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STEEL-FRAMED COAL CARS of 100,000 lbs. capacity are being built at the shops of the Norfolk & Western Ry. at Roanoke, Va., to the designs of Mr. W. H. Lewis, Superintendent of Motive Power of that road. There are four sills of 13-in. channels, with steel plates for the transoms, bolsters and ends, wooden end sills being bolted to the end plates. Diagonal plates are used to stiffen the corners of the frame. The body is of wood, with vertical sides, sloping ends, and a flat bottom formed by three sets of drop doors. The cars are mounted on diamond-frame trucks, with 13-in. I-beam bolsters and 12-in. channel spring planks. The axles have journals $5\frac{1}{2} \times 9$ ins. The weight of the car, empty, is about 38,000 lbs.

LARGE FREIGHT CARS built on the American system are to be tried on the Caledonian Ry., of Scotland, for handling the coal and ore traffic. They are 38 ft. 4 ins. long over all, and are mounted on two four-wheel trucks. The capacity is not given, but it is said to be equal to that of seven ordinary cars. The cars have been built at the railway company's shops, to the designs of Mr. McIntosh, the Superintendent of Motive Power, who is also having some exceptionally powerful freight engines built at the same shops. Apparently this road is to be the pioneer in introducing the economies in transportation which are due to the American system of handling bulk freight in large cars and heavy trains.

TEN SWEDISH LOCOMOTIVES, built by the Richmond Locomotive Works for the Swedish Government on a contract made five months ago, are ready for delivery. They filled 35 freight cars as the parts came to Newport News for transfer to the steamer.

THE EXHIBIT OF CIVIL ENGINEERING AND Transportation in the American section of the Paris Exposition of 1900 promises to be very large and thoroughly representative, says Mr. Willard Smith, Director of Transportation and Civil Engineering to the U. S. Commission to the Paris Exposition. Owing to the nature of the exhibits and the character of the buildings, this department will be represented in several different locations. The exhibit of the merchant marine will be made in the Merchant Marine Building on the banks of the Seine. The principal features will consist of a large exhibit by the American lines, and a fine showing of models, etc., illustrative of American yachting. Permission has also been secured to install in this building models of American naval vessels, and it is intended to show all of the most important battleships, etc., which have become famous in the recent war. This exhibit will prove a very great attraction, not only to Americans, but to representatives of other countries. In the Palace of Transportation and Civil Engineering on the Champs de Mars will be located the carriage and vehicle exhibit. It is expected that only vehicles of the very highest quality will be shown, and that the entire exhibition will be made by some ten or twelve of the leading American carriage builders. In the same location, on the ground floor and partly on the gallery, there will be an exhibit of civil engineering which will consist of models, maps, photographs, etc., illustrating the engineering features of our great cities, transportation lines, etc. One of the most important of these exhibits will be a model some 20 ft. in length of the Chicago Drainage Canal. In connection with this will be shown models of all the great variety of excavating and conveying machinery which was used in this most important of recent works of this kind. These models will be shown in operation, and it is believed that this will be the best exhibit of an engineering character ever made at any exposition. Similar models of several of the large cities will also be shown. The railway exhibit, consisting of cars, locomotives, railway machinery and appliances of every kind will be made in the buildings provided for this purpose at the Bois de Vincennes, where all railway exhibits made by all countries will be located. There will be at least 16 American locomotives which, on account of their magnitude and perfection, will be very attractive to foreigners. The fact that our locomotive builders are now securing business in all parts of the world, including even France and England, gives this exhibit peculiar importance and significance at this time. Steel cars and other recent developments in American railroading will also be properly represented. At the Bois de Vincennes will also be located the bicycle and "Automobile" exhibits. A space of 8,600 sq. ft. has been secured for the American Bicycle Building. It is located in conjunction with a special bicycle track for showing the bicycles in operation. American bicycle builders will erect a handsome building, and will make the largest and most important bicycle exhibit made by any country. A track some two miles in length running around the Lake Daumesnil in the Bois de Vincennes has been provided for showing motor vehicles of all kinds in operation. A space of 4,300 sq. ft. in the "Automobile" Building has been secured for American exhibitors. At Lake Daumesnil will also be shown steam, electric and gasoline launches in operation, as well as an exhibit of life saving service and everything of that nature. Actual allotments of space have not yet been made in the Transportation Department, owing to the fact that it has been impossible to get a definite location and information regarding the same from Paris. Commissioner-General Peck, who is now in Paris, has been extremely successful, and has secured a much larger amount of space than was heretofore deemed possible. All manufacturers of any material included under the general title of transportation and civil engineering should at once make their application for space, if they have not already done so.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Chicago & North Western Ry., at Des Plaines, Ill., on May 31, and resulted in the death of one man and the injury of three others. The accident resulted from the engine of a suburban train from Chicago to Des Plaines switching onto the opposite track to back to the roundhouse, a short distance away. Before it could clear the switch, an express, known as the "St. Paul Flyer," running at a speed of 40 miles per hour, crashed into the tender with the result mentioned.

A STAND-PIPE TEST was made at the St. Paul Building, New York, N. Y., on June 4, by Chief Croker of the New York Fire Department. Two engines of the first class were in the street. For the first test one of them was coupled to the 4-in. street connection of the 6-in. stand-pipe. Upon the roof a short line of 3-in. hose was run from the stand-pipe to the Broadway front, and a $1\frac{1}{4}$-in. nozzle was attached. When the engine got to work each 5 lbs. increase in pressure at the engine was signalled to the firemen upon the roof by a whistle blast. No water reached the roof until the engine pressure stood at 135 lbs. When the street pressure reached 150 lbs. the gage on the nozzle registered a pressure of 10 lbs. The street pressure was increased 10 lbs. at a time until the maximum of 300 lbs. was reached, when the roof pressure was 90 lbs. Between street pressures of 280 and 300 lbs. the roof pressure remained at 90 lbs. The stream thrown increased with the pressures until from a fretful dribble it became a column of water passing over St. Paul's steeple opposite. A second test was made with seven small lines of hose belonging to the building's plant, connected with the stand-pipe upon the seven upper floors. At the same time the large stream upon the roof, 309 ft. from the ground, was fed. The lowest of the small lines was 200 ft. from the pavement. Both engines having been attached, the small lines threw water 100 ft., while the department's roof hose wet St. Paul's spire. Each engine reached a pressure of 230 lbs. The roof gage registered 25 lbs. Then one engine alone took up the work, maintaining the same conditions. Chief Croker is reported to have spoken in regard to the test as follows:

> This is a complete demonstration of what the department can do with skyscraper fires. In the last test the engines were what firemen call "choked." They could not get rid of their water rapidly enough. Under such conditions we could have operated 15 streams from that one stand-pipe. In case of fire even in an adjoining building the system would be of great value to us.

Chief Croker said that next year a bill would be introduced into the legislature making the equipment of tall buildings with stand-pipes compulsory. The bill will explicitly specify every detail of the apparatus, the capacity of which will be on a fixed ratio to the height of the building.

THE HUDSON RIVER TUNNEL is to be sold on June 16, after several postponements. Among those rumored to have an interest in bidding are the Pennsylvania R. R., Delaware, Lackawanna & Western R. R., the Long Island R. R., the English syndicate holding $4,000,000 in judgments against the tunnel company, and the reorganization bondholders of the original tunnel company. No work has been done on the tunnel since 1892, when over $4,000,000 had been expended in driving and lining a tunnel 3,916 ft. long from the Jersey side, with less than 200 ft. finished on the New York side. About 1,200 ft. remain to be completed, and the estimated cost of that section is below $1,500,000.

A BRIDGE WAS RAISED at Chicago recently, by the Chicago & Northwestern Ry., on account of the track elevation work. The bridge carries the Evanston Division over the north branch of the Chicago River at Deering, near Fullerton Ave. It is a double-track truss drawbridge, the estimated weight of which is 250 tons. Two lifts were made, of 5 ft. 7 ins. each, with an interval of a week between the operations, in order to allow of adjusting the approaches. The center pier is built up under the bridge by two circular plate girders, each 5 ft. 7 ins. high. The lifting was done by means of scows, with cribbing built up on their decks. They were put in position with their holds full of water, and on being pumped out raised the bridge by their excess buoyancy. The work was planned by Mr. L. H. Evans, Engineer of Track Elevation, and was carried out under the supervision of Mr. J. W. Schaub, M. Am. Soc. C. E. The contractors were Lydon & Drews, of Chicago.

ENAMEL PAINT, or pigment ground in varnish instead of in oil, is to be used on such parts of the ironwork of the new Charlestown bridge at Boston, Mass., as are exposed to view. This paint is expected to prove considerably more durable than ordinary paint, besides being of better appearance. The bridge is being built under direction of the Boston Rapid Transit Commission, with Mr. Wm. Jackson, M. Am. Soc. C. E., as Chief Engineer.

PLANS FOR RECLAIMING MEADOW LANDS located in the 9th, 10th, and 12th Wards, of Newark, N. J., are to be invited until July 20, in accordance with a resolution of the Board of Street and Water Commissioners, just passed over the veto of Mayor Seymour. This action is taken under a statute of the last legislature.

GARBAGE AND REFUSE to the amount of 2,815,000 cart loads were collected and disposed of in Greater New York in 1898, under the direction of the Department of Street Cleaning. There were also 700,000 loads of snow and ice removed. The total expenses of the department for the year were $4,258,707, including sweeping the streets as well as the collection and final disposal of sweepings, garbage, paper and other refuse, and the removal of ice and snow. Of the refuse material collected 304,000 loads were garbage, the bulk of which, or 286,000 loads, was treated at the reduction works on Barren Island, under contracts with the New York Utilization Co. and the Brooklyn Sanitary Co., respectively. Mr. Jas. McCartney is Commissioner of the Department of Street Cleaning and Mr. Chas. A. Meade is Superintendent of Final Waste.

THE SEPTIC TANK SYSTEM of sewage treatment is gaining ground in England. At a recent hearing at Darfield, before an inspector of the Local Government Board, the inspector is reported by the London "Surveyor" as saying:

> I may say my Board does not refuse to sanction loans on these systems. It is chary of sanctioning loans for any system which may be regarded as of an experimental character; but after full and careful consideration with respect to this particular system before us, it has made up its mind to sanction loans for such schemes.

The inspector further stated that in the case of storm water overflows the Board had decided, with a dilution of 6 parts of storm water to 1 of sewage, to allow one-half the total volume to be thoroughly treated (by the septic tank, aeration and land filtration) and the other half to be treated by filtration only. The Darfield hearing was on an application for approval of a loan of $34,000 to install a small septic tank, aerating plant and filter beds. The size of the tank is not stated, nor the area of the filter beds, but eight beds are proposed, with a filtering capacity of about 425 U. S. gallons per sq. yd., or a little over 2,000,000 U. S. gallons per acre. The engineer for the scheme is Mr. F. Graham Fairbank, of Fairbank & Son, Westminster and York. The proprietors of the septic tank system were represented at the hearing by Mr. Arthur J. Martin, Assoc. M. Inst. C. E., of Cameron, Commin & Martin, Exeter and Westminster.

AN ELECTRICAL EXHIBITION is to be held in Chicago, from Sept. 25 to Oct. 9. It will be held in the Tattersall exhibition building, which has a floor space of 147 × 280 ft., and which is now being fitted up for the purpose. Power will be supplied by the Chicago Edison Co. The arrangements are being made by a corporation styled the National Exposition of Electrical Arts, which has a capital stock of $50,000. President, N. J. Heimbach; Secretary, J. Carrabine; Treasurer and Manager, W. E. Burnham. The offices are in the New York Life Building, Chicago.

A 1,500-HP. FOUR-STAGE AIR COMPRESSOR.

We illustrate herewith an unusually large air compressor recently installed for the American Air Power Co. by the Ingersoll-Sergeant Drill Co. at the former's power station, 24th St. and the North River, New York city.

Aside from the fact that this compressor will be used to furnish air to operate the most extensive compressed air street railway system in the world, the compressor is of interest because it is perhaps the largest of its class ever built.

A general view of the engine and compressor is given in Fig. 1, which, however, hardly does justice to the size of the machine. Fig. 2 shows the general details of the engine and compressor and the arrangement of the piping, intercoolers, etc.

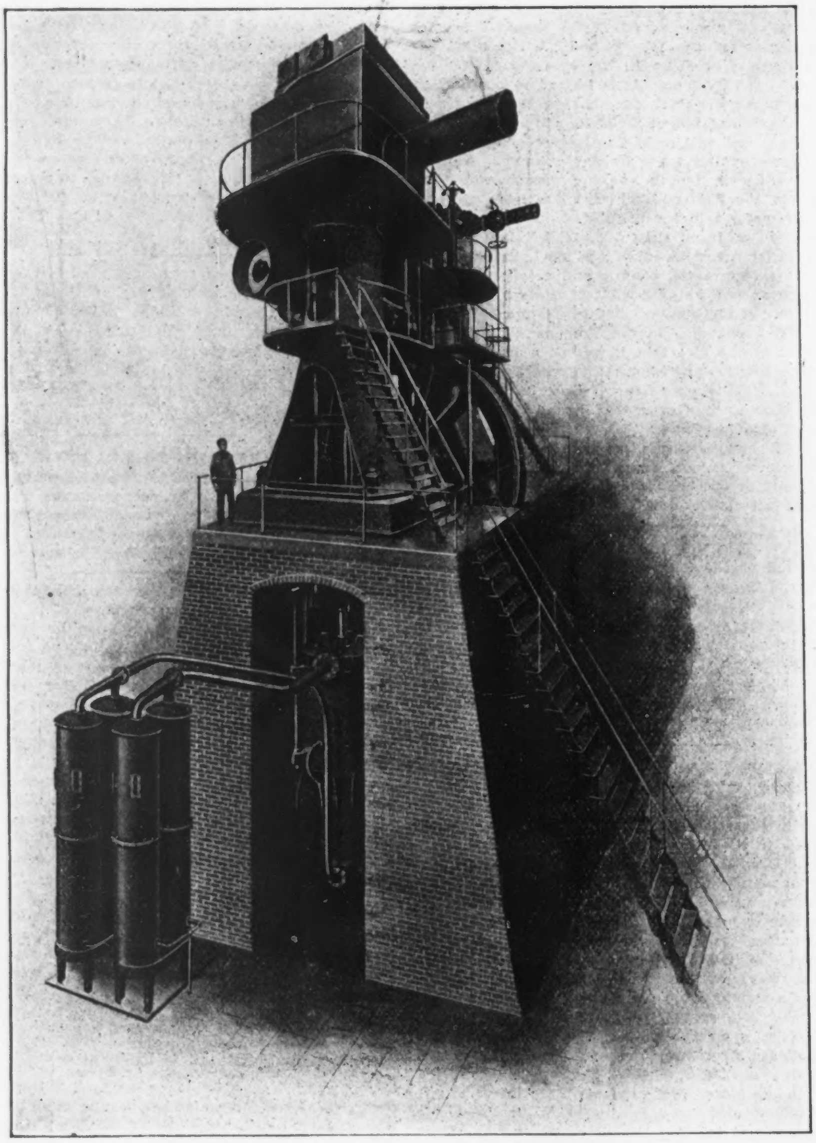


FIG. 1.—PERSPECTIVE VIEW OF A 1,500-HP. AIR COMPRESSOR.
American Air Power Co., New York City.
Engine built by E. P. Allis Co., Milwaukee, Wis.; Compressor by the Ingersoll-Sergeant Drill Co., New York City.

The engine proper was built by the E. P. Allis Co., of Milwaukee, Wis., and, as will be seen in the illustrations, is a vertical cross-compound condensing engine. It is practically the same as the standard Allis pumping engine, has the usual Reynolds valve motion and embodies no novel features, except, perhaps, the governing mechanism which is connected to the air storage reservoir. This arrangement regulates the speed at which the engine runs to suit the demands of the service until the limiting speed of 75 revolutions per minute is reached, when the automatic engine governor comes into play and prevents any further increase in speed. The feature is, however, common to pumping engines used for water-works.

The engine stands 32 ft. above the level of the engine room floor, which is even with the top of the massive brick foundation. This foundation is in turn 29½ ft. high to give room for the air compressing cylinders, so that the total height from the ground level to the top of the engine cylinder is 59½ ft. At the base of the foundation the overall dimensions are 29 x 33 ft. Running through the center of the foundation is an opening or tunnel 7 ft. wide and 22 ft. high, in which are hung the air cylinders. The engine flywheel is between the high and low-pressure sides of the engine and is 22 ft. in diameter with a rim 2 ft. wide and 18 ins. thick.

The steam cylinders are double acting, 32 and 60 ins. in diameter with a 60-in. stroke. Mounted on brackets close up to the cylinders is a reheating receiver. Steam is supplied at 150 lbs. pressure by four Babcock & Wilcox 250-HP. boilers. The engine speed can be varied from 40 to 75 revolutions by the air governor, as already stated. At 40 revolutions the nominal horse power is 1,000 and at 60 revolutions it runs up to 1,500 HP.

The main steam pipe, Fig. 2, is 12 ins. in diameter, and the exhaust pipe, which is 22 ins. in diameter, is provided with a suitable valve for throwing the exhaust into the condenser, or in case of accident or emergency into the air.

The air and circulating pumps were also furnished by the E. P. Allis Co., the former being a 32 x 12-in. vertical pump with the usual type of surface condenser.

The compressor part of the equipment is worthy of special attention, owing to the amount of air compressed and the high pressure attained. The four cylinders composing this part are arranged tandem below the engine shaft and directly in line with the steam cylinders. The low-pressure and first intermediate air cylinders are under the low-pressure steam cylinder, while the second intermediate and high-pressure are in the same position under the high-pressure steam cylinder. The heavy air cylinder piston rods end in substantial cast square cross heads, from the corners of which four steel rods extend up inside the engine frame through suitable guide bearings to the engine cross head.

The cylinders are all single-acting, compression occurring in the low and second intermediate cylinders on the up-stroke, and in the first intermediate and high pressure cylinders on the down-stroke. The cylinders have the following dimensions: Low-pressure, 46 ins.; first-intermediate, 24 ins.; second-intermediate, 14 ins.; and the high-pressure, 6 ins.; the stroke in all cases being 60 ins.

Water jackets are provided for the cylinders and the air after each compression is conveyed by heavy copper pipes from the cylinder to a suitable vertical surface intercooler placed outside the engine foundation, as shown in Fig. 2. The pressure in each intercooler and the aftercooler is, of course, the maximum of the respective cylinder, and is in each case as follows: First intercooler, 40 lbs.; second, 180 lbs.; third, 850 lbs.; and in the aftercooler between 2,500 and 2,600 lbs.

The free air capacity of the compressor per stroke is 56.735 cu. ft., which at 40 revolutions per minute gives a free air capacity of 2,269.4 cu. ft. per minute, and this is increased to 3,404.1 cu. ft., with a speed of 60 revolutions per minute. In other words, roughly speaking, this compressor will furnish between 14 and 21 cu. ft. of air per minute at 2,500 lbs. pressure. As this may not be sufficient at all times to supply the cars directly, a storage reservoir has been provided, consisting of a large number of steel bottles, made of a special nickel steel. These will safely withstand a pressure several times greater than that used in service. From this reservoir air will be taken as needed to charge the reservoirs on the street cars.

We are indebted to the Ingersoll-Sergeant Drill Co. for the material from which this description and the illustrations have been prepared.

THE MANHATTAN VALLEY VIADUCT, NEW YORK CITY.

(With two-page plate.)

We illustrate on our inset sheet this week some of the more notable structural details of the large new viaduct which is being constructed to carry the extension of Riverside Drive over the Manhattan Valley, from 127th St. to 135th St., in New York city. This structure is 80 ft. wide in the clear, including two 10-ft. sidewalks, and 2,120 ft. long, of which 1,770 ft. are viaduct proper, and 350 ft. are approaches. Its location in a conspicuous position on one of the principal highways of the city made it desirable to have a structure of some architectural pretensions, but the conditions of the location selected seemed to make a masonry bridge impossible, although the superior artistic merit of a masonry arch structure, could it have been employed, was fully appreciated. It could not be however, since the viaduct for its whole length extended along Twelfth Ave. and occupied nearly its entire width between curbs, and stone piers of this width would have obstructed not only the traffic north and south, but would have interfered with the property-owners' rights of light and air. The best solution of the problem, therefore, was deemed to be an arched viaduct of steel, and this is the style of structure now being erected.

The design adopted for the steel structure follows the general outlines of one in masonry, without any attempt to represent that material. Neither is it a true arch design, as will be explained further on. As will be seen from the diagram elevation, Fig. 1, the viaduct proper consists of one span of 128 ft. 7 ins., one span of 66 ft., two spans, flanking the large span, of 65 ft. 7½ ins. each, and 19 spans of 64 ft. 11½ ins. each. These do not include the partial spans of steel next to the north abutment, nor the masonry arch forming a part of the south abutment. The arrangement of the spans provides for a clear opening at each cross street, including one of about 128 ft. span at Manhattan St., which has been made double the ordinary spans at street crossings to avoid disturbing the cable railway tracks, and a large trunk sewer located there.

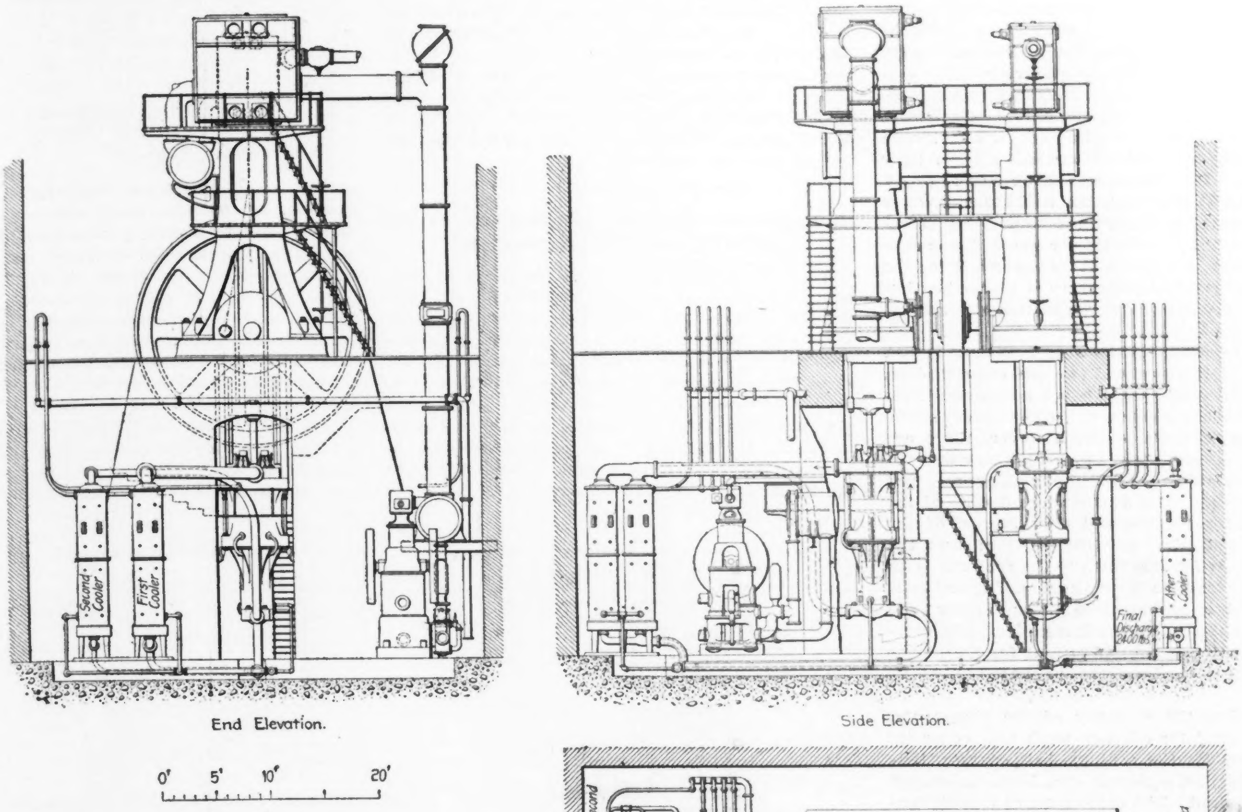
The construction of these various spans is in some respects peculiar. Each is supported by four columns. These columns carry at their tops plate girders running longitudinally. Below these girders a solid web arch is sprung between the columns, and the spandrel spaces between the arch ribs and the girders are filled with spandrel arches. Transversely, or across the street, the columns have a lattice girder connection, and also a plate cross girder, occupying a similar position in this direction to the outside plate girders in the longitudinal direction. Below these lattice girders are sprung latticed arched ribs, with spandrel arches above. The plate girders carry the floor beams, running transversely across and underneath the roadway. This steel structure is calculated to sustain a total load of a trifle over 16,000 lbs. per lin. ft. (8,000 lbs. dead and 8,000 lbs. live load), and a wind pressure of 500 lbs. per lin. ft., with a unit strain in all girders of 16,000 lbs. per sq. in. The longitudinal girders and arches are calculated in such a manner that the dead load of the completed structure brings no strains on the arches; such an adjustment being made during erection that, at mean temperature, under the dead load alone, the girders, while resting on the posts or columns, will touch the arches at the center. The arches will thus carry their share of the moving load, only, according to the intention. The general construction being briefly explained, we can now take up the special details with a better understanding of their purpose.

Substructure.—The masonry substructure consists of two rather extensive abutment approaches, and the column piers for the steel spans. The abutments have an ashlar stone facing with rubble backing, and have a cellular construction of interior brick arches. Wing walls which swing along the sides of the valley support the embankment of the approach, and carry flights of steps which lead from the valley below to the bridge level. The piers for the columns are of concrete, with granite caps, and are founded on piles.

The 130-ft. Span.—To illustrate the steel work we have selected the 130-ft. span. Accurately speaking, the span is 128 ft. 7 ins. c. to c. of columns. Taking up first the column, arch and girder construction, Fig. 2 shows the two elevations and a transverse section of one of the columns at the base, and also the connections of the arch girders at their springings. Fig. 3 shows the construction of the same column near the top, the expansion end of the longitudinal girder, and the spandrel arches. Fig. 4 shows the connection details at the crown of the longitudinal girders, and Fig. 5 gives details of the transverse bracing between the columns.

It will be noticed that the columns are of unusual size, being 6 ft. 3½ ins. x 1 ft. 11¾ ins. back to back of angles, and weighing 25 tons each. These posts carry a load of 450 tons, each, with a unit strain of 5,300 lbs. per sq. in., which is a load, inclusive of the concrete pier, of about 18 tons per foundation pile. The base plates of all columns are so proportioned that the pressure per square inch on the granite cap does not exceed 300 lbs., nor more than 125 lbs., on the concrete below. The columns are spliced once, details of the splice joint being shown in Fig. 2. This drawing also shows the details of the connections of the arch ribs to these columns. These arch ribs are composed of two channel sections latticed together to form a rectangular section, Figs. 2 and 3. At the crown the longitudinal arch rib is attached to the main girder by means of bolts, the holes for which, in the arch, are slotted. It will be noted that this use of slotted holes continues through all the connections of the spandrel arches with the main girder, Figs. 3 and 4. Details of the spandrel posts and of their connections with the main arch rib, with the main girder, and, with the spandrel arch ribs are given by Figs. 3 and 4. The transverse main arch rib and spandrel arches carry a latticed girder strut between the tops of the columns, as shown by Fig. 5.

Turning now to the main girder construction, there are two outside box girders and four intermediate plate girders running lengthwise of the span. These girders are connected at their ends over the columns by a transverse plate girder, Fig. 5, and at intermediate points by vertical sway bracing in alternate panels, as shown by Fig. 6. The transverse end plate girders are shown by Fig. 5, which also shows the spacing of the longitudnial girders. It will be noticed that these girders are of rather large dimensions; the intermediate plate girders being 126 ft. ¼ in. long c. to c. of the end cross girders and 10 ft. ¼ in. deep back to back of angles, while the side box girders are of the same depth, but 128 ft. 7 ins. long, and weigh 60 tons each. A cross section of one of the box girders is shown in Fig. 6, and partial side elevations appear in Figs. 3 and 4. Fig. 6 also shows cross sections of the intermediate plate girders. Besides the vertical sway frames in alternate panels, shown by Fig. 6, the main longi-



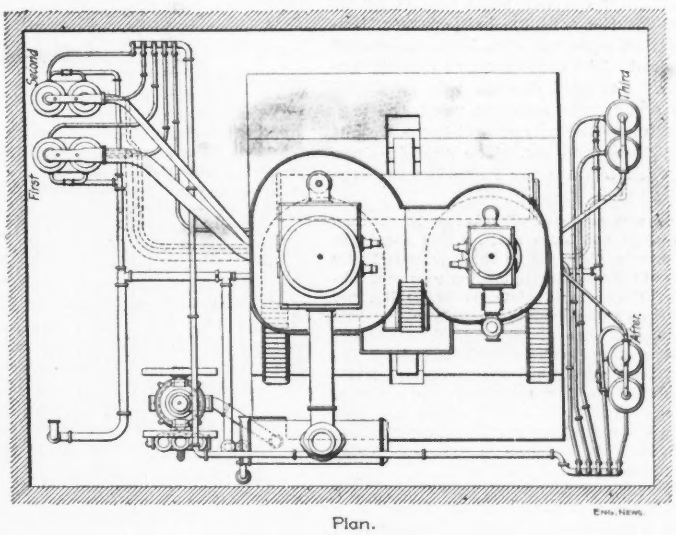


FIG. 2.—FRONT AND END ELEVATIONS AND PLAN OF A 1,500-HP. AIR COMPRESSOR FOR CHARGING COMPRESSED AIR CARS.

tudinal girders are connected in the open panels by struts of two 5 × 3 × ⅜-in. angles in the plane of the bottom flange, and by a simple triangular lateral system in the plane of the bottom flanges in the panels having the sway bracing. These laterals are single 4 × 3 × ⅜-in. angles.

The floor system proper is shown by Figs. 3, 4 and 6. It consists of transverse I-beams, 12 ins. deep, spaced 5 ft. apart, and carrying ⅜-in. buckle plates covered with concrete. Fig. 6 shows fully the sidewalk brackets and the corrugated flooring filled with concrete, which they carry. The floor system of the shorter spans is essentially different, as will be more fully noted further on.

The 65-ft. Spans.—The smaller spans are constructed in all respects similar to the large span just described, except for the girder and floor system. Accurately speaking, they are, with three exceptions, 64 ft. 11½ ins. long, c. to c. of columns. The columns are 4 ft. 11½ ins. × 1 ft. 11¾ ins. in lateral dimensions, and are spliced once in their total length. The longitudinal arch ribs are 3 ft. 7¾ ins. × 1 ft. 11 ins. in section, and the transverse arch ribs are 1½ ft. deep, the former being three-centered and the latter circular arcs. The spandrel details are similar to those described for the 130-ft. span, but the latticed cross girder has but two panels, instead of five, as in the larger span, Fig. 6.

The girder system consists of two outside box girders 5 ft. ¼ in. deep, and two end cross girders, 4 ft. 10¼ ins. deep, there being no intermediate longitudinal plate girders as in the longer span. In the place of these latter, however, there are six transverse floor beams proper, which carry the I-beams upon which are laid the buckle plates and concrete flooring. Fig. 7 shows the details of the end connections for the end floor beams, of the catchbasin and drainage construction, and the manner of securing the crown to the roadway with the necessary freedom for expansion. The end connections for the intermediate floor beams are double angles riveted to the box girder. The sidewalk construction is similar to that for the longer span, except that the brackets are spaced only 6 ft. apart.

Material.—For the masonry of the abutments, limestone is used for all face work and voussoirs of arches, but for the copings, belt courses, balustrades, lamp post supports, etc., bush-hammered granite is required. The face masonry is rock face coursed ashlar. Portland cement was employed for all mortar and for the concrete work, the proportions of the former being one and three, and of the latter one, three and six. The specifications for the steel work contain the following requirements:

Rivets are to be soft steel and all other metal medium steel, except gratings and beam seats, which are to be cast iron. The permissible shear on shop rivets is 10,000 lbs. per sq. in., and the permissible bearing pressure, taking diameter into thickness of plate, is 20,000 lbs. per sq. in. Two-thirds of these values are allowed on field rivets. No metal less than ⅜-in. thick shall be used except for fillers and where designated on plans. The buckle plates on the roadway and the corrugated plates on the sidewalks shall be ⅜-in. thick and have a rise of 3¼ ins. and 2 ins., respectively. The buckle plates shall be riveted down to the I-beams by ¾-in. rivets, spaced not more than 6 ins. apart, and shall be spliced by 6 × ⅜-in. plates were the unsupported ends meet.

All shear edges of plates must be planed off to a depth of ¼-in., and all punched holes will be reamed to a diameter of ⅛-in. larger, so as to remove all the sheared surface of the metal, unless the material is such that any rivet holes punched as in ordinary practice will stand drifting to a diameter one-third greater than the original holes, without cracking either in the periphery of the holes or on the external edges of the pieces, whether they be sheared or rolled. For any thickness of metal which will stand the above drifting test, reaming may be omitted. The medium steel shall have an ultimate strength of 60,000 lbs. to 68,000 lbs. per sq. in., an elastic limit of not less than half the ultimate strength and a minimum elongation of 22% in 8 ins. Before or after heating to a low cherry red and cooling water of 82° F. the steel must stand bending to a curve whose inner radius is 1½ times the thickness of the sample without cracking. Rivet steel shall have an ultimate strength of 50,000 lbs. to 58,000 lbs. per sq. in., and an elongation of 26% in 8 ins. The rivet steel under the above bending test stand closing solidly together without sign of fracture. The entire cost of testing and inspection not to exceed $1 per ton to be paid by the contractor. The steel, prior to shipment, will receive a coating of linseed oil, and after erection two coats of Alcatraz asphalt paint.

The specifications for the asphalt paving are very complete. The weight of steel in the viaduct is approximately 6,500 tons, or nearly four tons per lineal foot. The contractors for the entire work are O'Brien, Sheehan & McBean, of New York, whose bid for the work, compared with those of competing contractors, was published in Engineering News of Dec. 30, 1897. Ground was broken by the Commissioner of Public Works, C. H. T. Collis, in December, 1897. The steel work has been sub-let to the Carnegie Steel Co., whose shops are the Keystone Bridge Works. The construction is under the supervision of the Department of Highways of New York city, Mr. James P. Keating, Commissioner, with Mr. Andrew E. Foye, Principal Assistant-Engineer-in-Charge. The Consulting Engineer who has designed the structure is Mr. F. Stuart Williamson, with Mr. John W. Ripley as principal assistant.

FIRE TESTS OF FIREPROOF CONSTRUCTION BY THE BRITISH FIRE PREVENTION COMMITTEE.

A comprehensive scheme of fire tests of fireproof constructions has been planned by the British Fire Prevention Committee, which has constructed a well-equipped testing plant near Regent's Park, London, England. As stated by the committee, the purpose of the tests which it is proposed to make is, "to obtain reliable data as to the exact fire resistance of the various materials, systems of construction, or appliances used in building practice." The plant at which the tests are to be made has been constructed by the committee, which has also formulated a schedule of rules and regulations governing the conducting of the tests. These regulations and a description of the testing plant are given in the two last numbers of the publications of the committee, from which we abstract the following information of general interest:

Testing Plant.—So far only the plant for testing floors and ceilings has been constructed. This consists of eight furnaces, or huts, arranged in two parallel rows, of four huts to the row, as shown by Fig. 1. A description of one of these huts will answer for all, and for this purpose hut No. 1, in which the first fire test, to be described further on, was conducted, will be selected. The hut was constructed of brick, as shown by Fig. 2, and measured 10 × 10 ft. inside. The ceiling of the floor to be tested is 7½ ft. above the floor of the hut. The door measures 2½ ft. in width, by 6½ ft. high, and is made of wood sheathed with iron. A galvanized iron roof covers the hut. There are two

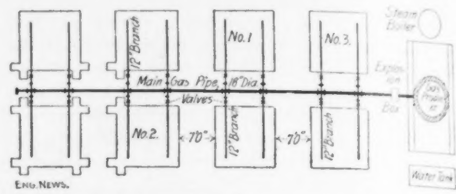


Fig. 1.—Plan Showing Arrangement of Plant for Making Fire Tests of Fireproofing, Regent's Park, London, England.

observation holes in the wall opposite the door, and one in the door itself, and the other walls have a row of ventilating holes located just below the ceiling line of the floor under test, which can be blocked partly, or wholly, as may be desired.

The fuel used to supply the heat is gas, which is made on the spot, there being a full installation, comprising a gas producer with a small vertical boiler, an explosion box, and a line of main with branches, all of which are shown by Fig. 1. This gas supply is regulated by valves and dampers, and is fed into the combustion chamber, as shown by Fig. 2. An almost perfect regulation of the gas supply and heat is claimed to be possible. The heat attained is recorded by the automatic electrical pyrometers, designed by Prof. Roberts-Austin of the Royal Mint; and photographs are taken to show conditions after the test. An ordinary hand-worked fire engine, equipped with a pressure gage, provides the hose stream employed in the water test.

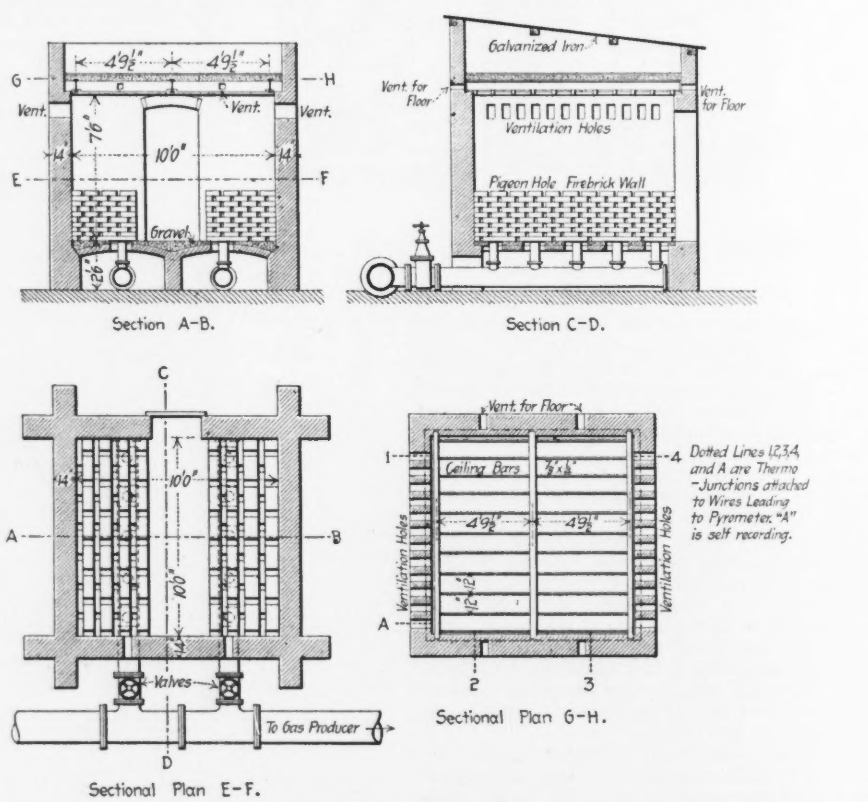


FIG. 2.—DETAILS OF TESTING-HOUSES OR FURNACES FOR FIRE TESTS OF DOOR AND CEILING CONSTRUCTIONS.

Regulations.—The investigations of the committee will comprise: (1) Its own official tests; (2) maker's official tests, and (3) maker's private experimental tests. In respect to the first division of the work, it may be explained that the committee itself proposes to make investigations from time to time, as its finances permit, of the fire resistance of the ordinary building materials or forms of construction which are not subject to any patent or controlled by any special makers. For instance, the committee has in hand tests of a floor composed of ordinary wooden joists with a concrete filling, and of a solid wooden floor, and in course of time it hopes to test in a similar manner all of the more common methods of construction used in the British Isles.

The second class of work mentioned is designed to afford makers of patented fireproofing materials or systems of fireproof constructions, opportunities for obtaining official and independent reports on these systems or appliances at a fixed tariff, the charges being based on the actual cost of such tests. Should the committee find that these testing charges have any material surplus, such surplus will, after due consideration of wear and tear of plant, instruments, etc., be distributed among the firms or individuals who have had work tested, proportionately to the amount of the testing charges originally paid by them, or the surplus may be utilized for such other purposes as the Commercial Section, which is made up of representatives of the fireproofing trade of Great Britain, may direct. The tariff of charges for tests is as follows:

For purposes of finance, the cost of the tests is divided into (1) preliminary expenses; (2) establishment capital, and (3) testing charges. All firms, or individuals not members of a firm, desiring tests shall contribute a donation of £5 5s. to the preliminary expenses incurred by the British Fire Prevention Committee in forming the station. All firms or individuals desiring tests shall contribute to the establishment capital of the station from £10 to £50, according to the nature of the test and the group to which it belongs, as defined below. All firms desiring tests shall pay in form of testing charges from £25 to £100, according to the nature of the test and the group to which it belongs, as defined below. These contributions and charges will cover all expenses for ground, carcass, walls, ovens or heating apparatus, instruments, firing, loading, water, attendance and supervision, and on no account shall any other expense be incurred; gratuities to the servants of the committee, for instance, being strictly prohibited. No responsibility for breakage of instruments, etc., is incurred.

The firm or individual having work tested shall supply and fix his materials, systems, or appliances at his own cost, everything pertaining to the actual test being covered by his contribution as per scale. The following classifications of tests has been decided on with the view of fixing the contributions:

Group A.—Tests with built-up walls, floors, partitions, etc.; safes, etc., intended to endure severe tests.

Group B.—Tests with built-up walls, floors, partitions, etc., with plaster, special lathing, etc., and intended to stand medium tests.

Group C.—Tests with individual pieces of material, with sprinklers, individual fittings, such as doors, glass-panels, skylights, etc.

Group D.—Tests with automatic appliances, such as fire alarms, etc.

When second tests are desired by the same firm or individual, the testing charge—no matter in what group—will be according to scale, but there will be no further contribution to the establishment, capital or preliminary expenses. Where three or more tests are undertaken for

Fig. 3.—Section of Concrete and Expanded Metal Fireproof Floor Tested by the British Fire Prevention Committee.

the same firm or individual, a discount of 10% off the scale charges will further be allowed. All contributions are payable in advance at such times as the executive shall determine.

Before any test with any materials, system or appliance is started, or the arrangements for such a test are commenced, all contributions shall have been paid in advance, and the ordinary application for a test shall have been supplemented by an undertaking on the part of the firm or individual desiring the test to accept all or any reports of the committee, framed on the lines indicated above, and further to permit the executive to issue such reports. The undertaking shall be on a form obtainable at the offices of the committee. Any firm or individual, however, desiring to see the report on a test with his work prior to issue will always have an opportunity given him for this purpose. Under exceptional circumstances, at the discretion of the executive and under special conditions to be determined on, tests may be undertaken elsewhere than on the committee's grounds.

The third class of work mentioned is designed to give makers of fireproofing an opportunity to conduct private tests and experiments to secure information for their own use. No reports of these private tests may be made public either by the committee or the makers.

In respect to the other reports of the committee, every possible precaution will be taken in wording them to avoid any semblance of opinion or comparison. They will be drafted solely as a record of facts. In the case of a maker's test, the exhibitor has an opportunity given him to put any grievance before the committee prior to the issue of the report dealing with his individual test. The reports will be published at the discretion of the executive officers of the committee.

Expanded Metal Co.'s Floor Test.—The first test conducted with the plant, and according to the regulations just described, took place on Feb. 15, 1899. The floor tested was the patented construction of the Expanded Metal Co., and the object of the test was to record the effect on this floor of a smoldering fire of 15 mins. duration, at a temperature not exceeding 600° F., followed by a fierce fire lasting one hour, and gradually increasing to a temperature of 2,000° F., followed by the sudden application for three minutes of a stream of water.

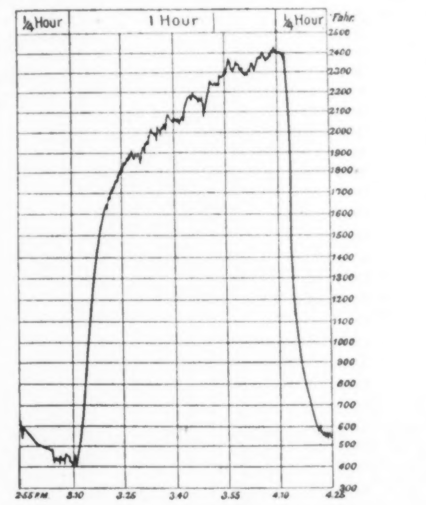


Fig. 4.—Automatic Pyrometer Record of Temperatures Obtained in Concrete and Expanded Metal Floor Tests.

The construction of the floor tested is quite clearly shown by Figs. 2 and 3, which show all the principal dimensions, the beam spacing, etc. The expanded metal was 3-in. mesh, and ¼ × ⅛-in. strand, and covered the whole floor area with an overlap of 18 ins. at the center. One-quarter of the area had also an additional layer of expanded metal of 3-in. mesh and ¼ × 3-16-in. strand. The concrete consisted of Portland cement and gas-works furnace ash broken to pass a 1½-in. ring, in the proportion of eight bushels of cement to 1 cu. yd. of cinder. The top dressing consisted of a plaster of 1 part Portland cement and 1 part pit sand. The ceiling plaster consisted of 1 part lime and 1 part sand, with 1 lb. of hair to each 3 cu. ft. of mortar. The expanded metal lathing was ⅜-in. mesh and 3-32-in. strand. One-half of the concrete was placed on Nov 16, and the other half on Nov. 17, 1898. The ceiling was plastered on Dec. 5. On Feb. 14 the gas was lighted in the hut and kept very low until the test was begun, and on the same day the floor was loaded with pig iron to a uniform load of 140 lbs. per sq. ft.

The actual test began at 2.55 p. m., and from that time until the water was turned on the temperatures ranged as shown by Fig. 4, which is an automatic record from the Austin-Roberts pyrometer, located at point A, Fig. 2. When the gas was shut off at 4.10 p. m., the ceiling was intact. The water was applied through a ½-in. nozzle, for three minutes, from 4.13 to 4.16 p. m., at pressures gradually decreasing from 40 lbs. to 20 lbs. On application of the water portions of the plaster immediately fell, but the untouched portions remained in place. The day after the test the center floor beam showed a deflection of 1⅜ ins., and one side beam had deflected 5-16-in., and the other none at all. The metal lathing of the ceiling, as shown by the photographs reproduced in the committee's report, was not broken through, and the embedded metal in the floor proper was not laid bare anywhere. We have commented upon these results in our editorial columns.

Wooden Joists Filled with Concrete.—This form of floor, which appears to be employed to some extent in England, was tested on Jan. 26, 1899. The construction of the floor is indicated by Fig. 5. To test their comparative resistances three kinds of concrete were employed: (1) one part cement and six parts coke breeze; (2) one part cement and six parts of ballast; (3) one part cement and three parts ballast, and threee parts of coke breeze. The ballast was clean pit ballast, and the coke breeze came from the gas works at Kensal Green. Both were small enough to pass a 1-in. ring, and both were fairly damp before being used. The Portland cement had a tensile strength of from 350 to 400 lbs. per sq. in. The age of the concrete when the test was made was about 48 days. The conditions of the test were a smouldering fire not exceeding 800° F. for the first 30 mins., and then a fire of 2,500° F. for one hour, followed by the sudden application of cold water for 4 mins.

At 2.15 p. m. the gas was gradually turned on, and the temperature raised between 600° F. and 1,000° F. From 2.45 p. m. to 3.45 p. m., the temperature was increased from 1,000° F. to 2,400° F. After a few minutes the plaster of the ceiling began to fall, whereupon the lower edge of the joists caught alight. The joists burnt upwards, especially at the ends and around the joists up to the fillets. The lower surface of the concrete was incandescent, and showed a light red glow. Vapor rose from the upper surface of the concrete. Smoke from the combustion of the joists showed itself between the joints of the floor boards. At 3.45 p. m., the gas was shut down and the door opened. The observations made were: The concrete was seen to be fully incandescent, particularly that in the first portion of the floor (west side, coke breeze and cement). The underside of the ballast and cement concrete disintegrated to the extent of 1 in., increasing where nearest the

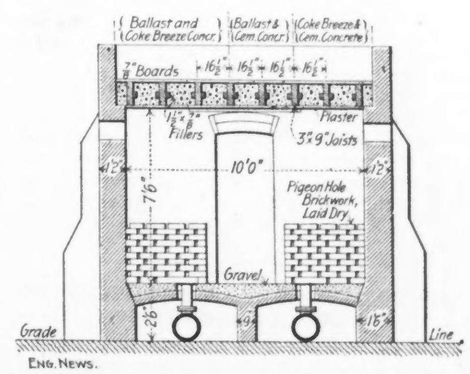


Fig. 5.—Section of Testing House Showing Wooden Joist and Concrete Floor.

wall. The joists, as far as could be seen, were burnt through.

From 3.45 to 3.49 p. m., a jet of water was applied, the pressure ranging at about 30 lbs. On application of the water, the lower surface of the ballast and cement concrete and the ballast, cement and coke breeze concrete immediately disintegrated. About 3 ins. of the ballast and cement concrete fell. The coke breeze and cement concrete was not affected. From 3.45 to 4.15 p. m., the temperature rapidly decreased. At 4.15 p. m. the test was closed. The floor appeared to be seriously weakened and deflected. After the test the floor was further cooled by pouring water on the top of the floor.

At 9 p. m., the floor suddenly collapsed, the whole of it falling bodily, no part of it whatever remaining in position. The joists were found to be burnt through from 2 ins. to 6 ins. deep, and tapering to a further depth at the ends. The boarding was found to be slightly charred on the underside and at the joints, but otherwise remained sound. All the concrete, when it fell, broke into lengths varying from 12 ins. to 36 ins. Some of the concrete of each aggregate broke away in layers of 3 ins. All the concrete broke easily into small pieces when knocked with a 5-lb. hammer. The underside of the coke breeze and cement concrete showed its straight flat original

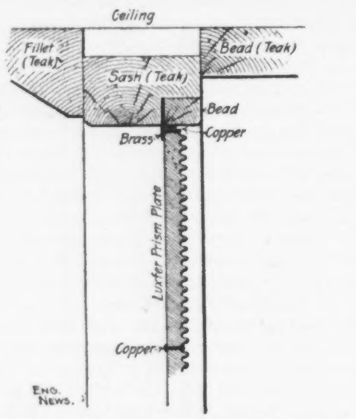


Fig. 6.—Part Section of Luxfer Prism Window Tested by Fire.

soffit. The underside of the ballast and cement concrete had crumbled away. The underside of the coke breeze, ballast and cement concrete had crumbled away.

Luxfer Prism Casements.—In this test a partition was built longitudinally through the center of the testing house, and heat applied to one side of this partition. There were three casements, each having a glazed area of 3 × 4 ft., made up of 4 × 4 ins. panes. Fig. 6 shows the construction quite clearly. The test was begun at 4.15 p. m., when the temperature was 150° F., and stopped at 4.45 p. m., when the temperature was about 1,300° F. Water was turned onto the glazing on the side away from the fire for 2 mins. at 4.30 p. m., and for 3 mins. at 4.45 p. m. The effects on the casements were as follows:

The Luxfer window prisms, in squares of 4 ins. × 4 ins., remained in position. The whole area of the glazing commenced to bulge inwards to the extent of 1 in., 1½ ins., and 2⅛ ins., respectively, after 12 mins. After 21 mins. the top portion of the center casement sagged and left a space between the glazing and the teak frame; 317 squares out of the total number of 324 withstood the action of the fire and water, except for stars and cracks, the remaining seven squares were broken and had pieces out. No glazing bars were broken or appreciably oxydized. The teak casements were charred to a depth of about half an inch on the inside.

WATER CURTAINS FOR THE FIRE PROTECTION OF THE CHICAGO PUBLIC LIBRARY.

One of the greatest risks from fire to which incombustible buildings are exposed, is that of being attacked from the outside by heat and flames from adjacent burning buildings, and this danger is especially great where the building exposed has large windows and contains inflammable materials. This peril has been recognized by the directors of the Chicago Public Library, and a system of external fire protection has recently been completed, by which a sheet of water, or "water curtain," can be thrown down 90 ft. from the main cornice to the sidewalk, extending the full height and length of each side of the building which is thus exposed. This is effected by means of a series of nozzles overhanging the cornice. The total length of cornice so provided is 540 ft.

The water for these "water curtains" is supplied through two 7-in. standpipes extending above the roof, and cross-connected in the basement with two fire pumps. From these standpipes, 7-in. mains extend across the roof and supply 5-in. and 6-in. pipe headers for the nozzles. All bends in the pipes are made with long-sweep tees fitted with plugs. At intervals of about 2 ft. the bottoms of these headers are provided with water-pipe clamp connections, with ¾-in. brass pipes extending just over the edge of the cornice, each having a brass elbow at the end, with a short nipple, to which the brass nozzle is attached. Each nozzle is ¼-in. diameter, and is provided with a baffle plate to give a sheet spray of about 65° in a plane parallel to the walls of the building. The maximum amount of water discharged from each nozzle in case of fire, is about 10 gallons per minute, at a pressure of about 30 lbs. per sq. in. Galvanized iron branch pipes, fitted with brass nozzles, are also placed over the rear court windows. Fig. 1 is a general plan and part elevation of the system, and Fig. 2 gives some details of the pipes and nozzles.

The supply of water to the nozzles on each side of the building and over the court windows is controlled by gate valves on the main roof. In seven different places on the main pipes on the roof there are standard fire hose nipples and gallons. They are circular in shape and lie horizontally in cradles on the floor. They are all connected with the suction headers of all the pumps, and can be filled and emptied automatically. Each tank is provided with a gage glass, air, relief, and main valves, and manhole, and is tested to a hydraulic pressure of 75 lbs. per sq. in.

In designing this system of fire protection the architects were confronted with the problem of constructing an effective apparatus which would not impair the appearance of the building. The first scheme considered was for a 5-in. or 6-in. pipe, suspended over and parallel to the cornice, with slots cut in the bottom to discharge the water down in sheets over the building. This large pipe, however, projecting out in front of and over the cornice would have seriously affected the appearance of the building. After careful study of the problem, it was finally decided to adopt the scheme of a large main set well back on the roof, out of sight, with short lengths of small brass

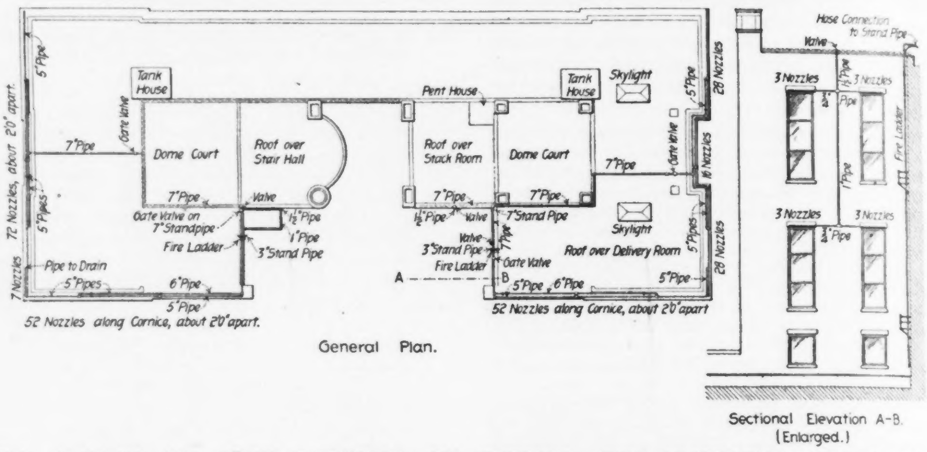


FIG. 1.—PLAN AND PART ELEVATION OF EXTERNAL FIRE PROTECTION SYSTEM FOR THE CHICAGO PUBLIC LIBRARY.

Shepley, Rutan & Coolidge, Architects.

valves for the use of firemen, to enable them to throw streams on adjacent burning buildings.

Two independent 3-in. standpipes, attached to fire ladders, are placed in the rear court, the lower ends of these being fitted with Siamese couplings for fire engine connections. At the top of each standpipe, and at the fourth story windows, standard fire hose nipples and valves are provided. Two balconies in connection with each ladder are provided for the use of firemen as resting-places, and for hauling extra hose to the roof, if desired.

All pipes leading to the nozzles are arranged to drain themselves completely. The nozzle headers on the cornice are set back about 2 ft. from the cornice line. These and all other pipes on the roof are supported and fastened in place with bolts and wrought-iron standards, 10 ft. apart, allowance being made for contraction and expansion. After erection, all the iron work was given one coat of red oxide of iron ground in pure linseed oil, and a final coat of paint.

The two fire pumps have each a capacity of pumping 750 gallons of water per minute, in case of necessity. This capacity can be increased by the addition of the house pumps, and, further, by six fire engines connected to three Siamese hose couplings on the Michigan Ave. side of the building. These auxiliary supplies are all connected with the main pump discharge header in the basement, in such manner as to allow of the separate or collective use of the fire pumps, house pumps or fire engines. From this main pump header are also four other standpipes in the interior of the building, with hose reels on each floor, for interior protection.

The water supply from the street service is at present through one 4-in. and one 6-in. pipe from the street mains, and to obviate the possible inconvenience from a water famine in case of a large conflagration in the immediate vicinity, which would draw heavily on the supply, an additional means of supply is being installed, consisting of four water storage tanks in the basement. These tanks have a total capacity of 25,000 pipe having nozzles projecting at intervals over the edge of the cornice, to discharge the water in the required manner. These nozzles are hardly noticeable from the street, thus leaving the outline and proportion of the cornice unmarred.

The result of the official test of the apparatus, made under the direction of the Chief of the Fire

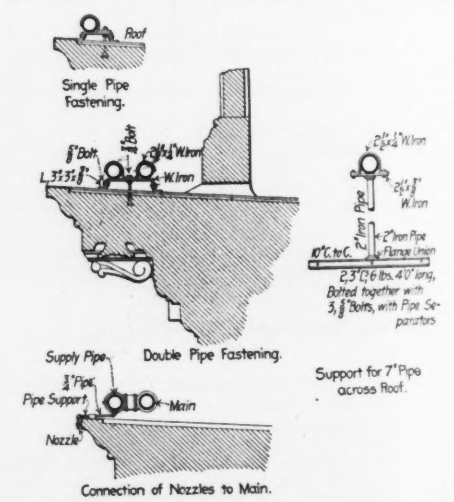


Fig. 2.—Details of Pipe and Nozzles for "Water Curtain."

Department, was highly satisfactory, although it revealed certain points where improvements could be made in again constructing a similar system. Although water had been forced through all the piping before the nozzles were attached, it was found that rust scales, dirt, and small fish would partially clog some of the nozzles. This, however, did not materially affect the efficiency of the nozzles in creating the water curtain.

This difficulty could be largely, if not wholly overcome by straining the water before it entered the pumps; by using galvanized iron pipe for all mains and headers so as to prevent rust scales; and by connecting the nozzle pipes to the side of the headers at an angle of 45° or 90° instead of at the bottom, and draining the headers at their ends with large drain cocks.

The cost of piping and nozzle work outside the building was about $4,000, the material being furnished and erected by Thomas & Smith, of Chicago. The same contractors also furnished the water storage tanks and all connections in the basement. The fire pumps were furnished by Fairbanks, Morse & Co., of Chicago.

The fire protection system was designed by the architects, Messrs. Shepley, Rutan & Coolidge, of Chicago, to whom we are indebted for copies of the plans and specifications. They consider that similar devices to throw sheets of water over the walls or windows could be used very effectively on tall buildings where they are exposed to possible danger by fire in adjoining buildings. Where buildings are of considerable height, two, three or four curtains in the height of the buildings should be provided, as the sheets of water turn to spray or mist as the distance of fall increases, and are also somewhat affected by strong winds. The nozzles or pipes could be placed in ornamental band courses and in the soffits of windows.

We have commented on this apparatus in our editorial columns.

THE COLOR OF RAILWAY NIGHT SIGNALS.*

The accident which occurred Sept. 6, 1898, at Whittenton Junction, and which was in some respects one of the most peculiar that has ever occurred in Massachusetts, illustrates forcibly, among other things, the importance of a careful consideration of the matter of colors for night signals on railroads. Briefly stated, the accident was a train collision, and resulted from the fact that an engineer mistook the white lantern on a highway crossing gate for a safety home signal, whereas the signal was in reality at danger, though the lantern was extinguished. We are informed that since the occurrence of this accident, and in consequence of it, the New York, New Haven & Hartford R. R. Co. has adopted the green light as a safety signal at night in place of the white light.

The usual colors for railway signals, which until recently have been almost universally adopted in all civilized countries, are the following: White, to signify safety; Red, to signify danger; and Green, to signify caution. These colors were agreed upon at a congress of railway men held in Birmingham in 1841.

The choice of these colors resulted originally from the experiments of the brothers Chappe, in France, in connection with the establishment of a signal system devised by them. Among other results of these experiments, they stated that the visibility of a red light was but one-third that of a white light of the same intensity, that of a green light one-fifth, and that of a blue light one-seventh. White was chosen as the signal for safety as being the usual light, as well as the most easily visible; while red, as the most easily visible of the colored signals, was chosen for the most important signal, that of danger. So far as visibility was concerned, it would have been desirable for the danger signal to be of the color most easily seen; but it was of course impracticable to use white for a danger signal.

The serious objections to the use of white as a safety signal soon became evident, and have resulted in England in the universal substitution of green as the safety signal at fixed signals, and the abandonment of the cautionary signal. Green, however, is still used to signify caution in the case of hand or temporary signals. The permissive block system, so widely used in this country, is not used in England, so that a cautionary signal is not there considered necessary; and on English railways the distant signal is simply a duplication of the home signal.

The objections to white as a safety signal are familiar to all railway men. They are, first, that if the red lens which forms the danger signal be broken, the light will show safety instead of danger; and second, that (as in the Whittenton accident) the danger signal may be extinguished, and the engineer may mistake some other white light for the safety signal. The first objection may be in a measure and perhaps wholly obviated by the use of wire glass for the lens; nevertheless, the principle seems sound that the safety signal should be a positive signal, which in case of accident or doubt would show danger, and not the mere absence of a danger signal.

Notwithstanding the abandonment of white as a safety signal in England, the great majority of American railways still use this color. The principal arguments urged against giving it up seem to be the following: first, that the engineers are accustomed to its use, and that any change would be dangerous, since a white light not on the railway might be taken as a safety signal from force of habit; second, that on our railways, principally because of the extensive use of the permissive block system, it is necessary to have a signal for caution; and it appears difficult to find a suitable color for this purpose. Blue is not suitable, on account of its slight visibility; particularly since the light from the usual lamp flame contains few blue or violet rays. Amber or orange has been suggested, but is objectionable as being so easily confused with red (if the tint is dark), or with white (if the tint is light). This difficulty has been met on some roads, however, by using as a cautionary signal a red and a green light, or by using some combination of green lights.

This subject has frequently been considered by the official railroad organizations, especially by the American Railway Association, but no general agreement has been reached. In 1894, the committee on interlocking and block signals recommended red for danger, violet for caution, and green for safety; but within a month it revised its opinion, and recommended (though not unanimously) continuing the use of green for caution and white for safety; and the Association voted against giving up the use of white as a safety signal. Later in the year, the committee reported definitely that the use of blue or orange lights did not appear practicable, but that a combination of red and green could be used for caution. In March, 1895, the committee went so far as to pass the following resolution:

> That the committee does not at this time deem it wise to recommend abandoning white for a night signal; as first, three indications are necessary in many cases, and second, no entirely satisfactory single color has been found for a third indication. The committee approves, however, the use of red for danger—stop; and green for clear—proceed; as good signal practice.

In the standard rules for block and interlocking signals, adopted in the same year, the Association decided on red for a danger signal, but left blank the colors for safety and cautionary signals, allowing each company to decide this for itself. In the standard train rules adopted in 1898, the same course was followed.

The opinion seems to be gaining ground, therefore, that white should be abandoned as a signal color. We conceive this to be probably the better opinion. The matter should at all events receive the careful attention of railroad managers.

*From the 30th Annual Report of the Massachusetts State Railroad Commission.

BLANKS FOR BRIDGE REPORTS AND RECORDS; GULF, COLORADO & SANTA FE RY.

In the bridge department of railway service it is very important that complete records should be on file as to the type, foundations, waterway and drainage area of all bridge openings, and equally important that such records should be kept corrected up to date. We present herewith a copy of two forms for report and record of bridges, for which we are indebted to Mr. C. F. W. Felt, M. Am. Soc. C. E., Chief Engineer of the Gulf, Colorado & Santa Fe Ry.

The first of these represents the form of blank used in making drainage area reports for permanent bridge work. The second is the form of permanent bridge record:

Form No. 1.—Bridge Report; Gulf, Colorado & Santa Fe Ry.
DRAINAGE AREA REPORT.

Bridge No.......... Location stationing of South End ....
Location, Mile Post plus telegraph poles ....
Length.......... No. of frame bents.......... No. of pile bents..........
Bridge is on..........(State whether main line or branch,)
(If branch state which branch.)
Height, base of rail to bottom of channel..........to high water line..........
Distance: Base of rail to elevation of lowest improvements..........
Area of Drainage..........sq. miles.
Area of Waterway..........sq. feet.
Area of water way to high-water line, under bridge..........sq. feet.
Up stream, above bridge.......... " "
Down stream, below bridge.......... " "
Foundation .... Character .... Depth from base of rail..........
Description of Drainage Area.
..........per cent. Black soil. ....per cent. Clay.
.... " " Sandy soil. .... " " Woody.
.... " " Cultv. land. .... " " Pasture.
Adjacent slopes .... Remote slopes ....
Yardage of Embankment required to fill bridge opening..........
Remarks:
Recommendation for Permanent Work:

Form No. 2.—Bridge Record; Gulf, Colorado & Santa Fe Ry.
BRIDGE NO..........

Location stationing .... Mile post location..........
Length.......... Number frame bents.......... Number pile bents.......... Iron spans..........
Height: Base of rail to bottom of channel.......... To high-water line..........
Distance: Base of rail to elevation of lowest improvement ....
Area of drainage..........sq. miles. Area of waterway..........sq. ft.
Area of waterway to high-water line: Under bridge......sq. ft. Up stream......sq. ft. Down stream......sq. ft.
Foundation .... Character..........Depth from base of rail..........
....
....
DESCRIPTION OF DRAINAGE AREA.
..........per cent. Black soil. ....per cent. Clay ....per cent. Sandy soil.
.... " " Cultv. land. .... " " Woody. .... " " Pasture soil.
Adjacent slopes .... Remote slopes ....
REMARKS..........
....
....
Drainage Survey by .... Date..........
RECOMMENDATION FOR PERMANENT WORK..........
....
..........By.......... Date..........
IMPROVEMENT ORDERED ....
..........Authorized .... Completed..........
COST.......... Voucher Record ....
....
....
....
Total Cost .... Original cost of old structure..........
Reported Complete ....
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TO INSURE BUREAU HARMONY, in the Navy Department, the Secretary of the Navy has appointed a Board of Admirals, or Bureau Chiefs, with Assistant Secretary of the Navy Allen as President. The board includes Rear Admirals Frederick Rogers, President of the Board of Inspection; Charles O'Neill, Chief of Ordnance; Royal B. Bradford, Chief of Equipment; Philip Hichborn, Chief Constructor; George W. Melville, Chief of Steam Engineering; M. T. Endicott, Chief of Yards and Docks; and Lieut.-Commander W. H. H. Southerland as Recorder. This board is to revise the regulations relating to the working bureaus of the Department, defining for each its duties; the extent of its authority afloat and ashore; fixing responsibility and preventing duplication of work. The past practice is a growth that does not meet existing conditions, and much confusion and conflict of authority has resulted, that it is now proposed shall be done away with.

ENGINEERING NEWS
AND
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"A Western railroad superintendent" has recently been quoted to the effect that the large freight car has been much overrated as a vehicle for economical freight transportation. He has found that his 60,000-lb. cars are carrying average loads very little heavier than the old 30,000-lb. cars, and that large capacity cars are being used for shipments which could easily have been sent in small cars.

We do not know where this criticism originated, but whoever made it was criticising his own practice as a traffic manager. The modern large capacity freight car is not a panacea for all ills, certain enthusiastic statements to the contrary notwithstanding. For handling long-distance traffic of great volume the 60,000, 80,000, or 100,000-lb. car is an improvement of enormous value. For picking up way freight on an out-of-the-way branch road, the old ten-ton car is a better and more economical vehicle. This is so simple a matter that it is strange that it should be so frequently misunderstood. Cases are undoubtedly frequent in the railway service where modern large capacity cars, which ought to be running in through freights loaded to the roof, are jogging about in local trains, carrying frequently no more goods than could be packed into a two-horse wagon. Of course, it is not always possible to choose cars to suit the traffic. In dull times when cars are standing idle, there is a tendency to use the newest and largest cars, and let the old ones of small capacity stand idle on the side tracks, and within limits there is really no great loss in this practice. Hauling the extra dead weight of the larger cars does not cost so much as is sometimes thought. Nevertheless the principle remains true, and should not be overlooked in these days when large capacity cars are the rage, that certain classes of traffic by no means inconsiderable in amount can be better and more economically handled in small cars.

The electric railways which are handling express freights are really teaching the railway companies a lesson, and so are the express companies for that matter. It is altogether probable that a good many thousand miles of steam railway in this country might be more profitably operated by a service of combination passenger and freight steam motor cars, which could be run by a couple of men, than by the regular trains which are now run.

It is true, as we have frequently pointed out, that American railways have accomplished wonders in the cheap carriage of long haul freights. The cheap carriage of local freights, however, is a field to which comparatively little attention has been given. Such traffic as that between a city center and its suburbs, and the districts further distant from which market garden produce is received, while small in amount at any one point, is yet large enough in the aggregate to be well worth cultivation.

What size or capacity of cars is best adapted for the economical handling of this class of traffic we shall not attempt to say. It is at least certain, however, that the modern 60,000-lb. car presents no advantages in this department of the railway business, and that provision for this traffic should be made in the rolling stock department, as well as for the movement of coal, grain, and through merchandise freights.

The only armor plate makers in the United States, the Carnegie and the Bethlehem companies, have refused to furnish armor under the latest call for bids made by the Government at the limit of price set by the last Congress, $300 per ton, and as a consequence a large number of newspapers are denouncing Congress in unmeasured terms.

We see little reason to criticise Congress for its action. The fact that the Carnegie and Bethlehem companies did not bid under the recent call for proposals does not prove that there is no profit for them in making armor plate at $300 per ton, as some of the newspapers seem to suppose. It merely proves that the officers of these companies concluded that on the whole they could get a larger price than this from the Government. They have a perfect right to do this, for they are not in business for their health. Each of them spent great sums on their armor plate plant, and they naturally desire to get as large profits as possible from the investment.

The root of the whole difficulty which the Government has had in dealing with this armor plate matter has been that the assumption that competition could be relied upon to regulate the prices of armor plate. When armor was first required for American war vessels, the Carnegie and the Bethlehem companies were each encouraged to build an armor plate plant, with the idea that the competition between these two would keep prices down. No more absurd mistake was ever made. The slightest knowledge of the economic laws which govern competition would have shown the futility of such an idea. The two concerns have of course never bid against each other. Some sort of understanding, actual or tacit, between them, has always existed to prevent them from cutting each other's prices. Had there not been such an understanding, prices would have been reduced to a point that would have left nothing in the way of return upon the companies' investment in their plant.

A great deal has been written as to the cost of producing armor plate. The fact is that no one can possibly say what this cost is. If armor plate could be made as steel rails or boiler plates are, with the mills running year in and year out, a close estimate could be made as to the cost of its production. But the total production of the armor plate plants is but a few thousand tons a year, and it is all the time uncertain whether any orders at all will be secured. Under these circumstances what shall we charge to the account of "interest and depreciation," in computing the cost of armor plate per ton? It is practically impossible to set any figure. We can estimate the cost of the material in a ton of armor very closely, and also the cost of operating an armor-making plant at its full capacity for a given time; but who shall say what shall be allowed as a fair return on the investment in a plant which has cost two or three millions to construct, and which is liable to be rendered obsolete and worthless any day by some new invention?

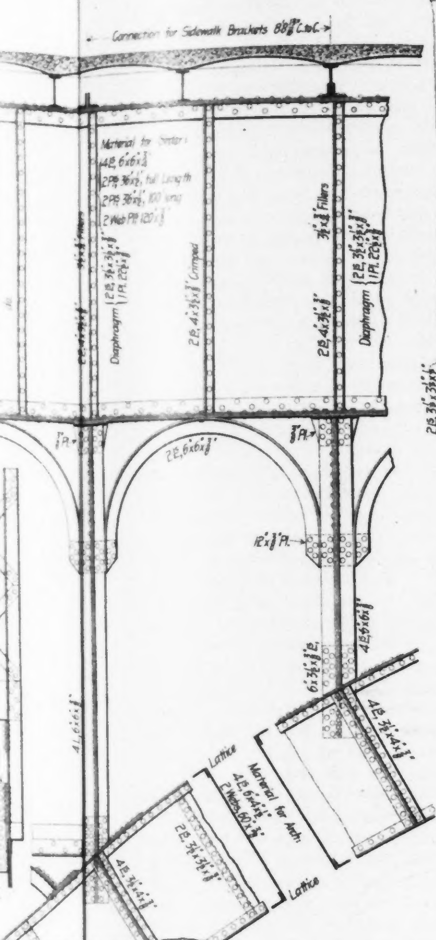
Under present conditions, the question what price the Government shall pay for its armor is a mere matter of pulling between the buyer and the seller. Congress, honestly, as we believe, thought that past contracts had given the armor companies enough profits to repay them for all they had expended upon their plants with a good rate of interest besides, and that the companies could, therefore, afford to accept lower prices. The armor-making companies do not accept this offer merely because they believe that Congress will offer more. We are inclined to think that they are mistaken, and that the card which Congress has up its sleeve—the building of a Government armor-making plant—is likely to be played at the next session.

Had such a plant been built a decade ago, it would have been a wise move; but to add a third armor-making plant to the two already existing would be a pity, to say the least. A much better plan for all parties concerned would be for the Government to purchase either the Carnegie or the Bethlehem armor plants, and operate it to fill the requirements for the armor of future naval vessels. It may be said that this would be unjust to the owners of the other plant; but this would still have the foreign market to supply, and could probably obtain enough business to enable it to be kept intact.

FIRE TESTS OF FIREPROOF CONSTRUCTION IN ENGLAND.

The fire tests of fireproofing to be conducted by the British Fire Prevention Committee, which we describe at some length elsewhere in this issue, have a number of unusually commendable features, but are, we think, also open to criticism in some respects. As a brief study of the outline which we have given of the proposed work will show, these tests, if carried out as planned, will differ from any similar tests made heretofore by including a far wider range of constructions, and, also, in being conducted by an independent technical body, which has never save once been the case in any previous tests. The American committee, made up some years ago of members of the Architectural League, the American Society of Mechanical Engineers, and the Insurance Tariff Association, was of a thoroughly scientific and independent character, but as many of our readers know, it was soon compelled to abandon its work because of lack of funds. Without wishing in any way to undervalue the information which other fire tests have furnished to engineers and architects, it cannot fail to be recognized by anybody who studies them carefully, that in all but a few instances they have assumed too much of a competitive character to command entire confidence. The often-quoted Denver, Colo., fire tests made in 1890, for instance, were purely competitive tests between rival manufacturers competing for an order. They were, however, conducted before a fairly independent tribunal, composed of the competitors, the client and his professional advisers, and the results were carefully recorded so that they very properly rank high in authority, and form a worthy stepping stone towards the official tests which followed later both in America and abroad.

These official tests were themselves mostly organized to meet some special circumstance, however, and, therefore, did not have the general utility they might have had. The first of them, as may be remembered, were the tests conducted during the "Accidents Exhibition," held in Berlin in 1893, for the purpose of determining the award of prizes for the methods employed in the limitation and prevention of fire which were exhibited there. These tests were conducted by a fairly representative committee made up from the local architectural and engineering societies, municipal officials, insurance interests and the fire department, but here again, as in the Denver tests, the element of competition between rival manufacturers appeared prominently. The two series of tests



SION END OF
FT. SPAN.

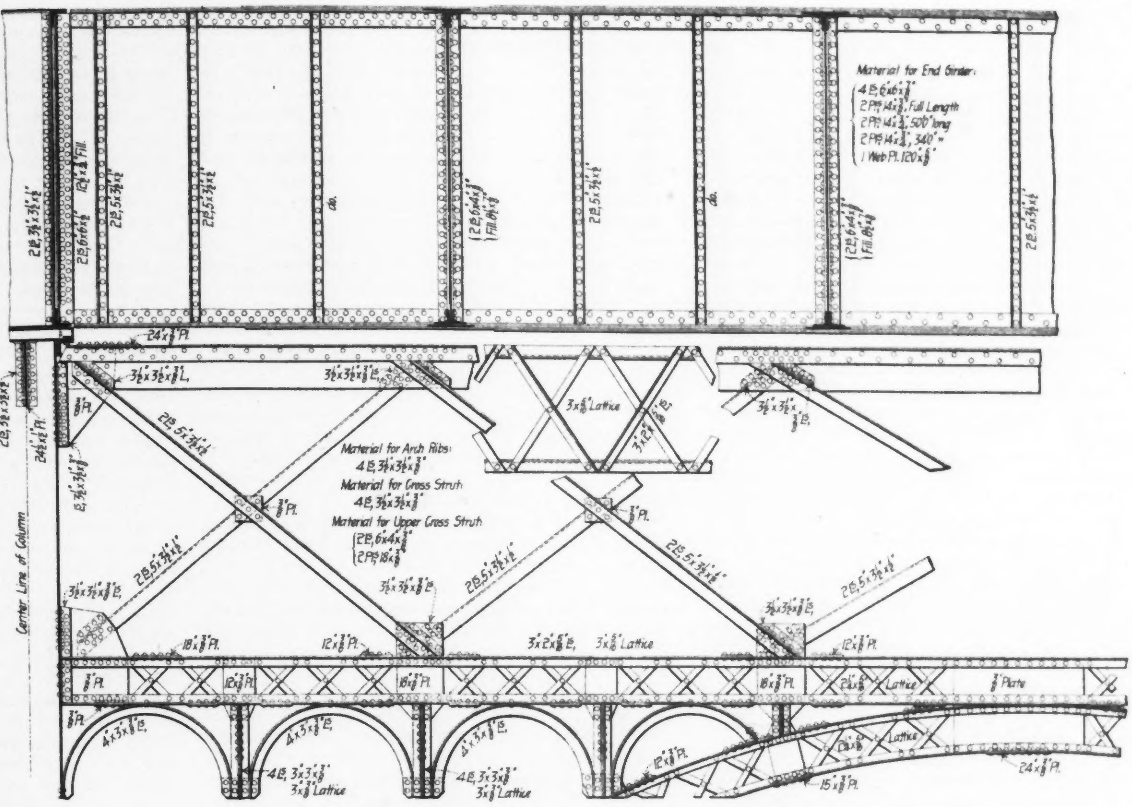
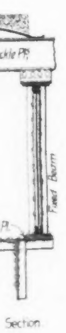


FIG. 5. DETAILS OF END CROSS GIRDER AND TRANSVERSE BRACING BETWEEN COLUMNS, 130-FT. SPAN.



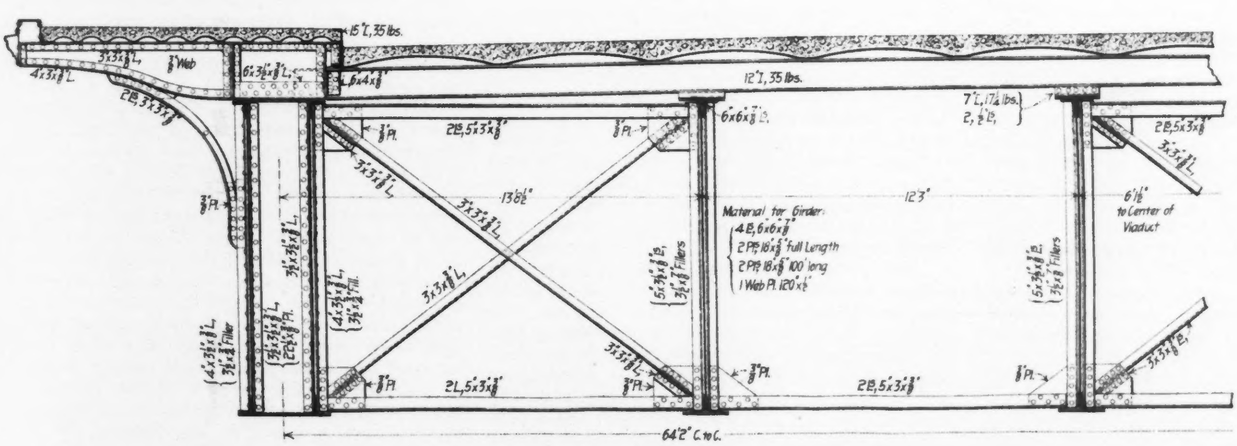


FIG. 6. HALF TRANSVERSE SECTION OF MAIN GIRDERS AND FLOOR SYSTEM OF 130-FT. SPAN.

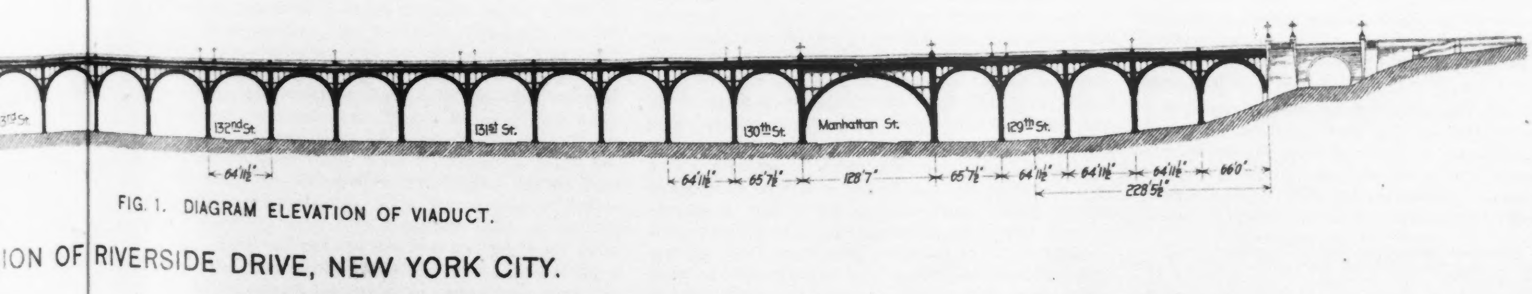
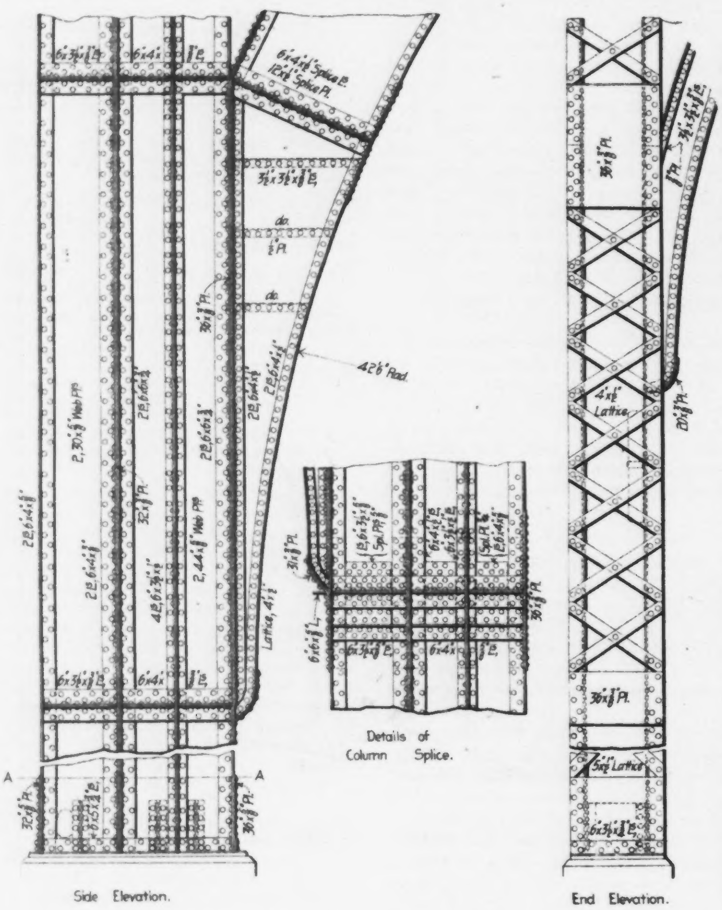


FIG. 1. DIAGRAM ELEVATION OF VIADUCT.

ION OF RIVERSIDE DRIVE, NEW YORK CITY.

O'Brien, Sheehan & McBreen, Contractors.

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



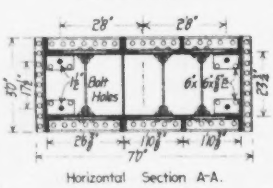


FIG. 2. DETAILS OF FOOT OF COLUMN AND CONNECTIONS OF ARCH RIBS AT SPRINGING LINE, 130-FT. SPAN.

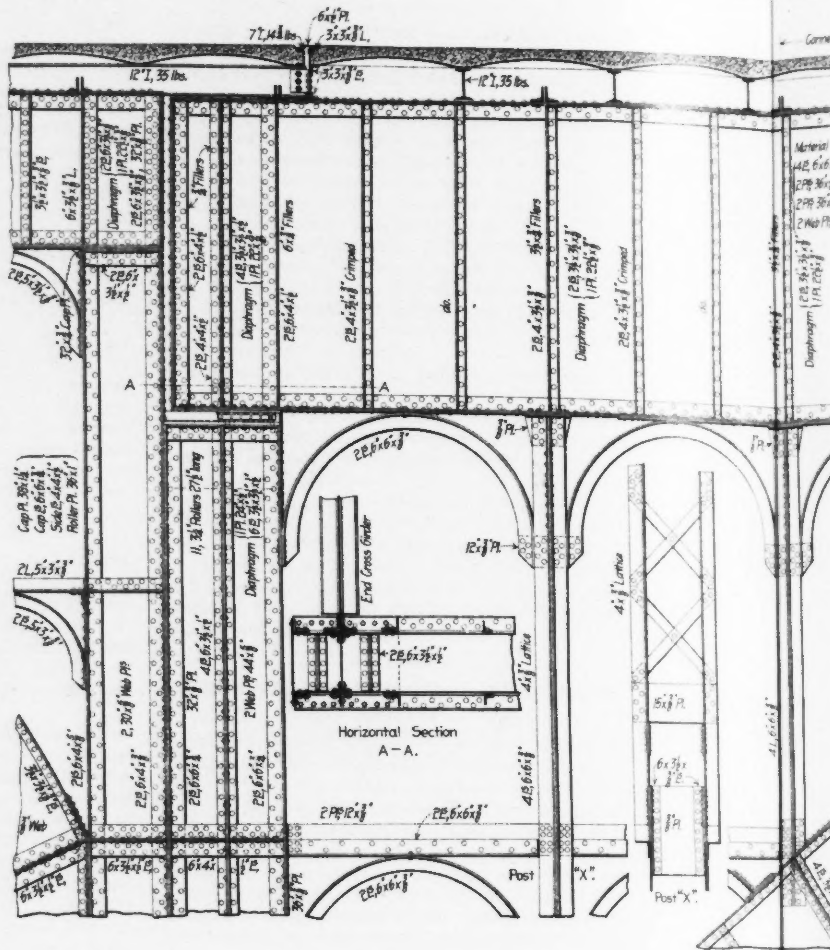


FIG. 3. DETAILS OF TOP OF COLUMN, EXPANSION END OF MAIN GIRDER AND SPANDREL FRAMING, 130-FT. SPAN.

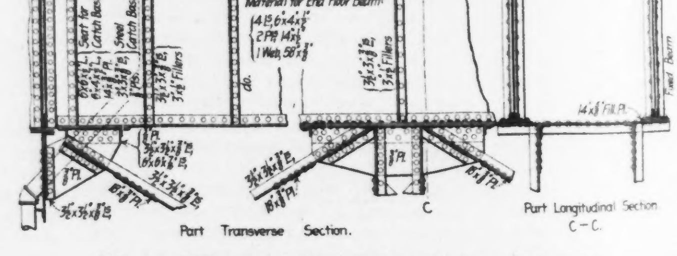


FIG. 7. DETAILS OF FLOOR SYSTEM FOR 65-FT. SPAN.

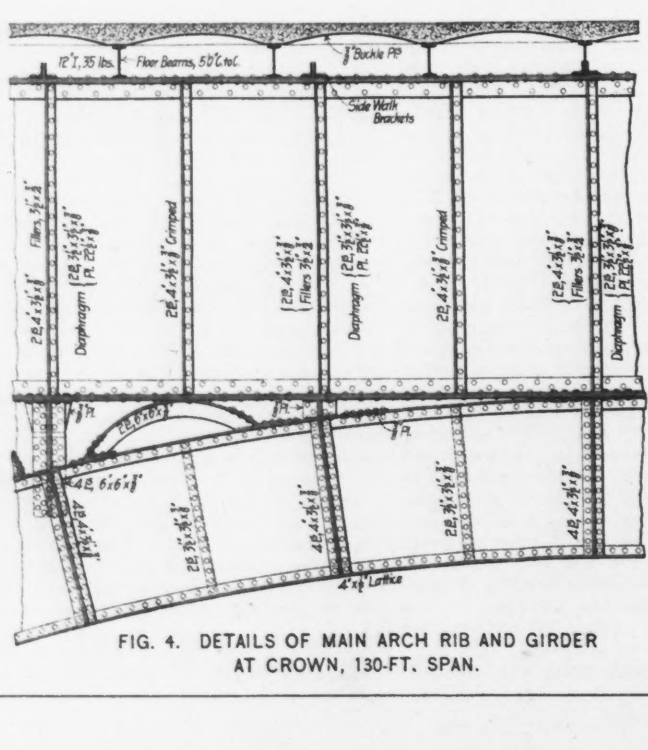
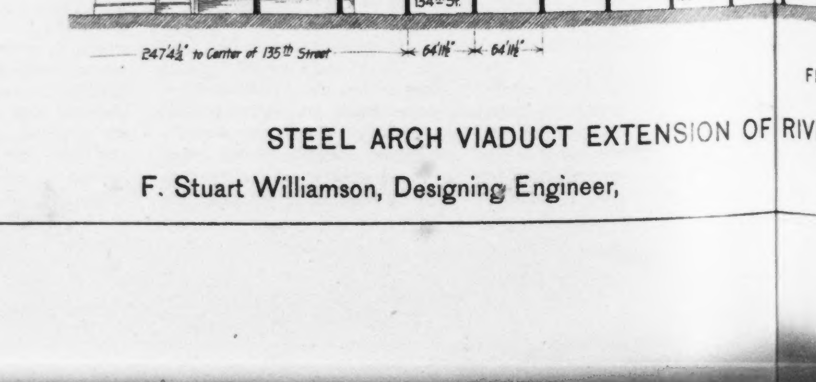


FIG. 4. DETAILS OF MAIN ARCH RIB AND GIRDER AT CROWN, 130-FT. SPAN.



FIG

STEEL ARCH VIADUCT EXTENSION OF RIVE

F. Stuart Williamson, Designing Engineer, which followed at Hamburg were more of the character of a client's private test, they being made to discover the materials and systems best adapted to fulfil the conditions required for certain public works, and the investigation being conducted by a committee made up entirely of public officials. The last of the Hamburg tests was made in 1895, and it was followed in 1896 by the single Brooklyn, N. Y., test of unprotected columns, which the committee of architects, engineers and insurance men previously mentioned succeeded in completing before its funds ran out. The final and most elaborate series of tests of all, which was conducted under the supervision of the New York Building Department in 1896-7, is so familiar to our readers as to require only mention at this time. Here, as everyone knows, an unusually bitter rivalry prevailed between the different manufacturers engaging in the tests, and the results had also to bear the additional burden of doubt arising from the unfair dealings of the building authorities in regard to matters of fireproofing in New York. Nevertheless, these tests were well managed on the whole, and added greatly to the knowledge of engineers regarding the fire resisting qualities of the various fireproof materials and systems of construction employed in America. While freely granting the great value of this and previous tests of fireproofing, the fault which we pointed out in the beginning is plain from what has been said.

Turning now to the tests of the British Fire Prevention Committee which we describe, it will be seen that the aim has been to remedy this fault, as well as to broaden the work of investigation to include much building work which has never been considered in previous tests. Just how successful the committee will be in accomplishing its plans cannot, of course, be told at this early date, but we think that engineers will agree that the beginning already made promises useful results. There is no doubt that more exact and reliable information than we now have regarding the subject of fireproofing is urgently needed; and, except, possibly, by the test of actual conflagration, a series of systematic fire tests conducted on broad lines by an independent technical body, is the best way of obtaining it. In some respects, however, we doubt if these English tests have been best designed to bring out this information. One thing about them which will, we think, strike American engineers particularly, is their mildness as compared with the tests which have been commonly employed in America. Fireproof floor systems, for example, will be subjected to heat for 1¼ hours, during one hour of which the heat will reach 2,000° F. In the New York Building Department tests the fire burned steadily for five hours, during the last three of which a uniform temperature of 2,000° F. was maintained. In the British tests, at the end of the 1¼-hour fire test, water is applied to the underside of the floor through a ½-in. nozzle for three minutes at a pressure gradually decreasing from 40 to 20 lbs. The corresponding test of the New York Building Department was a stream from a 1¼-in. nozzle under 60 lbs. steady pressure, applied to the underside of the floor for 15 minutes, and then turned onto its top until it was flooded. In loading the floor, also prior to the test, the English test calls for 10 lbs. less per square foot than was used in the New York tests. There may, of course, be room for argument as to which of these tests is designed to bring out best the particular degree of resistance and protection which is most desirable in fireproofing work; but there certainly can be no question as to which is the most severe. As a result, the fault which American engineers will be inclined to find with these English tests is that they do not approach the ultimate resistance of any but the poorest fireproof floor systems. It will be seen that most of the floors which failed early in the New York Building Department tests withstood a more severe test than the one planned by the British Fire Prevention Committee. The comparison of different floors is, therefore, possible only up to the point where all but the weakest are perfectly safe, and this is certainly not the proper criterion for a structure whose strength or weakness may involve so much in loss of life and property.

We are fully aware that the complaint has sometimes been made that the New York Building Department tests were too severe. There may possibly be some justice in this, but the fault, if it really was a fault, was on the side of safety. It may be true that in actual conflagrations a floor will never be subjected to so fierce a heat as 2,000° for upward of three hours, but a floor which withstands this heat will withstand a milder one. It is doubtless more likely to be true that a floor will seldom be subjected to an attack of a 60-lb. fire stream from a distance of a few feet, but if a floor will resist this attack it will certainly resist one less severe. Indeed, we have no hesitation in saying that any of the floors which were tested in the New York Building Department tests would have undergone the English test without more than surface injury, and as far as that test would indicate could all be classed as equally good. We hardly need to point out how erroneous such a conclusion would be, and we believe that American engineers will agree with us in advising the adoption of far more severe tests by the British Fire Prevention Committee, if it really wishes to bring out anything like a true comparison of fireproof floor systems.

Two lines of inquiry which deserve particular praise, as they are planned by the British committee, are the testing of floor systems which are in more or less common use, but which do not properly come into the strictly "fireproof" class, and the testing of partition, casement and shutter constructions designed to resist fire. It is presumably not intended to test all sorts of common floor constructions, but to select mostly those for which slow combustion or fire-resisting qualities of some sort are commonly claimed. The wooden joist and concrete floor described elsewhere belongs essentially to this class. Some of our readers will perhaps remember that a floor of a very similar type was at one time quite extensively advertised, and also used to some extent in America, and it is yet, we understand, frequently employed in England.

Doubtless few really well-informed engineers will have any misconception of the true value of such floors as barriers to fire, but they are just the kinds by which the less discriminating layman is most likely to be taken in. As every engineer knows, who has had occasion to observe it, a specious security clings in the public mind to the use of incombustible material just because it is incombustible, without much regard as to manner in which it is employed. It is very largely for this reason that the use of a cinder or a concrete filling between wooden beams is commonly believed to give the construction a security in case of fire which would never be claimed for a solid timber construction. The test described elsewhere shows clearly how little basis there is for such a belief, and it illustrates also how these proposed tests of common constructions will be of value. It is sometimes forgotten that it is not always enough to prove that proposed constructions are safe; in many instances it is far more important to show that the constructions in common use are not safe, and in fire tests of fireproofing this line of investigation has been almost entirely neglected. We believe that engineers generally will agree with us that a very profitable line of inquiry can be carried out in this direction by the British committee if it is undertaken with the proper intelligence.

In some respects we believe that results of still greater value to students of fireproofing may be obtained by suitably designed tests of partition, casement and shutter constructions. In nearly every instance where fireproof buildings have undergone the test of actual conflagration, one of the most significant facts brought out has been the easy passage of flames through window openings, and from room to room on the same floor. In a number of instances of actual fire which most of our readers will easily call to mind, the greater part of the destruction was made possible solely because of structural weakness or lack of precaution in these particulars of partition construction and window protection. Despite this fact, window openings designed or protected to resist fire are commonly neglected in the considerations of builders, and a very frequent excuse which is offered for this neglect is the lack of any definite knowledge as to the relative value of various forms of protection, and the uncertainty as to the real utility of any of them.

It must be confessed that there is some justice in these charges. While fireproof shutters of the best design are pretty certainly known to be efficient barriers to fire, they are objectionable in many respects. This is particularly true of swinging shutters, because of the necessity of opening and closing them individually by hand, and also because of their ugly appearance, which architects and owners of buildings naturally enough refuse to countenance in costly structures designed with some care for their architectural appearance. Rolling or sliding shutters largely avoid this charge of unsightliness, but their operation is not entirely free from objection, and not very much is known regarding their actual efficiency against fire. These considerations have led to numerous attempts to invent a fire-resisting glazing or casement construction, and some of these give promise of considerable efficiency. The advantages of a casement construction which will resist fire and also furnish light and ventilation equally as good as the ordinary window are too plain to need much emphasis. What is perhaps most wanted at the present time is a series of tests of casements such as those proposed by the British committee, to weed out the faulty designs and discover the weaknesses which are almost certain to lurk in the others. If we may judge from the single test of special casement construction already made by the committee, one failing which is likely to be encountered is insufficient lateral stability to resist heavy blasts of flame and strong hose streams. The Luxfer Prism glazing certainly resisted shattering from the effect of fire and water remarkably well in this British test.

Another form of protection against exposure fires which has recently been employed is the outside sprinkler system. This has been applied on an elaborate scale to the costly new public library building for the city of Chicago, and is described in another column of this issue. As many of our readers doubtless recall, water curtains have been frequently suggested as a means of fire protection, but this is, we believe, the first instance, in America at least, in which such a device has actually been constructed, and the innovation is sufficiently important to warrant a slight digression from our immediate subject to consider it briefly.

To be frank, such a construction as has been employed on the Chicago Public Library does not on first blush inspire much confidence in its efficiency, where a really severe fire is concerned. Briefly described, a ¼-in. nozzle discharging ten gallons of water per minute is depended upon to protect a section of wall 2 ft. wide and 90 ft. high, or an area of 180 sq. ft. Supposing the water falling freely to maintain an unbroken sheet over this area, it would form a curtain less than 0.02-in. thick.* It would be, in fact, much thinner, for we have neglected to consider the initial velocity due to the pressure of 30 lbs. per sq. in. under which the discharge takes place. This might resist with some success the passage of a dangerous amount of radiated heat from a fire across the street, but it pretty certainly would not withstand bursts of flame of such volume and intensity as are driven against an exposed wall in the fires which frequently occur in our large cities. In such an attack of fierce flame, for instance, as that to which the Horne store in the Pittsburg fire (Eng. News, May 20, 1897), was subjected from the blazing Jenkins building across the street, or as the Home Life Insurance Building received from the burning Rogers, Peet & Co.'s clothing store at its side (Eng. News, Dec. 8, 1898), no such small volume of water would have altered to an appreciable extent the course which the flames actually took.

It must be remembered, however, that the discharge from the nozzle will assume no such perfect sheet-like form as we have supposed, but that the water will break into drops and spray almost immediately. This decreases enormously the resistance which the water discharged offers to the

*According to a rough calculation an orifice 2 ft. long and 0.02-in. wide will discharge 10 gallons per minute. In other words, the sheet of water at the start would be 0.02-in. thick and would decrease in thickness as it progressed in its fall because of the acceleration of velocity due to gravity.

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passage of flame and heat. Another fact which must also be remembered is that the entire wall of a building seldom receives a uniformly distributed attack of flame and heat from an exposure fire, but the attack is concentrated upon some small and particularly exposed area, and however great the aggregate protective efficiency of the water curtain may be it is only that portion of the discharge which is concentrated at the point of attack which is of immediate value. A single well-directed fire hose stream may for that reason be more efficient in preventing the entrance of flames to a building at times than the best sprinkler system which would be practicable. This is particularly true of tall buildings where the application of an outside sprinkler system, with all it means in extra pumping capacity, piping, etc., reaches probably its greatest difficulty of application and highest cost, and its lowest practical efficiency.

At this point it may be noted that there is a tendency on the part of the general public to exaggerate the difficulty of fighting fire in tall buildings. The task is certainly not an easy one, but the reason that it has been only partially successful in such tall building fires as have occurred in the past has been for the most part due to inadequate equipment and faulty design from the point of view of efficient fire fighting, as we pointed out in our issue of Dec. 22, 1898. Recent tests made in New York city upon the stand-pipe systems of some of the better designed buildings have tended strongly to confirm this opinion, as we may take occasion to point out more fully at another time.

Returning, however, to the scheme of tests proposed by the British Fire Prevention Committee, we think that what has been said indicates quite clearly in what respect the work demands hearty commendation, and also wherein it may reasonably be criticised. We think that we may say for American engineers generally that they would prefer to see far more severe requirements, in the tests for floor systems at least, and will generally question the conclusiveness of the results obtained from the work of the British committee because of this one fault. This is all the more disappointing for the reason that these English tests are the first fire tests of fireproofing to be undertaken by an independent body of unbiased experts.

LETTERS TO THE EDITOR.

Borings in Gravel.

Sir: Referring to the request for experience with "Borings in Gravel" (Eng. News, May 4 and 25), I would state that I have obtained very satisfactory results by using a 2½-in. casing and a 1-in. drill rod or water pipe. I used a flat chisel bit or drill attached to the water pipe and always got the gravel up. (Sometimes dynamite was used to overcome the compactness of the material or to breaw up bowlders.) I have also used a cross-chopping bit successfully.

It will not do to drive a lot of gravel up into the casing, or to drive a cobble or bowlder ahead of the casing; time is lost by so doing, and very often the casing becomes bent. It is much better to keep the casing clear of the gravel by manipulating the drill. If I were in "P. W.'s" place, if I could not shift the hole far enough to avoid a bowlder, I would use dynamite with electric primer.

Very truly yours,
A. W. Saunders,
Late Supt. Borings, U. S. Deep Waterways Commission,
60 Morgan St., Buffalo, N. Y., May 27, 1899.

The New Boston System of Sewer Assessments.

Sir: I notice in Engineering News of May 25, upon p. 325, a short comment upon "The New Boston System of Sewer Assessments," in which appears: "Its principal novelty was in the placing of three-fourths the cost of maintenance as an assessment on real estate."

This statement is a mistake, which you will kindly correct.

One-quarter part of the cost of maintenance was apportioned upon the real estate of the entire city, as this was considered a proper allotment for "general benefit," such as care and operation of pumping station, outfall and intercepting sewers and catchbasins.

The remaining three-quarters was apportioned and based upon the actual use of the sewers by each estate, and this use was best measured by the amount of water which entered the sewers, as indicated by the water bill, after discounts has been ascertained by inspection of the quantity of effluent not reaching the sewers—discharging into the harbor by private drain, or the quantity of water evaporated into steam, etc.

Respectfully,
J. F. Williams,
Engineer in Charge, Record Office.
Street Department, Sewer Division, Boston, May 29, 1899.

(We should have said that the total cost of maintenance was assessed upon real estate, one-fourth in the general tax levy and three-fourths on individual estates, proportioned to the use of the sewers by each estate.—Ed.)

Concerning the Prismoidal Formula.

Sir: Mr. "W.," in yours of May 11, replying to my letter of April 13, only emphasizes what I tried to make clear in my previous article, viz.: that the Prismoidal Formula is worth nothing to one who does not know how or when to use it. Mr. "W." objects to the usual mode of application of the formula to earthwork; i. e., the assumption that the ordinates of the mid section are means of corresponding ordinates of end sections. This, of course, supposes that the figures to which it is applied is a true prismoid; i.e., that the bounding surface may be generated by a right line generatrix moving over the boundary of two parallel end planes as directrices. Now, whether the straight or curved line generatrix most nearly represents the average earth or rock cut is a question for the engineer to decide. But where the generatrix is known to be a curve, of course no engineer will fall into such an error as to assume the ordinates of mid section equal to means of corresponding end ordinates. He will compute them from the equation of the surface or curve; or, else plot and measure them: or, what is better still, use alternate sections as end area and the intervening section as middle areas—supposing, of course, that adjacent cuts are of equal length—and double the length. Whether or not such an assumption as the one objected to is an essential feature of the "formula as set forth by J. Macneill, Esq., in 1883," I do not know. I can only say that I have never seen it expressed that way.

That "Prismoidal" formula is a misnomer, when applied to the formula as correctly expressed, I will admit, for it is not only applicable to the prismoid, but, as Mr. "W." has said, "is applicable to all solids of a fair degree of regularity of shape." This formula was enunciated and proved by Newton. What claim Stirling has to it I do not know.

I cannot see why any well grounded engineer should "regard the formula with mystery," or why the necessity for specifying in the "Legal Statute" that "the middle area shall be measured." But to dissipate any such mystery let us examine the formula and its proof.

We will assume that the area of any section of the solid may be expressed by the formula

$$A = P + Q x + R x^2 + S x^3, \qquad (1)$$

where X = distance of section from one end, and P, Q, R and S are constants to be determined from the shape of the bounding surface. Then the volume.

$$= \int_0^l A\,d\,x = \int_0^l (P + Q x + R x^2 + S x^3)\,d\,x = P\,l + \frac{Q\,l^2}{2} + \frac{R\,l^3}{3} + \frac{S\,l^4}{4}. \qquad (2)$$

In equation (1) make

$$x = O, \text{ then } A_1 = P. \qquad (3)$$

$$x = \frac{1}{2}, \quad A_{1/2} = P + \frac{Q\,l}{2} + \frac{R\,l^2}{4} + \frac{S\,l^3}{8}. \qquad (4)$$

$$x = l, \quad A_2 = P + Q\,l + R\,l^2 + S\,l^3. \qquad (5)$$

Now to $A_1 + A_2$ add 4 times $A_{1/2}$, and multiply by $\frac{1}{6}$ and we have volume by prismoidal formula

$$= \frac{1}{6}\left\{P + 4\left(P + \frac{Q\,l}{2} + \frac{R\,l^2}{4} + \frac{S\,l^3}{8}\right) + P + Q\,l + R\,l^2 + S\,l^3\right\}$$

$$= P\,l + \frac{Q\,l^2}{2} + \frac{R\,l^3}{3} + \frac{S\,l^4}{4}$$

which agrees with the result obtained by integration in (2). Hence it is seen that the prismoidal formula will correctly represent the volume of any solid the area of which may be expressed in terms of the ascending powers of x; and it makes no difference whether the middle area is "measured" or "deduced;" only, if deduced, it must be correctly deduced.

In conclusion, I would like to know what "amusing thing" an engineer would find by plotting the sections of cones or pyramids? He would probably not find the middle area equal to the mean of end areas, but he would find that the ordinates are a mean of the corresponding end ordinates, and hence that they are only particular cases of a prismoid. Respectfully, "X."

May 22, 1899.

Engineering Notes at Santiago de Cuba.

Sir: From break of day nearly a week ago, when I caught my first glimpse of the shores of Santiago Province, off Daiquiri, until the present writing, the conceptions I had formed of this portion of Cuba have been undergoing rapid changes, all favorable to the country. The dire tales which I had read during the progress of the siege and blockade of Santiago had conveyed to my mind the impression that this was about the worst spot in all the West Indies, if not upon the face of the globe. The notions which I had imbibed as to the topography hereabout, especially as to the abruptness with which the hills rose from the ocean and as to the size of the mountains between the coast and Santiago city, have been entirely dispelled.

Viewed from the sea, off Daiquiri and Siboney, great mountain masses appear to rise with some abruptness from the coast line. Seen more closely, however, these coast hills have the general effect shown in the accompanying sketch. Bordering the ocean along the entire coast line for many miles in each direction are from two to three well-defined terraces of recent coral formation. The lower bench rises abruptly from the ocean in a vertical ledge 15 to 20 ft. in height, rendering it impossible to land anywhere in this neighborhood excepting where the ledge is broken away, and also rendering the construction of docks or piers difficult excepting in the few embayments with shelving beach, which occur between Guantanamo and Santiago. This flat coral shelf or bench is from a few feet to a few hundred feet in width. Back of it rises a second ledge of coral rock, 20 to 30 ft. in height, nearly vertical, and this is topped by low rolling hills, also of coral; but these are heavily covered with chaparral thicket, tropical trees and undergrowth. The tops of these coral hills are at a comparatively uniform elevation of 200 to 250 ft. above sea level. They extend as shown in the foregoing and in the following sketch, from the ocean well inland to and beyond Santiago, and have a width from the water's edge both on the ocean shore and on the shores of the bay of Santiago, of from 3 to 6 miles. Back of and above them rise abruptly the Sierra Maestra, the highest summits of which are several thousand feet in elevation.

We thus have about Santiago Bay, as predominant topographic features, a low coral bluff rising abruptly from the ocean; a second ledge equally low, in places a third topping it, each bench a comparatively few feet in width horizontally. These are topped by a tableland of 150 to 200 ft. in height, of coral, this table land being so deeply cut in places by the various streams which flow from the surrounding heights of the Sierra Maestra as to convert it into valleys and hills with summits at a uniform elevation. This table land is several miles in breadth from the ocean, and extends backward around the embayment of Santiaga de Cuba proper, so that the Sierra Maestra itself curves to the north around the bay. After entering the harbor mouth the coral benches become less sharply marked and near the city front disappear entirely, the shores of the bay ending in low, smooth slopes. As one leaves the wharves at Santiago, the streets incline upward, rapidly leading one into the city at an elevation of 50 to 100 ft., and on a level with and on top of the upper coral formation. Back of the city, in its immediate suburbs, the country rises rapidly for another hundred feet or less to the summit of a series of hills, formed by the channeled coral tableland already described.

The rolling tableland which I have tried to describe is in places, especially about the city of Santiago, more highly eroded than between there and the ocean, in the neighborhood, say of Siboney, and has more the appearance of series of hills and valleys. Some of these hills are those known as the San Juan hills, El Pozo, and the hills about El Caney. Their summits are at a considerably greater altitude above Santiago and the bay, however, than above the stream bottoms which flow between them and the mountains. The topography of the immediate surroundings of Santiago is fairly well indicated in the maps published in Engineering News of October 13, 1898, yet these maps do not give a clear idea of the tableland-like structure of this region.

The effect of an analysis of these topographic forms is that, instead of high mountains near the ocean at Siboney and Daiquiri, the landing place of our forces, there is but a low mesa line, the highest summits of which are but a few hundred feet in height, and these are separated by ravines and valleys so that there is no climb of any moment, in passing from the ocean directly towards Santiago. Las Guasimas hill is but little over 300 ft. in height, as shown in the first sketch. Morro Castle, at an elevation of 200 ft., is nearly as high as the highest point among these rolling hills, and so is San Juan hill. The ascent of San Juan hill as made by our troops from the east and south was but 50 to 80 ft. in maximum height. The summit of this hill overlooks other hill summits at an equal elevation, among others those in the immediate outskirts of Santiago in the neighborhood of the barracks.

The harbor of Santiago is one of the most beautiful I have ever beheld, and is exceedingly roomy. The immediate entrance off Morro Castle is not at all difficult, and requires no dredging to render it easily navigable by ships of the greatest draft. Unfortunately, however, these conditions do not continue into the extreme inner harbor. Vessels exceeding 15 to 18 ft. draft cannot approach nearer than within several hundred yards of the shore of Santiago city, and vessels exceeding 20 ft. draft, like the City of Berlin, on which I entered, are brought into the inner harbor only after the exercise of the greatest skill and at considerable risk. The navigable channel within a mile to two miles of the city front is exceedingly narrow and treacherous and large vessels have to back and turn and twist in an amazing manner to enable them to anchor within half a mile of the wharves. From the above it is therefore evident that though this is a magnificent harbor of refuge, it lacks much of being a first-class harbor from the point of view of the engineer or for purposes of commerce. Every ounce of freight and every passenger must be transported in lighters or in row boats from the wharves to vessels of any size. Much better facilities for the handling of freight and passengers can undoubtedly be found below Santiago city, as far south as the Juragua Iron Company's pier, or still farther toward the harbor entrance. At such a point one or more long piers could be constructed and electric railways could readily haul passengers and freight thence into the city. It is not unlikely, however, that the channel can be greatly improved by dredging and that this may be carried nearer to the city wharves. The Spanish did no more because the considerable sums appropriated to harbor improvements were diverted by the thrifty officials to other uses.

This harbor is of a peculiar pocket-like shape, into which no river flows. As a result its waters are stagnant, there being no current to scour or carry off sewage and other matter deposited in it. In consequence, the bottom, near the upper or city end, is of the most foul and pestilence-breeding kind, consisting of alluvial matter and deep mud, the washings and discharge of the city for centuries. This mud is so soft that the ship's captains and pilots do not hesitate to bring their vessels into the harbor until they finally stir up the mud and actually ground in it, its depth and softness being such that they have no fear of injury to the bottoms of their ships. The moment an anchor is dropped into it great bubbles of ill-smelling gases begin to rise to the surface and these continue to foam and bubble for hours afterwards, and in fact so long as any movement occurs in the anchor chain. The difficulties of improving the sanitary condition of such a harbor are many. Like the harbor of Havana, nothing can be done for its improvement by natural means, as there is no littoral current nor any scouring action to be derived from rivers. The first precaution to be taken is to avoid the discharge of further sewage or surface drainage into this harbor. Its further pollution should be immediately stopped. Any efforts to dredge channels must, it seems, results in the liberation of gases which would breed malarial and other fevers.

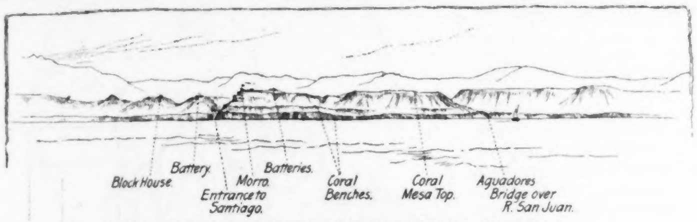
At this time the sanitary condition of Santiago is very fair; it compares well with the best cities of Porto Rico, though it is, to be sure, considerably worse off than Mayaguez or San Juan. Its present cleanly condition is entirely due, however, to General Leonard Wood and his assistants, as it was at the time of occupation of the Americans a typically filthy city. Now the streets are regularly cleaned by a well-organized force, much as are the streets of the larger cities in the United States, and garbage is removed. Little has been attempted yet, however, in the way of providing a proper sewage system, though plans have been made and some work has been done already on the laying of underground pipes for the carrying of sewage.

Unfortunately, as in Porto Rico, there are no engineering officers of the American army on duty nor any civilian engineers in the service of the military government. Until such men are available nothing of permanent betterment can be looked for. Santiago should be at once provided with a first-class system of underground sewerage, properly designed and constructed, and this should be discharged or dumped well up the bay after being chemically treated or otherwise rendered innocuous by precipitation or filtration. Nothing but treated sewage should be discharged into the harbor. This sewerage system should include capacity to carry the surface drainage in order that this should not enter the harbor directly. Garbage and street sweepings should not be dumped in the neighborhood of the city, but should be removed for treatment or for cremation.

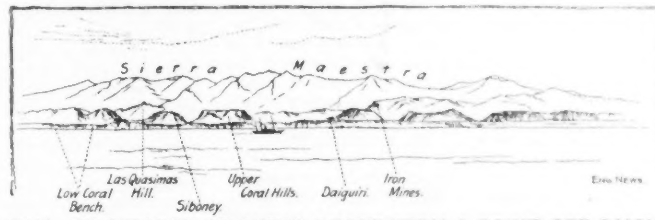
The water supply from Santiago is pumped from a stream in the hills to the north of the city, and is of fairly good quality though not of sufficient quantity to meet the requirements of modern sanitary plumbing. It is piped several miles from a reservoir in a 10-in. underground iron pipe, well laid. Within the city distribution pipes are laid underground through the more important streets and to the more prominent buildings. This system is now being rapidly extended and improved under the present military government by the officers of the Quartermaster's Department of the Army, not by engineers.

The grades of the streets of Santiago are fortunately rather steep, thus lending themselves well to surface drainage and washing by occasional showers which occur here. Unfortunately, however, in this connection, the rainfall of Santiago is not great. The official records show a total of 100 days of rainfall in the year, ranging from 2 showers in the month of January, which is in the midst of the dry season, to 19 showers in September. The precipitation in no month is great. The total for the year is but 33.8 ins., ranging from a minimum of .5 ins. for the month of January, the same amount falling in June, to a maximum of 8.9 ins. in September. The actual temperature experienced in Santiago is not sufficiently high to render the climate unhealthy, and the dryness of the climate should make this naturally a healthy city were it under proper supervision, with well-inspected water supply and cleanliness in the harbor and harbor bottom. The average temperature of the year is a little over 78° F., ranging from an average monthly minimum in January, February and March of 77° for each of those months, to an average maximum of 83° for June, July and August. The uniformity of temperature is its most marked characteristic.

Practically all of the streets of Santiago are paved with cobblestones, well but roughly laid, though some streets are macadamized. There are quite good surface slopes and the gutters are in good condition. At present these streets are remarkably clean, thanks to the well-organized street sweeping force and the system of garbage collection inaugurated by the American officers. House drainage is generally discharged, however, into the streets, as is the case in Porto Rico, and bad smelling sewage water is frequently seen running through the open gutters. The people have not yet learned to abstain from throwing decaying vegetable matter and dead animals and other offal into the streets, though penalties are now provided for such offenses, and every effort is being made to reduce this source of evil to a minimum. Here as in Porto Rico, the people frequently answer all calls of nature in secluded corners of streets, thus adding materially to the unsanitary condition. A similar evil practice is that of leaving excreta in unoccupied houses or even rooms of occupied houses, and of stabling animals in the same. There is little or no sanitary plumbing within the houses, and, as in Havana, and everywhere in Cuba, and as already described for Porto Rico, the larger portion of the house drainage and sewage is discharged into cesspools in the inner courts of the buildings. These, as heretofore stated, are the greatest menace to the health and cleanliness of the city.



VIEW OF ENTRANCE TO SANTIAGO HARBOR.



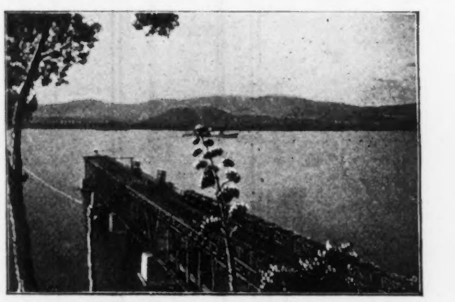
GENERAL APPEARANCE OF CUBAN COAST FROM A POINT OFF DAIQUIRI.

The streets are all quite narrow, so narrow that in places two wagons can find no more than sufficient room in which to pass. The sidewalks, too, are often so narrow that two people can scarcely walk abreast upon them. The streets are poorly lighted, with a few electric lights about the plaza and more prominent streets and an occasional oil lamp in the other streets.

Aside from the harbor and its condition as described, and the streets of the city, there are no public or engineering works within the city worthy of description. In the suburbs a considerable amount of valuable public work is being vigorously prosecuted under the American administration in the improvement of public highways. Excellent macadamized roads have been built or are under construction toward the northeast, in the direction of Cobre; northward toward Cubitas; northeastward toward El Caney, and east and southward toward Siboney. It is the apparent purpose to extend some of these well across the island as main military highways, to Guantanamo, Bayamo, etc. At present the most activity in road construction is in the immediate neighborhood of San Juan hills, and nearly every portion of the Santiago battlefields is now easily accessible over well-graded and well-surfaced roads. For road metalling there is an abundance of hard coral rock, easily broken up and yet of such texture as to furnish the best kind of macadam surface.

Two railway lines lead out of Santiago, both of which were built primarily for the purpose of opening up mining properties. To the northward, toward El Cobre and San Luis, is a 25-mile narrow gage railway, built by the American owners of the mines. A branch line extends to the manganese mines at Ponupo, a distance of 26 miles. There is no difficult or interesting engineering work on either of these lines, the grades being easy, and the highest pass, leading into a valley behind the mountains, is at an elevation of about 700 ft. This railway terminates opposite the center of the water front of Santiago with a number of wharves at which vessels can be loaded.

About a mile south of Santiago is the iron pier which extends out to deep water, and is the terminus of the railway of the Juragua Iron Co., of Bethlehem, Pa. This is a narrow gage road, which runs southward, just a little to the northeast of Morro Castle, to the ocean front, which it skirts thence for a distance of perhaps ten or twelve miles eastward, via Siboney, to its terminus in the hills at the Firmeza iron mines. The roadbed is well ballasted with coral rock and mine refuse. There are several substantial iron plate girder bridges of no considerable length, and the iron pier at the terminus of the road in Santiago bay is a type of the best American construction, provided with ore chutes by which to discharge the cars directly into sea-going ships. The Spanish-American Co., the property of which is owned chiefly in Ohio, has built a branch line from the mines at Lola to the sea at Daiquiri, where a substantial ore dock extends into deep water. This dock rests on iron cylinders, each 10 ft. in diameter, sunk to bedrock. These cylinders are in pairs, placed 20 ft. between centers, each pair being 6 to 7 ft. apart. There are four such pairs, and the whole dock is similar in all respects to ore docks in use on the Great Lakes. Still further to the eastward are the mines of the Sigua Iron Co., also owned in the United States. These, like the Lola mines, have no direct connection by rail with Santiago, their product being carried directly by railway to the wooden ore dock and breakwater at Sigua bay, the length of the connecting line being 9 miles. But little work or output has resulted from the investment of perhaps two million dollars by this company. In 1897, the Sigua Iron Co., according to the report on Mineral Resources of the U. S. Geological Survey, made no shipments to the United States. Its only shipments to this country being, in 1892, 7,800 tons, and double that amount in 1893, the internal disturbances in the country being the chief cause of inactivity. The Juragua Iron Co. has shipped to the United States over 3,000,000 tons since their mines were first opened in 1884. The greatest ship-



Pier of the Juragua Iron Co. in Harbor of Santiago.

A Street in Santiago.

York city, whose offices are in the same building as those of Engineering News. This company has been organized to control the inventions of Messrs. O. P. Ostergren and Moriz Burger, relating to the liquefaction of air. It has secured patents in the

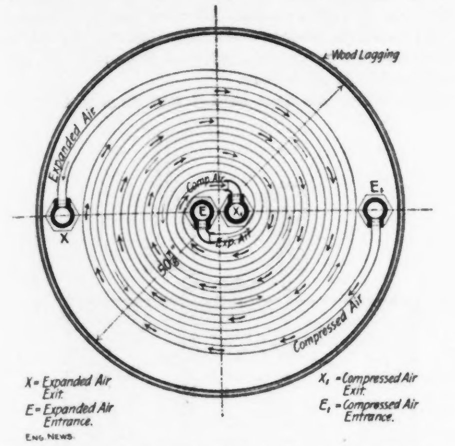


Fig. 3.—Plan of the Brine Tank, Showing One Layer of Coils.

United States, and in a large number of foreign countries, and it has built and has now ready for operation a plant for the commercial production of liquid air on a scale sufficiently large to demonstrate the efficiency and value of its process.

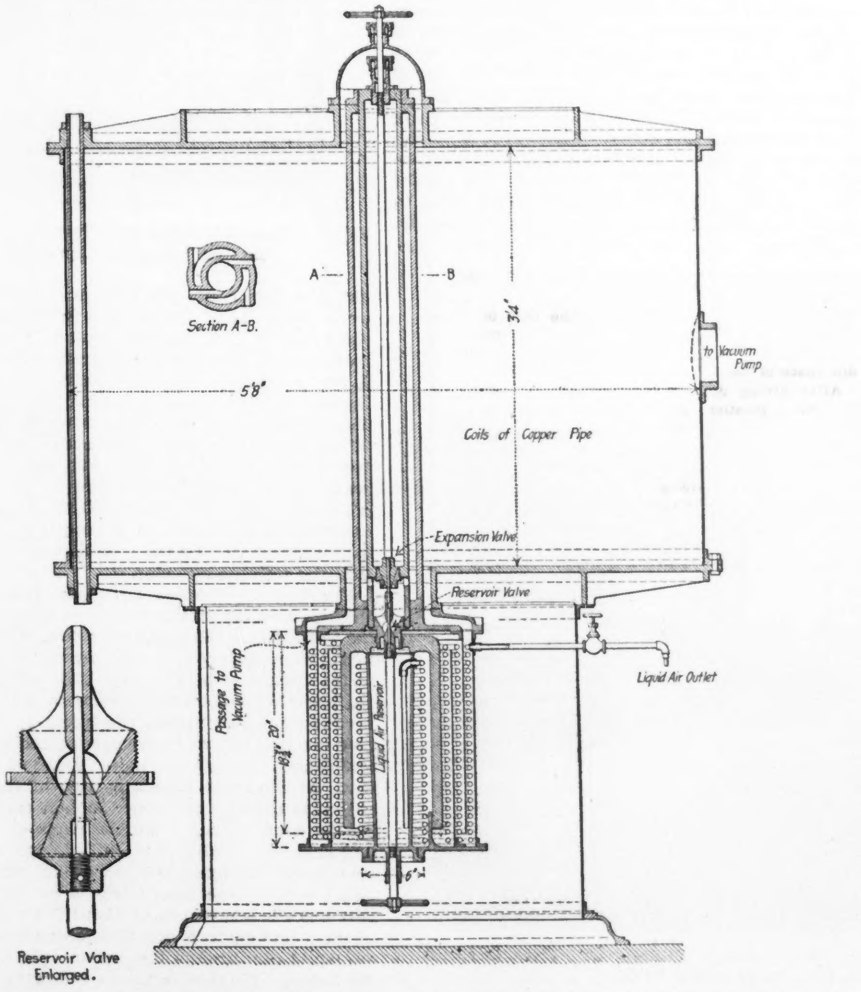


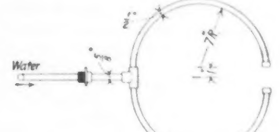
FIG. 5.—SECTIONAL ELEVATION OF LIQUEFIER AND AFTERCOOLER, SHOWING DETAILS OF VALVES. LIQUEFIER COILS ARE NOT SHOWN.

In the accompanying diagram, Fig. 1, we have represented in symbol the various parts of the apparatus, and by reference to this the operation of the plant will be readily made clear to the reader. It may be said in the first place that in principle the plant is merely a steam-power refrigerating plant, utilizing the expansion of compressed air to produce a low temperature, and causing this cold air to react upon itself, utilizing a different principle, as they claim, from that of the Tripler or the Hampson apparatus, until a temperature is reached so low that liquefaction occurs.

The steam is furnished by three vertical fire tube boilers, of 75 nominal HP. each. These deliver steam at 150 lbs. pressure to two independent, two-stage horizontal straight line air compressors, built by the Ingersoll-Sergeant Drill Co., of New York city. The one at the left, which may properly be termed the low-pressure compressor, has a 16 x 18-in. steam cylinder, an 18¼-in. low pressure cylinder, and a 12-in. intermediate air cylinder. These are connected by the first intercooler. The large low pressure cylinder is in reality a vacuum cylinder, whose function will be explained later, and in this the maximum pressure is never more than the atmosphere, or 15 lbs. The air leaves the second cylinder at 60 lbs. gage pressure, and passes through the second intercooler to the low pressure cylinder of the second or right-hand compressor. This has a 22 x 24-in. steam cylinder, low and high pressure cylinders 7¾ and 7 ins., respectively, in diameter.

The third compressing cylinder delivers the air into the third intercooler at a pressure of 300 lbs., and from it the air enters the high pressure cylinder and is raised to 1,200 lbs. pressure. The air then passes to the aftercooler. In this, as well as in the intercoolers, the operation is simply to extract the heat which has been generated by the compression of the air by passing the air over water-cooled tubes.

So far the operation is identical with that of any ordinary four-stage air compressing plant. It is from this point on that the special apparatus for purifying and refrigerating the compressed air comes into play. Continuing the circuit from the aftercooler, the air enters at the base of a tall separator, Fig. 2, whose purpose is to remove all moisture, oil, dust or other impurities from the compressed air, an operation quite essential to prevent the liquefier becoming clogged with ice and grease. As it enters the separator the compressed air meets a perforated disk, which breaks the incoming current up into a large number of fine jets. These bubble up through a column of



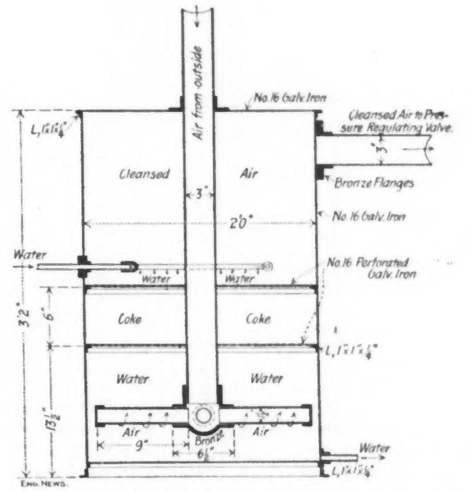


Fig. 4.—Section of the Cleanser for Removing Dust from Air Previous to Compression.

water which washes the air and extracts from it all grease or other impurities which it may have accumulated in its journey through the compressors, intercoolers and piping. Breaking from the water surface, the level of which can be maintained by means of the blow-off pipe shown in Fig. 2, the air rises towards the top of the separator and strikes a series of conical baffle plates, between which it zig-zags, as shown by the arrows, until the top of the separator is reached. It will be noticed that the alternate plates with open tops have a series of holes in the inner casing which supports all the plates. This arrangement permits the entrained moisture to run back to the water chamber without coming into contact with the rising current of air.

Just beyond the outlet end of the separator is a pressure regulating valve, whose duty is to let the compressed air pass by at a constant pressure, so that it will enter the liquefier in a constant and steady stream. From the far side of this valve a small pipe is carried to the automatic governor of the steam end of the high pressure compressor to insure its proper action.

Passing on the air enters the header of the brine or cooling tank, Fig. 3. The header has an inner tube, which is small enough to considerably increase the velocity of the entering air, and at its lower end is provided with a small inverted conical, nozzle closing receptacle, known as the "supplementary moisture collector." The air passing through the small tube with increased velocity projects into the nozzle any moisture which may have passed the separator, and then passes up between the small tube and the header. Radiating from this header and winding spirally inward towards the center of the tank, Fig. 4, is a series of flat coils, all of which terminate in a second header, from which the air pipe leads to the liquefier. Beginning at the center of the tank and winding outward in the reverse direction, is a similar and duplicate set of spiral tubes which terminate in an outside header. This second set contain the expanded air returning from the liquefier. The principle of this apparatus is seen by referring to Fig. 4, in which it will be seen that the cold expanded air in passing through its coils is in close proximity to the entering compressed and warm air.

ment was 362,000 tons in 1890, this falling off during the troublous times of 1897 to 244,800 tons. The Spanish-American Iron Co. began with a shipment of 75,000 tons in 1895 and increased that rapidly to 206,800 tons in 1897. It is estimated that these three American companies represent an investment of about $8,000,000. The engineering work connected with all of them is of the best type and has been designed and is maintained under the guidance of skilled American mining engineers.

At Cobre, the terminus of one branch of the railway leading northward from Santiago, is the site of the celebrated copper mines, which have been worked to a limited extent for 300 years. At one time, under English management, they employed as many as 2,000 men; to-day they are practically abandoned. It is said that under more liberal concessions from the Americans they are about to be reopened. The quality and amount of the copper ore are such as to give promise of a large and valuable output, the deepest existing shafts reaching nearly 1,000 ft. beneath the surface. The other branch of this railway leads to the property of the Ponupo mining company, a Pennsylvania corporation. This is a manganese mine, having the greatest promise of any in this hemisphere. The manganese occurs in an apparently unlimited quantity and the ore is of very high grade. Shortly after the construction of this railway the mine was closed down by the recent rebellion, and is only now beginning to resume active operations. In 1897 this company shipped 7,000 tons of ore to the United States, the only shipment of any importance which it made prior to the present revival of activity.

In 1895 the population of Santiago was 59,600 persons; since then many persons have left as a result of the recent rebellion and war. It is evident, however, from the foregoing, that there is great promise of engineering activity in this neighborhood, primarily, in connection with the development of the unsurpassed mineral wealth in

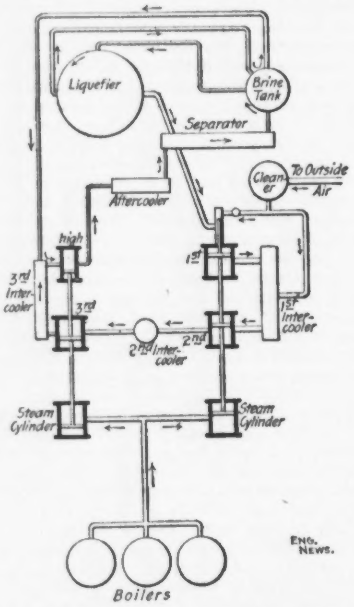


Fig. 1.—Sketch Diagram of Air Liquefying Plant, Showing Principal Apparatus and Piping.

copper, manganese and iron, and, secondly, in connection with the public works and the improvement of highways. Aside from its mineral resources, there is little to give commercial importance to the city of Santiago. The country behind it is not well adapted to agricultural purposes, nor is it at present cultivated to anything like the extent of the eastern portion of Cuba, or of Porto Rico. At the same time there has been a great deal of money invested in recent years in the cultivation of coffee in the mountains, and there are a number of large coffee plantations already producing considerable crops of excellent quality. In the foot hills of the Sierra Maestra to the north and west of Santiago, pineapples are now being cultivated extensively, it having only recently been discovered that the soil and climate are especially adapted to them. It is apparent, therefore, that under a more liberal government and the activity which must follow, that the agricultural resources of this region will shortly be much more extensively exploited than they have been in the past.

H. M. W.

Santiago de Cuba, Mar. 5, '99.

Notes and Queries.

Copies of "The History of the Mississippi Jetties," a book published by John Wiley & Sons, in 1880, and now out of print, are desired by Mr. E. L. Corthell, 27 Pine St., New York city, who was Mr. Eads' principal assistant on the jetty work.

THE REPORT OF THE WALKER COMMISSION ON NICARAGUA CANAL SURVEYS.

The report of the Commission which was appointed in June, 1897, to make further surveys for the Nicaragua Canal, was presented to President McKinley on May 29. The following official abstract of it was given to the press by the State Department on May 31; and it was announced that the full report will be submitted to Congress at the opening of its next session, prior to which time nothing further regarding the report will be made public:

The commission understood that it was required to consider all routes heretofore proposed having any merit, that new routes that appeared to have merit should be developed, and the entire region of canal possibilities should be examined with sufficient thoroughness to enable a just and comprehensive comparison of the various routes to be made, and the most desirable one selected.

With this view the commission made a careful study of all data bearing upon the Nicaraguan Canal question and organized a large force.

Much delay to the work and great annoyance to working parties was caused by attempts at revolution and by the strained relations between the governments of Nicaragua and Costa Rica. The outbreak of the war between the United States and Spain was also a serious matter.

The report goes into minute details in respect to all questions connected with the construction of the canal, and says that after mature deliberation the commission has adopted and estimated for the route from Brito to Lake Nicaragua, called the Childs route, and from the lake to Greytown, called the Lull route. This line, leaving Brito, follows the left bank of the Rio Grande to near Bueno Retiro, crosses the western divide to the valley of the Lajas, which it follows to Lake Nicaragua. Crossing the lake to the head of the San Juan River, it follows the upper river to near Boca San Carlos, thence, in excavation, by the left bank of the river to the San Juanillo and across the low country to Greytown, passing to the northward of Lake Silico. It requires but a single dam, with regulating works at both ends of the summit level. The surveys have in general revealed better physical conditions than were hitherto supposed to exist, especially as to the amount of rock in the upper river, whereby it is possible to greatly reduce the estimated cost of construction.

To determine the proper unit prices for excavation, the average of prices actually paid to contractors on the Chicago drainage canal, which represent cost of plant, prices paid for work done, and contractors' profits were taken. To these prices certain percentages were added for the difference in location, climate, etc.

In obtaining the estimates for the cost of locks, the prices actually paid for building the government locks at Sault Ste. Marie were taken, and 33% was added for the difference of location.

After giving due weight to all the elements of this important question, and with an earnest desire to reach logical conclusions based upon substantial facts, the commission believes that a canal can be built across the isthmus on this route for not exceeding $118,113,790.

Col. Hains concurs generally with the views of the other members of the commission, but his estimate of the cost is $134,818,308.

It will be seen from the above abstract that the Commission has finally abandoned the Menocal high level location, from Ochoa eastward to the locks beyond the Divide cut, which has been so strongly criticised, and follows instead the valley of the San Juan until the delta of the river is reached, when a straight cut across country toward Greytown is made. By this change the great Divide cut and the extensive series of dams in the San Francisco Basin are both eliminated. Whether other difficult features may be injected into the work by the adoption of the new route, will not be known until the full report of the Commission is available.

A PLANT FOR THE COMMERCIAL MANUFACTURE OF LIQUID AIR.

The announcement that within a short time there will be in operation in New York city a commercial liquid air producing plant, with an estimated capacity of some 1,500 gallons of liquid air per day, is certainly a remarkable one, and especially so when it is remembered how short a time has elapsed since the liquefaction of air was first effected, and that up to a couple of years ago or so the liquefaction had only been accomplished on a minute scale in one or two laboratories, and at an expense which made the product almost as costly as a precious metal.

In the issue of Engineering News for April 14, 1898, was given the first technical description of the laboratory and apparatus of Mr. Chas. E. Tripler, of New York city, who was unquestionably the first to produce liquid air on anything like a commercial scale.

Since then descriptions of this laboratory, and statements concerning Mr. Tripler's work of all

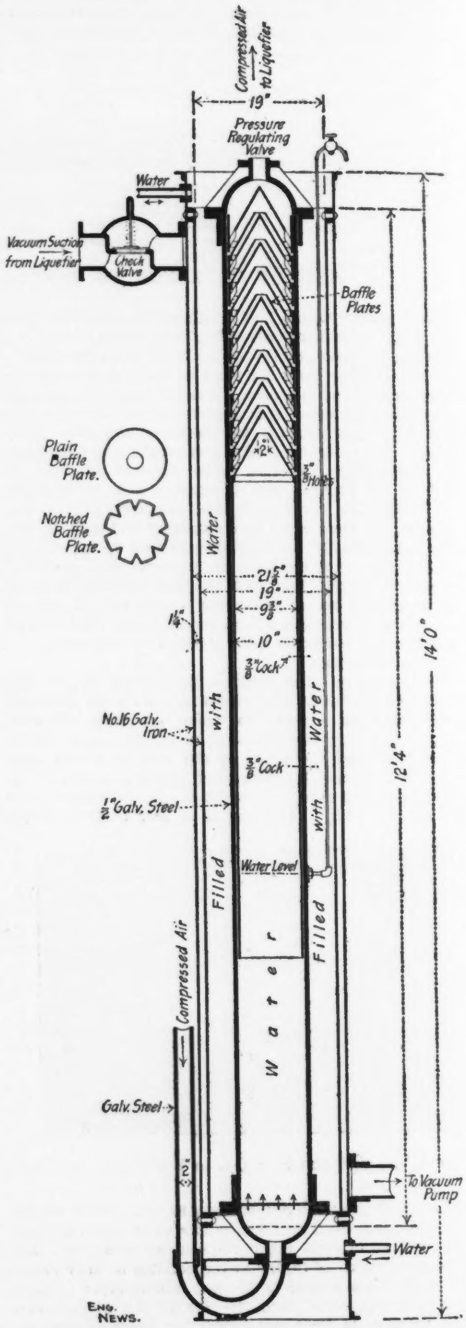


Fig. 2.—Sectional Elevation of Separator for Removing Oil and Moisture from the Air After Compression.

degrees of accuracy and inaccuracy have run the rounds of the newspapers and the popular magazines, so that the general public has become quite conversant with liquid air, at least from the spectacular standpoint.

In our article above referred to, and in an editorial discussion of the possibilities of liquid air, published in the same issue, some of the uses and the limitations of liquid air were pointed out. These prospective uses and the great popular interest in the subject, have set a large number of investors and scientists at work in this field, both in this country and abroad.

By all odds, the most extensive work, however, to the best of our knowledge, has been done by the General Liquid Air & Refrigerating Co., of New constantly having the intensely cold evaporated air passing through it and the temperature of the whole apparatus is therefore being gradually reduced towards some minimum which so far as present indications go is remarkably near absolute zero. In fact, judging from results obtained the first time the plant was operated to test the compressors, etc., it may pe expected that air will be actually solidified.

The same test seemed to indicate that the brine tank is superfluous, and it was found that the entering and leaving air and the liquefier casing were at practically the same temperature.

One of the problems to be solved before liquid air can be of any great commercial value is some method of carrying and storing the material so that it can be retained in a liquid form. The company has endeavored to perfect this feature in a practical and business-like way. The results of its efforts is shown in Fig. 7, which represents a 40-gallon reservoir and also illustrates the principle of the larger and smaller sizes. The inner metal vessel is closed, except for a small offset pressure gage tube, and the larger opening constituting at the same time the filling tube and the relief valve. Surrounding this is a second vessel, in its turn surrounded by some non-conducting material such as corn pith, excelsior, granulated cork or the like, contained in a wicker basket. The inner tank being filled with liquid air the relief valve automatically opens slightly from time to time, as the pressure exceeds about 6 lbs., and permits the escape of the cold air into the space between the two metallic tanks. This forces the warmer air out through the bottom of the tank and maintains a very cold blanket of air between the liquid air and the exterior insulating casing; smaller and cheaper forms are made by using an open inner vessel made of wood pulp similar to the well-known one-piece water buckets. These are surrounded by wire netting held away by small wooden strips.

The vessel is then put in a wicker basket, packed about with some insulating material as in the former case, and is provided with a wooden cover which rests on the wire netting and forms an air space.

Still another form consists of two metallic spheres, between which is a third molded cork sphere held away from the others.

Both the inner and outer spheres are provided with separate relief valves, so that when the pressure exceeds a certain set amount the inner valve lifts and, one might say, exhales into the space between the inner and the cork spheres. The cold air gradually works outward through the cork, becoming warmer as it progresses. Finally it reaches the space between the cork shell and the outer metal casing and accumulates until the pressure is sufficient to lift the second valve when it passes into the surrounding atmosphere.

While the company has devoted its chief endeavors to the process of liquid air manufacture and transportation, it has also paid some attention to the possible applications of liquid air. One which is of especial interest in these summer days is the operation of a cooling fan by compressed air obtained from volatilizing liquid air. The liquid is held in a suitable receptacle, while a coil connected with this receptacle constitutes a vaporizer and heater utilizing the heat of the atmosphere. The fan is revolved by a small turbine driven by the air under pressure, which, as it escapes from the motor, is caught by the fan blades and whirled forward in the current of air. In this way not only is the air in a room kept in constant motion, but it is continually cooled and freshened by the addition of the cold exhaust air of the motor.

To our readers who have followed the above description of the air liquefying process, it will be apparent that its efficiency, or the quantity of liquid air produced for a given expenditure of power, depends primarily upon the amount of refrigeration which is effected in the expansion of the air through the contracted orifice of the expansion valve from a pressure of 1,200 lbs. to a pressure of 300 lbs. The cooling which is effected in such an expansion from ordinary atmospheric temperatures, when the expansion takes place in a cylinder against a piston, is, of course, known with fair accuracy; but what the cooling may be when the expansion occurs through a nozzle and the jet of air at high velocity performs more or less internal work which tends to restore its original heat, is something as yet unknown, and which can only be determined by careful experiment.

Such preliminary tests as have been made with the aboye apparatus, however, indicate that the refrigeration due to the expansion under the conditions existing in this apparatus, is much greater than such emperical formulas as have been heretofore relied upon have indicated. The results of complete and accurate tests to determine the product of liquid air per horse-power hour in this apparatus will therefore be awaited with interest.

For the material from which this description and the accompanying illustrations have been prepared, we are indebted to Messrs. O. P. Ostergren, President and Engineer of the General Liquid Air Co., and S. M. Gardenhire, Esq., its Secretary.

THE STREETS OF BOSTON ARE TO BE LIGHTED with Welsbach incandescent lamps of 60 c. p. A contract for seven years, renewable for a like period, has just been made with the Rising Sun Street Lighting Co., for this service. The lamps are to be equipped with new boulevard lanterns and are to burn 3,826 hours a year. The city is to maintain the gas service pipes between the street mains and the lamp, but the company will supply all other material and labor. The contractor will buy gas of the several local companies, and if gas rates are lowered the contract price of $30 per lamp per year will also be lowered accordingly. The president of the contracting company is Mr. Wesley A. Gove. Mr. Josiah Quincy, Mayor, and Mr. James Donohue, Superintendent of Lamps, signed the contract for the city. All the lamps must be equipped within four months from June 1, 1899. The contract may be abrogated by either side on three months' notice.

NO ARMOR FOR THE WAR SHIPS, authorized by the late Congress, is the result of the action of that Congress fixing the maximum price at $300 per ton for three armored cruisers and $400 per ton for 3 battleships and 4 monitors. In answer to the late invitation of the Navy Department one proposal only was received for the 24,000 tons wanted, and that was impossible of acceptance, as it was above the limit of cost, or $450 per ton, and 5 years were stipulated for delivery. The Carnegie and Bethlehem companies declined to bid, for the reason that the ballistic requirements demand armor treated by the Krupp process, entailing increased cost of manufacture.

THE PLANS FOR THE SIX STEEL CRUISERS, authorized by the last Congress, have been determined upon by the Naval Construction Board, and the circular to shipbuilders will be issued in a few days. The act of March 3 authorized "six protected cruisers of about 2,500 tons trial displacement, to be sheathed and coppered and to have the highest speed compatible with good cruising qualities, great radius of action, and to carry the most powerful ordnance suited to vessels of their class, and to cost, exclusive of armament, not exceeding $1,141,800 each." The general dimensions fixed by the Board are as follows:

Full load displacement	3,400 tons.
Length	292 ft.
Beam	43 "
Greatest loaded draft	16 ft. 6 ins.
Coal bunker capacity	700 tons.
Coal on trial trip	470 "
Trial draft	15 ft. 6 ins.
Speed	16½ knots.
Power	4,500 I. HP.

Battery: Ten 5-in. rapid-fire; eight 6-pdr. and two 1-pdr.; four machine guns and one field gun.

The specifications will call for a hull of steel, sheathed and coppered and subdivided into watertight compartments. Each ship will be schooner rigged, and carry ten boats. At the waterline, for the entire length, will be a belt of American corn-pith cellulose; all woodwork used must be fireproofed, and to avoid danger from coal-bunker fires, from spontaneous combustion or other causes, all magazines are to be surrounded by a 4-in. air-space, well ventilated. All fire-mains are well below the waterline with shut-off valves on the rising mains; and special attention is paid to making the coal bunkers large and easily accessible for rapid firing. The main engines will be of the twin vertical triple-expansion type in separate watertight compartments; and steam will be obtained from six water-tube boilers aggregating 4,700 I. HP. The weight of the machinery is limited to 405 tons, with 22 tons of engines and 40 tons of reserve feed-water. The two smokestacks will be 70 ft. high above the grate. Of the 5-in. 50-caliber guns, two will be mounted on upper deck, one forward and the other aft, with all-around range. The others will be mounted four on each side of the deck below. Including machine guns, the entire battery will weigh 98 tons. The magazines will carry 153 tons of ammunition, not including 3 tons for small arms, and 140 rifles and 80 revolvers. Bathrooms, with salt and fresh water, will be provided for officers and crew, and electricity will operate the ventilating and forced draft fans, the ammunition hoists, winches, anchors, etc. There will be auxiliary steam engines only for the steering gear, ice machines, dynamos, distilling plant and machine shop.

THE TORPEDO-BOAT DESTROYER "DAHLGREN" was launched at Bath, Me., on May 29. The contract for this boat was awarded to the Bath Iron Works on Oct. 6, 1896, for $194,000 for hull and machinery only. The "Dahlgren" is 147 ft. long, 16 ft. 4½ ins. beam, 4 ft. 7½ ins. mean draft, and 146.4 tons displacement. She has two Normand water-tube boilers and twin vertical triple expansion engines of 4,200 I. HP. The contract speed is 30½ knots, and she has a bunker capacity of 32 tons of coal. She is fitted with two-deck discharging tubes for 18-in. Whitehead torpedoes, and carries four 1-pdr. rapid-fire guns.

THE SPANISH CRUISER "REINA MERCEDES," recently brought from Santiago to Norfolk by the Merritt & Chapman Wrecking Co., has been accepted by the Navy Department. The wrecking company is to receive $75,000 in full for all services. It is not yet determined whether this cruiser will be repaired and put into active naval service, or preserved as she is as a trophy.

STEEL-BRONZE QUICK-FIRING GUNS, of 7.5 to 7.8 c. m. caliber, are wanted by the Austrian Army and the War Minister demands 50,000,000 florins for this purpose.

THE DAUDETEAU RIFLE is proposed as a substitute for the Lebel small arm in the French army. The military authorities have been making extensive tests of the new weapon at Chalons, and while its exact form is kept a secret, the following points are published: The Daudeteau rifle is 6.5 mm. caliber and its chief advantage is a new feeding device, which makes it impossible for an extra cartridge to slip and get jammed in the breech with the first cartridge supplied from the magazine clip of five cartridges. At a distance of 1,000 m. the deviation of the Daudeteau rifle was only 7.3 m., as compared with 10 to 18 m. for the 7.8 mm. caliber; the pressure of explosion is only 3,200 kilos. to the sq. cm., as compared with more than 4,000 kilos. for the other rifles. Experiments to determine the "danger zone" showed that its bullets disabled a horse at 2,000 m.; and at 1,500 m. a bullet struck a horse's chest and penetrated the whole length of the animal. It smashes and splinters bone, and surgeons say that an unusually large percentage of wounds made with it will prove fatal.

TWO NEW COALING STATIONS for the Navy are soon to be ready for use by government vessels. The first one to be completed is situated at Dry Tortugas, Fla., and will have a capacity of 40,000 tons; this will be opened within a few weeks. A new channel has been dredged, and with the sheds on iron piers projecting far enough into the water to permit warships of the largest class to be alongside and coal, this will become one of the most important naval stations on the Atlantic Coast. About $100,000 has already been expended, and a like sum will be spent for coal. The other station will be at New London, Conn., where about $150,000 is being expended to make this also an important coaling station. This station will not be ready for service before the coming fall.

A SCIENTIFIC EXPEDITION TO THE PACIFIC is to be sent out on the "Albatross" under the auspices of the U. S. Fish Commission, and in immediate charge of Prof. Agassiz. Among other islands to be visited will be the Marshall, Society, Friendly, Fiji and Gilbert. It is to leave San Francisco in August, and in outfit will be the most important expedition arranged by the Commission.

ANOTHER NORTH POLE EXPEDITION is being organized by the Duke of Abruzzi, of Italy. The expedition will include the Duke himself and several Italian naval officers and scientists, with Norwegian sailors—21 persons in all. He is to sail for Franz Joseph's Land and push as far north as possible for winter quarters. In the next spring, with sleds and dogs, he will move towards the pole over the ice, and by the shortest line. He expected to depart in June.

A CONCRETE OF REMARKABLE STRENGTH was described by Mr. James Christie, M. Am. Soc. C. E., at a recent meeting of the Engineers' Club of Philadelphia. It composition is as follows: Cement mortar, 1; slag or broken stone, 4; cast-iron cuttings (by weight), 2. Add 1 lb. of sal-ammoniac for each 50 lbs. of iron. This concrete weighs 210 to 220 lbs. per cu. ft., and will stand a crushing load of 3,000 lbs. per sq. in. after four months. If the sal-ammoniac is omitted its strength is about half as great.

Before considering the liquefier it is perhaps well to trace the course of what has just been called the expanded air. In reality this is only partially expanded for it reaches the exit end of the brine tank coil at a pressure of about 300 lbs. per square inch. Referring again to Fig. 1 it will be noticed that a pipe leads to the third intercooler, which has also a pressure of 300 lbs. This arrangement, it will be observed, starts the cleaned and cooled air which has not been liquefied on the circuit again at a point where only a

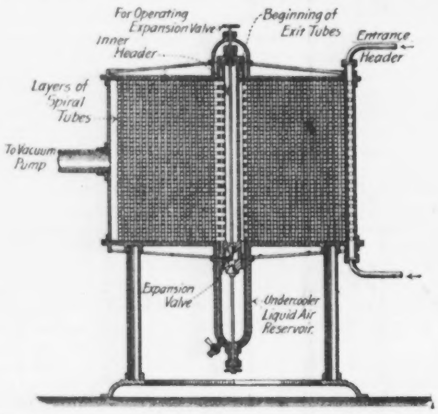


Fig. 6.—Diagrammatic View of Interior of Liquefier, Showing Principle of Its Construction.

single compression is necessary to put it into condition for supplying to the liquefier.

The principal part of the system and, of course, the one to which the most interest attaches, is this liquefier. For the present let us consider the apparatus without air, as it stands when inoperative.

Its outside appearance is well shown in Fig. 8, which shows the exterior lagging, the entering and leaving air pipes and the valves and gages connected with different portions of the intensifying coils inside.

The liquefier consists of two portions, Fig. 5, the upper and larger or the liquefier proper, and

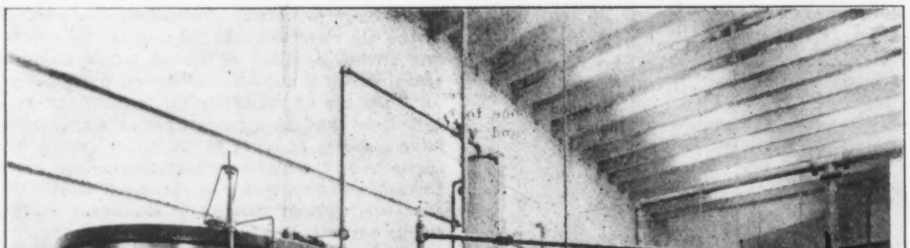


FIG. 8.—GENERAL VIEW OF THE LIQUID AIR MANUFACTURING PLANT, OF THE GENERAL LIQUID AIR & REFRIGERATING CO., NEW YORK CITY.

the smaller and lower portion called the aftercooler which contains the reservoir for the liquid air and plays a very important part in the proper working of the system.

Referring now to Fig. 6, it will be noticed that the upper portion is filled with two sets of coils of small copper pipes which, as in the case of the brine tank, Fig. 3, are wound in flat spirals in reverse directions, that is, those for the entering air spirally inward to the central of the header, shown in Figs. 5 and 6, and the other set starting from the outer section of the breaker and spiralling outward to an outside header. However, a fundamental difference exists between the brine tank and the liquefier in the fact that the tubes of the latter are soldered together in vertical rows, thus forming a spiral space from the outside to the inside, or vice versa. In other words, it is as if a solid flat strip of 40 tubes were wound in a spiral. Connected with the space which surrounds both sets of tubes is a large exhaust pipe leading to the suction end of the first cylinder of the low pressure compressor, already mentioned, whose function it is to exhaust the air from this space and the interior of the aftercooler, as will be explained later.

The aftercooler, shown in detail in Fig. 5, consists of a central chamber closed by a heavy cast-iron inverted cup, resting on a knife-edge turned on the top of the reservoir, and a siphon tube dipping to the bottom of the reservoir, and winding around the cup and cover, and finally emerging to the outside of the supporting casing of the apparatus. This is all enclosed in an air-tight casing which connected to the spiral space of the liquefier, and hence to the vacuum pump.

At the lower extremity of the central header of the liquefier, and at the top of the aftercooler, are two similar valves, shown in detail in Fig. 5, and operated by separate valve handles from the outside of the apparatus, as shown clearly in Fig. 8.

Having now an idea of the mechanical construction of the apparatus, let us start with the compressed air entering the liquefier, and follow the operation of the several parts. The air, at a pressure of about 1,200 lbs., and a temperature equal to that of the brine tank, say 50 or 60° F., flows into the outside header, and round and round through the spiral tubes towards the central chamber, and finally through the expansion valve into the small space below. This valve is so adjusted as to throttle the flow and keep the difference of pressure between the two sides of the valve at approximately 900 lbs. This drop in pressure, and consequent expansion cools the air a certain amount. This cooled air now passes upward in the outer portion of the central header and starts in its spiral course outward, the tubes in which it is confined being in close metallic contact with the entering air tubes. No matter how small the difference in temperature may be, the entering air will in consequence lose some of its heat to the outgoing cooler air, and will thus arrive at the expansion valve at a slightly reduced temperature only to expand and produce a further drop in temperature, which in its turn still further cools the entering air. This accumulative cooling continues until eventually the critical temperature of air is reached. Then, and then only, a portion of the air passing through the expansion valve liquefies and collects in the small chamber over the second or aftercooler, or reservoir valve. That portion which does not liquefy, which is, however, intensely cold, of course passes into the cooling tubes as before.

From what has been said it will be seen that the

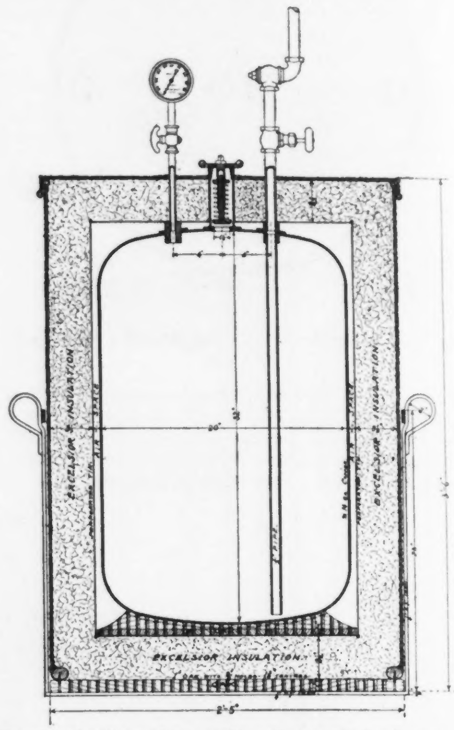


Fig. 7.—Section of Large Size Reservoir for Conveying and Retaining Liquid Air.

air once taken into the system is used over and over. There is, of course, need for new air to take the place of that liquefied, and this is drawn in from outside through the cleanser, shown in Fig. 4, and a suitable automatic valve. This cleanser consists of an inlet tube coming from the roof of the building, and extending down to the bottom of the containing tank. From the bottom of the four arms, the air bubbles out and up through water to a coke filter, where it is thoroughly scrubbed. It is also subjected to a water spray, after which it remains in the upper portion of the tank until needed by the system, when it is drawn into the vacuum cylinder.

Returning to the liquefier again, it will be seen that opening the aftercooler valve allows the liquid air to pass into the reservoir below, where at first it will immediately volatilize, owing to this portion of the apparatus being warm. This will produce in the reservoir sufficient pressure to lift the heavy inverted cup and permit the intensely cold air to flow out into the vacuum space of the aftercooler, and thence through the spiral space of the liquefier. At the same time a portion of the cold air will pass through the coiled siphon tube and out the draw-off valve. Soon the parts of the aftercooler become sufficiently chilled, and the liquid air passing through the lower valve, remains in a liquid state. The heavy cap is so proportioned that there is a pressure of about 6 lbs. per sq. in. on the liquid surface, and this is sufficient to force the liquid air through the siphon tube and out of the faucet. We then have the following condition of affairs:

The reservoir is partially filled with liquid air, as is also the coils of the aftercooler, and the space surrounding the tubes is constantly being exhausted, so that whatever liquid air or vapor air may spill over when the inverted cap lifts is instantly evaporated in and around these filled tubes, thus further reducing the temperature of the air about to be drawn off; the vacuum spiral space surrounding the tubes of the liquefier is

BOOK REVIEWS.

THE SANITARY CONDITION OF CITY AND COUNTRY DWELLING HOUSES.—By Geo. E. Waring, Jr. Second Edition. Revised. No. 31, Van Nostrand's Science Series. New York: D. Van Nostrand Co. Boards; 4 x 6 ins.; pp. 130. Price, 50 cts.

This little volume, originally published about 1877, was revised by the late Colonel Waring shortly before his death. It originally consisted of two papers, read before health associations, on country and city houses, respectively, and some correspondence regarding them in the "American Architect." The papers, only, have been revised. The correspondence is chiefly of interest in showing how some ideas regarding the land disposal of sewage have developed in the past twenty years. The two papers may be consulted with profit by those wishing to learn some of the essentials of house sanitation, more especially as relates to plumbing and sewage disposal.

EXPLOSIVE MATERIALS.—The Phenomena and Theories of Explosion and the Classification, Constitution and Preparation of Explosives. By First Lieut. John P. Wisser, 1st Artillery, U. S. A., Instructor Department of Military Science, U. S. Artillery School, Editor of "Journal U. S. Artillery." Van Nostrand's Science Series, No. 70. D. Van Nostrand Co., New York; boards, 6 x 3¾ in.; pp. 145-15; 50 cts.

The first edition of this work appeared 15 years ago; but the development of the science of explosives has been so great in the interval and views have changed so radically that the entire treatise has been rewritten for the present edition. The title indicates the scope of treatment; and it would be well to say that some knowledge of chemistry is essential to the understanding of much of the text, as without it the various explosive compounds could not be described, nor the methods of preparation made plain. An excellent and full index adds to the value of the treatise.

REPORT OF THE FILTRATION COMMISSION OF THE CITY OF PITTSBURG, PA.—Geo. L. Holliday, Secretary; Allen Hazen, M. Am. Soc. C. E., Assoc. M. Am. Soc. C. E., Consulting Engineer; Morris Knowles, Assoc. M. Am. Soc. C. E., Resident Engineer. Paper; 6 x 9 ins.; pp. 393; illustrations and many tables. Pittsburg: City Doc.

An abstract of the most important parts of this report, prepared from a copy of the MSS., was given in our issue of Feb. 23, 1899, with proper credit to the various experts and assistants who took part in the investigation. It will therefore be sufficient to say here that this volume contains the results of an exhaustive investigation to determine the system of water purification best suited to remove sediment and bacteria from the Allegheny River at Pittsburg, together with a study of the needs for purification and for a gravity water supply. Sedimentation, mechanical and slow sand filtration were investigated, and a combination of the first and last was recommended. The volume is a fit companion to Mr. Geo. W. Fuller's report on "Water Purification at Louisville."

SANITARY ENGINEERING OF BUILDINGS.—By Wm. Paul Gerhard, C. E. Vol. I. New York: Wm. T. Comstock. Cloth; 7 x 10 ins.; pp. 454; six plates and 103 illustrations in the text. Price, $5.

Most of the various phases of building sanitation are discussed at length in this book. The author presents his ideas clearly and accompanies his text with numerous well-chosen illustrations. The faults of the book are needless repetition, due to the fact that the author seems to have desired to collect and preserve in more permanent or accessible form a number of papers published in reports of State Boards of Health and elsewhere. The subjects of these papers overlap at many points, and as each was designed to be complete in itself, there is necessarily much repetition. Judging from the actual contents of the present volume and the table of contents, announced for the next one, practically all the information in the two might have been presented in one volume, with a great increase in economy and convenience for the purchaser. This would be all the easier if the book was made more compactly, for needlessly large type, heavy leading and wide margins are employed. An edition-de-luxe is out of place for a treatise on plumbing and allied subjects, or for technical books in general. Architects, health officers and engineers should have the encouragement of moderate prices to buy sanitary works, instead of being asked to pay $10 for what might have been supplied them in admirable shape for half that amount.

CHANDLER'S ENCYCLOPÆDIA.—An Epitome of Useful Knowledge in Three Volumes. Edited by William Henry Chandler, Ph.D., F.C.S., of the Lehigh University. With Contributions from a Large Number of Eminent Scientists. Illustrated by maps and engravings. New York: Peter Fenelon Collier. Cloth; 9 x 12 ins.; pp. 1,710; 3 vols. $6.

This encyclopædia is notable for the large number of subjects treated in three low-priced volumes, and also for the general high character of the work. It is distinctly an encyclopædia for busy people, who wish to learn the most salient facts relating to a subject without having to read columns or pages. The text of few articles exceeds a half column in length, while the majority are comprised in from one to five lines.

The work is designed to be particularly strong on the scientific side and great care has been taken to bring it up-to-date. One criticism we would make of the scientific articles is that some of those on related subjects are not wholly consistent with each other, while others appear to have been written by students with a limited range of observation and research. These criticisms apply more especially to articles giving comparative statistics.

The editor-in-chief is Professor of Chemistry and Director of the Library of Lehigh University. Prof. Mansfield Merriman, of the same institution, has contributed articles upon a wide range of subjects in connection with civil engineering. Among other contributors may be mentioned, without attempting to indicate their assignments: Geo. F. Barker, Professor of Physics, University of Pennsylvania; F. R. Hutton, Professor of Mechanical Engineering, Columbia University; and Wm. Henry Pettee, Professor of Mineralogy, Economic Geology and Mining Engineering, University of Michigan.

The type is of fair size, and the presswork and binding are good. The illustrations are numerous and are remarkably well executed, considering the low price of the work. Many of the illustrations will be familiar to readers of Engineering News.

THE ELEMENTS OF WATER SUPPLY ENGINEERING. —By E. Sherman Gould, M. Am. Soc. C. E. New York: The Engineering News Publishing Co. Cloth; 6 x 9 ins.; pp. 168; illustrated. $2.

As this is one of our own publications, we will let the author's preface speak for it, as follows:

"Practical Hydraulic Formulæ" was first published in 1889. The second edition appeared in 1894 in a form much extended by notes on the quality and the quantity of water and on the calculation and the construction of dams.

In the present work all the matter contained in the first and second editions of "Practical Hydraulic Formulæ" is republished; but, under the heading of "Notes to Parts I. and II.," it has been supplemented with copious memoranda, elucidating and greatly extending many important points inadequately treated in the previous editions.

An entirely new part (Part III.) has been added. This treats of the Flow of Water Through Masonry Conduits on the basis of Darcy's formulæ, with some practical details of aqueduct and tunnel construction. A few paragraphs are devoted to the subject of the Filtration of Public Water Supplies, sufficient, it is hoped, to indicate the proper lines of further investigation to those who are interested in pursuing them. A somewhat fuller treatment is given to the subject of Pumping Engines and Duty Trials. Some pages have been added on the subject of Arches and Abutments. As an extended project of water supply frequently embraces the construction of arched masonry aqueducts, it is believed that the brief and practical rules given in this part of the book will prove acceptable to the hydraulic engineer. A set of carefully calculated, labor-saving Tables, with explanations and examples, terminates the book.

It will be seen that the present work covers so wide a field that to retain for it as a whole the title originally given to the first part would be misleading. It is, therefore, called "The Elements of Water Supply Engineering," which name more truly indicates its scope.

While it is believed that every topic connected with water supply engineering has been at least touched upon, especial pains have been taken to go into very close detail in the matter of the principal dimensions and quantities involved in the designing of hydraulic work. As these are the points which the author has most carefully sought for in his own reading and observation, so he believes that they are the ones which others may be most interested in finding fully treated of in the present volume.

REPORT OF PROGRESS OF STREAM MEASUREMENTS for the Calendar Year of 1897.—By F. H. Newell, Hydrographer, U. S. Geological Survey. Charles D. Walcott, Director, Department of the Interior. Extract from the 19th Annual Report of the Survey. Washington, D. C. Paper; 13½ x 7¾ ins.; pp. 632; very fully illustrated.

This is an advance copy of the part of the 19th annual report of the Survey relating to hydrography. It contains gagings of the principal streams of Maine; some other North Atlantic streams, and many rivers of the South Atlantic, Gulf, Ohio, Great Lakes and other watersheds, to the Pacific Ocean. The water supply of the San Bernardino Valley is separately treated. This careful study of the water resources of the United States has been carried on continuously for the past ten years, and a very large fund of most useful information has already been published. Both surface and underground flow of water is included in the investigations, and in computing the discharge of streams the results are based upon original measurements of the cross-sectional area and the velocity as obtained by some form of current meter. As soon as possible after the close of the calendar year the immediate results of these measurements and a statement of the field operations are published, so as to be at once available to engineers. But for further accuracy these field notes must be carefully digested and compared through several seasons; and the Division of Hydrography therefore makes what may be termed a double publication in the form of final results. The present volume embodies the tables and diagrams based upon this later study of the preliminary data already published in Water Supply and Irrigation Papers, Nos. 15 and 16. The estimates of daily discharge are here omitted, as being too bulky for the purpose intended, and as being easily recomputed from the material presented in the Papers referred to. We here have the results of river measurements given in tabular form, by months and for several years. The tables give the maximum and minimum daily average flow in cu. ft. per sec.; the average flow for the month; the equivalent in inches on the drainage area for one month; the equivalent in cu. ft. per sec. of continuous flow per sq. mile of drainage area, and the rainfall in inches. The character of the fluctuation is shown by a diagram, and in all cases the drainage area is stated along with copious notes as to the geographical position of the stream, its elevation, character of the watershed, utilized power, etc. The Division is continually adding to this data and correcting as rapidly as possible any errors that may possibly creep into the work, or such as are due to too brief observations. When the figures extend over ten years for any considerable number of streams, some valuable general conclusions may be drawn. While the data here published is scattered over the whole area of the United States, in a somewhat arbitrary geographic arrangement, the information covers a great number of the more prominent rivers and their tributaries, and the data cannot fail to be of great service to the engineering profession. The report is handsomely illustrated with a great number of half-tones taken from photographs, showing actual conditions on the streams investigated, while other views show the appliances and methods employed in measuring stream velocities and cross-sections.

THE MICROSCOPY OF DRINKING WATER.—By George Chandler Whipple, Biologist and Director Mt. Prospect Laboratory, Department of Water Supply, Brooklyn, N. Y.; formerly Biologist of the Boston Water-Works. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 6 x 9 ins.; pp. 300; 21 figures in the text and xix. plates. $3.50.

The services of chemists and bacteriologists are now pretty generally recognized as essential to the study of the character of domestic water supplies. In a few years the microscopist will receive equal recognition in his own peculiar field. During the past ten years, microscopical examinations of some 50,000 samples of water have been made in the laboratories of the Massachusetts and Connecticut state boards of health and of the cities of Boston, Brookline and Lynn, Mass., and Brooklyn, N. Y., and the number at these points is increasing at the rate of about 8,000 a year.

The chief function of microscopical examinations of water, in the words of the author of this book, are as follows:

This book has a twofold purpose: It is intended primarily to serve as a guide to the water-analyist and the water-works engineer, describing the methods of microscopical examination, assisting in the identification of the common microscopic organisms found in drinking water and interpreting the results in the light of environmental studies. Its second purpose is to stimulate a greater interest in the study of microscopic aquatic life and general limnology from the practical and economic standpoint.

The work is elementary in character. Principles are stated and briefly illustrated, but no attempt is made to present even a summary of the great mass of data that has accumulated upon the subject during the last decade. The illustrations have been drawn largely from biological researches made at the laboratory of the Boston water-works, and from the reports of the Massachusetts State Board of Health. In considering them one should remember that the environmental conditions of the Massachusetts water supplies are not universal, and that every water supply must be studied from the standpoint of its own surroundings. So far as the microscopic organisms are concerned, however, the troubles that they have caused in Massachusetts may be considered as typical of those experienced elsewhere.

The above statement, combined with the following quotation from the preface, will give a pretty clear idea of the scope of the work:

By far the most important service that the microscopical examination renders is that of explaining the cause of the taste and odor of a water and of its color, turbidity and sediment. Several of the microscopic organisms give rise to objectionable odors in water, and, when sufficiently abundant, have a marked influence on its color. They also make the water turbid and cause unsightly scums and sediments to form. Upon all such matters related to the aesthetic qualities of a water the microscopical examination is almost the only means of obtaining reliable information.

The volume is divided into two parts. The first describes methods of examination, interpretation of results, and gives practical deductions regarding tastes and odors in water supplies, the storage of ground and surface waters, and the growth of organisms in pipes. Limnology is the subject of an important chapter of Part I. This is defined as "that branch of science that treats of lakes and ponds—their geology, their geography, their physics, their chemistry, their biology, and the relations of these to each other." The chapter is confined, however, more especially to the relation between organisms and the physical characteristics of water, as density, temperature, light penetration and food supplies present.

Part II. is made up with descriptions of those microscopic organisms of most importance in connection with the subject in hand. An extended bibliography is given, which will be of great service to those who wish to avail themselves of it.

The plates were reproduced by the half-tone process from wash drawings by the author, and deserve high praise for their minuteness, delicacy and artistic rendering. It is a pity that they could not have been reproduced by the three-color photographic process, which has recently become comparatively cheap, and has given such marvelous results in the bird and butterfly books published by Doubleday & McClure. Probably this could have been done by adding 50 cents to the price of the book, which most purchasers would gladly pay for the change. Perhaps this will be done for a subsequent edition, when the demand for such a book has increased somewhat, as it certainly will as time goes on. The high character and great possible usefulness of the work should result in its wide circulation.