May 9, 1939. A. W. KNIGHT 2,157,959

FLOATING BRIDGE

Filed Jan. 25, 1937 2 Sheets-Sheet 1

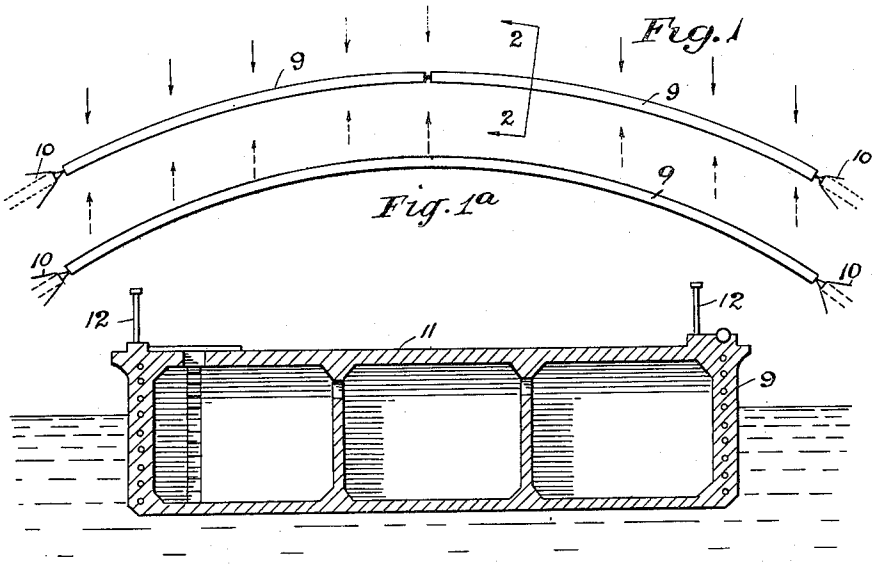

Fig. 1

Fig. 1a

Fig. 2

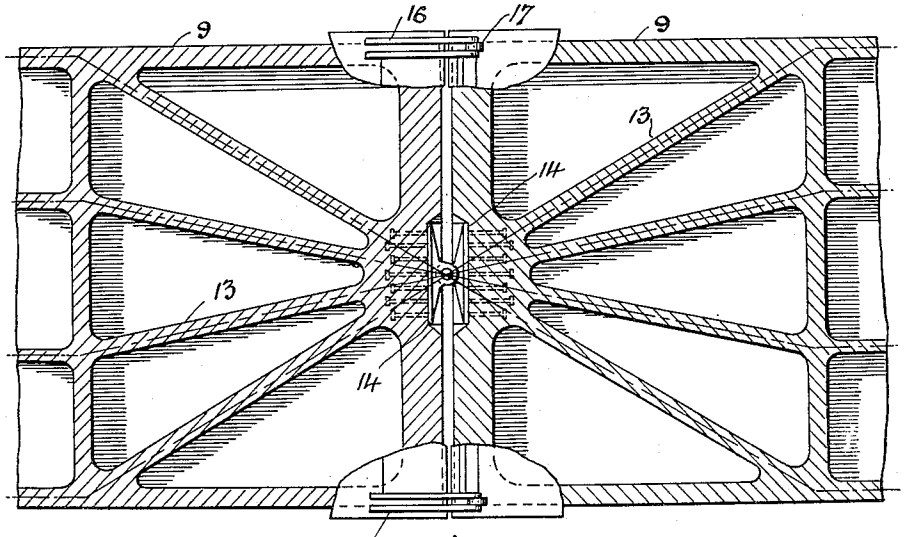

Fig. 3

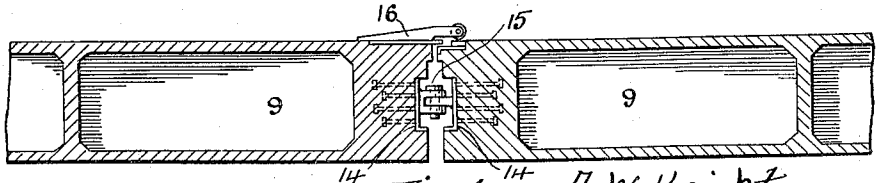

Fig. 4

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FLOATING BRIDGE

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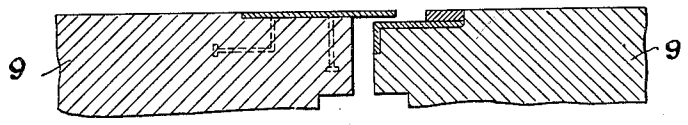

Fig. 5

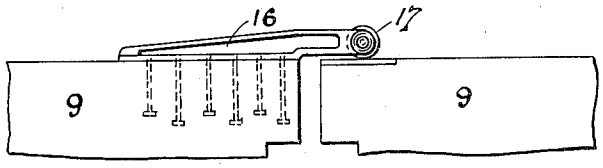

Fig. 6

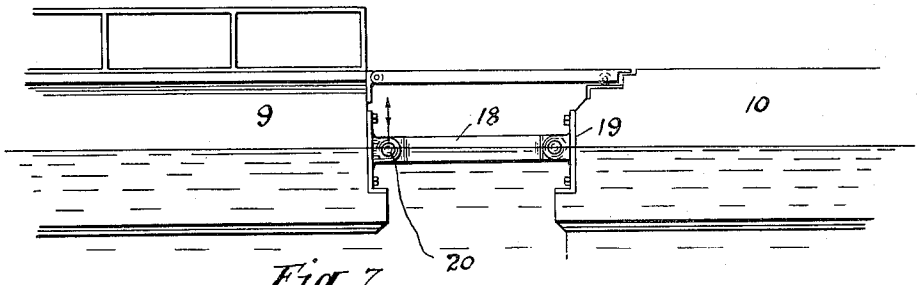

Fig. 7

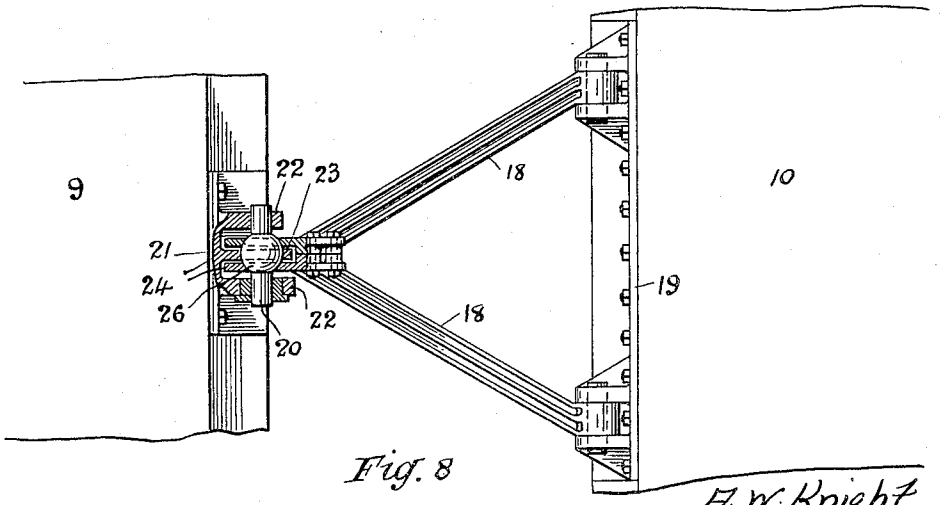

Fig. 8

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UNITED STATES PATENT OFFICE

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FLOATING BRIDGE

Allan Walton Knight, Hobart, Tasmania, Australia

Application January 25, 1937, Serial No. 122,317
In Australia February 26, 1936

6 Claims. (Cl. 14—27)

This invention relates to floating bridges and has been specially designed to connect points of land, separated for considerable distances by water, with spans of say three thousand (3000) feet.

A bridge such as contemplated by this invention will be found suitable and commercially practicable in wide rivers and estuaries or lakes and is constructed in the form of an arch in the horizontal plane, buoyant upon water. The bridge can be composed of one rib or span with each end flexibly attached to a massive shore abutment: or the rib may consist of two components, but not more, hingeably connected at the crown of the arch and flexibly attached at each end to a shore abutment. The bridge may, furthermore, be arched in the horizontal plane and formed of concrete buoyant upon water and composed of a rib in two parts hingeably connected at the crown of the arch and flexibly attached at each end to a shore abutment.

There are many instances of the effective use of floating bridges but the influence of currents, tides and weather upon the local structure are such that in floating bridges of the ordinary type anchors have been necessary. In the structure now suggested the alignment of the bridgeway can be maintained without the assistance of submarine anchors.

Furthermore, where the waterway to be spanned is very deep or the bed is such as to present difficulties in the building of suitable foundations for piers, this invention will have special significance.

The material for the construction of this waterborne bridge may be of wood, steel or concrete and concrete has been selected as a material well suited to the purpose in hand. The components which form the rib of the arched bridge when joined together at the crown can each be a composite integral structure of a length say of fifteen hundred (1500) feet, more or less, and each part can thus be constructed and assembled by methods well known to concrete engineers. The rib of the arch will be in contact with the water throughout the whole of its length. In a bridge having a roadway of say thirty-four (34) feet and a total span of three thousand (3000) feet the rib of the arch if made of concrete material may weigh up to twenty thousand (20,000) tons. The purpose of this revolutionary change in the position of the arch as compared with a steel or concrete bridge with the arch in a vertical plane, is to relieve the arch span from its own weight which in this instance is carried by the buoyancy of the water upon which it rides, leaving the structural members free to cope with the stresses produced by traffic, wind, waves, tides and changes in temperature.

In a vertical arch bridge of long span the live loads upon the decking or roadway are relatively small as compared with the dead loading. The length of the spans of such bridges is therefore limited but with the arch in a horizontal plane and adapted to float upon water spans up to three thousand (3000) feet or more may be contemplated with confidence. To obtain the necessary buoyancy it will obviously be necessary, if concrete is used, to make the arch structure hollow and preferably in compartments or cellular and to strengthen the same with reinforcing rods or plates embedded in the walls thereof.

If the arch structure is reinforced with steel rods or plates it resists the tensile forces produced by wind and tide loads which act in the opposite direction to the wind and tide loads which cause a thrust or compressive force throughout the member or members forming the arch rib. The hinged connections between the ends of the arch and the abutments are therefore designed to carry both tensile and compressive forces. If the arch rib is composed of two members the hinge at the crown is also capable of carrying either tensile or compressive forces.

The primary function of this bridge is to bear and permit of the passage of fast moving vehicular traffic for which it is particularly suited owing to the great rigidity of the structure and its behaviour under such loads and the pressure of winds and tides.

My invention therefore concerns a bridge composed of a single member in arcuate form or two equal components in horizontal plane buoyant upon water with which the bridge is in contact throughout its entire length and an abutment at each end to which the bridge can be flexibly connected, the structure having the necessary rigidity inherent in the curved member to resist forces directed there-against substantially horizontally.

In a waterway spanned by this bridge and bearing sea-going traffic provision can be made for the passage of such by the construction of a number of fixed spans supported on ordinary piers from one shore into the waterway to a point where the depth will be sufficient to allow for the passage of large craft, drawing say thirty (30) feet. At the end of the piers a bascule or lift span is provided and operated in the usual way. Immediately beyond this the first massive abutment will be built and from this point the float-

ing bridge will begin, to extend in the form of an arch in the horizontal plane in one or two parts. If of two parts these will be connected only at the crown. At the opposite shore the second abutment is placed, the bridge ends being flexibly and respectively connected to an abutment to complete the bridge.

The attachments at the shore ends between the arch and the abutments transmit the forces produced by the varying loads upon the arch to the abutments. The connections, which are hereinafter described in detail, are of great strength and designed to allow the bridge to rise and fall bodily with the tides. The joints of the connections may be protected from the water by rubber or other shields. Means are also provided, if the rib is in two parts, for keeping the roadway substantially in transverse alignment such as when a live load is upon one rib and before it passes to the other and provision is also made for the passage of the usual traffic over the shore and crown joints of the bridgeway.

But in order to fully understand the invention reference is made to the accompanying drawings in which

Fig. 1 is a diagrammatic representation of the lay-out of my arch waterborne bridge.

Fig. 1*a* is a similar view of a floating bridge in one piece.

Fig. 2 illustrates on the line 2—2 of Fig. 1 the transverse sectional elevation of the concrete arch.

Fig. 3 is a sectional plan view of the structure at the crown of the arch and the flexible joint between the ribs of the arch.

Fig. 4 shows the crown joint in sectional elevation suitable for joining two components in the rib.

Fig. 5 is a fragmentary view in sectional elevation of a deck expansion joint.

Fig. 6 is a fragmentary side elevation at the crown of the bridge and the compensating device for relieving the crown joint from torsional stresses.

Fig. 7 illustrates in side elevation the span between the bridge and the shore approach to concrete abutment and

Fig. 8 shows in plan view the construction of the abutment links and joint between a link and the bridge in section.

The bridge is composed of a waterborne arch formed in one piece as shown in Fig. 1*a* or in not more than two parts 9, Fig. 1, flexibly joined at the crown and flexibly attached at each end to a strong shore abutment 10, the north and south arrows of Fig. 1 indicating the direction of alternating currents of wind or water. The material selected for the construction of the rib 9 is concrete and each part thereof is integrally formed and capable of being floated on water by approved methods known to concrete engineers. The structure is cellular and suitably reinforced with rods or plates, deeply embedded in the material, with vertical partitions or bulk heads that in a bridge having a roadway 11, of say a thirty-four (34) feet width, will adequately support the same. This roadway will be capable of carrying the usual vehicular traffic, footways, tram-cars and even steam or electric trains and can be fitted at the sides with spray or water screens 12.

Referring to Fig. 3 the cellular halves, as the crown of the bridge is approached, may be formed with the thrust members 13 radiating from the hinge connection between the same. The hinge will be composed of a pair of heavy cast members 14 the base plate of each of which is securely anchored to an opposing part by bolts deeply sunk in the concrete material. Each hinge member will overlap and be held by a substantial pin 15.

In an arch bridge of this type the play upon the pin 15 in respect to its ordinary function in a hinge will be very slight but to relieve the hinge from undue stresses due to any tendency of the bridge components to vary in transverse alignment such as when heavy traffic is approaching the crown at one side of the bridgeway, compensating devices are installed on the deck at each side of one component to overlap the joint and bear upon the opposing member. These devices are illustrated in Figs. 6, 3 and 4 and consist of a stout cast steel beam 16 that is securely anchored into one part to extend over the opposing part and move over and in contact therewith as the relative positions of the components alter. The forward end of the casting can support a roller 17 that will bear upon a plate on the bridge deck. Such a device is placed at each side of the bridge or roadway. When a heavy load upon one side is approaching the crown of the bridge and there is a tendency for that side to be depressed by such load to cause the roadway to incline from the horizontal the movement will be checked by the bearing of member 16 on the opposite side of the roadway, and, in part at least, for the movement of one component to be conveyed to the other, thus relieving the hinge and pin 15. If necessary, two or more of the members 16 may be placed in parallel at each side of the bridgeway to function in the manner explained, the second set being placed reversely to the first set.

The bridge ends are connected to the abutments 10 by massive links 18 preferably in the form of an equilateral triangle. At the base the links can be hinged to a plate 19 secured to an abutment and at the apex are attached hingeably to a bracket on the end of the bridge through a pin 20. By this means the bridge is permitted to rise and fall with the tides while attached to the fixed abutments. The bridge bracket 21 in which the pin 20 resides is made with two side members 22 and with a central horn plate 23. The pin 20 will pass through the side members and the plate 23 which latter acts as an intermediary support for the pin. The links 18 should be separately fashioned of cast steel and the end of each link is flanged as at 24 and holed to receive the pin 20 while being securely held together by the bolts 25. The pin may further be fitted with a spherical member 26 about its middle part and in such case the link flanges 24 and the horn plate 23 will be fashioned to ride upon the sphere 26, the whole thus providing a secure and flexible union between a bridge end and an abutment.

In cases where the bridge is subjected to considerable rises and falls due to tides this form of connection between the bridge ends and the abutments may be varied. The alternative connection may thus consist of a strong cast frame fixed upon each end of the arch while upon each abutment is a stout cast member having a vertical slot. On the end of the bridge connection is a roller of a size to be freely accommodated in and to move along the slots as the bridge rises and falls.

Having now described my invention what I

claim as new and desire to secure by Letters Patent is:

1. A bridge arched in the horizontal plane buoyant upon water composed of a broad rib, a roadway on the surface of the rib, a shore abutment at each end of the bridge and hinged links between each end of the bridge and the adjacent abutment, a flange on the outer end of each link, a bracket on each end of the bridge, side members to the brackets, a central horn plate in said bracket and a pin in each bracket that passes horizontally through the side plates, link flanges and horn plate.

2. A bridge arched in the horizontal plane buoyant upon water composed of a broad rib, a roadway on the surface of the rib, a shore abutment at each end of the bridge and hinged links between each end of the bridge and the adjacent abutment, a flange on the outer end of each link, a bracket on each end of the bridge, side members to the brackets, a central horn plate in said bracket, a pin in each bracket that passes horizontally through the side plates, link flanges and horn plate and a sphere on the pin about its middle part upon which the link flanges and the horn plate are adapted to ride.

3. A bridge arched in the horizontal plane buoyant upon water composed of a rib or span in two parts, a hinge connection between the parts at the crown of the arch, a stout steel beam at each side of the bridge deck at the end of one component and extending over the other component to bear thereon.

4. A bridge composed of a single member in arcuate form in the horizontal plane buoyant upon water with which the bridge is in contact throughout the whole of its length and an abutment at each end to which the bridge is flexibly connected, the structure having the necessary rigidity inherent in the curved member to resist forces directed thereagainst substantially horizontally.

5. A bridge in arcuate form in the horizontal plane buoyant upon water composed of two equal components, an abutment at each end to which the bridge is flexibly connected, and a pin at the crown of the curve for connecting said components, the structure having the necessary rigidity inherent in the curved member to resist forces directed thereagainst substantially horizontally.

6. A bridge in arcuate form in the horizontal plane buoyant upon water composed of concrete material and cellular, adapted to be in contact with the water throughout the whole of its length, an abutment at each end to flexibly connect and retain the bridge in position, the bridge having the necessary rigidity inherent in the curved member to resist forces directed against it substantially horizontally.

ALLAN WALTON KNIGHT.