 there appears a criticism hy me of some designs of roof trusses illustrated in former numhers. My note was accompanied hy a design which was credited to me and which, I think, requires explanation. The hlue print sent to you was of a drawing made hy me when Instructor at the California School of Mechanical Arts in this city. It was made for the instruction of students, and, with the exception of the joints in the lower chord, and a few other minor parts, was a copy of the standard form of timber truss used by Mr. Howard C. Holmes, Engineer of the Board of State Harhor Commissioners of this city. To the best of my knowledge, the credit for the design belongs to Mr. Holmes. It is, however, the general practice of Mr. Holmes to make the lower chord of his trusses of one stick of timber, such pieces being obtained of sufficient length from Oregon and Washington. The writer was led to design the splice formed of wedges and timber ties when constructing some trusses of 60-ft. span in the interior of this state where it was impossihle to obtain timbers of this length. The other design was drawn for the instruction of the students in the ahove-mentioned school. I trust that you may give this explanation space, as I do not wish to appear to claim the credit for a design not my own.

Very truly yours,
J. D. Galloway.

San Francisco, Cal., Nov. 14, 1899.

Sir: As considerahle interest has heen manifested in a design for a roof truss which I published in your paper some time ago, Mr. Brush having criticised it and Mr. J. D. Galloway, by attacking Mr. Brush, really defended my construction, and as I have also received letters from a numher of engineers asking for further information, I think it may he of interest to your readers if you publish the additional details which are hereby forwarded. These details were designed by me before the ones I published through your paper, and are prohahly better where the truss is not exposed to view. The splice of the chord is practically the same as the one suggested by Mr. Galloway, only I think it easier to make a good job by my design, as it would be hard to make all the projections on Mr. Galloway's cast-iron plates act at the same time. The detail I forward you is designed for a chord strain of 40,000 lbs., giving ahout 10,000 lbs. per sq. in. of the bolts, and 2,000 lhs. per sq. in. of the shoulders of the chords, and something less than 1,500 lhs. per sq. in. on the net section of the chord.

Yours truly,
Gunvald Aus,
Engineer of Construction,
Supervising Architect's Office, Washington D. C.
Nov. 13, 1899.



DESIGN FOR TIMBER ROOF TRUSS,
By Gunvald Aus.

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Notes and Queries.

H. J. M., Dayton, O., writes:

I expect to use a steel suction main, 66 ins. in diameter and ⅜-in. thick, in some improvements for a water-works plant. This main will have about 12 ft. covering of river gravel and sa and also will be under a 3-in. to 4-in. vacuum. If one has ever constructed anything similar, I would to know what method they used to stiffen the upper of the pipe, so that it would not distort or flatten ou the main shonld not he running full.

It seems to us that stiffening rings of angle-iron co readily he applied; and care in filling in solidly at sides of the pipe would be advisable.

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REPORT OF THE SPECIAL COMMISSION ON TH CHICAGO DRAINAGE CANAL.

The Special Commission appointed by Govern Tanner to report as to whether the work on th Chicago Drainage Canal has been executed an completed in accordance with the law, has sen to the Trustees of the Sanitary District a prelim nary report as to its conclusions. We give belo an abstract of this report, and also of the rep submitted by the Trustees, who dispute some the assumptions made by the Commission.

Report of the Commission to the Drainage Boar

Our Commission, appointed hy Gov. Tanner, by author ity of the Statute of 1889, creating the Sanitary Distri of Chicago, while not yet able to make final report of it findings, yet thinks it good public policy to advise your Board of some of the conclusions reached through its investigation thus far made. It finds that the Statute of 1889 clearly sets forth two propositions:

(1) The flow of water to he introduced into the channel should he at the minimum of 300,000 cu. ft. per minute, or when the population of the District should he more than 1,500,000 inhabitants, that the flow required should be 20,000 cu. ft. per minute for each 100,000 inhahitants of the District. (2) The flow required should he maintained at all times. We quote certain sections of the act as follows:

Section 20. Any channel or outlet constructed under the provisions of this act, which shall cause the discharge of sewage into or through any river or stream of water beyond or without the limits of the district constructing the same, shall he of sufficient size and capacity to produce a continuous flow of water of at least 200 cu. ft. per minute for each 1,000 of the population of the district drained thereby, and the same shall he kept and maintained of such size and in such condition that the water thereof shall he neither offensive nor injurious to the health of any of the people of this State, and hefore any sewage shall he discharged into such channel or outlet all garhage, dead animals, and parts thereof, and other solids, shall be taken therefrom, and said District shall, at the time any sewage is turned into or through any such channel or channels, turn into such channel or channels not less than 20,000 cu. ft. of water per minute for every 100-000 inhabitants of said district, and shall thereafter maintain the flow of such quantity of water.

Section 23. If the population of the district draining into such channel shall at any time exceed 1,500,000 inhabitants, such channel shall he made and kept of such size and in such condition that it will produce and maintain at all times a continuous flow of not less than 20,000 cu. ft. of water per minute for each 100,000 of the population of such district at a current of not more than three miles per hour, and if at any time the general government shall improve the Desplaines or Illinois rivers, so that the same shall be capable of receiving a flow of 600,000 cu. ft. of water per minute, or more, from said channel, and shall provide for the payment of all damages which any extra flow ahove 300,000 cu. ft. of water per minute from such channel may cause to private property so as to save harmless the said District from all liability therefrom, then such sanitary district shall within one year thereafter, enlarge the entire channel leading into said Desplaines or Illinois rivers from said district to a sufficient size and capacity to produce and maintain a continuous flow throughout the same of not less than 600,000 cu. ft. per minute, with a current of not more than three miles per hour, and such channel shall be constructed upon such grade as to be capable of producing a depth of water not less than 18 ft. throughout said channel, and shall have a width of not less than 160 ft. at the hottom.

Section 25. Any district formed hereunder shall have the right to permit territory lying outside its limits and within the same county to drain into and use any channel or drain made by it, upon such payments, terms and conditions as may be mutually agreed upon, and any district formed hereunder is hereby given full power and authority to contract for the right to use any drain or channel which may be made by any other sanitary district, upon such terms as may be mutually agreed upon, and to raise the money called for by any such contract in the same way and to the same extent as such district is authorised to raise money for any other corporate purposes. Provided, that where the united flow of any sanitary districts thus co-operating shall pass into any channel constructed within the limits of the county wherein such districts are located, and which passes into the Desplaines or Illinois rivers, such united flow shall in no case and at no time be less than 20,000 cu. ft. of water per minute for each 100,000 of the aggregate of the population of the districts co-operating.

The two propositions being so clearly defined by statute, our Commission deemed it highly important to ascertain the population of the Sanitary District. Our Chief Engineer, Desmond FitzGerald, M. Am. Soc. C. E., after having given the question of population of the District thorough investigation, reached the conclusion that there are at least 1,800,000 inhabitants in the Sanitary District. We are fully convinced that the conclusion is correct, and have therefore based our estimates of the quantity of water to be introduced into the Drainage Channel at 360,000 cu. ft. of water per minute.

Velocity of Current.—We find upon investigation that our Commission is charged with the inspection of the main channel or channels and the Chicago River, to ascertain their size and capacity to flow the amount of water required under the law, and to pass upon the capacity of the channel being dug from Lockport to the end of the Sanitary Trustees' work in the city of Joliet. From the surveys made by our Chief Engineer, and from his reports, we find as follows:

(1). The main channel when freed from all existing obstructions (occasioned by the Sanitary Trustees not having completed their work in the channel) will more than fully meet the requirements of the law as stated in Section 23, namely, having a depth of 14 ft. in the alluvial part and 18 ft. in the rocky portion, and will have the size and capacity of carrying the amount of water required by the Special Commission under the act, namely: 360,000 cu. ft. of water per minute in the alluvial part and 600,000 cu. ft. in the rocky portion, at a current not to exceed three miles per hour. (2). The Chicago River with the dredging done thus far and the improvements made along its banks by the Sanitary District and the U. S. Government, also by the construction of the by-passes from Adams St. south, on the west bank of the river, has (when various temporary obstructions in said river are removed) the capacity of carrying into the main channel from Lake Michigan the amount of 360,000 cu. ft. of water per minute at a current not to exceed three miles per hour.

As the application of the Sanitary Board to the Secretary of War for permission to cause the waters of the Chicago River to flow in the main channel restricted the velocity of the Chicago River to 1¼ miles an hour, and as the permit from the Secretary of War to the Sanitary Board also contained in the preamble said restriction as to velocity, the Special Commission was in doubt as to whether this matter of velocity of 1¼ miles an hour should be considered by them in determining the capacity of the river in furnishing the quantity of water required by law. Deeming this a matter of the utmost importance, it submitted this question to counsel. He reported that under the act creating the Sanitary District our Commission had no legal right to consider this question, as the law under Section 27 specifically says: "Of a current not to exceed three miles per hour," which velocity is intended for both river and channel.

Solids.—Under Section 20 we find the following: "And before any sewage shall be discharged into such channel or outlet all garbage, dead animals and parts thereof, and other solids shall be taken therefrom." On investigation our Commission is unable to find that any provision has been made by the Sanitary Trustees for the fulfillment of this requirement of the law.

Unfinished Work.—Our Commission desires to call the attention of your Board to the following, which has been reported by your Chief Engineer, which should be completed by you in order to meet the requirements of the law and before a final report can be submitted to the Governor.

Chicago River.—(1) Some dredging still remains to be done on the Chicago River to attain a depth of 20 ft. as planned by the Sanitary District. The cofferdams at the by-passes at Adams and Van Buren Sts., have not been removed and a considerable amount of work remains to be done in connection with the Van Buren St. by-pass, principally earth excavation, construction of masonry and bridge work.

(2) The Taylor St. bridge has not yet been erected, the superstructure not having arrived upon the ground.

(3) At the Chicago Terminal Transfer R. R. crossing very little work has been accomplished. The center pier has not yet been removed from the channel, the abutments have not been built and no material for the superstructure has arrived upon the ground.

(4) At the 18th St. bridge the U. S. Government has nearly completed the work of widening the river on the north side of the bridge, but has not yet begun the widening of the river on the south side.

Chicago Drainage Channel.—(5). At Campbell Ave. the Sanitary District is working as rapidly as practicable on the construction of the eight-track bridge. There is a dam across the channel, and below this dam a considerable portion of the channel is obstructed by the construction of the masonry for the new bridge and by the temporary pile trestles of the railways. The abutment on the north side of the river is completed, and work is now progressing on the south abutment and two piers in the channel. Earth is also being removed from under the temporary trestles.

(6) The Sanitary District is constructing a small collateral channel to connect the West fork of the South Branch of the Chicago River with the channel below the site of the eight-track bridge. This collateral channel is nearly completed, and is to be connected with the main drainage channel by a flume now in course of construction.

(7) About 50,000 cu. yds. of earth excavation still remain to be completed between stations 104 and 110 at the site of the old Illinois Central R. R. crossing. The earth is being removed by steam shovel and scrapers.

(8) About 40,000 cu. yds. of earth excavation still remain to be removed from the channel between stations 122 and 154.

(9) At station 225 a large amount of work remains to be done in connection with the construction of the four-track Belt R. R. bridge. Excavation has just been started for the center pier and the abutments have not yet been built. About 6,000 cu. yds. of earth remain to be excavated. A new temporary trestle is to be erected at the site of this bridge, and preparations are now in progress for this work.

(10) At station 348 two dams about 6 ft. in height exist across the channel.

(11) At Lemont about 2,000 cu. yds. of rock still remain to be excavated from the bottom of the channel. Work on this excavation is progressing rapidly and will probably be completed early in the coming month.

Desplaines River.—(12) The work on the tail race below the controlling works at Lockport is very nearly completed.

(13) At Joliet a large amount of work still remains to be done in connection with the construction of Dam No. 1 and also in connection with the construction of the channel below this dam. The dam itself is not yet completed, a large amount of rock remains to be excavated in connection with the construction of the tail race, and about 15,000 cu. yds. of rock remain to be excavated from the channel below the dam.

(14) There is also a considerable amount of work remaining to be done in connection with the construction of the bridges at Joliet.

In the above has not been included any of the work of cleaning up or of repair.

Dams.—The law, in Section 23, requires, that the Sanitary District shall remove the dams at Henry and Copperas Creek in the Illinois River before any water shall be turned into the channel, and while your Board (we are informed) has already by resolution ordered the removal of said dams, yet our Commission would, as a matter of public policy, advise that said dams be not taken out until the work is fully completed, and the Commission is prepared to make its final and favorable report to the Governor.

Suggestions.—The Commission would suggest that a water gage be placed at some convenient place at or near the controlling works, in order that we may be assured that the amount of water required by the law is passed from the controlling works down the Desplaines River into the Illinois Valley.

Conclusion.—In conclusion the Commission desires to say that it fully realizes the importance of this great work to the citizens of Chicago, and also appreciates the urgent necessity for its completion from a sanitary standpoint, and the earnest desire of the Board of Sanitary Trustees to open the channel. Our Commission is as anxious in this respect as the Board, and there is no intention on our part to stand on technicalities in passing on this great undertaking. As representatives, however, of the State of Illinois, we have a duty to perform, and must demand that the law be complied with for the protection, health and welfare of all the people concerned. When the Sanitary Board of Trustees has its work fully completed and is ready to turn over to our Commission the channel unobstructed, for the full and free passage of the amount of water determined by the Commission under the law, then our Commission will be found ready and willing to make its final report to the Governor, recommending that the law has been complied with and that the water be allowed to be turned in.

Respectfully submitted,

Isaac Taylor, President,
Al. F. Schoch, Secretary,
Special Commissioners, Chicago Drainage Channel.
Nov. 23, 1899.

Reply of the Drainage Board to the Special Commission.

While the conclusions of your Commission in regard to the population of the Sanitary District are not vital to present conditions and do not constitute an objection to the opening of the channel, we feel it our duty, courteously, to dissent from the method of reasoning by which you find it necessary to maintain a flow of 360,000 cu. ft. of water per minute through the drainage channel at the time of opening. To our minds, the only known legal method of ascertaining the population of the Sanitary District is by the last Federal census, and an examination of this census will demonstrate that the present population will range between 1,000,000 and 1,100,000. Your method of "estimating" the population is, we respectfully submit, without precedent in any official or legal proceedings in the past, and was certainly not within the intent or expectation of the General Assembly at the time the Sanitary District law was enacted. Even admitting your right to consider the population of the District by an unofficial estimate rather than by the last Federal census, we represent that your Commission has ignored the clear intent of the General Assembly and the undoubted spirit of the act by assuming that the limitation of a flow of 20,000 cu. ft. of water per minute for every 100,000 of population applies to the Sanitary District as a whole rather than to the population of the District actually draining into the channel and down the Illinois valley. The Sanitary District act, in all its provisions, safeguards and conditions, shows throughout that the literal and essential requirement of the General Assembly was that for every 100,000 of population draining into the channel there should be for sanitary dilution a flow of 20,000 cu. ft. of water per minute. Your Commission has entirely ignored the fact that, of the Sanitary District, at least 300,000 inhabitants and an area of 91 sq. miles now drain into Lake Michigan, and will not drain into the Drainage Channel and down the Desplaines and Illinois Valley for at least two years, or until the intercepting sewer system of the city of Chicago and the conduits of that municipality at 39th St. and Lawrence Ave. are completed, so as to permit the diversion of this sewage from the lake into the Drainage Channel with a capacity to provide 120,000 cu. ft. of lake water per minute for the purpose of dilution for the increasing population. Consequently this population of one-fourth of the Sanitary District will not drain into the Drainage Channel at all and, therefore, will not offer that pollution which your excessive requirement of 360,000 cu. ft. of water per minute would deem it necessary to dilute.

However, as above stated, you have not found our channel inadequate even for this extreme volume, and this requirement is not of present importance, but we have found it proper to make these observations, lest by our silence we should admit our obligation to carry this increased volume through the Chicago River for all time, to the possible detriment of the important navigation interests which must be always considered by our Board in our relations to the Federal Government and the current to be maintained in the Chicago River.

In the consideration of the unfinished work to which you have called our attention, we desire to express our belief that the supervision of all work of the Sanitary District of Chicago, south of the upper basin at Joliet, is entirely beyond the purview of your Commission. All our work south of this basin and through Joliet has been designed and performed entirely for the purpose of protecting the interests of the Sanitary District of Chicago and the tax-payers of this municipality from the damages which will follow by possible overflow, and have no bearing upon the dimensions or capacity of the Drainage Channel as defined by law. Our channel ends at Lockport, and the rapid declivity and the work performed from the controlling works south to the upper basin leaves no doubt as to the downward flow of many times the flow of our channel as required by law. None of the work which we have performed south of that point and through the city of Joliet is called for by the Sanitary District act, but has been planned and executed solely for the protection of the Sanitary District. It has never been contemplated that much of this work, especially the superstructure of the bridges and special portions of the tail race and sundry points of excavation, would be completed for several months yet, or for long after the date of our expected opening of the Drainage Channel. Your suggestion that your Commission might consider this protective work as within the purview of your observation and require its completion before the opening of the channel fills us with apprehension, and we suggest that under no degree of diligence and day and night effort could this work be totally completed within such limits as not to prove a serious delay in the opening of our channel.

We stated verbally, at the time of the submission of your communication, and desire now to repeat, that an insistance of the actual completion of all the work mentioned by you in the 14 enumerations of unfinished work, would retard for several months the opening of the Drainage Channel and prove a great hardship to the inhabitants of this municipality. We shall assume, therefore, in the consideration of this unfinished work, and in the explanation given below of the condition of progress at the various points, that the duties of your body will be fully performed in requiring such conditions as will permit the legal flow of water per minute at all these points, providing that flow can be secured with a current not exceeding three miles per hour. Also, that the uncompleted condition of the substructure and superstructure of the various bridges will not receive your consideration so long as the work thereon and the coffer-dams erected in connection therewith do not offer such obstruction to the flow of water as to reduce the volume to less than the legal requirements:

(1) Our total work of dredging in the Chicago River is already so far completed as to readily permit the flow of water required by your Commission within the velocity required by law. The small portion of work remaining under contract can be completed without any inconvenience or delay after the opening of the channel. The Adams St. by-pass has been completed and the coffer-dams are now being removed and will be out before the close of the present month. The by-pass between Quincy St. and Van Buren St. is fast nearing completion, and the present condition is such that the required flow can be admitted through the bridges at this point within the velocity required by law.

(2) At Taylor St. the center pier of the old structure has been entirely removed and the channel deepened to 20 ft.; hence complete provision has been made for flow and navigation, which are in no way dependent upon the completion of the superstructure.

(3) At the Chicago Terminal Transfer R. R. bridge, the cross-section of the river is now such as to permit the required flow of water. The remaining work at this point is under contract, and is being pushed with all vigor to an early completion.

(4) At the 18th St. bridge, the widening to be made by the U. S. Government is in the interest of navigation and is not wholly to give cross-sectional area for flowage. The present condition at that point will permit the required

flow of water with a much less current velocity than required by law.

(5) The south abutment of the Campbell Ave. bridge and the two piers are rapidly nearing completion, and we may confidently fix a date not later than Dec. 6, for the finish. The masses of earth crossing the channel beneath the temporary pile trestles are being cut down to a plane 15 ft. below Chicago datum, and that plane should be reached on or before Dec. 12, after which the channel my be filled and the dam east of the railways be removed by dredging.

(6) The plans of the District provide for filling the channel through the collateral channel.* A timber flume is now being constructed, through which the supply will be admitted, and this will be done on or about Dec. 4. As soon as the channel is filled, the collateral channel will be completed, connecting with the main channel, its cross-section being 60 ft. wide at bottom, and 90 ft. wide at datum line.

(7) The excavation on the line of the old right of way of the Illinois Central R. R. is being carried down to a plane 16 ft. below Chicago datum. This plane will be reached by Dec. 8.

(5, 6, 7) In a discussion of the channel supply, the situations discussed under each of these heads must be taken into consideration. The channel could be supplied with the required flow of water per minute over and across the barriers left under the railway trestles and on the line of the right of way of the Illinois Central R. R., at a velocity not in excess of two miles per hour. But to reduce velocities and make the conditions at the trestles safer for the operation of the railways, a part of the flow is admitted through the collateral channel and the velocity of current is thus reduced to about 1.2 miles per hour.

(8) Excavation of the material between stations 122 and 134 is progressing steadily, and by Dec. 5 ample channel section will be afforded for the required flow of water.

(9) The situation at the Belt R. R. crossing is the most serious one remaining along the entire main channel. A new trestle is being built to carry the tracks of the railways, and a large force is being employed excavating the pit for the center-pier. The concrete base of the center-pier is to be laid as rapidly as possible, and the construction thereupon carried up until work is arrested by turning in the water, after which the center-pier is to be surrounded by a coffer-dam, and the work completed within it. At this place the earth under the new existing trestle is to be excavated to a plane 18 ft. below Chicago datum, and this will be accomplished on or before Dec. 10.

(10) As to the two cross-dams, provision has been made for these obstructions to be washed by the current into excavations below grade just below their location. These obstructions, however, are not of such a character as to hinder the required flow of water, the channel at this point being 8 ft. deeper than required by law.

(11) The rock remaining in the channel under the A., T. & S. F. Ry. bridge at Lemont will be all removed on or before Dec. 1.

(12) The work on the tail-race below the controlling works will be completed on or before Dec. 1.

(13) The work on Section 17, down as far as the upper pool and within the jurisdiction of your Commission will be finished on or before Dec. 8.

As above stated, we do not regard the work of the Sanitary District south of the upper pool and for the purpose of conducting the water through the city of Joliet without injury to property-owners and the municipality, as within the purview of inspection of your Commission; but for your information we will state that the work of the Sanitary District at all points in Joliet is being prosecuted with the greatest possible vigor to an early completion. Ample provision will be made to comply with the requirements of the law with reference to the removal of solids, etc., by instructions to our Police Department before the opening of the channel.

The unfinished work above noted can be finished after the water is turned into the channel, as the velocity of the current will not (at any point where the work is being carried on by the Sanitary District) reach the velocity of over two miles per hour. Hence, to deprive the people of the Sauitary District of this great benefit would be solelyt based on technical points and objections, since every assurance exists that the work partly unfinished will be completed at the earliest time possible in view of the fact that it is all under contract, and that it is the desire of every trustee to have the work at every point enumerated by your Commission pushed with the utmost vigor and energy towards completion. We, therefore, request your Commission to modify some of its conditions based on the opening of the canal.

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THE NEW TERMINAL STATION OF THE PITTSBURG & LAKE ERIE TERMINAL R. R., AT PITTSBURG, PA.

By Burcham Harding.*

The city of Pittsburg is undoubtedly one of the most important centers of industry in the United States. The present demand for its products and manufactures has never been equalled. This marvelous prosperity is reflected in an enormous increase in railway traffic. Hitherto better provision has been made for handling the increased freight, than for providing accommodations for passengers, for in the latter respect Pittsburg is behind the age. The Pittsburg & Lake Erie Ry., operating through a rich manufacturing district of Pennsylvania and Ohio, with trunk connections running east and west, will shortly have by far the most handsome and extensive terminal station in Pittsburg.

Several important undertakings for giving increased facilities are being carried out by the Pittsburg & Lake Erie Ry. The shops and yards at McKee's Rocks will be completely rebuilt at a cost of about $500,000, and Messrs. Westinghouse, Church, Kerr & Co., Pittsburg, have received a contract for an extensive and elaborate equipment for a new terminal station. The roadbed is being widened for a four-track system from Pittsburg to Coreopolis, a distance of 30 miles, and substantial sidings are being extended within these limits to provide for the rapidly increasing traffic.

Great interest attaches to the equipment of the new terminal station. All the engineering, specifications, and designing, have been prepared by Westinghouse, Church, Kerr & Co., of Pittsburg, under the direction of Mr. J. A. Atwood, Chief Engineer of the Pittsburg & Lake Erie Co., and they were finally approved by Col. J. M. Schoonmaker, the Vice-President and General Manager. Arrangements have since been made for the execution of the entire work by the designing engineers, in accordance with their own plans and specifications.

The new terminal station will extend over a considerable tract of ground alongside the present depot, by the side of the Monongahela River. The foundations are already completed, the steel structural work is in an advanced state, and all the work is being pushed ahead as rapidly as possible. The station is conveniently situated close to the Smithfield St. bridge over the Monongahela River, and several lines of electric cars connect it with the Pittsburg and Allegheny systems.

The general plan, as well as the details, will be as complete as those of the South station of the Boston Terminal Co., which was also designed and erected by the same engineers. The Boston station is the most extensive engineering work of the kind ever undertaken, and its successful accomplishment led to the preference being given to Westinghouse, Church, Kerr & Co. for the installation of the terminal station at Pittsburg. The present contract includes a power-house equipment; a wiring installation for electric arc and incandescent lighting; elevators for passenger, freight and dumbwaiter service; heating and ventilating the head-house and other buildings; a plant for filtering, purifying, and mechanically cooling drinking water; a system for heating cars in the train shed and coach yard; apparatus for furnishing a supply of compressed air for car cleaning; train brake and signal testing, etc.; means for fire protection; a pumping plant for disposing of drainage water; a system for the general supply of hot and cold water for the railway terminal and office buildings.

These varied services will together constitute a complete engineering equipment. Each portion is merely a branch of the system, but by employing one firm of engineers to design the whole, large gains have been secured in simplicity of design, in first cost, and in operating expenses.

The equipment of the power-house includes a plant with its accessories, of sufficient capacity to provide for all the exigencies of heating, lighting and power purposes, and, in addition, adequate provision is made for relay, and for extensions should they become necessary in the future. The boilers will be of the water tube type, each being equipped with a Roney mechanical stoker and smokeless furnace. Coal and ash handling machinery, having a capacity of about 35 tons of coal per hour, will be provided in the boiler-house, that the furnaces may be supplied automatically. A self-supporting steel stack, lined with brick throughout its entire length, will furnish draft for the furnaces, and will be of sufficient size for providing draft for additional boilers when installed. The engine equipment will consist of five 14 and 24 × 14-in. Westinghouse single valve, compound automatic engines, to be operated non-condensing with steam at 125 lbs. pressure, and will be provided with single weight inertia governors. Each engine will be direct-connected to a 120-K-W. Westinghouse multipolar direct-current "engine type" generator, delivering current at 125 volts. Each of the engines with its generator will be mounted upon a heavy cast-iron bed plate. The steam piping of the power-house has been designed with a view of securing the greatest freedom from internal strains due to expansion or contraction. There will be no pockets except those provided for the purpose of handling entrained water, and a system of separators and steam loops will return such water automatically to the boilers. Provisions will be made for treating and purifying the water for feeding the boilers. The power-house will have an overhead travelling crane of sufficient capacity to handle all parts of the engine-room machinery.

The electric wiring installation has been very ingeniously designed, that the operator at the main switchboard may control every part of the system. Local distributing centers will be connected with the switchboard by two-wire feeders. Pressure wires and an annunciator system connect the power-house with the distributing centers, and are so arranged that co-operation is secured between the local operators in the various departments and the power-house attendants. This arrangement is made necessary and desirable by the stations of the various distributing centers with reference to the power-house, and from considerations of convenience in operation. The feeders will be mainly of open-work construction, with porcelain insulators, and the tap circuits will be conduit construction, using unlined iron conduits and the best quality of rubber-covered wire. Raceways will be provided for telephone, bell and other small wires, in addition to the lighting circuits. The entire lighting installation will comprise about 3,700 incandescent and 70 arc lamps.

The elevators will be operated electrically, supplied with power from the same bus-bars as supply current for the lighting system. There will be two passenger elevators, one for freight service, and two dumb-waiters.

Heating and ventilation have received the closest attention. A supply of fresh air will be provided, tempered to 70°, for the rooms in the head-house which are regularly occupied, perfect ventilation being secured by a change of air every 15 minutes. Direct heat is furnished to the rooms in the head-house by means of direct radiators, which will compensate for leakage and other losses, maintaining the temperature at 70°. The main waiting-room will be warmed wholly by the indirect method. Exhaust ventilation, in addition to the fresh air supply, is secured by two exhaust fans, placed in the upper part of the building, one of which will exhaust the vitiated air from the offices, and the other from all the lavatories. In addition there will be a third exhaust fan in the basement, for the removal of foul air from the main waiting and first floor rooms. The lavatories will be provided with an entirely separate set of ducts, connected with a separate fan. No air will be supplied directly to the lavatories, the air movement being from the surrounding rooms toward fixtures, and through fixture vents to the duct system, through which the air will be discharged above the roof, thus greatly improving the sanitary condition of rooms that in railroad stations are often very objectionable.

The exhaust steam from the main and auxiliary engines in the power-house will be used for supplying heat. Water, rapidly and positively circulated, heated by this waste steam, will convey the necessary heat through the circulating system to the direct and indirect radiators. Provision will be made for filtering and purifying the air before it is distributed to the buildings, and for furnishing clean air to the offices during warm weather.

Great care will be taken with the drinking water distribution. A plant will furnish cooled drinking water to some forty or fifty outlets in various parts of the building. It will be distilled, filtered and chilled in cypress tanks, by means of submerged direct expansion ammonia coils. This chilled water will be pumped through pipe circuits to the water taps in the offices and corridors on the various floors. The distributing system is so arranged that the chilled water will continuously circulate close to the outlets, thereby providing a cooled supply without unnecessary waste at the faucets. This plant will have a capacity for cooling 1,500 gallons per twenty-four hours to 40° F. The pipes of the circulating system will be covered with non-conducting material to reduce the loss through radiation, and to prevent the condensation of moisture on the piping.

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*This collateral channel is east of Kedzie Ave., running from the South Branch of the Chicago River to the Drainage Canal, and acting as a by-pass around the uncompleted work referred to. It is 1,600 ft. long, 60 ft. wide at bottom and 12 ft. deep. The flume or sluiceway is 12 ft. wide and 8 ft. deep, with timber gate, and will admit 15,000 cu. ft. of water per minute to the canal.—Ed.

*6328 Marchand St., East Liberty, Pa.

To provide the necessary heating for cars in the station when the locomotive is detached, a steam supply will be taken from the auxiliary line of steam piping in the power-house and will be connected with the existing system leading to the various stub-tracks in the station. Facilities will be provided for warming 30 cars simultaneously.

Compressed air will be furnished for various purposes. It will be supplied from a steam-driven air compressor and from a small air pump in the main power-house, distributed through pipe system connected with apparatus for car cleaning, air brake and train signal testing, a pneumatic tube service, and for an interlocking switch and signal system. In addition to the large air compressor for regular service, a 9½-in. Westinghouse improved air pump will also be erected to perform service when only a small quantity of air is required, or to handle the most important service in the event of an accident to the large compressor. The total rated capacity of the two compressors will be 531 cu. ft. of free air per minute and a large reservoir capacity will be installed to provide a liberal air storage.

Protection against loss by fire will be secured by a pipe system with fire hose attachments, placed within the building, connected with the high pressure water pipes of the Monongahela Water Co. The fire hose, hose nozzles, hose brackets and spanners will be permanently attached ready for immediate use at points throughout the building. There will be eighteen outlets and hose connections with lengths of fire hose in the buildings and on the roof.

An electrically driven centrifugal pump will be installed for freeing the sump well which will be built in the power-house to catch the seepage or other water which may find its way to the well through a system of drains to be provided for the purpose. The pump will have a capacity of 1,000 gallons of water per minute, against a head of 2. ft., and in addition to the possible seepage, it is intended to remove emergency water which may find its way to the basements at times of extreme high water in the adjoining river. This pump, of the centrifugal type, with vertical shaft, will be driven by a Westinghouse special vertical iron clad motor connected at the upper end of the shaft, and will start and stop automatically by means of a float arrangement and controlling apparatus.

The general supply of water will be provided from a well to be driven near the power-house. The water will be delivered by a pump with a capacity of 225 gallons per minute, and will be distributed for feeding the boilers, for the drinking water system, for a general supply to the head-house, and for providing hot water to sinks, bowls, etc. The heating plant for the hot water is placed in the basement, and will have a nominal capacity of 400 gallons per hour, heated to 212° F., the heat being supplied through copper coils in the heater connected with the live steam system; the amount of steam being regulated to maintain any desired temperature by an automatic thermostat valve. Hot water will be provided at 73 outlets in the head-house. The main supply pump will be connected with a double system of piping now buried in the railroad yard, and through this sytem to a proposed storage tank of some 100,000 to 200,000 gallons capacity.

The foregoing enumeration of the several branches of work connected with this railroad terminal shows the large range of engineering skill necessary to produce a modern equipment. In the present age of competition railroad companies find it to their advantage to provide fully and liberally for the comfort of passengers, but it is only during recent years that improvements have been so freely introduced, that terminal stations rival the best hotels in comfortable and sanitary surroundings.

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THE TORPEDO-BOAT DESTROYER "BAILEY" was launched on Dec. 5, at the works of the Gas Engine & Power Co. and Charles L. Seabury Co. on the Harlem River. The "Bailey" is 205 ft. long, 19 ft. beam, 13 ft. 5 ins. depth of hold; 235 tons displacement on trial and 265 tons when in commission. She carries two 18-in. Whitehead torpedo tubes, and four 6-pdr. rapid-fire guns. The engines, which are not yet installed, will develop 5,600 HP. The contract speed is 30 knots, and the boat is to cost $250,000.

THE TWIN-SCREW SOUND STEAMER, "Chester W. Chopin," on her trial trip in Annapolis Roads, on Dec. 2, developed a speed of 20½ statute miles per hour, according to a Baltimore item. This steamer was built by the Maryland Steel Co. for the New Haven Steamboat Co., and she is to run between New York and New Haven. The "Chopin" is built of steel and is 324 ft. long on deck and 310 ft. on the water line. Power is furnished by two inverted direct-acting triple-expansion engines, with 24-in., 38-in., and 60-in. diameter cylinders, and 30-in. stroke, developing 4,200 I. HP. Steam is supplied by six Scotch boilers.

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THE ALABAMA STEEL & SHIPBUILDING CO.'S plant, at Eusley, Ala., made its initial run of steel on Nov. 30. This plant has a capacity of 1,000 tons per day, of which 600 tons will be consumed by the adjacent Alabama Steel & Wire Co.'s mills. These two plants represent an investment of about $3,000,000.

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THE CAST-IRON PIPE COMBINATION has been decided by the United States Supreme Court to be unlawful and contrary to the Anti-Trust law of 1890. The six companies which composed the combination were: Addyston Pipe & Steel Co., of Cincinnati; Denuis Loug & Co., of Louisville; the Howard Harrison Iron Co., of Bessemer, Ala.; the Anniston Pipe & Foundry Co., of Anniston, Ala.; the South Pittsburg Pipe Works, of South Pittsburg, Tenn., and the Chattanooga Foundry & Pipe Works, of Chattanooga, Tenn. Their agreement provided that there should be no competition between the companies in 36 states, which were mentioned, in the manufacture and sale of cast-iron pipe. An executive committee was named by the combination, the duties of whose members, among other things, was to determine to which member of the combination a given contract should be awarded. Once this were determined, a price was decided upon, and then the other members of the company made fictitious bids above the price of the company selected for the work. The defense urged that the clause of the constitution giving Congress power to regulate interstate commerce did not apply, as the manufacture and sale of cast-iron pipe was not interstate commerce. The court, however, ruled against this position

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CIVIL SERVICE EXAMINATIONS for the position of building inspector for iron and steel construction and for a mechanical draftsman will be held at the rooms of the Municipal Civil Service Commision of New York city on Dec. 15 and 19, 1899.——State civil service examinations will be held Dec. 16, 1899, for assistant civil engineer, leveler, rodman, chainman and engineering draftsman. For information, applicants should address the State Civil Service Commission, Albany, N. Y.

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AN EARTHQUAKE-PROOF STEEL PALACE is being designed for the Crown Prince of Japan, by E. C. & R. M. Shankland, of Chicago. It is to cost $3,000,000; will be 400 × 270 ft. in extreme dimensions, and 60 ft. high, and is to be of steel skeleton construction cased in granite and marble. It will rest on 400 steel columns anchored in concrete piers. It is to be heated and ventilated after American methods; be lighted by electricity, and also to contain an ice-making plant.

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THE PROPOSED JOINT OUTLET SEWER for some of the Oranges, Irvington, Millburn, a part of Newark, and other municipalities in the vicinity, has been approved by the New Jersey Sewerage Commission, with the proviso that purification works be built on demand of the commission, if deemed necessary. The sewage will be discharged into Arthur Kill, near the city of Elizabeth. It is quite likely that Elizabeth may connect some of its sewers with the outlet.

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IMPROVEMENTS TO THE MAIN SEWERAGE SYSTEM of London have been recommended to the London County Council by the Main Drainage Committee of that body. The proposed work consists almost wholly of supplementary intercepting sewers, pumping stations and accessories. The total estimated cost of improvements needed is about $15,000,000. For the next eight years, however, the expenditure of a total of only some $6,000,000 is proposed. The main drainage system, the committee states, "was constructed to serve 3,450,000, with an average water supply of 31¼ (Imp.) gallons per head, whereas it now serves 4,700,000, or 36% more persons, with a water supply of from 35 to 40 (Imp.) gallons per head. The population is increasing at the rate of about 400,000 persons in every ten years, and will in all probability amount to a total of 7,000,000 within the county of London when it is fully built over. The dry-weather flow of sewage for which the system was designed was 108,000,000 (Imp.) gallons daily, whereas the quantity now passing may be taken at about 195,000,000 (Imp.) gallons, or an increase of about 80%."

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FOREIGN COMMERCE for the calendar year promises to break all records and may exceed $2,000,000,000. For the ten months ending October, 1899, the Treasury Bureau of Statistics report total exports of 1,029,242,000, as compared with $987,879,000 for the corresponding months of last year. The imports and exports, or total commerce for the ten months ending in October in preceding years was $1,368,439,860, in 1890; $1,321,141,920, in 1895; and $1,687,617,470 in 1899. This remarkable growth is largely due to the export of manufactures, which were, for 1899, $50,000,000 in excess of those of 1898, and $65,000,000 greater than in 1897. Imports have also increased; and those for the ten months ending with October, 1899, were $658,375,000 against $527,734,000 for last year. This large increase in importations is chiefly in supplies for the manufacturers, and which cannot be produced at home.

WATER PURIFICATION EXPERIMENTS AT WASHINGTON, D. C.

Some experiments with slow sand and mechanical filters are being made at Washington, D. C., under the direction of Lieut.-Col. A. M. Miller, Engineer-in-Charge of the Washington Aqueduct. The slow sand filter bed has an area of 95.0.33 sq. ft., being enclosed by a circular wooden tank, open at the top. The filtering material proper consists of 3 ft. of sand. Beneath this is 10 ins. of gravel, resting, in turn, on 8 ins. of stones about 4 ins. in diameter, thus making the filter bed 4½ ft. in depth. The filter is operated under a head of 3 ft. and is cleaned when the loss of head reaches 3 ft. A gage is provided to indicate the loss of head and a meter to register the amount of water passing the filter. Petcocks are inserted in the side of the tank so that samples of water may be drawn at points 6, 12, 18 and 24 ins. beneath the surface of the filter bed.

The mechanical filter consists of a gravity unit, of the New York Filter Manufacturing Co.'s type. The tank is of steel, and is not covered. It has an inside diameter of 6 ft., giving a filtering area of 28.14 sq. ft. The filter is usually cleaned about once in twelve hours, the maximum loss of head being some 13 ft.

These two filters have been in operation for a number of months. The slow sand filter is now working at the rate of 3,500,000 gallons an acre, and has been run at 4,000,000 gallons, with good results. The mechanical filter is operated at the rate of 130,000,000 gallons an acre a day. For obvious reasons the detailed results obtained cannot be made public until Col. Miller submits his report to Congress, within a few months. It can be stated, in general, that good results are being obtained, both in the removal of bacteria and sediment.

One of the most interesting features of the experiments is the method employed to determine turbidity. The platinum wire test having been adopted, it was decided to add a standard turbid solution or mixture to the samples to be tested, in order to make it feasible to record the turbidities of comparatively clear natural waters, and also of the filtered water. A turbidity gage, of the platinum wire type, was designed and constructed with an unusual degree of refinement. The platinum wire is set into a rod or tube about 1 in. in diameter, and at exactly the same level a hook gage is attached to the rod. The wire and hook gage may be raised or lowered at will. The gage being set so as to give a zero reading when exactly at the level of the water surface, it is next lowered into the water under observation until the platinum wire is at the point of disappearance. The reading is then taken, to hundredths of an inch if desired, the gage remaining absolutely stationary meanwhile.

Turbidity records, under the platinum wire system, are the reciprocals of the readings. That is, if the wire disappears at a depth of 0.5 ins., the result is recorded as 2.0. The turbidity of the standard is made as nearly as convenient to 2.0. Equal parts of the standard and sample are mixed together and the resulting turbidity noted. The difference between double this result and the turbidity of the standard is the turbidity of the sample.

Turbidity records for 20 years, taken in a manner far less accurate, but which has served admirably for rough general comparison, are available at Washington. The method employed was to record the depth beneath the surface at which a silver ball could be seen. Disappearance at depths of 7 ins. or less was recorded as turbid, and at 22 to 36 ins. as clear, with various graduations between.

The filtration experiments described above are the outcome of an agitation for an improvement in the quality of the water supply of the National Capitol, which has been in progress for many years. The character of the water supply, as then understood, was set forth in brief special reports made in January, 1898, by Geo. M. Sternberg, Surgeon-General U. S. A., and Capt. D. D. Gaillard, Corps of Engineers, U. S. A., then in charge of the Washington Aqueduct.

These reports review previous reports on the filtration of the water supply of the District of Columbia, made in 1886 and 1894, by Captain (now Major) Thos. W. Symons, and Col. Geo. H. Elliott, respectively.

NOTES ON THE OPERATION OF THE MONTREAL GARBAGE FURNACE.

The city of Montreal is one of the very few cities in this country that claims to burn its garbage with practically no expense for fuel. Such a claim is common enough in England, and perhaps would be more so here if American cities followed English methods in furnace construction, and dealt with wastes more as foreign cities do. The Montreal furnace is built on English lines, and the material burned in it appears to be more comparable to English than American wastes.

The garbage furnace, or incinerator, at Montreal, was put in operation in 1894. It was designed and built by Chas. Thackeray & Co., and was described and illustrated in Engineering News for Nov. 29, 1894. It differs from most other garbage furnaces in America in having several small cells, each with its own fire, instead of one large one; and also in being especially designed to secure the drying-out of the refuse before it reaches the flames.

The following notes on the operation of the Montreal plant were made on Oct. 6, 1899, by a member of the editorial staff of this journal, who visited the furnace through the kindness of Mr. J. E. Dore, Sanitary Engineer of the Montreal Health Department: It was found that some modifications of the original design had been introduced with apparent advantage; but aside from these, the plant seemed to be doing its work as intended, in a sanitary manner and without the use of extra fuel. As to the latter point, the word of those in charge was taken without question, as must be expected under the circumstances, but there were no evidences of coal or other extra fuel about the plant, nor of any place for the storage of fuel. It was stated that the fires are started, after cleaning or repairs, with dry stuff reserved for the purpose from the collections. The fires are stopped, it was said, only once in a year or two, for removing fine ashes and dust and for repairs. The fires are banked 24 hours a week, on Sundays.

Garbage, ashes, tin cans, and lighter and more inflammable refuse are collected together. The tin cans are sorted out, before the stuff is dumped in the furnaces, so far as possible, without taking too much time. In addition, during December, January, February and half of March, when 75 to 80% of the matter collected is ashes, the whole collection is screened before going to the furnace, to get rid of the ashes. The screen is about 12 × 24 ft., supported on rafters some 12 ft. long, inclined at an angle of, say, 45°. It has a mesh of about ⅞-in. A smaller mesh was first tried, and found to be too fine. The ashes, obviously, fall through the screen. The balance of the material slides to the ground and is shovelled into carts and hauled up the incline to the furnace mouths.

The grate bars have never been renewed, and the castings on the dumping floor were being renewed for the first time when these notes were taken. The fire brick used for linings have proven to be too small, both in area and thickness, the many joints and the thinness of the brick accelerating breakage through clinkering. In the English furnaces, Mr. Dore said, bigger brick are used to advantage.

The boiler originally set in the horizontal flue leading to the chimney has been taken out. It required a monthly cleaning, and when the air blast was used in the furnaces the steam pressure would fall from 60 to 15 lbs. Mr. Dore stated that if a steam blast were to be used he would apply it at the top of the refuse, instead of beneath, and that a strong, independent coal fire would be needed to generate the steam. The blast was found to be unnecessary, besides which it carried fine cinders up the chimney. The fires in the small, intermediate cells have also been abandoned, as quite unnecessary, besides requiring much clinkering.

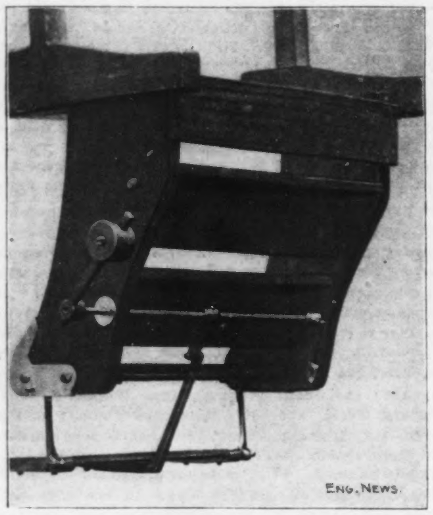

Fig. 1.—An Extension Step for Passenger Cars. A. C. Wrede and D. R. Saunders, Inventors.

Mr. Dore stated that if he were to rebuild the plant he would have one door to each cell for clinkering, instead of two, and one large ash door below, instead of two small ones.

There was a large pile of ashes and clinkers in the yard. They accumulated some time ago and are now being taken away by suburban and steam railways. The present daily output is being hauled away by city carts, for filling purposes.

There are three men employed on the dumping floor by day and three by night, together with six day and six night stokers, below, a day and a night foreman. This does not include the labor of loading and carting away the clinkers and ashes, which are dumped on the floor, then thrown out on the ground and subsequently shovelled into carts. A trough, Mr. Dore stated, should have been provided just beneath the clinkering doors for receiving and cooling the clinkers.

The two foremen are paid $15, and the 18 laborers, $9 per week each, the fires being banked on Sundays, as stated. The total cost of running the plant is $14,000 a year, including carting away the cinders. Of this amount about $10,000 is for the wages of the men named just above. The $14,000 includes repairs, lighting and all running expenses, but no capital charges. Whether or not the city, which owns its water-works, charges for water used at the plant, and whether insurance is included, was not learned.

Everything about the plant seemed to be in good sanitary condition. The smoke from the chimney was plentiful, but very light-colored, and in striking contrast to the dark clouds that poured out from the pumping station of the city water-works, not far distant.

The garbage is collected by the city at night. Wooden carts, covered with cloth, are used, both one and two-horse. The latter are preferred, except in those parts of the city having many narrow lanes and alleys. All one-horse carts hold over 50, and all two-horse carts over 100 cu. ft. The carts are dumped into the cells until the latter are full (six loads), then onto the floor.

The cart horses are stabled in an old stone building, in the same yard as the incinerating plant. The building was erected years ago, serving first as a governor's residence, then being occupied, in turn, by monks, a school, a private family, and, finally, by the horses. It bears a tablet with a French inscription, which, translated literally, is about as follows:

> **Here was Ft. St. Gabriel and (very) near here Father Le Maitre was massacred by Iroquois from an ambuscade, Aug. 26, 1661.**

The building is large enough to provide stabling for 24 horses, with room for a blacksmith shop besides. Its walls, interior as well as exterior, are of stone, about 3 ft. in thickness. Split cedar boughs were used for lath, and hand-made nails and moldings are still to be seen. On making a foundation for an anvil, the solidity of the floor evidently not being known in advance, it was found that the floor was composed of four different layers of wood, the top being 1 in. and the others 3 ins. thick, with 6 ins. of mortar between the two lower layers, 4 ins. between the second and third layers, and 3 ins. between the third and fourth, or top layer.

AN EXTENSION STEP FOR RAILWAY CARS.

The lowest fixed steps of passenger cars are usually inconveniently high above the rails at many stations, and on some few railways the brakemen on passenger trains are required to carry a movable step or stool which they place on the station platform, as is almost invariably done by the porters of sleeping and parlor cars. This arrangement is an awkward one, however, and as the steps cannot be made lower without danger of striking obstructions, some forms of folding steps have been introduced.

One of the latest of these extension car steps is that recently patented by A. C. Wrede and D. R. Saunders (Patent No. 630,764, Aug. 8, 1899). It consists of a step-board carried by levers attached to the side boards of the fixed steps, and operated by balanced levers on the rocker arms. Fig. 1 is a view of the device, and Fig. 2 is a drawing showing the working parts, the dotted lines showing their position when the step is folded, it lying then on top of the lower fixed step. It is operated by pulling the balanced lever forward to close the step, or by throwing this lever back in order to lower and extend the step. The device is adapted to street cars and electric cars, and is being introduced by Mr. Sidney H. Wheelhouse, Lincoln Trust Building, St. Louis, Mo., to whom we are indebted for blue prints and photographs.

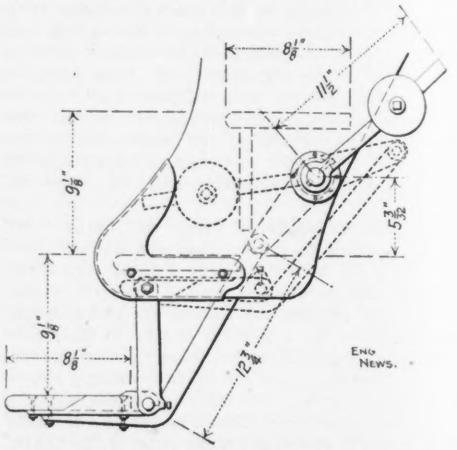

Fig. 2.— Elevation of Extension Step for Railway Cars.

MODERN PHOTO-PRINTING PROCESSES.*

By Herman Esser.†

There are at present three different processes in actual use for copying drawings by the aid of the sunlight. The so-called blue or negative process, giving white lines on a blue background; the nigrosine or positive black process, giving neat black lines on a white ground; the umbra process, a variety of the nigrosine, and the maduro or brown process, being also a negative process, and giving white lines on a dark brown ground.

All other processes for the purpose of copying drawings by the aid of the sunlight are either too cumbersome in their manipulation, or need dark rooms and other appliances, so that they cannot

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†127 Fulton St., New York city.

come into general use with architects, engineers and draftsmen.

The prepared papers for any sun printing processes must be kept in a dry place, as moisture is very injurious to them. They must be kept away from heat and from daylight.

The best way of keeping and preserving photo papers is in a tightly closed tin tube, and when this is not at hand the paper should always be kept rolled up tightly in its original wrapper and placed in a drawer.

Blue Process Paper.

The prepared paper for this process is of a light greenish yellow tint when freshly coated. In the course of time, however, and particularly during the summer months, the paper turns to a darker tint up to a blue-gray, which, however, is no indication that the paper is spoiled and unfit for use.

Good prepared paper for this process will keep unimpaired at least three months. Blue process papers cannot be judged by their color; only an actual test will show whether the paper is perfect or not. The exposure of blue process paper takes from 4 to 8 minutes in bright sunlight, varying, of course, with the intensity of the light and the transparency of the material upon which the tracing is made. In the shade, or on dark and foggy days, the exposure may last up to one hour before it is completed, and on such days judgment must be used in determining its duration, and good care taken that the paper is not taken from the frame before it has been sufficiently exposed.

When the margin protruding from under the original drawing has attained a greenish-bronze color, open one part of the back of the frame and observe the copy. If the lines stand out sharp and distinct on a gray background, the exposure is completed. Then take the copy from the frame and place it in a bath tray containing sufficient water fully to cover the print. Here the lines will gradually turn into white while the back ground is changed into brilliant blue. Rinsing the print by means of a spray will quicken the washing. As soon as the lines stand out in clear white the print may be taken from the bath and hung up to dry, which completes the work. Remember that the fresher the paper is the slower it will print and the quicker it will wash out; the older the paper is the quicker it will print, but the slower it will wash. To obtain satisfactory results never take prints from the water bath before the lines are perfectly white, although it may take hours to effect this. As soon as the bath becomes discolored, renew by fresh water, as otherwise the chemicals dissolved in the water will discolor the white lines to a bluish hue. The longer the exposure, the darker the blue ground of the paper will be, but the lines of the drawing should always appear in a clear white color, provided the original shows opaque lines. The copies after drying will be darker than when they are taken from the bath.

Papers printed in direct bright sunlight will generally not produce such a rich and beautiful blue background as those which are exposed in the shade.

Quick Printing Blue Process Paper.

These papers are coated with a solution which is effected in considerably less time than those with which the regular papers are prepared. Consequently the exposure of this "quick paper" is materially shorter and is completed in from 1½ to 2 minutes in bright sunlight.

They are a great advantage on dark days, particularly in winter when days are short, and the rays of the sun are less intense. The sensitiveness of this paper, therefore, makes it especially necessary to be careful in keeping it from light and moisture, and also in handling and manipulating it. The printing, washing and drying is exactly the same as explained above, and just as perfect copies are produced with no more trouble than with the regular papers. It must, however, be said that "quick print" papers have not the same lasting qualities as the regular papers, that heat has more effect on them, and that therefore they spoil easier and quicker during the summer months.

Nigrosine Paper.

This is a positive paper, giving a fac-simile of the original drawing, in clear black lines on a white ground. It overcomes the great objection to blue-prints of shaded drawings which show light and shade reversed. Nigrosine prints can be colored, shaded, altered, etc., just like an original drawing. The nigrosine paper is of a reddish yellow color which turns to white in sunlight. The paper with the original to be copied is placed in the printing frame exactly the same as blue process paper. When the protruding margin has turned white, which takes from 3 to 5 minutes in sunlight, the exposure must be carefully watched. As soon as no difference in color can be observed in comparing the margin with the paper that was not covered by the original, the exposure is completed and the copy will show reddish yellow lines on white background. The copy is then immersed in the developing bath, prepared according to directions accompanying the developer, and left there for one or two minutes until all of the lines have turned to a grayish black color. After this the copy is placed in a clear water bath, rinsed off on both sides by means of a spray and left in the water bath for about half an hour, when it is hung up and dried. If copies are taken too soon from the water bath, heavy lines are apt to run, which however, can be prevented by drying the prints off with blotting paper before hanging up to dry. Faint lines on white ground are an indication that the exposure was too long, whereas sharp and distinct black lines on a dirty bluish gray ground indicate that the exposure was too short.

By observing these directions, especially those which relate to the time of exposure, perfect prints will be obtained without any trouble.

Umbra Paper.

The umbra paper is essentially the same as the nigrosine paper except that no developing bath is necessary, as the developer has been added to the sensitive coating. It is handled and exposed like nigrosine paper, takes from 4 to 6 minutes to complete the exposure and is immersed in the water bath only, where it remains until all the lines are sharp and distinct. After this it is manipulated exactly like nigrosine paper. Proper care has to be taken with umbra paper, particularly in summer, as the smallest amount of moisture (perspiration of the fingers, etc.), on the unexposed paper will produce black spots.

Photographers will observe that nigrosine and umbra are positive processes and give a negative print from a photographic negative.

Maduro Paper.

This is the quickest and in many respects the most satisfactory sun copying process so far in existence. After exposure for about two minutes in bright sunlight, the margin protruding under the tracing turns from its original light yellow color to a reddish brown. The copies are then taken from the frame, immersed in the water bath and thoroughly rinsed on both sides by means of a spray when the ground will immediately change to a sepia brown color, the lines coming out in perfect white; or the prints may be left for 15 to 20 minutes in running water with the same results, but spraying off for a few minutes is preferable. They are then immersed in fixing solution made from the salt, which accompanies each roll of maduro paper, taking 2 oz. of the fixing salt to one gallon of water. The fixing solution may otherwise be applied with a wide brush, this will make the prints not only permanent but will turn the sepia brown color to nearly black, while the lines become white. After this the prints must be thoroughly washed for 20 to 30 minutes and then hung up to dry.

The brown color of the maduro prints being impervious to light makes this paper very valuable for making negatives which may be used to produce positive copies either with the blue or maduro process. For this purpose a very thin but strong paper is used.

The manipulations are the same as explained before, with the exception that the original to be copied is placed with its back to the glass in the frame, the side drawn upon being in direct contact with the prepared side of the maduro paper. After exposing and finishing the result will be a reversed copy, white on brown ground, of the original. If now this reversed copy is used as a tracing, exposing it again in the manner described above, with a sheet of maduro or blue process paper it will yield an exact reproduction of the original in either brown or blue lines on a white back ground. The time of exposure will naturally be somewhat longer, as the maduro paper, no matter how thin it is, will never be as transparent as tracing cloth or tracing paper. The distinctness and sharpness of even the finest lines are astonishing, but are due to the fact that in both manipulations the original was in direct contact with the sensitive paper, so that no light could reach sideways under the lines.

It is very essential that the first copy, when it is to be used as a negative should lay perfectly flat and without wrinkles.

A CURVED GLASS LUE-PRINT MACHINE.[*]

By Paul Melien Chamberlain, M. Am. Soc. M. E.[†]

The desirable features of a blue-print machine are ease and rapidity of operation, such adjustment as to secure the direct rays of the sun, and means whereby close contact between the tracing and the sensitized paper may be secured. The machine here described and illustrated was designed to meet the above requirements, and was first built for, and in the shops of, the Lewis Institute.

The operation of the car and the universal adjustment is so clearly shown in Figs. 1 and 2 that explanation seems unnecessary. The iron work is all galvanized to avoid rusting after exposure to rain or snow. The glass is curved to a radius of 13 ft. Attached to one end of the frame is a sheet of canvas-rubber packing about 1-32-in. thick. The other end of the rubber cloth is fastened to a steel tube which serves as a roller to roll the cloth on and also as a stretcher. Square projections at each end of the roller are engaged by hook cams, which are operated by eccentrics on each end of a steel rod, rotated by a handle at one end, through an angle of 180°.

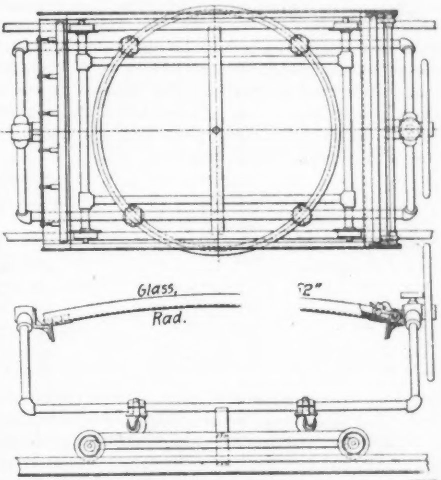

Fig. 1.—Plan and Elevation of Curved Glass Blue Printing Frame.

The operation is this: The rubber cloth is rolled back on the steel tube, and the paper and tracing are placed on the convex side of the glass; the cloth is unrolled with one hand, leaving the other free to adjust or turn down crumpled edges of the tracing, the ends of the steel roller are engaged by the cams, and a turn of the handle stretches the cloth, giving a pressure component normal to the glass; the frame is turned over, the car pushed out of the window, and the frame adjusted to the proper angle with the sun's rays. The operation is rapid; the placing of tracings very easy, and the contact obtained between tracing and paper all that could be desired. Three years of use have demonstrated its convenience and durability.

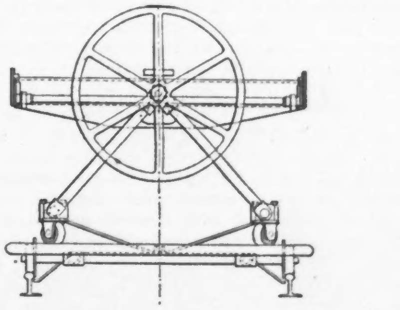

Fig. 2.—Side Elevation of Curved Glass Blue-Print Frame Mounted on Track.

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[*] A paper presented at the New York meeting of the American Society of Mechanical Engineers.

[†] Assistant Professor of Machine Design, Lewis Institute, Chicago, Ill.

STEAM TENDERS FOR DREDGES ON THE MISSISSIPPI RIVER.

(With two-page plate.)

Nearly all the large modern dredges employed in maintaining the navigable channel of the Mississippi River are equipped with dredging machinery only, and not with propelling machinery. They therefore have to be handled by steam tenders or tow boats. The newest of the hydraulic dredges for this work, however, will be self-propelling, by means of side-wheels, thus avoiding the trouble and expense of handling by means of tenders. Five large steam tenders and one propelling dredge are now under construction for the Mississippi River Commission. The former are described in the present article, and in a later article we shall describe the dredge. These articles are prepared from drawings, specifications, and other information kindly furnished by Capt. Mason H. Patrick, U. S. Engineers, who has succeded the late Capt. H. E. Waterman, U. S. Engineers, as Secretary of the Mississippi River Commission. The designs were prepared under the supervision of Capt. Waterman and the Committee on Dredges.

The tenders are stern-wheel steamers, and one of the most interesting features of their design is that the hulls are built entirely of steel. Upon the hull is a two-story superstructure, the engines and boilers being on the lower or main deck, and the living quarters on the upper deck. Above the superstructure rise the two tall smokestacks and the pilot house. The general design of the hoats is shown by the longitudinal section, Fig. 1, and the main deck plan, Fig. 2. The principal dimensions are as follows:

	ft.	ins.
Length between perpendiculars	171	6
" over fantails	195	6
" from forward nosings to outside of buckets of stern-wheel	199	4
Beam molded	36	0
Width over nosings	37	8
Depth, molded	5	6
Draft	4	0
Crown of deck	..	6
Sheer, forward	3	6
Sheer, aft	2	6
Length of fore body	66	0
Length of after body	45	6

The hull framing will be on the transverse system, with 114 frames 18 ins. apart. There will be six transverse bulkheads, one longitudinal bulkhead on the center line and four longitudinal truss frames. The flat bottom has a rise of 1 in. from the outward truss frame, and the hull is wall-sided, with no projecting guards. The frames are of angle irons 3 × 2½ ins., weighing 6.6 lbs. per ft., attached to the center bulkhead by gussets of 7.65 lb. plate 15-ins. high and 14 ins. wide. Reverse frames of angle irons 2½ × 2½ ins., 5 lbs. per ft., will be riveted to the floor frames, except where the transverse bulkheads occur. The stem will be made from a bar 1½ ins. × 5 ins., with its lower end flattened for riveting to the plating. The towing head will be built of plates and angles, and is to be of sufficient strength to render unnecessary the use of the usual gallows frame. The deck beams will be Z-bars 3 × 3 ins., 8.4 lbs., spaced to coincide with the frames, to which they are to be secured by gusset plates.

The transverse bulkheads will be watertight, built of 7.65 lb. plates, riveted to floor and deck beams, and stiffened by angle irons 2 × 2 ins., 3.2 lbs., placed alternately on opposite sides of the bulkhead and 24 ins. apart. In the collision bulkhead will be a manhole, strengthened by an iron ring, and provided with a water-tight door. The central longitudinal bulkhead will extend from frame No. 21 to the stern. It will be of similar construction to the transverse bulkheads, with double-riveted lap joints for the plates, but its stiffeners will be 18 ins. apart, coinciding with the frames. This bulkhead will not be water tight, and will have manholes 12 × 16 ins., stiffened on the free edges with bars ¼ × 1½ ins. The manholes will not be fitted with doors. The longitudinal truss frames will be 6 ft. c. to c., with top and bottom chords composed of two 5-lb. angle irons, 2½ × 2½ ins., and a 10-lb. web plate. The chords will pass unbroken through the transverse bulkheads, and between these bulkheads they will be connected by double-panel lattice bracing of 4.1 lb. angles, 2½ × 2½ ins.

The hull plating will be of 12.75-lb. and 10.2-lb. plates, laid with 15 strakes, alternately inside and outside. The width on the flat will be 36 ins., c. to c. of laps, and the ruling length will be 18 ft. All seams will be single riveted, except the keel strake seams, which will be double riveted. The butts will be double riveted, and fitted with butt straps 1-16-in. thicker than the plates. The deck plating will be 13 strakes, 36 ins. c. to c. of laps, except the plate sheer, or outside strake, which will be of the requisite width to come flush with the gunwale angle. The center strake and plate sheer will be of 12.75-lb. plate; all the others will be of 12.2-lb. plate.

All plates and angles are to be of soft steel, having an ultimate tensile strength of 52,000 to 62,000 lbs., an elastic limit of not less than half the ultimate strength, with an elongation of 26% in 8 ins., and a minimum reduction in area of 50% at point of fracture. Rivets must stand driving the shank into the head, when cold, without showing any signs of fracture on the outside edge. The rivets will be of soft steel or Burden's best, ⅝-in. diameter, all double riveting being done in chain fashion. Heavy drifting must not be resorted to, but holes made fair by reaming. The depth of countersink must be at least 75% of the thickness of the plate or bar. The bottom of the hull will be tested by filling with about 6 ins. of water before the boat is launched, and all leaks or imperfections then discovered must be made good.

The deck-house will commence at frame No. 14 and will be 28 ft. wide as far as the engine room, where the side bulkheads will widen out to 34 ft. and conform to the run of the boat. The stanchions will be of oak, 3¾ × 3¾ ins., 8 ft. apart, except that at the boilers 4-in. iron pipe stanchions will be used, set in cast-steel flanges. The boiler deck or upper deck will be 11 ft. 6 ins. above the main deck, and floored with yellow pine planking ⅞ × 3 ins., tongued and grooved, and beaded on the under side. The siding of the deck-house will be of similar planking. The pilot-house will be 13 ft. long, 13 ft. wide and 12 ft. 6 ins. high.

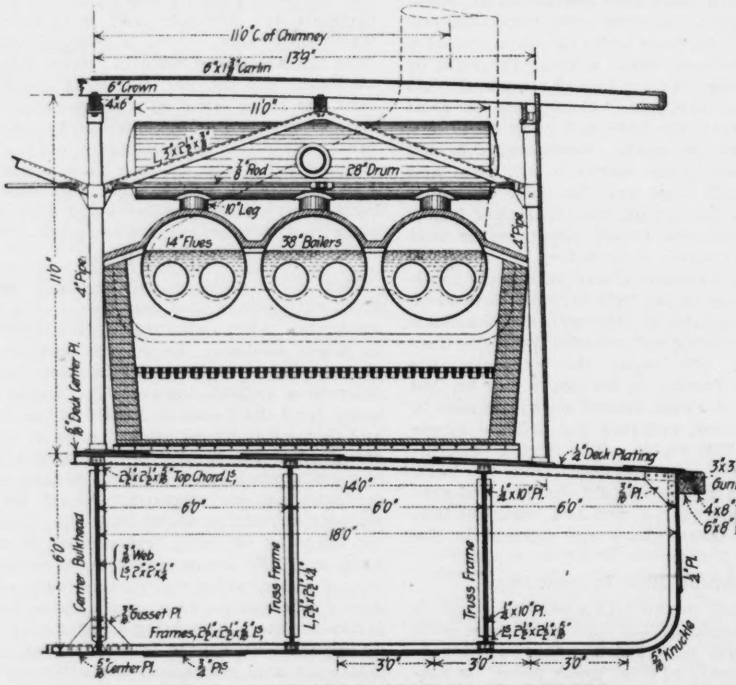

FIG. 3.—HALF CROSS-SECTION AT BOILERS.
STEAM TENDER FOR HANDLING DREDGES ON THE MISSISSIPPI RIVER.

There will be two balanced rudders, 9 ft. 6 ins. apart, with blades extending 11 ft. forward and 11 ft. aft of the rudder stocks, which are 8-in. lap-welded tubes, ⅝ ins. thick and 17 ft. long. The blades will be of 7.65-lb. steel plates and 5-lb. angle irons 2½ × 2½ ins., with a 3-16-in. bottom plate and a top filling of 3-in. plank. They are not to be watertight, and a number of ¾-in. holes will be punched in the bottom plates.

The main engines will be of the usual horizontal type for Mississippi River steamers, having two horizontal cylinders 22 ins. diameter and 8-ft. stroke resting upon the box-girder cylinder beams. The pitmans or connecting rods will be 40 ft. long, c. to c., built of iron or steel lap welded tubes efficiently trussed and having solid stub ends inserted. The shaft will be of hammered steel, with five wheel flanges for the attachment of the arms or spokes. The wheel will be 24 ft. 6 ins. diameter over the arms, with five sets of 16 arms, carrying floats or buckets 34 ins. wide, 24 ft. long and 1⅝ ins. thick. Steam will be supplied by six main boilers of the Mississippi River type, 38 ins. diameter and 30 ft. long, designed for a working pressure of 200 lbs. Each boiler will have two 14-in. lap-welded flues of 0.33-in. steel. The shells will be of marine steel 0.31 in. thick, of 62,000 lbs. tensile strength, and in rings of as great length as practicable. The longitudinal seams will be above the fire line. Each battery will have a 28-in. steam drum, 11 ft. long, connected to each boiler by legs 10 ins. diameter and 6 ins. long; also two mud drums 16 ins. diameter and 11 ft. long. The smokestacks will be 3 ft. diameter, with the tops 50 ft. above the grate bars. The main steam pipes will be of lap-welded tube, with riveted steel flanges. They will be 8 ins. diameter from the drum to the T connection, thence 9 ins. to the throttle valve, beyond which two 7-in. pipes will lead to the cylinder. The boilers and pipes will be covered with magnesia block clothing. Fig. 3 is a half eross-section at the boilers.

There will be two vertical, duplex, outside-packed feed pumps, each having sufficient capacity to supply both batteries of boilers when running at a piston speed of 60 ft. per minute. A similar pump, but of the horizontal pattern, will be supplied for fire purposes, and with a piston speed of 100 ft. per minute will have a capacity of 100 gallons per minute, delivered at a pressure of 125 lbs. There will also be two feed water heaters, three double-barrel double-cylinder "Providence" steam capstans, with cylinders 7 × 8 ins., a steam steering gear, and an auxiliary boiler of the vertical, submerged-tube type, 42 ins. diameter and 9 ft. high. The current for 60 incandescent lamps, 2 arc lamps and an 18-in. searchlight of 4,000 c. p. will be supplied by a 110-volt multipolar dynamo, directly coupled to a horizontal steam engine. The living quarters will be heated by steam. The drawings and details were prepared by Mr. Percy H. Middleton, Assistant Engineer, who is now in charge of the inspection of the construction of the boats. The contract for the five tenders were let in May, 1898, to the Iowa Iron Works, of Dubuque, Ia. The list of bids was given in the supplement for our issue of June 9, 1898.