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TABLE OF CONTENTS.

THE NAVAL PROGRAM FOR 1900 calls for three armored cruisers of about 13,500 tons displacement each; three protected cruisers of about 8,000 tons each; six light draft gunboats of about 1,000 tons each, and six smaller gunboats of about 800 tons each. This is a total of about 75,300 tons, or the largest annual increase ever proposed, though this program is not yet definitely fixed by the Board of Construction. The six armor clads already provided for may be carried over until 1900-1901, or until the armor question is settled by Congress. The armored cruisers proposed can best be appreciated when it is considered that our present largest ship of that class—the "Brooklyn"—has a displacement of only 9,215 tons.

THE TEST OF THE "HOLLAND" SUBMARINE BOAT, officially made by the Board of Inspection and Survey of the U. S. Navy Department, has been reported upon by the board. This report is, that after a thorough inspection of the plans and of the vessel itself, that the "Holland" fulfilled all the requirements of the Department. Chief Engineer John Lowe, U. S. N., who was on the boat during the test, believes that the "Holland" is a successful and veritable submarine torpedo boat, capable of making an efficient attack on an enemy, unseen and undetectable; and that she is an "engine of warfare of terrible potency."

CONTRACTS FOR THE NEW CRUISERS of the "Denver" class have been made. All bidders' plans were rejected and the contract for one ship each was given to the following firms:

Townsend & Downey, New York.	$954,500
Trigg & Co., Richmond, Va.	1,027,000
Lewis Nixon, Elizabethport, N. J.	1,039,966
Bath Iron Works, Bath, Me.	1,041,650
Union Iron Works, San Francisco, Cal.	1,041,900
Fore River Engine Co., Massachusetts.	1,065,000
Total	$6,170,016

THE WESTERN WATERWAYS ASSOCIATION held a two days' convention at Memphis on Nov. 14 and 15. The following resolutions were adopted at the close of the convention:

That we are more firmly convinced than ever that it is the duty of the general government to make liberal appropriations for the improvement of all the navigable rivers and harbors in the United States. The work which has been done in this regard heretofore has proven of great advantage to the people of this country, and we believe that no appropriation the general government has ever made has been received by the people with such unanimous approval.

That in the judgment of this convention it has become the imperative duty of the United States to assume exclusive control of the work now being prosecuted in conjunction with the Riparian States and levee districts for the protection of the lower Mississippi Valley from the floods which perpetually endanger and frequently inflict great disaster upon that section of the country.

That an unobstructed outlet to the sea is of vital importance to the entire Mississippi Valley, and inasmuch as the present channel through the South Pass is entirely inadequate to meet the wants of commerce and has already caused serious damage to the shipping, the conditions are such as to demand the immediate attention of Congress, and we urge that early provision be made for the improvement of Southwest Pass, so as to permit loaded ships of the largest tonnage to pass through with ease and safety.

We favor liberal treatment of the Mississippi River, the Arkansas River, the upper White River, St. Francis River, Calcasieu Pass and River, Red, Ouachita and Black Rivers, and that the improvement of said rivers be prosecuted under the system of continuous appropriations, suitable locks and dams for overcoming the shoal places in the Tennessee River and that the work be placed under the continuous contract system. We approve the work which has been done by the government for the Cumberland River and recommend prosecution of the same.

We favor the construction by the general government of an isthmian canal, connecting the waters of the Gulf of Mexico with the Pacific Ocean.

We favor the establishment of an additional department of the government to be called "the Department of Commerce and Industries," believing that great and constantly increasing appropriations would thereby be secured and these interests would receive greater and more direct consideration and that the people of our country would be greatly benefited. The head of such department should be a member of the Cabinet.

THE IMPROVEMENT OF THE OUACHITA RIVER was debated at a convention held at Monroe, La., Nov. 8. Resolutions were adopted petitioning Congress to appropriate funds for the improvement of the river by a system of locks and dams.

A CHICAGO SHIP CANAL connecting the North Branch of the Chicago River with Lake Michigan is again being proposed, and the matter has been submitted to the council committee on harbors. The channel would be located near Bowmanville, and would be $2\frac{1}{2}$ miles long, 150 ft. wide and 45 ft. deep. According to reports, about half of this would be in brick clay, which could be sold to brick makers. Mr. M. Van Allen, C. E., is one of the projectors.

INTERCHANGEABLE MILEAGE TICKETS ON RAILWAYS are asked for from the Trunk Line Commissioners, in a petition representing 15,000 merchants in 19 States, forwarded by Mr. Simon Sterne, Chairman of the Railway Committee of the New York Board of Trade and Transportation. What is wanted is a 2,000-mile mileage-book, interchangeable and accepted as fare on all railways controlled by the Commission, this book to permit also the free carriage of 250 lbs. of baggage, and to be sold at the uniform rate of 2 cts. per mile net, with a time-limit of one year. The petitioners believe that such a book would be very popular, and enhance freight and passenger traffic, and be in the interest of public policy. The Western and Central Passenger Associations have already thoroughly tested the system with profit to all concerned. As compared with the present issue of 1,000 and 2,000-mile books for fixed lines of travel, the proposed system means a book good for travel on any railway within a prescribed limit.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Norfolk & Western R. R., near Riverton, Va., on Nov. 15. The engine of a heavily loaded freight train left the track in a deep cut. Ten cars were demolished and three trainmen killed.

THE STEAMER "PATRIA," of the Hamburg-American Line, caught fire on Nov. 15 while in the English Channel on the way from New York to Hamburg, and was abandoned the next day, when all attempts to tow her into port had failed. The passengers and crew were saved. The "Patria" was a twin-screw vessel of 4,249 tons, and was built at Stettin, Germany, in 1894.

THE CLYBOURN JUNCTION STATION of the Chicago & Northwestern Ry., at Chicago, is being built in the angle between two sets of diverging lines, both of which have been elevated above the street level. A roadway from Armitage Ave. forms the approach for express wagons, etc., the roadway being widened out to the full available width at the front of the building, so as to allow the wagons to turn. The baggage is raised to the platform level by an elevator. There is also a stairway approach between the tracks at Clybourn Place. On each side of the station is a subway leading to an island platform, separated from the main platform by two tracks. The building is about 50 x 100 ft., one-story high, and is built of rough red brick, with stone trimmings and covered with a tile roof. The architects are Frost & Granger, of The Temple, Chicago, and the work is being done under the direction of Mr. E. C. Carter, Principal Assistant Engineer, C. & N. W. Ry.

THE FIRST COREAN RAILWAY was opened to traffic, on Sept. 18. This is the Kyeng-in Railway, between Seoul and Chemulpo, the track being laid to within 5 miles of Seoul. It owes its existence to the American Trading Co., which bought the control from the Japanese. It is of standard gage and is $26\frac{1}{4}$ miles long, as opened. The Japanese government appropriated $900,000 for its completion, and American materials and cars are used adapted to first, second and third-class passengers. For the present there are two trains daily, each way.

A RAILWAY CONGRESS is to meet in Paris on Sept. 15, 1900, for the discussion of the following subjects: Ways and works; locomotives and rolling stock; traffic; railway accounts, etc., and light railways. A number of prominent railway men in Europe and the United States have signified their intention to contribute papers on these topics, and the United States government has been invited to send delegates.

TWO HANDSOME TRAINS have been put in service by the Chicago & Alton R. R., to run between Chicago and St. Louis, as the "Alton Limited." On Nov. 15 the trains were on exhibition in the two cities, and short trips were made with parties of invited guests, the Chicago train running from the Union Station to Joliet and back. Lunch was served on the trip. Each train consists of six cars, built by the Pullman Palace Car Co., and hauled by an eight-wheel engine built at the railway company's shops. The cars include a mail car, with anti-telescoping vestibule; a combination baggage and day car (40 passengers); a combination chair car, in which the forward half of the car is fitted with ordinary reversible seats and the rear half with revolving chairs (80 passengers); a chair car (80 passengers); a smoking and dining car (with six tables in the dining room, 14 chairs in the smoking room, and a buffet for serving light lunches), and a parlor car having two private staterooms or compartments forward of the saloon and a long covered and enclosed observation platform at the rear end. The mail car is 66 ft. long over the sills and 60 ft. inside; the other cars are 72 ft. 6 ins. long over the sills, and they are all mounted on six-wheel trucks. Gas and electric light are fitted to the cars. The interior finish is very elaborate, and all the cars have wide vestibules. The exterior finish is rather novel, the color being dark maroon to the belt rail and a light shade of crimson above, while the trucks and iron work are olive green. The engines correspond to this color scheme and are gorgeous with crimson and maroon cab, dome, etc.; olive green wheels and pilot, and a maroon tender. Mr. C. H. Chappell, Vice-President and General Manager; Mr. A. V. Hartwell, Purchasing Agent, and Mr. J. Charlton, General Passenger Agent, were among the representatives of the railway company on the trip.

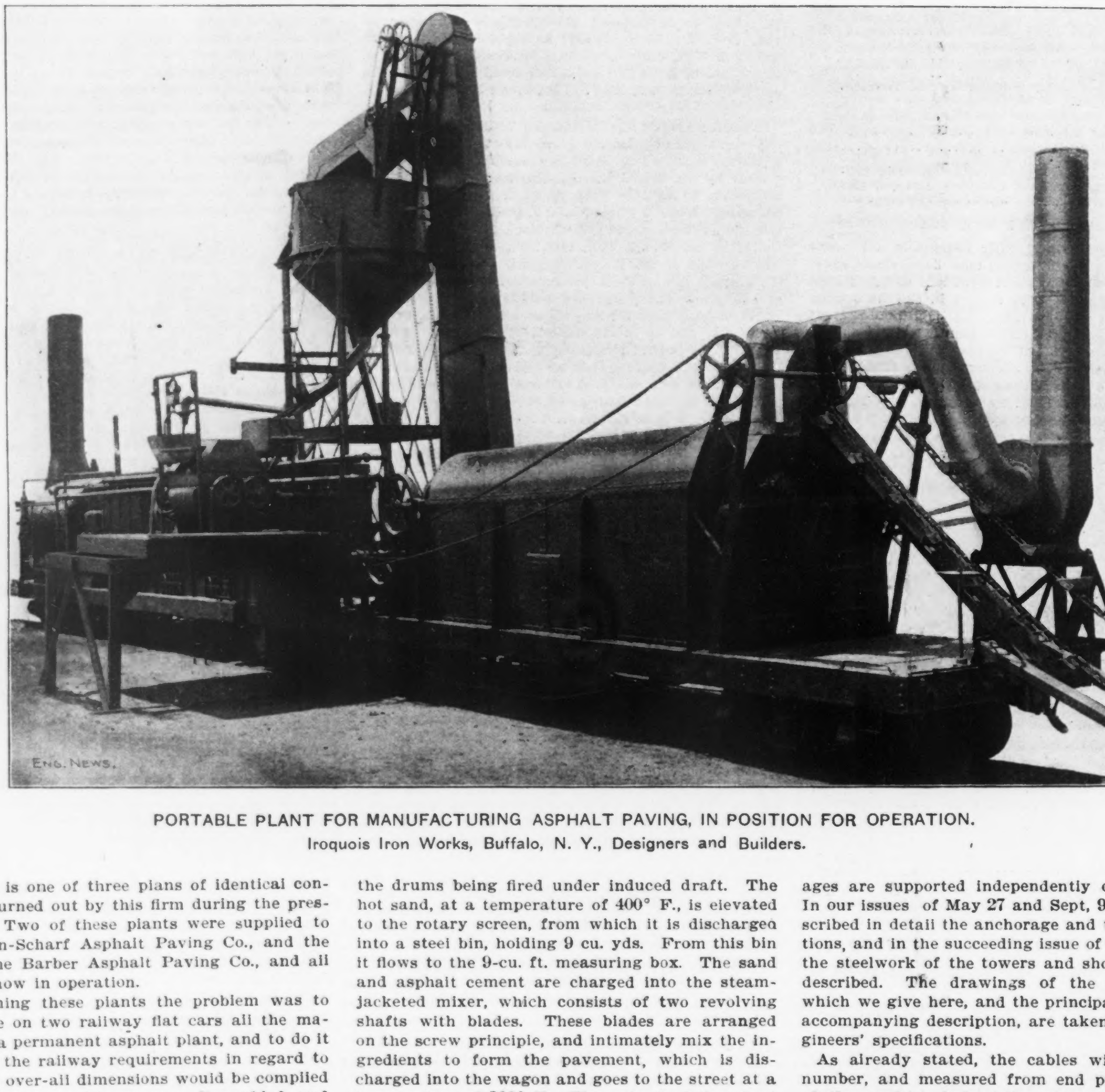
THE GRANTING OF FRANCHISES IN CUBA will be brought before Congress at its next session. Under the Foraker resolution prohibiting such grants during the American occupation, the Administration and the promoters of Cuban progress are convinced that much harm is being done, and that progress is retarded. Cuba wants railways, trolleys, sewers and water supply; and these can only be secured with American money and under franchises making the investment of money safe. It will be the business of Congress, however, to frame legislation that will prevent an abuse of the privileges granted, and to allow the broadest competition.

THE SEWERAGE SYSTEM OF HONOLULU, Hawaiian Islands, is now under construction, according to the plans prepared by Mr. Rudolph Hering, M. Am. Soc. C. E. The contract for all work except the outfall, including about 12 miles of vitrified pipe, was let to Vincent & Belser, of San Francisco, Cal., at about $90,000. The outfall will include about 700 ft. of 24-in. vitrified pipe laid in the mud and 4,100 ft. of 24-in. steel pipe, laid in a trench blasted in the coral rock. This will include cutting through a ridge of rock 22 ft. below water. The discharge end of the pipe will be in 100 ft. of water. For some hundreds of feet from shore the pipe must be covered with concrete, which will be laid in bags by native divers, without the use of diving suits. The method of laying the pipe is not yet determined upon, but it will probably be floated on the surface by pontoons and gradually lowered. For the heavy drilling a pier will be built, enabling work to be done more expeditiously than from a scow. The power for the compressors, etc., will be furnished by a gasoline engine, owing to the high cost for coal, which is about $10 per ton, while gasoline costs but 12 cts. per gallon. This outlet sewer has been let to Wilson & Whitehouse, of Honolulu, at about $34,000.

RECENT FIRE TESTS OF FIREPROOFING by the British Fire Prevention Committee comprise tests of fire-proof wood, wire glass casements and Luxfer prism skylights. The fire-proof wood was tested as a partition running across the testing chamber, and fire was applied to one side for 5 mins. at 1,000° F., for 10 mins. at 1,150° F. and for 15 mins. at 1,300° F. The partition was made of 1-in. pine boards treated by the process of the British Non-Inflammable Wood Co., of London. As a result of the test, the surface of the boards was charred, but no incandescence or spread of flame was observed, nor did the material, as far as could be seen, contribute in any way to the spread of flame. The Luxfer prism skylights, five in number, were built at the top of the testing chamber. The duration of the test was 30 mins., with a temperature rising to 1,300° F., and an application of water at two 15-min. intervals for 2 mins. each time. Only one skylight survived the test, the other four failing after 21 mins., 22 mins., 29 mins. and 30 mins., respectively. In the casement test with wire glass, the casements, three in number, each 2 ft. 9 ins. x 3 ft. 11 ins., were arranged in a partition across the chamber and heat was applied on one side for 45 mins., the temperature rising to 1,800° F. Water was applied at 30 mins. and at 45 mins. As a result of the tests, the glass in the casements was unbroken, but it fused and doubled up into various shapes.

A PORTABLE ASPHALT PAVING PLANT OF LARGE CAPACITY.

We illustrate in the accompanying cut a portable plant for manufacturing asphalt paving, which has been designed to meet the requirements of paving in small cities where the expense of a permanent plant is not warranted. In our issue of Oct. 6, 1898, we illustrated and described briefly, the first plant of this sort built in the United States, which was designed for the Warren-Schart Asphalt Paving Co., in 1889, by Mr. Samuel Whenery, M. Am. Soc. C. E., of New York city. In 1896 a similar plant was built for the Barber Asphalt Paving Co., by the Iroquois Iron Works, of Buffalo, N. Y., and since that time a number of others have been put into use, one of which, designed by Frederick H. Hetherington, of Chicago, Ill., for the Assyrian Asphalt Co., was described in our issue of Sept. 15, 1898. The plant illustrated here was built by the Iroquois Iron Works, of Buffalo, N. Y., and is one of three plans of identical construction turned out by this firm during the present year. Two of these plants were supplied to the Warren-Scharf Asphalt Paving Co., and the other to the Barber Asphalt Paving Co., and all three are now in operation.



PORTABLE PLANT FOR MANUFACTURING ASPHALT PAVING, IN POSITION FOR OPERATION.
Iroquois Iron Works, Buffalo, N. Y., Designers and Builders.

In designing these plants the problem was to concentrate on two railway flat cars all the machinery of a permanent asphalt plant, and to do it so that all the railway requirements in regard to weight and over-all dimensions would be complied with when the machinery was dissembled and packed for shipment. The cars were constructed of 12-in. channels decked with ¼-in. steel plates. Each car is 45 ft. long and 10 ft. wide, and weighs 36,000 lbs. empty and 112,000 lbs. loaded. The trucks are 80,000-lb. capacity Pennsylvania R. R. standard trucks. As will be seen from the illustration, one car carries the boiler and steam melting tank for the asphalt, and the other car carries the sand dryers and storage bin. The platform for the mixer extends from the side of the latter car, when the plant is set up for operation, and spans a driveway for the wagons used to convey the material from the plant to the street being paved.

The boiler is of the Scotch marine type, and is 8 ft. diameter and 9 ft. long, with two furnaces, and works at 130 lbs. pressure. The asphalt received in barrels is broken into lumps and hoisted in buckets by a special hoisting engine to the charging holes in three rectangular tanks fitted with steam coils and holding 10 tons each. In these it is melted and heated to 320° F., being constantly agitated during the melting by compressed air being blown through the material at 15 lbs. pressure. From the tanks, the asphalt cement flows by gravity to a pneumatic lift, placed under the car, from which it is forced to the bucket on the suspension scale by compressed air, the man at the mixer operating a two-way air valve for this purpose.

On the other car, the cold sand elevator discharges the sand into two 40-in. drums, 18 ft. long, the drums being fired under induced draft. The hot sand, at a temperature of 400° F., is elevated to the rotary screen, from which it is discharged into a steel bin, holding 9 cu. yds. From this bin it flows to the 9-cu. ft. measuring box. The sand and asphalt cement are charged into the steam-jacketed mixer, which consists of two revolving shafts with blades. These blades are arranged on the screw principle, and intimately mix the ingredients to form the pavement, which is discharged into the wagon and goes to the street at a temperature of 320° F. The output of the plant depends on the time allowed in the mixer, which is the limiting element, and in practice this time varies from 1 to 1½ mins. Allowing a minute and a-half, the maximum output is 350 boxes per day of 10 hours, and this, converted into square yards of pavement, gives on the average 1,750 sq. yds. of 2-in. topping, and 2,275 sq. yds. of 1½-in. topping.

The new features in these plants are their large size and capacity, the use of steam melting tanks, and the power transmission. The last is simple and direct, the drums and elevators being driven by a 25-HP. Westinghouse engine, geared direct, and the mixer by a 25-HP. engine, geared direct, doing away with all belting and countershafts. The general mechanical excellence of the plant is well illustrated in the accompanying illustration.

THE CABLES AND SUSPENDERS FOR THE NEW EAST RIVER BRIDGE, NEW YORK CITY.

(With full-page plate.)

The drawings on our inset sheet this week show the general details of the main cables and suspender cables, and their various accessories, for the center suspension span of the New East River Bridge, now under construction at New York city. As stated in a previous issue (Eng. News, July 30, 1896), the center span of this bridge is 1,600 ft. long, and is carried by four cables passing over steel framework towers to inshore anchorages. The shore spans between the towers and anchorages are supported independently of the cables. In our issues of May 27 and Sept, 9, 1897, we described in detail the anchorage and tower foundations, and in the succeeding issue of Feb. 17, 1898, the steelwork of the towers and shore spans was described. The drawings of the cable system which we give here, and the principal facts of the accompanying description, are taken from the engineers' specifications.

As already stated, the cables will be four in number, and measured from end pin to end pin of the anchor chains; the outer cables will be 2,985.08 ft. long and the inner cables 2,985.06 ft. long. Each cable will be made up of No. 8 B. W. G. (0.165-in.) steel wire, in 37 strands, each strand containing 281 wires laid straight. The arrangement of the different strands in the cable is shown by Fig. 1. The cable will be built up strand by strand, and each strand will be kept separate by confining its component wires with temporary wire bands, until all the strands have been completed. When all the strands are completed, the temporary wire bands will be removed and the whole 10,397 wires will be firmly clamped into a cylindrical cable by the permanent bands of cast-steel which carry the suspenders for the support of the floor beams. When all the permanent bands are in place the cables will be covered with steel plates, overlapping so as to shed water.

Referring to the illustrations, Fig. 1 shows the arrangement of the strands making up each of the four main cables. Fig. 2 shows the arrangement of the suspenders for the eight panels on each side of the center of the span, and Fig. 3 shows their arrangement elsewhere. Fig. 4 gives enlarged details of the suspender connections with the main cables, and with the stringers and floor beams. Fig. 5 shows the steel plate coverings for the cables. Fig. 6 shows the wire splice adopted for connecting the ends of the cable wires. Figs. 7 to 15 shows the various cable bands and saddles for the suspender cables; the suspender at the span center being No. 70, and the numbers increasing toward this from Suspenders No. 32 at the towers.

The methods of erection and the character of the material and workmanship required are given as follows by the specifications:

Method of Erection.—Each cable strand will be built several feet higher, or with a smaller versed sine, than its final position in the cable. This will be accomplished by placing the shoe at one end of the strand several feet back of its final position. Then when the strand is finished, the shoe will be placed on the permanent pin and the strand will be adjusted to its proper versed sine. When all the wires of a strand have been laid and before the shoe is placed in its final position on the pin, the strand will be banded to keep the wires in place. The bands will be composed of five or six turns of No. 10 steel

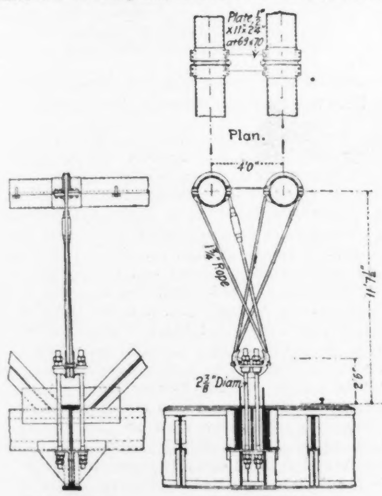


Fig. 2.—Arrangement of Suspenders for the First Eight Panels Each Side of the Span Center.

wire, securely locked, and will be placed at intervals of not more than 5 feet. For the ends of the strands within the anchorages, these bands will be permanent and must be placed not more than 2 ft. apart.

When all the strands for a cable are complete, the temporary wire bands will be removed therefrom; all the wires of the cable will be brought together, compactly, into cylindrical form; and the main cable bands will be put on and screwed up so as to grip the cable tightly. The main bands will be spaced at intervals of about 20 ft., measured horizontally. Intermediate bands, composed of eight turns of No. 8 steel wire, securely locked at the ends, will be spaced at intervals of about 4 ft. between the main bands. When completed the cables will be covered with steel plates of 1-16-in. thick, extending from main band to main band, and overlapping at the joints so as to shed water and keep the cable wires dry. The suspenders, with their sheaves and fittings, will be put in place on the cable bands when the cables have been completed.

During erection the saddles will be placed about 6¾ ins. back of their mean position on the saddle beds; and the cables between the main towers and the anchorages must be supported at the elevations which they will assume at mean temperature when the total dead load of the bridge is suspended from their main spans. The lower portions of each cable will be supported in their proper permanent positions at points near the cable clamps within the anchorage; and, as each of the strands of the upper portions of the cables is lowered into permanent position, it must be pressed down and held to its place at these points in adjusting to position.

Steel for Wire.—All steel for wire shall be made in an open hearth furnace lined with silica. This steel shall be made entirely from pig iron, without the admixture of scrap of any kind or form and without the use of any other stock. No portion of the pig iron used shall contain more than .06 of 1% of phosphorus nor more than .05 of 1% of sulphur. The use of iron ore for the reduction of carbon in the furnace charge will be allowed according to usual and good practice. The recarbonization of steel and the addition of manganese shall be accomplished by the use of ferro-manganese or spiegeleisen only, and shall be performed carefully in a manner most likely to give good results. During the reduction of the steel in the open hearth furnace, it shall not be decarbonized below .10 of 1%. The finished steel shall not contain to exceed the following limits of the elements named:

Phosphorus	.04 of 1%.
Sulphur	.03 of 1%.
Manganese	.50 of 1%.
Silicon	.10 of 1%.
Copper	.02 of 1%.

The finished steel shall be made into bottom cast ingots, not larger than 16 ins. square in greatest cross section, weighing not more than 5,000 lbs. each, and cast in groups of not less than six ingots to each group. The steel shall be run slowly and continuously from the ladle, in order that the ingot molds may fill gradually with the steel at as low a temperature as practicable. All portions of ingots containing bubbles shall be cut out. Sand shall not be thrown in the top of the ingot molds after they have been filled with steel. The engineer reserves the right to take drillings from the finished steel, for check analysis, and the same must not show an increase over the specified limits for phosphorus or sulphur of more than 25%.

Steel for Castings.—Steel for castings shall be made in an open hearth furnace lined with silica. At least one-third of all stock used for steel castings shall be pig iron; and, where scrap is used, it shall be of a kind and quality satisfactory to the engineer: During the reduction of the steel in the furnace, it shall not be decarbonized below .10 of 1%. In making steel for castings, the use of iron ore, ferro-silicon, ferro-manganese and spiegeleisen will be allowed according to usual and good practice. The finished steel shall not contain to exceed the following limits of the elements named:

Phosphorus	.06 of 1%.
Sulphur	.04 of 1%.
Manganese	.80 of 1%.
Silicon	.35 of 1%.

All steel castings shall be carefully and thoroughly annealed. Test pieces taken from coupons on the annealed castings shall show an ultimate strength of not less than 60,000 lbs. per sq. in., an elongation of not less than 20% in 2 ins., and shall bend 90° around three times their thickness without rupture. All steel castings must be true to the drawings, with smooth surfaces, and all re-entrant angles must be neatly filleted. They must be planed smooth and true where the drawings require, and all holes for bolts must be drilled accurately. The main bands and suspender sheaves must have the grooves, in which the suspenders are to rest, chipped and filed sufficiently to remove all irregularities and to leave them smooth and true, so as to afford a satisfactory bearing for the suspenders. They must have their end surfaces trued up in the same manner, in order to afford a smooth and uniform support for the cover plates.

Steel for Bolts, Nuts, and Cover Plates.—The methods of manufacture and the chemical requirements of the steel for all bolts, bolt ends, nuts, and cover plates will be the same as those of the steel for wire. It must have the following physical requirements: Maximum ultimate strength, 68,000 lbs. per sq. in.; minimum ultimate strength, 60,000 lbs. per sq. in.; maximum elastic limit, 35,000 lbs. per sq. in.; minimum percentage of elongation in 8 ins., 20%. All bolts will be turned and machined and must have the threads true and carefully made. All screw threads shall be of the United States standard. Their threads must be full and true and fit neatly.

General Provisions as to Steel.—All steel shall be made in works of established reputation for the kind and character of materials specified. All stock and materials used in the manufacture of the steel and all operations at the furnaces or rolls or elsewhere about the establishments, where the steel is made or manipulated, shall be subjected to the examination, approval, and acceptance of the engineer, or his authorized inspectors, who shall have free access to all records appertaining to the manufacture of the steel from the beginning until its final acceptance, and shall upon their request be furnished with neat and legible copies thereof. All superintendents, foremen, melters, helpers and others engaged in the manufacture of the steel for this work shall be men experienced in this line of work, and of sufficiently recent practice to insure the best results.

The manufacturer shall have an analysis of every melt made by a chemist satisfactory to the engineer; and two copies thereof certified by such chemist shall be delivered to the inspector appointed by the engineer. All specimens for testing must be made to shape required by the inspectors, at the expense of the contractor. The inspection will be very thorough and tests will be made and repeated as often as is deemed necessary by the engineer to satisfy him that none but the best material goes into the work. A piece of wire 10 ft. long shall be cut from each coil of wire by the inspector at the site of the bridge for the purpose of testing; and no coil shall be used before the tests therefor have been fully completed.

Acceptance of any material at the mill, or foundry, or elsewhere, before its use, will not be considered as final. Should any piece prove to be defective, under any of the manipulations, until it is in its final position on the work, it will be rejected and must be replaced by a satisfactory piece, without additional compensation to the contractor. When acid open hearth steel is made in mills producing other kinds of steel, no material will be accepted unless made especially for this work; and, when so made, it shall be subject to a system and manner of identification approved by the engineer; and, furthermore, such especially made steel shall be handled and manipulated by itself or isolated in any manner required by the engineer, to prevent the possibility of its becoming mixed with other kinds of steel. No steel shall be made or cast unless the engineer or his representative is present.

Wire.—The wire for the cables and for the suspenders and ties must have an ultimate strength of 200,000 lbs. or more to the square inch, and must have an elongation under test of at least 2½% in 5 ft. of observed length, and of at least 5% in 8 ins. of observed length. It must be capable of being coiled cold around a rod of its own diameter without cracking. All wire will be bright and, for the cables, it will be of size No. 8, Birmingham wire gage, not straightened by machine, but drawn absolutely straight and free from any tendency to coil when

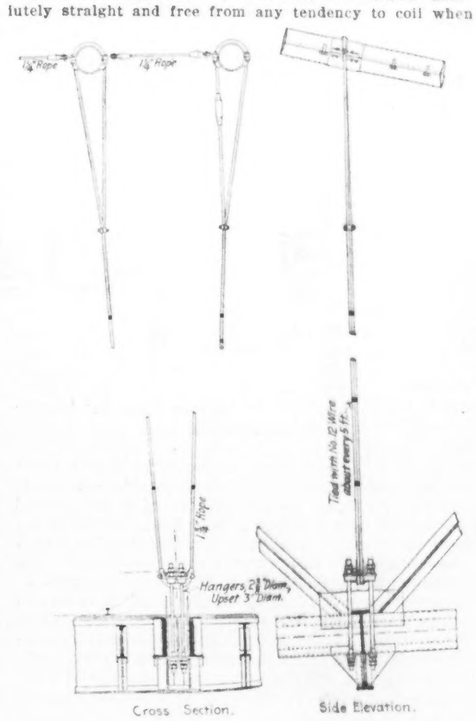


Fig. 3.—Arrangement of Suspenders Outside of the Sixteen Center Panels.

unrolled from the drums. It shall be made in lengths of not less than 4,000 ft. and shipped to the site on drums of such diameter as not to cause any tendency to coil.

All the wires of each cable strand will be spliced so as to form one continuous wire. The splices must be made so as to have a strength of at least 95% of the strength of the wire. The splice, which will accomplish this result with the least increase in size above that of the wire, will be approved by the engineer. The right and left sleeve nut splice, shown on the drawings and used for the cables of the New York and Brooklyn Bridge, is the only one known to the engineer which will give the required strength. The lengths of the wires must be arranged so that the splices will be uniformly distributed throughout the cables.

The suspenders will be made of seven strand (wire core) steel wire rope, 1¾ ins. in diameter. The two ends of each suspender will have socketed screw ends, one with a right hand and the other with a left hand thread; and these screw ends will be joined by a sleeve nut, as shown on the drawings. The suspenders and ties must be laid or cut off under a stress of not less than 10% nor more than 15% of their ultimate strength. The suspenders will be made of such lengths as to permit the adjustment provided for in the drawings.

Protection from Oxidation.—As soon as the wires are made they will be coated by immersion in boiling linseed oil. Each of the cable strands will, while it is being banded with the temporary bands, be filled with as much cable shield, to be approved by the engineer, as it will hold. Before the main cable bands are put on, the interstices of the cables will also be thoroughly filled with as much cable shield as they will hold. After the main cable bands are in place, the outside of the cable will be coated with the cable shield. During their manufacture the suspenders will be filled with as much cable shield as they will hold. Before leaving the shops the main bands and the cover plates will receive, inside and out, two coats of durable metal coating, to be approved by the engineer. After the suspenders are in place, and after the erection of the suspended structure has begun, the suspenders will receive two thorough coats of durable metal coating, to be approved by the engineer. When the cables and suspenders are fully completed, the main bands, cover plates, suspenders, and all the connections will receive two coats of white paint, to be approved by the engineer.

IMPROVED APPLIANCES FOR LAUNCHING SHIP'S BOATS.*

By John Hyslop.

Were it expected that heavy boats would have to be launched at sea with any frequency, it is safe to say that no such means of launching them would be relied upon as the crude and inadequate swinging boat davits commonly fitted to ships at present. It would be regarded as a novelty to see a whale ship fitted with davits of this kind. While it is not to be expected that Atlantic liners shall be fitted with whale ship's davits, it appears both interesting and instructive to enquire how far it is prac-

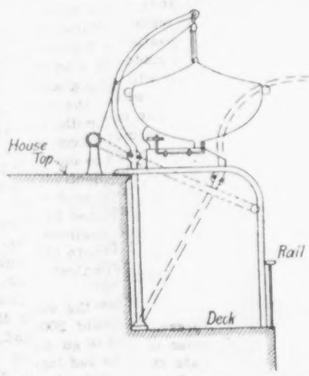


Fig. 1.—Modified Form of Mallory Davit for Lowering Ships' Boats at Sea.

ticable to carry ship's boats inside the lines of a ship's sides, and yet at all times outside the davits; and also to enquire if any better means can be used to operate and control the present common form of davit. Before doing this it may be well to mention the chief details of work necessary in launching: removal of the canvas covering, casting off the gripes, throwing down the outer chock (if this be so arranged), casting off the lanyards or tackles of the guys, hoisting the boat clear of its seat, pushing outward the boat and davits and securing the guys, lowering away evenly the boat by the falls, and unhooking the falls and pushing clear of the ship. Every one of these processes is important, and many of them in instances have been improved.

In the search for new forms of davits it is questionable if the same identical form will be found equally applicable in all cases; and even if the same form is found to be generally applicable, some modification of detail will be necessary. To my mind the principle of the Mallory davit, patented in 1871 and 1873, has much to recommend it. It is simple and vastly superior to the common form. It is inexpensive, not bulky, and it has no need of guys. The boat, though kept inboard, is always outside the davits, and gravity alone will carry the boat outward, ready for lowering, when the ship is on an even keel or only moderately listed, and when more extremely listed any force used to overcome this is more easily and much more effectively applied. The accompanying illustration, Fig. 1, makes the construction and the mode of operation sufficiently clear. A frame made of stout angle-iron is extended outward from the top of a house or boat deck, across the width of the gangway of the deck below, and then vertically to that deck, where it terminates and is secured inside the rail; the horizontal part, and a small portion of the vertical part of this frame is made double, with a separation and a space of approximately 2 ins. between the two members of the frame. Hinged near to the house on the lower deck, on a level with the foot of the frame, and separated from it by the width of the gangway is the davit; this extends upward from the hinge, to and beyond the inboard side of the boat, over which the head is bent in the usual manner.

When the boat has to be launched it is raised by the falls from its seat, the chocks thrown down, and the boat allowed to move outward by means of the fall attached to the back of each davit, and to a distance sufficient for the boat, when lowered in the ordinary or in any other way, to be clear of the ship. This form of davit does not appear to have been adopted or known to the extent that might have been expected. It is a strong and a light device, the strain upon it being only in one direction, and there being no occasion to make it circular in cross-section, being made from flat bar iron. Those I have seen on the newer vessels of the Old Dominion Line (used for boats not of the heaviest kind) being about 5 × 1¼ ins. in cross-section. There is no uncertainty, in my view, as to the advantages of this davit, and none as to the differences in result which might have been attained to, had this method of working been in use where it has been my painful experience to see others fail.

It is, however, I think, susceptible of adaptations that have not yet been made, and is too open to the criticism that the means to operate it under favorable and also unfavorable conditions are not present, are not all of them fixtures, and always ready for use. The fact that two tackles, one to each davit, have to be stretched across the deck, seen to be clear, and hooked on before the davits are operated, is an objection; and although, in case of rolling or of extreme list, these davits would be much easier to control than the ordinary ones, this is not enough. To meet fitly such occasions as arise, appliances should be such that, by reliable and simple means, not to be defeated by rolling or listing, and requiring only manual power and a few men, and controllable throughout the process, the boat can be moved out to a position ready for lowering. The operative means to effect this should be a reasonably compact and unobtrusive fixture, always ready for use. Reference to Fig. 1 will show how easily a small shaft upon the upper deck, running in line with the boat and just inside the davits, could be arranged, in connection with them. This shaft could be supported at each end by a compact frame or standard, have which handles on, and a sprocket wheel near to each end. Over this wheel would pass a chain, which would also pass over a pulley upon the outer part of the davit frame. The ends of the chain would be connected with the davit on opposite sides, in such a way that the revolution of the sprocket wheel by the handles would move the davits either outward or inward, and hold them at any point desired.

Any reference to the class of davits which fall outward from the sides of a vessel would be very incomplete which should omit to notice the ingenious and well-worked-out device of Sir Bradford Leslie, of Falmouth, England, a retired engineer of much experience in the East Indies. The chief novelties of his method are that there are no boat falls, no lowering or hoisting tackles attached to the boats—these are supported from below on cradles situated on the heads of the davits. (Fig. 2.) The davits themselves are lowered vertically in slides down

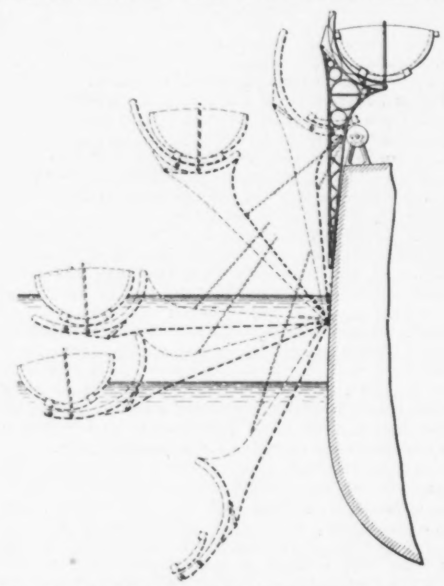


Fig. 2.—Leslie's Davit for Lowering Ships' Boats at Sea.

the outside of the ship through a space of a few feet; and having passed downward through this space, the heads of both davits, with the boats resting upon them, fall evenly outward and downward, until the boat is deposited on the water at an oar's length or more away from the ship, the davits being allowed to sink a sufficient distance free of the boat. The lowering apparatus consists of a wire rope wound round a drum on the ship's deck, and fitted with a suitable brake.

It appears doubtful if any simple and reliable means can be devised for getting boats ready to lower, where the davits have to be rotated, and where the boats have to be moved from a position inside the davits to one outside of them, and this operation, so easy when the deck is level and still, becomes one of extreme difficulty when the vessel is rolling, or when she is inclined; ordinarily the work involves time and effort, which ought to be eliminated. The use of a cog-wheel secured to the vertical part of the davit, say immediately over the rail of the vessel, the cogs of which wheel engage with a worm attached to a shaft running horizontally across the rail of the vessel, the said shaft being turned by a handle situated on the periphery of a wheel placed on the inner end of the shaft, seems calculated to give a control over the whole range of the davit's movement not to be had in the ordinary way. The vessel on which I recently crossed the Atlantic had two of her boats fitted with davits operated in this way, and it seems strange that so simple a device is not in more common use. The patent of James W. McKinney, March 16, 1897, No. 579,119, has this appliance as one of its features,, and has otherwise many ingenious contrivances for raising the boat clear of the chocks, and for the even and steady lowering of it, either from the deck of the vessel of from the boat itself.

In discussing this subject, I have hitherto occupied myself chiefly with the means for operating the davits themselves, and there is with me no doubt that here, more than anywhere else, is there a confessed need of improvement. I have spoken with many ships' officers, but have yet to meet with one who will say that, with the ordinary appliances a ship's boat could readily be launched under conditions of practical difficulty such as have been alluded to. But, while the kind of davits and the mode of oper-

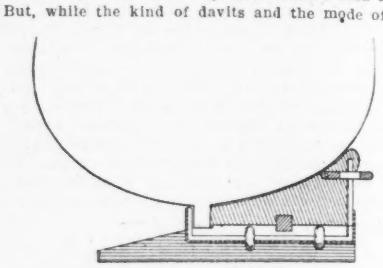


Fig. 3.—Special Chock for Holding Boats Used on the Steamer "Kaiser Wilhelm der Grosse."

ating them is of first importance, every detail and process of launching ships' boats is important and deserving of more attention than it appears to be receiving.

The differing situation of boats about vessels' decks is deserving of consideration—some on chocks near to the deck level and needing to be hoisted several feet to pass over a rail; some kept at rail height and too high for passengers to get into them; some overhead and inaccessible until lowered outside the rail; and some, like the boats of the "Kaiser Wilhelm der Grosse," placed upon, and close to, the upper deck, having no rail either inside or outside of them, themselves constituting a bulwark, and ready to be launched with all the facility attainable where the ordinary davit is in use. Of the various means in use of throwing down the chocks on which the boat rests, or at least of removing the outer ones so that it can be launched, those on the "Kaiser Wilhelm der Grosse" seem adequate and nothing could be more simple. On the inner side the boat is supported by the two chocks in the customary manner, and is held in firm contact with it by the gripes. It is held from moving outward by an iron rod, carried from inboard outward and horizontally through eye bolts on the face of the lower part—the stationary part—of the chock; this rod is turned up at a right angle, for a few inches at the outer end, in such a way as when operated from the deck at the inner end, where a lever handle is situated, the outer end is turned up outside the keel and the boat's movement is prevented.

*Abstract of a paper presented at the general meeting of the Society of Naval Architects and Marine Engineers, held in New York on Nov. 16 and 17, 1899.

SURVEYS OF SITES FOR IRRIGATION STORAGE RESERVOIRS BY THE U. S. GEOLOGICAL SURVEY.

The Secretary of the Interior, on Nov. 11, approved a statement relating to the widely-discussed subject of water storage, recently prepared by Mr. F. H. Newell, Hydrographer in Charge of the Division of Hydrography of the U. S. Geological Survey. This statement will not be officially published for some time; and as the subject is one interesting to many engineers, and to those depending upon a better water supply, we are enabled, through the courtesy of Mr. Newell, to give it, as follows:

Legislation.

The organic law from which has grown the present work of the Geological Survey is dated March 3, 1879. It creates the office of the Director of the Geological Survey, and states that "this officer shall have direction of the Geological Survey and the classification of the public lands and examination of the geological structure, mineral resources and products of the national domain." A fundamental function of the Survey is, therefore, the classification of the public lands, a work which cannot be accomplished until a thorough knowledge is had of the water resources, since for the most part the public lands are within the arid region. The Geological Survey has not only to do with the fundamental scientific problems relating to the earth, but more largely with present and prospective developments of mineral resources and products. Throughout much of the United States the principal mineral of economic value is water, and the study of the distribution and fluctuations of the water supply is among the most important of the functions of the Survey.

The work of the Survey is not confined to the public lands, for later acts of Congress have extended its operations to the "national domain," which includes all of the territory within the possession of the United States. In every state and territory surveys have been or are being made. The extent of these is governed by many considerations, such as the economic and scientific importance of results and the aid or co-operation of individual states.

From the initiation of this Survey in 1879, much attention has been given to the arid region, its great possibilities having been early appreciated. In 1887 the Director was called upon by Congress to consider the question of Federal recognition of the irrigation subject, and in March, 1888, a resolution was passed requiring the Secretary of the Interior, by means of the Director of the Geological Survey,

to make an examination of that portion of the arid region of the United States where agriculture is carried on by means of irrigation, as to the natural advantages for the storage of water for irrigating purposes, with the practicability of constructing reservoirs, together with the capacity of streams and the cost of construction and capacity of reservoirs, and such other facts as bear on the question of storage of water for irrigating purposes.

In October, 1888, an appropriation was made for the purpose of investigating the extent to which the arid region of the United States can be redeemed by irrigation and for the selection of sites for reservoirs and other hydraulic works necessary for the storage and utilization of water for irrigation and the prevention of floods and overflows.

In an act, approved Aug. 30, 1890, it was specified that reservoir sites heretofore located or selected shall remain segregated and reserved from entry or settlement, and reservoir sites hereafter located or selected on public lands shall in like manner be reserved from the date of the location or selection thereof. In a subsequent act, approved March 3, 1891, it is provided that the reservoirs shall be restricted to the land actually necessary for the construction and maintenance of reservoirs.

By the act of Aug. 18, 1894, a specific appropriation was made "for gaging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in arid and semi-arid sections." In later acts there has been included the preparation of reports upon the best methods of utilizing the water resources of these sections.

Maps and Estimates.—Under the authority thus given work has been carried on systematically by the Division of Hydrography, and each year reservoir sites have been discovered and surveyed. In the discovery of reservoir sites assistance is given by the Division of Topography in the course of the preparation of contour maps showing elevations of the surface. These maps also furnish information concerning the extent and character of the catchment areas tributary to various streams.

Differences exist in the character of the surveys in various localities. In many places only a reconnoissance has been made, this being sufficient to develop the fact that a suitable basin exists. At the other extreme, detailed surveys of some localities have been made, showing by contours at 1-ft. or 5-ft. intervals the entire basin to be flooded, and also on a larger scale the site of the proposed dam. Borings to bedrock have also been made—the Survey being in possession of two complete diamond drill machines with all the equipment for work of this character. From the maps and borings, estimates of the cost of construction have been prepared, and plans drawn showing the character of structure proposed, the information being complete for making an appropriation for construction. As a matter of course, if an appropriation should be made, the constructing engineers would modify many features, but the examinations have been carried far enough to afford a close approximation of the cost. A considerable number of reconnoissance surveys can be made during the field season, but large expenditures are required for detailed examinations, so that it has been possible to complete comparatively few of the latter.

The reservoir sites surveyed or segregated have been listed or described in various annual reports of the Survey, beginning with the eleventh. Reference should be made to these volumes for details. During the last year, 1899, surveys in great detail have been made of three sites on the Gila River in Arizona, and of one large reservoir in Hetch Hetchy Valley, on the head waters of Tuolumne River, Cal., also of several sites on the Rio Grande in New Mexico. The results of these surveys will be given in the twenty-first annual report, if not in earlier publications.

It is proposed to continue these surveys as rapidly as funds may be available, giving precedence to those where results have the greatest public importance and interest. As a result of several years' experience, this office has a corps of competent engineers, together with instruments and equipments, and is carrying forward the work probably more rapidly and economically than such work ordinarily can be done by private or corporate enterprise. The question of expense has been carefully considered, and the methods in use have been adapted to secure the maximum efficiency at a minimum cost, consideration being given, of course, to the importance and the permanent character of the results.

Extension of Surveys.—The Geological Survey is often requested to examine reservoirs in this and that locality, and is asked to do work, the aggregate cost of which would far exceed its available funds. With the amount of money that has been appropriated, it is possible to do only a limited amount of work each year, and it has been found economical to follow somewhat closely the progress of the topographic mapping. If the public in general take an interest in the matter and funds are provided, work can be expanded by an increase in the corps of skilled men.

Another question frequently asked, is whether the government will build these reservoirs. That is a subject upon which this office cannot express an opinion. The duty of the Survey is to ascertain the existence of reservoir sites and the cost of storage works, whether these are ultimately built by individuals, by corporations or by the State or Federal government. Some of the reservoirs surveyed or examined have already been constructed, others may be; but the most important are of such magnitude that they cannot be built except by the use of public credit in one form or another. It is to develop these facts that examinations are being made so that intelligent action can be taken by the people.

Co-operation.—In pushing forward these reservoirs surveys co-operation is sought wherever practicable, as in the case of the topographic mapping. In several of the states there is an arrangement by which topographic work is increased within a state, and mapping is pushed forward more rapidly than otherwise would be possible. This results from the state making an annual appropriation to help defray field expenses. An equal or greater amount is spent in field work by the Geological Survey, and the resulting map is prepared and published by the latter, proper credit being given to the state authorities. Such an arrangement was under consideration in the case of reservoir surveys in California during the recent session of the state legislature. Should co-operation in reservoir surveys be offered by states, and appropriation therefor made, it is anticipated that equal sums will be expended by the Geological Survey to hasten the completion of the work within those states.

Summary.—The relation of the Geological Survey to reservoir surveys may be summed up as follows:

The Survey was created primarily for the purpose of examining and classifying the public domain, including the mineral resources and the waters.

It is specifically authorized to survey reservoir sites and to ascertain the extent to which the arid region can be redeemed by irrigation.

It is making general explorations for the reservoir sites and surveying a few of these in detail each year.

It will extend its operation as fast as funds will permit, the work being more rapidly advanced where state co-operation can be had.

Its officers have no concern with the question whether these reservoirs are to be built by private capital or public funds, their work being to ascertain the facts, such as capacity and cost of reservoirs.

REGULATING THE WATER-LEVELS OF THE GREAT LAKES BY A DAM ON THE NIAGARA RIVER.

The proposition to control the water levels of the Great Lakes and deepen the navigable harbors and the waterways connecting them by building a dam across the Niagara River, has attracted the attention of engineers at intervals for a number of years. One of the foremost advocates of this propostion has been Mr. Geo. Y. Wisner, M. Am. Soc. C. E., of Detroit, Mich., who, we believe, was the first to outline a definite plan in a paper presented at the convention of the International Deep Waterways Association, held in Toronto, Ont., in the Fall of 1894. In an address delivered before the Cleveland Chamber of Commerce on Oct. 17, 1899, Mr. Wisner again takes up the subject of damming the Niagara. As Mr. Wisner is at present a member of the United States Deep Waterway Commission, and has access to the data collected by its engineers regarding the hydraulics and hydrography of the Great Lakes, the figures and conclusions given in this address assume an unusual interest. The following is an abstract of the address, and in our issue of Oct. 3, 1895, there will be found a discussion of the same subject in connection with the possible effect of the Chicago Drainage Canal on the lake levels:

The average annual rainfall on the Lake Superior Basin is 28 ins., and varies, so far as known, between the minimum limit of 20 ins. and a maximum of 34 ins. Lakes Michigan and Huron have an average precipitation of 32.5 ins., which varies on different years between 27 and 40 ins. On the Lake Erie basin, the average rainfall is 36 ins., and for different years varies between 28 and 41 ins, from which it will be seen that the amount of water distributed over the entire lake basin may vary upwards of 50% on years of maximum and minimum supply.

The volume of precipitation falling directly upon the surfaces of the lakes is entirely supply, while of that falling upon the watershed tributary to the lakes, a certain portion is absorbed into the earth for supply to subterranean water courses, to appear elsewhere as artesian springs; a part is taken up by vegetation and evaporated, to be again redistributed as rainfall, and the balance finds its way through the swamps, creeks and rivers into the main reservoirs of the lake system. The percentage of the water falling on the watershed which eventually flows into the lakes as supply depends upon the topographical and physical features of the country, and has a wide variation. The clearing up of forests and converting of the land into tile drained farms have greatly modified the volume of flow, and the time required for the run-off from watershed to reach the lake reservoirs. In the original condition of the lake region, the water which was months in working its way through swamps and obstructed water courses, under improved conditions may not be as many days in reaching the lakes, a condition tending to increase the rapidity of a rise from any given rainfall on the watershed. The amount of water which the ground of any given locality is capable of absorbing and evaporating, from its vegetation, and from the surfaces of swamps and ponds, is practically constant for different years, provided the supply is adequate and sufficiently regular, and, since the volume of rainfall for some years is not much in excess of that needed for vegetation, the run-off for dry years is very small, and for wet years very large, making the total supply to the lakes for different years have a much greater variation than the volumes of rainfall from which derived.

The total supply to the lakes is eventually either discharged at the outlets or evaporated from the surfaces. The amount of annual evaporation from the lakes varies with the condition of the atmosphere, and winds, being greater during dry than during wet seasons, while the volume of discharge at the outlets of the lakes depends largely on the stage of the water in the lakes, the outflow increasing rapidly with the rise of the lake levels.

The areas of the surfaces of Lakes Michigan and Huron are so great that 1 ft. in depth corresponds to a supply of 40,300 cu. ft. per second for an entire year, or 484,000 cu. ft. per second for one month; and, since the level of the lakes falls at times at the rate of 0.66 ft. per month, or 320,000 cu. ft. per second (when the discharge at outlet is only 190,000 cu. ft. per second), the corresponding evaporation must be at least 130,000 cu. ft. per second in excess of actual supply.

The regulation of the level of any lake implies that the surface must be maintained at or near some fixed stage, to accomplish which the discharge must be so controlled that it will be at all times approximately equal to the difference between the supply of water to the lake and the evaporation from the lake surface. It has been shown, however, that the evaporation from the surfaces of Lakes Huron and Michigan is at times largely in excess of the supply, and, therefore, it is practically impossible to regulate the levels of those lakes. If actual supply is a negative quantity the level must fall even within any discharge at outlet. It has been found from recent investigations that the fluctuations of those lakes may be decreased, however, about 25% by backwater from Lakes St. Clair and Erie, by the regulation of the latter lake, without interfering with the volume of storage necessary for the maintenance of the proper volume of flow through the connecting waterways during dry periods.

Recent examinations have shown that the bed of the St. Clair River in the rapids just below the outlet of Lake Huron has deepened from erosion about 18 ft. since 1886, and that the level of Lakes Michigan and Huron has been permanently lowered about 1 ft. by the lower slope needed through the increased area of outlet. To raise the present low water level of the lake 1 ft. would practically restore the limit of the low stage existing previous to 1886.

From a careful study of the levels of Lakes Huron, St. Clair and Erie, and of the slopes of the connecting rivers for different volumes of flow, it appears that for any given amount that the low water stage of Lake Erie may be raised, that for Lake St. Clair will be raised two-thirds as much, and the low stage for Lake Huron one-third of the increase of elevation given to Lake Erie. In other words, if the level of Lake Erie should be raised 3 ft., the 3-ft. fall now existing in the Detroit River would be wiped out, and the level of Lake St. Clair would rise until the necessary slope was established to produce the same volume of flow as previous to making the improvement. Since the area of the river cross-section would be increased by the greater depth obtained, the resulting necessary slope would be reduced to about 2 ft., making the low stage at the Flats 2 ft. higher than under present conditions. For similar reasons, the low water stage of Lakes Huron and Michigan would be raised 1 ft.

Under present conditions the slope of the waterway from Lake Huron to Lake Erie decreases slightly as the lakes rise, but with the level of Lake Erie maintained at a fixed stage, the slope would vary with the stage of the water in Lake Huron, and consequently the discharge would become a function of the elevation of water at the outlet of the lake, a condition requisite for taking care of a maximum variation of supply to the lake reservoirs with a minimum fluctuation of the lake surfaces. The surface of Lake Superior has a mean fluctuation of 1.2 ft. and a maximum change of level of 3.5 ft., and reaches its high stage in September, so that it produces the maximum discharge into Lake Huron at the time that the level of that lake is being lowered most rapidly by evaporation and outflow.

The storage capacity of Lake Superior amounts to 28,000 cu. ft. per second annually for each foot in depth on the lake surface, and in connection with Lakes Huron and Michigan forms a reservoir system absolutely essential for an adequate continuous volume of flow through the St. Mary's, St. Clair and Detroit rivers. Since the time of the greatest discharge into Lake Huron is that when a large supply is necessary for the maintenance of the level of Lake Huron and Michigan, it is apparent that any modification of the range of levels of Lake Superior would be an injury to the entire waterway system, and, therefore, the natural conditions on that lake should be maintained.

The average annual supply of water to Lake Erie (not including loss from evaporation), amounts to a volume about 28 ft. deep over its entire area, and since the annual evaporation does not exceed 2.6 ft. in depth on the lake, it is evident that a sufficient positive inflow always exists to allow the levels to be maintained at a fixed stage without materially affecting the volume of discharge from the lake. The change of outflow which would be produced by regulation would accelerate the discharge during the first six months each year by an amount equivalent to the annual storage of the lake, and diminish the outflow a similar amount during the last half of each year. This modification will not affect the total annual discharge of Niagara River, and will amount to an increase of only 5% of the annual discharge during the first half of each year, and a decrease of a similar amount during the last half. This modification will produce no measurable change in the levels of Lake Ontario.

It may be safely stated that a proper regulation of the level of Lake Erie will produce no injurious effect on the waterways of Lake Ontario and St. Lawrence River, and that such an improvement will increase the depth at low water on Lake St. Clair 2 ft., and on Lakes Huron and Michigan about 1 ft. The question to be decided is, therefore: Can the level of Lake Erie be controlled at an elevation near its high water stage, and thus improve the low water depths about 3 ft. and insure a constant depth of channel for the entire season of navigation? Observations have recently been made from which, in connection with the record of the water levels of the lake, the discharge of Niagara River has been computed for every month of each year since 1865, and the actual supply to the lake for each month for the same period. When the lake is at its highest stage, the outflow is practically equal to the maximum supply, and, if such maximum inflow should continue constant for any length of time, a practical state of regulation would exist. That is, with inflow and discharge equal, the stage must necessarily remain constant. If, therefore, such works be placed in the foot of the lake that when the supply commences to decrease the outflow will be correspondingly diminished, the level of the lake will remain constant, except as affected by winds. In order to obtain control of the lake level, it will be necessary to construct a fixed dam in connection with a system of sluice gates, such that when the gates are closed the low water discharge will pass over the crest of the dam, and, when the gates are all open, the maximum supply to the lake will pass through the works. For all intermediate volumes of supply, it is evident that the proper control would be obtained by closing the requisite number of gates.

The stage of the lake at which the level should be controlled, is a matter for international consideration, and must have the approval of the Canadian government before the works can be constructed. While under existing conditions the elevation at which the level would have to be controlled is that of the high-water stage of the lake, the regulation can be effected at any stage deemed advisable by simply increasing the cross-section of the gorge at the head of the Niagara River sufficiently to produce a corresponding lowering of the water below the works for the maximum outflow, similar to that which has occurred at the outlet of Lake Huron, where the natural deepening of the channel has permanently lowered the lake level about 1 ft. The natural conditions at the outlet of the lake are such that any necessary enlargement can be made at reasonable cost, and the stage at which the level of the lake should be controlled fixed at any elevation deemed desirable by the United States and Canada. If the adopted stage for regulation be lower than the ordinary high water of the lake, no damage to property rights could arise, and the usual low water depth during the latter part of the season of navigation, when the heaviest traffic on the lakes occurs, would be improved about 3 ft.

The benefits to be derived from the increased depth of harbors and channels of Lake Erie and through the Detroit and St. Clair rivers will be many times the amount that the regulating works will cost. A channel 600 ft. wide through the waterway from Lake Huron to Lake Erie will soon be an absolute necessity to safely accommodate the rapidly increasing commerce of the lakes. The difference in the amount of money needed to construct such a channel under the existing conditions, or with the level of Lake Erie regulated, would be more than sufficient to build the controlling works at the foot of the lake. The improvement obtained would be permanent, which cannot be said of the results obtained by present methods, by which the enlarging and deepening of any section of the river channels produce a lowering of the water levels above the improvement. Improving of waterways by regulating the levels at a higher stage increases the area of the cross-section of channels and correspondingly decreases the velocity of currents, thus making navigation less dangerous—a condition very desirable to establish where channels are narrow and tortuous.

If it should be established that the control of the level of Lake Erie is a feasible and economical method of improving the low water depths of the lake, the question naturally arises as to what the existing conditions are which it is desirable to improve. The channels at the entrances of Lake Erie harbors, which originally had depths of 6 to 10 ft., have been deepened by dredging until unstable depths of about 17 ft. have been secured, and which silt up more or less every year from the severe storms of the fall and winter seasons, and, unless made still deeper, the respective ports will not be able to reap much benefit from a 21-ft. channel through the lake waterways.

At the Lime Kiln in the mouth of the Detroit River the natural depth at ordinary stage of the lake was formerly about 13 ft., through which a channel is reported to have been cut 440 ft. wide and 20 ft. deep. This improvement is the outcome of a resolution of the House of Representatives on Dec. 18, 1873, which called for "an approximate estimate of the cost of deepening and widening the navigable channels of the rivers and waters connecting Lake Huron and Lake Erie for practical navigation for vessels drawing 20 ft. of water." The project formulated on this resolution was for a curved channel through the reef 300 ft. wide and 20 ft. deep. This was modified in 1883, making the channel straight and of the same dimensions. In 1886, it was again modified by increasing the width to 400 ft., which was increased to 440 ft. in 1888. In the report of the chief of engineers for 1891, page 2798, it is stated that:

The river and harbor act of August 11, 1888, appropriated $130,500 for improving Detroit River, Mich., to complete the work. When proposals were called for it was found that the lowest bid was at such a price as would not only suffice to complete the 400-ft. channel, but an additional width of 40 ft.; and upon presentation of the facts to the chief of engineers, the project was again modified, the additional width being gained on the American side of the cut, and a contract was duly entered into with the lowest bidders, Messrs. Dunbar & Sullivan, at the low price of $4.43 per cu. yd. of solid rock and $1.00 for loose rock. Work under this contract was begun Oct. 27, 1888, and completed Oct. 1, 1890. 26,304 cu. yds. of solid rock and 3,380 of loose rock were excavated, and the channel completed to a width of 440 ft. and a depth of 20 ft. The work under this contract also included the removal of the five following shoals in the vicinity to a clear depth of 20 ft.; Ballard Reef (partly), Texas Shoal, Milwaukee shoal, Boston shoal and Hackett shoal.

On page 2818 of the same report it is stated: "The obstruction which existed at the Lime-Kiln crossing, Detroit River, has been removed to the full depth of 20 ft. for a width of 440 ft., and only a comparatively small amount of excavation on the bar at the mouth of Detroit River is required to secure a 20-ft. channel from Lake St. Clair to Lake Erie."

Since the resolution of Congress, on which the project for this work was based, called for a channel "for practical navigation for vessels drawing 20 ft. of water," it would appear that the original wishes of Congress have not been carried out or else some serious blunder has been made in the execution of the work, for, while it is officially reported that this work is completed and a 20-ft. channel obtained, the fact is well known that there is a navigable channel across the reef to-day of less than 17¾ ft., and at mean stage of the lake the navigable depth is only about 18 ft., instead of 20 ft., as given in reports. So far as the speaker is aware, the project supposed to have been completed in 1890 has never been modified, except in 1892, when it was proposed to make the channel 800 ft. wide and 20 ft. deep, from the head of Ballard reef to the head of Lime-Kiln crossing, estimated to cost $180,000, and of which one-half was appropriated and expended previous to 1899; yet, in the river and harbor act, approved March 3, 1899, the following appropriation is made:

Improving Detroit River, Michigan, removing shoals from Detroit to Lake Erie, continuing improvement, $100,000; provided that a contract or contracts may be entered into by the Secretary of War for such materials and work as may be necessary to complete the same in accordance with the present project, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate $661,500, exclusive of the amount herein and heretofore appropriated; provided further, that the Secretary of War shall cause to be made and reported as practicable a survey of the Detroit River from Detroit to Lake Erie, with a plan and estimate of the cost of such improvement as will secure a safe and convenient channel 21 ft. deep between said points.

The above appropriation cannot refer to the construction of a 21-ft. channel, for the reason that the act itself calls for a survey and estimate for such a channel, and we must, therefore, conclude that the $761,500 appropriated is to construct a channel already officially reported as having been entirely completed in 1890. The fact is that the $761,500 apparently palmed off on Congress as the amount necessary to complete an unfinished project, is shown by the reports of the chief of engineers to be simply the difference between the original estimate of what the engineers expected the work would cost—with rock excavation estimated at $25 per cu. yd.—and the amount actually paid to contractors for completing the work called for under the plans of the engineer department, which has been reported several times as having been completed, and the full depth of channel required by project obtained. If the work for which the recent appropriation was recommended and obtained was for the purpose of a new project to secure a navigable channel for vessels drawing 21 ft. of water, which the engineers in charge failed to obtain by the execution of the original project for this purpose, it should have been so stated, and the citizens of the lake district and their representatives in Congress informed as to the nature of the project under which more beneficial results are to be obtained. This appropriation, if applied to the construction of properly designed regulation works, would improve the channel at the Lime-Kiln crossing, and of every harbor on Lake Erie, at least 3 ft., and give the lake waterways a constaut depth for the eutire season of navigation.

The condition of affairs iudicated by these official reports and the vast sums of money being used on completed projects should receive the careful consideration of every one interested in the future commerce of the great lakes. Wider, straighter aud deeper channels for harbors and through the Detroit and St. Clair rivers, are an urgent necessity, and, if these desired results can be obtained with a saving of several millions of dollars by adopting more modern methods of improvements, as no doubt can be done, it should be our duty to carefully consider these methods, and, if they are found to be effective, safe, and economical, the proper steps should be taken to have them utilized at the earliest date practicable.

A GAS ENGINE AND FUEL-GAS PRODUCER POWER PLANT.

As a means for utilizing the energy of fuels for mechanical work, the internal combustion motor has far outdistanced in point of efficiency those types of heat engines in which the heat is transferred to the working fluid from an outside source. While the largest and most perfect steam plants are able to show an indicated efficiency of not more than 15% in converting the heat arising from the combustion of fuels into mechanical energy, the gas engine, even in comparatively small sizes, has closely approached 30%. The gas engine, however, has heretofore been greatly restricted in use by the fact that it can use only a special kind of fuel, namely, inflammable gases.

Where natural gas is available, it is an ideal fuel for gas engines. Coal-gas, while satisfactory merely as a fuel, is necessarily expensive, as it represents only about 25% of the energy originally contained in the coal from which it was manufactured. While the fact that salable by-products, such as coke and ammonia, are produced along with the gas partially offsets this objection, still it is very questionable whether power can be produced as cheaply by a gas engine using coal-gas as by a steam engine plant burning the same coal under boilers.

Because of the above considerations, much attention has been bestowed upon the fuel-gas producer as a possible source of cheap fuel gas. Fuel-gas contains about 80% of the energy of the coal or coke used in its manufacture, and the fuel-gas producer, therefore, fairly equals the steam boiler in efficiency. The gas can be used without difficulty in gas engines, for, although of low calorific value as compared with coal-gas or natural gas, it requires no increase in the size of engine for a given power, as the amount of oxygen required for its combustion is also low, and a much larger volume of combustible gas may be taken by a cylinder of a given size.

The fuel-gas producer, however, as a source of power, has only recently reached a satisfactory stage of development. For success in this connection, it must combine continuity of action, uniformity of product and ease of operation, together with the ability to use cheap fuel. The producer invented by Mr. J. E. Dowson, of England, possesses all these requisites in a considerable degree, except the last. It requires for its operation either coke or anthracite. This, however, is not always an objection, as there are many localities where cheap anthracite can be obtained. This fact is well shown by the fuel-gas producer plant which is herewith illustrated, and which we will proceed to describe.

This plant has been designed and built by R. D. Wood & Co., of Philadelphia, and erected by them at the new shops of the Erie R. R. in Jersey City. The power is used for electric lighting, running shop tools, etc., and the plant has been in successful operation for nearly six months.

The manufacturers guaranteed to deliver in the form of gas on an average not less than 10,000 B. T. U. per pound of "buckwheat" anthracite. It has, however, been found possible to use "rice" coal, which is almost refuse. The gas produced contains on an average about 140 B. T. U. per cu. ft. The Otto gas engines used with the plant give an indicated horse power on about 85 cu. ft. per hour of this gas, which is equivalent to about 1 1-10 lbs. of coal.

The two 7-ft. producers are each provided with the Taylor revolving bottom and Bildt automatic feeders. The coal is raised from the storage bin by a link belt elevator and discharged into the receiver of the feeder, the hopper of which has a capacity for several hours' run. The feeding device runs continuously and its speed is under the control of the attendant. As it is fed, the coal is sprinkled uniformly over the gas-producing surface.

large portion of the tar from going into the scrubbers and also act as automatic seals to prevent the gas in the holder from passing back into the producer. A small vertical boiler has been installed to furnish the steam for the blower.

From the wash boxes the gas passes into the bases of two large vertical scrubbers of the ordinary type, whose compartments are filled with coke, which is continually wetted by water sprays from above. The use of these scrubbers is to extract from the gas the ammonia, tar and sulphur, so that it may be suitable for use in the engines. From the tops of the scrubbers the gas is conducted downwards to the purifiers, which are rectangular boxes filled with wood shavings, to catch the remaining particles of tar and sulphur carried over from the scrubbers.

From the purifiers the gas passes into the gas-holder outside the building, and thence to the main leading to the engine house. The holder is large enough to carry about ten minutes' supply for the engines, aggregating 270 HP., and serves to balance the irregularities in production, consumption and constitution of the gas. The water used to cool the tops of the producers is led into the holder and serves to prevent the latter from freezing in winter.

During the past summer a test of the producer was made by the manufacturers. Gas was produced during a 30-minute run at a rate of 21,831 cu. ft. per hour. Chemical tests of samples of the gas gave the following composition:

CO_2 (carbon dioxide)	8.2%
O (oxygen)	.8%
CO (carbon monoxide)	19.4%
H (hydrogen)	16.6%
CH_4 (marsh gas)	2.8%
N (nitrogen)	52.8%

The calculated calorific value of this mixture is 142.94 B. T. U. per cu. ft. A test of one of the 90-HP. Otto engines showed that 1 HP. could be developed from 92.6 cu. ft. of this gas per hour, which was equivalent to a consumption of 1.03 lbs. of coal. From the above it will be seen that the producers are capable of supplying a total of 471 HP.

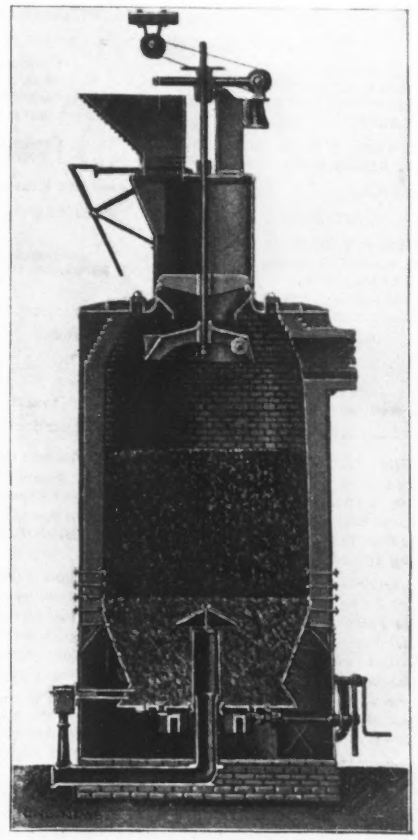
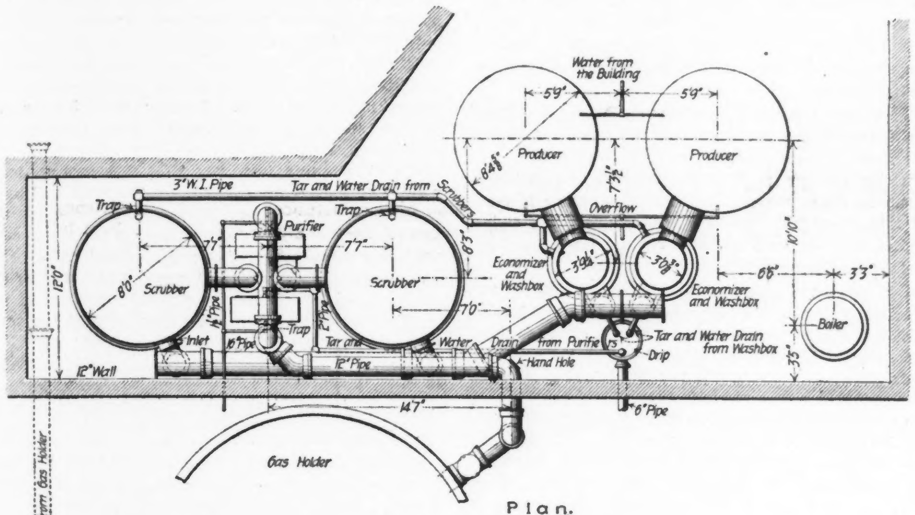
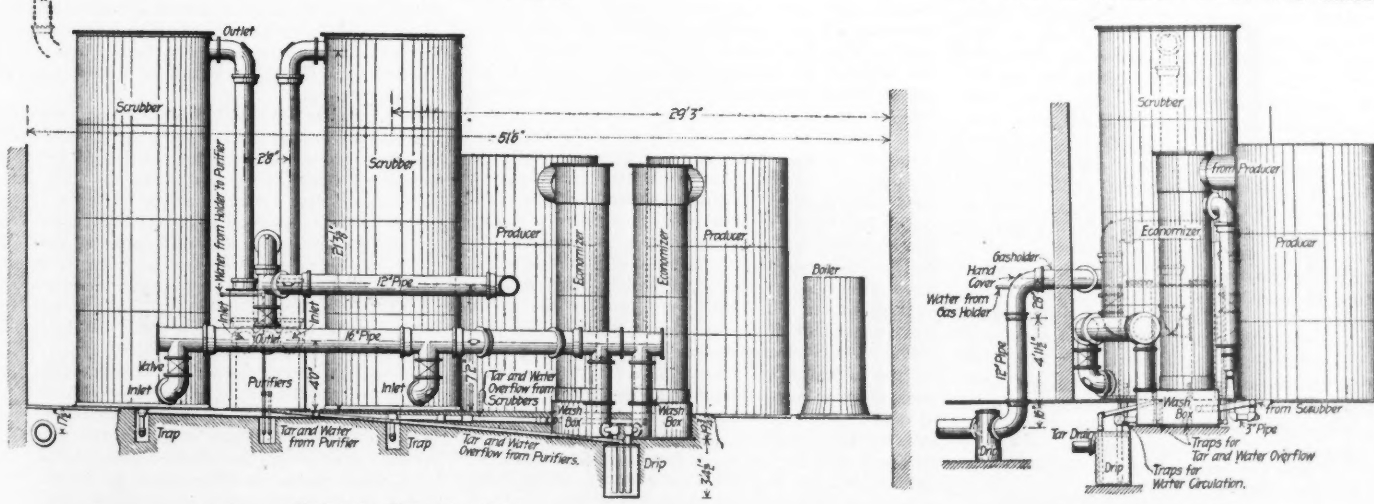


Fig. 2.—Sectional View of the Wood Gas Producer, Showing Taylor Revolving Grate and Bildt Automatic Stoker.



Plan.



Sectional Side Elevation. Sectional End Elevation.

FIG. 1.—GAS PRODUCER PLANT AT THE ERIE R. R. SHOPS AT JERSEY CITY, BUILT BY R. D. WOOD & CO., OF PHILADELPHIA.

As was pointed out, a producer of the above type can use, for gas engine purposes, only coke or anthracite coal. The manufacturers, we are informed, are perfecting, however, a type of producer which will manufacture a gas suitable for gas engines form bituminous coal. If this can be done, and it probably will be accomplished, the gas engine will find a field of application much wider than the present and probably encroaching materially upon that of the steam engine.

For the details and drawings accompanying this article we are indebted to Messrs. R. D. Wood & Co., of Philadelphia.

The gas passes from the producers to the economizers, which are designed to cool the gas and impart its heat to the incoming blast of air and steam. The gas enters at the top of the economizer and passes out through a wash box at its base, while the air is drawn upwards by means of a Korting steam blower from the bottom of the economizer and passes out near the top. The wash boxes above mentioned serve to prevent a

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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.

The "Municipal Program," adopted last week by the National Municipal League, is one of the best pieces of constructive work ever done by an organization devoted to the improvement of municipal government. In judging its merits or defects, it should be considered primarily as a declaration of principles, with suggestions for putting them into effect and continuing them unviolated. At the same time, the charter outlined in the Program is in itself a better and more complete framework for a municipal government than any existing city charter which we now recall. The Program has been made flexible in order to permit modifications to meet the traditions and needs of different states and cities; but certain fundamental principles are always kept in full view, especially as wide a measure of municipal home rule as is consistent with the interests of the commonwealth.

To city engineers and others occupying positions demanding technical ability, the Program should appeal with great force, since it is designed to raise the heads of the chief administrative departments out of the maelstrom of partisan politics and clothe them with the dignity of technical advisers and executive officers, appointed by the mayor and holding office until removed by him or death. Minor officials are placed under civil service rules, and day laborers are protected from loss of position for political reasons.

The main features of the Program were reviewed editorially in our issue of Dec. 1, 1898, and many of them are indicated in our report of last week's convention, elsewhere in this issue. In a few weeks, it is promised, the Program, with revisions and explanatory papers, will be published by the National Municipal League, whose offices are in Philadelphia. When that is accomplished everyone interested in municipal government (and who that reads these lines is not vitally affected by it?) would do well to secure and read what may well be termed "A Declaration of Municipal Independence and Progress."

THE CONTRACT FOR THE NEW YORK RAPID TRANSIT RAILWAY.

At last, after more than a decade of planning and contriving, of controversy and litigation, of alternate hope and disappointment, the city of New York has reached the point of advertising for bids for the construction and operation of a rapid transit railway. Such bids—if any are received—will be opened on Jan. 15 next.

In past issues of Engineering News we have reviewed various features of this enterprise; but it seems proper at this time to summarize anew the conditions under which it is now proposed to carry out this great work.

The advertisement which the Rapid Transit Commission is publishing in the New York daily papers is headed "Invitation to Contractors;" but it should properly be headed "Invitation to financiers and street railway syndicates." No contractor or contracting firm is in a position to undertake to operate a street railway system for half a century, and that is what the successful bidder for this road must do. On the other hand, any group of capitalists which may secure this contract will doubtless sublet to regular contracting firms the actual work of construction.

At the present time, the New York public, aided by the newspapers, is doing a large amount of guessing as to whether any bids are likely to be received; and if so, from what parties. Rumor credits about every prominent passenger transportation company in the vicinity of New York with intention to bid, and equally reliable rumor credits each of them with the intention to refrain from bidding.

Let us see, briefly, just what it is that New York city offers to the successful bidder upon this work and how much risk must be run to secure it.

In the first place, New York is really offering a franchise for the operation of a street railway system, together with the loan of its credit to provide capital for its construction, rather than inviting bids for building a railway.

It is true the construction precedes the operation; but it is a much larger task to undertake for a half century the operation of a railway system such as that proposed than to build it; and the contractor who builds the road must also operate it. He cannot transfer his lease to other parties when the road has been completed, except by himself becoming a bankrupt, forfeiting all that he has invested, and abandoning the work. Further, the contractor, in order to make a profit, must make the operation of the road profitable. He may indeed make also a handsome profit on the construction of the road; but unless he makes the road pay, at the least its operating expenses and the interest on its cost, this profit will be swallowed up in meeting the yearly deficit. On the other hand, if the contractor can make the road pay, he will not only make a profit in the construction of the road, amounting very likely to several million dollars; but he may make also a large annual profit from the operation of the road.

The contractor for the work must give a heavy bond, amounting in the aggregate to seven million dollars, as a guarantee that he will complete the work according to the specifications, and for the amount of his bid. Further, the bids are to be lump sums, not unit prices for each class of work. Under these circumstances, bidders will be pretty certain to make their estimates very liberal. They must allow a large margin over the estimated cost of construction in order to make themselves reasonably safe against loss. They will have to be paid not only for the work done and for the profit upon it, but for the risk they assume. New York must expect thus to pay an excessive price for her Rapid Transit road, considerably more proportionately than Boston paid for hers. This, however, is the fault of those who framed the Rapid Transit law, not of the Rapid Transit Commissioners or their engineers.

With the bid once made and accepted and the required bonds furnished, the financial path of the contractor for the road is made remarkably easy. He is paid as the work progresses on monthly estimates, and this although he is building a road which he is to possess and operate for fifty years after completion. The specifications are drawn with great care to secure the best and most durable work, and provide for a railway which shall be at once attractive to passengers, economical of operation and capable of handling a large traffic. It is for the contractor's direct interest to comply with the specifications, and it will be his own fault if he does not make his bid cover the full cost of such a road, and take every effort to see that it is secured.

Thus the work of construction continues until the road is completed, the time required for construction being set at 3 to 4½ years. As the road approaches completion, the contractor has to provide, at his own expense, the equipment for it, including rolling stock, power houses, signaling and ventilating apparatus, and in general everything necessary for the operation of the road. The investment for this purpose may be roughly estimated at five to eight million dollars; but if the contractor has made his bid sufficiently large at the outset, his profit on the construction should cover a considerable proportion of this, leaving his net investment perhaps not more than two to four million dollars.

The contractor now begins the operation of the road. Let us see what obligation he assumes and what are his chances of profit. Suppose that his bid for the construction is $35,000,000, and that the interest which accumulates during construction amounts to $2,000,000 more. Suppose also that the bonds to pay for the road bear an average interest rate of 3%. The annual rental for the first five years of the lease will amount, then, to only $1,100,000, unless the road shall be so profitable from the start that its earnings are sufficient to pay, besides the operating expenses and the above rental, a profit of more than 5% on the money which the contractor has invested in equipment, etc.

We will assume, however, that this does not happen. Let us see what earnings the road will have to make in order to pay its operating expenses, the fixed charges stated above, and 5% on the contractor's investment of say $7,000,000. The operating expenses may be fairly assumed at 60% of the gross earnings. Then the annual earnings of the road, to save the contractor from loss at the start will need to be:

Rental	$1,100,000
Interest on contractor's investment, 5% on $7,000,000	350,000
Operating expenses	2,175,000
Total gross earnings	$3,625,000

It will be seen from the above that the earnings of the railway, in order to meet the above requirements, must average a little under $10,000 per day. With 5 ct. fares, this means an average daily traffic of 200,000 passengers, allowing nothing for the income of the contractor from the carriage of mail, express and freight, and from advertising and news privileges.

Now, can the proposed Rapid Transit road secure a traffic averaging 200,000 passengers daily during the first five years of its operation? There seems to us no doubt that it can do so. The Manhattan railway, with 36 miles of lines, carries about 500,000 passengers daily. The Rapid Transit system will have about 25 miles of road, and there can be no question that it is better located, on the whole, for securing traffic, than the Elevated lines. Certainly then, it ought to secure as many as 200,000 passengers daily within a short time after it is put in operation.

Under the conditions of the contract the local trains are required to make at least 14 miles per hour, including stops, and the express trains at least 30 miles per hour. That is to say, the time from the City Hall to 42d St. will be reduced to 7 minutes by express trains or 15 minutes by local trains. Under these conditions a large proportion of the suburban traffic of the Grand Central station will certainly be secured by the Rapid Transit trains. It is also certain that a very large part of the traffic from the district lying north of 100th St. will be drawn to the Rapid Transit road by reason of its greater speed. The most northerly part of the lines, also, will develop a region which is now entirely without railway facilities, and the traffic, while moderate at the start, will undoubtedly grow in the course of a few years to very large proportions.

We might continue at much greater length to

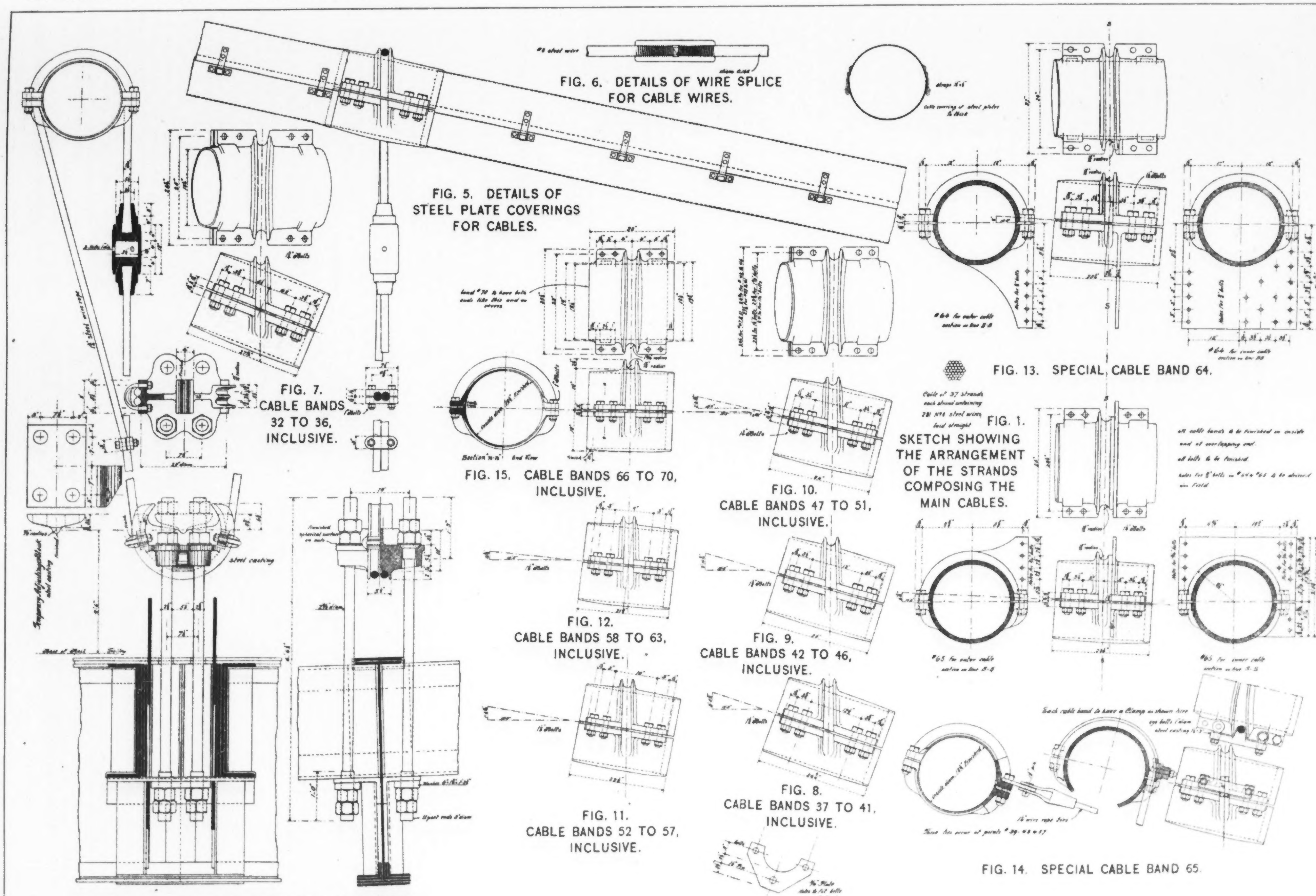


FIG. 4. DETAILS OF SUSPENDER CONNECTIONS.

FIG. 5. DETAILS OF STEEL PLATE COVERINGS FOR CABLES.

FIG. 6. DETAILS OF WIRE SPLICE FOR CABLE WIRES.

FIG. 7. CABLE BANDS 32 TO 36, INCLUSIVE.

FIG. 15. CABLE BANDS 66 TO 70, INCLUSIVE.

FIG. 12. CABLE BANDS 58 TO 63, INCLUSIVE.

FIG. 11. CABLE BANDS 52 TO 57, INCLUSIVE.

FIG. 10. CABLE BANDS 47 TO 51, INCLUSIVE.

FIG. 9. CABLE BANDS 42 TO 46, INCLUSIVE.

FIG. 8. CABLE BANDS 37 TO 41, INCLUSIVE.

FIG. 1. SKETCH SHOWING THE ARRANGEMENT OF THE STRANDS COMPOSING THE MAIN CABLES.

FIG. 13. SPECIAL CABLE BAND 64.

FIG. 14. SPECIAL CABLE BAND 65.

DETAILS OF CABLES AND CONNECTIONS FOR THE NEW EAST RIVER BRIDGE, NEW YORK CITY.

L. L. Buck, M. Am. Soc. C. E., Chief Engineer.

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

scuss the prospects of traffic upon this system; ut it seems unnecessary. Surely a railway offer- g much faster and more comfortable transit hrough the central portion of the most densely pulated city in the world, and along the line of eatest travel, can earn at least as much per mile existing slower and less attractive roads. As e have seen above, it may do much less than this nd still pay a profit on its operation.

We have taken no account in the above com- utation of the sinking fund requirements. These ill increase the rental (taking the total cost of he road as above) by $185,000 per annum after he first five years, and by $370,000 after ten years. n other words, after five years it will require bout 210,000 passengers daily, and after ten ears about 220,000 daily to make the road pay, ccording to the assumptions made before. It will be seen that this is a very small percentage of rowth indeed; and there can be no doubt that a much larger percentage of growth than this would take place.

In our computations thus far, we have assumed the road to earn the lowest amount consistent with the payment of its expenses, fixed charges and interest on the contractor's investment. But now suppose it does much better than this. Suppose it earns $5,000,000 a year gross. Allowing nothing for earnings from other sources, this would mean a traffic of 275,000 passengers per day, and would give the contractor about 8% on his investment.

We know of no reason to set the limit to the growth of the traffic at this point. Fifty years is a long time in the growth of such a world metropolis as New York. Who that observes the records of this growth and of the growth of its passenger transportation systems and of the traffic upon them can doubt that such a road as that proposed will find a traffic that will not only pay its expenses, but yield a large profit to the company operating it.

We have said in the past and still maintain, that the plan adopted for the construction of this road is not the wisest that might have been framed, or the best calculated to give to the city what it wants at the least expense. It does, however, offer such prospects of profit to any syndicate financially competent to undertake the work that there ought to be several responsible bids received as a result of the Rapid Transit Commission's invitation. If this does not happen, we believe it will be because of fear as to legal complications interfering with the work rather than any doubt on the part of capitalists as to the profitable operation of the Rapid Transit road.

LETTERS TO THE EDITOR.

A Transit Telescope With Bubble Tube on Top.

Sir: I have recently had occasion to run some levels with a transit, having a level on the telescope, and I found it very trying on my eyes to read the bubble in ordinary position below the telescope, owing to the interference of the telescope axis and standards. I have therefore moved the bubble tube to the top of the telescope and find it quite an improvement both in facility of reading and better results due no doubt to closer reading. As the change can be readily made, I bring the matter to your attention as of possible interest to others.

Very truly, Ira W. Sylvester.

Alexandria, La., Nov. 13, 1899.

Hinged Switches and Cast-Steel Frogs.

Sir: We notice with interest the switches and frogs (or points and crossings as they are termed in England) described in your issue of Sept. 7. We are familiar with this type of construction, and in fact we have just received an order for points of the same design for the Japanese Government Railways, but the crossings are built up from rails. We have supplied similar reversible cast-steel crossings to those you illustrate for Spain, and at one time they were used on the Indian State Railways by Mr. Rendel, but they are seldom specified now, built-up crossings being found by experience to be superior in many points. One of the principal objections to solid cast crossings is that they are a break in the flexibility of your line, which should be as uniform as possible, and their unyielding rigidity brings them too much into evidence when traveling over them.

Yours truly, Samuel Summerson.

(Thomas Summerson & Sons.)

Albert Hill Foundry, Darlington, England, Nov. 3, 1899.

The Balancing and Adjustment of Compass-Survey Notes.

Sir: In almost all books on compass surveying rules are given for correcting the latitudes and departures of the courses of a survey, when they do not balance (and they never do); but no method is given for correcting the lengths of the courses. It is evident that, when the latitude and departure of a course, calculated from the measured length and bearing of the course, are changed so as to make the survey balance, the probabilities are that both the length and the bearing of the course will be changed. The change in bearing, being less than the usual degree of approximation with which angles are measured with a compass, need not be taken into account. The change in the length of the course, however, may be appreciable, and is worth calculating and noting. This calculation can be effected by means of a very simple and convenient formula, derived in the following manner:

The usual rule for correcting latitudes and departures, when all measurements are assumed to have the same weight, is this: As the sum of the lengths of all the courses is to the length of any one course, so is the total error in latitude or departure to the correction to be applied to the latitude or departure of that course. If we consider north latitudes and east departures as positive, and south latitudes and west departures as negative, the total error in latitude may be represented by ΣL, and the total error in departure by ΣD, the expressions ΣL and ΣD standing, respectively, for the algebraic sum of the errors in latitude, and the algebraic sum of the errors in departure. Notice, now, that, if ΣL is positive, this means that the sum of the northings is greater than the sum of the southings; the north latitudes must, therefore, be diminished, and the south latitudes increased arithmetically, or diminished algebraically. The sign of the correction is, consequently, opposite the sign of the total error ΣL. The same principle applies to the departure corrections. This being understood, and using algebraic quantities only, the rule given above is expressed in symbols as follows:

$$\Sigma C : C = \Sigma L : -l_c,$$
$$\Sigma C : C = \Sigma D : -d_c.$$

in which

ΣC = sum of lengths of all courses;
C = length of any one course;
l_c = latitude correction for that course;
d_c = departure correction for that course;
ΣL and ΣD, as above.

From these proportions we get

$$l_c = -\frac{\Sigma L}{\Sigma C} C. \quad (1) \qquad d_c = -\frac{\Sigma L}{\Sigma C} C. \quad (2)$$

The quotients

$$\frac{\Sigma L}{\Sigma C} \text{ and } \frac{\Sigma D}{\Sigma C}$$

are calculated once for all, and then multiplied by the lengths of the different courses in succession.

Now, as to the correction to be applied to the lengths of the courses. If C, L and D are the length, latitude and departure, respectively, of a course, before any corrections are applied, and C', L' and D', are the corresponding corrected quantities, we shall have

$$C = \sqrt{L^2 + D^2}. \quad \text{(a)}$$
$$C' = \sqrt{L'^2 + D'^2}.$$

But

$$L' = L + l_c; \qquad D' = D + d_c.$$

Therefore,

$$C' = \sqrt{(L + l_c)^2 + (D + d_c)^2}.$$

Developing the binomials under the radical, and neglecting the squares of l_c and d_c, there results

$$C' = \sqrt{L^2 + D^2 + 2\,(L\,l_c + D\,d_c)}$$
$$= \sqrt{C^2 + 2\,(L\,l_c + D\,d_c)}$$
$$= C\sqrt{1 + \frac{2\,(L\,l_c + D\,d_c)}{C^2}}.$$

Developing the radical, and neglecting the square and higher powers of the second term,

$$C' = C\left[1 + \frac{L\,l_c + D\,d_c}{C^2}\right]$$
$$= C + \frac{l_c}{C} L + \frac{d_c}{C} D \quad \text{(b)}$$

By means of this equation and formulas (1) and (2), the value of C' finally reduces to the form

$$C' = C - \frac{\Sigma L}{\Sigma C} L - \frac{\Sigma D}{\Sigma C} D. \quad (3)$$

As the values of the two fractions entering this formula have already been found for the determination of the latitude and departure corrections [formulas (1) and (2)], the extra work necessary to calculate the value of C' amounts to very little.

A much shorter way of deriving formula (3) is afforded by the calculus. Differentiating equation (a) we get

$$\delta C = \frac{L\,\delta L + D\,\delta D}{C}.$$

Substituting finite increments for differentials, we have, nearly,

$$C' - C = \frac{l_c}{C} L + \frac{d_c}{C} D,$$

whence equation (h) and formula (3).

Antonio Llano.

International Correspondence Schools, Scranton, Pa., Sept. 17, 1899.

Rail vs. Water Transportation; a Defence of the Latter.

Sir: In your issue of Oct. 26 you announce that a railroad has a new locomotive; which phenomenon inspires an editorial entitled "The Revolution in Railway Transportation." The motive of which seems to be the theory that under ideal conditions and "neglecting terminal charges" a railway can move freight in 2,000-ton train loads, and for a mill per ton-mile.

(1) Wherein does the "revolution" consist? This is certainly no news to those who keep reasonably well posted on transportation matters. But it does not mean that many men now living will get freight transported by rail at any such rate. Between that dream and its fulfilment interpose two facts, viz., "terminal charges" and the percentage of efficiency of the railway as a machine.

(2) The same editorial indicates very clearly (assuming your figures as unital) that this efficiency is about 25%, and that on a railway approximating your ideal conditions the mill per mile vision materializes as a 4-mill rate. I allude to your statement that in 1898 this rate ruled on the Pittsburg & Bessemer Ry. The builders of this much-talked-of road were advised (free and at a price) by all the doctors and announced that it should be the latest and best thing in railroading and give the lowest freight rates possible by rail transportation. The outcome is the 4-mill rate—certainly not revolutionary, and probably disappointing.

This is not good stuff to make dreams of; and its force is attempted to be broken by the statement "The traffic" (on the P. & B.) "is almost wholly in one direction and the length of haul comparatively short, making the terminal expenses a large proportion of the total."

Now the return traffic is there in abundance; and other roads (as the Pennsylvania) haul it, presumably because they can haul it cheaper. The terminal expenses on the P. & B. ought to be less than on any trunk line because one terminal is an ore dock where the cars are loaded with a steam shovel, and the other is a stock-pile where the cars are dumped, and which costs the railway not one cent.

(3) It is erroneous to assume that through trunk-line traffic can be handled at a lower rate than local bulk freights. The volume of the latter is more regular; and such freights generally do not cost the railway a cent for terminals, being loaded and unloaded on the patrons' switch.

(4) On the contrary, traffic such as interests New York requires terminals of the most expensive kind; and the volume is less regular. A close reasoner would expect to find, what actually obtains, the cost of through freights higher than costs for local bulk freights. The Pennsylvania, which handles 10 tons "local" to one "through," conducts transportation ¼ cheaper than the New York Central, which handles 2 tons "through" to 1 "local." The latter road, which, more nearly than any other trunk line, approximates your ideal physical conditions, charges rates averaging more than five times the mill per ton-mile editorially set forth as its proper compensation.

(5) If the people of this country were led to believe that railway freight can be carried for one mill per ton-mile, they would believe that the railways do it; and they would believe the railway officials to be a gang of thieves for whom no treatment could be too severe; and legislation would be so drastic as to smash our business organization and bring our governmental system to anarchy.

Such fallacious reasoning, while out of place in a sober professional journal, and only likely to breed mischief, is less surprising than the misstatements of fact which characterized the editorial in question, as witness the following:

> American railway managers have proved to the world that with the steel rail as a roadway, and steam for motive power, freight can be moved far more cheaply than in any artificial waterway or river channel. * * * * *
> We have shown above that the railway can carry freight at less cost than any inland waterway, river or canal.

No proof of these assertions was printed in the editorial in question; and no such proof exists. On the contrary, oft-published and well-authenticated statistics prove the very reverse of these statements.

(6) As long ago as 1891 the whole cost of bulk freights on the Ohio and Mississippi rivers was given, in official reports, as half a mill per ton-mile; and recent statistics show much lower costs. Recent reports have given instances of rates on small barge canals in England of ¼ mill (this figure is from memory, see "Water Commerce

Congress," 1893; and others). It is well known that barge transportation on the St. Lawrence approximates lake transportation in cheapness. The cost on the Erie Canal ditch and Hudson River, in 240-ton barges, is even now only 1.5 mills, with more than half the season wasted in port and a considerable part of the remainder lost in unnecessary locks. A sensible revision of terminal arrangements and locks would enable the Erie boatmen to make enough more trips to cut the rate below the mill per ton-mile figure.

The report of Maj. T. W. Symons gives an estimated rate on an enlarged barge navigation of 0.54 mill with the barges losing half their season in ports.

The figures published by me in 1895, based on then-existing conditions, and substantiated by all subsequent valid data, gave the estimated transportation costs between Chicago and New York via the proposed St. Lawrence, Champlain-Hudson ship canal, in a 7,000-ton ship, reduced to ton-mile rates, as follows:

	Mill.
With Full Return Cargoes.	
Conducting transportation	.011
With profits and amortization added	.017
With terminal charges added	.028
With Half Return Cargoes.	
Conducting transportation	.015
With profits and amortization added	.024
With terminal charges added	.035

Further citations are not worth while just now because the forthcoming reports of the N. Y. State Committee on Canals and the U. S. Board of Engineers on deep waterways will shortly bring the data up to date.

The editorial states "Terminals for railways are in general cheaper than those for waterways."

This has no application to canal boat freights, which pay no wharf rent in this port. So far as it applies to the matter, it is an argument in favor of a ship canal and the abolition of breaking bulk at Buffalo. The interest on terminals is a fixed amount; and the longer the haul, the less it amounts to per ton-mile. On shipments from Chicago, taking present pier rentals as a basis, and supposing all the freight to be handled on a pier doing half the business it is capable of, and the entire interest paid by the incoming freight, it would amount to less than 1-50 of a mill per ton-mile. The editorial statement may be true "in general," in small towns; but in particular, in great ports such as this, it is untrue, as is patent to those who note the great expense and difficulty of enlarging our railway terminals. Every few days I pass a terminal built by one railway which has cost more, probably, than New York has spent on her water front in ten years.

New York water front property taken in condemnation proceedings a few years since, cost about $450 per front foot, or 60 cts. per sq. ft.; and first-class water front property, on the new 40-ft. channel and 1,800 ft. from street to pier line, can be bought for $600 a front ft., or 30 cts. a square foot. The improvements, also, are cheap and efficient. One steamship company here receives and dispatches a 3,000 to 3,500-ton ship every day, using one medium-sized pier.

In view of what precedes it, one cannot wonder that the editorial should "point out that it is to the railways and not to the canal that New York must look for the preservation of its export trade." This sounds like a jest, unless, indeed, the suggestion of a more recent editorial is seriously meant, that New York state should build and maintain a trunk line railroad. It is well known that the railways have for years maintained a heavy differential against the port of New York; and experts know the reason for it, and that it cannot be done away with for at least a generation, except by a modern waterway or a state railway to the Great Lakes, with complete connections and terminals.

(7) The facts are as follows: The only trunk line railroad vitally interested in having rates favor New York is the New York Central. Unfortunately this road has not nursed industry along its line and consequently has a relatively small local tonnage, and depends for its existence on a profitable through traffic.

On the contrary, the Pennsylvania, the Colossus of railways, has coddled its local industries until almost its entire length realizes your ideal of "freight delivered wherever a spur track can be run," and is supported by a local tonnage 10 times its through business. Therefore the Pennsylvania is master of the situation, and will be, so long as controlling rates to the seaboard are made by private corporations. In a rate war its vast preponderance of local business would enable the Pennsylvania to make and maintain through rates which would bankrupt the New York Central in two seasons. The people of this state will not heed your advice because it is contrary to facts and logic.

(8) New York city is a merchant, and lives by the profits of exchange. A merchant cannot long succeed if he permits his rivals to control his trade. The rivals of New York do control New York's traffic in the vital matter of freight rates. If this condition be long continued, the bulk of trade will go where it can go cheapest; and wealth and population will follow it.

These conditions inhere in the existing transportation arrangements, by virtue of which private corporations, not subject to control by New York state, can make the controlling freight rates to the seaboard. New York cannot remedy the situation by legislation affecting railways because the railways which control the situation lie without the state. Attempts at legislative cure-alls would ruin our state corporations without benefiting the situation. But New York can control the situation and her own rivals' business by complying with the laws of trade.

The only practicable water routes from the Great Lakes lead to New York. No other Atlantic port in the United States can be connected with the interior by a good water route at a cost commercially practicable. New York can be connected with the Great Lakes by a 12-ft. barge navigation which can move freight at 1-10 the prevailing rail rates, and ½ the dream rate; and by a ship canal which can move freight at 1-20 the prevailing rail rates and ¼ the dream rate.

Wise policy will lead New York to do one or both these things, and forever assure her citizens the controlling freight rates. So to do will not only give her citizens control of commerce, but also save and profitably invest at least a small part of their surplus earnings. This aspect of the matter should not be overlooked. The only investment savings of the great mass of wage-earners are those invested in wise public works. The average man cannot attain to invested remunerative personal savings. At best he can own a home, educate his children, provide his family the things usual to their condition, and by life insurance, protect his widow and orphans from the worst shocks of fortune.

But the state, by wise public works, not only makes investment savings for the wage-earner, but also for his posterity, saving the present surplus and also that which is to be, and augmenting both, and bringing immediate and constant returns to the wage-earner in higher wages with greater purchasing power. Such works as above contemplated are the best and wisest of their kind; in the present instance they are the only wise procedure; for, whatever our opinion may be as to future state or national ownership or regulation of railways, every intelligent man must admit that the peculiarities of our federal system, and the extreme conservatism inherent in its structure, make it extremely unlikely that such a result can be attained except by long and painful experiments, which will stretch beyond the lives of us and our children. The twelve years' experiment with the Interstate Commerce law certainly confirms this view. To begin experiments in state legislative cures may benefit some future generation, but hardly this—a result desirable but not satisfying.

A state railway would prove a costly disappointment. The Pittsburg & Bessemer road and its 4-mill rate are conclusive evidence to that fact. That road is up to date and cannot be much improved on at present. A state railway, to be of practical value to New York's commerce, must have complete railway connections at Buffalo and terminals at both ends; and the varied character of the commodities it must handle makes it certain that its terminal costs would greatly exceed those of the Pittsburg & Bessemer, which was built to relieve at most two lines of business. It is therefore certain that the suggested state railway could not handle the freights of New York as cheaply as the P. & B. can handle its limited list of commodities, and the resulting freight rates would be little if any lower than the 4 mills obtaining on the P. & B., even allowing that there are no charges for interest and maintenance of way.

On the other hand, rates less than a mill per mile are certain to result from building either the 12-ft. barge canal, or the 20-ft. ship canal—facts which have been theoretically demonstrated and will be fully substantiated by the forthcoming reports above referred to. That of the U. S. Board of Engineers on Deep Waterways in especial, I hear it said, will be an engineering classic, and give the latest and fullest data relating to this most important subject.

Respectfully yours,
Chauncey N. Dutton.

Bowling Green Building, New York city, Nov. 18, 1899.

We have taken the liberty of numbering certain paragraphs, in our correspondent's letter, for greater clearness in replying to some of his statements:

(1) We do not know what our correspondent means by the "percentage of efficiency of the railway as a machine." As nearly as we can gather, however, he means the ratio between the actual cost to a railway company of handling traffic (including in this cost interest on its invested capital), and the rate which it actually charges. Now, as a matter of fact, a railway company does not take into account the cost of moving traffic in making its rates. It figures on what the traffic will bear, and makes its rates to suit that. The Pittsburg, Bessemer & Lake Erie R. R. carries its freight at the lowest cost that its managers can secure by exercise of their best abilities, but it charges for this service all it can get, and so long as railways are run on the competitive basis is within its rights in so doing.

(2) Our correspondent thinks experience with the P., B. & L. E. R. R. is "probably disappointing." Against this we may very fairly set the remarks of Mr. Andrew Carnegie, who knows a thing or two about railroading in general and about the railroad referred to in particular. In an address before the Pittsburg Chamber of Commerce, Nov. 10, 1898, Mr. Carnegie said:

> I was the first to suggest that the abandoned canal should be replaced by a deeper one which should lead the waters of Lake Erie into the Ohio. Conditions, however, have changed. Such has been the progress of railway development that if we had a canal to-day from Lake Erie through the Ohio Valley to Beaver, and it was opened free of toll like the Erie Canal, we could not afford to put boats on it. * * * It is cheaper to-day to transfer the ore to 50-ton cars and bring it to our works in Pittsburg over our railway than it would be to bring it by canal.

That does not sound to us like disappointment.

(3) If our correspondent would take a job as traffic manager of a railway, he might change his mind concerning the comparative cost per ton-mile of handling local and through freight. As the next best thing we suggest that he take a day's ride in the caboose of a through freight and see what an astonishing number of ton-miles are manufactured in the course of ten or twelve hours. If he will then spend another day on a way freight, picking up and setting off cars at every station, he will come to appreciate how much smaller is the output in ton-miles for a given expenditure of labor and a given investment. As for local traffic "not costing the railways a cent for terminals," a very large proportion of the through traffic as well as the local is loaded and unloaded on private sidings. The cutting out and switching of cars to and from these sidings constitute "terminal expenses," however, and is an item of no small proportion in the railway expense account.

(4) We warn our correspondent that it is easy to draw entirely erroneous conclusions from averages of ton-mile rates. His statement that the New York Central carries 2 tons through freight to 1 of local is wide of the mark. The annual report of the New York Central company shows about six times as many tons of local freight handled as of through freight. The difference in the average ton-mile rate of the Pennsylvania and New York Central is not due, therefore, to the former company handling local freight and the latter through freight. We believe it to be due to the great volume of soft coal traffic on the Pennsylvania, which is moved at very low rates, sometimes, we believe, as low as 2 mills per ton-mile.

(5) We have stated plainly under what conditions the railways can move bulk freight traffic at very low rates. One of these conditions, and perhaps the most important one, is that they shall have the traffic to move. So far as the waterway routes are successful in diverting traffic from the railway lines, they increase the costs and necessary scale of charges for rail transportation.

(6) We freely admit that coal from the upper Ohio is carried down the Mississippi, by the peculiar system of transportation which has grown up there, at a rate which is given by Major Symons as 71 cts. per ton for a voyage of 1,970 miles, or 0.36 mill per ton-mile. We know of no other instance anywhere of any such rate being reached for freight transportation by river or canal, and are compelled to doubt the accuracy of Mr. Dutton's memory respecting rates on English barge canals. The important point which we wish to emphasize, however, is that practically all published statements of rates for water transportation, and especially of rates on canals, are seriously misleading in that no allowance whatever is made for the interest on the money spent in creating and improving the waterway or for the annual expenditure for its maintenance.

Now if any fair comparison of the costs of rail and water transportation is to be made, it must evidently be upon an equal basis. If in the case of the Erie Canal we are to omit the interest upon its present value as an investment to the state and the state's annual expenditure upon it, then we should also omit in computing the cost of rail transportation the interest on the cost of the roadway and the annual expenditures for maintenance of way.

The proper way, however, is undeniably to consider all the expenses of waterway and railway alike. Figure Erie Canal rates on this basis, and they become something quite different from the

1½ mills per-ton mile which our correspondent claims.

As for the proposed large barge canals and ship canals, the case becomes much worse, as the investment and maintenance account are so greatly increased. Doubtless Mr. Dutton will say that since the Government builds and maintains the canal it is proper to omit its expenditures from the cost of transportation; but this seems to us fallacious and dangerous reasoning. What the public wants to know is what is the cheapest machine for moving freight, the railway or the waterway, and it is entitled to a fair and honest answer.

(7) Since Mr. Dutton's premises as to the proportion of local and through traffic on the New York Central are so faulty, it is reasonable to doubt his conclusions.

The remainder of our correspondent's letter contains some matters already answered above, and others with which we are far from agreement, but to which time and space do not now permit a reply.—Ed.)

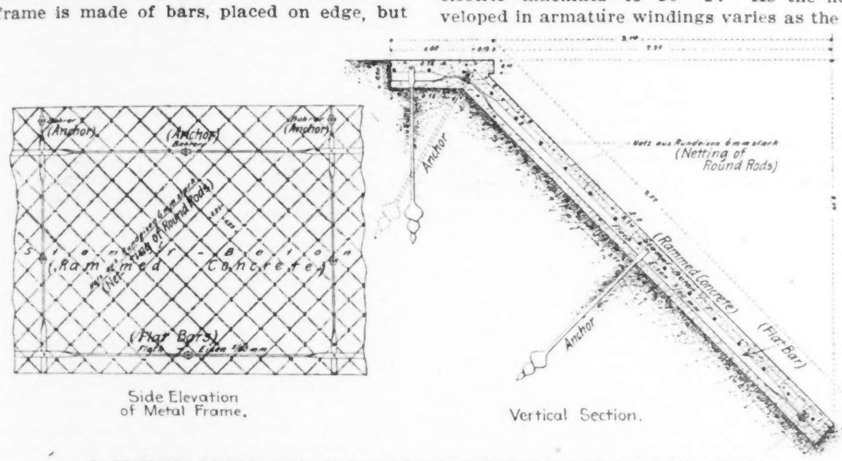
A STEEL AND CONCRETE PAVING FOR CANAL SLOPES.

We illustrate herewith, from a German exchange, a new system for protecting the wet slope of canal embankments from wash. The system is the invention of C. Rabitz, of Berlin, and has been put into use on the Wentow canal, at Marienthal.

This protection consists of a continuous sheet of concrete, in which is embedded a main framework and a net of iron bars, as shown in the illustration. This frame is made of bars, placed on edge, but twisted to 90° at the intersections, so that they may be riveted together. Midway between each of the intersections of this frame screw-anchors are put down, provided with forked-heads, which hold the bars rigidly in place, and about 8 ins. above the ground surface. This forked-head is connected to the bars by a split-pin.

On this frame is placed a network made of ¼-in. round iron rods, which are tied to the frame and to each other by wires. This skeleton is finally incased in a layer of concrete 8 ins. thick, the concrete being made of broken bricks, gravel and cement. It is surfaced by a coating of pure cement.

The main advantage claimed for this type of protection is its rapid execution. A stretch of the protection here described, 443 ft. long, was finished in 18 working days, working in the dry. It is claimed to be strong, durable and relatively cheap.



Side Elevation of Metal Frame. Vertical Section.

A GERMAN STEEL AND CONCRETE PROTECTION FOR CANAL BANKS.

CAPACITY LIMITS IN DIRECT-CURRENT MACHINES.

Alton D. Adams,* M. Am. Inst. E. E.

In electrical machinery the maximum possible rate of work is far beyond the practical limit. A steam engine, at a given speed, cannot work at a greater rate than that which corresponds to boiler pressure through the entire stroke of its piston. If heat can be got rid of fast enough to prevent destruction of its materials an electric generator or motor does external work at its maximum rate when one-half of the electric energy generated in, or applied to, the armature coils is wasted there as heat. In this case the efficiency of the machine disregarding the losses in magnet coils, local currents, hysteresis and friction is 50%. As the normal losses in armature windings of large and medium sized machines is usually from 1 to 3 %, at full rated load, the enormous increase possible is evident. As a matter of practice, none, save experimental or very small machines, are ever built in which the maximum rate of work above indicated could be realized. The two practical limits of capacity in direct-current dynamos are determined by the heating of the conductors and sparking at the brushes. The electric circuit, consisting of the windings, in an electric machine is separated from the other metallic parts by cloth, paper and other materials which may be injured by heat. This insulation is absolutely essential to the operation of the machine. It is found, as a matter of experience, that cloth and paper when kept in contact with metal at much above 250° F. rapidly deteriorate in insulating properties and mechanical strength. This fact makes it imperative that the maximum rise in temperature of an electric machine, plus the temperature of the surrounding air, shall not exceed the limit of 250° F.

Dynamos and motors are apt to be operated in basements and engine rooms where the temperature is as high as 120° F., and it is common in good practice to limit the maximum rise above the surrounding air, in the windings of electric machines to 90° F. As the heat developed in armature windings varies as the square of the current, that is, as the square of the rate of work, the maximum temperature rise increases rapidly with the rate of work, in a given machine. The rise in temperature that will take place in a particular machine under continuous operation at a certain load depends on the rate at which the parts of that machine dissipate heat. As is well known, a body in free air dissipates its heat the faster, the higher its temperature above that of the surrounding air. Complying with this law, the windings of electrical machines when put in operation at first give off but little heat, and the temperature increases up to the point where the energy expended in the windings just equals that dissipated as heat. In small machines the maximum rise of temperature may frequently be reached in three or four hours run at full rated load, while in large sizes the time usually extends to ten hours or more.

An electric machine may, however, be brought to its maximum temperature for rated load by operation during a shorter period than would be necessary with that load at a properly determined greater load. It is at once evident from the above, that rise of temperature in the windings is but a slight limit to momentary overloads or even to those of some few minutes duration, since a comparatively small amount of heat is generated in the coils during these short periods by the extra load. The heat limit to capacity in electrical machinery thus requires a considerable time for its operation and is cumulative, tending to the destruction of the insulation.

The limit imposed by sparking at the brushes is immediate in its action and but slightly destructive, while, intimately connected with it, are tendencies to reduce at once the output. To understand the phenomenon of sparking and its production by an overload, a glance at the function of a commutator is necessary. In a direct current generator of ordinary construction the commutator is but a series of connections to the armature coils at stated intervals, for the purpose of brush connection. This fact is well illustrated by the pracice of two well-known makers, who in some large machines arrange the brushes for direct contact on the bars forming the armature winding.

That part of the armature winding with which the brushes makes direct connection is subjected to a reversal of the current flowing in it at the time it passes the brush, since the current divides at the brush contact, one-half flowing through the winding in each direction. The strength of the magnetic field through which the conductor is moved must have a certain relation to the current flowing through the conductor, if reversal is to be accomplished without sparking at the brushes. In all well-designed dynamos the distance between the face of the pole-piece and the iron of the armature coil is proportioned with special view to sparkless commutation, thus making its length much greater than is usually necessary for mechanical clearance. This air-gap generally requires about 70 to 90% of the exciting power of the magnet windings, the remainder being utilized to force the magnetic flux through the iron circuit of the machine. As the magnet winding requires more copper than any other part and constantly consumes energy while the machine is at work, it is desirable to keep the magnetizing force required for the air-gap as small as consistent with good operation. To allow for temporary overloads, however, it is customary to so design apparatus that the sparking limit allows somewhat greater output than the heating limit. This last is particularly true in machines intended only for intermittent work, as crane motors, where an all day load, quite within the sparking limit, would seriously injure the insulation of the windings.

An excessive current in the armature coils produces sparking, and this latter is usually obviated in some degree by changing the angular position of the brushes on the commutator to a point where the commutating coils will be in a stronger magnetic field. A reaction of the armature on the magnets results from the brush movement just noted in such a way as to decrease the total magnetic flux and, consequently, the electric pressure and output in the case of a dynamo.

Detection of overload through rise in temperature requires some time and careful observation, but when the sparking limit is exceeded the trouble is at once apparent.

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STEEL TIES ON THE SUMATRA STATE RAILWAYS.

The railways in the Dutch colony of Sumatra (in the East Indies) are owned by the state and operated by the Netherlands State Railways Co., which company operates the state railways in Holland. The system is 130 miles long, of which 22.3 miles are on the Abt rack-rail system. The first section, from Port Emma to Padang-Pandjang, 46.5 miles, was opened in July, 1891, but track-laying was commenced in 1888, and the line was operated by construction, passenger and freight trains up to the time of its official completion. It has, therefore, had about 9½ years of service, and some parts have carried as many as 100,000 trains. The native djatti wood is suitable for ties, being a species of teak, with properties much resembling oak. If this wood had been used for ties, the line would now require extensive renewals, but as steel ties were used no renewals have yet been required. A report on the experience with the steel ties has been made recently by Mr. L. K. Lindhout, Assistant Chief of the Division of Track and Works, and is printed in the October number of the "Bulletin of the International Railway Congress." From this report we take the following particulars, and may refer our readers to former reports on the steel ties of the Netherlands State Railways, and the Gotthard Railway in our issues of April 7 and Aug. 25, 1898.

The gage is 3 ft. 6 ins. The rails are of steel, 51½ lbs. per yd., while 80-lb. rails have been used in a tunnel 2,710 ft. long and on one of its approach grades. The joints are spliced with angle bars. The ties are of the well-known Post type (Eng. News, Aug. 25, 1898), weighing 86.4 lbs. each, and there are eight ties per rail length of 23 ft. on ordinary track, and nine ties on the rack-rail track. The ties for the former are made narrower and deeper at the middle, while those for the rack are of uniform width and depth, but slightly thicker in the middle, where the supports of the rack are riveted. The rack is of the Marsh type, with bars riveted between two steel channels having narrow top and wide bottom flanges. The weights of the ordinary and rack-rail tracks are 210 and 374 lbs. per yd., respectively, while the cost at the works in Europe was $2.52 and $8.10 per yd., respectively. The ties are 6.23 ft. long, about 6½ ins. wide at the rail seats, and 2½ to 5 ins. deep. The metal is from 0.24 to 0.4-in. thick. The rails are secured to the ties by bolts having eccentric rectangular necks which fit into rectangular holes in the ties and allow for widening the gage on curves. Three types of bolts are used, differing only in the projection of the neck, and thus allowing for a widening of the gage from 0.23-in. (on curves of 3,126 to 1,968 ft. radius), to 0.93-in. on curves of 656 to 492 ft. radius.

The ballast is of coarse gravel, with a top dressing of sand or fine gravel, and broken stone is being used in maintenance. One part of the Payacombo branch was laid in 1895-96 with ties of native djatti wood, 6.56 long, 9 ins. wide and 4.8 ins. thick, with base plates on the joint ties.

The equipment includes some 19½-ton engines, but most of the traffic is operated by side-track mogul engines of 34½ tons weight, with 9.3 tons on each driving axle, and a driving wheelbase of 9.25 ft. Most of the passenger and freight cars are mounted on trucks. The maximum speed is 18½ miles per hour.

The ties of the rack-rail track show less deterioration than those of the ordinary track, and eleven ties from the oldest section of the latter track were therefore selected for examination. Their general condition were very satisfactory and the loss of weight was only 0.22-lb. per tie per year, or about 0.25% of the weight of the tie when new. This loss was somewhat greater at stations. The wear under the rails was from 0.04-in. to 0.12-in., and it is suggested that in future track construction tie-plates should be used or should be applied when the wear of the rail seats has reached a certain limit. The wear of the bolt holes was insignificant, except in a few cases where corrosion had been caused by dampness and ashes. Widening of the gage on curves occurred by the wear of the rail flange and bolt, and the tie and bolt at their points of contact. On tangents and on curves of over 656 ft. radius this wear, after 9½ years' service, amounted to but 0.08 to 0.12-in. On sharper curves the wear has aggregated 0.36 to 0.45-in. If wooden ties had been used on the curves, they would already have been renewed once or twice, while renewals of the metal ties are only just commencing. These renewals will be few, since by using new bolts, or reversing the ties, so as to bring the unworn inner holes under the outer rail, the track can be restored to its normal gage. On the sharp curves, the track will gradually be strengthened by the addition of one or two new ties per rail length.

As to the work of maintenance it is found that the first ballasting and tamping requires greater care than with wooden ties. But when the ties are once filled with a well tamped core of ballast (which operation is facilitated by the shape of the Post tie) they require much less maintenance, as proved by 9½ years of experience with native labor. There is no creeping of the track, and no lateral shifting of the ties, owing to their deep ends. Where the wooden ties have been used, however, on the Payacombo branch, there is considerable trouble from this lateral movement, especially in damp ballast and in the rainy season. Thus the cost of maintenance is far less with the steel ties than with the wooden ties. The cost of maintenance of track, works and buildings declined from 13.82% of the total cost of operation in 1895, to 12.36% in 1897. On the Dutch railways of Java, where djatti wood ties are used, the percentage of cost of maintenance was 21.58% in 1897.

The ties are of very good quality and have developed few defects, and the same may be said of the fastenings, even the renewal of the outside bolts on the outside rails of sharp curves having been insignificant. It is found that the nuts must be kept tight, or sand will work in between the rail and tie and cause wear. In order to avoid the expense of four spring washers to each tie, a length of track was laid in 1896 with nuts and clamps having serrated hearing surfaces, and these are found to keep tight. This effects a saving of about 2 cts. per tie. The wear of the base of the rail is almost imperceptible.

As to the cost of renewals, the native djatti wood ties cost 70.6 cts. each, or 73.6 cts. with four spikes, omitting the tie-plates and extra spikes on joint ties. The average life in Java is about 9 years, which would give an average cost of say 8.2 cts. per tie per year. Steel ties cost $1.29 each in Europe, to which must be added 12.6 cts. for four clamps, 16 cts. for four bolts and 2 cts. for four spring washers, making a total of $1.596 per tie complete. The cost of transportation brings the cost up to $1.84 per tie delivered at Port Emma. This cost, divided by 8.2 cts., gives 22¼ years as the minimum life required to make the annual expense for tie renewals equal to that of wooden ties. If the ties alone are compared, exclusive of fastenings, the minimum life for the steel tie is reduced to 19 years. Mr. Lindhout estimates that the steel ties now in use will have a life of at least 23 years and will cost less than wooden ties for renewals as well as for maintenance. On the sharp curves, also, wooden ties would already have had to be renewed, as above noted, whereas none of the steel ties have as yet had to be renewed.

THE STERILIZATION OF WATER BY OZONE.*

The author shows: (1) Ozone produces an arrest of bacterial development and sterilizes solutions rich in bacterial life.

(2) The passage of 17.2 mgs. of ozone is capable of sterilizing 1 liter of water containing 1,250 bacteria per c. c. (about 1 grain of ozone per gallon of water).

(3 In the author's experiments by far the greater portion of the ozone is not used up in its passage through the water to be sterilized.

In general the work confirms that of Dr. Geo. A. Soper (Eng. News, Oct. 19, 1899), but the points brought up were not so judicially treated, neither does the German investigator show so keen an appreciation of the problems and conditions of water supply as the American. The most interesting part of the experiments was that where the simultaneous action of ozone and iron on sewage effluents was tried.

Iron was introduced in the form of wire gauze into the wash bottles containing the effluent, and the ozonized air passed through. It was found that more complete clarification and sterilization was obtained in this way than by using either of the re-agents alone.

The number of bacteria and the amount of oxidizable organic matter was certainly reduced by the action of iron and ordinary air (Anderson process), but the decrease was far inferior to that brought about by iron in conjunction with ozonized air as might have been expected.

It is stated by the author that the oxygen consumed is reduced by ozone alone, by 50.9%; with iron and air, by 61%; with iron and ozonized air, by 87%. A similar reduction of organisms takes place. The applicability of the so-called ozone and iron treatment to the purification of drinking water was ascertained by treating 40 liters of water which had been artificially contaminated with a "Dibdin" (sewage?) effluent enormously rich in bacterial life, with 40 liters of air containing 20 mgs. of ozone and in the presence of 100 disks of iron gauze. By this process the number of bacteria was reduced 99%.

By the Anderson process the bacteria are reduced 50%. The experiments show that ozone is useful in removing color due to the so-called humous substances. The author does not pay attention to the effect of ozone on the odors contained in waters, probably because these troubles are not of frequent occurrence in the high latitudes of northern Germany.

A plant capable of treating about 25,000 gallons of water per day with ozone has been established hy the author at Charlottenburg, the main feature of which is a tower (in this case 14.5 [illegible] high) down which the water flows through a layer of coarse stones, meeting the ozonized air on its way downwards. Before entering the tower the water is subjected to a rough process of filtration through coarse gravel to free it from cloth, paper, floating fruit and living fish.

The cost of active ozone is estimated at $807 per kilo., or $367 per lb., and the cost of 1,000,000 gallons of water sterilized by ozone is estimated to be $3.20, with a corresponding increase if the water is of very bad quality.

In conclusion Weyl considers that the ozone process as applied at Charlottenberg is preferable to sand filtration on the following grounds:

(1) The cost of construction and maintenance is said to be less in the case of the ozone waterworks than in that of the sand filter.

(2) Sand filtration is uncertain, germs passing through the filter, and defects can only be detected hy bacterial methods which require three days, during which time contaminated water may be supplied to consumers. With the ozone process, on the other hand, if every portion of the water is hrought into contact with the ozone the water is rendered germ free.

Weyl considers that the ozone process should be considered by every one intending to derive a water supply from surface sources, and that by its use surface water will be more generally available than heretofore.

(Criticism by Mr. Weston.)

In general the author bases his opinion on too little evidence, and fails to consider the question of turbidity, the absence of which, together with the absence of color, odor and unpleasant taste is an indication to the consumer and taxpayer that a water purification plant is doing satisfactory work, no matter what experts may say. Both the author and Dr. Soper assume that the enginemen and the electricians in charge of an ozone plant would be more careful than men with the same degree of training in charge of a filter plant.

The use of ozone and iron as a coagulant for river waters, in connection with the American system of filtration is, perhaps, worth considering experimentally. Most waters, because of their high carbon dioxide and insufficient oxygen contents, are unsuitable for treatment by the Anderson process. Moreover, there is considerable criticism (the result of ignorance, it is true), against the use of sulphate of alumina as a coagulant.

Such a process, combining, as it might, bactericidal, and coagulating functions, would, perhaps, be useful in some cases, especially where the alkalinity of the water would not permit the use of sufficient sulphate of alumina for the proper coagulation of the water. Such a process could not cost as much, however, as estimated by Weyl, and reported from Paris by Dr. Soper.

*Abstracted by Robert Spurr Weston, 14 Beacon st., Boston, Mass., from an article by Mr. Th. Weyl, in "Centralblatt for Bakteriologie, vol. 26, p. 15.

A 297-FT. PENDULUM has been swung in the Masonic Temple, under the direction of Prof. J. R. Bevis, of Northwestern University, for the purpose of scientific experiments. The building has an interior court, and a steel wire is hung from a swivel attached to one of the skylight beams. A 56-lb. ball is attached to the lower end of the wire and carries a small brush, which marks the course of the pendulum on boards placed at the limit of its swing, which is about 18 ft. This is said to be the largest pendulum ever used, the next to it being one of 220 ft., suspended from the cupola of the Pantheon, in Paris.

A HIGH LEVEL BRIDGE over the Chicago River, near its mouth, is proposed by Mr. Rector, one of the aldermen. The bridge itself would be 265 ft. long and 110 ft. high, but would be a minor part of the structure, which is to include two great towers, two immense buildings, and two approach viaducts. The grade of the approaches would bring the roadways into the towers at 35 ft. above the river, and a winding road of one complete turn would reach the level of the bridge. The buildings are to be for armories, steamship offices, auditoriums, etc. The cost is estimated at $7,000,000, with a revenue of 4%.

ANNUAL MEETING OF THE SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.

The seventh general meeting of the society was held at the house of the American Society of Mechanical Engineers in New York city on Nov. 16 and 17. In most respects the meeting was a very successful one. There were 14 papers on the programme, and the majority of them received discussion. Considerable time was wasted, particularly at the first day's session, by the authors of the papers reading them in full. This practice is, however, a common mistake of convention work, and the naval architects are no worse in this feature than many of their sister engineering societies. Where the papers are printed and distributed well in advance of the meeting, reading them by abstract, or, in some instances, by title only, will usually promote rather than restrict discussion, and will save a great strain upon the patience and good temper of the majority of the members who have already studied the paper. This fact was evidenced in the work of the second day's session, when most of the papers were read in abstract, and when the discussion instead of being curtailed thereby, was, if anything, more active than during the first day's meetings.

The opening sessions of the meeting were presided over by Rear-Admiral Francis M. Bunce, U. S. N. (retired), the President of the society, Mr. Clement A. Griscom, being absent on a trip abroad. Mr. Griscom's presidential address was read by the Secretary, and was in part as follows:

Whatever may be the political, moral or constitutional aspects of a policy of expansion, it is not without advantages to shipbuilders. The large number of vessels purchased by the Government last year for use of the army and navy, together with increasing use of steam vessels in the coasting trade, have produced the greatest activity ever seen in our coast shipyards, both on the Atlantic and the Pacific oceans. The orders for large steel steam vessels now taken exceed largely those of any year in our history. The record on the Great Lakes is such as to tax the capacity of the shipyards of that district until the fall of 1900. There are now building or to be built on the lakes, 26 steel vessels of large size of an aggregate value of about $8,000,000, and an aggregate carrying capacity of 154,000 gross tons. These vessels comprise 1 passenger vessel, 2 steel barges of 7,000 tons capacity each, 5 steamers of 3,000 tons capacity, suited to trade between the Great Lakes and the Atlantic seaboard, and 18 steam freight vessels of about 6,000 tons capacity.

On the sea coasts we have the unusual condition of nine steamships building for ocean commerce. At least nine large steamers, recently built, have been added to the coasting or West Indian trade in the past year.

This is probably the first occasion that I have found any statistics in regard to American shipping industries of a character desirable to contemplate, and even now I feel obliged to accompany them with a note of warning, "One swallow maketh not a summer." The proportion of our export and import trade now carried in American bottoms is too small to be mentioned, and last year was smaller than ever before. To make this percentage a respectable one would require ten times the number of American shipyards working at full time for a number of years. While we have the materials, the tools and mechanics, the successful building of a modern vessel from a commercial point is in reality a triumph of organization of the multitude of diversified trades which it includes. This stage is yet to be reached, and can only be attained by regular systematic production. Production depends upon a market and upon traders who see a profit to be made in shipowning under the laws of the United States.

The Secretary's report showed the total membership to be 573, not including the members elected during the meeting. The total receipts during the year from all sources were $5,614, and the total expenditures were $5,669. The balance in the treasury was $3,586, and the total resources of the society were $13,935, with no liabilities.

The first paper on the programme was presented by Mr. Spencer Miller, M. Am. Soc. C. E., and was illustrated by lantern slides and models.

Coaling Vessels at Sea.

The paper described briefly the various devices proposed in the past for coaling vessels at sea, and concluded with illustrations and a description of the cableway system devised by the author and soon to be tested with the U. S. S. "Massachusetts" and the collier "Marcellus." This system was described in its general features as follows:

(1) It it proposed, with this device, for the warship to take the collier in tow, or the collier to tow the warship, leaving the distance between ships about 300 ft. This method of securing boats at sea is recognized as being safe.

(2) The warship to receive the coal will erect a pair of shear poles on its deck, which, secured by guys, will support a sheave wheel and a chute to receive the load.

(3) The collier is provided with a specially contrived engine located aft the foremast, having two winding drums. A steel cable, ¾-in. diameter, leads from one drum to the top of the foremast, over a sheave, thence to the sheave on the warship, back to another sheave on the top of the foremast, thence to the other drum. This engine gives a reciprocating motion to the conveying rope, paying out one part under tension; a carriage secured to one of the parts passes to and from the warship, its load clearing the water intervening.

(4) A carriage of special form is provided with wheels which roll on the lower part to the conveying cable, and grip slightly but sufficiently the upper part of the cable. This carriage will carry bags of coal weighing 700 to 1,000 lbs. The load is held by a hook pivoted at the bottom of the carriage, which hook is held by a latch. When the carriage comes in contact with the rubber buffer on the sheave block at the warship, this latch is pressed in, thereby releasing the hook and its load. Should the carriage strike heavily at either terminus the upper part of the cable will slip through the grip and no damage will be done.

(5) As soon as the bags are dropped, the direction of the rope is reversed, and the carriage returned to the collier. During the transit of the load an elevator car descends to the deck, bags of coal are placed thereon, suspended from a bale, and elevated again to the stops on the guides, so that when the carriage has returned to the collier, the pointed hook finds its way under the bale or hanger supporting the coal bags. The instant the load is hooked on, the direction of the ropes is again reversed, the carriage takes its load from the elevator and transfers it across the intervening space to the warship, and drops it again into the chute.

In a future issue we hope to be able to give more complete details of the construction and operation of this device. There was no discussion on the paper, and the reading of the next paper on "Reasons for the Adoption of the Water-Tube Boiler in the U. S. Navy," by Rear-Admiral Geo. W. Melville, Engineer in Chief, U. S. N. This paper was printed in our last issue. The discussion brought out very little information in addition to what was given in the paper. The next paper was by Mr. John Hyslop, and had been written in response to the invitation issued by the society at its meetings of Nov. 10 and 11, 1898, asking for papers on the subject of "Life Saving at Sea." An abstract of this paper is printed elsewhere in this issue. In discussing this paper, Capt. George Randle, of the Atlantic liner "St. Louis," suggested the adoption of very large ship's boats, capable of holding say 100 persons, carrying them athwartships on ways and launching them endwise on chutes exactly similar to the way in which ships are launched from the building ways. Captain Randle stated that experiments which he had seen conducted had convinced him that the plan was perfectly feasible.

The next paper was by Naval Constructor J. J. Woodward, U. S. N., and described in considerable detail the electrical installation on the new United States battleships "Kearsarge," and "Kentucky." These are the first vessels of our navy on which the use of electricity as a motive power for the ship's auxiliary machinery has been adopted to the practical exclusion of steam. The only auxiliaries operated by steam on these two vessels will be those connected with the main propelling engines, such as air, feed and circulating pumps, forced draft blowers, ash hoists, etc., and the windlasses and steering engines. Some of the more notable features of the electrical plant will be described in an abstract of the paper, which we shall publish in a future issue. The discussion on the paper was very short and turned chiefly upon the relative advantages of the two-wire and three-wire system of distribution for such conditions as prevail on board warships.

The next paper was read by Mr. Geo. W. Dickie, of the Union Iron Works, San Francisco, Cal.

A Simpler Arrangement for the Mechanical Apparatus on Warships.

The present complicated condition of affairs in the arrangement of the various mechanical contrivances used on modern warships is due to two causes, as follows:

(1) Uncontrolled growth of new devices for doing the many things for which mechanism is required on these vessels, without the new devices being considered reliable enough to supersede the old. Hence, duplication and, in

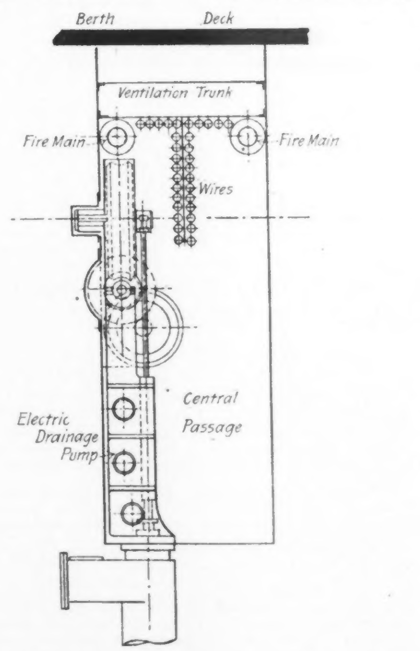

Fig. 1.— Transverse Section of Proposed Longitudinal Amidships Passage for Power Transmission Lines.

many cases, triplication of apparatus for doing one thing, for which one good device alone should be used.

(2) The system of divided control over the work, rendering it impossible to have a homogeneous design to begin with, that would enable the ship and all that is required of her to be treated as one machine, and provision made at the start for every function being considered with relation to every other function.

As a remedy, the arrangement shown in Fig. 1 is suggested. This arrangement consists in the construction of a tunnel or passage lengthwise of the vessel at the center and just below the protective deck, and the installation of all pipes and wires in this passage. From this central passage the pipes and wires branch off on each side to the various mechanisms located throughout the ship. All steam pipes are confined to the main engine room, the auxiliary engine room and electric generator room, and all machinery outside of these rooms is operated by electric motors. Referring to the illustration, the relative location of the ventilating trunk, fire mains and electric conductors are clearly shown. The drainage pumps are electrically operated, and are located in six groups of three pumps each at regular intervals lengthwise of the central passage. The suction mains for these pumps, two in number, are located on each side of the center line bulkhead just above the bottom stiffener brackets and the various suctions branch off transversely. The laterals and standpipes from the fire mains are arranged in a similar manner to the suctions from the drainage mains. Doors at frequent intervals in the central passage give access for repairs, inspection, etc. In conclusion, the duplication of devices for doing the same work is condemned, and it is urged that the duplication be abandoned. The use of mechanical arrangements for closing bulkhead doors singly or in groups from a central station at a distant part of the vessel is condemned as a useless and objectionable complication of apparatus.

The Wooden Sheathing of the U. S. S. "Chesapeake."

The "Chesepeake" is a practice ship being built at the Bath Iron Works, Bath, Me., for the U. S. Naval Academy, and it was launched June 20, 1899. One notable feature of the vessel is that the steel hull is entirely sheathed with wood. The woodwork comprised a keel of teak, and a false keel of oak spiked to the main keel, which in turn was fastened to the metal keel plate with 1⅜-in. brass screw bolts. The sheathing proper is of 4-in. Georgia pine, except for the two top strakes, and near the stem and stern, where 3½-in. planks are used. The upped edge of the sheathing, which reaches 26 ins. above the water line amidships, with an up-sheer forward and aft of 15 ins. and 12 ins., respectively, is covered with a 3-in. × 3 in. angle. The planking is fastened to the steel hull with ¾-in. naval brass screw bolts. Before applying the sheathing the metal hull was carefully cleaned and a thick coat of red and white lead was applied, and after the sheathing was applied a special putty was injected through holes bored in the planks into the space between the planking and the steel hull. The mixture injected consisted of 63.57% white lead, 32.1% dry red lead, and 4.32% linseed oil. Altogether 6,857 lbs. of this mixture was pumped between the plating and planking. The injected putty was confined to a series of longitudinal sections in the following manner: Each third strake of planking commencing with the top of the garboard strake was lightly chinked with a thread of oakum before the next strake was put in place. The brass screw bolts were composed of 62 parts best selected copper, 37 parts Silesian zinc, and 1 part tin. The specifications required these bolts to be bent cold to an angle of 40° without cracking or fracture, and to have a tensile strength of 42,500 lbs. per sq. in. The mean of 21 test pieces gave an average tensile strength of 47,204 lbs. per sq. in. The heads of the bolts were countersunk and packed with hemp grommet and red lead putty, and were fastened by a nut and washer inside the iron hull plating. The counter sink of the bolt heads was filled with Portland cement. The total weight of the sheathing and its attachments was 174,196 lbs., of which the metal used comprised 11,883 lbs. The approximate area of sheathed surface was 7,583 sq. ft.

Second Day's Session.

After some routine business the reading and discussion of papers were resumed. The first paper was read by Mr. W. I. Babcock, Manager Chicago Shipbuilding Co., and described the duplicate mold system of building vessels employed at the yards of that company, and to a greater or less extent in other shipbuilding yards on the Great Lakes. The contents of the paper being of special rather than of general interest, and it being difficult to abstract it satisfactorily, we shall refer such of our readers as wish to study it carefully to the published proceedings of the society where the details and illustrations can be examined. In discussing this paper, Mr. Geo. W. Dickie, of the Union Iron Works, called attention to the great simplicity of design and construction which had been developed in the building of ships for the bulk freight service of the Great Lakes. Some of these features he thought could be studied to advantage by marine architects with a view to their adoption in or adaptation to the design and construction of sea-going ships. A number of other members who had had experience with the duplicate mold system described in the paper confirmed the opinion of the auther regarding its convenience and economy.

The next paper was presented by Mr. James Dickie, Union Iron Works, San Francisco, and described the system of overhead cranes and side stagings used at the works of that company:

Shipyard Building Slips with Overhead Crane and Staging Arrangements.

The need of some means by which material can be hoisted and deposited in any position on a vessel while it is under construction has developed a number of overhead devices which are now in general use in shipyards. These devices are of comparative recent development. Previous to 1884 the only means used to hoist material on a vessel while building was the derrick pole with the swinging gaff. Among the forms of cranes now in use are the following: (1) The cantilever crane, of which the one employed by the Newport News Shipbuilding Co. is a good example; (2) the overhead crane or gantry, so much used on the Great Lakes, which travels all over the vessel with rails on the ground on each side; (3) the large gantry employed in building the "Oceanic" at the works of Harlan & Wolf, at Belfast, and (4) the overhead framework construction such as is used at the works of Swan & Hunter, in England, and the Union Iron Works, at San Francisco. At the Union Iron Works there are four of these frameworks in use, the latest of which is shown in transverse section in Fig. 2. This framework consists of a series of bents of the form shown by the drawing, which are placed about 12 ft. apart and form a skeleton steel-like structure over the vessel. The bents are firmly braced together longitudinally, and the entire framework is 408 ft. long and 78 ft. wide. A 50-ft. crane at each end enables the framework to cover a vessel 500 ft. long, and for longer vessels the framework can easily be lengthened by adding bents at the ends. The whole length of the framework is traveled over by two bridge cranes, as shown, and the jib cranes are spaced at such intervals along the sides that their fields of operation overlap each other. The paper continues the description as follows:

It will be noticed that the apex of the roof is 3 ft. from the center, making one crane 6 ft. longer than the other. This is done to enable pieces such as beams, etc., to be landed on the center line. The cranes are electric and travel at the rate of 180 ft. per minute, fore and aft, and 90 ft. crosswise, and the hoisting speed is 90 ft. per minute, with a lifting capacity of 5 tons. A manila rope is used for hoisting, which gives considerable elasticity, and enables a plate to be holted up if within an inch or two of the place. For plating under the bottom and under the counter we use a wire rope, rove through the plate and the corresponding hole in the frame and toggled under the plate, which enables the plate to be drawn close up to its place.

One feature of the structure is the facility with which staging can be erected. Where the ship is large, the spauls, which are 4 x 8 ins., are rove through the main posts and held by loose bolts at the ends. Where the vessel is narrower, a standard made of 3 x 6-in. double is set on top of the ground, and held from canting by the rigidity of the spaul in the posts, thus saving all bracing. As the posts are all 12-ft. centers, we use 2 x 12-in. x 26-ft. plank for staging, which we find strong enough for any work, and light enough to be easily handled.

We propose, in our new slips, to fit up cranes for riveting as shown in the section. These cranes are made of 8-in. T-bulb beam, and are supported by two suspension rods. The trolley for the riveter runs on the lower flange of the beam; the wheels being 20 ins. in diameter makes it very easily moved.

The machines we are at present using are the toggle-jointed air machines, which drive ⅞-in. rivets with a 30-in. gap. The weight of the machine is about 1,400 lbs. It moves so easily that the operator has no difficulty in making the nicest adjustment. We are also using the percussion air machine, with a 4 or 6-ft. gap, which weighs only about 250 lbs. As will be noticed, the cranes for riveting are only 32 ft. long, with a beam hung from them. This enables us to do hoisting and riveting at the same time, as all the material is hoisted up over the vessel and carried along near the center line to a point opposite to where it is to be landed. This center cross beam can be raised or lowered to suit the work on the vessel. When working on the inner bottom it will be down as shown; when on deck it will be close up to the cranes.

We have studied all the various overhead cranes and claim for this structure that it is no more expensive in first cost and fulfills more functions than any other, except the one at Messrs. Swan & Hunter, on the Tyne, and in comparison with it I think we have the advantage in staging. We find no disadvantage in having the posts as close as 12 ft., all the hoisting being done at the upper end, then carried over the vessel to the required place, and, when there, lowered into its proper place. As we use no side shores above the bilge, the top sides are always clear for lowering a shell plate into position, and, as I said before, the bottom plates and plates under the counter are hoisted from the ground with a wire rope rove through the corresponding hole in the frame, and toggled outside the plate; thus the entire plating can be put on the vessel with these cranes.

We have two cranes at the upper end of the structure. These we use for frame riveting and all other pieces that can be riveted before going on board.

As mentioned before, we use this structure to keep the upper works of the vessel fair while in the early stages. For fairing the upper works we use turnbuckles from the sides of the vessel to the structure, and pull in or slack out when necessary. All of which is done by the men on the upper stage, at small cost and with much convenience.

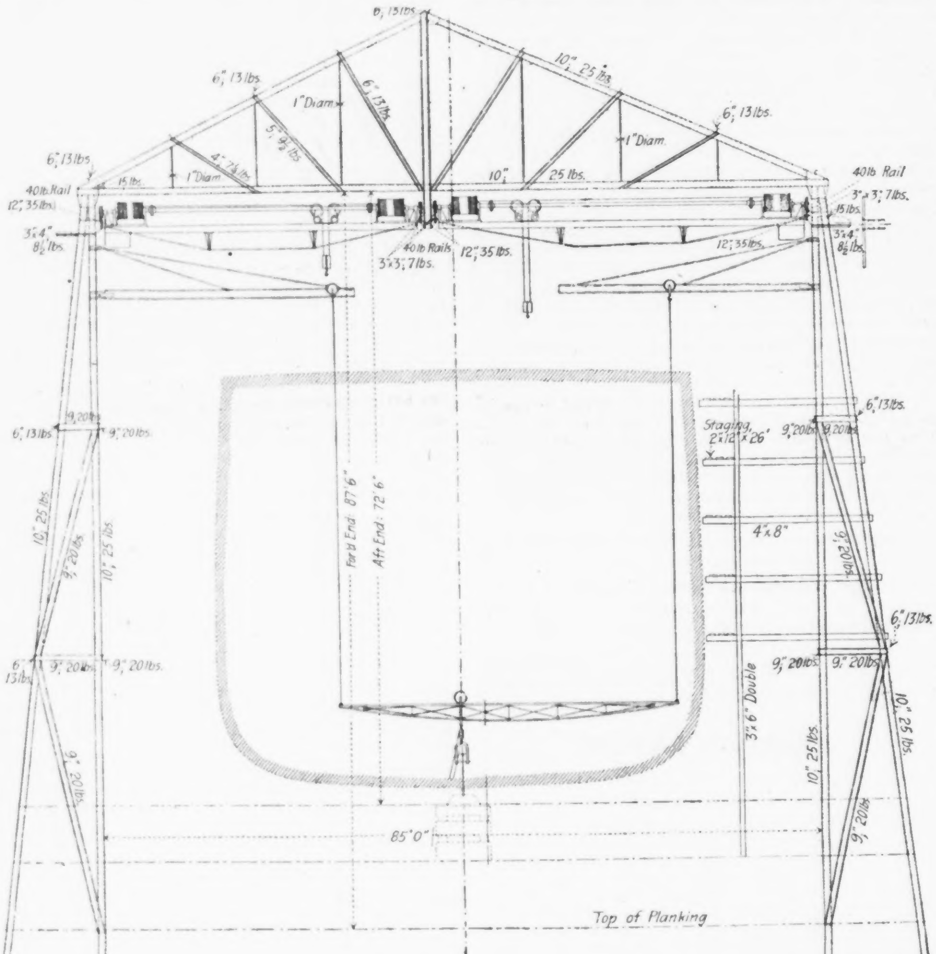

FIG. 2.—TRANSVERSE SECTION OF OVERHEAD ERECTING FRAMEWORK FOR SHIPBUILDING SLIPS, UNION IRON WORKS, SAN FRANCISCO, CAL.

In discussing this paper, Mr. John Platt pointed out that there was some misconception of the purpose of the Harlan & Wolf gantry crane employed in building the "Oceanic." This crane was in the first place intended only for use in building very large vessels, and, second, it was designed purely for carrying riveters, and not for handling materials. The material was all handled on the ground alongside the vessel by cars, and was hoisted on board by derricks. The gantry was used for riveting only, and that it seems to have proven successful for this purpose was evidenced by the fact that Harlan & Wolf are building two more exactly similar, except for some slight changes in dimensions.

The next paper, describing the "Designs for the 'Denver' Class Sheathed Protected Cruisers," for which bids have recently been received, was by Rear-Admiral Philip Hichborn, Chief Constructor, U. S. N., and will be published in our next issue. In a written discussion Chief Engineer Geo. W. Melville deprecated the fact that the writer of the paper should have felt called upon to defend the design of the new cruisers against newspaper criticisms. He also thought the implied criticisms of the cruisers of the "Raleigh" and "Cincinnati" class were somewhat unfair, and said:

Let me say that the "Cincinnati" and the "Raleigh" were designed at a time when there was a perfect craze for big speed in all classes of vessels. The statement had been dinned in our ears so much that we must get at least as good results from every ship as were obtained from foreign ships, and must, if possible, do better, that our designers were working, as one might say, under the lash. Just before the designs were prepared the British Admiralty had got out designs for what were known as the "M class of cruisers," which were exactly the characteristics of the "Cincinnati" and the "Raleigh" in the way of putting a large power in a small hull and aiming at a very high speed. The history of those ships has been very much the same as the history of ours, in that they have not been a brilliant success.

Respecting the speed of the "Raleigh," Admiral Melville pointed out that her speed of nine knots shown at Manila was obtained after she had been six months without cleaning, and that after she was cleaned at Hong Kong she regularly made an average of 12 and 13 knots for long distances on her run home from Manila.

Referring to the question of speed, Mr. Geo. W. Dickie, Union Iron Works, commended the courage of the Navy Department in reducing the speed of the new cruisers to 16 knots and giving the vessel greater coal endurance. He regretted, however, that a soft wood like pine had been adopted for the sheathing. A hard wood like teak was far better and but a very little more expensive. Naval Constructor Francis T. Bowles expressed himself decidedly as being against sheathing for a steel vessel. It might be necessary as long as a considerable number of vessels were required in the Far East, but only until a dry-dock could be built there.

The next paper was read by Assistant Naval Constructor R. M. Watt:

Novelties in Ship Fittings.

This paper described a number of new devices in fittings which have recently been employed in some of the vessels of the U. S. Navy. The novelties described included a water-tight metal skylight for use over mess-rooms and staterooms; a metallic folding berth for ships' staterooms; an asbestos sheathing for finishing staterooms and living quarters; and an electrically operated water-tight bulkhead door. The new bulkhead door is similar to the water-tight sliding door devised by Mr. W. B. Cowles (Eng. News, Aug. 18, 1898), fitted for operation by electric power instead of by hydraulic power. Fig. 3 indicates quite clearly the construction of the electric features of the mechanism, which are also described as follows in the paper:

The motor used is 1 HP., compound-wound, of the short-shunt type, the short-shunt coils being relatively weak, and wound outside the series coils. The circuits are so arranged that for raising the door, only the series coils are in circuit, giving quick and easy starting, while for closing the door where it may be necessary to cut through coal, the shunt and series coils are both in circuit.

The electric current taken from the mains passes through a three-point spring lever switch. Moving the lever to the right or left completes the circuit through the motor and raises or lowers the door. The shaft of the switch handle pierces the bulkhead so that the switch may be thrown from either side. A spring returns this lever to its central position, and when in this position, the door-closing circuit may be completed from one or more distant stations in any part of the ship. The door-opening circuit can be completed only at the door, and when completed cuts out the closing circuits.

Beyond the spring lever switch, the circuit contains a limit switch opened by a bell crank lever when the door reaches either of its extreme positions. The shaft of the pinion that engages in the door rack, carries at its end another pinion that gears into a spur wheel keyed to a shaft that carries the bell crank levers for working the limit switches. The position of these levers may be adjusted for varying the lift of the door.

Beyond the limit switches, the circuit contains two Sprague solenoid gravity controllers which throw in either the series or the series and shunt fields of the motor. These controllers have carbon and copper contacts, which prevent pitting of the copper bars, but necessitate occasional adjustment of the carbon tips. The controllers are fitted in a water-tight receptacle with a hand hole and glass cover; this allows constant inspection of the carbons, and their adjustment when necessary, without removing the front of the receptacle. The working of the controllers is easy and simple, and there are no springs or pins; the copper bars are carried on phosphor-bronze flexible plates allowing for a little wear of the carbons without readjustment, and ensuring good contacts. All the parts are enclosed in water-tight boxes.

Speaking of the progress made in the task of rendering ships' fittings free from danger from fire, the paper gives the following interesting summary of present practice:

Six years ago the divisional bulkheads were of untreated wood; likewise the ceiling overhead, and the ceiling or sheathing against the side of the ship. The berths, lockers, and all the furniture, including a closed-in wardrobe, also the ship's ladders, shelving everywhere, etc., were of untreated wood. Now, the constant endeavor is

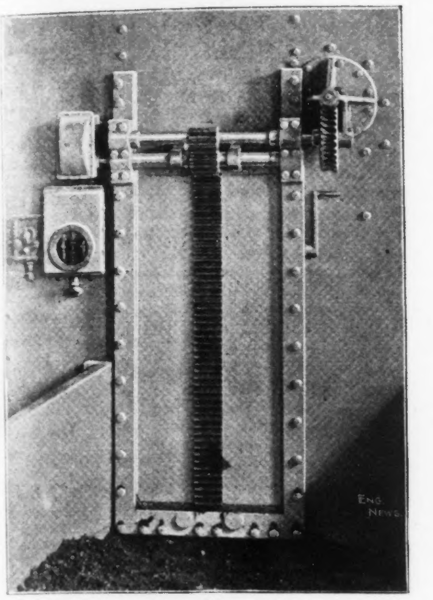

Fig. 3.—Electrically Operated Water-Tight Bulkhead Door for Ships.

to reduce woodwork everywhere to a minimum, steel or some other non-combustible material being substituted wherever practicable, and where wood is used at all it is required to be subjected to an approved fireproofing process. The present practice at Brooklyn Navy Yard is as follows: The unnecessary overhead ceiling is altogether omitted. In crew's quarters the outboard sheathing is omitted, but in officers' quarters asbestos sheathing is fitted. All divisional bulkheads are built of light corrugated sheet metal (first fitted on the "Texas" in 1892) and finished with a sheet-metal cornice (first fitted on the "Atlanta"). The uncleanly wooden berth is replaced by a compact and cleanly metal folding berth. The wooden ladders are altogether done away with, and metal ladders with some form of non-slipping tread are in general use. For the unsatisfactory wooden skylights over mess-rooms and inboard staterooms a water-tight metal skylight is substituted. At the present time the desks, chairs, tables, and chiffoniers used on naval vessels are made of fireproofed wood; but samples of metal furniture, by which the use of wood for this purpose will be entirely dispensed with, are now being prepared at the Brooklyn Navy Yard for the purpose of selecting types for naval use. All lockers supplied to the "Atlanta," including rifle lockers, petty officers' lockers, and marines' lockers, are of metal, and the "Atlanta's" cabin has been fitted with a metal roller-top desk.

In the discussion which followed, a member called attention to the fact that in the new Russian war vessels now being built at the Cramps' yards, all the sheathing was asbestos, all the furniture except the chairs was of metal, and the deck planking was the only woodwork in the whole ship. Mr. W. B. Cowles spoke at some length regarding the comparative advantages of hydraulic or pneumatic power and electric power for operating bulkhead doors. He thought that either hydraulic or pneumatic power lent itself more directly to the work to be performed than did electric power, and was more cheaply transmitted. He also criticised some of the details of the door tightening apparatus described in the paper. The next paper was by Lieut. A. B. Niblack, U. S. N.

Tactical Considerations Involved in Torpedo-Boat Design.

The highest development of the present type of torpedo is one about 16 ft. long and 18 ins. in diameter and carrying a charge equivalent to 110 lbs. of gun cotton. The highest pressure used in the air flasks to operate the engines is 1,500 lbs. per sq. in., giving a speed of 30 to 32 knots at 400 yds., 28 to 30 knots at 800 yds., and 26 knots at 1,000 yds. Some unusually long torpedoes for coast defense run as high as 30 knots for 1,000 yds., and 24 knots for 2,000 yds. The torpedo is not a delicate instrument. Recent inventions and improvements have worked a complete revolution in the status of the torpedo. The first improvement is the application of the principle of the gyroscope to the steering rudders of the torpedo, and the second is the perfection of apparatus that will safely and accurately launch torpedoes from the underwater broadside of a rapidly moving ship. The latter invention practically does away with above-water discharge in large ships, and the former has doubled the accuracy of fire.

Torpedo-boat attack, to be reasonably certain, must be a surprise. Attacks are made in groups of boats, and a single boat would attack only as a forlorn hope. A successful attack is, therefore, a question of team work.

In approaching to the attack, previous to discovery, reduced speed must be used so as to avoid white bow waves, smoke and flame, and that peculiar and far-sounding hum which accompanies fast-running machinery. Once discovered, or once within striking distance, high speed becomes important, but it takes some little time to attain it after having once slowed. As between a speed of 20 and one of 30 knots the time it takes to cover 1,000 yds. is only as 90 secs. to 60 secs. Can the 30-knot boat pass from 20 to 30 knots in 30 secs.? If you can build three boats of 22 knots for what two of 30 cost, and if the greater the number of attacking boats the better the chances, is it not wise to forego phenomenal speed? This craze for great speed is illogical and tactically it is indefensible. Back of it is generally an advertisement for somebody. People who handle torpedo boats have never sanctioned it. What they do ask is that boats be built in groups on identical designs, and that every reasonable effort be made to standardize fittings. As long as fittings are standardized, we may improve groups progressively from year to year as experience dictates.

The vast majority of torpedo boats are single-screw boats. Single-screw boats with bow rudders handle quite as well as twin-screw boats without, and it is claimed for the single-screw boat that there is a saving in oil and the number of men required to operate the machinery; there are fewer moving parts and less liability of breakdown, and the weight and dimensions of the machinery are smaller.

As torpedo boats abroad are frankly intended to manœuver or cruise in groups, questions of spare parts, breakdowns, shortage in supplies, etc., are not so serious, since the boats rely on one another somewhat in cases of emergency. Probably no country has developed her torpedo-boat system so thoroughly as Germany. Fully 90% of her boats were built by Schichau, and the custom is to order them in groups of eight, all practically of similar design and with interchangeable parts. The tonnage has gradually increased from 85 to 140, as at present. Six of these boats form a group for manœuvring purposes, so that two of the eight are kept in reserve to take the place of any that may come to grief. There are ten large division, or "D" boats, of from 250 to 380 tons displacement, and from 1,800 to 5,500 HP. They are each a sort of flagship, or "mother" boat, for each group of six smaller ones, and accompany it everywhere. This division, or "D" boat, carries the heavier spare parts for the six accompanying boats, such as cylinder-heads, piston-rods, propellers, and a reserve supply of stores and fittings. Each "division" has its headquarters at a certain navy yard and has a group of small storehouses at the water front, one for each boat, including the "D" boat and the two in reserve. When a whole division is in the second reserve all the stores of each boat are in its own storehouse, and the group of boats is tied up near the group of storehouses. Any deficiency in stores or fittings are made up from the large central torpedo storehouse, where all articles are standardized. In the winter the boats in reserve are kept at a uniform temperature by means of steam coils, connected with the shore by piping. Only when repairs are needed are boats hauled out, so that the division may always be ready to be put into commission for trials in 24 hours and ready for war in 48. If in drills, or cruising, a boat is injured, it is astonishing to see how quickly a spare boat of the group is forthcoming, and ready with the crew of the injured boat. Boats in the second reserve are looked out for by the navy-yard force, and a vessel under repair is always in the second reserve.

Oil fuel recommends itself for torpedo boats as compared with coal for numerous reasons. Moderate reliable sea speed coupled with a large capacity for carrying and distilling fresh water is the fundamental requirement for a torpedo boat.

All this suggests the question, "What are the desirable characteristics of a first-class sea-going torpedo boat?" The answer here given is:

(1) It should be as small as is consistent with sea worthiness, so as to offer as small a target and be as little visible as possible, and, at the same time, should offer a reasonably stable platform for its torpedo tubes.

(2) It should be designed to have as small a bow wave as possible; its machinery should be as nearly noiseless as practicable; and it should not show flames or smoke from the stacks.

(3) It should have a large fresh-water tank capacity and be fitted with two smaller evaporators and distillers in preference to one larger one.

(4) It should have a reasonable bunker capacity. If for coal, the design should have in view the future use of liquid fuel.

(5) The efficiency of the boat depending so largely upon the physical condition of the crew, habitability should receive due consideration in the design.

(6) Speed is not essential, although desirable, but a moderate reliable sea speed, obtained without forcing and without noise, flame and vibration should be striven for.

The discussion which followed this paper turned almost entirely on the question of speed, and the opinion was very generally expressed that in seeking for exceedingly high speed for torpedo boats many far more essential qualities had to be sacrificed, such as habitability, strength and endurance, coal capacity, etc. It was also pointed out that too many different kinds of service had been demanded of torpedo boats in actual employment. They had been required to do blockade duty and to act as dispatch boats, and required to keep at sea in all sorts of weather. The result had been that they had suffered damage, and had to be repaired. The experience of the Spanish-American war and the Cretan blockade by the English during the Greco-Turkish war had shown conclusively that the modern torpedo boat would wear itself out in a very short time when called upon to do continuous duty at sea.

The papers on the "Progressive Speed Trials of the 'Manning,'" by Prof. Cecil H. Peabody, and on "The Action of the Rudder," by Prof. Wm. F. Durand, were presented briefly in abstract by their authors. Both papers were of a mathematical character, and were only briefly discussed. The same statement is true of the paper on "Beam Formulas Applied to Vertically Stiffened Bulkheads," by Mr. H. F. Morton. The convention closed with a banquet on the evening of the last day's meeting, at which there were a number of invited guests.

During the first session the following officers were elected for the ensuing year: President, Clement A. Griscom; First Vice-President, W. T. Sampson; Vice-Presidents, Francis M. Bunce, Charles H. Cramp, Frank L. Fernald, Philip Hichborn, Geo. W. Quintard, Irving M. Scott, Edwin A. Stevens; Secretary and Treasurer, Francis T. Bowles.

ANNUAL CONVENTION OF THE NATIONAL MUNICIPAL LEAGUE.

The fifth annual meeting of the league was held at Columbus, O., Nov. 15 to 17. Like the meeting of a year ago, this one was devoted almost wholly to the presentation and discussion of the "Municipal Program," framed by a special committee appointed two years ago. The program, which, as presented a year ago, was reviewed editorially in our issue of Dec. 1, 1898, was amended somewhat during the year, but its main features remain unchanged. In brief, it includes an outline of a model city charter, supplemented by a few constitutional amendments needed in some States of the Union to make possible its full adoption. It may be characterized as a crystallization of much of the best modern thought and practice as to the great underlying principles of municipal government.

After the usual preliminaries, the convention first listened to a review of "Municipal Work During the Past Year," by Mr. Clinton Rogers Woodruff, of Philadelphia, secretary of the League. This review showed advance along many lines. For instance, about 50,000 of some 52,000 employees in the service of Greater New York are now under civil service or personal registration rules; Mayor Quincy, of Boston, has continued at the very front of progressive mayors; Controller Coler, of New York, has left partisanship behind in behalf of the public interest; and many State Leagues of Municipalities, perhaps ten, are now lending their aid to the cause that the National Municipal League has at heart—good city government.

The report of the Treasurer, Mr. Geo. Burnham, Jr., of Philadelphia, showed receipts of about $2,400 during the year, and a balance of $160. The election of new officers resulted in the choice of Mr. Jas. C. Carter, of New York City, as President, and the re-election of Messrs. Woodruff and Burnham as secretary and treasurer, respectively.

An analysis of the Municipal Program was presented by Dr. Delos F. Wilcox, of Michigan. He said the three great evils of municipal government are: (1) economic "or the waste of public funds"; (2) political, "or inadequacy of municipal service"; and (3) moral, "or the corrupt use of civic authority for the furtherance of individual ends." The analysis was continued as follows:

The causes of wastefulness in public expenditures are ignorance, partisanship, State interference, municipal irresponsibility and indefiniteness of organization. The causes of inadequacy of municipal service are individualism, inadequacy of power and undemocratic organization. The causes of corruption are greed, lack of civic integrity and private control of public privileges.

The speaker then subdivided these evils and difficulties still further, and showed just how the program was designed to remedy them, by presenting a complete synopsis of it. Some of the main features of the program are municipal home rule, including the right of each city to frame its own charter, and a large measure of exemption from legislative interference; separation of legislative and executive functions of city government; the merit system; nominations to office by petition instead of party primary; a minimum number of elective officials; the referendum and proportional representation, where desired; enlarged opportunities for municipal ownership, guarded by provisions as to debt limitations; short-term franchises and publicity of accounts of franchise companies; and a uniform system of municipal accounting under State control.

One evening was largely given up to a discussion of the proposed Ohio Municipal Code, which will be submitted to the legislature in January. A digest of this code was presented by Mr. Edw. Kibler, of Newark, O., a member of the commission that drafted it. The code is founded largely on the Municipal Program. One of the main reforms proposed by the code is the abolition of the classification of cities. At present there are 15 classes of cities in Ohio, but there is only one city in each of ten of these classes. The new code provides for cities and villages, only, the dividing line being a population of 3,000. Municipal ownership of telephone systems is permitted under the proposed Ohio code, and cities of 50,000 population and over would be allowed to own their street railways.

Mr. E. J. Blandin, of Cleveland, made an address devoted to the Ohio code. The code provides for one legislative body, composed of only seven members in cities, regardless of size, and six in villages, all of the latter and three of the former to be elected at large, instead of by districts. Mr. Blandin would prefer five, or better still, three councilmen, all elected at large. He would not limit municipal ownership of street railways to cities of 50,000, or any other size.

A paper was sent in by Mr. Harry Garfield, of Cleveland, O., entitled the "Relation Between Public Service Corporations and Municipalities." The author urged that fair treatment should be accorded to such corporations, and reviewed the street railway situation in Cleveland. Although the present street railway franchises have from 6 to 14 years to run, the companies are already agitating for their extension. The Cleveland Municipal Association has the matter under consideration, and has suggested, or proposes to suggest, that in case the franchises are extended the city should reserve the right to buy out the companies, paying for the physical property a sum to be determined by arbitration, and an allowance for the unexpired term of the franchise, if any. While under private ownership, the companies should pay the city a percentage of gross receipts and their books should be open to the inspection of the city officials.

Thursday forenoon was devoted to the single topic, "The City's Power to Incur Indebtedness Under the Municipal Program," and particularly the provision that bonds for revenue-producing works should not be included in the debt limit. This latter provision was amended during the past year so as to throw into the debt limit balance any bonds for works designed to earn a revenue, but failing to do so, and also to define revenue as "including interest, sinking fund and insurance against accidents and fires."

The discussion was opened by Mr. Bird S. Coler, Controller of New York city, who presented a brief review of the debt-limit situation in New York since consolidation, and of the great demand for certain specific improvements; a demand so imperative that he thought the best interests of the city required that it should be met, even if thereby it became necessary to increase the debt limit. The public works needed most are more bridges across the East River, rapid transit and more city docks. It has long been recognized that water bonds are properly excluded from city debt limits, since the rates collected provide for interest and redemption. Why should not the same principle be extended to other public service industries? The proposed plan for an underground railway in New York provides that the contractor shall pay the city a rental sufficient to meet all capital charges, the contractor operating the road at his own expense during the lease. Why, then, should the bonds issued by the city to build the road have any effect upon the debt limit? The business interests of New York demand many more new city docks and the rentals pay the city a good profit on the investment; but the docks would be imperative, even if their cost increased the debt limit.

Mr. W. D. Foulke, of Richmond, Ind., told how a committee, of which he was the chairman, had recently adopted some of the features of the Municipal Program in a codification of the township laws of Indiana, which codification has gone into effect. In general, he agreed to the proposed exemption of revenue-producing bonds from the debt limit, but thought that there should be some further restriction on the exemption.

Mr. Geo. C. Sikes, of the Chicago "Record," thought the new clause restricting exemptions from the debt limit partially failed of accomplishing its purpose, since the debt for a given undertaking would be incurred before it could be known whether the industry would pay its way, even though the city was already at the debt limit. He favored the proposal of Mr. A. R. Foote, to make bonds for such industries a lien on the industries alone, instead of the whole municipality; at least, this might be the rule when a city had already arrived at its debt limit.

Mr. M. L. Maltbie, of New York city, questioned the advisability of requiring that all bonds must be redeemed within twenty years. Mr. M. N. Baker, of the editorial staff of this journal, questioned whether the partial failure of a municipal undertaking to earn a revenue should throw all the corresponding bonds into the debt-limit account; why not make the amount so transferred vary with the ratio of the deficiency to the full revenue needed?

Mr. Coler said he would not for a moment advocate municipal ownership in cases where it would mean the purchase of existing franchises. He would wait until franchises expired. Endless jobbery, and finally municipal bankruptcy would follow the announcement of the fact that a city stood ready to pay such prices as might be fixed as the value of unexpired franchises.

Mr. Horace E. Deming, of New York, speaking for the Committee on Municipal Program, closed the discussion of this topic by urging that the program is designed to present general principles, and the principle here involved is local self-government, and the extent to which a city should be able to decide for itself the amount of its municipal indebtedness.

Thursday afternoon was devoted to a discussion of the effect of the program on political parties and public opinion, the speakers being Prof. Frank J. Goodnow, of New York; Mr. John A. Butler, of Milwaukee, and Mr. Deming.

The opening paper on Thursday was on municipal accounting, by Prof. L. S. Rowe, of Philadelphia, a member of the Program Committee. He said one of the common allegations regarding municipal reformers is that they confine themselves to destructive criticism. The program is a piece of constructive work. With proper municipal accounts cities would have the advantage of comparative statistics and could more readily determine their ability to take up additional enterprises. One of the chief causes of the deterioration and final lease to a company of the Philadelphia gas works was improper system of accounting, which led opposing interests to draw entirely different conclusions from the same reports and by showing a large gross revenue continued the diversion of receipts needed for repairs and improvements into the general revenue fund. Full public records of the operations of franchise companies would tend to check over-capitalization, aid in the proper municipal control of such industries, throw light on the advisability of municipal purchase and lessen blackmail.

An interesting address on the "Financial Reports of Municipalities" was made by Dr. E. W. Hartwell, Secretary of the Boston Statistical Commission. The heterogeneity of municipal accounts was enlarged upon, and especially the uncertainty of populations for intercensal years. Within about a year three articles on municipal affairs, published within a few months of each other, gave the population of Baltimore as 500,000, 541,000 and 600,000, respectively. The recent report on Municipal Statistics, issued under the direction of Mr. Carroll D. Wright, U. S. Commissioner of Labor, stated that the municipal reports of the 140 largest cities of the country were so unsatisfactory that he had to send special agents to the cities to secure the information he desired. Notwithstanding this, Dr. Hartwell said the report in question is so full of inconsistencies and gaps that it could hardly be made a basis for further work. For instance, the population of Boston is given in the report as 580,000, whereas the Boston Board of Health, as a result of geometrical progression, placed the population at fully 40,000 less. In general, municipal statistics are ill-digested and unintelligible. In the matter of State supervision, he would go further than the program has definitely laid down, although it opens the way for it, and provide a central administrative body, like the Local Government Board of England. This idea was also favored in a later address by Prof. Tooke, who instanced the Gas & Electric Light Commission of Massachusetts as a distinct step along this very line.

Dr. Sparling continued the discussion by a review of opinions on the subject gleaned by correspondence. He had found many city officials in favor of both State supervision and uniform accounting, although some favored the latter while opposing the former. Wyoming has led in providing a State Examiner of Accounts, both municipal and State. Minneapolis and Indiana have made beginnings along the same line.

Mr. A. L. Crosby, of Cleveland, O., spoke very highly of a classification of city receipts and expenditures, formulated by Prof. Rowe, and published about a year ago, in the "Annals of the Academy of Political and Social Science."

Prof. C. W. Tooke, of Champaign, Ill., sent a paper on "The Accounts of Municipal Public Service Industries," which he thought should be identical in all respects with those of private companies performing the same functions. The accounts of such private companies should be given as much publicity as those of public enterprises. He thought the proposed restriction on exemptions from the bonded debt limit tended to nullify the very object of the debt limit, since under it the limit might be exceeded by the sudden addition of millions of debt incurred for industries which had proven to be not self-supporting. He favored, like Mr. Sikes, the making of such bonds a lien on the property for which they are issued, instead of on all the real estate of the city.

The last session of the convention was devoted to a general discussion of the program as a whole and in detail. It was opened by a statement in behalf of two members of the Program Committee that instead of a bare majority popular vote on incurring debt outside of the limit for revenue-producing works, a higher majority, say two-thirds, should be required.

A speaker urged that some of the reproaches heaped on political bosses should be showered on the highly respectable citizens and business men who hide behind and enjoy the profits reaped by public-service corporations, through collusion with the bosses.

The convention, in concluding its labors, adopted the program as reported by the Committee on Program, referred the program to the Executive Committee with power, and dismissed the Committee on Program.

ANNUAL CONVENTION OF THE AMERICAN INSTITUTE OF ARCHITECTS.

The thirty-third annual convention of the Institute was held at Pittsburg, Pa., Nov. 13 to 16, inclusive. Mr. Henry Van Brunt, of Kansas City, Mo., President of the Institute, and Mr. Glenn Brown, of Washington, D. C., Secretary, fulfilled the duties of their respective offices during the meeting. Mr. Van Brunt, in his presidential address, estimated that there are 5,000 architects in the country, of which one-tenth are members of the Institute. He referred to the fact that there are now seven U. S. government buildings in different sections of the country being designed or built under the direction of private architects, instead of under the Supervising Architect of the Treasury Department, as formerly. He regretted that there are still so many competitions conducted without proper safeguards to the competitors, and that so many architects still enter such competitions. Among recent examples of properly conducted competitions, he mentioned that for the group of buildings for the University of California, under the Phoebe Hearst prize offer.

The report of the board of directors showed that 44 new members had been added during the year, besides which 20 applications for membership are now pending. During the year permanent headquarters have been established for the Institute in The Octagon, Washington, D. C. The rooms are kept open from 9 a. m. to [illegible] p. m. The rules governing competitions have been modified so as to make the compensation to competitors range from $100 to $1,500, according to the importance of the work. The report of the treasurer showed a balance of $[illegible], on Nov. 4, 1899.

Synopses were given of the reports from about 20 chapters of the Institute, pretty well distributed over the United States. They showed that most of the chapters had held meetings during the year, the number of meetings ranging from 1 to 15, and the average attendance for each chapter from 5 to 15. The various chapters are entitled to send delegates to the Institute meeting, the number varying on a sliding scale, with the membership of the chapters.

A paper by Mr. E. Rowland Hill, of the Westinghouse Electric & Manufacturing Co., was read on Tuesday. It was entitled "Electricity in Modern Buildings," and reviewed the subject with much detail. The electric elevator plants and other electrical equipments of several large buildings were described.

Another paper treating on engineering topics was "The Manufacture of Steel for Building Construction," by Mr. F. H. Kindl, structural engineer for the Carnegie Steel Co. This paper was printed in our last week's issue.

Two papers were read on "The Legitimate Design of the Architectural Casing for Skeleton Steel Structures." In the first of these, Mr. H. R. Marshall, of New York, said:

> In the modern steel skeleton structure our problem is the construction of a beautiful screen wall. We must make a screen which will protect the steel structure from injury, and at the same time protect the occupants of the building from the elements. Now the simplest solution of this problem is the construction of a plain wall pierced at practically regular intervals with openings, and with no projecting cornices, and no lines of shadow whatever. But such a structure can only in exceptional cases be anything but ugly. We are bound to try to make it interesting, and to this end we ought first to attempt to divide our surface into masses of pleasing proportion, and this we may do by differences of color in the material used, or by the introduction of projecting parts which will divide the surface by means of the shadows cast.
>
> With this end in view, I see no objection to the introduction of projecting cornices, and even of applied classical pilasters, or superimposed "orders," if you will; always provided these features do not pretend to be what they are not, and provided they are beautiful in themselves, as in our common practice is not always the case; and provided they divide the spaces into masses of beautiful proportions, as, I am free to confess, I think in our practice they seldom do.
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> Nor do I see any objection to the use of arches carried on piers running through many stories, to which our friendly critic, Mr. Russell Sturgis, so much objects; this again, however, provided there is no deception as to the interior structure or use, and always provided that the forms given to the mass are beautiful in their proportions and relations.
>
> All this you will, perhaps, say is little more than a statement of platitudes. The question before us is whether we should make it our aim to express upon our screen wall the structure back of it. My answer to this is that if we ever evolve a perfectly satisfactory type of skeleton construction building, it will inevitably, to a great extent, express this structure behind the screen; but I am convinced that the way to get at this happy result is to try to design a beautiful screen wall, for to do this we, of course, will incidentally have to see to it that it does not lie about the structure behind it. If we design in this way we shall be compelled to keep in mind the structure behind our wall, and presently, if we keep the thought of beauty always before us, we shall find that we are making beautiful buildings, and at the same time are expressing, to a great extent, their construction—as much so, at all events, as any other architects ever have done.

Mr. C. H. Blackall, of Boston, in his paper, took quite a similar ground. He favored the Italian Renaissance as the architectural style most suitable for the decorative treatment of a high building.

The program included a number of interesting excursions to important manufacturing plants and other points of interest, including the following: Standard Manufacturing Co.; Westinghouse Machine Co., Westinghouse Electric & Manufacturing Co., The Westinghouse Air Brake Co., East Pittsburg; Pittsburg Plate Glass Co., Ford City; Carnegie Steel Co., Homestead; Carnegie Library and Art Exhibition; Allegheny County Court House.

The election of officers resulted as follows: President, R. S. Peabody, of Boston; first vice-president, W. S. Eames, of St. Louis; second vice-president, Frank Miles Day, of Philadelphia, secretary and treasurer, Glenn Brown, of Philadelphia; directors, Henry Van Brunt, of Kansas City; James G. Hill, of Washington, and Norman S. Patton, of Chicago. The next annual convention will be held in Washington, D. C.

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