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[54] **HYDRAULIC JACKS FOR CONTROLLED LOAD TRANSFER**

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[52] **U.S. Cl.** **405/209**; 405/203; 405/204

[58] **Field of Search** 405/203, 204, 209, 195, 405/196, 202, 211, 224; 92/48, 90, 91, 92

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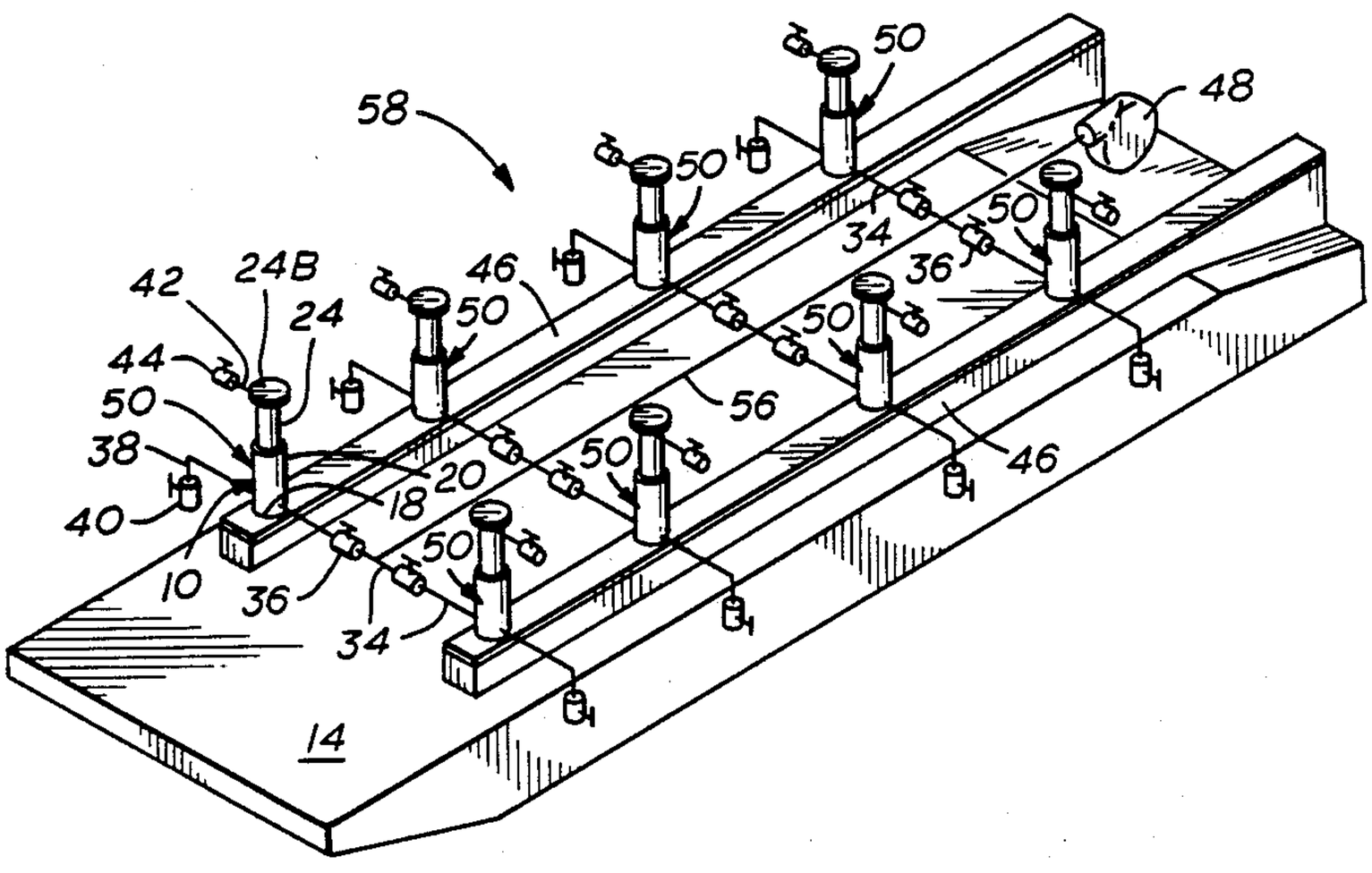
[57] **ABSTRACT**

A load transfer device and method is disclosed for rapid, controlled transfer of a load between two support surfaces such as transfer of a prefabricated deck from a barge to an offshore deck support structure. The load transfer device connects a piston chamber to a support base on the barge and receives the prefabricated deck on one end of the piston rod, the other end of which is received within the piston chamber and is supported upon an enclosing membrane of a bladder assembly which distends and contracts as hydraulic fluid enters and is dispelled therefrom to raise, support or lower the piston rod.

22 Claims, 2 Drawing Sheets



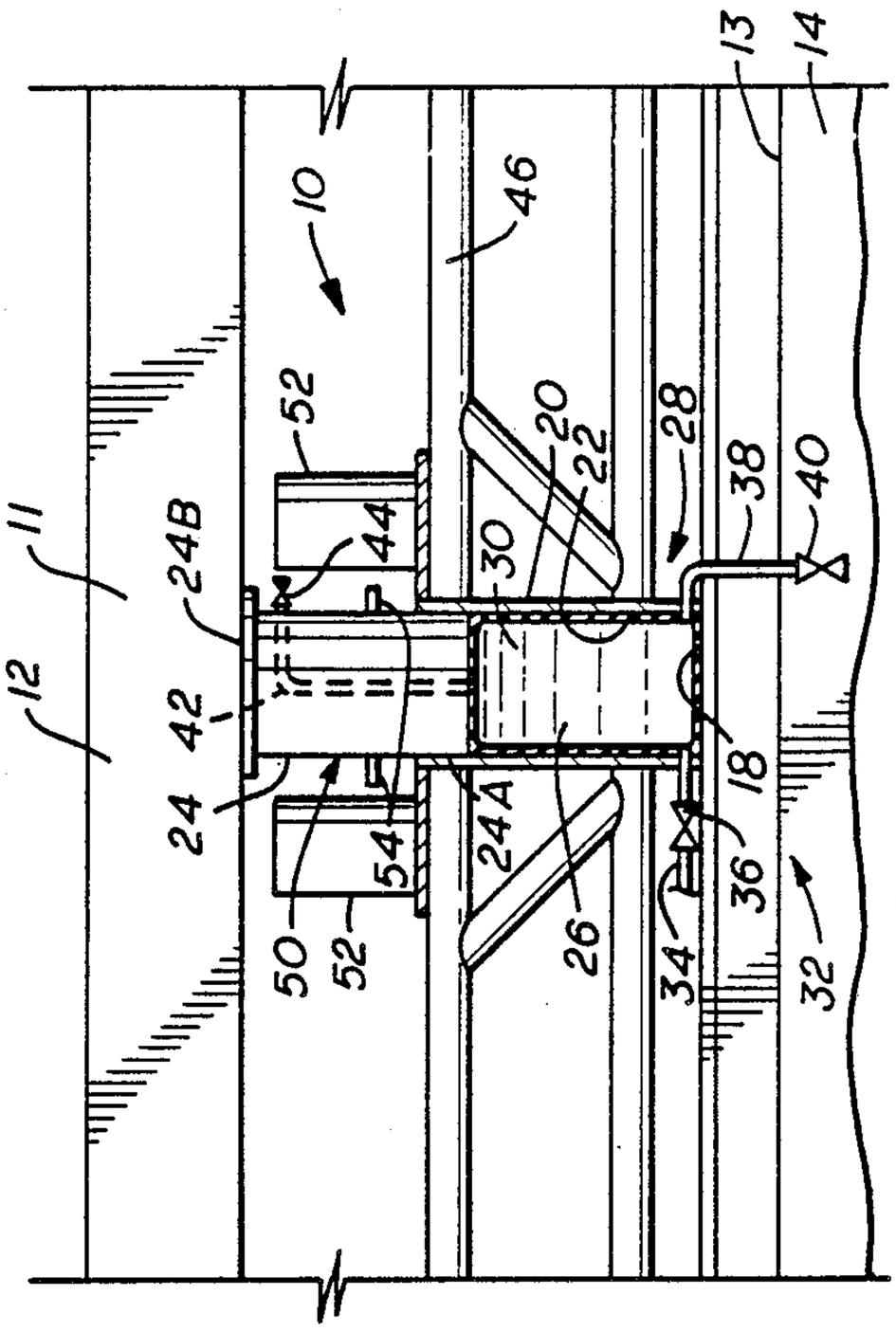


FIG. 2

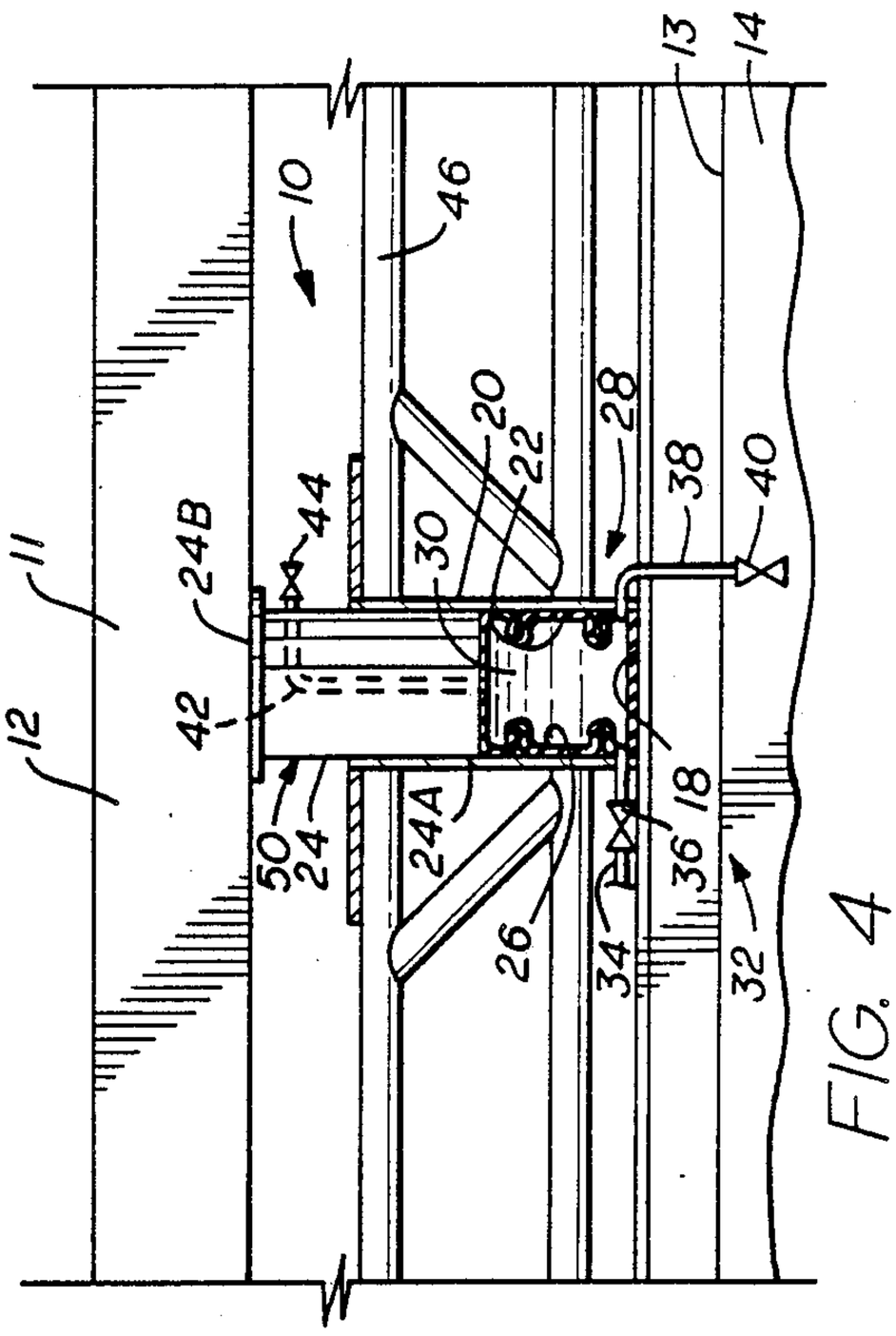


FIG. 4

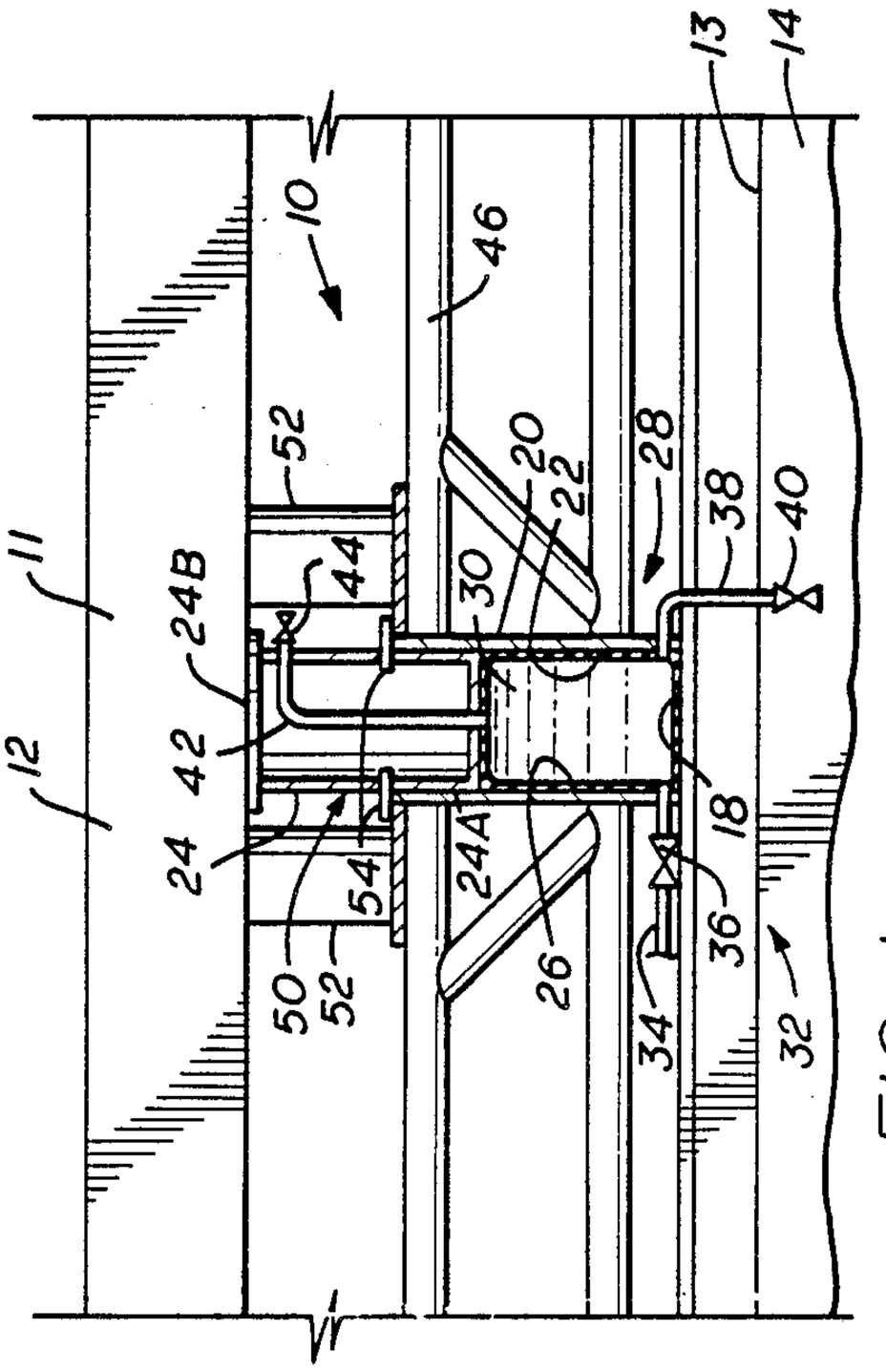


FIG. 1

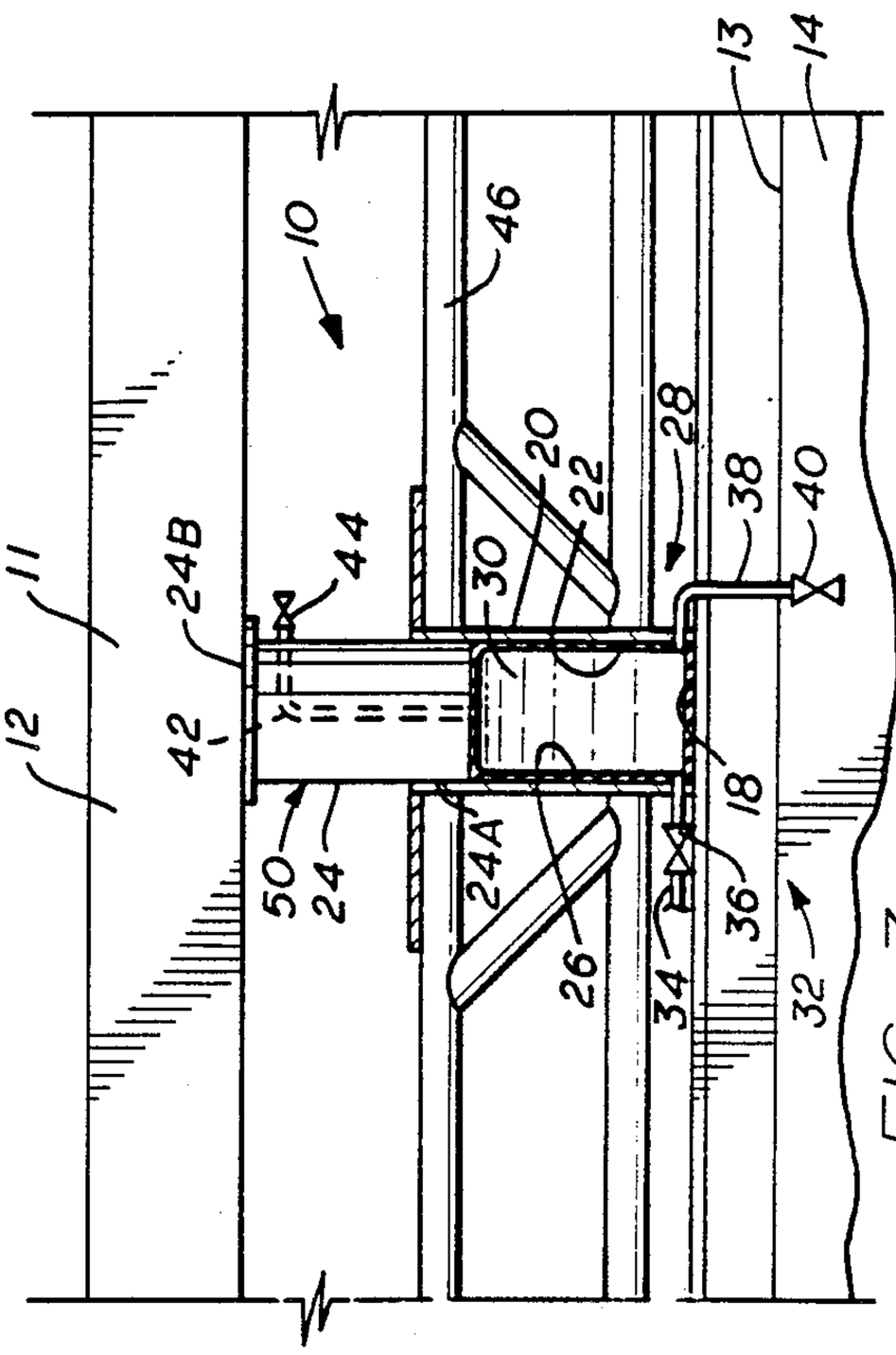


FIG. 3

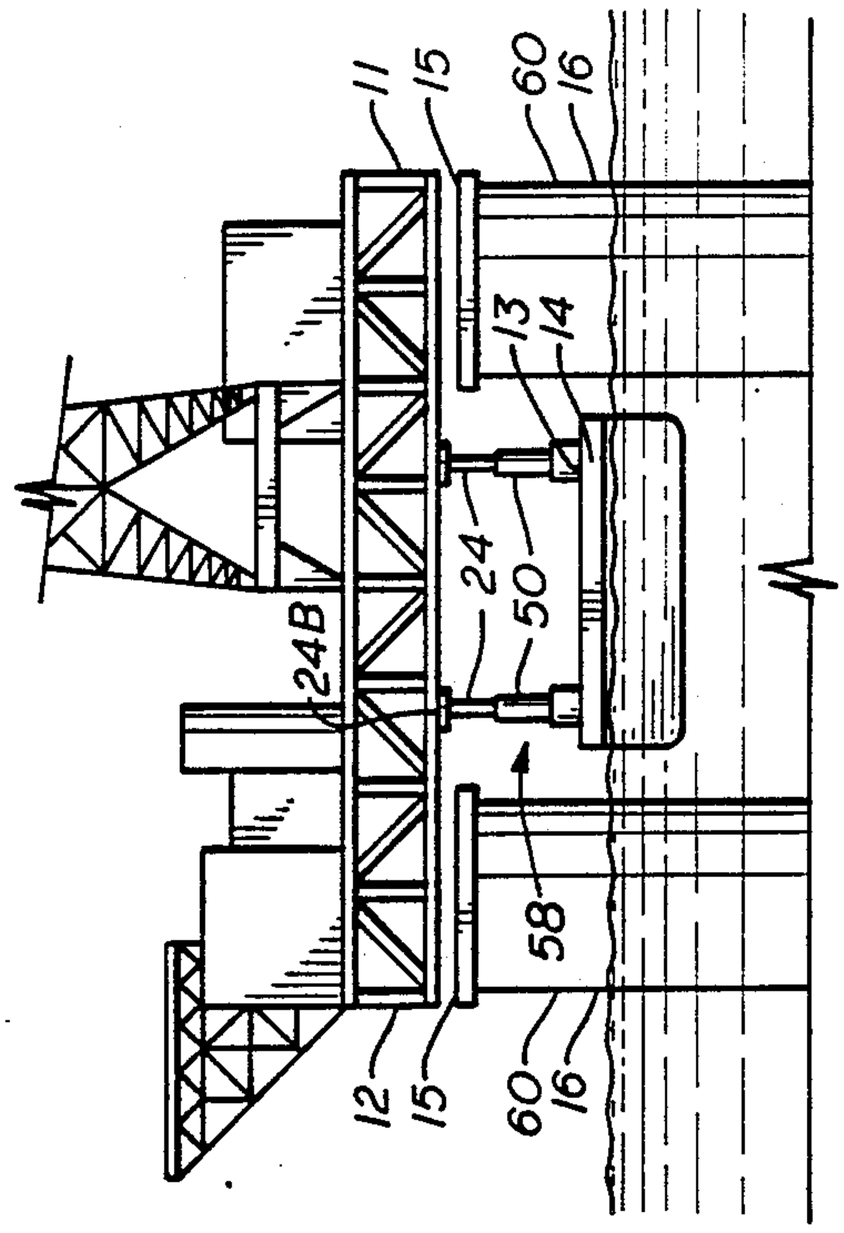


FIG. 6

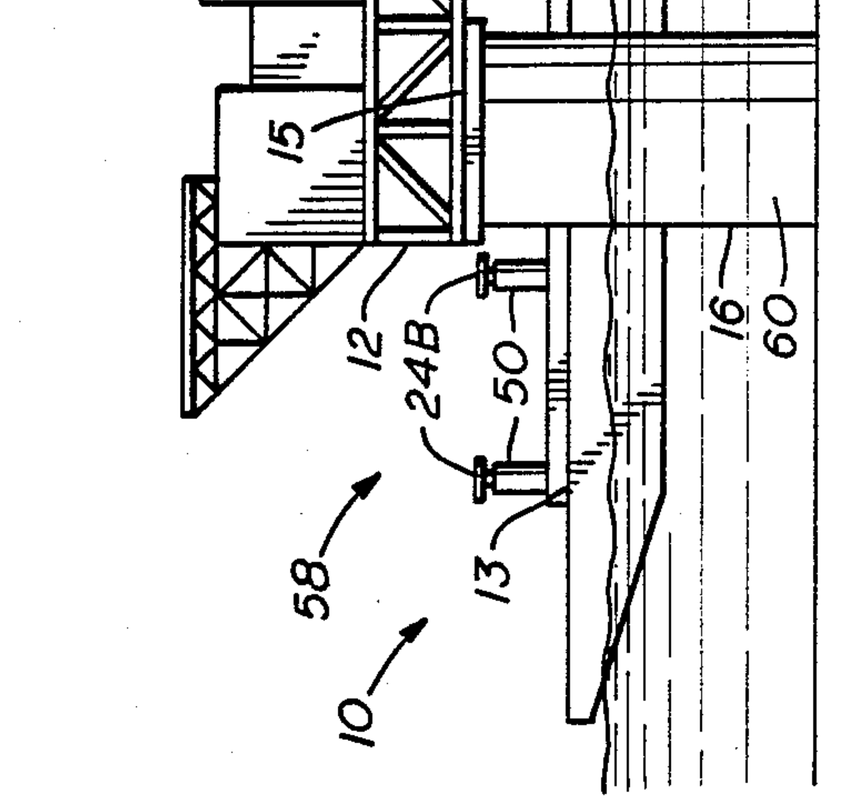


FIG. 8

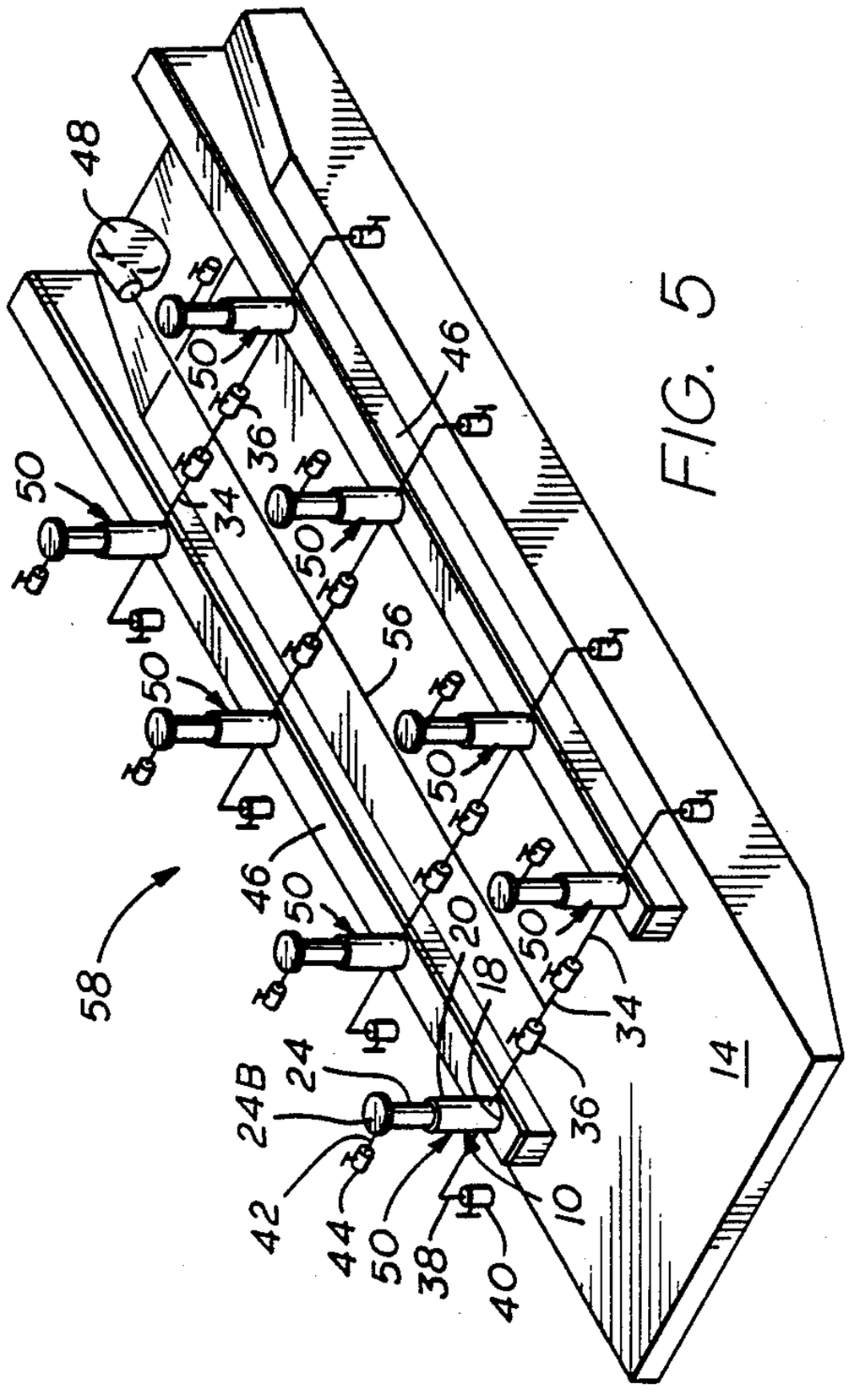


FIG. 5

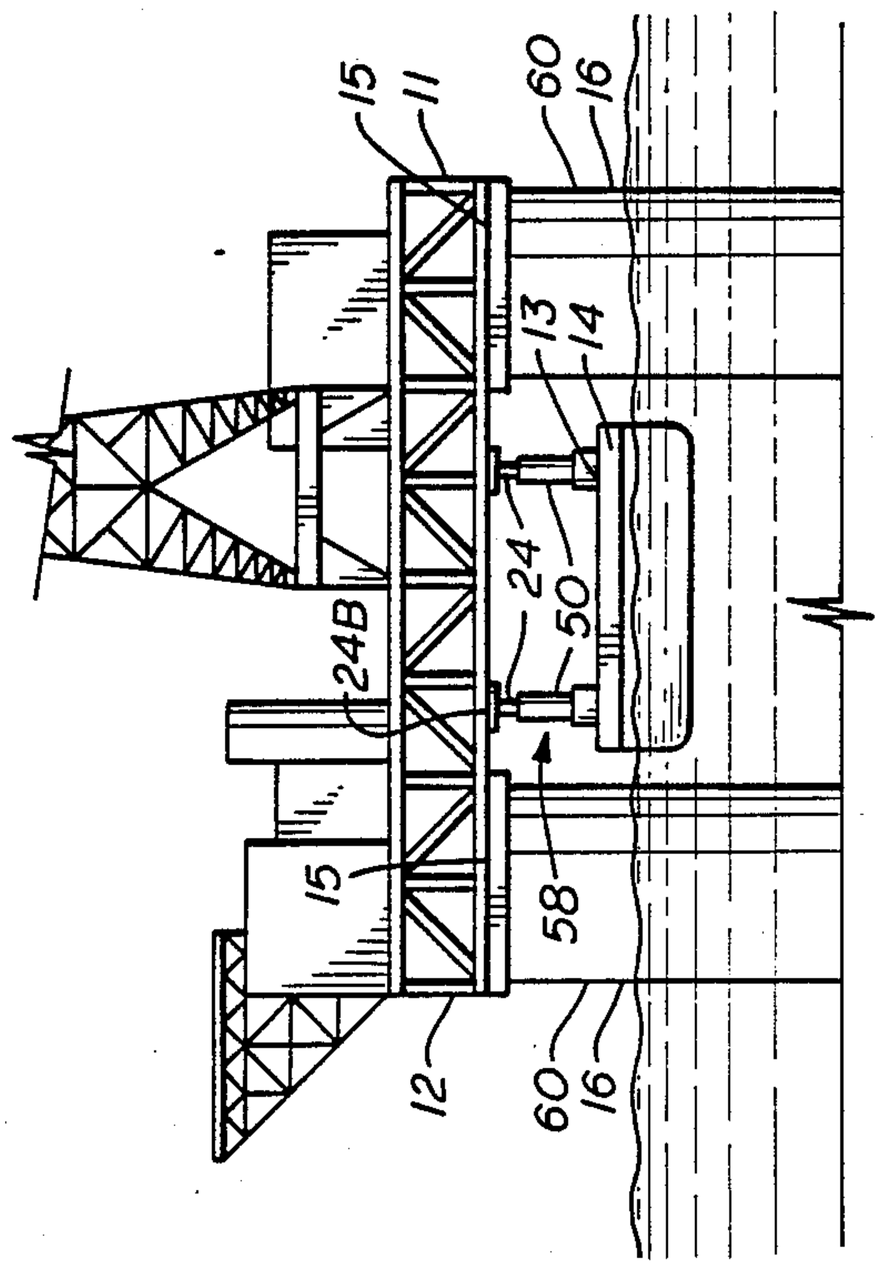


FIG. 7

HYDRAULIC JACKS FOR CONTROLLED LOAD TRANSFER

BACKGROUND OF THE INVENTION

This invention relates to a method and apparatus for controlled, rapid load transference between first and second support surfaces. More particularly, the present invention relates to transferring a load such as a prefabricated deck from a barge to an offshore deck support structure utilizing improved hydraulic jacks.

It has been found cost effective to fabricate certain major subassemblies of offshore drilling platforms onshore and then join the subassemblies by floating mating operations offshore. The drilling platform deck is one such major subassembly appropriate for onshore fabrication, provided that it can be effectively transferred to deck support structures offshore. Numerous deck support structures might accept such a prefabricated deck including rigid towers, compliant pile towers, semisubmersible vessels, and tension leg platforms.

Prefabricated decks have been joined to deck support structures offshore in the prior art by transporting the deck to the platform site by barge, maneuvering the barge between a plurality of deck support members to position the deck over the deck support members and transferring the weight of the deck to the deck support members by ballasting the barge. Alternatively, hydraulic jacks have been used in the prior art to effect this transfer. However, neither approach has been effective in transferring the deck weight quickly enough to prevent wave motions operating on the barge from slamming both the barge and the deck support members into the deck during the latter stages of load transfer. Further, excessively rapid transfer accentuates the slamming action in that removing the load from the barge too quickly causes excited motions of the floating barge to combine with wave motions of the ambient sea conditions. This problem is even more severe where the deck support structure is itself a floating structure as in the case of semisubmersibles and tension leg platforms.

SUMMARY OF THE INVENTION

The present invention is a load transfer device and method for rapid, controlled transfer of a load between two support surfaces. Both the device and method are of particular application in joining a prefabricated deck to an offshore deck support structure. In this case the load is the prefabricated deck and the two support surfaces are a barge and the deck support structure.

A load transfer device constructed in accordance with the present invention and employed in offshore platform construction connects a piston chamber to a support base on the barge and receives the prefabricated deck on one end of the piston rod, the other end of which is received within the piston chamber and is supported upon an enclosing membrane of a bladder assembly which distends and contracts as hydraulic fluid enters and is dispelled therefrom to raise, support or lower the piston rod.

The method of transferring a prefabricated deck from a barge to an offshore deck support structure in accordance with the present invention includes supporting the deck on the barge upon an array of hydraulic jacks in which the load is carried by bladder assemblies filled with a hydraulic fluid, then positioning the deck over the deck support members and draining the hydraulic fluid from the enclosing membrane within the hydraulic

jacks thereby lowering the deck onto the deck support structure and then removing the barge from beneath the deck.

BRIEF DESCRIPTION OF THE DRAWINGS

The brief description above, as well as further features and advantages of the present invention will be more fully appreciated by reference to the following detailed description of the preferred embodiment which should be read in conjunction with the accompanying drawings in which:

FIG. 1 is a cross-sectional view of a controlled load transfer device constructed in accordance with the present invention;

FIG. 2 is a cross-sectional view of a controlled load transfer device constructed in accordance with the present invention in which the piston arm has been distended to remove the load from the removable supports;

FIG. 3 is a cross-section a controlled load transfer device constructed in accordance with the present invention in which removable supports have been removed;

FIG. 4 is a cross-section view of a controlled load transfer device constructed in accordance with the present invention in which the hydraulic fluid is being removed from the bladder assembly;

FIG. 5 is a perspective schematic illustration of a barge in which a plurality of load transfer devices constructed in accordance with the present invention have been deployed in an array;

FIG. 6 is a front elevational view of a barge deploying controlled load transfer devices of the present invention positioning the deck over the deck support structure in accordance with the method of the present invention;

FIG. 7 is a front elevational view of a barge deploying load transfer devices of the present invention lowering a deck onto the deck support structure in accordance with the method of the present invention; and

FIG. 8 is a side elevational view of a barge deploying load transfer devices of the present invention being removed from beneath the deck in accordance with the method of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 1 of the drawings, reference numeral 10 refers generally to a controlled load transfer device constructed in accordance with the present invention. In the preferred embodiment, load transfer device 10 is configured to transfer a load 11, illustrated as prefabricated drilling deck 12, from a first support surface 13 to a second support surface 15, illustrated as barge 14 and offshore deck support structure 16, respectively. The offshore deck support structure is illustrated in FIG. 6. Those having ordinary skill in the art will recognize that the present invention can be employed with numerous types of offshore deck support structures including rigid towers, compliant pile towers, semisubmersible vessels, and tension leg platforms.

Returning to FIG. 1, load transfer device 10 is supported by barge 14 at support base 18. Cylinder 20 defines a piston chamber 22 and is connected to the support base. The first end 24A of piston rod 24 is slideably received within piston chamber 22 and presents its second end as load engaging surface 24B. Enclosing

membrane or bladder **26** fills the piston chamber between piston rod **24** and support base **18**. The enclosing membrane is filled with a hydraulic fluid **30** which controls the volume of the enclosing membrane within piston chamber **22** and thereby the position of load engaging surface **24B** in relation to support base **18**.

Enclosing membrane **26** is part of a bladder assembly **28** which also includes means **32** for conducting hydraulic fluid **30** into and out from the enclosing membrane. The conducting means of FIG. **1** is provided by fill line **34** which connects a reservoir and pump (not shown) to the interior of enclosing membrane **26** through valve **36** and connects the interior of the enclosing membrane to the exterior environment through outlet line **38** and valve **40**. Further, the preferred embodiment provides vent line **42** communicating with the top of enclosing membrane **26** through valve **44**.

FIG. **1** further illustrates cribbing **46** which provides additional support for the load and distributes the load across barge **14**. The cylinder and piston rod assembly previously described is generally referred to in FIG. **1** as hydraulic jack **50**. In transporting deck **12** across distances that require prolonged support on barge **14**, hydraulic jack **50** can be supplemented with removable supports **52** which carry the load of deck **12** and transfer it directly to cribbing **46**.

The sequence of FIGS. **1** through **4** illustrate the operation of load transfer device **10**. As discussed above, FIG. **1** illustrates the transportation mode in which deck **12** is supported on barge **14** by removable supports **52** which carry the load of deck **12** upon cribbing **46**. Further, it may be preferred that all fluid be drained from enclosing membrane **26** for extended transport. In this instance, and with load **11** carried by removable supports **52**, retractable pins **54** can be deployed to fix pistion rod **24** in a somewhat distended position which facilitates filling enclosing membrane **26** with hydraulic fluid.

After barge **14** has carried deck **12** into close proximity to an offshore deck support structure, removable supports **52** are withdrawn. Deck **12** is lifted from rest upon supports **52** by pumping hydraulic fluid **30** through fill line **34** with valve **36** open and with valve **40** closed to prevent the hydraulic fluid from leaving through outlet line **38**. See FIG. **2**. If fluid has been drained from enclosing membrane **26** during transport, it will be necessary to first fill the enclosing membrane with valve **44** open to permit air within enclosing membrane **26** to exit through vent line **42**. Once all air has been removed from the enclosing membrane, valve **44** is closed and hydraulic pressure causes the enclosing membrane to expand and thereby distend piston rod **24**. After deck **12** has been disengaged from supports **52**, the supports are removed and retractable pins **54** are no longer needed and are removed. See FIG. **3**.

FIG. **3** illustrates load transfer device **10** in which hydraulic jack **50** is carrying the load of deck **12** while barge **14** is maneuvered to place deck **12** in position for lowering into engagement with an offshore deck support structure. Hydraulic fluid **30** is held within enclosing membrane **26** by closing valve **36** in fill line **34** and closing valve **40** in outlet line **38**. FIG. **4** illustrates the lowering of deck **12** by discharge of hydraulic fluid **30** through outlet line **38** by opening valve **40**. Valve **44** of vent line **42** remains closed through the lowering procedure so that all hydraulic fluid **30** is expelled through outlet **38**.

Valve **40** controls the rate at which hydraulic fluid **30** is drained from enclosing bladder **26** and thereby controls the rate at which piston rod **24** sinks into piston chamber **22** of cylinder **20**. Retracting piston rod **24** lowers deck **12** and rests it upon the offshore deck support structure and piston rod **24** continues to drop to where it is no longer subject to slapping against the bottom of deck **12** by wave action acting upon barge **14**.

In the preferred embodiment, a plurality of hydraulic jacks **50** are mounted on barge **14** in an array within cribbing **46** as illustrated in FIG. **5**. FIG. **5** is a schematic drawing and illustrates pump **48** leading to fill lines **34** through supply line **56** through valves **36**. In the preferred embodiment, the hydraulic fluid is sea water which can be drawn from the ocean by pump **48** and expelled directly into the ocean from outlets **38** through valves **40**. In addition, vent lines **42** are illustrated which discharge though valves **44**. Various means of valve control are known in the art in which the array **58** of hydraulic jacks **50** can be operated in a coordinated manner in the raising and lowering operations discussed above.

A method for transferring a prefabricated deck from barge **14** to deck support structure **16** is illustrated in FIGS. **6** through **8** which should be read in conjunction with the foregoing figures and discussion. FIG. **6** illustrates deck **12** being supported by array **58** of hydraulic jacks **50** on barge **14** while the deck is positioned over deck support members **60** of deck support structure **16**. Once in position, deck **12** is lowered into position in a rapid, controlled deployment by draining the hydraulic fluid from the bladder assemblies within hydraulic jacks **50** in accordance with the foregoing discussion. See FIG. **7**. After deck **12** is firmly seated upon deck support members **60** of deck support structure **16**, further hydraulic fluid is drained from the bladder assemblies and the load engaging surfaces **24***b* of piston rods **24** are further lowered in a continued deployment so that wave action acting on barge **14** will no force load engaging surfaces **24B** to slam into the underside of deck **12**. Thereafter the barge is removed from beneath the deck. See FIG. **8**.

In addition, the method for transferring the prefabricated deck from the barge onto an offshore deck support structure can further include use of removable supports **52** by adding the steps of supporting the barge on the removable supports during transportation to the offshore deck support structure and then rigging for deployment by transferring the deck load to an array of hydraulic jacks **50** by distending piston rods **24** until the hydraulic jacks carry the load of the deck and then removing the supports.

This invention facilitates offshore construction by providing for rapid, controlled load transfer of prefabricated subassemblies constructed onshore to other subassemblies positioned offshore.

Other modifications, changes and substitutions are intended in the foregoing disclosure and in some instances some features of the invention will be employed without a corresponding use of other features. Accordingly, it appropriate that the appended claims be construed broadly and in a manner consistent with the spirit and scope of the invention herein.

I claim:

1. A controlled load transfer device comprising:

a support base;

a cylinder defining a piston chamber connected to the support base;

a piston rod having its first end receivable within the piston chamber;
a load engaging surface on the second end of the piston rod; and
a bladder assembly comprising:
an enclosing membrane within the piston chamber between the first end of the piston rod and the support base;
means for conducting a hydraulic fluid into the enclosing membrane;
means for conducting the hydraulic fluid out from the enclosing membrane; and
means for controlling the rate of flow of the hydraulic fluid out from the enclosing membrane.

2. A controlled load transfer device constructed in accordance with claim 1 wherein:
the means for conducting the hydraulic fluid into the enclosing membrane comprises:
a fill line connected to a hydraulic fluid reservoir at one end and to the interior of the enclosing membrane at the other end;
an inlet control in the fill line; and
means for driving the hydraulic fluid through the fill line and into the enclosing membrane;
and the means for conducting the hydraulic fluid out from the enclosing membrane comprises:
an outlet line connected to the interior of the bladder on one end and to a discharge line on the other end; and
means for driving the hydraulic fluid out of the enclosing membrane.

3. A controlled load transfer device utilizing a hydraulic fluid for transferring a load from a first support surface to a second support surface comprising;
a support base connected to the first support surface;
a cylinder defining a piston chamber connected to the support base;
a substantially vertical piston rod having its first end receivable within the piston chamber;
a load supporting surface on the second end of the piston rod; the piston rod throwing between an extended position higher than the second support surface and a contracted position lower than the second support surface; and
a bladder assembly comprising:
an enclosing membrane for containing the hydraulic fluid within the piston chamber between the first end of the piston rod and the support base;
a controlled fill line for introducing hydraulic fluid into the enclosing membrane;
an outlet line for releasing the hydraulic fluid out from the enclosing membrane; and
an outlet valve for controlling the rate of release of the hydraulic fluid out from the enclosing membrane through the outlet line;
whereby the load is carried on the load supporting surface on the second end of the piston rod when the enclosing membrane is full of the hydraulic fluid and the load can be rapidly transferred at a controlled rate to the second support surface by releasing the hydraulic fluid at a controlled rate through the outlet valve and deflating the enclosing membrane.

4. A controlled load transfer device in accordance with claim 3 wherein the load is a prefabricated deck, the first support surface is a barge and the second support surface is an offshore deck support structure.

5. A controlled load transfer device in accordance with claim 3 further comprising removable supports

placeable between the load and the first support surface for releasing the loading of the enclosing membrane through the load support surface and the piston rod.

6. A controlled load transfer device for transferring a prefabricated deck from a barge to an offshore support structure, comprising;
an array of hydraulic cylinders attached to the barge, each hydraulic cylinder comprising:
a support base attached to the barge;
a cylinder defining a piston chamber vertically oriented over the support base;
a piston rod having its first end receivable within the piston chamber;
a load engaging surface on the second end of the piston rod configured to engage the underside of the prefabricated deck;
a bladder assembly comprising:
an enclosing membrane within the piston chamber between the first end of the piston rod and the support base;
means for conducting a hydraulic fluid into the enclosing membrane;
means for conducting the hydraulic fluid out from the enclosing membrane; and
means for controlling the rate of flow of the hydraulic fluid out from the enclosing membrane; and
a control system for coordinating throughout the array the respective means for conducting the hydraulic fluid in each hydraulic cylinder.

7. A controlled load transfer device constructed in accordance with claim 6 wherein seawater is the hydraulic fluid.

8. A controlled load transfer device constructed in accordance with claim 7 wherein the control system comprises a pump connecting seawater from the ocean to the means for conducting the hydraulic fluid into the enclosing membrane and wherein seawater conducted out of the enclosing membrane returns to the ocean.

9. A controlled load transfer device in accordance with claim 6 further comprising removable supports placeable between the prefabricated deck and the barge.

10. A controlled load transfer device in accordance with claim 9 further comprising retractable pins engagable between the cylinders and the respective piston rods.

11. A controlled load transfer device in accordance with claim 10 further comprising a sealable vent line connected to the top of each enclosing membrane.

12. A method for transferring a prefabricated deck from a barge to an offshore deck support structure comprising;
supporting the deck on the barge upon an array of hydraulic jacks in which the load is carried by bladder assemblies filled with a hydraulic fluid;
positioning the deck over the deck support members;
lowering the deck onto the deck support member in a rapid, controlled deployment by draining the hydraulic fluid from the bladder assemblies within the hydraulic jack at a rate controlled by an outlet valve from the bladder assemblies; and
removing the barge from beneath the deck.

13. A method for transferring a prefabricated deck from a barge to an offshore deck support structure in accordance with claim 12, further comprising the additional steps:
supporting the deck on the barge on removable supports set between the barge and the deck; and

rigging for deployment by transferring the deck load to the array of hydraulic jack in which the piston rods which are supported by bladders filled with hydraulic fluids, said rigging for deployment including the following steps:

pumping hydraulic fluid into the bladders causing them to inflate and distend the piston rods supported thereby to lift the deck off the removable supports; and

removing the removable supports.

14. A controlled load transfer device in accordance with claim **2** wherein the means for controlling the rate of flow of the hydraulic fluid out from the enclosing membrane comprises an outlet control in the outlet line.

15. A controlled load transfer device in accordance with claim **14** wherein the outlet control is a valve.

16. A controlled load transfer device comprising:

a support base;

a cylinder defining a piston chamber connected to the support base;

a piston rod having its first end receivable within the piston chamber;

a load engaging surface on the second end of the piston rod; and

a bladder assembly comprising:

an enclosing membrane within the piston chamber between the first end of the piston rod and the support base; and

means for conducting seawater into and out from the enclosing membrane.

17. A controlled load transfer device constructed in accordance with claim **16** wherein the means for conducting the seawater into and out from the enclosing membrane comprises:

a fill line connected to a body of seawater at one end and to the interior of the enclosing membrane at the other end;

means for driving the seawater through the fill line and into the enclosing membrane;

an outlet line connected to the interior of the bladder on one end and to a discharge line on the other end; and

means for driving the seawater out of the enclosing membrane.

18. A controlled load transfer device in accordance with claim **17** wherein the discharge line discharges the seawater directly into the body of seawater.

19. A controlled load transfer device utilizing seawater for transferring a load from a first support surface to a second support surface comprising;

a support base connected to the first support surface;

a cylinder defining a piston chamber connected to the support base;

a substantially vertical piston rod having its first end receivable within the piston chamber;

a load supporting surface on the second end of the piston rod; the piston rod throwing between an extended position higher than the second support surface and a contracted position lower than the second support surface; and

a bladder assembly comprising:

an enclosing membrane for containing the seawater within the piston chamber between the first end of the piston rod and the support base;

a controlled fill line for introducing seawater into the enclosing membrane;

an outlet line for releasing the seawater out from the enclosing membrane; and

an outlet valve for controlling the rate of release of the seawater out from the enclosing membrane through the outlet line;

whereby the load is carried on the load supporting surface on the second end of the piston rod when the enclosing membrane is full of the seawater and the load can be rapidly transferred at a controlled rate to the second support surface by releasing the seawater at a controlled rate through the outlet valve and deflating the enclosing membrane.

20. A controlled load transfer device in accordance with claim **18** wherein the load is a prefabricated deck, the first support surface is a barge and the second support surface is an offshore deck support structure.

21. A controlled load transfer device for transferring a prefabricated deck from a barge to an offshore support structure, comprising;

an array of hydraulic cylinders attached to the barge, each hydraulic cylinder comprising:

a support base attached to the barge;

a cylinder defining a piston chamber vertically oriented over the support base;

a piston rod having its first end receivable within the piston chamber;

a load engaging surface on the second end of the piston rod configured to engage the underside of the prefabricated deck;

a bladder assembly comprising:

an enclosing membrane within the piston chamber between the first end of the piston rod and the support base;

a fill line for introducing seawater into the enclosing membrane;

an outlet line for releasing the seawater out from the enclosing membrane; and

an outlet valve for controlling the rate of release of the seawater from the enclosing membrane through the outlet line; and

a control system for coordinating throughout the array the respective means for conducting the seawater in each hydraulic cylinder.

22. A method for transferring a prefabricated deck from a barge to an offshore deck support structure, comprising the steps of:

supporting the deck on the barge upon an array of hydraulic jacks so that the deck is carried by bladder assemblies within the hydraulic jacks that are filled with seawater;

positioning the deck over a set of deck support members;

lowering the deck onto the deck support members in a rapid, controlled deployment by draining the seawater from the bladder assemblies within the hydraulic jacks; and

removing the barge from beneath the deck.

* * * * *