April 20, 1943. H. H. ALLEN 2,317,017

PIER AND METHOD OF CONSTRUCTING THE SAME

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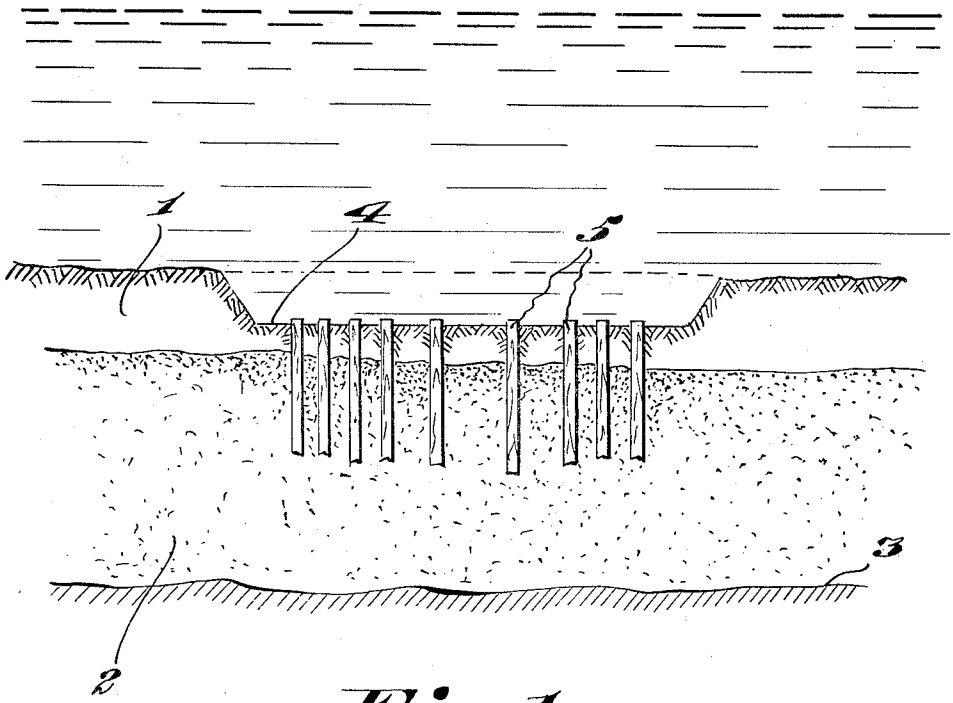



Fig. 1.

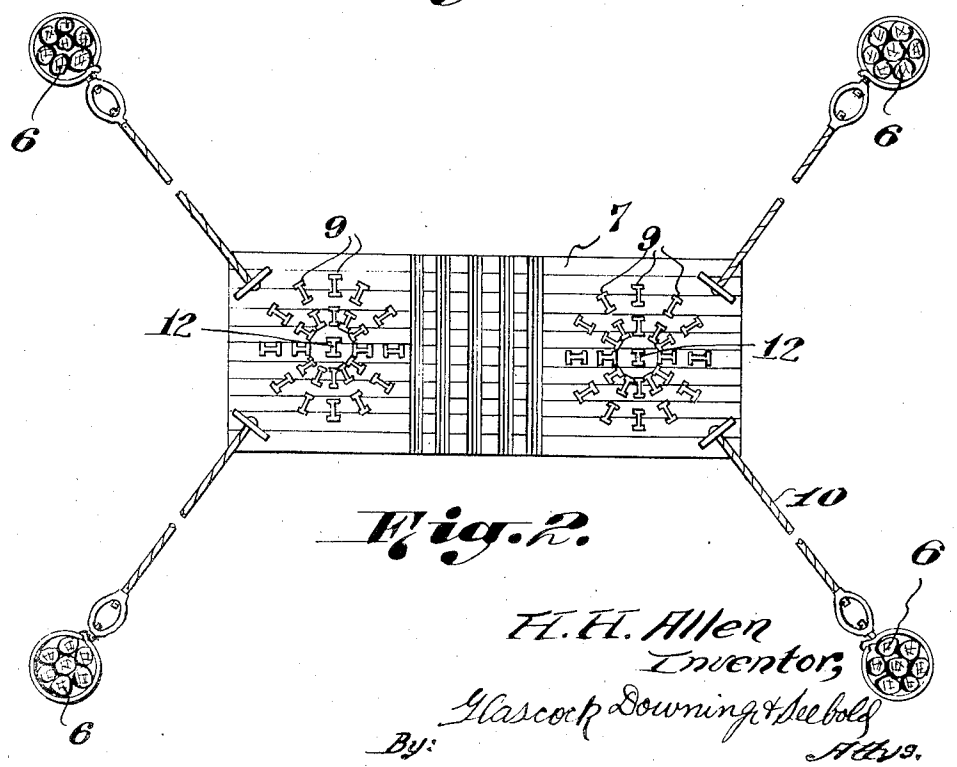



Fig. 2.

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Fig. 3.

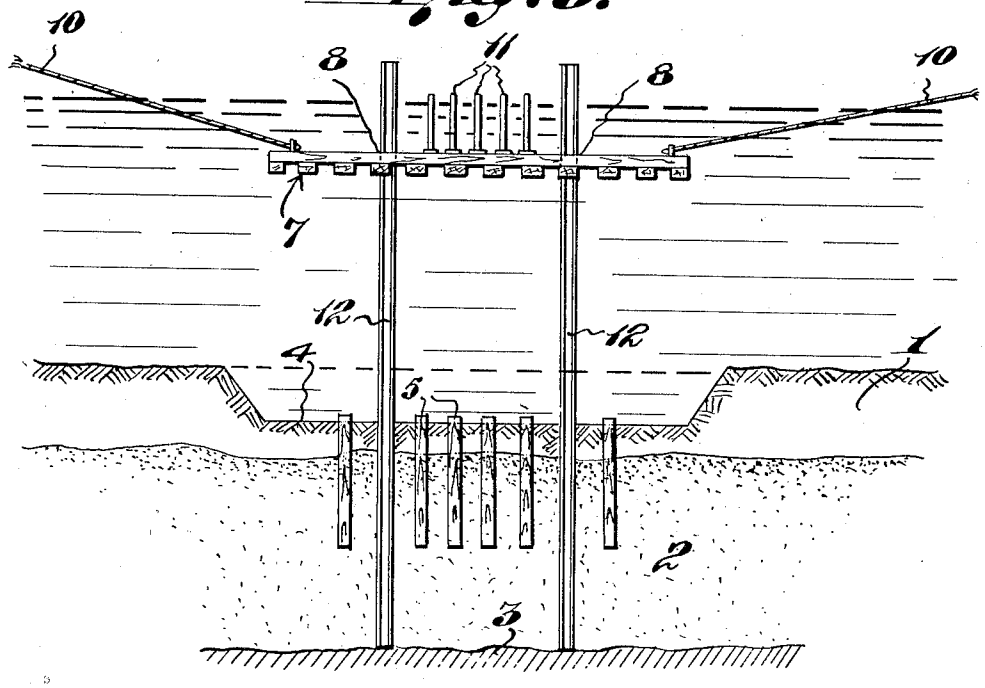
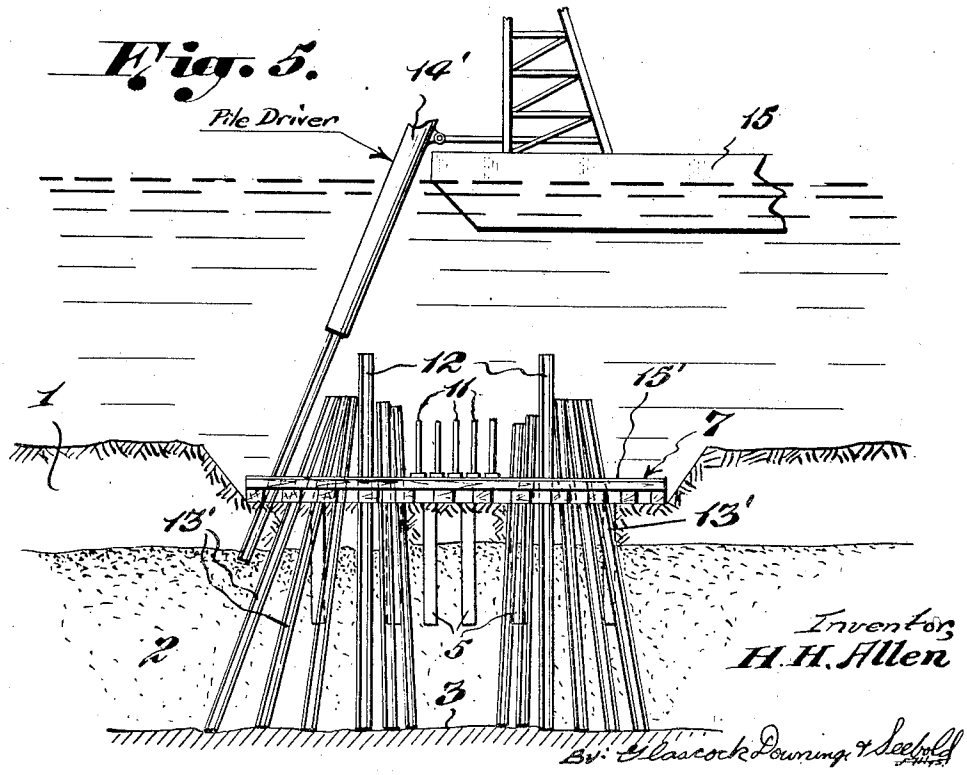



Fig. 5.




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Fig. 4.

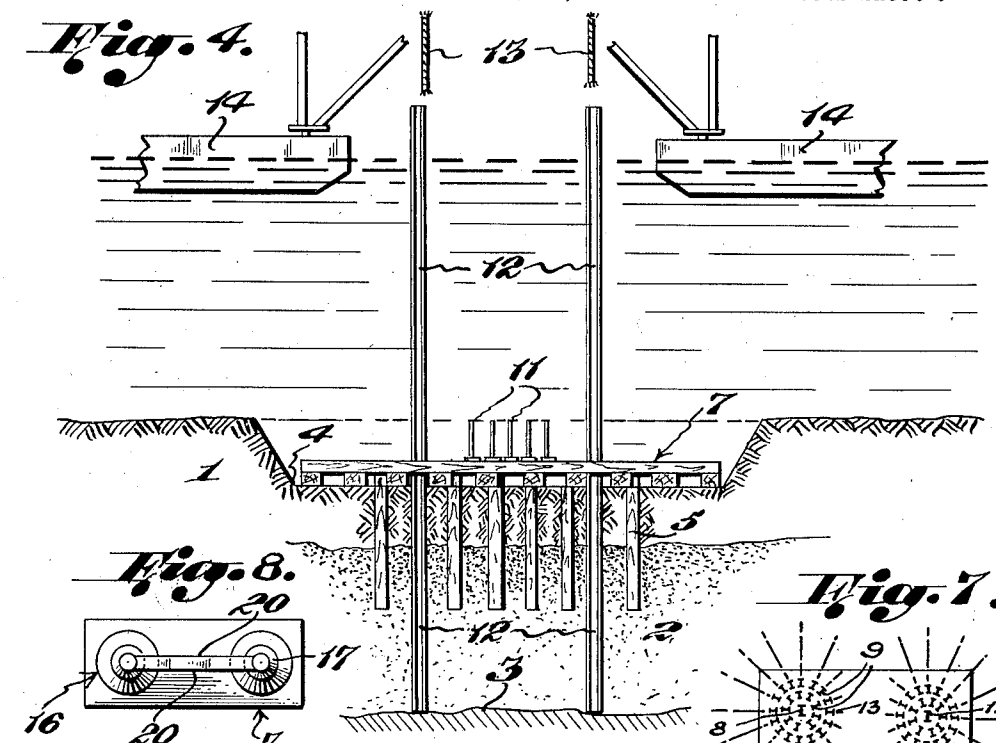


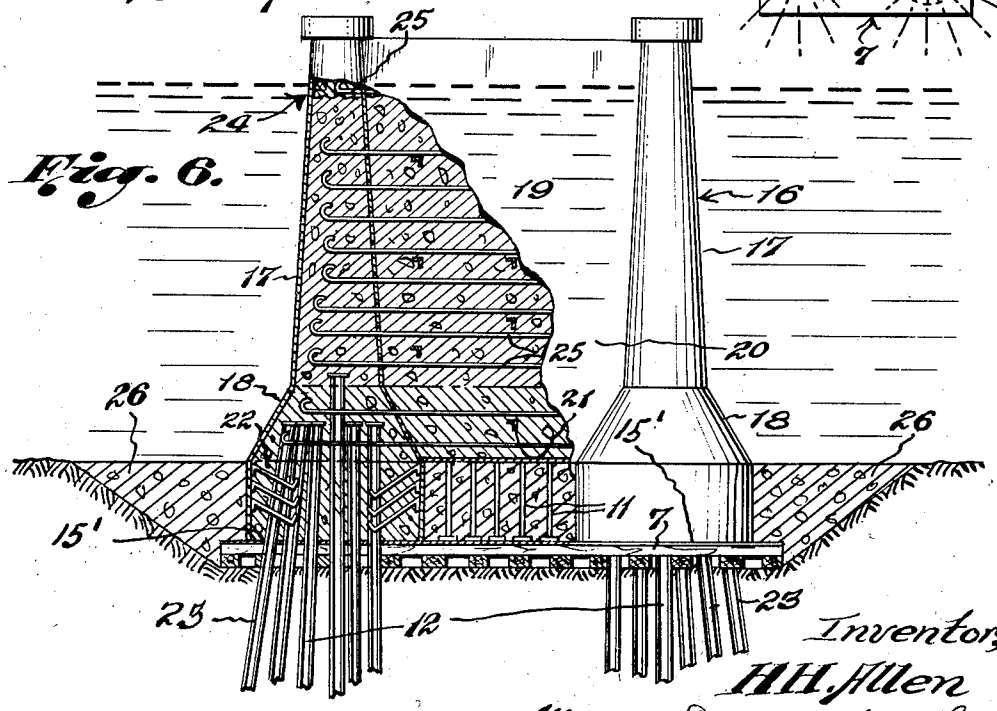

Fig. 8.




Fig. 7.




Fig. 6.



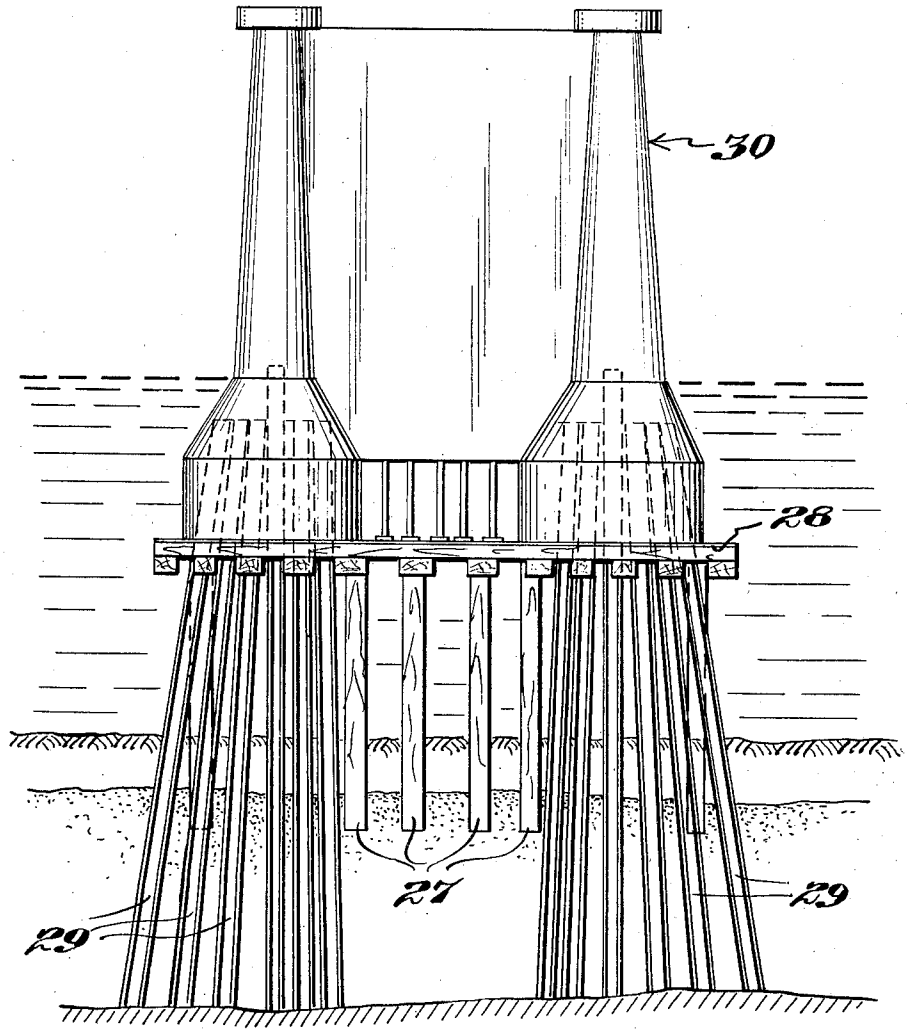

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Fig. 9.




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Patented Apr. 20, 1943

2,317,017

# UNITED STATES PATENT OFFICE

2,317,017

## PIER AND METHOD OF CONSTRUCTING THE SAME

Herschel H. Allen, Baltimore, Md.

Application October 31, 1940, Serial No. 363,753

2 Claims. (Cl. 61—52)

This invention has reference generally to improvements in that class of inventions known as bridges and more particularly relates to an improved pier and method of constructing the same.

The invention is an improvement or variation over my co-pending application bearing Serial Number 300,482 filed October 20, 1939.

The primary object of the invention resides in a provision of a bridge or pier to be built in very deep water, and where the river bed does not offer sufficient support for a cofferdam or caisson of the general types now in use.

Generally, the invention may be said to consist in the provision of a foundation, preferably, though not necessarily, in the form of a pier, temporarily maintaining a support above the bed of a river; driving plumb and batter piles therethrough until they strike rock and leaving portions projecting above the support, positioning a metallic shell over the projecting pile ends and on the temporary support, effecting a pour of Tremie concrete within the shell and on the support and allowing the same to set so that it will be bonded to the piles and the shell and constitute a main support for the latter; then making further pours which are bonded to the extreme upper projecting and capped ends of the piles and the shell and inserting reinforcing material in the shell.

More particularly the invention may be said to consist in the provision of a pier and a method of erecting or constructing the same consisting, briefly, in excavating a trench in the bottom of a river bed wherein the top soil is too soft or yielding to support a pier without piles; then temporarily arranging pile clusters or dolphins at or beyond the corners of the trench; then driving and cutting off at proper elevation sufficient timber piles at desired points in the trench so as to form a temporary support; then taking a buoyant body in the form of a timber mat and positioning the same as by floating to a position above the trench; then driving guide piles through openings positioned substantially, centrally, or in other convenient points of the mat until they strike rock; then sinking the mat preferably through the aid of diaphragm supports, along the guide piles so that the mat will rest in the proper position in the prepared trench; then removing or cutting off the extreme upper part of the guide pile or piles; then driving plumb and batter piles through openings provided in the mat in such manner that portions of the upper part of the piles extend considerably above the mat, then arranging covers on the upper surface of the mat about the projecting ends of the piles to close any openings in the mat and preventing the passage of mud therethrough then flotating and sinking a hollow steel pier shell of metal so that the leg portion or portions of the metal shell enclose the upper projecting ends of the cluster or clusters of piles on the mat; then pouring Tremie concrete into the lower portions of the pier shell or form, for instance to a depeth of five feet, and allowing the same to set and to be bound to the upper portions of the batter piles so that the weight will thereby be transmitted through this pour to the piles and thence to the rock then effecting a second pour of Tremie concrete on the first pour and about the upper projecting and preferably capped ends of the piles, for instance to the top of the enlarged leg portions or bells of the pier shell then continuing Tremie pours to a point near the surface of the water; then unwatering the top of the shells and finally pouring concrete in a dry state to the top of the pier shell and simultaneously with the various pourings arranging reinforced steel throughout the height of the pier from the mat to the top thereof.

Other objects, as well as the nature, characteristic features and scope of the invention will be more readily apparent from the following description taken in connection with the accompanying drawings and pointed out in the claims which form a part of this specification.

The invention is clearly illustrated in the accompanying drawings in which:

Figure 1 is a sectional view through a river bed showing a trench dug therein, the bottom of which is reinforced by timber piles.

Figure 2 is a top plan view showing diagrammatically a mat connected with temporary dolphins in a position to be properly sunk into the trench.

Figure 3 is a sectional view showing guide piles which have been driven through desired points of the mat and trench until they strike rock, the mat being shown prior to being sunk and anchored to the dolphins.

Figure 4 is a similar view showing the mat after it has been sunk.

Figure 5 is a similar view with the guide piles cut off and with plumb and batter piles driven through the mat to the rock.

Figure 6 is an enlarged sectional view partly in elevation of the completed pier.

Figure 7 is a top plan detail showing an arrangement of piles in the mat.

Figure 8 is a top plan view of a completed pier.

Figure 9 is an elevational view of a modified arrangement.

Similar characters of reference are employed in all of the above described views to indicate corresponding parts.

Referring now, more particularly, to the accompanying drawings, there is illustrated a river bed which consists of soft river mud 1, over a layer of silty sand 2, which rests on solid rock 3. A trench 4, is dredged in the soft river mud to a sufficient depth to insure that the piles supporting the pier may be protected by the surrounding mud or sand in the river bed after the trench has been backfilled. Driven into the trench 4, are timber piles 5, for reinforcing purposes which are cut off to a predetermined elevation by means of an underwater or submarine saw.

Temporarily arranged about the trench in the proximity of, or otherwise arranged in convenient locations are pile dolphins 6.

There is now provided in mat 7, subsequently to be used as a bottom form, which is preferably constructed on shore, and is provided with openings 8 and 9. The mat is towed to a position over the trench and is fastened to the pile dolphins 6 by suitable connecting means 10 adjustable in any suitable manner in order that the mat may be accurately positioned on the exact center line of the bridge and the exact center line of the pier prior to being sunk.

Also arranged transversely of the mat, are supports 11 for the diaphragm of the pier shell. These supports, in effect, constitute a weight.

In order to guide the mat with the supports 11 thereon into a proper position prior to being sunk, guide piles 12, which later are to be used in a permanent manner, are driven through the central openings 8 and into and through the mud and sand of the river bed until they strike the rock formation 3. After the adjusting means 10 has been released, the mat is sunk and is controlled by suitable means such as cables 13 on derrick scows 14 or other floating equipment utilized for this purpose. The mat, on contacting the previously cut off timber piles 5 or the bottom of the trench 4, acts as a support and a bottom form.

After the mat has been sunk to the position shown in Figure 5, the upper parts of the guide piles 12 are removed to facilitate the driving of additional plumb and batter piles 13', through the mat which may be of any desired form, such as H-piles or pipe piles, or combination pipe and H-piles, or wood, or concrete, or, in effect, any type of pile in use today. These piles preferably are driven through the mud and silty sand until they strike the rock, and driving may be effected by telescopic leads and with the use of an underwater hammer or they may be driven to the exact position by a pile driver 14' supported on a scow 15.

Preferably, the batter piles are located, only at the outside of the mat, to overcome the effect of longitudinal and lateral forces applied to the pier. In order to positively exclude the passage of mud from passing upwardly through the mat, suitable covers 15' are installed on the upper surface of the mat to close the openings through the mat and around each pile. This also effects a saving of concrete, in a manner which will appear.

The next step is the arranging of the steel pier shell generally designated 16 about the clustered upper ends of the piles and on the mat. In the present instance, the pier shell consists of two leg portions 17, having enlarged or bell shaped lower ends 18, the leg portions being connected by a diaphragm or reinforced steel web 19 consisting of, for instance, spaced walls 20 reinforced in proper space relation by suitable steel struts or ties 21. The sinking of each reinforced shell is effected in any desired manner. It is to be noted that the reinforced web 19 has its walls joined with the shells in such a manner that it forms a buoyant body and it is highly instrumental in effecting a proper sinking of the unit by permitting of the desired amount of water being pumped thereinto during the sinking operation; or the entire unit consisting of the two leg portions 17 connected rigidly by the reinforced web 19 may be lowered into position by means of suitable cables without effecting the watertight connection, by allowing the leg portions and the entire connecting reinforced web to be entirely opened to allow water to pass freely between the side walls of the reinforced web into the steel shells. If desired, temporary domes or caps may be applied to the top of the steel sheel 16 to facilitate the floating of the same into position, the caps being removed prior to the sinking of the shells.

A first pour of Tremie concrete 22 is now made within the bell-shaped portions 18 to a depth, for instance in practice of about five feet or to a point short of the upper ends of the piles 12 and 13. This pour is allowed to set and being bonded to the piles 12 and 13 and to the pier shells constitute the main support for the latter. A second pour of Tremie concrete is now made to the tops of the enlarged portions or bells 18 and is bonded to the first pour and the extreme upper projecting ends of the piles 12 and 13. Additional pours of Tremie concrete are made, for instance to a point 24 in Figure 6 from which point the pier shells may be unwatered and the remainder fitted with further reinforcing means 25 in a manner similar to that described in my co-pending application 300,482 filed October 20, 1939, and concrete poured in a dry state to the top of the pier.

Finally the trench is backfilled as shown at 26. The second and additional pourings of Tremie concrete into the shell 16 and about the reinforcing means therein, act to tie the leg portions and the web together as a unit and insure the transit of all vertical and horizontal portions to the first pour within the bottom of the leg portions, particularly since the second pour is bonded to the first pour by the extreme upper projecting ends of the piles 12 and 13.

Obviously, instead of having two leg portions in a pier only one may be used, or a four-legged or four stemmed pier may be used as in my co-pending application, Serial Number 300,482 filed October 20, 1939. It is to be noted that the supports 11 which serve as a weight, act to support the diaphragm or web 19 of the bridge shell.

As shown in Figure 9 instead of excavating a trench, timber piles 27 are driven through the mud and part of the sand while the upper ends terminate at points considerably above the river bed and constitute a support for the mat which if desired instead of being buoyant may consist of a perforated metal plate 28. The plumb and

batter piles 29 are now driven through the perforated mat 29 until they strike rock in the same manner as in the preferred form. The pier shell generally designated 30 is now arranged on the mat and then pourings of concrete as described in connection with the preferred form indicated herein.

It is believed in view of the foregoing description that a further detailed description of the invention is entirely unnecessary. Likewise it is believed that the advantages of the invention will be readily apparent.

Having thus fully described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A method of making a bridge pier including excavating a trench in the bottom of a river bed, temporarily arranging pile dolphins at the corners of the trench, floating a perforated buoyant mat into a position above the trench, adjustably connecting the buoyant mat to the pile dolphins to ensure an accurate positioning of the mat, driving guide piles at desired points through perforations in the mat, applying diaphragm pier supports to the mat to serve as weights to facilitate sinking of the mat along the guide piles so that the mat rests properly in the prepared trench, then removing the upper part of the guide piles, then driving plumb and batter piles through perforations in the mat in such manner as to leave the upper portions projecting above the mat, then floating a pier shell having spaced and diaphragm connected leg portions and sinking the same so that the lower ends of the leg portions enclose the upper projecting ends of the piles and contact the mat while the diaphragm portion between the leg portions rests on the supports on the mat, then effecting a pour of Tremie concrete within the lower portion of the leg portions so as to form a base and to bond the leg portions to the piles, then effecting a second pour of Tremie concrete on the first pour and about the upper projecting ends of the piles, applying reinforcing material within the pier shell, and finally completely filling the pier with cementitious material.

2. A pier of the character described including a perforated mat, piles arranged through the mat and having the upper ends projecting above the mat, a metallic pier shell including spaced leg portions having open bottoms and a hollow web connecting the leg portions together, the leg portions having enlarged bell-shaped lower ends disposed over the upper projecting ends of the piles and arranged on the mat, supports on the mat between the leg portions for the connecting web, a pour of Tremie concrete arranged within the enlarged ends of the leg portions of the pier shell and on the mat and forming a base and bonded to the projecting ends of the piles and to the pier shell, a second pour of Tremie concrete also arranged within the lower ends of the leg portions and bonded to the extreme upper ends of the piles situated therein, and further pours of Tremie concrete arranged in the leg portions and the web and extending to the top of the pier shell, and reinforcing means within the pier shell.

HERSCHEL H. ALLEN.