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Variety of wood, black gum; dimensions, approximately 3½x8x3. Exact measurement taken in each case in calculting cubic-foot weight. These series, before being dipped, averaged 3.9 per cent. water absorption; after dipping the blocks were heated for twenty-four hours to 100 degrees F., then exposed for seven days to the direct rays of the sun, in an exceptionally hot summer spell, during which several short but severe rain storms occurred. The blocks were then placed in an incubator at 100 degrees for twenty-four hours, and tested as usual.

The Monroe Street Bridge, Spokane, Wash.

THE Monroe street bridge, Spokane, Wash., which is shown in the photograph here reproduced, is remarkable for a number of features. It has one of the largest monolithic concrete arches in the world; it was constructed in record time by the city and under the day labor system, and it possesses a beauty of design seldom found in the larger bridges.

In 1907 the plans for the proposed bridge were prepared by Charles McIntyre, who was then city engineer, but construction was started under direction of City Engineer J. C. Ralston. The structure which this bridge replaced was a steel bridge, which became so weakened under traffic that it was found necessary to remove the street railway tracks before the bridge was finally abandoned. All the plans and drawings were made in the city engineer's office, and great credit is due to that department for the choice and execution of the design.

All the preliminary work upon the bridge was done under direction of Mr. Ralston, but owing to the fact that other bridge work interfered, the actual construction was not begun until Morton Macartney became city engineer. Mr. Macartney had been first assistant under Mr. Ralston. Professor Wm. H. Burr, instructor in civil engineering at Columbia University, checked the plans before construction work started.

The main arch of the bridge is of monolithic concrete, 281 feet in length, and the over-all length is 784 feet. A wooden trestle approach, shown at the right of the photograph, will later be replaced by an earth fill. With the trestle approach, the entire length is 965 feet.

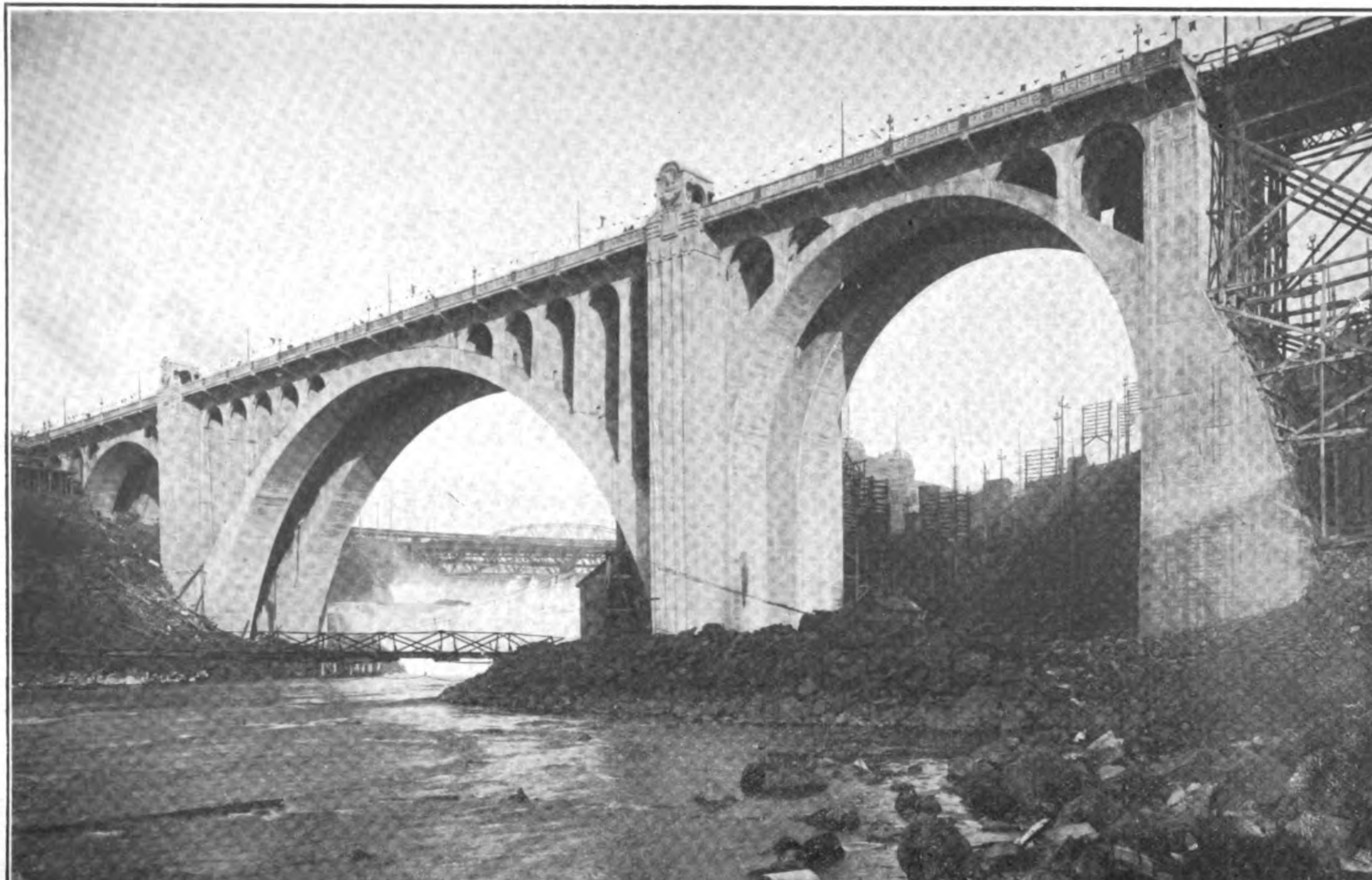
The clear height above the water is 130 feet; the width over all is 68 feet, carrying two 9-foot sidewalks and a 50-foot roadway. The sidewalks are supported on cantilevers capable of supporting a dead load of 500,000 pounds at the center of the arch. The floor system is of steel, incased in concrete. About 25,000 cubic yards of concrete were used in the job.

The main arch is of the turn-ribbed segmental style. The rise of the intrados is 113 feet 9 inches, and the width of the ribs at the crown 16 feet, flaring to 19 feet 9 inches at the haunches. The thickness at the crown is 6 feet 9 inches. The smaller arches are constructed of two segmental spans, 120 feet long, with four ribs, each 6 feet wide by 3 feet 3 inches thick at the crown, and are connected in pairs by a 6-inch soffit wall. The spandrel and north arches are semicircular, with spans 17 to 17 feet 6 inches, with spandrel columns 3 feet 6 inches thick.

The roadway is handsomely finished by a decorative railing and by archways which are placed over the sidewalk on both sides, at the two piers. These arched stations are attached to the walls of the stations on the sidewalk side, and on the roadway sides are modeled concrete buffalo skulls. Ornamental lighting standards are placed along the roadway on both sides, spaced 8 feet apart. These poles support white ball globes and tungsten lamps. The driveway is paved with wood blocks treated with carbolineum.

As was stated, the bridge was constructed under the day labor system. Owing to the fact that the cost of labor in all lines was greatly increased shortly after the start of the job, the estimate fell far short of the actual cost of the bridge. The labor cost alone was $220,723, the greater part of which was paid for carpenters upon the form work. When the different classes of labor raised their prices, the carpenters increased theirs from $3.50 to $5, so that some idea may be gained of the difference which was made between the estimate and the cost, due to the increased scale.

The preliminary construction was carried on by means of aerial tramways, and later a wooden trestle was constructed. The collapse of this trestle, and the consequent injury to a number of workmen, led to the planning and construction of a steel false work, by means of which the main arch was completed.



MONROE STREET BRIDGE, SPOKANE, WASH.

The cost of this steel trestle was about $40,000, but as it may be used in constructing future bridges, its price was not a total loss. A unique feature of the construction was the method adopted of separately completing each segment in the arches before putting them in place, which is a departure from the customary method of building the molds and then filling in the concrete.

The net cost of the bridge, after credits have been made for machinery and supplies on hand, is $487,000, and the gross cost was $535,000. The time of construction, excluding delays, was twenty-three months.

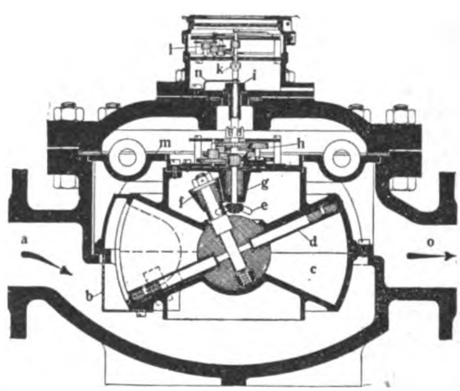
A Hot Water Meter.

By Dr. Robert Grimshaw, Dresden, Germany.

THE average water meter reminds me of the darkey's sermon, which he commenced by saying, "Dere am two ways, breddren; er broad en narrer way dat leads ter distraction en er narrer en broad way dat leads ter perdiction," to which the comment of one of his hearers was, "Ef dat's de case, dis nigger takes ter de woods!"

The particular reason why the average water meter reminds me of this sermon is that there are two principal kinds—one that, under higher pressure than ordinary, registers too much, and one that, at low pressure, shows too little; so that the only way to use them is to couple one of each kind tandem, weigh or measure the water after it reaches the meter, and not bother about the latter at all. Some stick open with grit, and some stick shut with soft dirt. The ones with hard rubber disks bulge out when they are used with warm water; the ones with brass pistons wear and leak when there is sand in the water. Altogether, one is "between the devil and the deep sea" in the matter. Of course, the difference of temperature of the water between summer and winter makes a difference in volume that is appreciable when it comes to exact work. Be this as it may, as a rule we rely on volume meters. They are a good deal better than guesswork.

One which is used in great quantities in Germany is that here illustrated, made by the Siemens & Halske Company, of Nonnendamm, near Berlin, and is used for hot water. A hollow metal disk, resting on a ball joint, is inclosed in a housing, the form of which corresponds to the peculiar oscillating movement of the disk. The latter moves about the spherical surfaces, and its periphery or outer edge describes a spherical curve corresponding to that of the housing, always dividing into two parts, an upper and a lower, the chamber which this housing incloses. The inlet and the outlet opening are beside each other, but separated from each other by the vertical partition wall tending towards the center of the disk chamber, and which fits in a slot in the brass disk, preventing the latter from turning about its vertical axis and hindering the water from passing through the meter without oscillating the disk. Passing through the disk chamber, the water has prescribed for it a definite path, by means of which it brings the disk into oscillation, and the result is that with each oscillation of the disk a quantity of water flows from the disk chamber, corresponding to its net volume. The result is in effect that of a piston pump in which one to-and-fro movement of the piston drives out an amount of fluid corresponding to the piston displacement.



A HOT WATER METER.

Referring to the sectional view: The water enters at (a) and passes through a sieve (b) into the measuring chamber proper (c). The movement of the disk (d) is transmitted by the roller (f) and the dog (e) to the wheelwork (h). The measuring disk or oscillating piston is guided by the cones (g) and (f), so that there is always close contact between

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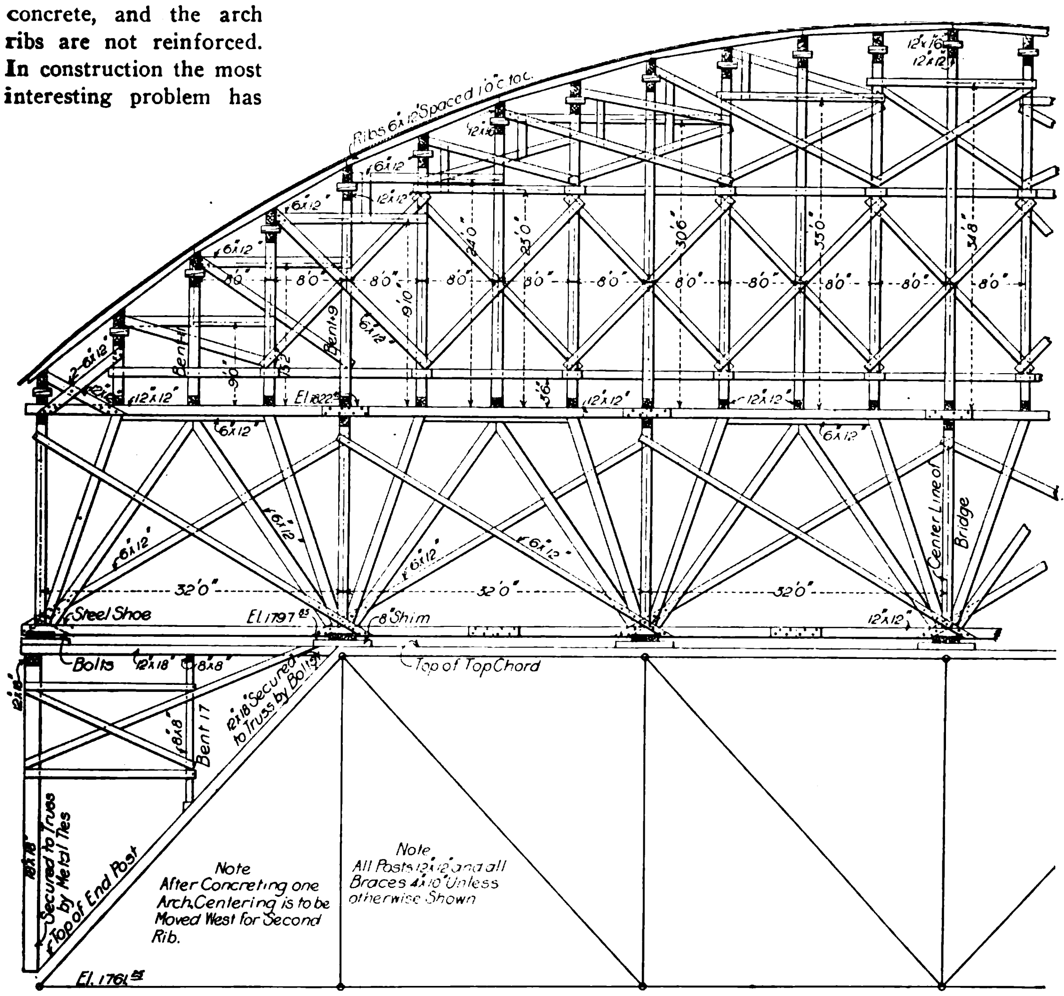
CENTERING FOR THE MONROE STREET BRIDGE, SPOKANE.

By P. F. Kennedy, Assistant Engineer, Engineering Department, Spokane.

The Monroe Street Bridge now under construction in Spokane, Wash., will be 791 ft. long, and will consist of a main center span of 281 ft., a 100-ft. span at one end, and 100 and 120-ft. spans and an approach fill at the other end. The roadway is to be 50 ft. wide, flanked by 9-ft. cantilevered sidewalks. The material throughout is concrete, and the arch ribs are not reinforced. In construction the most interesting problem has been the centering of the main or river arch, which has a clear span of 281 ft., with a rise of intrados of 114 ft. This arch is of the twin rib type. The ribs are 16 ft. wide by 6 ft. 9 in. deep at crown and are 36 ft. apart, center to center. They flare toward the haunches, at which point their width is 19 ft. 9 in.

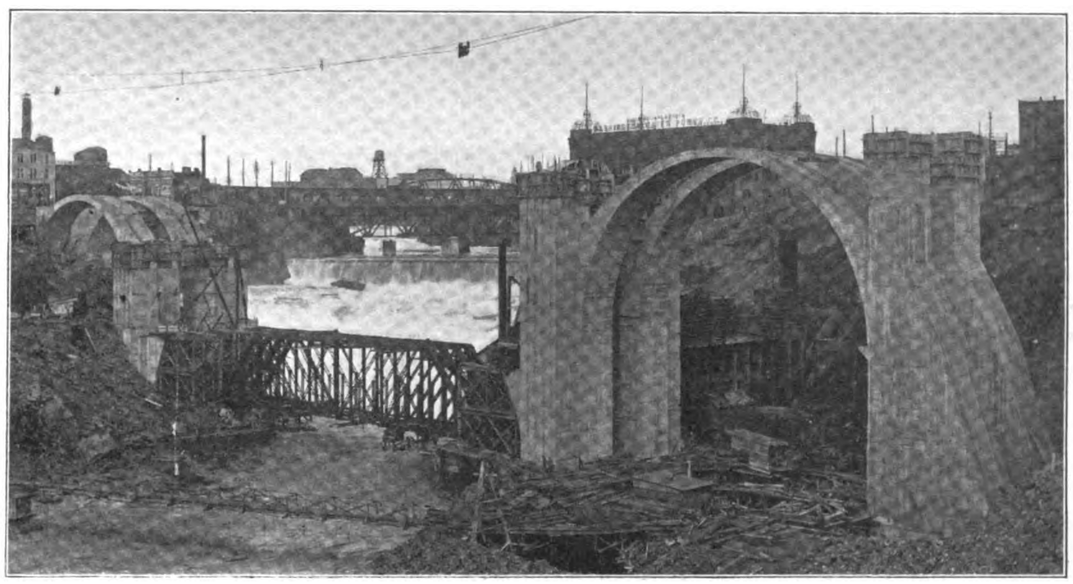


Half Elevation of Falsework for Monroe Street Arch Bridge, Spokane.

Monroe Street runs north and south and the Spokane River is crossed by it at the foot of the last of a series of falls, the total drop in which approximates 135 ft. In the course of the ages a basin has been formed on the line of Monroe Street, in which the water varies in depth from 50 ft. on the east property line to 30 ft. on the west property line. The low water flow of the river is 2,000 cu. ft. and the high water flow 40,000 cu. ft. per second. During the period of high water the stream is very swift and turbulent. Just above the falls there are situated several lumber mills and the breaking of a log boom would precipitate an immense number of logs over the falls.

The power plant building of the Washington Water Power Company abuts on the east property line of Monroe Street and extends north from the south pier of the river span to the south border of the deep basin that has been described. The tailraces of the power plant traverse the line of the bridge. These several circumstances eliminated from consideration not only the use of falsework supported on bents in the river, but also the use of falsework which would require many temporary river bents for its erection.

On the other hand, the existence of a steel bridge on the line of Monroe Street offered a means of erecting falsework by suspension therefrom. This steel bridge was of the cantilever type; the anchor spans 189 ft. long, the cantilever and suspended span crossing the river, 277 ft. long. By placing one pier upon a rock shelf rising between two of the power plant tailraces, and another pier upon a similar shelf on the north edge of the deep water basin, it was possible to obtain a span of 192 ft. for falsework symmetrically located with respect to the 281-ft. concrete arch. In the 44½ ft. between such falsework piers and the piers of the concrete arch a simple system of vertical post falsework could readily be constructed. The span of 192 ft. was therefore chosen for the center falsework.



Erecting Falsework for Monroe Street Arch Bridge; Steel Trusses in Place.

After comparison of arch and truss spans for falsework, an arch was determined upon. The large steel bottom chords required in a truss by the heavy load of the concrete arch made a combination arch, in which the heavily stressed members were all in compression much cheaper. A combination arch was designed, consisting of seven timber ribs spaced 3 ft. apart on centers. A wider base was not given to the structure because of the location of the power plant upon the east property line of the street. Wind pressure was to be taken care of by guy cables in addition to the bracing.

Construction on the falsework arch was begun late in June, 1910. Cables suspended from the steel bridge supplied the means of erection. It was possible to erect the four westerly and the two easterly ribs without any interference with the steel structure. The third rib from the east, however, came directly in line with the easterly chord of the steel bridge and interfered in its upper four panels. Consequently, after six ribs were completed and the seventh brought up to the point of interference, really active operations were suspended until the steel could be removed. Due to the fact that the uncompleted rib was kept blocked up in order to insure its ready adjustment when meeting at the crown, it was not feasible to put on the final bracing. The ribs were all tied together with temporary braces and there were 22 guys, up and downstream, upon the structure.

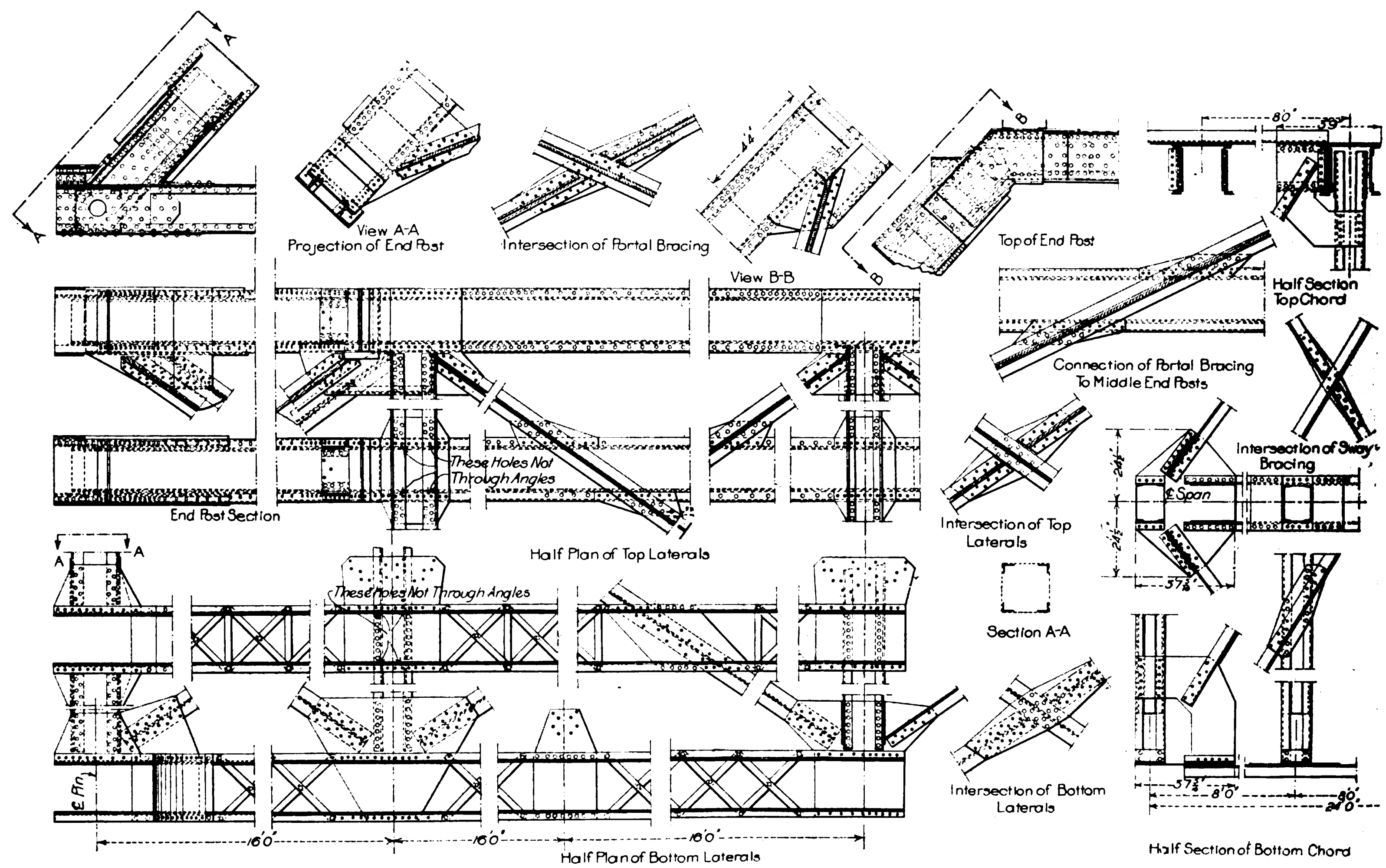
The timber arch was cut free from the steel July 13 and the work of removing steel begun. On July 20 the last piece of interfering steel was removed. The following day, July 21, a squall of unusual nature occurred, during which the timber arch collapsed. With the resumption of work after the noon hour the clear weather of the morning continued, with the wind blowing 16 to 20 miles per hour from the southeast. About 1:40 p. m. there were evidences of a storm gathering in the west. According to the local weather reports the first thunder clap came at 1:45 p. m. and at 1:46 p. m. the wind changed from 20 miles per hour southeast to 42 miles per hour southwest. There followed a brief wind squall accompanied by rain.

The weather bureau is located about 1/3 mile southeast of the river basin. The river gorge at the bridge site runs from southwest to northeast and in all likelihood the storm following the ravine caused a higher wind than on top of the building wherein the weather bureau is located.

From the testimony of eye witnesses the structure raised and collapsed, all members holding well together. Due to the excitement incident to such events and the brief space of time offered in which to make observations, the condition of the debris after the collapse offers perhaps a more noteworthy indication of what actually happened than the evidence of excited witnesses. The debris was piled high on the north shore and, of that portion which fell in the water, the most distant piece was scarcely over 50 ft. from the original line of the arch. There was no debris on the south pier and some timber which had been lying there was left undisturbed. Although positive conclusions are impossible, it seems reasonable to infer from the above circumstances that the sudden wind from the southwest, striking the structure at an angle of about 45 deg., lifted it clear of the south support and did not merely cause it to topple sideways as would have occurred had the arch not been guyed. An examination showed all the guy cable anchorages intact and none of the guys themselves broken.

In the collapse the power plant was slightly damaged and was out of service about 30 minutes.

The collapse of this timber arch presented anew the problem of centering. To re-erect the arch would necessitate the replacing of that portion of the old steel bridge already removed. Such a procedure was not only a step backward and therefore undesirable, but it was also deemed



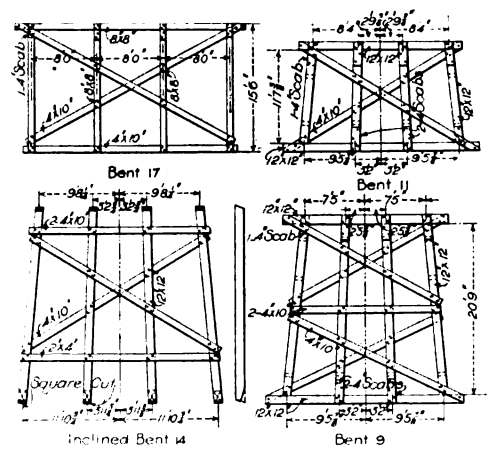
Details Showing Lateral Bracing Connecting the Four Steel Trusses in the Lower Part of the Falsework.

unwise because those portions of the removed steel members which were inaccessible in the erected structure showed that the 20 years of over-stressing service had made their future use unsafe and the structure had in consequence already been condemned for re-erection as a highway bridge without car service farther downstream as was originally intended. It was then decided to adopt a system of centering composed of timber bents supported on four steel trusses of 192-ft. span, the four trusses to be used later in pairs to form part of the proposed bridge downstream. The adopted system is shown in the accompanying plans and photograph.

The work of dismantling the old steel bridge was continued after the accident and provision made in building the piers of the main spans for anchorages and toggles to allow of the erection of the steel trusses as cantilevers.

The steel for the trusses began to arrive in Spokane in the middle of February, erection was started March 2 and was completed in 11 working days of 8 hours each at a cost of $10 per ton.

All work is done by day labor, under the direct supervision of the writer and Mr. J. F. Greene, who in turn are under the direction of



Details of Typical Falsework Bents.

the city engineer, Mr. Morton Macartney, Assoc. M. Am. Soc. C. E.

RAILROAD LOCATION in the desert "washes" of the West should be well above or to one side of the area which gives evidence of having been at times covered by the stream, instead of following near its bed. This is stated by Mr. J. G. Van Zandt as the indication of the destruction of roadbed and bridges on 60 miles of the San Pedro, Los Angeles & Salt Lake Railroad, after a study of the washed-out section, of which he gives an account in the "Railway and Engineering Review." In this case a thaw and unprecedented flood occurred at a time when the soil, naturally highly absorptive, was frozen. The maximum flow seems to have been at least 50,000 second-feet, for which provision would not be expected. Channels were created on both sides of the track, washing out long stretches of embankment between. There are evidences that the high-water marks are not reliable as determining the stages, since the level of the bed of the stream changes with every flood.

A Sewage Flow Recorder in Germany.

A sewage flow recorder is in use on the main sewer at Barmen, Germany. It plots on a chart the fluctuations in depth of flow for a 7-day period, and is described in the "Gesundheits-Ingenieur" as follows: A short 8-in. pipe is tapped horizontally into the sewer 6 in. above its bottom, and connects with the lower end of a vertical cylinder 16 in. in diameter. Sewage enters this cylinder through the pipe and maintains a sheet-copper float at the same level as the surface in the main sewer. A phosphor-bronze wire passes from the float over a wheel placed above the cylinder. Fixed on the same axle with this wheel is a drum over which the cord of a counterweight is wound, the system being so balanced that any fluctuations of the water level cause corresponding motion of the wheel. The wheel has a toothed hub working in a vertical rack, and the upper end of the rack is fitted with an arm holding a recording pen. The pen is thus caused to move up and down and its motion is in the proportion of 1 to 5 to the flow fluctuation in the sewer. Record is made on a revolving drum provided with a specially graduated chart. This drum is revolved by clockwork at the rate of one turn in 24 hours and in order that one chart may serve for a week the drum is automatically lowered a certain amount after each revolution. All connections and apparatus are contained in an excavation over the sewer.

TRAFFIC ON CANADIAN CANALS during 1910, according to a report by Mr. H. P. Dill,, U. S. Consul, of Orillia, Ont., amounted to 42,503,305 tons, an increase of 9,857,407 tons as compared with 1909. The increase in tons occurred in the following canals: The Soo, 9,155,503; Welland, 313,166; St. Lawrence, 335,754; Ottawa, 43,204; Rideau, 43,107; St. Peters, 746; Murray, 62,693. Decreases in tonnage for the year of 82,818 and 13,948 are reported for the Chambly and Trent canals respectively.