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(54) DRYDOCK LIFTING PLATFORM

(71) I, RAYMOND PEARLSON, a citizen of the United States of America, of 6400 S.W. 129th Terrace, Miami, Florida, United States of America, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to lifting type drydock means and more specifically to a lifting platform therefor.

Drydocks of the general type disclosed in United Kingdom Patent Specification No. 864,581 employ a lifting platform supported for vertical movement by a plurality of synchronous motor driven winches connected to the ends of the main transverse support or lifting beams of the platform for lifting and lowering the platform along with any ship or vessel carried thereon. The aforementioned Patent Specification, discloses longitudinally extending beams extending perpendicular to the main tansverse support beams parallel to the length of the platform which are provided with ears on each end through which pins pass to connect the beams to the main transverse support beams to which the lifting winches are connected. Since each of the main transverse load carrying beams is simply supported at each end, the beams are capable of a certain amount of undesirable pivotal twisting movement about their longitudinal axis when subjected to torsional loads as frequently occurs as the result of one or more of the longitudinal beams being subjected to heavier loads than the beams on the other side of a particular main lifting beam. Another drawback of prior drydock constructions is that they require complete fabrication assembly of the lifting platform at the installation site in that their construction is such that prefabrication of the components is not feasible. Consequently, substantial labour costs are incurred at the site of the installation.

Another problem with the previously known winch operated lifting type drydocks is the fact that the lifting platform itself must be formed of large havy duty beams and other components which are quite heavy and which must also obviously be lifted along with the weight of the vessel supported by the platform. In fact, the lifting platform itself is frequently substantially heavier than the vessel being lifted. While counterbalancing of the platform weight is feasible in some instances, it adds substantially to the complexity and cost of the system. The foregoing facts necessitate the employment of extremely powerful heavy duty winches capable of lifting the total weight of the platform as well as the vessel carried by the platform. Consequently, the size of the vessels that can be handled by drydocks of this type is limited due to the massive weight of the platform itself. As a result, larger ships and vessels which are too heavy to be lifted on a lifting type drydock must be accommodated by the expensive and sometimes difficult-to-secure floating drydocks.

It is an object of the present invention to provide an improved lifting type drydock.

In accordance with the present invention I provide a lifting type drydock including an elongate vertically movable multi-section platform formed of a plurality of platform sections each extending across the width of said platform, a plurality of main transverse lifting beams each extending across the width of the platform one at each end of the platform and one between each two adjacent platform sections, each of the latter including a plurality of beams each extending longitudinally of the platform, each main transverse beam intermediate the ends of the platform being fixedly connected on one side to one end of each of the longitudinally-extending beams of the platform section at said one side and pivotally supporting at its other side but not being connected thereat to one end of each of the longitudinally-extending beams of the platform section at said other side; secondary transverse support beams fixedly connected to said longitudinally-extending beams of each platform section and power driven lifting support means connected to the ends of said main transverse beams for lifting or lowering said main transverse beams to effect a unitary vertical

movement of said movable multi-section platform.

According to one aspect of the present invention there is provided a lifting type drydock including an elongate vertically movable multi-section platform formed of a plurality of platform sections each extending across the width of said platform, each of said platform sections including a main transverse lifting beam extending across the width of the platform along one edge of the platform section, a plurality of beams extending longitudinally of the platform, said longitudinally-extending beams being fixedly connected at one end to said main transverse beam and having their opposite ends pivotally supported by but not connected to the main transverse beam of a next-adjacent platform section and secondary transverse support beams fixedly connected to said longitudinal beams; and power driven lifting support means connected to the ends of said main transverse beams for lifting or lowering said main transverse beams to effect a unitary vertical movement of said movable multi-section platform.

According to another aspect of the present invention there is provided a lifting type drydock comprising an elongate vertically movable multi-section platform formed of a plurality of platform sections each extending across the width of said platform, a plurality of main transverse lifting beams extending across the width of the platform, a plurality of beams extending longitudinally of the platform between and supported by said main transverse lifting beams, each of said main transverse lifting beams intermediate the ends of the platform providing pivotal support on one side to one end of each of the longitudinally-extending beams of the platform section at said one side, and being fixedly connected on its opposite side to one end of each of the longitudinally-extending beams of the platform section at said opposite side, secondary transverse support beams mounted on said longitudinally-extending beams of each platform section, and power driven cable means connected to the ends of said main transverse beams for lifting or lowering said main transverse beams to effect vertical movement of said movable multi-section platform.

According to a further aspect of the present invention there is provided a drydock installation on a body of water having maximum water level and a minimum water level, comprising a fixed support consisting of a pair of parallel piers defining therebetween a slip of sufficient depth to receive ships or other vessels to be removed from the water for maintenance purposes, a lifting type drydock as claimed in any one of claims 11 to 13, 19 and 20 with the vertically movable platform extending between the piers and supported by power driven winch means mounted on said fixed support, said platform being movable between an upper limit position and a lower position, the buoyancy tanks on said platform being capable when submerged in a body of water of providing a substantial upward force on said platform, said buoyancy tank means being positioned on said platform to be substantially immersed in said body of water when said body of water is at its minimum water level and said platform is concurrently in its upper limit position so that the buoyancy tanks are always effective to provide an upward buoyant force on said platform for all positions of said platform.

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a top plan view of a drydock in accordance with the preferred embodiments of the invention;

Fig. 2 is a sectional view taken along lines 2–2 of Fig. 1;

Fig. 3 is a sectional view taken along lines 3–3 of Fig. 2;

Fig. 4 is a sectional view similar to Fig. 2 but illustrating a second embodiment of the invention;

Fig. 5 is an exploded perspective view of a portion of the embodiment of Fig. 4;

Fig. 6 is an enlarged view of a portion of Fig. 2;

Fig. 7 is a sectional view similar to Fig. 2 illustrating a third embodiment of the invention;

Fig. 8 is a sectional view taken along lines 8–8 of Fig. 7; and

Fig. 9 is a sectional view similar to Fig. 2 but illustrating a fourth embodiment of the invention.

Attention is initially drawn to Fig. 1 of the drawings which comprises a plan view of a drydock installation provided adjacent to a body of water including a lifting support means consisting of a pair of parallel concrete piers 10 and 12 between which a slip 14 is provided of sufficient depth to receive ships or other vessels to be removed from the water for maintenance purposes. A vertically movable lifting platform 13 extends between the piers 10 and 12 and is supported for vertical movement by cable members 16 (Fig. 3) extending about pulley sheaves 18 mounted in the ends of main transverse support beam members 20 extending transversely across the width of the slip 14 as best illustrated in Fig. 1. Main transverse support beams 20 provide support for the remaining portion of the lifting platform 13 including a plurality of longitudinal beams 22 connected to and supported by the main transverse support beams 20 in a manner to be discussed hereinafter. Moreover, the longitudinal beams 22 provide support for secondary transverse support beams 24 connected to and supported

on the upper surface of beams 22. It will be noted that alternate ones of the beams 24 extend substantially the entire width of the platform while the other beams merely extend between the longitudinal beams 22. Lifting platform 13 also includes upper timber decking components 26 supported on the upper surfaces of beams 20 and 24. Additionally, the platform 13 can include platform rail members 28 for supporting a movable railway type carriage if desired. Rail members 28 would be provided in alignment with inland transfer rails 30 for effecting movement of any such carriage from the platform inland away from the drydock such as for the purpose of conveying a ship or vessel to a work station. In any event, the arrangement of the main transverse support beams and the longitudinal beams 22 is of particular significance to the invention.

Platform 13 is divided into a plurality of rigid unitary sections extending across the width of the platform and bounded by the main transverse lifting beams 20 with the construction in a first embodiment being as shown in Fig. 2. Specifically, Fig. 2 illustrates two complete adjacent sections "A" and "B" of the platform with the remaining platform sections being connected in exactly the same manner along the entire length thereof. The component parts "A" and "B" are designated by the same reference numerals as used above with addition of the suffix "A" or "B" for the parts of the respective sections so as to provide a clear illustration of the extent of each section.

The first platform section "A" consists of a single main transverse lifting beam 20A to the main vertical web of which the longitudinal beams 22A are welded as shown at 32 between an upper spacer plate 25 and a lower spacer plate 27. Secondary transverse support beams 24A are supported on the upper surface of the beams 22A with the timber decking 26 being supported on the upper surface of the beams as shown.

The second complete section "B" which is adjacent the first section "A" consits of a main transverse support beam 20B and a pair of longitudinal beams 22B which are welded to the right side of the main web of main transverse beam 20B. However, the main transverse support beam 20B is provided on the left side of its main web with means for pivotally supporting the free ends of longitudinal beams 22A of the first platform section "A".

The pivotal support for the free end of beams 22A is best illustrated in Figs. 3 and 6 (an identical support for a different beam 22G is also shown in Fig. 5) and includes a horizontal saddle plate 34 welded to the main web of beam 20B positioned above the lower flange of the main transverse beam between vertical stiffener plates 36 welded to beam 20B and spaced apart sufficiently to receive the end of beam 22A. An upwardly extending retaining lug 38 is welded to the upper surface of the saddle plate 34 to co-operate with a retaining lug 40 extending downwardly from the lower flange of beam 22A. Additional support for the saddle plate 34 is provided by a centre support plate 42 welded between the lower surface of saddle plate 34 and a lower flange of the main transverse support beam 20B. Consequently, it will be seen that the free end of the longitudinal beams 22A is pivotally supported with respect to the main transverse beam 20B so that the platform section A is capable of limited pivotal movement with respect to the platform section B. It will be understood that the number of sections in any particular lifting platform will vary in accordance with the size of the installation. The pivotal connection between the free ends of the longitudinal beams 22 and the adjacent main transverse beam of the next adjacent section provides for sufficient movement of the platform to accommodate the unbalance of load on the platform as frequently occurs while the unitary rigid platform section provides adequate rigidity necessary for a stable support of the load on the platform.

Fig. 4 illustrates a second embodiment of the invention, and Fig. 5 illustrates parts thereof, in which a multi-section platform is formed of two groups of platform sections consisting of alternate sections F and G respectively differing in the manner in which the longitudinal beams of the sections are connected to the main transverse support beams. More specifically, the longitudinal beams 22F of sections F are welded at both ends to the support beams 20F in exactly the same manner that the beams 22A are welded to beams 20A in the previously discussed embodiment of Figs. 1 to 3. The secondary transverse beams 24F are welded to the upper surface of the longitudinal beams 22F in the same manner that the previously discussed beams 24A are supported on their longitudinal beams. Section G, on the other hand, has its longitudinal beams 22G pivotally connected to the main transverse support beams 20F adjacent each end of beams 22G in exactly the same manner that the free ends of beams 22A are connected to the beams 20B of the first embodiment and which is best illustrated in Fig. 5.

The embodiment of Figs. 4 and 5 also provides flexibility between adjacent sections while preventing the rotation of the main transverse support beams by torsional loads.

Figs. 7 and 8 illustrate a variation in the embodiment of Figs. 4 and 5 in that they constitute a sectional view of a portion of a lifting platform in its upper limit position of movement (i.e. the highest position to which the winches can lift the platform) with the lowest possible water level LWL as shown with

respect to the platform. The embodiment of Figs. 7 and 8 is identical to the embodiment of Fig. 4 with the exception that a tank 50 is formed between upper plates 52, lower plates 54, the main webs of the main transverse support beam 20F and side plates 56 (only one of which is shown beneath a supplemental longitudinal beam 22^1). Tank 50 is subdivided by plates 58 and encloses blocks of expanded synthetic resinous material 60 such as that sold under the Registered Trade Mark "STYROFOAM". The buoyancy tank 50 cooperates with similar bouyancy tanks provided along the length of the platform in the section F so that the buoyant effect of the tanks is equal to a substantial portion of the weight of the entire platform such as, for example, in the order of 75% to 90%.

The number, thickness and location of the buoyancy tanks 50 can obviously be varied in accordance with the weight of the particular platform with which they are associated. Additionally, it should be understood that buoyancy tanks of the type illustrated in Figs. 7 and 8 can also be incorporated in the other embodiments of the invention by merely welding similar tanks to the lower surfaces of the longitudinal beams such as beams 22A of the embodiment of Figs. 1 and 4. It is of critical importance that the buoyancy tanks 50 be located in the lower portion of the lifting platform so that they are always below the low water level LWL even when the platform is in its uppermost limit position as illustrated in Fig. 7 so that the buoyancy effect of the tanks is always provided to the fullest extent possible. Consequently, the weight of the platform is largely offset for all positions of the platform and the lower requirements of the lifting winches are not nearly as great as they would be if it were not for the presence of the buoyancy tanks.

Fig. 9 illustrates another embodiment quite similar to that of Figs. 7 and 8 in that buoyancy tanks 50^1 are provided in the same location as buoyancy tanks 50. However, the buoyancy tanks 50^1 are different in that they are air tanks and do not incorporate resinous foam material in the manner of the tanks 50. Tanks 50^1 are connected to an air line 64 and have an inlet pipe 66 on their interior so that compressed air can be provided on the interior of the tanks to force the water in the tanks outwardly through valve means 70 to provide a desired amount of buoyancy. It should also be appreciated that the platform section illustrated in Fig. 9 is shown in its upper limit position of movement in conjunction with the lowest possible water level LWL and that the tank 50^1 is consequently always completely submerged below the water level so as to provide for its full buoyancy effect if desired. It will be appreciated that the buoyancy effect provided by tank 50^1 can be varied in accordance with the amount of air introduced into the tank.

Additionally, it would also be possible to use combinations of the foam containing tanks 50 and the air tanks 50^1 if desired.

An advantage of the lifting type drydock platform, as hereinbefore described, is that the main lifting beams are connected to means resisting their torsional rotation but with the overall platform retaining sufficient flexibility to accommodate varying loads along its length.

Another advantage is the provision of means to offset a substantial portion of the weight of the lifting platform to reduce the load on the lifting winches.

A further advantage is that the lifting type drydock is capable of being prefabricated and assembled at the installation site.

Achievement of the foregoing objects is enabled by the preferred embodiments of this invention all of which employ a plurality of parallel transverse main lifting beams each connected on its ends to a lifting winch by means of a cable extending from the winch. The lifting platform is formed of a plurality of platform sections of given width extending transversely across the length of the platform.

In the first embodiment, the fact that the longitudinally extending beams are welded to one of the main transverse support beams provides rotational stability for the support beams due to the lever effect of the longitudinally extending beams connected to the main beam.

In a second embodiment, the fact that the platform sections of the second group are pivotally connected to the platform sections of the first group to provide an overall platform flexibility and that the main transverse support beams are connected by the longitudinal beams extending between the support beams and welded thereto provide substantial resistance to torsional twisting of the support beams.

In the third embodiment, the platform sections are provided with buoyancy means having the capacity for providing an upward buoyant force equal to approximately 90% of the weight of the entire lifting platform when the buoyancy means is immersed in the body of water with which the installation is associated. Such installations are of particular value only in locations in which there is a minimum vertical differential between the maximum high tide and the maximum low tide since the flotation chambers must always be positioned beneath the surface of the water so as to provide their full buoyant lifting effect at all times. This result is achieved by carefully selecting the installation site at a geographic location where there is no great tidal fluctuation and by designing the uppermost limit position of the platform and the vertical spacing below the upper part of the

platform of the flotation chamber so that the flotation chamber is always below the water level even when the tide is at its lowest possible position and the lifting platform is in its maximum elevated position. As a consequence of the foregoing construction, substantially smaller winches and cables can be employed for lifting the platform since the weight of the ship and only a small percentage of the platform weight such as in the order of 10%–25% need be lifted whereas in previous installations it has been necessary to provide winches capable of lifting the sum total of the weight of the platform and the ship. Alternatively, by using winches of the same type presently used it would be possible to lift much heavier ships than is now the case with the presently known constructions.

WHAT I CLAIM IS:—

1. A lifting type drydock including an elongate vertically movable multi-section platform formed of a plurality of platform sections each extending across the width of said platform, a plurality of main transverse lifting beams each extending across the width of the platform one at each end of the platform and one between each two adjacent platform sections, each of the latter including a plurality of beams each extending longitudinally of the platform, each main transverse beam intermediate the ends of the platform being fixedly connected on one side to one end of each of the longitudinally-extending beams of the platform section at said one side and pivotally supporting at its other side but not being connected thereat to one end of each of the longitudinally-extending beams of the platform section at said other side; secondary transverse support beams fixedly connected to said longitudinally-extending beams of each platform section; and power driven lifting support means connected to the ends of said main transverse beams for lifting or lowering said mean transverse beams to effect a unitary vertical movement of said movable multi-section platform.

2. A lifting type drydock including an elongate vertically movable multi-section platform formed of a plurality of platform sections each extending across the width of said platform, each of said platform sections including a main transverse lifting beam extending across the width of the platform along one edge of the platform section, a plurality of beams extending longitudinally of the platform, said longitudinally-extending beams being fixedly connected at one end to said main transverse beam and having their opposite ends pivotally supported by but not connected to the main transverse beam of a next-adjacent platform section and secondary transverse support beams fixedly connected to said longitudinal beams; and power driven lifting support means connected to the ends of said main tansverse beams for lifting or lowering said main transverse beams to effect a unitary vertical movement of said movable multi-section platform.

3. A drydock as claimed in Claim 2, wherein said main transverse lifting beams are I-beams and said longitudinally-extending beams each comprise an I beam of a height less than the height of said main transverse lifting beams.

4. A drydock as claimed in Claim 3, including horizontal saddle plate members each respectively fixedly positioned on one of said main transverse lifting beams beneath the ends of and providing support for said longitudinally-extending beams adjacent the web of each of said main transverse lifting beams upwardly spaced above the lower flange of the respective main transverse lifting beam on which said saddle plates are mounted.

5. A drydock as claimed in Claim 4, wherein the pivotally-supported end of each of said longitudinally-extending beams includes a holding lug extending downwardly from the lower flange of the longitudinal beam in a position adjacent the pivotally-supported end of the longitudinally-extending beam and wherein each saddle plate member beneath the pivotally supported end of a said longitudinally-extending beam includes an upwardly-extending retaining lug co-operable with said holding lug for preventing axial movement of the pivotally-supported end of each longitudinally-extending beam from its support position on the saddle plate.

6. A drydock as claimed in Claim 4 or 5, including vertical stiffener plates fixedly attached to said main transverse lifting beams on opposite sides of said saddle plates pivotally-supporting the ends of said longitudinally extending beams for retaining said ends from sidewise movement.

7. A drydock as claimed in any one of the preceding claims, wherein said secondary transverse support beams are I-beams.

8. A drydock as claimed in any one of the preceding claims, wherein the upper surfaces of said main transverse lifting beams and said secondary transverse support beams are positioned in a common horizontal plane.

9. A lifting type drydock comprising an elongate vertically movable multi-section platform formed of a plurality of platform sections each extending across the width of said platform, a plurality of main transverse lifting beams extending across the width of the platform, a plurality of beams extending longitudinally of the platform between and supported by said main transverse lifting beams, each of said main transverse lifting beams intermediate the ends of the platform providing pivotal support on one side to one end of each of the longitudinally-extending beams of the platform section at said one

side, and being fixedly connected on its opposite side to one end of each of the longitudinally-extending beams of the platform section at said opposite side, secondary transverse support beams mounted on said longitudinally-extending beams of each platform section, and power driven cable means connected to the ends of said main transverse beams for lifting or lowering said main transverse beams to effect vertical movement of said movable multi-section platform.

10. A drydock as claimed in Claim 9, wherein the individual beams of the longitudinally-extending beams of alternate platform sections are fixedly connected at each of their ends to the two main transverse beams between which they extend, and the individual beams of the longitudinally-extending beams of the other platform sections are pivotally supported at each of their ends in relation to the two main transverse lifting beams between which they extend.

11. A drydock as claimed in Claim 10, including a buoyancy providing tank fixedly positioned between said beams of said second longitudinally-extending beams of each of said alternate platform sections, and the main transverse lifting beams to which said beams are fixedly connected.

12. A drydock as claimed in Claim 11, wherein each buoyancy providing tank is a variable buoyancy air tank.

13. A drydock as claimed in Claim 11, wherein each buoyancy providing tank comprises a tank filled with an expanded synthetic resinous material.

14. A drydock as claimed in any one of Claims 10 to 13 wherein said main transverse lifting beams and said longitudinally-extending beams are I-beams.

15. A drydock as claimed in any one of Claims 10 to 14 including horizontal saddle plate members each respectively mounted on a main lifting beam fixedly positioned beneath the ends of and providing support for said longitudinally-extending beams of said other platform sections adjacent the web of each of said main transverse lifting beams, between which the former beams extend upwardly spaced above the lower flanges of the respective transverse lifting beams on which said saddle plate members are mounted.

16. A drydock as claimed in Claim 15, wherein the pivotally supported ends of said longitudinally-extending beams of said other platform sections each include a holding lug extending downwardly from the lower flange thereof in a position adjacent the pivotal support thereof and wherein each saddle plate member beneath each pivotally-supported end of each of said longitudinally-extending beams of said other platform sections includes an upwardly-extending retaining lug co-operable with said holding lug for preventing axial movement of the pivotally supported end of each longitudinally-extending beam of said other platform sections from its supported position on the saddle plate.

17. A drydock as claimed in Claim 15 or 16, including vertical stiffener plates fixedly attached to said main transverse lifting beams on opposite sides of said saddle plates pivotally supporting the ends of said longitudinally extending beams of said other platform sections for retaining the ends of the latter beams from sidewise movement.

18. A drydock as claimed in Claim 9 wherein similarly; facing sides of the respective main transverse lifting beams are the sides to which ends of longitudinally-extending beams are fixedly connected.

19. A drydock as claimed in any one of Claims 11 to 13, wherein said buoyancy providing tanks when immersed in water, provide an upward force on said platform in an amount so that no more than 10% to 25% of the weight of said platform is supported by said power driven cable means.

20. A drydock as claimed in any one of Claims 11 to 13 or 19, wherein said platform is movable between an upper limit position above which it cannot move and a lower position, said buoyancy providing tank means being positioned on said platform in a sufficiently low position to ensure that said buoyancy tank means is always below the water level of the body of water with which the platform is associated even when said platform is in its upper limit position.

21. A drydock installation on a body of water having maximum water level and a minimum water level, comprising a fixed support consisting of a pair of parallel piers defining therebetween a slip of sufficient depth to receive ships or other vessels to be removed from the water for maintenance purposes, a lifting type drydock is claimed in any one of claims 11 to 13, 19 and 20 with the vertically movable platform extending between the piers and supported by power driven winch means mounted on said fixed support, said platform being movable between an upper limit position and a lower position, the buoyancy tanks on said platform being capable when submerged in a body of water of providing a substantial upward force on said platform, said buoyancy tank means being positioned on said platform to be substantially immersed in said body of water when said body of water is at its minimum water level and said platform is concurrently in its upper limit position so that the buoyancy tanks are always effective to provide an upward buoyant force on said platform for all positions of said platform.

22. A lifting type drydock substantially as hereinbefore described with reference to Figs. 1 to 3 and 6 of the accompanying drawings.

23. A lifting type drydock substantially

as hereinbefore described with reference to Figs. 4 and 5 of the accompanying drawings.

24. A lifting type drydock substantially as hereinbefore described with reference to Figs. 7 and 8 of the accompanying drawings.

25. A lifting type drydock substantially as hereinbefore described with reference to Fig. 9 of the accompanying drawings.

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1586788 COMPLETE SPECIFICATION

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Sheet 1

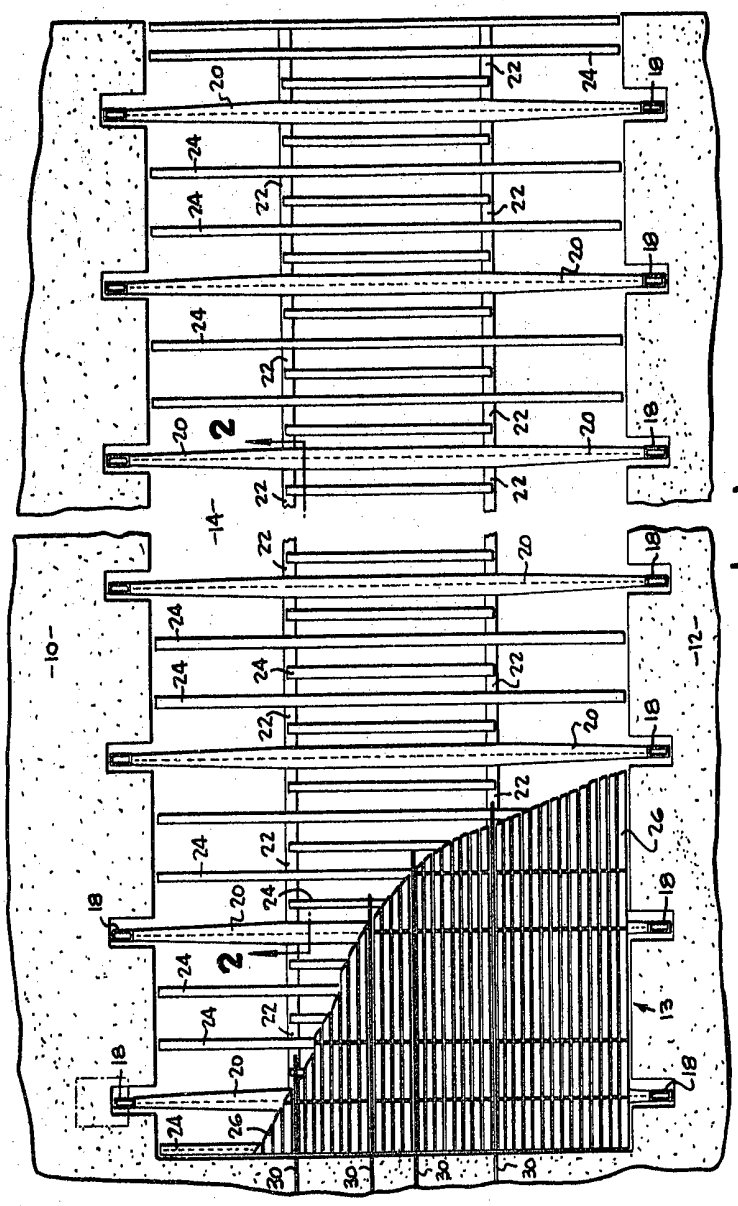

FIG-1

1586788 COMPLETE SPECIFICATION

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Sheet 2

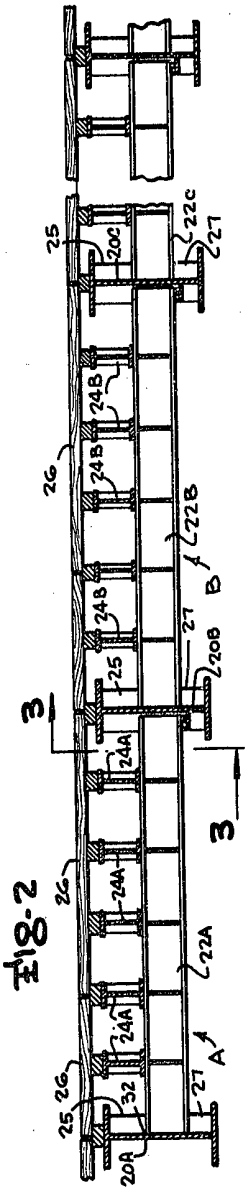

FIG 2

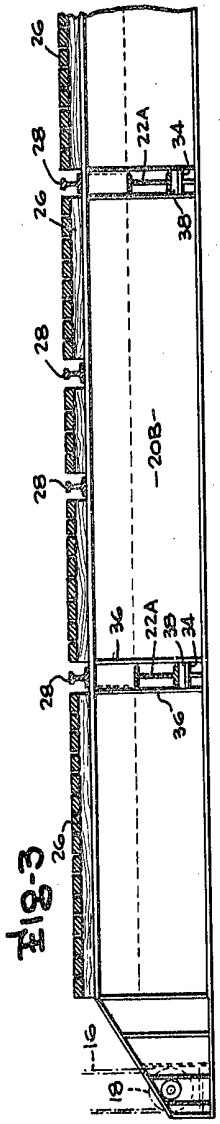

FIG 3

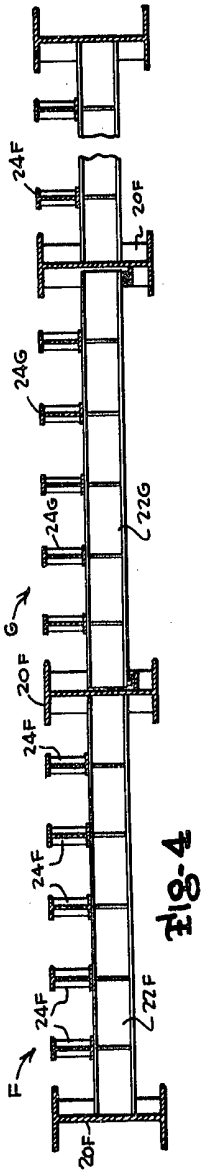

FIG 4

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Sheet 3

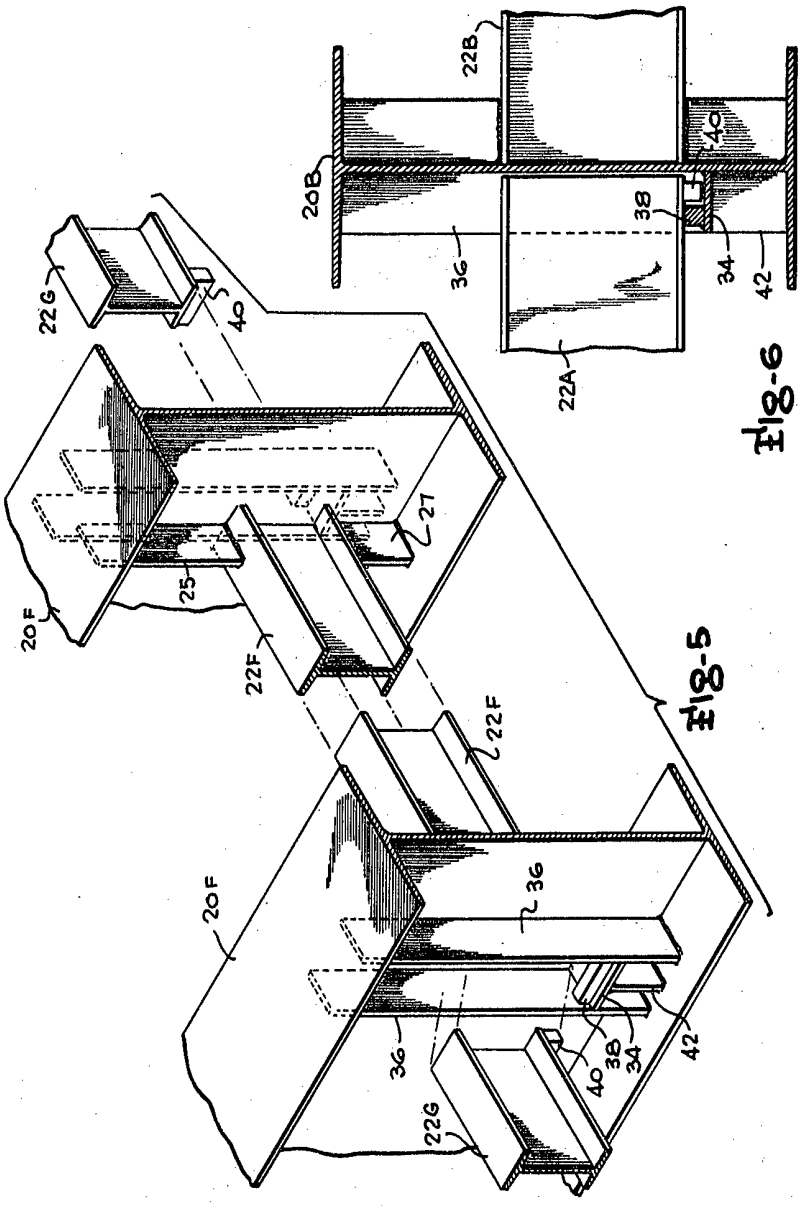

Fig 6

Fig 5

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Sheet 4

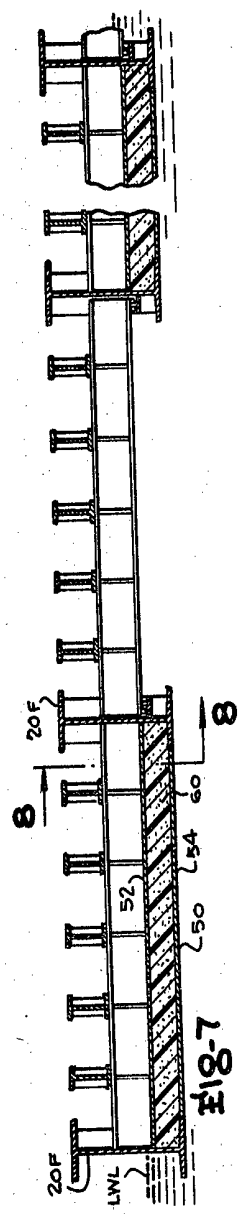

FIG 8-7

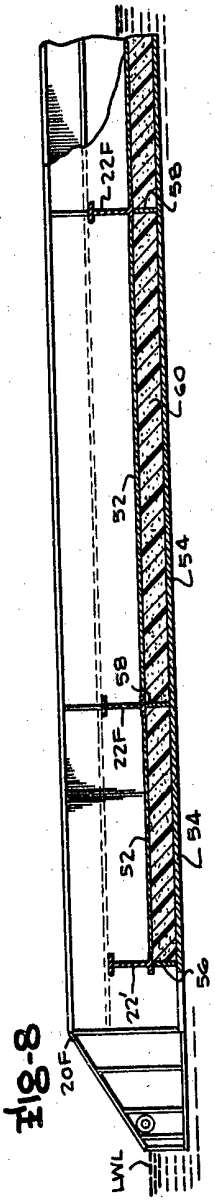

FIG 8-8

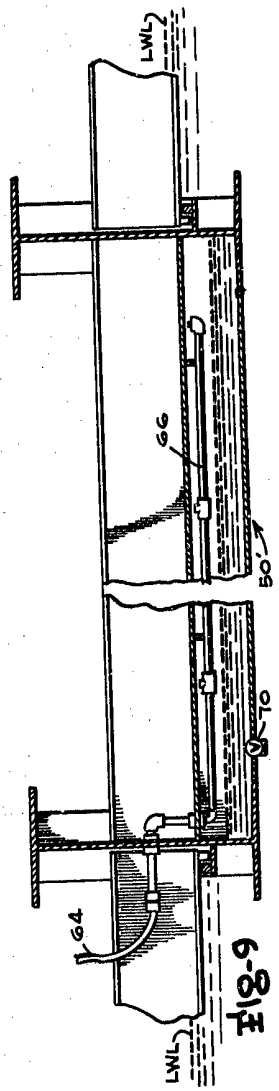

FIG 8-9