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VARIETIES OF CLAY, AND THEIR DISTINGUISHING QUALITIES FOR MAKING GOOD PUDDLE.*

Geologists agree in ascribing the origin of clays to the decomposition and disintegration of the feldspars in granite, gneiss, mica slate, and clay slate, by atmospheric erosion and trituration in water. The argillaceous rocks, from which clays are principally derived, are distinguished by a peculiar earthy odor, emitted by them when breathed upon. Clay-beds are due to the deposition of water-borne materials at the bottom of estuaries, lakes or seas; and boulder-clay is ascribed to glacier action. Any substance formed of minute particles of decomposed earthy material, which, when worked up with water, becomes plastic or capable of being moulded, is commonly called clay. No natural deposit of absolutely pure clay has been found; but the residue, after washing out all the impurities from clay, is a hydrated silicate of alumina, which is the plastic, and consequently the most important constituent of clay, insoluble in water, and incapable of supporting vegetable life. Water combined with the silicate of alumina gives it its plasticity. Part of this water is merely absorbed into the pores of the clay, and can be driven off by exposing the material to a temperature of about 212° Fahr.; but the remainder, which is in combination with the clay, can only be removed by a prolonged high temperature, as in baking bricks, depriving the material of its plasticity, and causing it to shrink in proportion to the bulk of water expelled. Some analyses of different kinds of clay gave from 46 to 66 per cent. of silica, 22 to 38 per cent. of alumina, from 5 to 13 per cent. of water, small variable quantities of oxide of iron and lime, and traces of magnesia.

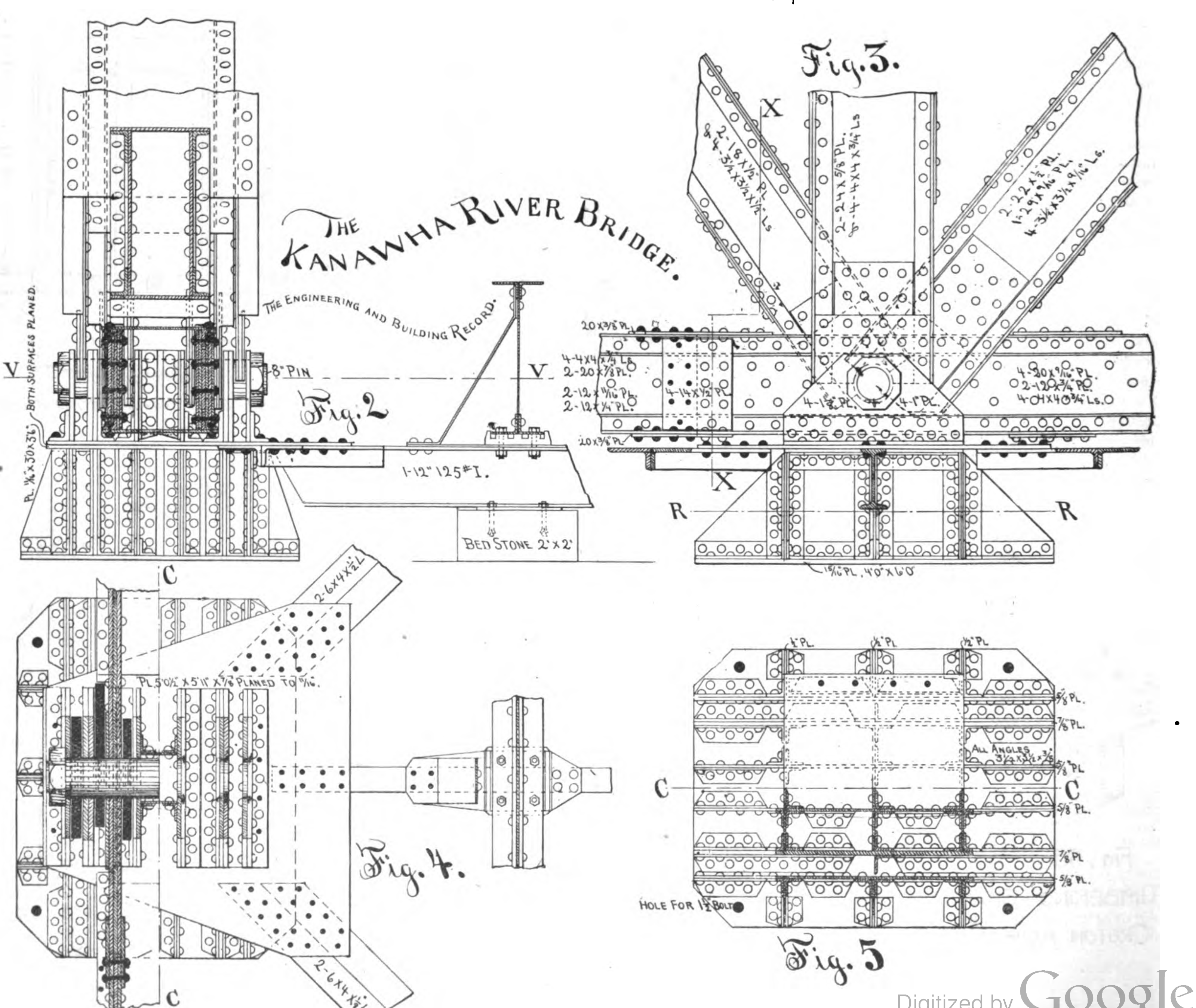
The purest form of clay, containing the largest proportion of alumina, is known as kaolin, the name of a mountain in China, where a pure white clay is worked, described as a pure chalk-white, dull, earthy, unctuous substance. The kaolin found in Devonshire and Cornwall is called Cornish, or sometimes China clay. Teignmouth clay, so called from being shipped at Teignmouth, is as free from quartz as washed kaolin, and is believed to be the sediment washed down from Dartmoor, which was deposited in a fresh-water lake. Some clays are designated by the principal use to which they are applied, namely, china-clay, potter's-clay, pipe-clay, and fire-clay. The main difference between china-clay and pipe-clay consists in the proportion of silica in their composition. Pipe-clay shrinks too much in heating to be available for making pottery. Potter's-clay includes a variety of clays containing considerable quantities of impurities. Fire-clay resists fusion owing to the large proportion of silica it contains; thus Stourbridge fire-clay contains 65 per cent. of silica, or nearly 20 per cent. more than pure koalin. Clays are also designated by their color, as red, blue, brown, yellow or ochrey, and variegated clay. The coloring matters consist mainly of metallic oxides, notably oxide of iron; organic substances also affect the color. A red color in clay in its natural state indicates the presence of peroxide of iron. A yellowish or brown color denotes the presence of hydrated peroxide of iron in the clay, which becoming anhydrous on burning imparts a red color to the clay. The Dorset and Devonshire clays, being free from iron, are white when burnt, which renders them especially valuable for pottery. Clays containing manifest impurities to a considerable extent are designated by the terms shaly clay, sandy clay, loamy clay, and marly clay. Any soft admixture of clay and lime is termed a marl—clay-marl when the clay is in excess, and marl-clay when the lime predominates. Many clays are known by the name of the neighborhood from which they are obtained, such as London clay, Oxford clay, Grinstead clay, Wadhurst clay, Weald clay, Kimmeridge clay, Gault clay, Poole clay, and others.

Puddle is of considerable importance in engineering works for arresting the passage of water. Some clays, such as the London, Kimmeridge, and Oxford beds, are practically impervious to water in their natural conditions; whilst others offer more or less resistance to its passage in proportion to the absence of impurities. Springs at faults or at the outcrop of clay-beds furnish evidence of the impermeability of these beds. Most clays, when free from coarse, gritty impurities, contain sufficient alumina to become practically impervious to water when worked up into puddle. When puddle is protected from evaporation, as is generally the case, the admixture of impurities has the disadvantage of diminishing its cohesiveness, and consequently its impermeability. If, however, puddle is placed so near the surface as to be liable to lose its moisture by evaporation or capillary attraction during dry weather, the addition of sand may be necessary to prevent the contraction of the mass, and the consequent formation of fissures such as occur in clay soils in times of drought. The sand, by diminishing the cohesiveness of the clay, obviates the rupture produced by the contraction of a tenacious mass; and with this object, the brickmaker adds sand to clays deficient in silica to prevent his bricks cracking when being burnt, and the potter incorporates ground flint with his clay to reduce the amount of contraction.

The general suitability of most kinds of clay for puddle has caused an absence of precision in the definition of the requirements for puddle in specifications. The essential condition for puddle is that it must be impervious to water; and no special purity in the clay is required to attain this result. Tempering the clay by working it up with water, so that its original formation is broken up and a new arrangement of particles formed, with additional water to fill up every pore, is the important requisite for the formation of good puddle. It is peculiar that puddle, though formed to exclude water, should require water for its manufacture. Tempering clay for forming puddle is greatly facilitated by exposing the material to the atmosphere, especially in winter, when rain, snow, frost and changes of temperature disintegrate the clay more thoroughly than even grinding it in a pug mill; and the labor of working it into puddle by cutting, cross-cutting, poaching it with a tool, or treading, is materially reduced. Clays well suited for puddle are opaque and not crystallized; they exhibit a dull, earthy fracture, exhale, when breathed upon, a peculiar faint smell termed argillaceous, are unctuous to the touch, free from all gritty matter, and form a plastic paste with water.

The important properties of clay for making good puddle are its tenacity or cohesion, and its power of retaining water, which really coexist, but are separated to facilitate description. The tenacity of a clay may be tested by working up a small quantity with water into a thoroughly plastic condition, and forming it by hand into a roll about 1 to 1½ inches in diameter by 10 to 12 inches in length. If such a roll is sufficiently cohesive not to break on being suspended by one end when wet, the tenacity of the material is ample. To test its power of retaining water, one to two cubic yards of the clay should be worked with water, by the usual methods, to a compact homogeneous plastic condition; and then a hollow should be formed in the centre of the mass capable of holding four or five gallons of water. After filling the hollow with water, it should be covered over to prevent evaporation, and left for about twenty-four hours, when its capability of retaining water would indicate its suitability or unsuitability for making puddle.

* Abstract of paper by William Gallon, Assoc. M. Inst. C. E., from Excerpt Minutes of Proceedings of the Institute of Civil Engineers.



SOME RULES FOR THE HEAD OF A DEPARTMENT.

Col. George Findlay, General Manager of the London and North-Western Railway, and Lieut.-Colonel in the Engineer and Railway Staff Corps, has written a book on "The Working and Management of an English Railway, in which, among other things, he gives, from the results of his own experience, some rules as to the way in which the head of a department should transact his business. Their sound practical sense will commend itself to every intelligent reader who has had experience in such a position and those in authority who have the wisdom and "grit," for it takes both, to adopt such rules and to stick to them will be well repaid. Rule 3 is especially important, and to secure its full benefit no duty should ever be put off beyond the time when it should be performed, for a duty postponed always weighs on the mind, and prevents undivided attention being given to anything else.

The rules are:

1. Choose your subordinates carefully and well, and let them be men you can thoroughly rely on. Do not concern yourself too much with points of detail, with which you must be fully conversant, but with which they are just as well able to deal as you are, and reserve yourself for such matters of moment as they are not competent to decide without your authority and experience.

2. Before any question is submitted to you for decision, insist upon having all the details filled in, and all the facts before you, so that you may not have to apply your mind to it a second time, but may decide it once and for all with a full knowledge of all its bearings.

3. Always decline steadily to attempt to do two things at once. If you are giving an audience to one person, be it a head of a department, or any other, let your door be rigidly closed to every one else for the time being. Let "one at a time" be always your maxim, and act upon it strictly. The man in authority, who is seen continually surrounded by a throng of subordinates, and striving to meet all their demands at once, is the man who, by reason of excessive wear and tear, is most likely to break down in mid-career, and fail either in health or intellect; but the man who steadily concentrates his brain power upon one thing at a time, never wasting a moment, but never flurried or hurried, is the man who gets through the greatest amount of work with the least toil and harassment to himself, and in the shortest possible time.

4. Always make a point of refusing (except, of course, in special circumstances) to see chance callers, who will otherwise occupy the best part of your time with trivial matters which could just as well be attended to by your subordinates. It is a good plan to make it a rule to see no one without an appointment made beforehand, either in writing or through your secretary, or else without previously knowing their name and the nature of their business. It is very amusing, at times, to see the pertinacious attempts which are made to break through this rule, and it can only be maintained inviolate by the agency of a wily and imperturbable secretary, and an office which can only be approached through his.

PORTLAND CEMENT FOR SETTING IRON WORK.

A correspondent has found clear Portland cement to be a good substitute for sulphur in bedding cast or wrought iron upon stone or iron foundations. It is unaffected by oil, and can be made thick or thin with water as may be required and does not chill upon contact with cold surfaces. Where used to bed wrought-iron beams upon cast-iron column brackets it has been found to answer perfectly, even when not more than an eighth of an inch in thickness.

THE KANAWHA RIVER BRIDGE.

PART I.—GENERAL DESCRIPTION, DIAGRAMS AND TOWER.

The single-track bridge carrying the Ohio River Valley Railroad across the Kanawha River, at Point Pleasant, West Virginia, is built chiefly of steel; has a total length of nearly 1,000 feet, and weighs about 2,000,000 pounds. It was built by the Union Bridge Company, of New York, at their Athens (Pa.) and Buffalo (N. Y.) shops, and was erected for the Union Bridge Company by William Baird. J. A. Fickinger was the Chief Engineer of the O.R.V.R.R.

The bridge is designed for a live load of two consolidated engines weighing 342,000 pounds on a wheel-base of 108 feet, and followed by a train weighing 3,000 pounds per lineal foot.

The lateral and vibration systems are proportioned for the following wind-pressures

ASSUMED WIND-PRESSURES PER LINEAL FOOT OF BRIDGE LENGTH.

The upper lines of figures are pressures assumed moving, the lower ones, static.	Cantilever Shore Arm.	Cantilever River Arm.	Suspended Span.
Lower chord	$L_0 L_1$ 375 / 75	450‡	450
Upper chord	$U_1 U_{11}$ 125 / 125	90†	120*

* 200 pounds when bridge is unloaded.
† 150 pounds when bridge is unloaded.
‡ 250 pounds when bridge is unloaded.

Figure 1 is a collection of diagrams in which the tension members are all shown by single light lines; the compression members of the lateral and vibration systems and vertical posts of the main trusses are shown by single heavy lines, and all other compression members of the main trusses are shown by double lines.

The points of connection in one truss are designated by the letters L M N U and T, and in the other truss by L' M' N' U' and T'. The trusses are both alike, and the bridge is symmetrical about its centre line L 24 U 24.

Figure 3 is an elevation from Z Z Fig 1, showing the connections of end posts and tower to pedestal at L 12.

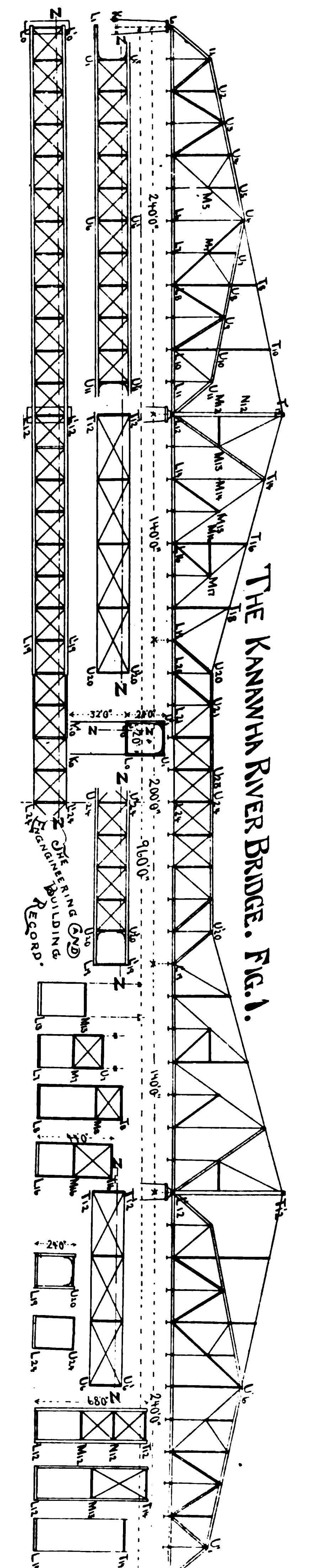
Figure 2 is a section and elevation at X X, Fig. 3.

Figure 4 is a plan of the pedestal from V V, Fig. 2. At the left of centre line C C of the truss, the connected members are shown in section through the centre of the pin, the sections of the tower and end posts are made solid black for clearness. At the right of C C the pin and the tower and end posts are removed to show the shoe more distinctly.

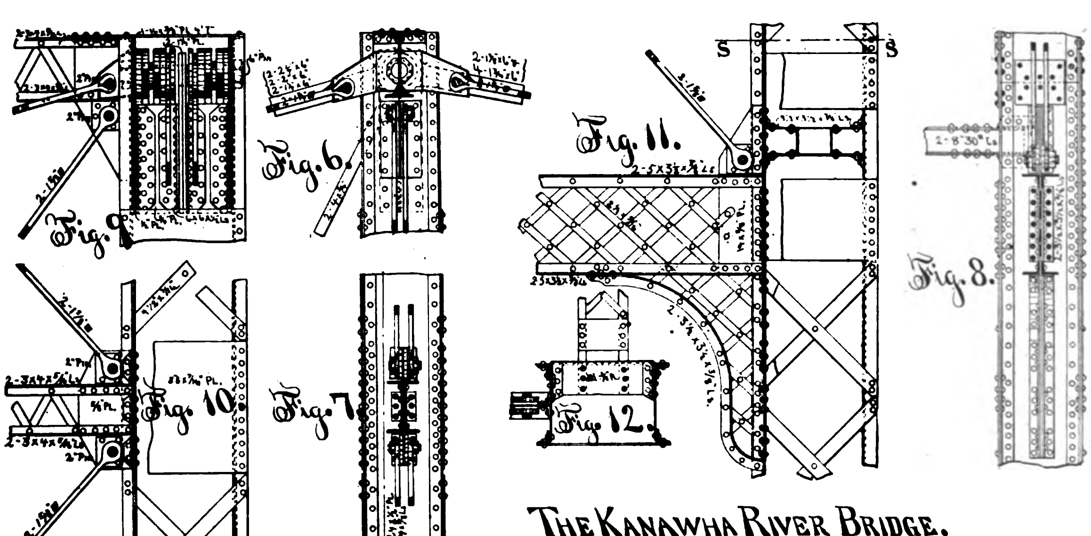
Figure 5 shows the pedestal with the shoe and connected members removed. The upper half, above centre line C C is in plan, the lower half is in section at R R, Fig. 3.

Figures 6, 7 and 8 are elevations and sections from Z Z, Fig. 1, showing details of connection at T_{12} N_{12} and M_{12}. Figures 9, 10 and 11 are elevations at right angles to Z Z, of the same connections; and Fig. 12 is a section at S S, Fig. 7. At the left of Figs. 10 and 11 part of the vertical post is removed to show clearly the sway bracing connections.

(To be continued)

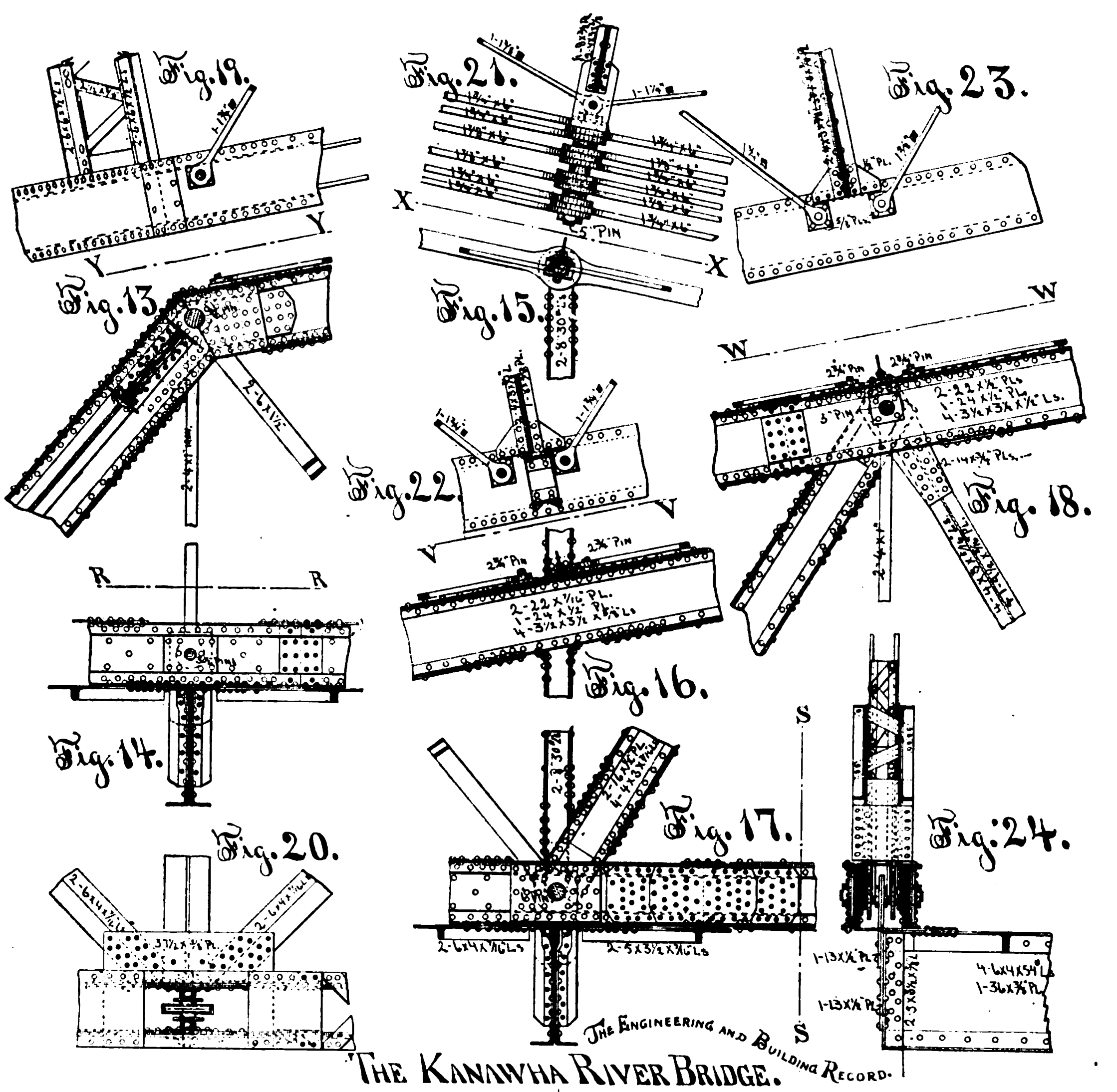


The Kanawha River Bridge. Fig. 1.



The Kanawha River Bridge.

The Engineering and Building Record.



THE KANAWHA RIVER BRIDGE.

PART II.—DETAILS OF CANTILEVER SHORE ARM.*

(Continued from page 161.)

FIGURE 25 is a diagram of the cantilever shore arm essentially the same as a part of Fig. 1, page 161, and is reprinted here for convenience of reference.

Figures 13, 14, 15, 16, 17, and 18, are sections and elevations from Z Z, Fig. 1, and Fig. 25, showing details of connections.

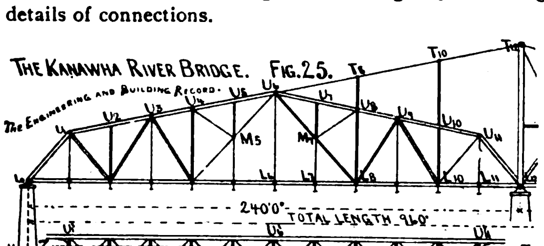


Figure 13, at U'_{11}; Fig. 14, at L'_{11}; Fig. 15, at T'_{10}; Fig. 16, at U'_{10}; Fig. 17, at L'_{10}; and Fig. 18, at U'_9.

Figure 19† is an elevation at Y Y, Fig. 13.

Figure 20 is a section and elevation at R R, Fig. 14.

Figure 21 is an elevation at X X, Fig. 15.

Figure 22 is an elevation V V, Fig. 16.

Figure 23 is an elevation at W W, Fig. 18, and Fig. 24 is an elevation and section at S S, Fig. 17.

(TO BE CONTINUED.)

THE OVERTHROW OF A CHIMNEY STACK.

IT having become necessary to remove the chimney stack, 100 feet high by 10 feet square, on the Griswold Mills property, New Bedford, Mass., it was undermined by knocking out the bricks on the west and north sides, and then shored up by planks placed in the apertures. These planks were liberally covered with tar and kerosene, and when the time arrived for overthrowing the chimney, they were fired. As they became sufficiently burned to cease to support the chimney, the mass settled to the north, and then cracked and fell with a crash to the ground. The bricks at the top were scattered over quite a large area, while the iron coping was broken into a number of pieces. Along the length of the chimney to the height of 60 feet or 70 feet, masses of brick for a length of two feet or more clung together, and did not break up.

* Part 1, General Description, Diagrams and Tower, was published August 17.

† Figures 19 to 22 inclusive *correspond* to Figs. 13 to 18, but are reversed in position and strictly accurate, only for the points in truss L_0 I_{11}, not L'_0 L'_{11} as Figs. 13 to 18 are.

IRON ROOFS.*

IT is the purpose of the writer to deal with manufacturing buildings as illustrated, in a measure, by the practice now prevailing among the manufacturing corporations of New England.

Styles of Construction.—There are as many different styles and forms of iron trusses for roof purposes used as there are different needs for different styles and outlines of buildings, from the plain hip roof, generally made with a Fink truss, to the Mansard and arched forms of trusses which are used for depots and train sheds.

Iron roofs are built either with riveted or pin connections, depending on the span, conditions of loading, etc. Spans of 60 feet and under, and sometimes longer spans, are almost invariably built with riveted connections.

The style of roof truss to be used depends on the span, condition of loading, surroundings, etc.

Iron buildings are usually one story high, and constructed of iron roof trusses, supported by iron columns on the sides, spaced from ten to eighteen feet apart, according to the circumstances.

The columns are connected with angle-iron purlins, and then covered with corrugated iron—a very simple form of construction, and one particularly adapted to locations where it is difficult to procure a good foundation for brick walls, or in cases where every inch is valuable, and you do not wish to take up valuable space with a thick brick wall, as the corrugated iron does not take up more than one inch of space for side walls.

Capacity.—The capacity of an iron roof varies with the location the same as with highway bridges, and is estimated at from 30 to 60 pounds per square foot of roof surface.

Live Loads and Shafting.—Where buildings are exposed to severe winds, and in northern latitudes, where there is liable to be a large accumulation of snow, 40 pounds per square foot is none too great capacity. The capacity also depends somewhat upon the construction; for example: a very steep roof over a building constantly warmed to such a degree that no snow will ever accumulate upon the roof, does not need as great a capacity as a flat roof over a building which is only heated to a medium temperature, where the snow is liable to remain for some time and to accumulate moisture from rain or the surrounding atmosphere.

Again, different roofs in the same building and different trusses in the same roof may require heavier capacity over certain portions where the snow is more liable to accumulate than over other portions where it may discharge itself easily.

Many roofs are built with the idea of carrying loads back and forth through the building by means of a trolly and cranes suspended from the trusses, and when occasion requires this, special precautions should be taken to have the trusses well braced and of a sufficient capacity to carry these loads. Roofs often built for a live load of two or three tons, are loaded with two or three times this by ignorant employees, who do not understand that because a bar of iron will stand two tons with safety, that sometimes three times that amount will rupture it, and twice that amount is liable to strain it beyond the elastic limit.

Most manufacturing buildings also require roofs to support shafting, and their capacity depends in a great measure on the size of the shafting used, and also upon the amount of pull from the belting carried by the overhead shafting.

The amount of allowance for pulling of belting is a matter more of judgment than of calculation.

Another thing to be guarded against in building iron roofs which carry shafting, is to have the trusses so well braced and stiffened that there will be little or no vibration owing to the shafting being out of line or unevenly balanced pulleys.

At the present time there is a good deal of trouble in securing large pieces of timber which are well seasoned, and if the rafters and tie-beams are made of three or four pieces, owing to the unequal shrinkage, the trusses or parts of the trusses are apt to warp and twist so badly as to throw the shafting out of line and thus increase the expense of power. Iron trusses contract and expand from change of temperature with a uniformity which does not affect the shafting or the walls if proper provision is made for it, but it is the unequal swelling and shrinking of wood trusses which causes trouble. The timber when put in is generally green, and as most buildings are warm and well ventilated, it soon gets very dry and well seasoned, and very liable to season crack and weaken the trusses, oftentimes to one-half their capacity.

Many times manufacturing establishments shut down for two, three or four days, and sometimes as many weeks, and are then cooled off and admit the roof to absorb enough moisture from the surrounding atmosphere to cause the trusses to get out of place from the swelling of the timbers. All this causes the shafting to get out of line and also increases the expense of power.

Unit Strains.—Under ordinary conditions the unit strains may be taken at 15,000 pounds per square inch in tension, and 12,000 pounds per square inch in compression, reduced by proper formulæ, as the loads are generally of a stationary character; but where large pieces of machinery are to be raised, or heavy shafting suspended from the trusses, the unit strains should be the same as for highway bridges, viz.: 12,000 pounds per square inch in tension, and 9,000 to 10,000 pounds per square inch in compression, reduced by proper formulæ.

Wherever live loads are to be considered in the construction of iron roofs, no part shall be strained under these live loads, and including the dead weight of snow and roof to exceed 12,000 pounds in tension and 9,000 to 10,000 pounds in compression, reduced by proper formulæ.

The particular advantage of a building with an iron roof rather than a wooden roof is that iron will not burn, and is, therefore, practically fire-proof. There is no such thing as a fire proof building for anything, whether made of iron or wood, for no matter what it is composed of it will burn if sufficient heat can be generated; but a building made of iron, if properly constructed, has nothing about it to catch fire.

The writer had occasion two years ago to design an iron roof over the muffles in a large brass mill. The main portion of the mill was made entirely of wood with a sheet-iron roof; but as there was no fire in any part of the building it was deemed by the Insurance Company a good risk. The owners, however, were afraid of fire being communicated from the muffles, and therefore built this building of brick with an iron roof, and well ventilated on the ridge so as to carry off the smoke, gasses and sparks.

Unfortunately during a night run the main mill took fire from a hot box, but being so poorly ventilated and the muffle room so well ventilated, the flames drew through into the muffle-room, as they could not escape owing to the iron covering of the roof of the main mill.

The result was that the iron roof over the muffles soon collapsed.

Here was a case where an iron roof was practically useless as resisting fire; at the same time it was not designed for this purpose, but was designed to prevent a fire from starting in the muffle-room.

Had there been a brick or iron partition between the two buildings, with sliding doors, the iron work of the muffle room would easily have resisted the heat of the burning main mill.

Purlins.—The purlins of an iron building should not be placed over 30 inches apart, and should be made of angle iron and well bolted to the trusses. It is bad practice to use wooden purlins on an iron roof, especially if the covering is made of iron or even of boards; for sparks often light in the cracks between the purlins and the boards; and at night, after the factory is shut down and no one around to watch, a fire will start up and endanger the loss of the whole plant.

It is advisable where more or less wood must of a necessity be used, to keep wood from wood, and where it must come in contact to place a piece of sheet iron between.

One great disadvantage of a roof covering composed entirely of iron is the fact, that in cold weather the outside temperature causes the hot air of the inside to lose a portion of its moisture, which condenses on the under side of the roof and drips. This trouble is found in roofs covered with slate as well as covered with iron. To guard against this it is necessary to have a layer of roof boards and tar paper under the corrugated iron covering, or else to use Field's patent fire-proof drip catcher, which consists of wire netting, asbestos and tar paper.

* Abstract of a paper by C. M. Jarvis presented at the Fifth Annual Meeting of the Connecticut Association of Civil Engineers and Surveyors.

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THE KANAWHA RIVER BRIDGE.

(Continued from page 186.)

PART III.—DETAILS OF CANTILEVER SHORE ARM CONTINUED, ANCHORAGE, ETC.*

FIGURE 25 is a diagram of the shore arm, and is here reprinted for convenience of reference.

Figures 26, 27, 28, 29, 32 and 33, are sections and elevations from Z Z Fig. 25 (and Fig. 1, page 161), showing details of connections.

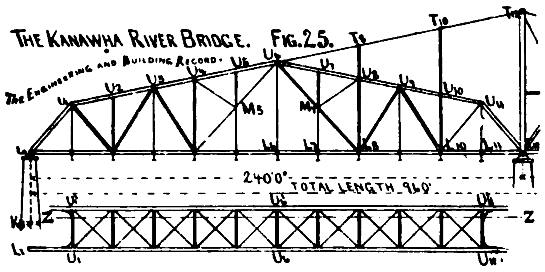


Figure 26 at U_8, Fig. 27 at M_7, Fig. 28 at U_6, Fig. 29 at M_8, Fig. 32 at U_1, and Fig. 3 at L_0 and K_0.

Figure 30 is a section and elevation at V V, Fig. 27.

Figure 31 is an elevation from Z Z, Fig. 28.

Figure 34 is a section and elevation from Z Z, Fig. 32, and Fig. 35 is a section and elevation from W W, Fig. 33.

(TO BE CONTINUED.)

AN EARLY ELEVATOR.

IN the "Greville Memoirs," it is mentioned that in March, 1830, Mr. Greville happened to be in Genoa, and visited the Royal Palace, formerly the Palazzo Durazzo. He states: "For the comfort of their bodies, he (King Charles Albert) has had a machine made like a car which is drawn up by a chain from the bottom to the top of the house; it holds about six people, who can be at pleasure elevated to any story; and at each landing place there is a contrivance to let them in and out."

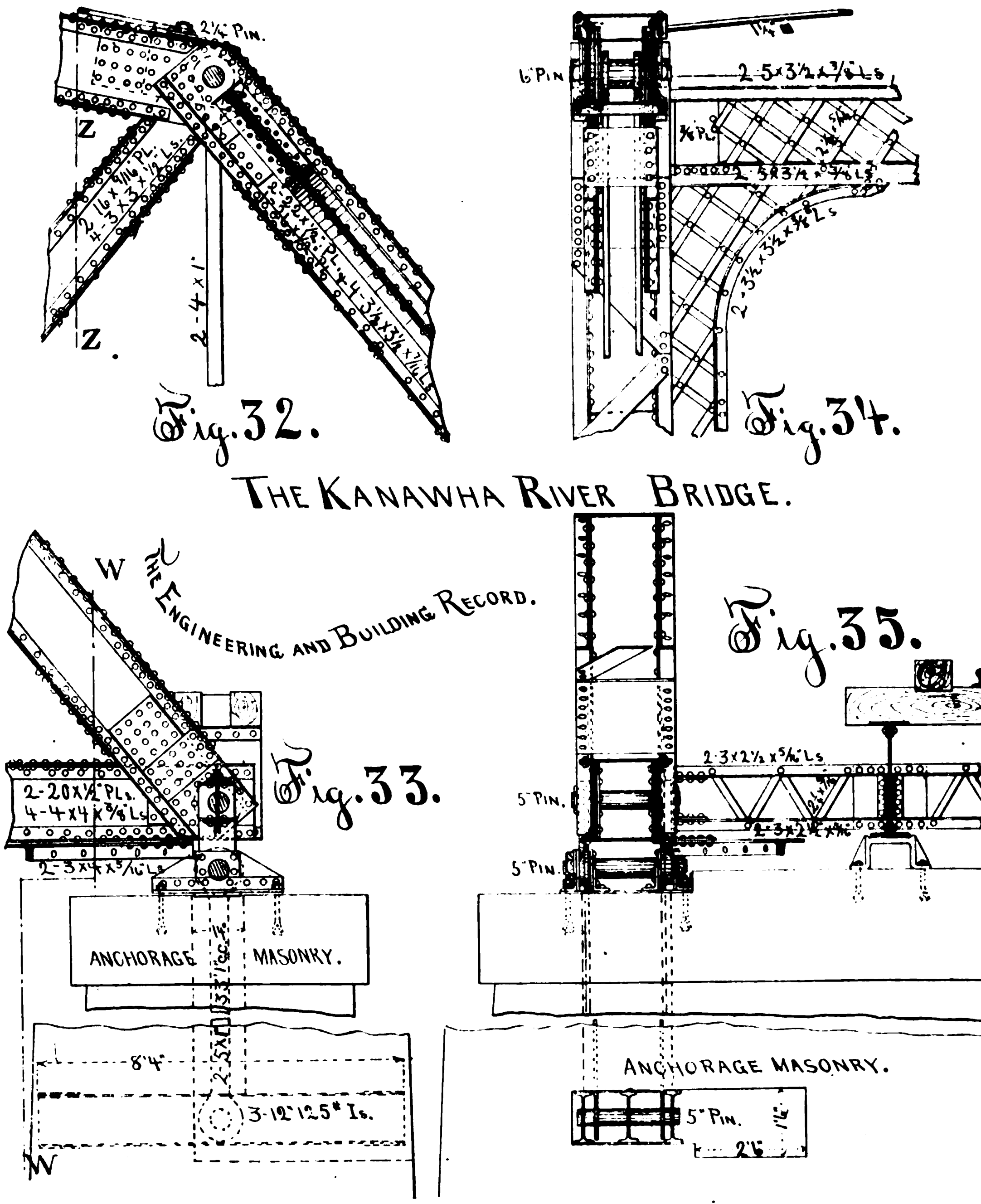
NEW YORK'S UNCLEAN L ROAD STATIONS.

THE New York Board of Health inspectors report that fifty-five of the Elevated Railroad stations are filthy, in bad sanitary condition and dangerous to health and life, the exceptions being the stations more recently constructed, where the sanitary regulations have been complied with.

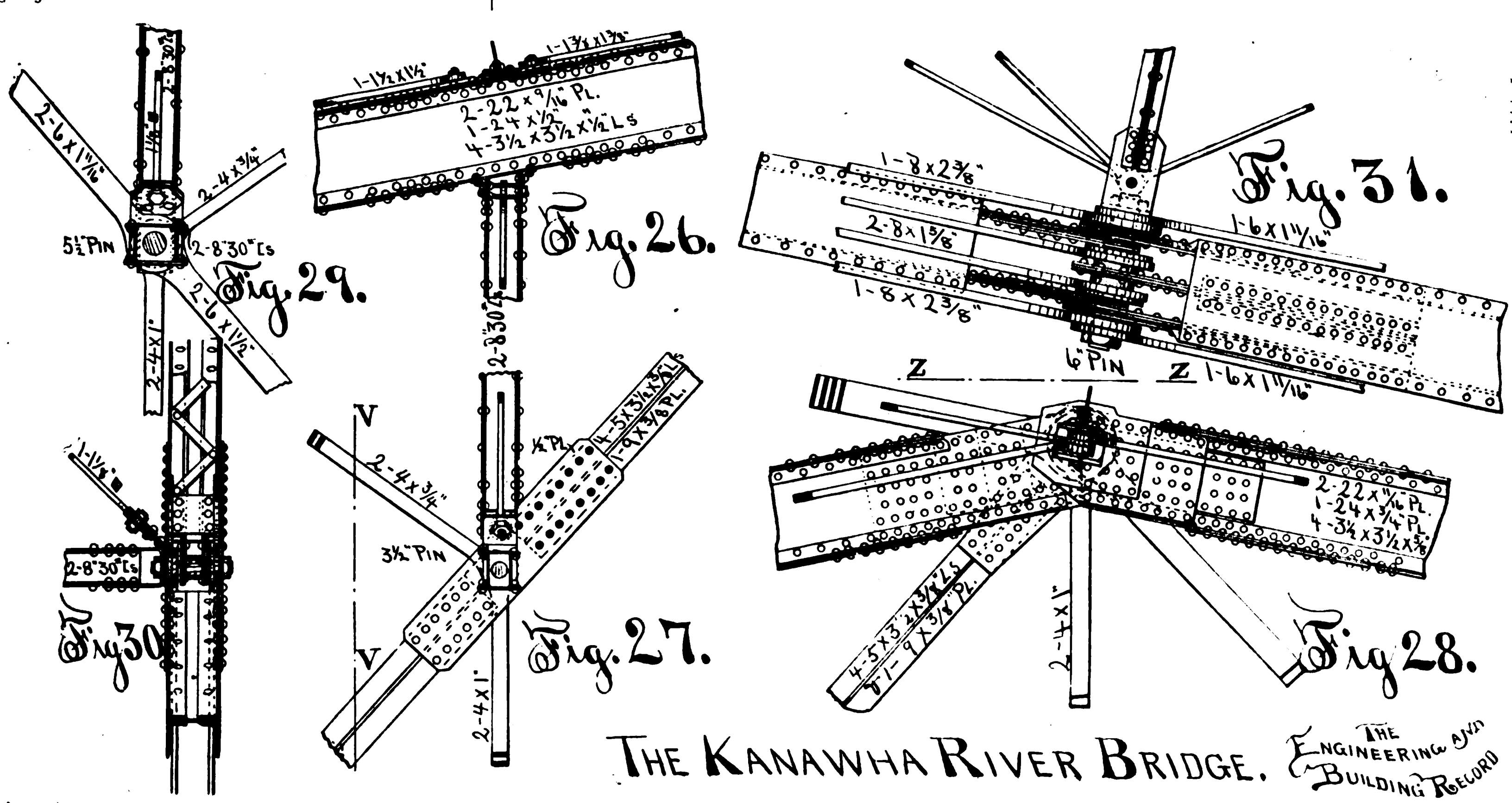
The principal nuisances complained of are in the waiting-rooms, whose plumbing is frequently defective.

IT IS REPORTED that Naples is to be extensively rebuilt for sanitary reasons. The Porto and Mercato districts, where more than 100,000 people live, are to be entirely reconstructed, at an estimated expense of nearly $20,000,000.

*Part I, General Description, Diagrams and Tower, was published August 17. Part II., Details of Cantilever Shore Arm, was published August 31.



THE KANAWHA RIVER BRIDGE.



THE KANAWHA RIVER BRIDGE.

Figure 24 is the detail of track and stringer arrangement at C, Figs. 19, 20 and 21, and Fig. 25 is a side elevation of Fig. 24.

Figure 26 is the detail of roller wheel at D, Figs. 19, 20 and 21 and Fig. 27 is the other elevation of the same corresponding to D, Figs. 17 and 18.

Figures 28, 29 and 30 show the vertical and batter post framing in Figs. 17 to 21 inclusive.

Figures 31 and 32 are elevations of derricks F and G (Figs. 14, 15 and 16, page 229).

Figures 37 and 38 are elevations of the iron derricks *a* and *b*, Figs. 14, 15 and 16.

In all these derricks the crab H is movable on a track carried by the plate girders A A'. The outside girders, A', are supported in the middle by overhead brackets B B, and are connected to inside girders A only at the ends, so that the fall C of crab H can travel unobstructedly from end to end. The girders A A' are surmounted by a working platform that is protected by a hand rail.

Traveler *a*, Figs 37 and 38, has the wheel base extended beyond the foot of the tower for stability and is further secured in position by grips (Figs 34 and 35) that anchor it to the rails. The plate girders are also guyed by steel cables (C C, Fig. 39), which can be adjusted by the tackles B B, Fig. 36.

These derricks command all parts of the trusses and have sufficient reach to hoist readily from the ground.

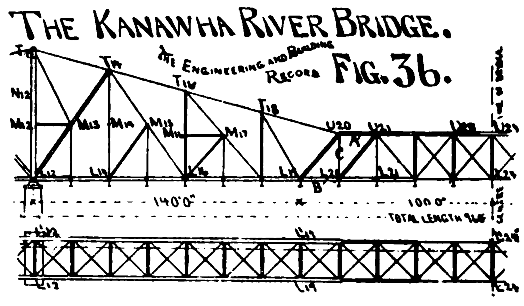
Of the 32,000 rivets in each panel, only 4,000 were shop-driven, 8,000 were driven on the ground at the foot of the false work, and the remaining 20,000 were driven from the platforms. About 215 men were employed daily. The first panel was finished May 24. The second and third were finished in 13 days each, the fourth and fifth in 12 days each, and the succeeding ones in 10 days each. Work on the nave was commenced in April and it was expected to be completed in September.

THE KANAWHA RIVER BRIDGE.

(Continued from page 217.)

PART IV.—DETAILS OF CANTILEVER RIVER ARM.*

FIGURE 36 is a diagram of half the 480-foot structure between towers that is symmetrical about the centre line, U_{24}, L_{24}, and comprises one cantilever river arm, T_{12}, U_{20}, and half the suspended span, U_{20}, U_{24}.



* Part I., General Description, Diagrams of Towers, was published August 17. Part II., Details of Cantilever Shore Arm, was published August 31. Part III., Details of Cantilever Shore Arm (continued), Anchorage, etc., was published September 14.

Figure 36 is the same as a portion of Fig. 1, page 161, but is reprinted here for convenience of reference.

Figures 37, 38, 39, 40, 41 and 42 are sections and elevations from Z Z, Fig. 36 and Fig. 1, showing details of connections.

Figure 37 at T'_{14}, Fig. 38 at T'_{14}, Fig. 39 at L'_{14}, Fig. 40 at M'_{13}, Fig. 41 at M'_{15}, and Fig. 42 at M'_{14}.

Figures 43 and 44 are elevations from lines Z Z and Z Z, Figs. 37 and 38.

Figures 45, 46 and 47 are elevations and sections from lines Z Z, etc., Figs. 40, 41 and 42.

(TO BE CONTINUED.)

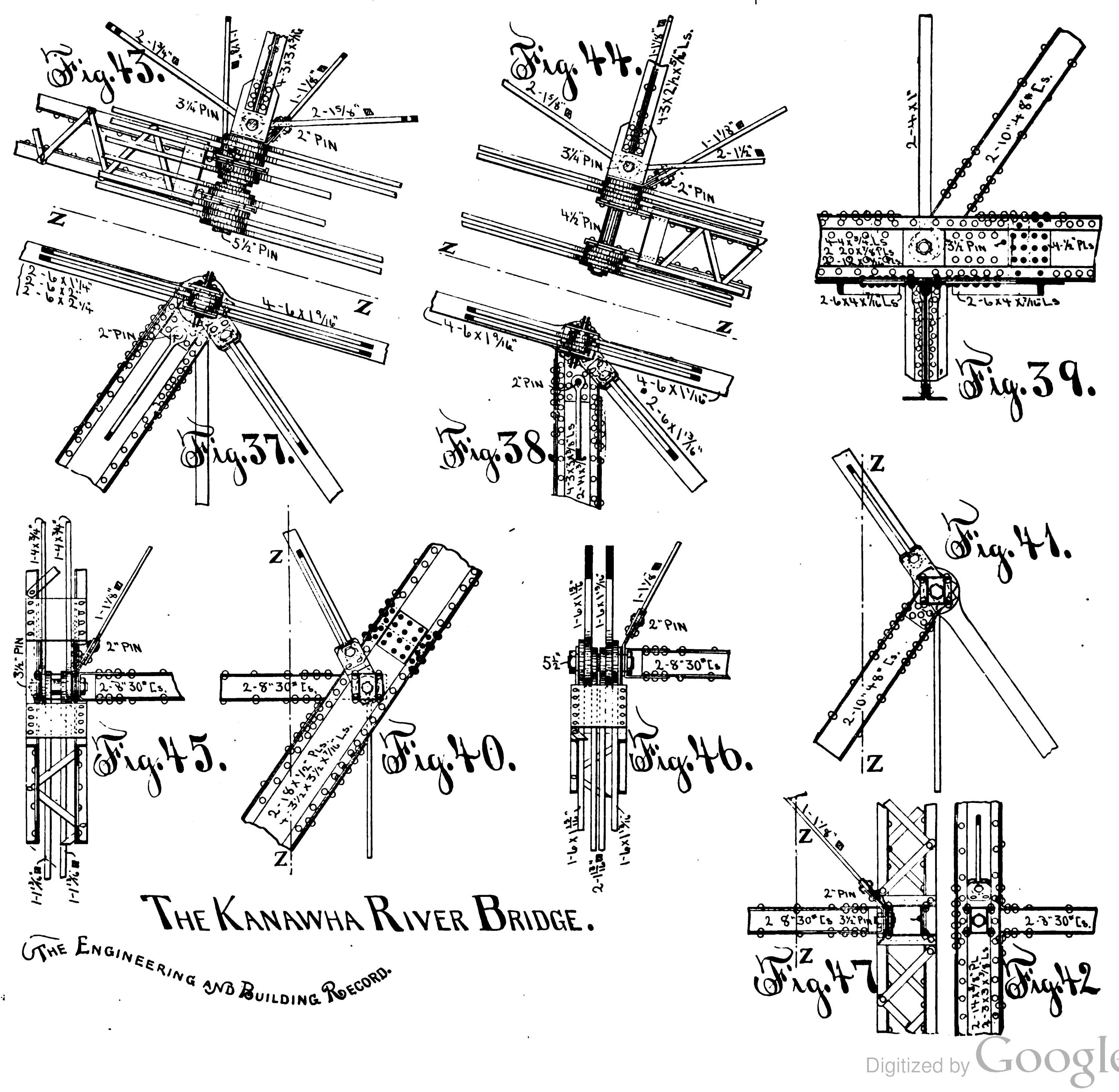
ROOF TERRACE CONSTRUCTION IN EUROPE.

IN a letter to *La Semaine des Constructeurs*, Engineer Paul Sée says, that for a roof terrace the "German Wood Cement" (improperly so called) is much used in Germany, and thus describes it:

On a strong grillage 2-inch matched plank are laid with a slope of 1 in 10, on this platform are laid four thicknesses of strong paper, between each of which is a layer of vegetable tar, especially prepared so as never to harden.

This gives a durable, cheap bed, seamless and elastic and about 3 or 4 m. m. (⅛" to $\frac{3}{16}$") thick, upon it sand or loam is spread 7 or 8 c. m. (2¾" or 3") thick, and the surface is then sodded or seeded.

This construction, which is being introduced in Belgium, has been much used for hotels, state buildings, etc., in Germany.



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THE KANAWHA RIVER BRIDGE.

(Continued from page 245.)

PART V.—DETAILS OF SUSPENDED SPAN.*

FIGURE 36 is reprinted from page 245 for convenience of reference.

Figures 48, 49, 50 and 51 are in section and elevation from Z Z, Fig. 36, and show principal details of the suspended truss.

Figure 48 at U'_{21}, Fig. 49 at U'_{22}, Fig. 50 at L'_{22}, and Fig. 51 at L'_{20}.

Figure 52 is an elevation from W W, Fig. 48.

Figure 53 is an elevation from W W, Fig. 49.

Figure 54 is a section and elevation at Z Z, Fig. 50.

Figure 55 is a section and elevation at Z Z, Fig. 48.

Figure 56 is a section and elevation at W W, Fig. 54.

Figure 57, 58, 59, and 60, show the stringer connections to floor beam B at panel points L_{19}, where the floor systems of the cantilever river arm and suspended spans meet. F is the cantilever stringer riveted to the floor beam. S is the suspended span stringer, and slides freely under yoke C and on bracket E, between the guide angles D D, etc.

Figure 57 shows the stringers in elevation, and the floor beam in section at Z Z, Fig. 58 (parallel to Z Z, Fig. 36).

Figure 58 is a section and elevation at V V, Fig. 57.

Figure 59 is a plan of the top of the floor beam with the stringers and yoke removed.

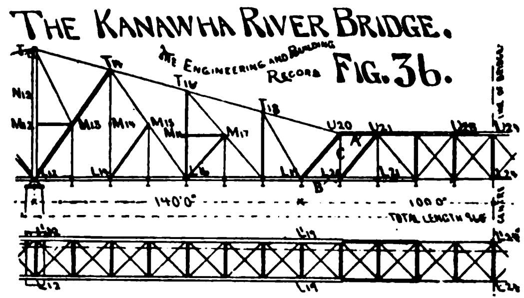


Figure 60 is an elevation from W W, Fig. 58.

(TO BE CONTINUED.)

* Part I. General Description, Diagrams and Tower, was published August 17.

Part II, Details of Cantilever Shore Arm, was published August 31.

Part III. Details of Cantilever Shore Arm continued, was published September 14.

Part IV. Details of Cantilever River Arm, was published September 28.

PUBLICATIONS RECEIVED.

REPORT OF THE TRUSTEES OF THE SANITARY IMPROVEMENT BONDS OF THE CITY OF JACKSONVILLE, FLA., TO THE CITY COUNCIL, July 1, 1889.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY: Abstract of the Proceedings of the Society of Arts, with List of Officers and Members, for the 27th year.

REPORT OF THE COMMITTEE ON WATER RELATIVE TO SECURING A PURER SUPPLY OF WATER. Allegheny, Pa. 1888.

FIRST ANNUAL REPORT OF THE HEALTH DEPARTMENT, CITY OF MANSFIELD, O., for the year from March, 1888, to March, 1889. By Harvey R. Reed, M. D., Secretary.

FOURTH ANNUAL REPORT STATE BOARD OF HEALTH OF THE STATE OF MAINE, for the fiscal year ending December 31, 1888.

SEVENTH ANNUAL REPORT PROVINCIAL BOARD OF HEALTH OF ONTARIO. P. H. Brice Secretary. Toronto. 1888.

SIXTEENTH ANNUAL REPORT BOARD OF PUBLIC WORKS, GRAND RAPIDS, MICH.

EXCERPT MINUTES OF PROCEEDINGS OF THE INSTITUTE OF ENGINEERS. London, Eng. Vol. 97. Session 1888-89:

- Perforated Cake Powder for Ordnance. By George Quick, late Fleet Engineer, R. N.
- Experiments on the Movements of Sewer Air at Wimbledon, 1888. By William Santo Crimp, Assoc. M. Inst. C. E., F. G. S.
- Foundations of Daly College, Indore. By David Michael Litster, Assoc. M. Inst. C. E.
- Water Softening and Filtering Apparatus for Locomotive Purposes at the Taff Vale Railway Company's Penarth Dock Station, near Cardiff. By William Wade Fitzherbert Pullen, Wh. Sc. Stud. Inst. C. E.
- The Removal of Rock Under Water Without Explosives. By Frederick Lobnitz, Assoc. M. Inst. C. E.
- On the New Steel Dock Gates of Limerick Floating Dock. By William Jeremiah Hall, B. E. Assoc. M. Inst.
- West of India Portuguese Railway and Harbor Works. By Ernest Edward Sawyer, M. A. M. Inst. C. E.
- Heat Expenditure in Steam Engines. By Bryan Donkin, Jun. M. Inst. C. E., and Pro. Dwelshauvers Dery, of Liege University.
- Armor for Ships. By Sir Nathaniel Barnaby, K. C. B.
- The Treatment of Steel by Hydraulic Pressure. By William Henry Greenwood, M. Inst. C. E.

REPORT OF THE COMMISSION OF ENGINEERS ON THE COLLECTION AND FINAL DISPOSAL OF THE SEWAGE, AND ON THE WATER-SUPPLY OF THE CITY OF MILWAUKEE, WIS. 1889.

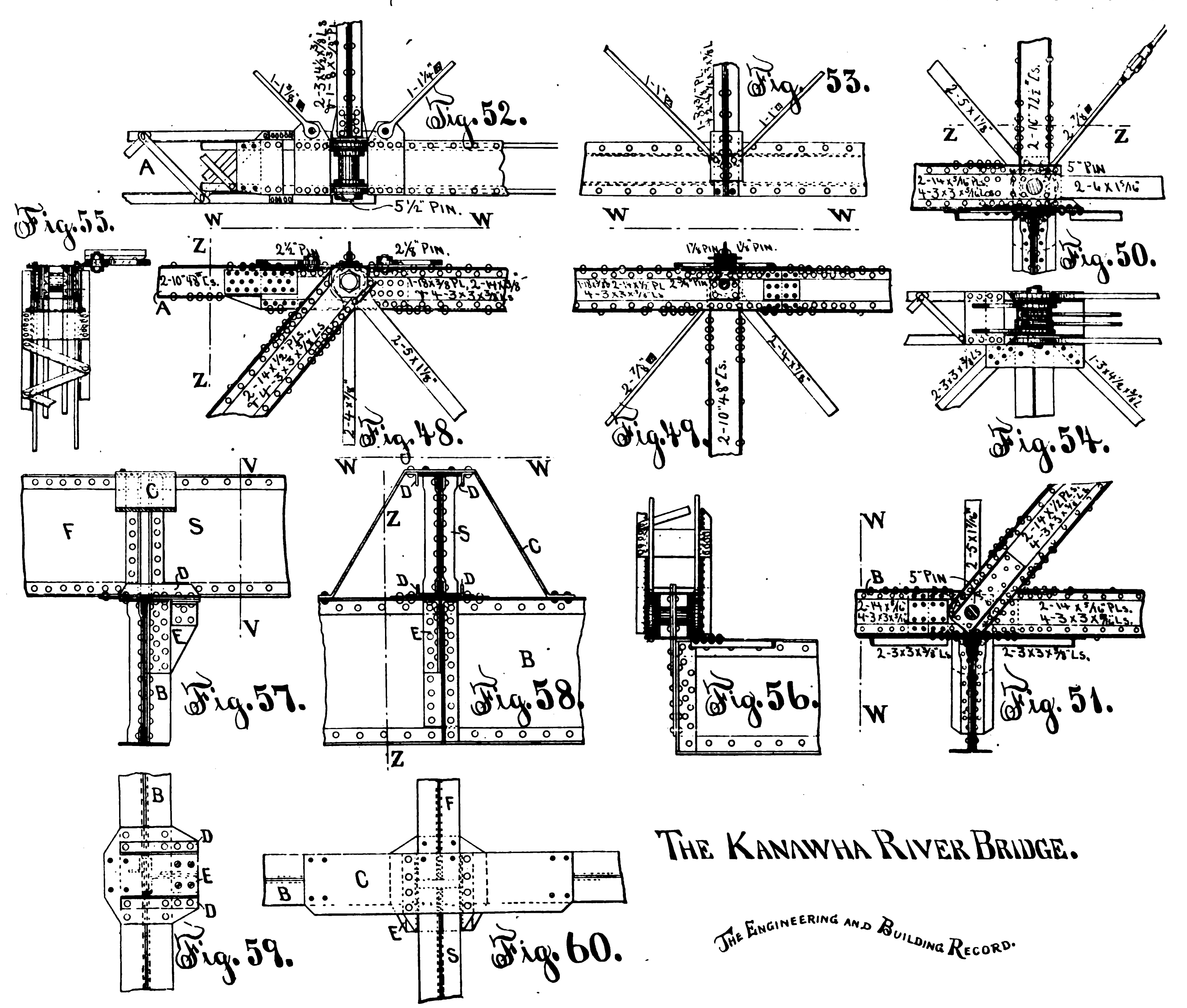
PRACTICAL BLACKSMITHING. Compiled and edited by M. T. Richardson, Editor of *The Blacksmith and Wheelwright*.

REPORT OF THE OFFICERS OF THE FIRE AND WATER DEPARTMENTS OF NORTH ATTLEBORO, MASS., for the year ending March 31, 1889.

TWENTY-SECOND ANNUAL REPORT OF THE WATER DEPARTMENT OF THE CITY OF BURLINGTON, VT. Frank H. Crandall, Superintendent.

A TREATISE ON MASONRY CONSTRUCTION. By Ira O. Baker, C. E., Professor of Civil Engineering in the University of Illinois. New York: John Wiley & Sons. 1889. Price, $5.

ANNUAL REPORT OF THE AUDITORS OF THE TOWN OF WESTBORO, MASS., AND THE ONE HUNDRED AND SEVENTY-FIRST ANNUAL REPORT OF THE TOWN OFFICERS, for the year ending February 1, 1889.



THE KANAWHA RIVER BRIDGE.

THE ENGINEERING AND BUILDING RECORD.

THE KANAWHA RIVER BRIDGE.

(Continued from page 259.)

PART VI.—DETAILS OF EXPANSION CONNECTIONS.*

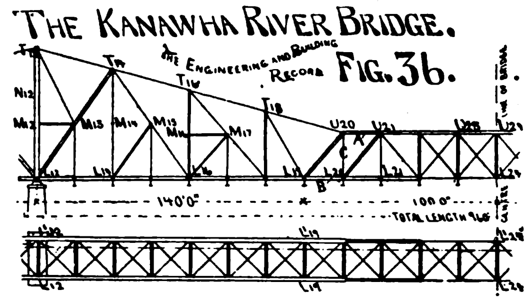
THE diagram (Fig. 36, reprinted here for convenience of reference) shows the lower end pin, L_{20}, of the centre span suspended by link C from the end pin, U_{20}, of the cantilever arm.

Members A and B are struts that receive in slotted holes the pins of the cantilever arm and permit the point L_{20} to swing freely in a vertical plane about U_{20} as a centre, thus providing for the elongations and contractions occurring in the structure between the towers. The details of main truss connections and arrangements for the separate floor and lateral systems are shown in Figs. 61 to 69, inclusive.

Figures 61 and 62 are in section and elevation from Z Z, Fig. 36, and show the connections at U'_{20} and L'_{19}. Figure 63 is an elevation from V V, Fig. 61. Figure 64 is a section and elevation at Z Z, Fig. 61. The eye-bars I I, shown in dotted lines, are temporary members used in erection. Figure 65 is a section and elevation at U U, Figs. 62 and 66, and Fig. 66 is a section and elevation at V V, Fig. 62. Struts A and B move freely on pins F and G in the direction of their own axes, but are fixed vertically and transversely.

Figure 67 is a separate elevation of part of strut A.

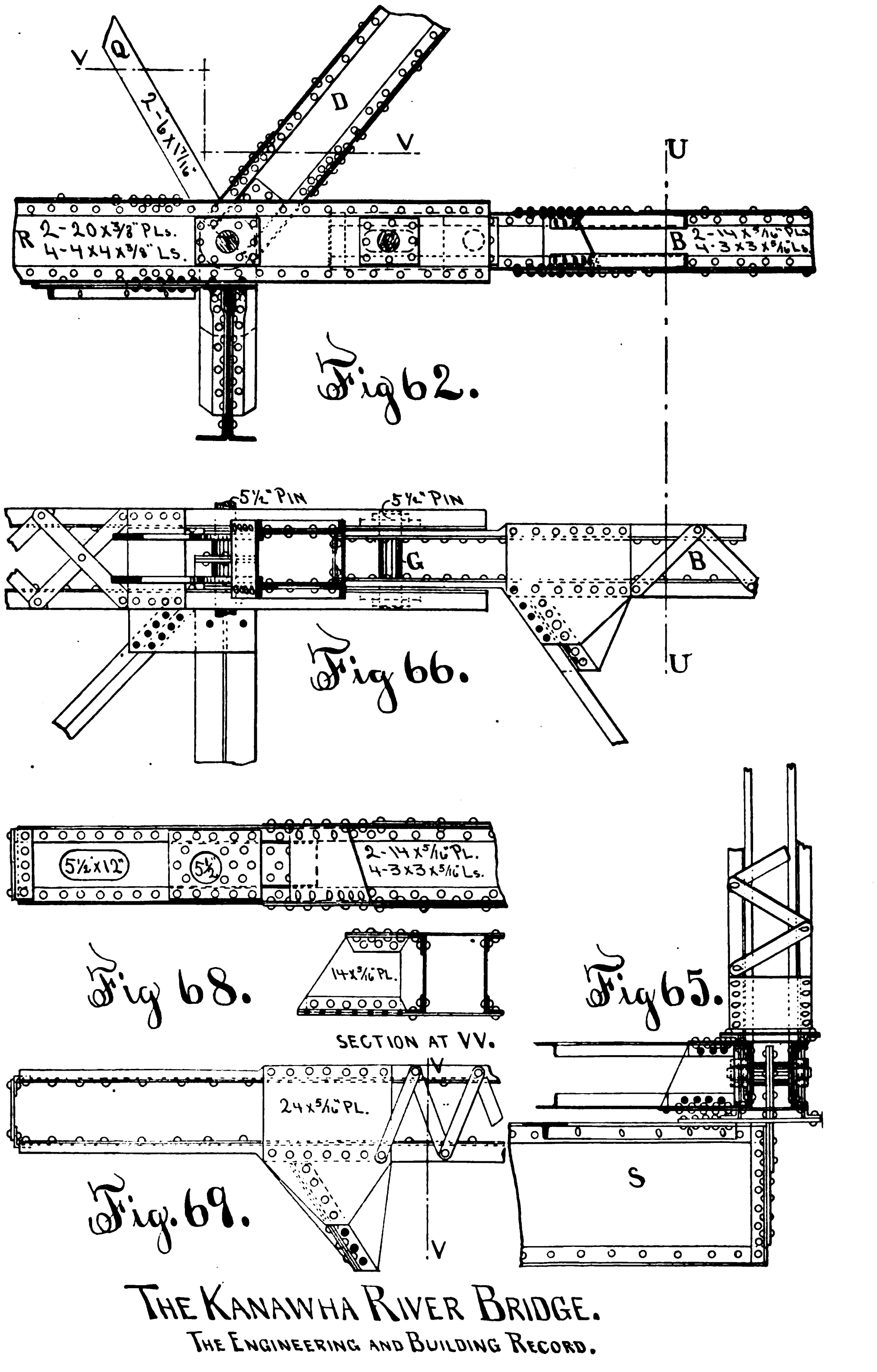
Figures 68 and 69 are vertical and horizontal elevations of strut B.



These and the preceding illustrations show all the main features of detail in this bridge, the connections not shown are similar to those that have been illustrated.

The method of erection adjustment at U_{20} and L_{19}, will be illustrated in the Builders' and Contractors' Engineering and Plant series.

* Part I., General Description, Diagrams and Tower, was published August 17. Part II., Details of Cantilever Shore Arm, was published August 31. Part III., Details of Cantilever Shore Arm (continued), was published September 14. Part IV., Details of Cantilever River Arm, was published September 28. Part V., Details of Suspended Span, was published October 5.



THE KANAWHA RIVER BRIDGE.
THE ENGINEERING AND BUILDING RECORD.

RESTORATION OF DUCAL PALACE, VENICE.

A CORRESPONDENT of the London *Times* says:

"To appreciate what has been done, it is necessary to know the weaknesses of construction in the old building, due to the carelessness or ignorance of the early builders, or to the lack of those mechanical appliances which modern art has developed. The original condition of the site was far more favorable for solidity than that of St. Mark's, being on a ridge of comparatively solid land, but the first building, of the eighth century, of which nothing is now visible externally, was evidently a modest brick castle with at least two towers, one at the corner next the Ponte di Paglia (in which the Emperor Otho was lodged), and the other where the triple column in the superior arcade of the western or Piazzetta façade breaks the uniformity of the structure. When, later, it was decided to construct a more splendid building, the Riva façade seems to have been alone originally planned for, and this triple column was intended to mark the extent of the plan. The exterior of the old building was pulled down and the new laid on the old foundations, and at the south-east angle, certainly without strengthening the foundations, intended for a much lighter building. The interior work of this tower is still visible, showing how the later structure was grafted on the earlier.

"The consequence of the piling of the enormous weight of the present mass on the slight foundation was that the foundation sank to such an extent that the superstructure on the angle was thrown forward to the distance of twenty-eight centimeters, and, but for shoring, must finally have sent the angle into the canal. The columns of the lower colonnade at the angles south-east and south-west were braced by iron bars which ran through the capitals so as to add the strength of the whole to the corner column, which bore the direct push. These bars, increasing in size by the oxidation, split the capitals without a single exception, thus weakening the building rather than strengthening it. Where the columns rested on the stylobate the bed was prepared for equalizing the pressure by pouring lead between.

"But this was never equally distributed and the pressure was not equalized, the consequence of which was that the columns sometimes split, and, as the capitals were similarly arranged and took more directly the pressure, they oftener split, and in some cases were crushed into many pieces, the corner column on the south-west into thirty or forty fragments. On the second story colonnade the capitals were tied in a similar manner, but through the entire extent of the colonnade every capital was split, and in some cases fractured badly. Then came the fire of 1577, which ruined the angle of the Ponte di Paglia especially, and when the building had escaped the Renaissance restorers, and the commission of architects decided to restore it as much as was possible to its original condition, the five arches at that angle were walled up solidly. This prevented any further deterioration on that side, but the south-west angle, that of the Adam and Eve group, was so weakened that, but for the shoring up, it had fallen into the Piazzetta.

"To remedy all these defects and release the building from the disfigurements of the balks of timber which alone prevented it from falling into the Grand Canal or Piazzetta, it was necessary to remove every column of both galleries and replace every defective stone. The arches were filled up with solid masses of timber, then wedged up till the column and capital were liberated; and this being done by sections, the columns, where found fatally injured, were replaced by new ones, the capitals in the same state were copied, the stones of the arches subjected to the same scrutiny and renewal, and the bed was prepared by the interplacing of a sheet of lead, which, yielding to the pressure, adapted itself to the inequalties of the surfaces and gave an equal bearing. The iron braces were replaced by a system consisting of bronze sockets, let into the footstones of the arch, into which the iron braces were screwed, so as to be removable if in time they were weakened by oxidation and required renewal, and at the same time the strain is removed from the capital, which is a sculptured stone, and thrown on the footstone, which is simple masonry.

"On the south-east corner it was necessary to extend the building twenty-eight centimeters to restore the equilibrium, and for this end it was necessary to renew almost the entire stone-work of the arches and entablatures; the foundations had to be strengthened and the whole angle rebuilt. All this has been done, and every column and capital has been replaced, or, if possible, repaired; the walls, where weakened by the fire, have been rebuilt, and the last brace of timber has been removed, so that the old building now stands as no one of this generation has seen it—on its proper foundations. There is still a boarding around the lower gallery, to enable the workmen who are paving the gallery to work undisturbed, and when this is done the last hindrance to a complete view of the ducal palace will be removed.

"But all this was only good and successful engineering. Something more was necessary to restore to us the palace of the fourteenth century. This, too, has been done. The broken capitals, where beyond mending and service, were cemented together and copied with the most absolute exactitude, the great capitals requiring the work of a competent sculptor two years. Where repairs were possible the pieces were brought together and cemented, and bronze rings were shrunk into circular grooves in the upper and lower surfaces of the stone, being first cushioned with lead; the fragments of the ornamentation replaced if existing, and if not by new work, cemented and held by bronze clamps, and so perfectly imitated that very few people who will walk along the colonnade on the Piazzetta will be able to tell which of the capitals are the new and which are the old. I cannot. The stains, the marks of time and weather, have been so perfectly imitated on the new stone that the closest scrutiny is necessary to see what is weather-worn and what is artificially treated."

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BUILDERS' AND CONTRACTORS' ENGINEERING AND PLANT.

No. LXXV.

(Continued from page 276.)

THE ERECTION ADJUSTMENT OF THE KANAWHA RIVER BRIDGE.*

FIGURE 1 is a diagram of the bridge between towers, the cantilever arms being shown by heavy lines and the suspended centre span by light lines. The same members are indicated by the letters A, B, C, D, E, F, G, R, and Q, as in Figs. 2, 3, 4, 5, and 6, and in Figs. 36, 61, 62, 63, 64, and 66, pages 284 and 285.

The cantilever arms and end sections of centre truss being erected by the usual methods, the sliding joints at F F, G and G permitted the struts A and A to virtually lengthen, and B and B to shorten up and throw the truss segments into the position shown, in an exaggerated degree, by the broken lines. To bring the truss to its required position, and connect the centre panel members (shown by dotted lines) it was necessary to bring points N_1 and N_1 to N and N, and this was accomplished by shortening the distances between bearings of struts A and A, and lengthening the distances between bearings of struts B and B.

Figures 2 to 11, inclusive, show the details of the device made for this purpose by the Union Bridge Company, of New York, who were the contractors and builders of the bridge which was erected for them by Contractor William Baird.

Figure 2 is an elevation at F, Fig. 1, Fig. 3 is a section and elevation at Z Z, Fig. 2, and Fig. 4 is a section and elevation at V V, Figs. 2 and 3. F is the end pin of the cantilever arm, from which one end of the centre span is suspended by the link C. A is a strut rigidly connected to the hip joint of the centre truss and sliding freely on pin F in a slotted bearing. E and D are members of the cantilever truss, and all the other pieces are temporary members used only for erection purposes and then removed.

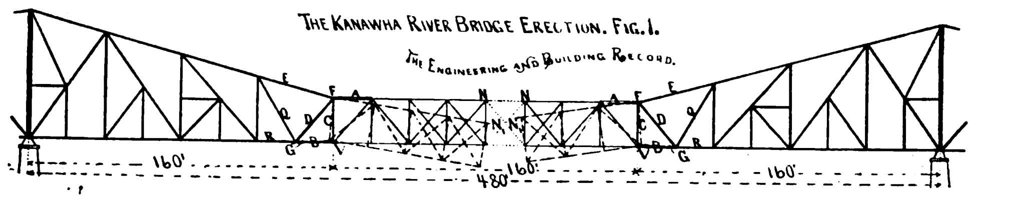
By turning capstan nut O the rod L is screwed down pulling the steel wedge K between the steel rollers J and J_1, which are thus separated, and J being secured by pin H, that is immovably connected to the fixed pin F by eye-bars I and I, the roller J_1 is forced to the left carrying with it strut A, to which alone it is connected by fixed pin G. Two slotted holes (hidden behind the eye-bars but here shown by shaded areas, for distinctness) in the strut A permit it to move freely on pins F and H while it s fixed transversely. Screwing down on L moves A in the direction P; screwing up permits a reverse movement.

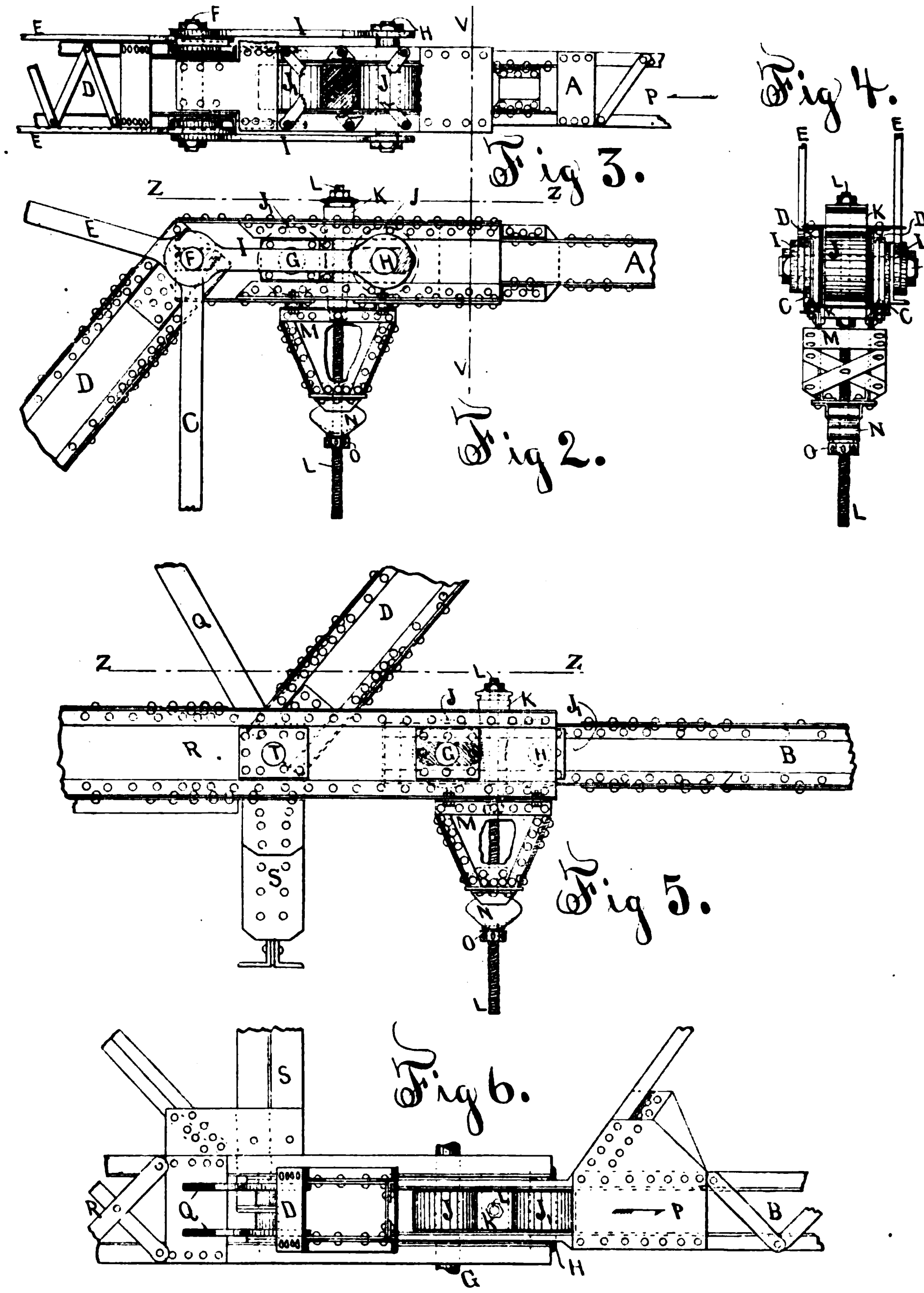
Figure 5 is a side elevation at G, Fig. 1.

Figure 6 is an elevation from Z Z, Fig. 5.

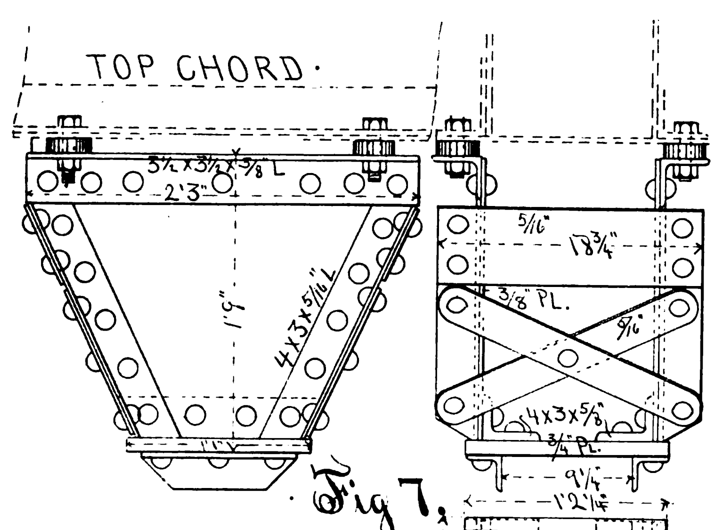
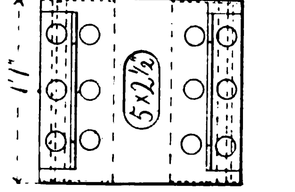
T is the end lower chord pin of the cantilever arm. D, Q, R and S are cantilever members; B is a strut rigidly attached to the lower chord of the centre span at V, Fig.

* Complete diagrams, description and illustrations of the details of this bridge have been published in THE ENGINEERING AND BUILDING RECORD as follows: Part I., General Description, Diagrams and Tower, August 17. Parts II. and III., Details of Cantilever Shore-arm, August 31, and September 14. Part IV., Details of Cantilever River arm, September 28. Part V., Details of Suspended Span, October 5, and Part VI., Details of Expansion Connections, October 19.

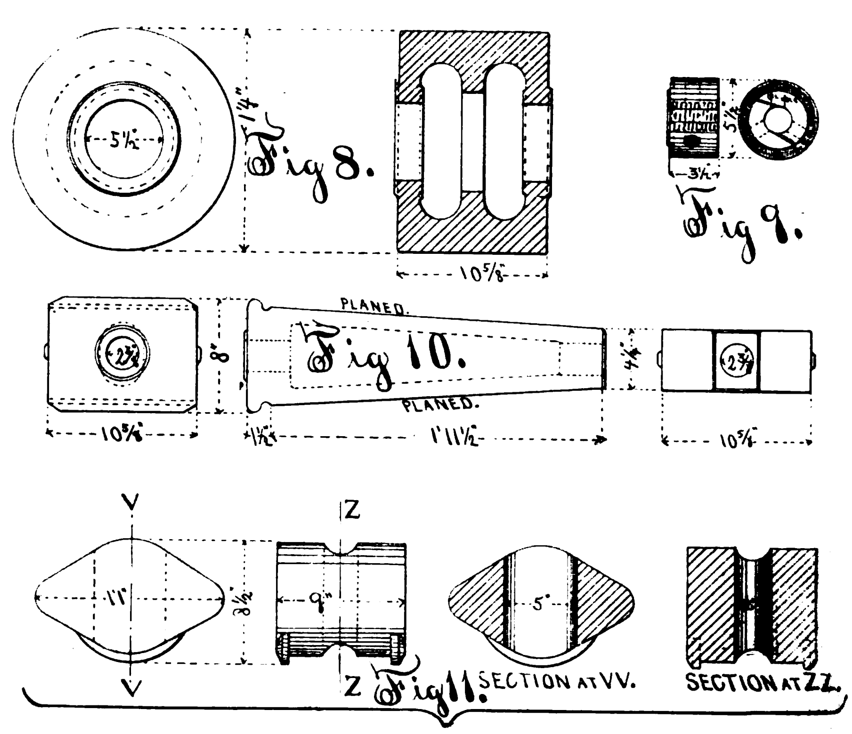




THE KANAWHA RIVER BRIDGE ERECTION.
THE ENGINEERING AND BUILDING RECORD.

THE KANAWHA RIVER BRIDGE ERECTION.
THE ENGINEERING AND BUILDING RECORD.



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1, and free to move longitudinally on the supporting pin G, which has a round hole in R and a slotted one (here hidden, but shown shaded for greater distinctness) in B. The other pieces shown are for temporary use in erection, and are afterwards removed.

As at strut A, by turning capstan nut O, the rod L is screwed down, pulling wedge K between rollers J and J_1, and separating them.

J is fixed on its pin G, immovable, in R; therefore J_1 is forced to the right, carrying with it the strut B, to which alone it is connected by fixed pin H.

Screwing down on rod L therefore moves strut B in direction P. Screwing up permits it to move in the opposite direction. Eight sets of wedge rollers, etc., were attached to the struts A and B in both trusses, and when the trusses were connected to N_1 and N_1' the wedges were operated so as to move struts A and B in the directions indicated by the arrows, until the top chords F N_1 F N_1 came into the horizontal line F F, and passed it sufficiently for required camber position. Then, by screwing up on the A wedges and down on the B wedges, the points N N were made to approach, or by reversing the screwing, they were made to recede horizontally until their position was right to receive the members shown by dotted lines, which were then connected, and the adjustment apparatus being removed, the centre span was left freely suspended from the cantilever arms by the links C and C, which can revolve enough about pins F F to conform to the temperature expansions and contractions of the trusses.

Figures 7 to 11, inclusive, show the details of the adjustment pieces in Figs. 2, 3, 4, 5 and 6.

Figure 7 is elevations of chair M. Figure 8 is an elevation and section of rollers J and J_1.

Figure 9 is elevations of the capstan nut O, Fig. 10 of the hollow wedge K, and Fig. 11 shows the rocker cushion N.

NOTES ON EUROPEAN CANAL COMMUNICATIONS.*

THE Rhine, on a navigable length of 435 miles, has a yearly traffic of 5,500 vessels averaging 200 tons each, ranging from 386 vessels of 50 tons to 14 of 1,300 tons. On the Danube the number of vessels is about 800, ranging from 75 to 525 tons, average 200 tons. On the Elbe the number is 9,400, average tonnage 106. From Vienna there may be reckoned three great waterways: (1) The Danube; (2) the Danube-Oder Canal, giving communication with Prussia; and (3) the projected connection from this canal to the Elbe.

On the Danube the westward limit of navigation is at present Regensburg, 281 miles from Vienna, although it is probable that the channel as far as Ulm, 131 miles further, is well suited for chain traction. Connection could be made with the Rhine in either of two directions: firstly, from Dillingen, about 31 miles below Ulm, *via* Konigsbronn (1,640 feet above sea-level) to the Neckar, and from Cannstadt to Mannheim; and secondly, by Kehlheim, Nurnberg and Bamberg (1,375 feet) to the Main, and thence from Frankfort to Mainz.

The canalization of the Main from Frankfort to Mainz has been attended by the most noteworthy commercial results, in spite of the unfavorable dry season following the completion of the work. The saving of freight on goods to and from Frankfort has amounted to £37,300, and to other places between the terminal points £19,750. The saving on coal freight alone has paid 6 per cent. on the Frankfort Harbor Works.

A canal is now projected from Strasburg to Ludwigshafen, which would make Strasburg a western central point of European inland navigation, as Vienna must be the central point for Eastern Europe.

RECENT WATER-WORKS CONSTRUCTION.

No. XVII.

(Continued from page 16, Vol. XVIII.)

THE MALDEN WATER-WORKS.

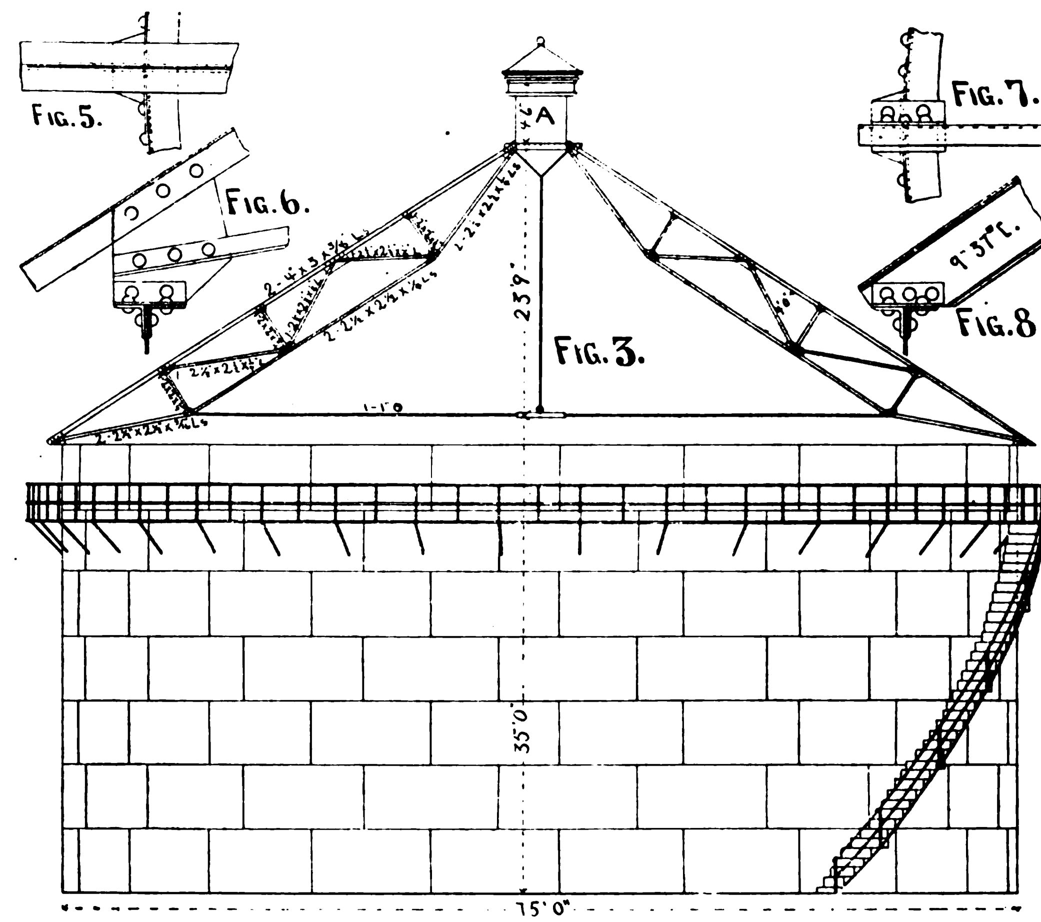
MALDEN, MASS., is a residential suburb of Boston, with city government and a population of about 20,000. The old supply is taken from Spot Pond, where there is but a limited amount of water, which runs into the city by gravity through a 12-inch cement lined pipe with about 50 pounds pressure.

In 1885 the city drove thirteen 2½-inch wells, which were experimented on with satisfactory results.

In 1888 the city appointed a committee to organize a new and enlarged system upon the plans and under the supervision of M. M. Tidd, of Boston.

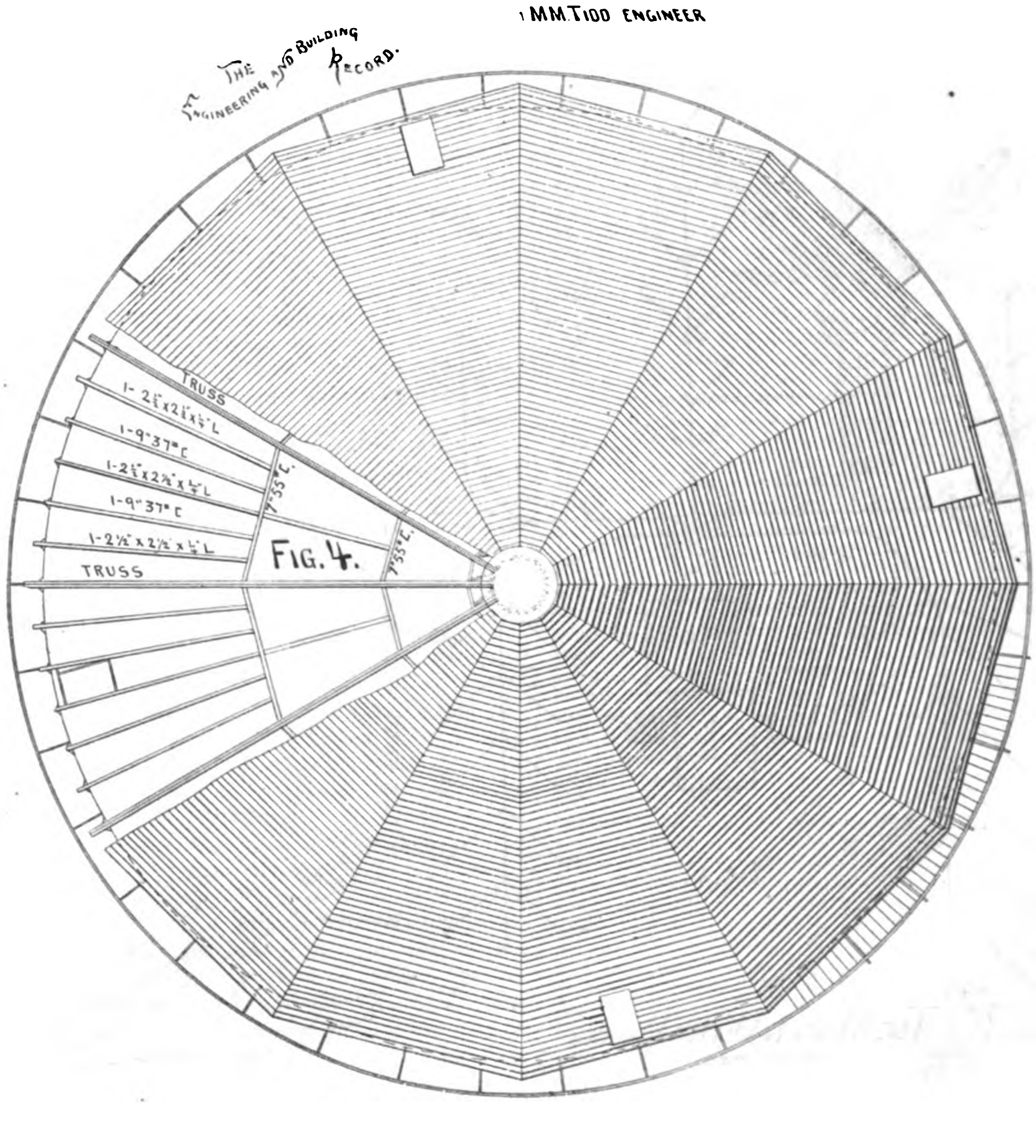
The new plant is just completed, and consists essentially of a Blake steam pump, drawing water from 51 driven wells and forcing it into a stand-pipe, which is of such proportions as to constitute a storage reservoir, from which the water is delivered by a 14 inch cast-iron main.

Figure 1 is a plan of the location and piping of the wells and the pump house. The wells are indicated by small circles with black centres, and are numbered in the order in which they were driven. Those from 1 to 13 inclusive were driven in 1885, and the remainder in 1888. Mr. Tidd rearranged the piping from the old wells, and arranged the new ones in such a manner and with such main pipes as to permit convenient future extension and secure economy and convenience of piping and a regular distribution over the water-bearing area. The soil is sandy clay to a depth of 10 to 30 feet, underlaid by a thick water-bearing bed of coarse gravel resting on a stratum of sandstone.



THE MALDEN WATER WORKS

M. M. TIDD ENGINEER



*By Paul Klunzinger. Wochenschrift des Osterreichischen Ingenieur-und Architekten-Vereines, 1889, page 33, and abstracted in Excerpts of Proceedings of the Institution of Civil Engineers.

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