Nov. 7, 1933. J. H. TOURCHETTE 1,934,286

PONTOON BRIDGE

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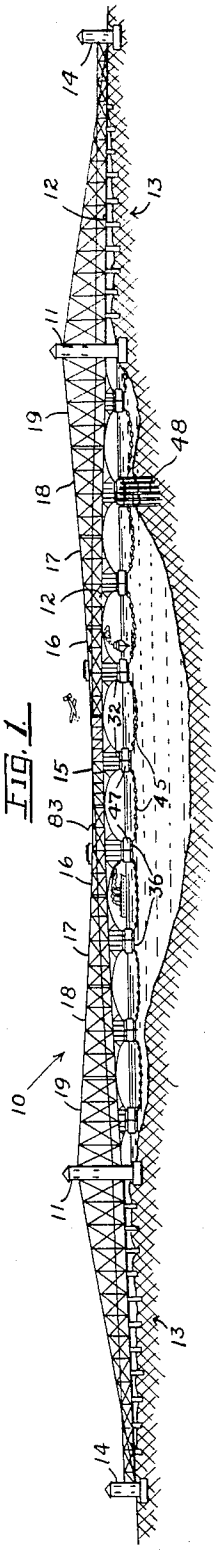


Fig. 1.

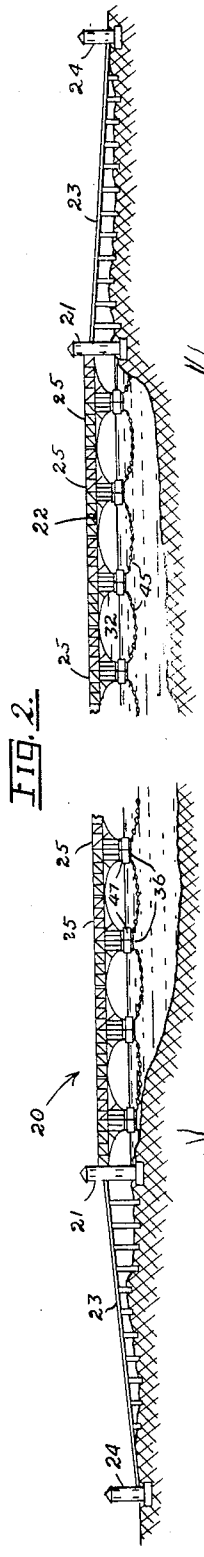


Fig. 2.

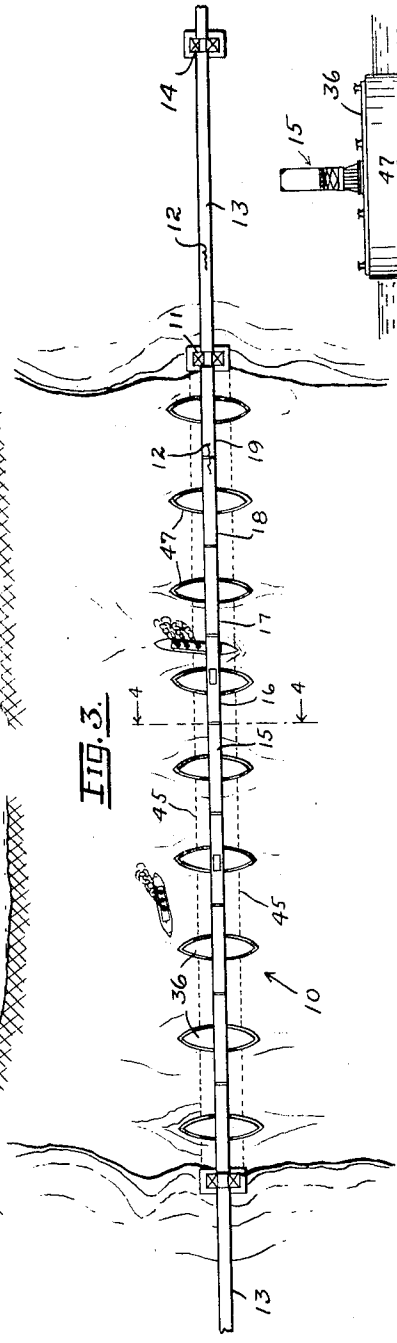


Fig. 3.

Fig. 4.

INVENTOR.
Joseph H. Tourchette
BY M. C. Frank
ATTORNEY.

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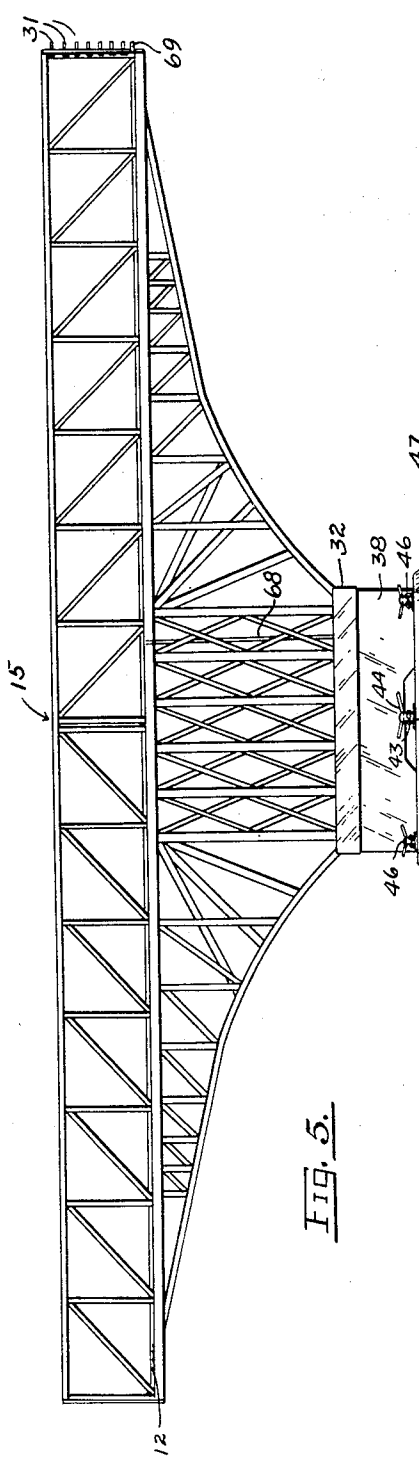


Fig. 5.

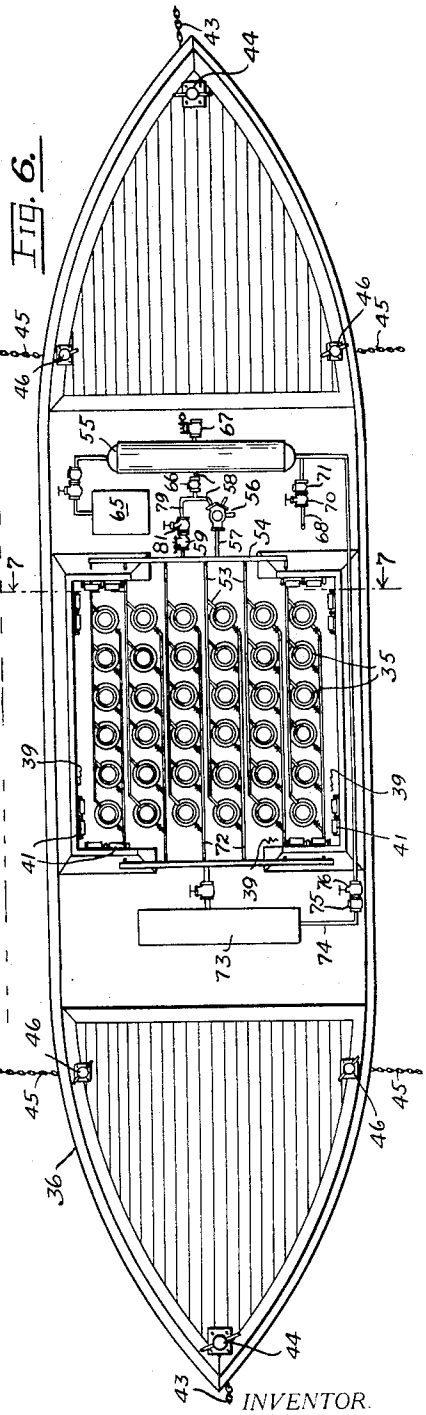


Fig. 6.

INVENTOR.
Joseph H. Tourchette
BY M. C. Frank
ATTORNEY.

Nov. 7, 1933. J. H. TOURCHETTE 1,934,286

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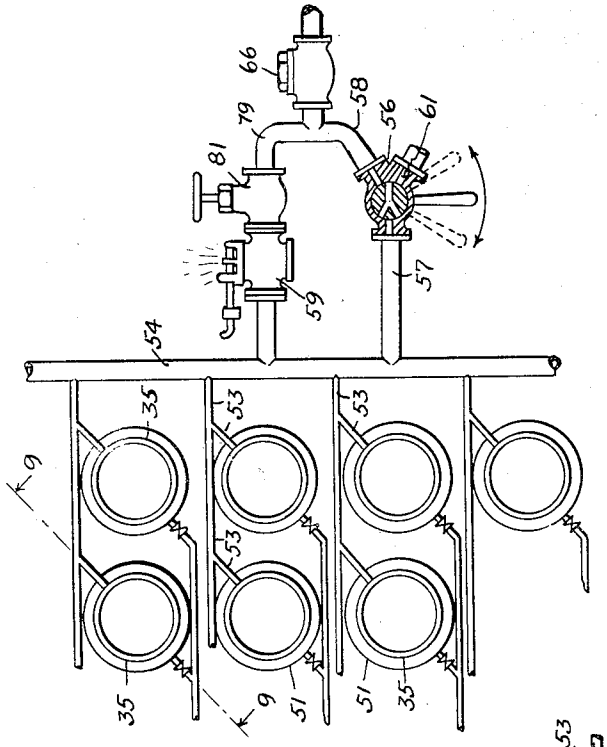


FIG. 8.

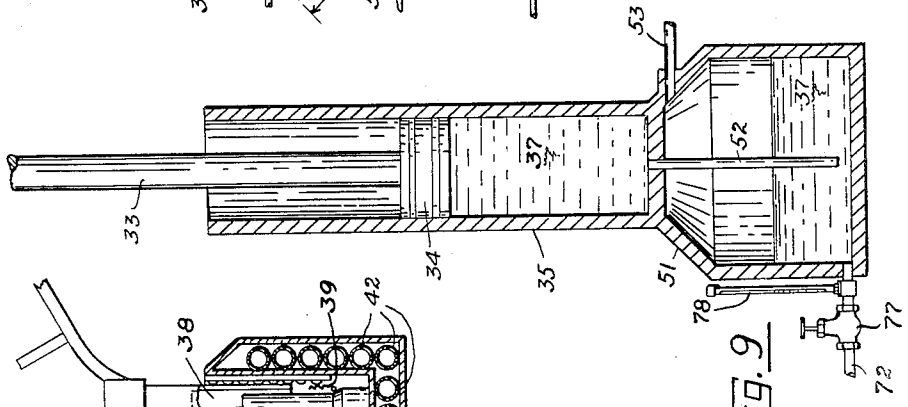


FIG. 9.

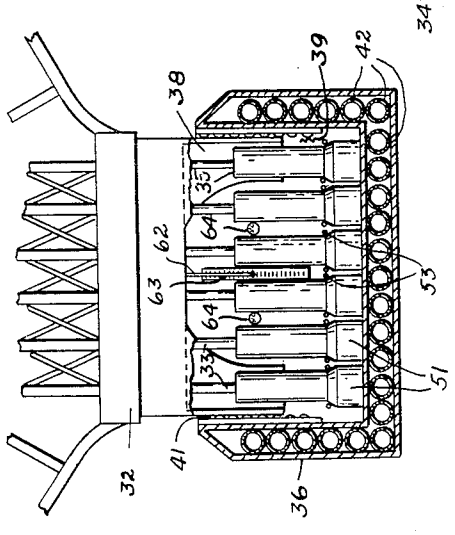


FIG. 7.

INVENTOR
Joseph H. Tourchette
BY
M. C. Frank
ATTORNEY

Patented Nov. 7, 1933

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PONTOON BRIDGE

Joseph H. Tourchette, Oakland, Calif., assignor of one-tenth to Rasmus P. Rasmussen, Oakland, Calif.

Application January 24, 1930. Serial No. 423,063

5 Claims. (Cl. 14—27)

The invention relates to a pontoon bridge for disposal across a body of water of which the level is variable.

An object of the invention is to provide a bridge of the class described which is adapted to provide a roadway in a relatively fixed position and without regard to the level of the supporting water below it.

Another object of the invention is to provide a sectional pontoon bridge of the class described which may be assembled in place as a permanent installation.

A further object of the invention is to provide a bridge structure of the class described in which the floating sections thereof are arranged to be independently removed or replaced in the assembly.

Yet another object is to provide particularly effective means for controlling the relations between the floating bridge sections and the pontoons which carry them.

A still further object is to provide for the automatic operation of the aforesaid controlling means.

The invention possesses other objects and features of advantage, some of which, with the foregoing will be set forth or be apparent in the following description of certain embodiments of the invention which are illustrated in the accompanying drawings, in which:

Figure 1 is a somewhat diagrammatic side elevation of a bridge installation embodying the invention.

Figure 2 is a somewhat diagrammatic side elevation of another embodiment of the bridge.

Figure 3 is a plan view of the showing of Figure 1.

Figure 4 is an enlarged elevation of a bridge section and its pontoon, the view being taken as at 4—4 in Figure 3.

Figure 5 is an enlarged view of a bridge section and the pontoon which carries it, the bridge section being shown in side elevation.

Figure 6 is a plan view of a section-carrying pontoon, the bridge section carried thereby being removed.

Figure 7 is a slightly enlarged transverse section of the pontoon taken at 7—7 in Figure 6, and showing a portion of a bridge section supported thereby.

Figure 8 is an enlarged view of a portion of a piping layout shown in Figure 6 and arranged for controlling the flow of fluids to hydraulic lift cylinders provided on the pontooon, a two-way hand valve of the piping being shown in diagrammatic section.

Figure 9 is an enlarged axial section through a cylinder of the structure, the view being taken at 9—9 in Figure 8.

As generally and more or less diagrammatically illustrated in Figures 1 and 3, the features of the present invention are incorporated in the structure of a pontoon bridge 10 disposed between a pair of similar land towers 11 and comprising a plurality of connected and longitudinally aligned sections mounted on pontoons and providing roadway portions for the bridge. The various bridge sections are of suitable truss structure and are of a balanced cantilever type with respect to underlying and central base, or pier, portions which are carried on the pontoons for vertical adjustment with respect thereto by means to be hereinafter described. In the present embodiment, the cooperative bridge sections are so formed that the upper and lower bridge lines are arcuately and oppositely curved whereby a rigid fixing of the sections to each other and of the ends of the bridge to the towers 11 produces a structure which resists up or down deformation, yet is not so rigid as to make the bridge self-sustaining between its ends, the bridge being arranged for spanning a stretch of water too deep for intermediate piers and too wide for spanning by self-sustaining bridges of present structure. In the present instance, the roadway 12 of the bridge conforms to and defines the before-mentioned lower and arcuate bridge line, and continues through the towers 11 for connection with suitable approaches 13 which cross the tidelands inshore of the said towers and terminate at bridgehead towers 14 at which access to the bridge may be controlled for military or other purposes.

As particularly shown, an odd number (nine) of bridge sections are connected between the towers, and the top and bottom lines of the middle section 15 are substantially straight, the latter section being the only section of the bridge in which the parts are symmetrically related with respect to a transverse and vertical central plane; the section 15, it will be noted, is that shown in Figures 4 and 5. Bridge sections 16, 17, 18 and 19 are arranged in order between the center section 15 and the respective towers 11, the like-numbered and correspondingly positioned sections being similar but reversedly related in the assembly. The precise number of sections in the bridge is of course determined by the distance between the land towers and the best practical

length for the various sections; as shown, the said sections are of equal lengths for cooperatively spanning the space to be bridged. The ends of the various sections are arranged for bolting together, or to the towers 11, throughout their entire heights thereat, as by bolts 31 shown in Figure 5, whereby rigid connections are provided at the section ends. The truss frames of said sections are such as provide a maximum rigidity of structure and may be as required, the arrangement indicated being intended as only suggestive of bridge trussing generally.

Referring now to the embodiment of Figure 2, a bridge 20 is shown as installed between land towers 21. In the present instance, however, the bridge 20 is formed of a plurality of mutually like sections 25 similar to the sections 15 of the previously described embodiment and cooperative to provide a plane roadway 22 between said towers. A rigidity against vertical distortion is not, however, provided for the bridge 20 as for the bridge 10, hence no such practical limit as to length between the terminal towers is imposed between the towers 21 as between the towers 11. The bridge 20 may thus be used to span greater stretches of water than the bridge 10, this fact being indicated in Figure 2 by a break in the bridge. Where the bridge 20 is usable, this structure possesses an added advantage in the fact that all the floating sections may be exactly alike, thus minimizing structural costs and the number of replacement sections which need be kept ready in case of emergency damage to a section. Approaches 23 and bridgehead towers 24 are also shown for the present bridge. Except for the upper structures thereof, the bridge sections of both embodiments are alike, and the following description of the mounting and positioning control of the sections on their pontoons applies in the same degree to the sections of both bridges.

Each bridge section shown extends upwardly from a central base portion 32, said base portions being alike in the present structures. A bank of piston rods 33 (Figs. 7 and 9) descends from each base 32, said rods carrying pistons 34 for sliding and sealed engagement in the bores of upwardly-opening cylinders 35 mounted on a pontoon 36 and containing a liquid 37 on which the pistons 34 are arranged to simultaneously rest in supported engagement. In this manner, a bridge section is arranged to be supported from the pontoon 36 through the cooperative bearing of the pistons 34 on the liquid 37 in the cylinders, means being provided to produce and maintain a uniform unit liquid pressure in the various cylinders of the bank thereof. In practice, the liquid 37 would usually comprise a relatively non-volatile oil, though water might serve for the purpose.

The base 32 and pontoon 36 are preferably constrained to a rectilinear relative movement thereof independently of the engagement of the pistons in the cylinders. To this end, and as shown in Figures 5 to 7, an apron 38 is provided to extend downwardly from around the base 32 and into a complementary guideway 39 provided on the pontoon. As shown, the guide-way 39 provides lines of rollers 41 for engaging the apron 38 whereby to facilitate the aforesaid relative movement of the bridge section and pontoon in the permitted direction, and to keep the same in required alignment. The height of the said guideway is of course determined by the required range of relative movement between the bridge section and its pontoon.

The pontoons 36, it will now be noted, are generally spindle-shaped in plan and are preferably disposed with their longitudinal axes at right angles to the line of the bridge. In this manner, a maximum width of surface channel is provided between the pontoons, a minimum resistance is offered to tidal or current flow transversely under the bridge, and a maximum resistance to a lateral tipping of the bridge is provided for. The bank of cylinders 35 is disposed amidship and the center of the supporting area provided thereby preferably lies in the axial line of the pontoon, this relation being particularly evident in Figure 6. Means are preferably provided for effecting a balanced support of the bridge section above the pontoon under varying conditions, a major device for the purpose being the provision and use of suitably disposed ballast tanks 42 (Figure 7) for liquid ballast, means (not shown) being provided for shifting the ballast when and as required. In this manner, weight, wind, or tide effects tending to tilt the bridge may be counterbalanced and the supporting axis of the pontoon may be maintained in a vertical direction with strain on the bridge structure minimized. The mutual end engagement of adjacent bridge sections is, of course, operative to resist an out-of-level disposal of the sections longitudinally thereof. Ballast tanks 42 are included at the ends of the pontoon for adjustment to prevent a lateral tipping of the bridge sections and the bridge as a unit; the latter tanks are not actually disclosed, as the installation and use of such tanks is well known.

For keeping the bridge sections in alignment, the pontoons may be moored at their ends to suitable anchors (not shown) by means of chains 43 (Fig. 6) of adjustable effective lengths, windlasses 44 being shown for adjusting the lengths of said chains for retaining the pontoons in their line. A further important feature respecting the relative positioning of the pontoons is the provision of means connecting adjacent pontoons beneath the water and deep enough to allow the passage of ships thereover; as particularly shown in Figures 1, 2, 3, 5 and 6, said means comprises chains 45 controlled from windlasses 46 suitably disposed on the pontoons, there being two chains 45 extending from each side of the pontoons and along opposite sides of the bridge. In this manner, a relatively fixed relation of the assembly of pontoons as a supporting means is provided independently of the bridge and as an essential feature of the bridge assembly.

Preferably, and as is indicated in Figures 1 to 5 inclusive, the pontoons are enclosed in suitable bulkheads which are spaced slightly therefrom and are structurally independent thereof. As shown, floating bulkheads 47 surround all but one of the pontoons of the bridge 10 and all of the pontoons of the bridge 20; the remaining pontoon of the bridge 10 being surrounded by a pile bulkhead 48 extending from the bed of the channel crossed. The function of these bulkheads is to minimize the effect of tidal and other surges on the pontoons, since the relative disposition of a bridge section and its pontoon is arranged to be controlled by the mean water level obtaining. The specific structure of the bulkheads 47 and 48 is not part of the present invention, and hence these elements are shown solely diagrammatically.

The unit pressure obtaining in the liquid 37 in

the various cylinders 35 of a set or bank on a pontoon is determined both by the bridge weight to be supported from a given pontoon and the total area of the pistons operative in said cylinder bank, and said pressure must not exceed a safe maximum for the cylinder structure and necessary piping provided. Control of the length of the liquid column in the cylinders 35, and therefore of the relative spacing of the section base 32 to the pontoon 36, is, for a number of reasons to be brought out, desirably effected by pneumatic means. Accordingly and as shown, in Figure 9, the bottom of each cylinder is connected with the bottom of an underlying reservoir 51 for the liquid 37 by means of a pipe 52 having its lower end arranged for constant immersion in the liquid 37 in the reservoir cavity. The various reservoirs 51 of a set are connected by means of pipes 53 (Fig. 6 to 9) with an air manifold 54 whereby the air pressures in the various reservoirs are arranged to be always equal, said pressure being determined, under static conditions, by the weight of the load to be carried by the liquid in the cylinders, and therefore being substantially constant, since the traffic load on the bridge will form but a slight part of the total load to be supported.

Should it be desired to lift the bridge section with respect to the pontoon, as when a tide has ebbed to lower the pontoon, the addition of more air under pressure to the system including the manifold 54, pipes 53, and reservoirs 51, is required. If a reverse action is desired, the escape of air would be permitted. For effecting the aforesaid control of air flow to and from the said air pressure system, the manifold 54 is connected to an air supply tank 55 through a normally closed two-way valve 56 connected to the manifold and tank by pipes 57 and 58 respectively. A relief or emergency valve 59 of the safety type is also connected to the manifold for preventing the existence of an excessive pressure therein, said latter valve being arranged to open when the excess of pressure over normal reaches a desired limit. By reference to the showing of Figure 8, the valve 56 is seen to be represented as of the hand-throttle type whereby it may be oppositely operated and adjustably set from an intermediate closed condition thereof either to allow a regulated air flow from the pipe 58 to the pipe 57, or to allow the regulated escape of air from the pipe 57 and through a normally closed port 61 of the valve while the pipe 58 is shut off.

As is indicated in Figure 7, the relative position of the bridge section and pontoon is arranged to be determined in terms of a pointer 62 carried on the section base 32 and disposable along a scale 63 carried on the pontoon. Indicators 64 are provided for determining the required reading on the scale 63, and if the actual reading varies from that required, the valve is appropriately operated to effect the required change in the relation between the bridge section and pontoon. It is noted that a too rapid inflow of air will, through the inertia of the bridge, temporarily create an excess pressure for relief by the emergency valve 59; an operator is thus constrained to add air to the hydraulic support system at a relatively slow rate.

It is noted that the piston and cylinder structure disclosed and described is the operative equivalent of a pneumatically controlled hydraulic lift having a single piston working in a single cylinder, said piston supporting a load under static conditions which approximates its working load. As indicated at 65 in Figure 6, a power-operated air compressor unit is provided on each pontoon for supplying compressed air to the tank 55 for maintaining the required supply therein. A one-way discharge check valve, indicated at 66, is provided in the discharge pipe 58 from the tank, and an automatic relief valve 67 is provided for the tank; in this manner, an excessive pressure in the pressure lift system is not communicated to the tank 55 and the pressure in said tank may be maintained at a desired maximum. Preferably, a supply of air for the various pontoons is arranged to be provided from a common source such as a compressor (not shown) located in one of the towers 11, or on a pontoon of a group thereof, and to be supplied to the tanks 55 through branch pipes 68 of a distributing pipe 69 running along the assembled bridge (Figs. 5 and 6), said pipes 68 having shut-off and check valves 70 and 71 respectively interposed therein; in this manner the operating expense for the bridge is minimized. When the latter air supply system is provided, the compressor units 65 are reserved for emergency use, said units including internal combustion engines, electric motors or other suitable operating means; if electric power is to be used, the conductors therefor may be strung along the assembled bridge from a central source. By providing for the individual control of each bridge section with respect to its pontoon, the assembly of bridge is, of course, greatly facilitated.

Replacement liquid for the various hydraulic cylinders is supplied through a system of pipes 72 from a supply tank 73 on the pontoon. As particularly shown in Figure 6, the tank 73 is connected with the compressed air tank by means of a pipe 74 having check and shut-off valves 75 and 76 therein whereby the liquid flow from the tank 73 may be controlled by air pressure. Each pipe 72 is provided with a shut-off valve 77, and a depth gauge 78 (Fig. 9) is provided for each reservoir 51; in this manner, an attendant is advised of the amount of liquid available for operating each piston and may introduce more liquid into a reservoir when and as needed. Since only leakage at the pistons may decrease the liquid supply at each cylinder, the addition of operating liquid will be only occasionally required.

Referring now more specifically to the bridge assembly 10 shown in Figures 1 and 3, said assembly is itself designed to provide for an automatic control of the fixed positioning of the bridge as the water level varies below it. For effecting such control, an alternative connection is provided between the air supply tank 55 and the air distributing manifold 54 through a pipe 79; as shown, the pipe 79 is connected to and between the pipe 58 at the discharge side of the check valve 66 therein and the relief valve 59 for the manifold 54, whereby said check and relief valves are operable for both lines of connection between the tank 55 and manifold 54. A shut-off valve 81 is interposed in the pipe 79, said valve being closed if the hand-controlled two-way valve 56 is to be used in the manner previously described.

For automatic control, the valve 56 is maintained in closed condition and the valve 81 is left open. Starting from a condition of balanced pressures wherein the unit pressures in the various parts of the pneumatic system are equal, if the water level lowers beneath the bridge, the bridge 10, by reason of its rigidity in a vertical

plane and the lowering of the pontoons, will tend to impress less of its weight on the supporting liquid in the cylinders and so lower the pressure therein. But the latter condition effects a discharge of air through the check valve 66 from the tank 55 to build up the supporting pressure to normal. Under reverse conditions, or when the water level rises, the bridge will tend to create a greater pressure on the liquid in the cylinders, and when this pressure exceeds normal by an amount which may be regulated at the relief valve 59, the latter valve is arranged to open to allow the escape of air from the pneumatic control system and permit the pontoons to move toward the bridge. The present type of automatic control is, of course, limited to bridge assemblies such as that of the bridge 10 and which are not too long to have the required rigidity for effecting said control, it being noted that such structures may be of considerably greater length than that permitted for single bridge spans which are supported only from their ends. While such is not actually disclosed, it is also intended to provide for an automatic control of the bridge 20. In the latter case, the control might be afforded through float mechanism operating in reference to a fixed point, as the shore or bottom of the body of water to be crossed.

The disclosed embodiments of the bridge are particularly designed for installation across bodies of water where periodic changes of water level occur, particular reference being made to tide waters. The levelling adjustment provided permits of the provision of a bridge of particularly high traffic capacity and for supporting trains as well as lighter vehicles. The bridge should preferably be designed to permit water traffic beneath it, and may be provided with a cover deck 83, as is indicated in Figure 1, arranged as an air port. In the case of the bridge of Figure 1, if a body of water to be spanned is too broad to be crossed by a single assembly, one or more special piers (not shown) might, when possible, be provided to extend from the bed of said body of water, each said pier providing a foundation for an intermediate tower 11. If the latter is not possible, or practicable, the embodiment of Figure 2 would be installed.

It is noted that the pneumatically controlled hydraulic support provided for the bridge functions to support the bridge proper in slightly cushioned relation to the line of pontoons. This feature minimizes the possibility of sharp and sudden strains in the structure and damps out any periodic vibrations which might tend to occur in the bridge structure.

From the foregoing description taken in connection with the accompanying drawings, the advantages of the construction and method of operation will be readily understood by those skilled in the art to which the invention appertains, and while I have described the principle of operation, together with the device which I now consider to be the best embodiment thereof, I desire to have it understood that the device shown is merely illustrative, and that such changes may be made, when desired, as fall within the scope of the appended claims.

Having thus described my invention, I claim as new and desire to secure by Letters Patent of the United States the following:

1. In a pontoon bridge, a bridge member, a pontoon member for supporting said bridge member, an hydraulic pressure cylinder on one of said members, a piston carried on the other of said members and arranged to constantly engage the liquid in said cylinder, and means automatically controlled by the level of water in which the pontoon floats to vary the quantity of fluid in said cylinder.

2. In a pontoon bridge, a bridge section, a pontoon for supporting said section, an hydraulic pressure cylinder carried by said pontoon, a piston carried by said bridge section and arranged to constantly engage the liquid in said cylinder, and automatic pneumatically operated means to vary the quantity of fluid in said cylinder whereby to vary the relative spacing of said section and said pontoon.

3. In a pontoon-supported bridge, bridge sections cooperative to provide the bridge, pontoons supporting the respective said sections, hydraulic means adjustably supporting said sections from said pontoons whereby the bridge is arranged for disposal at a constant level, and pneumatic means automatically controlling said hydraulic means to maintain said bridge at said constant level while permitting a vertical displacement of the pontoons in accordance with the water level thereat.

4. In a pontoon bridge, bridge sections co-operating to provide the bridge, pontoons under said bridge sections, cylinders carried by said pontoons, pistons in said cylinders and supporting said bridge sections, means automatically actuated by lowering of the water level under the bridge for delivering fluid under pressure to said cylinders to raise said pistons therein and means automatically actuated by rising of the water under the bridge to permit exhaust of fluid from said cylinders.

5. In a pontoon bridge, bridge sections co-operating to provide the bridge, pontoons under said bridge sections, cylinders carried by said pontoons, pistons in said cylinders and supporting said bridge sections, a source of supply of fluid under pressure, means for delivering said fluid under pressure to said cylinders, a check valve in said means whereby, upon lowering of the water level under said pontoons and relative upward movement of the pistons in the cylinders, fluid will be admitted to said cylinders from said source, and a relief valve in said means whereby fluid will be released from said cylinders upon rising of the water level under said pontoons and relative downward movement of said pistons in said cylinders.

JOSEPH H. TOURCHETTE.