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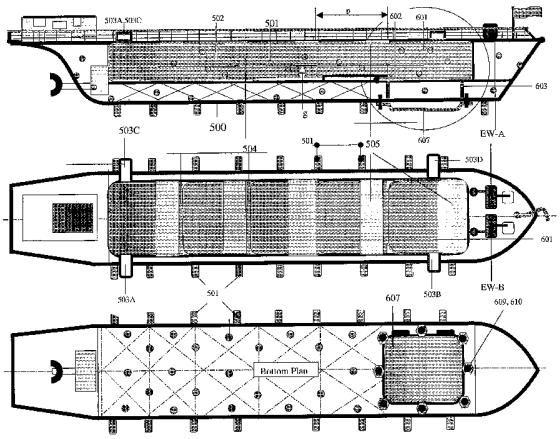
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(54) **Title:** THE BARGE UNLOADING SYSTEM TECHNICAL FIELD AND BACKGROUND ART



(57) **Abstract:** A barge emptying system and the method for unloading the granular bulk material from the double bottom barge (500), having plurality of interconnected and partly covered hoppers (502) and having at least one material discharging hopper (601), is floated into a buoyancy compartment (1001) closing the barge access gate (101) operating the pump (WP) and flooding the buoyancy compartment (1001) and floating the loaded barge (500) upwards and at required height floating the barge into another water flooded buoyancy compartment (1002) closing the gate (102) draining the buoyancy compartment (1002) and lowering the barge (500) to engage its plurality of barge anchors (501) into respective plurality of arced slots (1005) of the barge seat (1003) further draining for tilting, resting and anchoring the loaded barge (500) in the barge seat (1003) and sequentially opening the slide gate (1004), the hinged gate (607) at bottom of the barge and the plate gate (602) of the material discharging hopper (601) and emptying the granular contents of the barge (500) into a material receiving silo (2000) and performing reverse operation and returning the empty barge (500) back to water body (100).

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THE BARGE UNLOADING SYSTEM

TECHNICAL FIELD AND BACKGROUND ART

01. Present invention relates to the barge emptying method for unloading the granular bulk contents of the barge from the bottom opening of the barge.
02. Present invention also relates to a category of self-unloading barges or vessels meant for quick unloading of granular bulk cargo.
03. Present invention relates to a method involving buoyancy compartments for raising and tilting the granular bulk loaded barge for unloading its contents.
04. Granular bulk material such as various metal ores, coal, lime stone, gravels, crushed or quarried stones, sand and other industrial raw and finished material that are granular in nature and which are transported in bulk quantity in a mother ship which can not travel up to point of actual unloading due to inadequate cargo unloading facility or unable to navigate due to shallow waters, in such situations bulk contents of the ship is generally loaded on to the barges to transport the material to desired location and unload it quickly to save the turn around time of the ship.
05. Especially the granular bulk cargo loaded barges, which are generally emptied by jetty or berth mounted unloading machines, have to wait till they are emptied out. Their waiting time again depend on the efficiency of the machine, which is high as long as the barge is full and its efficiency decreases gradually as the content in the barge reduces. Barge waiting time further depend on the climatic conditions and breakdown of the unloading machine which demands for round the clock deployment of specialized and other trained crew in addition to operating the machine which is tedious job.
06. The barge unloading machines presently under use pollute the surroundings and create hazardous conditions due to multiple handling of the material.
07. The methods of prior art adopted for emptying the barges containing granular material include, single bucket cranes, multiple bucket conveyors, multiple bucket wheels and screw conveyors, which are common in use compared to the other type of barge or vessel tilting or upsetting systems, to which the present invention relates.
08. The bucket unloading system, multiple bucket unloading system or multiple wheels unloading system of prior art, may be a mobile or a fixed installation, is used for unloading granular bulk cargo, carried by a vessel or a barge, into land based or into a floating receiver, do not handle the barge directly. In all these systems the open hopper barge remains anchored in water within the operational reach of the unloading system. The extract of the buckets is limited due to their limitations of movements and reach

within the hopper resulting in incomplete unloading of cargo. Also such systems are relatively slow and affecting the turn around time of the barge. These systems incur huge cost of installation, operation and maintenance with additional drawback of noise and air pollution. Operation of these systems is, to a greater extent, also dependent of the surrounding climatic conditions due to their nature of construction and operation.

09. Other barge unloading system-involving barge tilting or upsetting type, to which the present invention belongs, are also in use. The methods of barge or vessel upsetting systems do act, using various means, directly upon the open hopper barge or vessel for unloading their granular contents. The prior art of this nature known to applicant have employed:

i. A cable lifting method wherein the barge is secured inside a carrier, which is then lifted to tilt within tracks by means of lifting cables (Note US Pat. No. 710,194 issued on 30.9.1902)

ii. A rotating cylinder system, wherein the barge is secured in a trough supported within a cylinder, then the cylinder is rotated by gear mechanism (Note US Pat. No.1, 823,172 issued on 15.9.1931.)

iii. An inclined track system, wherein the barge is secured in a carrier that is translated by rack gears all along the ramp to a rolling unit which is then rotated by cables (Note US Pat. No.3, 537,600 issued on 3.11.1970)

iv. Open hopper barge is lifted above the water by clamping the barge with the floating platform having ballast tank whose water is replaced by compressed gas. At required height the loaded barge is stopped and tilted by hydraulic arm to empty the bulk in to another floating body (Note US Patent No. 5,020,956)

v. A cargo vessel is secured in a container and lifted from the water by pulley-block mechanism and emptied into a receiver by tipping the container (Note GB Pat. No. 244343)

10. The art of lifting a barge or vessel above the water level in which it is floating, like dry dock has been also addressed by the following patents:

US Pat. No.	**Inventor**	**Issued on**
3,270,698	M R Fort	06.9.1966
4,072,119	B V Williams	07.2.1978
4,084,529	H Katenberg	18.4.1978

11. Barge upsetting or tilting type systems of the prior art are relatively expensive and complicated in nature moreover these systems are not as reliable or practical for bigger sizes of barges as in case of present invention.
12. Conventional self-unloading barges or vessels having plurality of hoppers, generally arranged in one or two rows, wherein each hopper having a discharge gate at the bottom within the barge for discharging and controlling the flow of the granular bulk cargo which is discharged on the conveyor installed below the hopper gates which is also within the barge or the vessel. The conveyor is used for conveying the material further out of the vessel or the barge.
13. However, as claimed in present invention, the granular bulk loaded barge, having plurality of interconnected and partly covered hoppers, discharges its entire contents directly into a receiver through the bottom opening provided to one of the hopper of the barge, comprising material discharging arrangements to discharge the contents from the bottom of the barge. Hence unlike other systems the present invention eliminates any additional means for emptying the barge.
14. The art of dumping the barge content from its bottom opening is addressed by:

i). Open bottom gravel dump boat used for transporting and dumping the materials, pertaining to water based construction work, such as gravels, crushed or quarried stones through its bottom gate, wherein the bottom gate constitutes entire bottom of the boat. The "L" shaped watertight gates integral to the sides of the boat. Hydraulic cylinders installed at four corners of the boat for operating the gates.
(Note US Patent No. 5,012,754 issued on 7.5.1991)

SUMMARY OF THE INVENTION

15. It is therefore; the first object of the present invention is to provide a self- unloading barge alongwith practical, safe, reliable, quick, economical and easy operateable and maintainable system.
16. The second object of the present invention is to provide a hazardless, superior system and method for emptying the granular bulk loaded barge **having significantly low Air, Water and Sound pollution, which** is the basic qualifying criteria or essential requirements of modern industry.
17. The third object of the present invention is to provide a completely watertight sealing arrangement for the bottom opening of the barge, which is essential requirement of a barge or vessel having bottom opening or bottom-dumping arrangement.

18. The forth object of the present invention to provide a barge capable of transporting heavy load of granular bulk and also emptying its contents on the land based receiver through its bottom opening while resting in tilted position.
19. The fifth object of the present invention is to provide a system and the method enabling the unloading of granular bulk material from the barge as described in the invention.
20. The sixth object of the present invention is to provide a system for handling the higher load carrying barge and emptying its granular bulk content without the use of additional mean of emptying its contents, wherein the buoyancy principle is employed for lifting as well as for tilting the barge at an elevation above the level of the water body without the use of any costly means and external force particularly for lifting the floating height of the barge with respect to water body and for tilting of the loaded barge.
21. According to present invention this object is achieved by using system that operates reliably in all respect, even during adverse climatic conditions and variable water levels, since the barge emptying operation is carried out by isolating the barge from the water body, in which it is floating, and protected from surrounding conditions during barge emptying operation hence eliminates the operational hurdles.

BRIEF DESCRIPTION OF THE DRAWING

22 For further understanding the concept and objects of this invention, the description shall be read along with the reference drawings and details.

Fig. 1 is the side elevated view, top view and the bottom view of the double bottom barge (500) indicating its construction and the general arrangement inclusive of plurality of hoppers (502) and material discharging hopper (601), plurality of partition plates (504), spillage prevention plate (505), bolting arrangement of the hinged gate (607) with the bottom plate of the barge (500), winches (EW-A and EW-B) mounted on the barge deck, the guide blocks (503A, 503B, 503C and 503D) integral to four corners of the barge, the view also shows the plurality of barge anchors (501) which are protruding out from the outer body of the barge (500).

Fig. 2 is a cross sectional details of the in material discharging hopper (601) equipped with bottom dumping arrangement which comprises the plate gate (602), the duct (603), winch cables (EWR-A and EWR-B), and the guide pulleys (EWP-A and EWP-B) which are anchored inside the duct (603) is the operating system provided for operating the hinge gate (607), seepage water level sensor (605), seepage water suction nozzle (604) connected to water pump (606), the barge bottom hinged gate (607) which is hinged with the bottom plate of the barge (500) which is shown in bolted condition indicating its stud bolts (609) and nuts (608) and the water sealing gasket (610).

Fig. 3 is a sectional view of the barge (500) showing four guide blocks (503A, 503B, 503C, and 503D) integral to four corners of the barge (500) along with operating arrangement, general details of plurality of barge anchors (501).

Fig. 4 is a top view which shows the buoyancy compartments (1001 and 1002), the barge access gate (101) and the interconnecting gate (102) installed between the said two buoyancy compartments, barge seat (1003) shown along with its arced slots (1005) on its inner side walls and in its top surface of its base, the slide gate (1004) at the bottom of the barge seat (1003) and material receiving silo (2000) is constructed on the ground exactly below the barge seat (1003).

Fig. 5 is a sectional view of the buoyancy compartment (1002) along with the barge seat (1003) viewed from the side which shows the inside shape and other details such as tilted base of the barge seat (1003), plurality of arced slots (1005), an opening which forms a port in the barge seat (1003), slide gate (1004) which is shown in open and retracted position and the material receiving silo (2000) constructed on the ground exactly below the barge seat (1003) is also shown.

Fig.6 shows the close view of one of the plurality of arced slots (1005), which are provided in the base of the barge seat (1003) in addition to plurality of arced slots on its side walls, into which the respective plurality of bottom anchors (501) of the barge (500) get engaged when the barge (500) gradually tilts and comes to rest and anchored in the barge seat (1003).

Fig. 7 show the bottom view and the sectional details of the slide gate (1004), the gate (1004), with water sealing gasket (1006) secured in its flange, is shown in bolted condition which provides a watertight joint around the bottom port of the barge seat (1003), the nuts (1007) are embedded in the bottom slab of the barge seat and the bolts (1008) are screwed in to nuts (1007) for bolting the gate (1004) with the barge seat (1003), the guide rails (1010) are integral to the bottom of the barge seat (1003) over which the slide gate (1004) moves up and down during its operation.

Fig. 8 is a side elevated view of the basic concept of the present invention of the barge emptying method, showing the stages (1 to 6) achieved by the loaded barge (500) during its emptying operation for unloading the granular bulk material carried by it. This view also shows most of the components of the invention such as flood water pump (WP), buoyancy compartments (1001 and 1002) along with its inlet and outlet floodwater ducts (FWD-1, FWD-2) and flood water drain duct (FDD-3) and floodwater regulating valves (FV1, FV2, FDV-3), gates (101 and 102) and vertical slots (1001A, 1001B, 1001C and 1001D)) on the inner side walls of the buoyancy compartment (1001) and the horizontal

slots (1001AB and 1001CD) are the common slots on the side walls of both the buoyancy compartments (1001 and 1002).

Fig. 9 is an inside sectional view of the buoyancy compartments (1001 and 1002) which shows the vertical slots (1001C and 100D) and horizontal slot (1001CD) remaining vertical slots (1001A and 1001B) and horizontal slot (1001AB) are on the opposite walls, which is not shown in the figure, said vertical and horizontal slots are provided on the inner sidewalls of the buoyancy compartments.

Fig.10 is a top view of the buoyancy compartment (1001) and (1002) viewed when the barge is inside the buoyancy compartments wherein the guide blocks are engaged in barge guiding slots during up ward floating or raising of the barge (500) in buoyancy compartment (1001) (refer stage 1) and the guide blocks are shown in retracted position in buoyancy compartment (1002) wherein the barge (500) is in resting in tilted position (refer stage 2).

Fig 11 is a side view of the barge seat slide gate (1004) operating arrangement comprising slide gate operating winch (EW-3), guide pulleys (EWP-3), winch cable (EWR-3) which is hooked to slide gate (1004) for pulling the gate up wards to open the material dumping port at the bottom of the barge seat (1003) and releasing the gate to close the said port during barge unloading operation. The nuts (1007) for bolting arrangements are embedded in the barge seat (1003) around the periphery of the material dumping port and the bolts (1008) are screwed in to nuts (1007) for bolting the gate (1004) with the bottom of the barge seat (1003).

Fig. 12 is a side elevated view which shows the barge pulling system provided for to and fro movements of the barge (500) between buoyancy compartment (1001) and the buoyancy compartment (1002) comprising winches (EW-1 and EW-2), guide pulleys (EWP-1 and EWP-2) and the winch cables (EWR-1 and EWR-2).

DETAILED DESCRIPTION

23. ***Referring to fig.1*** an example of a double bottom, self-unloading barge having plurality of interconnected and partly covered hoppers. The barge (500), as claimed in the present invention, is a modified version of an open hopper, double bottom barge. The plurality of interconnected and partly covered hoppers (502) of the barge (500) are constructed by welding plurality of partition plates (504) across the width of the open hopper of a barge at equal pitch (p) and at the same time leaving suitable vertical gap (g) between the bottom plate of the open hopper and the partition plates (504) to form plurality of interconnected hoppers (502) with bottom plate common to all. The plurality of hoppers

(502) always remains interconnected with each other through the bottom opening created due to the gap (g) provided between the partition plate (504) and the bottom plate of the hopper, so that the granular bulk contents of plurality hoppers can be easily discharged or transferred by gravity sliding into material discharging hopper (601) through this opening. The purpose of creating plurality of hoppers (502) by providing partition plates (504) is to check and prevent the gravity sliding of granular material from one hopper to another during barge tilting operation thereby avoiding destabilising of loaded barge. Gravity sliding of granular material generally occurs when the barge (500) is in the process of tilting and also after it achieves the tilted position in buoyancy compartment (1002) since the angle of its tilting is equals to the angle of repose suitable for gravity sliding of granular material loaded on the barge.

24. One of the hopper (502) of the barge (500) out of the plurality of hoppers, which is at the extreme end of the barge (500), preferably deck end of the barge, is converted into material discharging hopper (601) by installing the material discharging system at its bottom, as shown in the ***figure 2*** and explained its construction below in detail.
25. The partly covering to plurality of hoppers (502) including material discharging hopper (601) is imparted by welding spillage protection plates (505) with the side plates of the hoppers across the width of each hopper (502) in such a way that one end of the plate (505), which constitutes the length, is coinciding with the respective top end of the partition plate (504), which is towards the material discharging hopper (601), and the width of the spillage protection plate is such that the top opening of each hopper is partly covered keeping the major portion open for loading the material in to the hoppers. As the name suggests the function of spillage protection plate (505) is to prevent the spillage of granular bulk material, which generally occurs when the barge (500) is getting tilted, particularly when the material of lesser specific weight is being handled such as coal.

26. The function of all the hoppers (502 and 601) of the barge (500) is to carry the load of granular bulk material. However the material-discharging hopper (601) is utilised for discharging the granular bulk from its bottom opening, apart from carrying the load. ***Fig. 2*** shows the cross sectional details of the material discharging arrangements constructed at the bottom of the material-discharging hopper (601). The bottom discharging arrangement comprised of an opening in the bottom plate of the hopper (601) which acts as a material outlet port, and a plate gate (602) is installed to cover the said material outlet port of the hopper (601) so that the granular bulk load can be loaded and retained within the hold of the hopper (601) during the transportation. The plate gate (602), in

particular, can be operated by installing the hydraulic system or motorised gear mechanism, since sufficient force is required to overcome the weight of the granular cargo acting on the gate (602). The plate gate (602) when opened during unloading operation it moves inside a housing, which is welded on the top of the hoper plate of the adjacent hopper (502). (***Ref. section A-A of fig.2***)

27. The barge (500) is a double bottom barge wherein the bottom plate of the hoppers being the first bottom and the barge bottom plate is the second bottom of the barge, hence one more opening, similar to the material outlet port provided in the material discharging hopper (601), is made in the bottom plate of the barge (500) and act as material exit port which is of same shape and the size as that of the material outlet port. A hinged door type gate (607) is installed at the bottom of the barge (500) to close and seal the material exit port in all respect. One end of the hinged gate (607) is held with the bottom plate of the barge (500) by means of hinges that is welded with the bottom plate of the barge. The gate (607) accommodates a water-sealing gasket (610) secured in the groove of its flange. The gate is fastened with the bottom of the barge (500) by screwing nuts (608) on the stud bolts (609) which are welded / secured with the bottom plate of the barge around the outer periphery of the material exit port.
28. Said material exit port is closed and sealed completely to provide a reliable and safe watertight joint to the bottom opening of the barge (500) so that it can sail in deep waters safely to reach the desired destination. The material outlet port of the material discharging hopper (601) and the material exit port at the bottom of the barge (500) are interconnected by welding an interconnecting duct (603). The interconnecting duct (603) provides passage for granular bulk material during barge emptying operation by isolating the space between the said two ports at the same time it provides the room for accumulating seepage water, if any through the bottom joint.

29. For bolting or unbolting the hinged gate (607) with the bottom plate of the barge (500), the gate (607) is lifted or lowered for engaging or disengaging with the stud bolts (609) by operating the winches (EW-A) and (EW-B) which are mounted on the deck of the barge (500). One end of the winch cables (EWR-A) and (EWR-B) are tied with the gate (607) from inside and guided by the pulleys (EWP-A) and (EWP-B) which are mounted inside the duct (603) by welding the pulley mounting supports with the plates of the duct (603) from inside.
30. Though the possibility of water seepage through the water sealing gasket (610), secured in the flange of the gate (607) is remote however, in addition to water tight joint, a water

level sensor (605) and a water pump (606), which is connected to seepage water suction nozzle (604) is also provided to ensure further safety of the barge. The water level sensor (605) indicates the presence of seepage water in the duct (603), if any. Water accumulated due to seepage through the bottom joint of the gate (607), if any, is pumped out of the duct (603) by the pump (606).

31. ***Fig. 3*** that shows the arrangement of the four guide blocks (503A, 503B, 503C and 503D), which are integral to the four corners of the barge (500) .The said guide blocks are installed to prevent the lateral movements of the barge occurring during the up ward floating of the barge caused due to floodwater turbulence pumped by the pump (WP). The guide blocks (503A, 503B, 503C and 503D) are released or retracted by operating dedicated operating system installed for the purpose, which can be either pneumatic or hydraulic system.
32. The guide blocks (503A, 503B, 503C and 503D), when released, engage with the vertical slots (1001A, 1001B, 1001C and 1001D) of the buoyancy compartment (1001) respectively (***ref. Fig. 9/12***). Said vertical slots are provided on the four corners of the sidewalls of buoyancy compartment (1001) having gap between the slots and the slot size is kept suitable to accommodate the guide blocks. Said guide blocks are engaged with said vertical slots during vertically upward and downward floating movements of the barge (500). During the horizontal floating movements of the barge (500) between buoyancy compartments (1001 and 1002), the guide blocks (503A and 503B) and (503C and 503D) engage with the horizontal slot (1001AB) and (1001CD) respectively, which are the common slots on the sidewalls of both the buoyancy compartments (1001 and 1002).
33. The plurality of barge anchors (501) are integral to both the side plates and the bottom plates of the barge (500) as shown in ***fig 1, 3 and 6***, wherein one end of each barge anchor (501) is welded with the side plate of the hoppers (502 and 601) and the other end penetrates and protrudes out from the outer side plate of the barge (500). The penetrating area between each barge anchor and the plate of the barge is sealed and strengthened by welding the anchor and the plate. The barge anchors are evenly distributed on entire body of the barge so that each anchor shares the load of the loaded barge while tilting and anchoring the barge (500) .The protruding lengths of the anchors (501) are such that they are suitable to engage with the plurality of arced slots (1005). Similarly pluralities of barge anchors (501), which are at the bottom of the barge, are also welded with the bottom plate of the hoppers (502 and 601) and with the bottom plate of the barge (500) in

similar fashion. The barge anchors (501) are of solid steel bars or pipe sections having cross sectional area suitable for the purpose.

34. Note ***fig.4*** which shows the top view of the buoyancy compartments (1001) and (1002), as claimed in the present invention, the buoyancy compartment (1001) is constructed on the land connected with the water body (100) in such a way that the base of the buoyancy compartment (1001) and the base of the water body (100) is common to both. The barge access gate (101) is fitted on the opening at the bottom of the front wall of the buoyancy compartment (1001), which faces the water body (100). The entire structure is constructed on the land connected with the water body (100) so that the loaded barge (500) can be floated directly in to buoyancy compartment (1001). Second buoyancy compartment (1002) is constructed at an elevation suitable for the barge to get tilted and also to provide suitable room for constructing the material-receiving silo (2000). The cargo can be unloaded directly on the ground below the barge seat (1003) in that case the height of the buoyancy compartment gets reduced. The buoyancy compartment (1002) is supported on sturdy concrete structure suitable to withstand the weight of the floodwater and the weight of the loaded barge (500). Both the buoyancy compartments (1001 and 1002) are interconnected by installing an interconnecting gate (102) at the junction of the two. The basic function of the gate (102) is to retain the floodwater of one compartment while floodwater of other compartment is getting drained. Barge access gate (101) and the interconnecting gate (102) are operated by installing motorized gear mechanism or hydraulic operated system.
35. The plurality of arched slots (1005) on both the sidewalls of the barge seat (1003) are meant for accommodating plurality of barge anchors (501) (referrer .fig 1and fig.3), for guiding the barge (500) during its tilting operation and also for anchoring the barge (500) with the barge seat (1003). These slots are provided with steel liners so that the barge anchors can easily slide during barge tilting operation. The bottom slide gate (1004) is also shown which is in closed position (***also refer fig. 7***).
36. ***Fig. 5*** is the cross sectional view of the barge seat (1003), as claimed in the invention, the top portion of the buoyancy compartment (1002) has rectangular cross section and the lower bottom resembles the impression of the outer shape of the barge (500) The cross section shows the construction of the inner shape of the barge seat (1003) which is the impression of the outer body of the barge (500) created by first lowering the barge and then rotating its front deck end keeping the rear end hinged / anchored with the rear end of the barge seat (1003) to an extent that the barge attains the angle of repose suitable for gravitational sliding of the granular bulk material loaded on the barge (500). The barge

seat (1003) helps the barge to get tilted and also acts as a cradle for the barge (500), which holds the barge (500) in tilted position without use of any external means.

37. ***Fig.6*** shows the close view of one arced slot (1005), which are plurality in numbers and are provided in the base of the barge seat (1003), the plurality of barge anchor (501) which are integral to the bottom of the barge (500) get engaged with the respective arced slot (1005) at the bottom of the barge seat (1003). When the barge (500) gradually getting tilted which finally comes to rest with all the bottom anchors of the barge (500) engaged with the bottom arced slots of the barge seat (1003) thereby providing firm grip to the barge.

38. ***Fig. 7*** shows the details of the slide gate (1004), which is operated by the winch (EW-3), the gate (1004) moves over a guide rail (1010) integral to the bottom of the barge seat (1003) which keeps the gate very close and parallel with the lower bottom face of the barge seat (1003), so that the bolts (1008) can be screwed or unscrewed easily in to nuts (1007) which are embedded in the slab of the barge seat (1003) at its bottom side around the material dumping port. The water-sealing gasket (1006) is secured within the flange of the gate (1004), which gives a watertight joint when the gate is bolted with the barge seat (1003). The gate is designed in such a way that it is capable of withstanding water head present in buoyancy compartment (1002). The size of the material dumping port is such that it is suitable to allow the hinged gate (607), at the bottom of the barge (500), to hang down and protrude out through it.

39. ***Ref. fig. 8*** which is the basic concept of barge emptying system and the method for unloading the granular bulk material from the barge (500), as claimed in the invention. The concept can be understood better by referring the fig. 8/12 along with all other supporting figures of the invention. The loaded barge (500) (***see fig.1***) initially floating in the water body (100) in front of the buoyancy compartment (1001) (***ref. stage 1***), the barge access gate (101) is opened to receive the barge (500) into buoyancy compartment (1001) and closed back again so that the barge (500) can be isolated from water body (100). The guide blocks (503A, 503B, 503C and 503D) are released which get engaged with the vertical slots (1001A, 1001B, 1001C, and 1001D) of buoyancy compartment (1001) respectively so that the lateral movements of the barge (500) due to the floodwater turbulence can be curtailed (***refer stage 2***).

    The buoyancy compartments (1001) and (1002) are flooded by operating the water pump (WP) having higher capacity of pumping the water. The major time of the unloading operation is consumed by the flooding operation of the compartments (1001 and 1002)

hence higher the water discharging capacity of the pump or more number of pumps, lesser the time required to complete the barge emptying operation. Flooding causes the rise in water level in both the compartments (1001 and 1002). The barge (500) keeps floating and rising upwards as the water level in buoyancy compartment (1001) increases (***refer stage 3***).

As the loaded barge (500) reaches the required height, (***as shown in stage 4***), the water supply to buoyancy compartment (1001) is stopped. Once the water level in buoyancy compartment (1002) matches that with the water level of the buoyancy compartment (1001) and the water level sufficient to receive and float the loaded barge (500), its water supply is also stopped. Now the guide blocks (503A and 503B) and guide blocks (503C and 503D) get aligned with the horizontal slots (1001AB) and (1001CD) respectively, so that the barge (500) can be guided during its horizontal floating motion from buoyancy compartment (1001) to buoyancy compartment (1002). The interconnecting gate (102) is opened and the winch cables (EWR-1 and EWR-2) are hooked to the barge (500), winches (EW-1 and EW-2) are operated and the barge (500) is pulled in to the buoyancy compartment (1002) (***note stage 5, and the fig. 12***). The gate (102) is closed again so that floodwater of buoyancy compartment (1001) can be retained while the buoyancy compartment (1002) is getting drained. To initiate the tilting operation of the barge (500) initially the buoyancy compartment (1002) is partially drained by opening water-regulating valve (FDV-3) to lower the barge vertically downwards guided by the said four guide blocks of the barge (500). Once the barge (500) is about to enter the barge seat (1003), the plurality of barge anchors (501), integral to the side plates of the barge (500), are aligned with the respective plurality of arched slots (1005) provided on the inner sidewalls of the barge seat (1003), as explained earlier (***refer fig.1 and 5***). At this point the guide blocks (503A, 503B, 503C and 503D) are retracted back from the slots (1001AB and 1001CD). Water draining operation is continued so that the barge (500) can enter the barge seat (1003) with all its plurality of barge anchors (501), integral to its side plates, engaged with the respective plurality of arched slots (1005) on the side walls of the barge seat (1003). The rear end of the barge (500) first touches the shallow end of the barge seat (1003) with its bottom anchors at its rear end gradually entering the bottom arced slots of the barge seat (1003) and act as anchoring points for the barge. Further draining of water causes the tilting of the barge (500) guided by the plurality of barge anchors (501), which are integral to the side walls of the barge (500), which get engaged and move inside the plurality of arced slots (1005) on the sidewalls of the barge seat (1003) and bring the barge smoothly in to resting at the same time the barge (500) gets

anchored with the barge seat (1003) which acts as a cradle for the loaded barge. The barge (500) rests in the barge seat (1003) in such a way that its bottom-hinged gate (607) is located exactly above material dumping port of the barge seat (1003).

If the cargo handling demands, the inside surface of the barge seat (1003) can be washed with the jet of fresh water to remove the matters settled after draining the buoyancy compartment (1002). Since the lower most part of the barge seat (1003) is the material dumping port, the floodwater accumulated in this portion can be drained by providing a separate nozzle connected to the floodwater drain duct (FDD-3) or even a nozzle with a valve welded at the bottom of the slide gate (1004) can also be used for draining this water.

Once the buoyancy compartment is free from floodwater, (***refer fig.7 and fig.11***), the slide gate (1004) is unbolted by unscrewing the bolts (1008) from the nuts (1007) and the gate (1004) is released from the bottom of the barge seat (1003), which lands and rests on the guide rails (1010). The gate (1004) is pulled upwards by operating the winch (EW-3) and locked in that position. The material dumping port of the barge seat (1003) is now fully open.

(***Ref. fig.1, 2 and 11***) The bolted joint between the hinged gate (607) and the bottom plate of the barge (500) is accessed from the bottom of the barge seat (1003) through the material dumping port, the gate (607) is unbolted manually by unscrewing the nuts (608) from the stud bolts (609), the gate (607) is held tightly with the barge seat by the winches (EW-A and EW-B) during unscrewing of nuts (608). Once the nuts are unscrewed and removed, the hinged gate (607) is released, by operating the winches (EW-A and EW-B) and releasing the winch cables (EWR-A and EWR-B), which hangs down and protrudes out through the material dumping port. The plate gate (602) is opened by its dedicated operating system to initiate the actual barge emptying activity. The granular bulk material carried by the material-discharging hopper (601) gets discharged through the material outlet port, which passes through the duct (603) and escapes through the material exit port provided at the bottom of the barge (500) and gets dumped in to the material receiving silo (2000) or on the ground below the barge seat (1003). When the material-discharging hopper (601) is about to get empty the granular bulk carried by the upstream adjacent hopper (502), which is interconnected with the material discharging hopper (601) through the bottom opening between the partition plate (504) and the bottom plate of the hopper, gets discharged into material discharging hopper (601) due to gravity sliding. Granular bulk material slides down towards material discharging hopper (601), due to the barge (500) resting in tilted position with angle of tilting equals to angle of

repose suitable for gravity sliding of granular bulk material. Granular bulk material enters the material-discharging hopper (601) and gets dumped in to material receiving silo (2000) or on the ground.

This operation continues similar way for the remaining plurality of hoppers (501) of the barge (500). From the description it is obvious that, before getting discharged out of the barge (500) through the material discharging hopper (601), the granular bulk material carried by the last hopper (502) of the barge has to slide and pass through all remaining empty hoppers, which are down steam of it, since the said last hopper (502) is at extreme top end of the barge (500) and material discharging hopper (601) is at the extreme down most end of the barge (500) when it is resting in the barge seat (1003). This way the entire granular bulk material carried by the barge (500) is emptied out completely.

40. The granular bulk material received in silo (2000) is further conveyed by using various options of material handling such as open belt conveyor, pipe conveyor, pneumatic conveying system, screw conveyor or transporting by trucks.

41. For releasing the empty barge (500) back to water body (100), reverse operation is carried out by executing following **operating steps:**

The hinged gate (607) at the bottom of the empty barge (500) is lifted with the help of winches (EW-A and EW-B) and positioned over the material exit port and bolted with the bottom of the barge (500) by inserting the gate (607) on the stud bolts (609) and screwing the nuts (608).

Note the fig. 11, the slide gate (1004) is released from its locked position by operating the winch (EW-3) and positioned over the material dumping port, at the bottom of the barge seat (1003), bolted and secured with the barge seat (1003) by screwing the bolts (1008) in to nuts (1007) which are embedded in the slab of the barge seat (1003) around the periphery of material dumping port. The drain valve (FDV-3) is closed and floodwater-regulating valve (FV-2) is kept open and the buoyancy compartment (1002) is flooded with water by operating the pump (WP). ***Ref. Fig.2***, The bolted joint of the hinged gate (607) is checked thoroughly for water leak, if any, into the duct (603) before closing the plate gate (602). The plate gate (602) can be closed later on just before the fresh loading of the barge (500). As the water level in buoyancy compartment (1002) rises the empty barge (500) leaves its tilting position and starts floating upwards, which is guided by the plurality of barge anchors (501). Finally the empty barge (500) attains the horizontal floating position and leaves the barge seat (1003). The guide blocks (503A, 503B, 503C and 503D) are released as soon as they reach the required height and engage with the slots (1001AB, 1001CD). As the empty barge (500) attains the floating height suitable to

float in to buoyancy compartment (1001), water flooding is stopped. The interconnecting gate (102) is opened and the barge (500) is pulled back in to buoyancy compartment (1001) with the help of barge pulling winches. The gate (102) is closed again to retain the floodwater filled in the buoyancy compartment (1002). The guide blocks (503A, 503B, 503C and 503D) are aligned with the vertical slots (1001A, 1001B, 1001C and 1001D) respectively. The barge access gate (101) is opened partially and the floodwater from the buoyancy compartment (1001) is allowed to escape in to water body (100). As the water level starts decreasing the barge gets lowered gradually guided by the four guide blocks. As soon as the water level of the buoyancy compartment (1001) matches with the water level of the water body (100), the barge access gate (101) is completely opened and the empty barge (500) is released back to water body (100) for further cargo loading and transport.

42. It is observed that the present invention is not limited to the example shown and explained above because many varying and different embodiments can be conceived within the scope of the of the inventive steps for example:

i. Each hopper of the plurality of hopper barge or a vessel can have dedicated bottom-discharging arrangements; in that case tilting of the barge is not required. However the buoyancy compartment (1002) needs to be modified accordingly.

ii. There can be only one buoyancy compartment, which can be isolated from the water body by similar to barge access gate, as claimed in the invention. And the barge can be directly floated in to this compartment and isolated with help of a gate. Water from the compartment can be pumped out using pump. The contents of the barge can be dumped by tilting, as described in the invention, and dumping through its bottom opening in to an underground facility.

The invention in its broader aspects is, therefore, not limited to the specific details and illustrated examples shown and described. Accordingly, it is intended that the present invention cover such modifications and variations provided that they fall within the scope of the appended claims and their equivalents.

I Claim:

1. A barge emptying system for unloading granular bulk material from the double bottom barge (500) having interconnected and partly covered plurality of hoppers (502) and having at least one interconnected material discharging hopper (601) comprising:

A barge (500), loaded with granular bulk material in its interconnected partly covered plurality of hoppers (502) along with its material discharging hopper (601), is floated in to a floodable buoyancy compartment (1001) through an opening fitted with operateable barge access gate (101) and closing the barge access gate (101) and isolating the barge (500) from the water body (100), releasing the retractable guide blocks (503A,503B,503C and 503D) to get engaged in to vertical slots (1001A,1001B,1001C,and 1001D), flooding the buoyancy compartments (1001 and 1002) by operating water pump (WP) and floating the barge (500) vertically upwards in buoyancy compartment (1001) up to a height sufficient to float it in to floodable buoyancy compartment (1002), stopping floodwater supply to buoyancy compartments (1001) and (1002), opening the operateable interconnecting gate (102) and pulling the barge (500) in to buoyancy compartment (1002) by electrically operated winches (EW-1 and EW-2), closing of gate (102), draining floodwater from buoyancy compartment (1002) and lowering the barge (500) and aligning the plurality of barge anchors (501) with the respective plurality of arced slots (1005) provided on the side walls of the barge seat (1003), retracting the guide blocks (503A,503B,503C and 503D) and draining the water gradually from the compartment (1002) and tilting the barge (500) guided by the plurality of barge anchors (501) and bringing the barge (500) to rest and anchored in the barge seat (1003) in tilted position, unscrewing the fasteners (1008) to release the slide gate (1004), operating the winch (EW-3) to pull the slide gate (1004) upwards to open the material dumping port of the barge seat (1003), accessing the bolted joint between the barge (500) bottom plate and the hinged gate (607) through the material dumping port from below the barge seat (1003) and unscrewing the nuts (608) from stud bolts (609), operating the winches (EW-A and EW-B) and releasing the gate (607) and opening the operateable plate gate (602) to open the material outlet port of the material discharging hopper (601) and emptying the granular bulk contents from the hopper (601), via interconnecting duct (603), in to material receiving silo (2000) or on the ground followed by gravity sliding of granular material contents from upstream adjacent hopper (502) in to discharging hopper (601) and getting discharged in to silo (2000), continuing the

unloading operation and emptying all the hoppers of the barge (500) in similar fashion, performing reverse operations to return the empty barge (500) back to water body (100) for further cargo loading and transport, conveying the granular material received by the silo (2000) desired location.

2. The barge emptying system as claimed in claim 1, wherein said material discharging hopper (601) comprises at least one material outlet port in its bottom plate and at least one openable plate gate (602) to close the said material outlet port and at least one martial exit port in the bottom plate of the barge (500) exactly below and coinciding with the said material outlet port and at least one interconnecting duct (603) which interconnects the said two ports, and at least one hinged gate (607) having a water sealing gasket (610) secured in its flange , wherein the gate (607) held with the bottom plate of the barge (500) and bolted with the bottom of the barge (500) to close and seal the material exit port.

3. The barge emptying system as claimed in any one of the claims 1 and 2, wherein said interconnecting duct (603) comprises at least one water level sensor (605) and one seepage water suction nozzle (604) connected to a seepage water pump (606) and at least two guide pulleys (EWP-A and EWP-B) are anchored to said duct plates.

4. The barge emptying system as claimed in any one of the claims 1 and 3, wherein said hinged gate (607) holding a water sealing gasket (610) in its flange is engaged with the stud bolts (609) and fastened with the bottom of the barge (500) by screwing the nuts (608) on the stud bolts (609) to close and seal the said material exit port of the barge, wherein said hinged gate (607) is engaged with the stud bolts (609) by operating the winches (EW-A and EW-B) through the extended cables (EWR-A and EWR-B) guided by pulleys (EWP-A and EWP-B) which are installed inside the said duct (603), wherein said stud bolts (609) are integral to bottom plate of the barge (500) around the outer periphery of said material exit port .

5. The barge emptying system as claimed in claim 1, the barge (500) comprising plurality of barge anchors (501) integral to outer surface of the sidewall plates and bottom plate of the hoppers (502 and 601) and also integral to outer sidewall plates and bottom plate of the barge outer body and further protruding out from the outer body of the barge (500).

6. The barge emptying system as claimed in claim 1, comprising guide blocks (503A, 503B, 503C and 503D) which are integral to four corners of the barge (500).

7. The barge emptying system as claimed in claim 1, wherein the buoyancy compartment (1001) constructed on the land connected with the water body (100) and buoyancy compartment (1001) further comprises barge access gate (101) installed on the opening at the bottom of its front wall facing the water body (100), wherein water body (100) extends in to buoyancy compartment (1001) through the said opening in the front wall and the openable barge access gate (101).

8. The barge emptying system as claimed in any one of the claims 1 and 7, wherein the buoyancy compartment (1002) interconnected with said buoyancy compartment (1001) through an interconnecting gate (102) wherein said buoyancy compartment (1002) is an elevated open tank like structure having rectangular cross section at the top and the lower part is the barge seat (1003).

9. The barge emptying system as claimed in any one of the claims 1 and 8, wherein the inner shape of the barge seat (1003) resembling the outer body impression created by, initially lowering the barge (500) horizontally downwards and then anchoring the rear end and rotating the leading deck end of the barge (500) to an extent when the barge (500) achieves the angle of repose suitable for gravity sliding of granular material loaded in the barge.

10. The barge emptying system as claimed in any one of the claims 2, 8 and 9, wherein the said barge seat (1003) further comprising at lest one material dumping port in its bottom base at the location where the hinged gate (607) at the bottom of the barge (500) is located while the barge is resting in the barge seat (1003), and at least one sliding gate (1004) for closing and sealing the said material dumping port and at least one set of gate operating arrangement comprising a winch (EW-3), a winch cable (EWR-3) and a guide pulley (EWP-3).

11. A barge emptying method for unloading granular bulk material from the double bottom barge (500) having interconnected and partly covered plurality of hoppers (502) and having at least one material discharging hopper (601) as claimed in preceding claims, comprising the following steps:

a. Opening the barge access gate (101) and receiving the barge (500) in to buoyancy compartment (1001) and closing the barge access gate (101) and isolating the barge (500) from the water body (100).
b. Releasing the retractable guide blocks (503A. 503B, 503C and 503D) to get engaged with barge guiding slots (1001A, 1001B, 1001C and 1001D) respectively on the sidewalls of the buoyancy compartment (1001).
c. Flooding the buoyancy compartment (1001) and the buoyancy compartment (1002) and raising the floating height of the barge (500) with respect to water level of the water body (100) in buoyancy compartment (1001).
d. Stopping the floodwater supply to both the buoyancy compartments (1001 and 1002) once the floating height of the barge (500) is suitable to float the barge in to buoyancy compartment (1002) and water level in buoyancy compartment (1002) is suitable to receive the barge (500).
e. Opening the interconnecting gate (102) between the buoyancy compartments (1001) and (1002) and hooking the winch cables (EWR-1 and EWR-2) with barge (500) and operating the winches (EW-1 and EW-2) and pulling the barge (500) in to buoyancy compartment (1002).
f. Closing the interconnecting gate (102) and draining some quantity of floodwater from buoyancy compartment (1002) and aligning the barge (500) with the barge seat (1003) in such a way that the plurality of barge anchors (501) get aligned with respective plurality of arced slots (1005) of the barge seat (1003)
g. Retracting the guide blocks (503A, 503B) and (503C, 503D) from the horizontal slots (1001AB) and (1001CD) respectively
h. Complete draining of water from buoyancy compartment (1002) and guiding the barge during tilting operation to bring the loaded barge (500) to rest and anchored in the barge seat (1003) in tilted position.
i. Unbolting the joint between the sliding gate (1004) and the barge seat (1003) and operating the winch (EW-3) to pull the slide gate (1004) upwards and opening the material dumping port of the barge seat (1003).
j. Accessing the bolted joint, between the hinged gate (607) and the bottom of the barge (500) through the material dumping port from the bottom of the barge seat (1003) holding the gate (607) by the winches (EW-A and EW-B) and unscrewing the nut (608) from the stud bolts (609)

k. Operating the winches (EW-A and EW-B) and releasing the gate (607) which hangs downwards protruding out from the material dumping port of the barge seat (1003)

l. Opening the plate gate (602) of the material discharging hopper (601) to open its material outlet port and discharging the granular bulk contents of the material discharging hopper (601) which passes through the interconnecting duct (603) and gets dumped in to the material receiving silo (2000) or on the ground

m. As soon as the hopper (601) is about to get empty, the granular bulk material of the next hopper (502), which is upstream and adjacent to said hopper (601), slides down wards through the gap "g", between partition plate (504) and the bottom plate of the hoppers, and enter in to material discharging hopper (601), due to tilted position of the barge (500), and instantly escapes through the material outlet port and gets dumped in to material receiving silo (2000) or on the ground.

n. Continuing the barge emptying operation, in similar fashion as explained in "m", till all the plurality of hoppers (502) becomes empty.

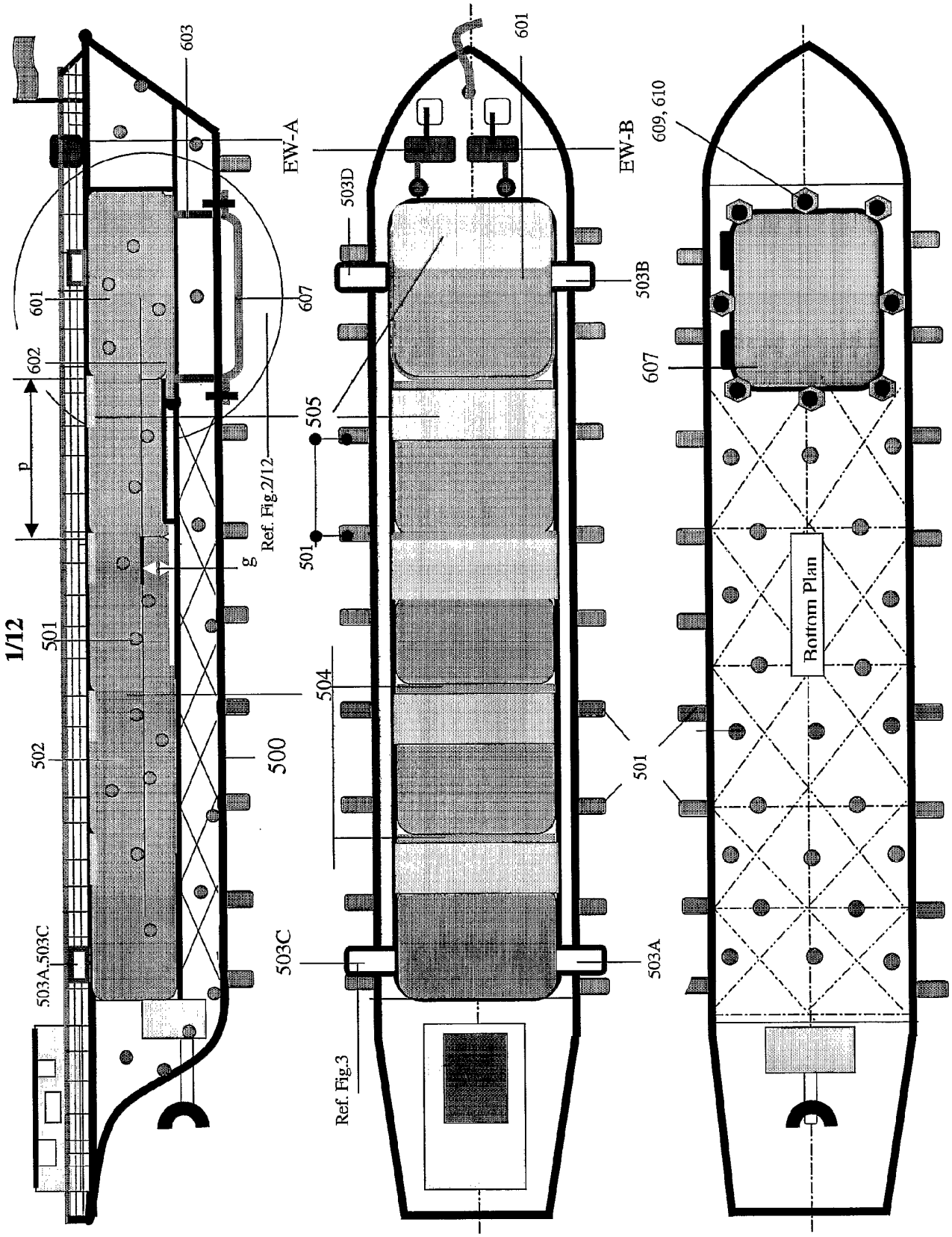
o. Performing reverse operation by sequential closing of gates (607), (1004) and plate gate (602).

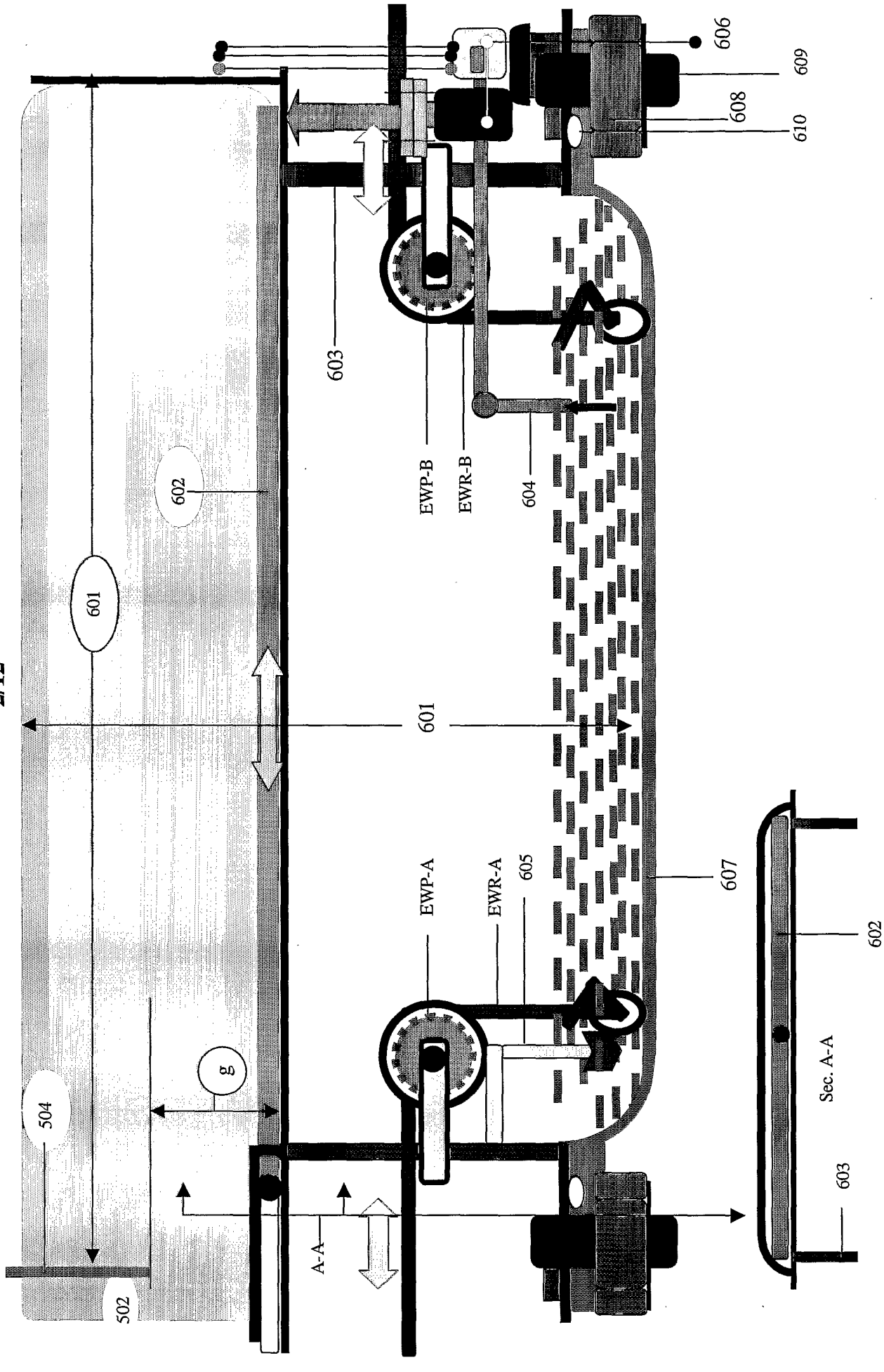
p. Flooding the buoyancy compartment (1002) and bringing the barge (500) back to floating from resting condition.

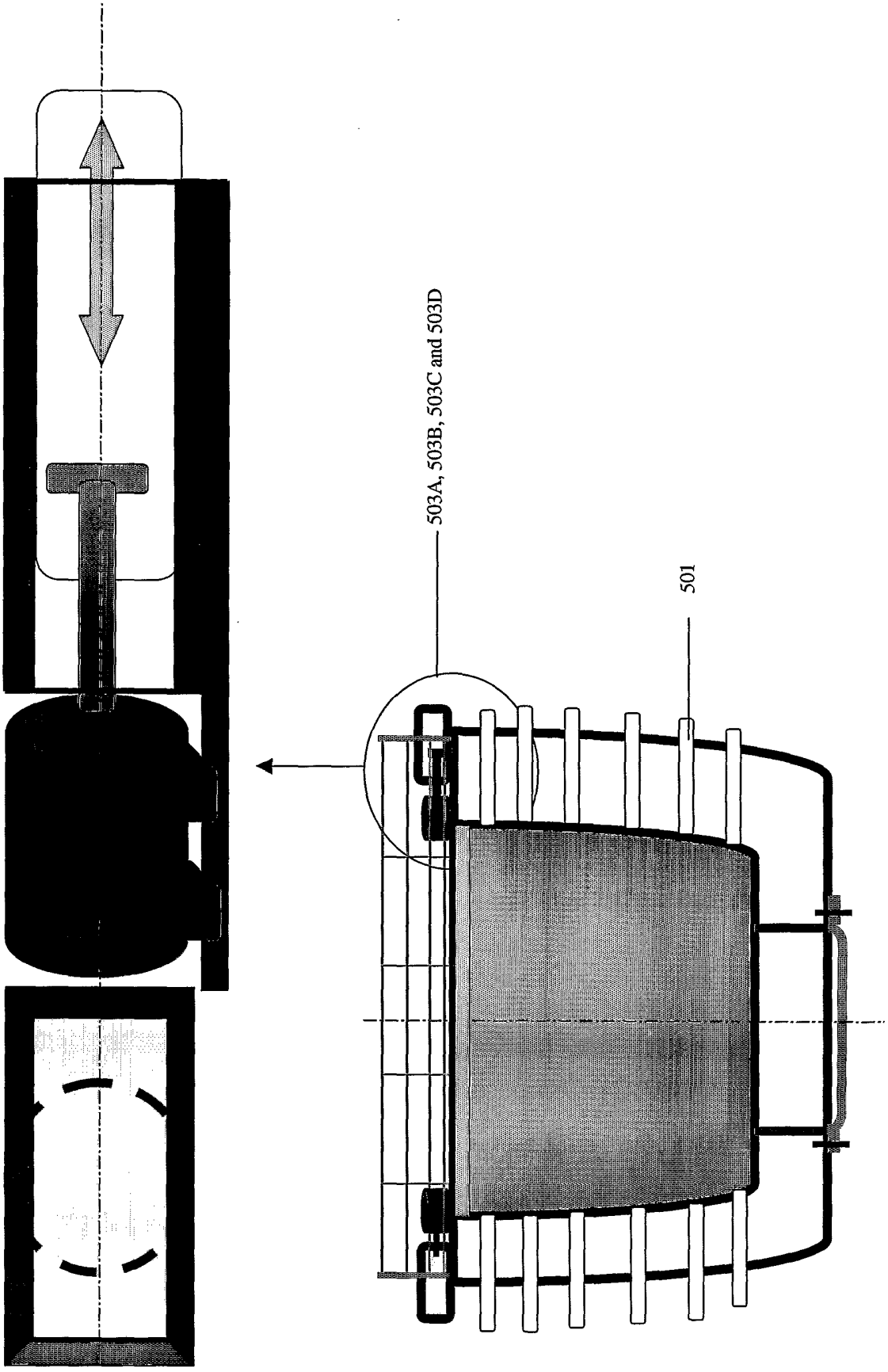
q. Releasing of guide blocks (503A, 503B) and (503C, 503D) and engaging with the slots (1001AB) and (1001CD) respectively.

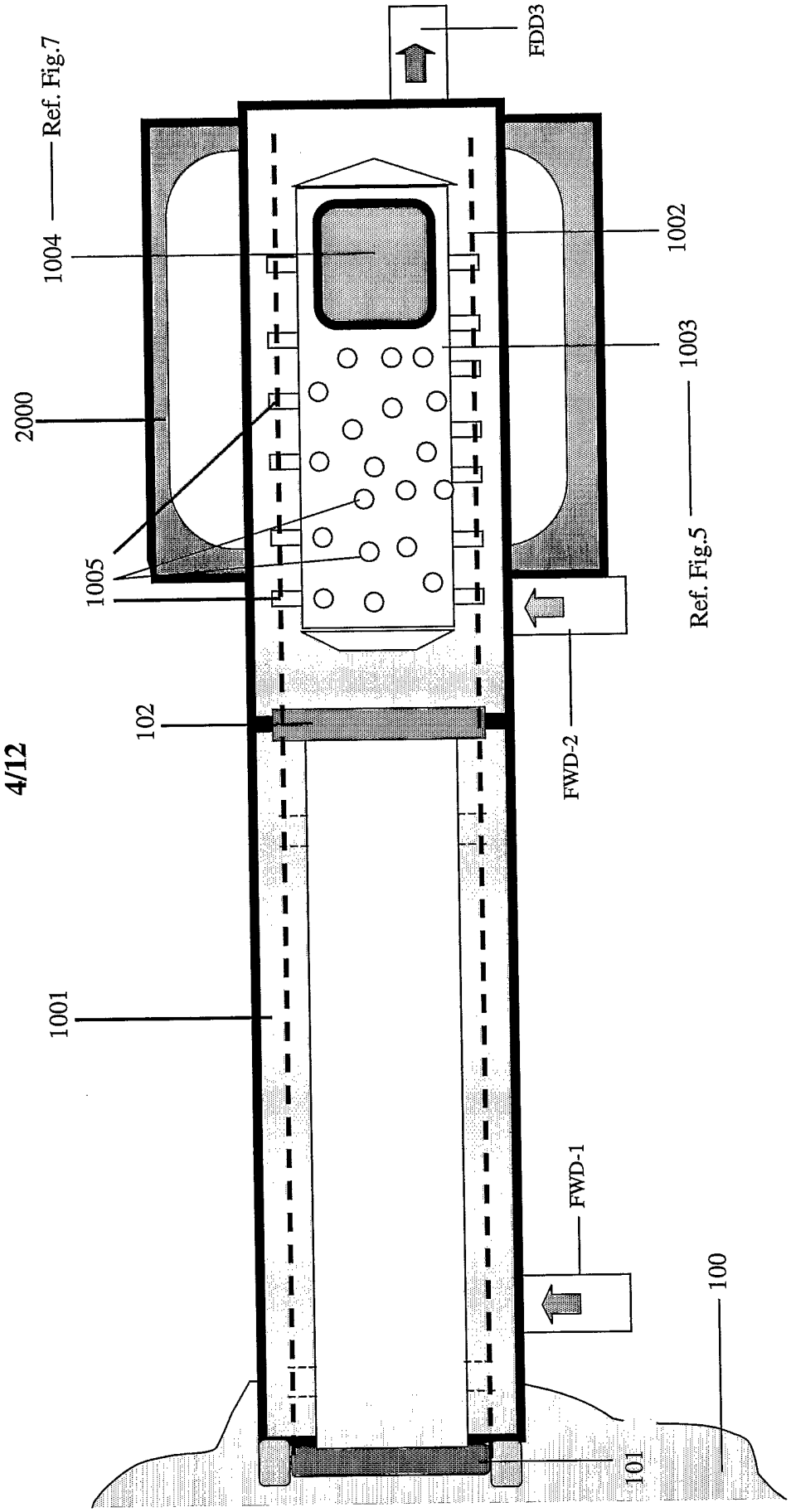
r. Opening of gate (102) and pulling the barge (500) back in to buoyancy compartment (1001) and closing the gate (102) and draining the floodwater from buoyancy compartment (1001) by partial opening of the barge access gate (101) and lowering the barge (500) with the lowering of water level in the buoyancy compartment (1001) till its water level matches with the water level of the water body (100) and retracting the guide blocks (503A, 503B, 503C, and 503D)

s. Opening of gate (101) and releasing the empty barge (500) back to water body (100) for further transport of granular bulk load.

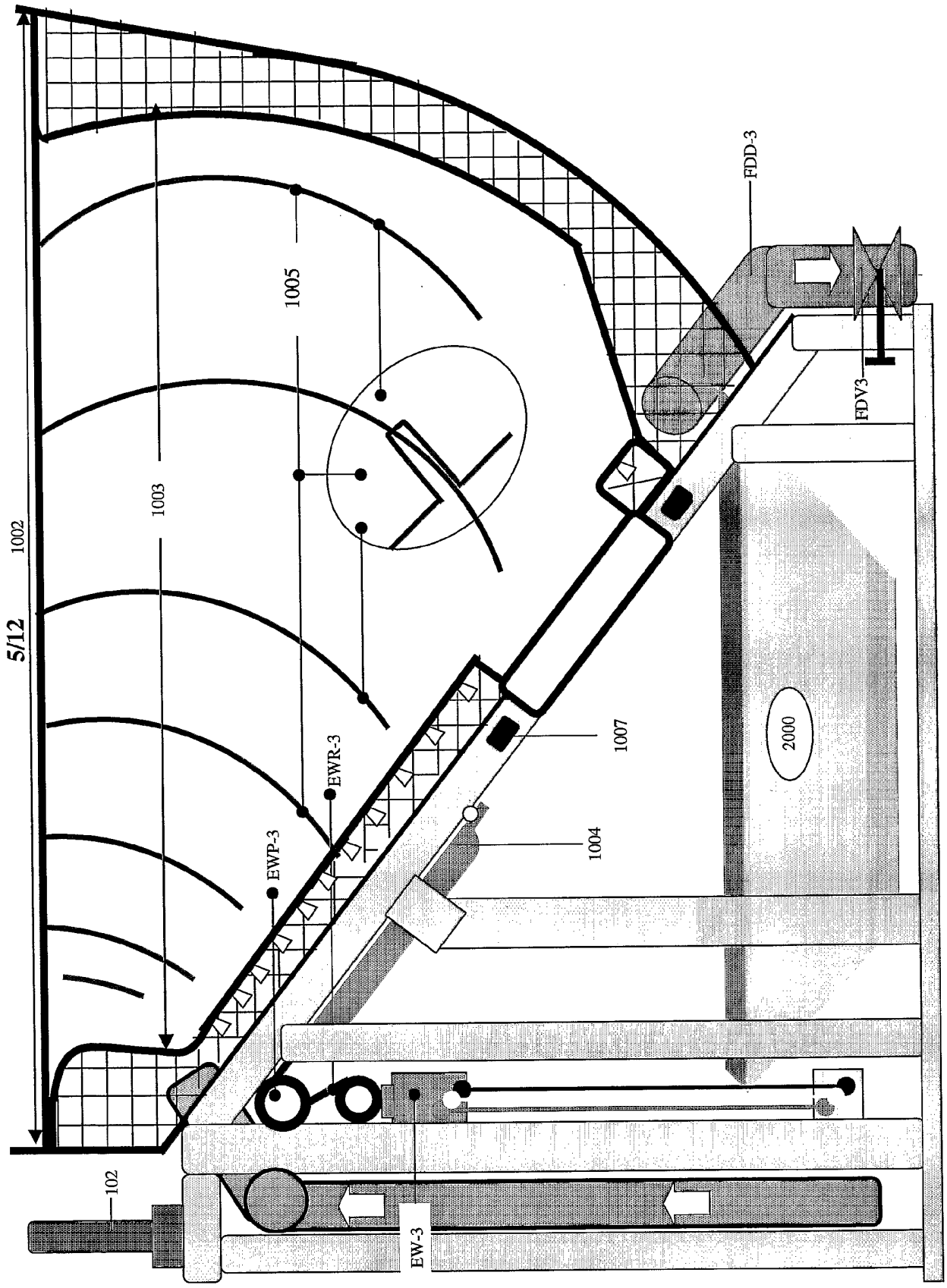

1/12
603
EW-A
601
607
602
505
p
Ref. Fig.2/12
g
501
502
500
503A,503C
504
503C
Ref. Fig.3
601
EW-B
503D
503B
501
503A
609, 610
607
Bottom Plan

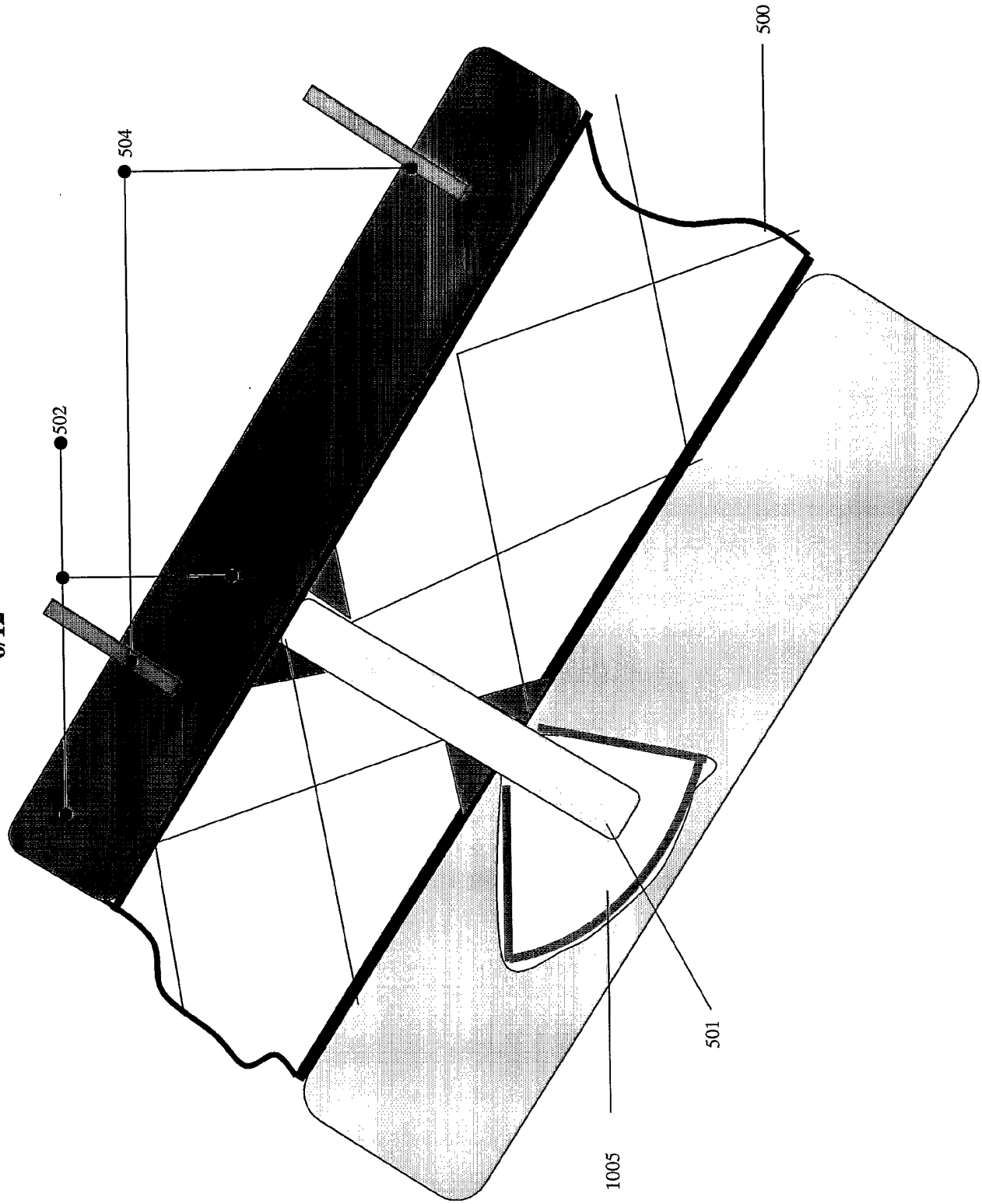

606
609
608
610
603
EWP-B
EWR-B
604
602
601
601
EWP-A
EWR-A
605
607
602
Sec. A-A
603
g
504
502
A-A

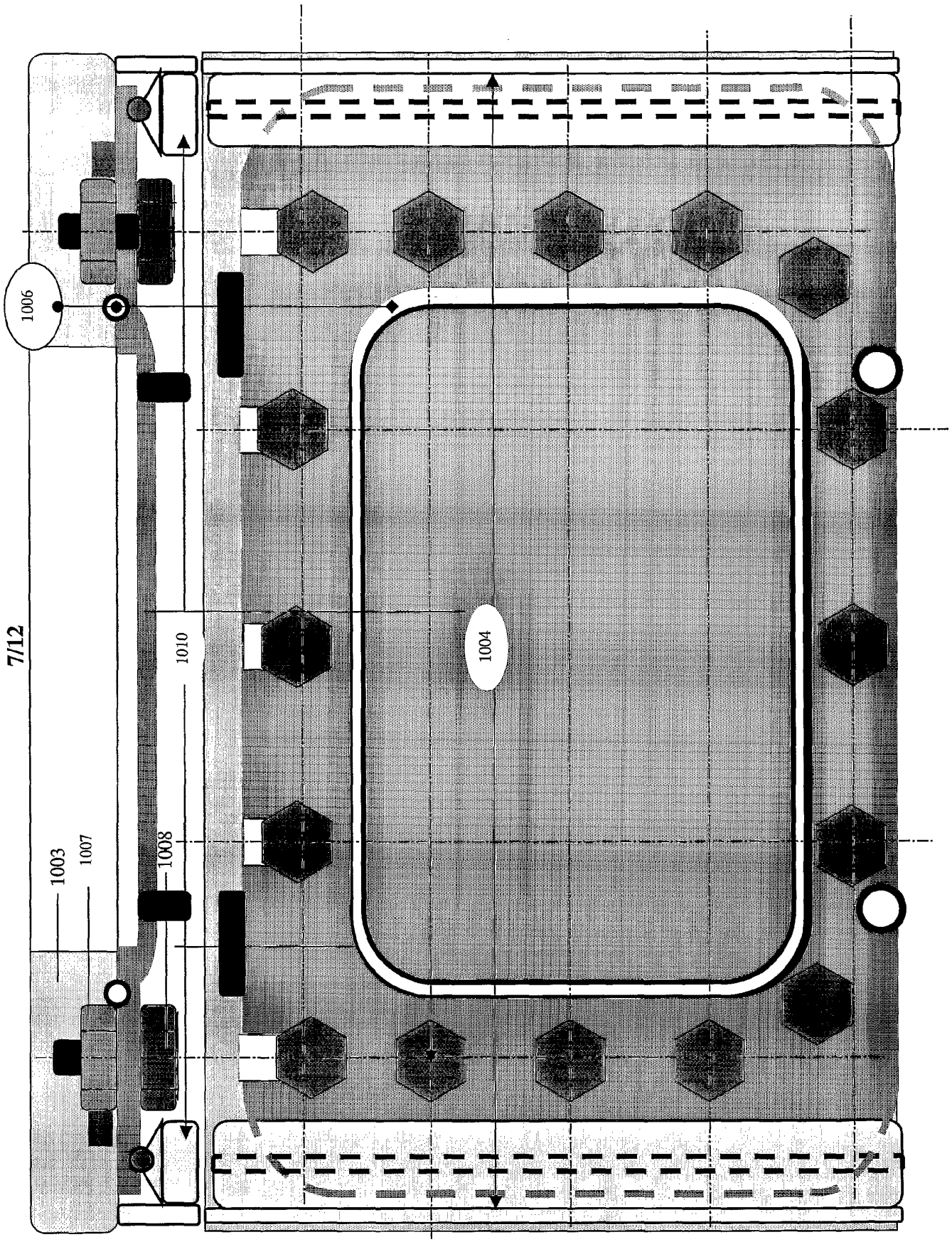

503A, 503B, 503C and 503D
501

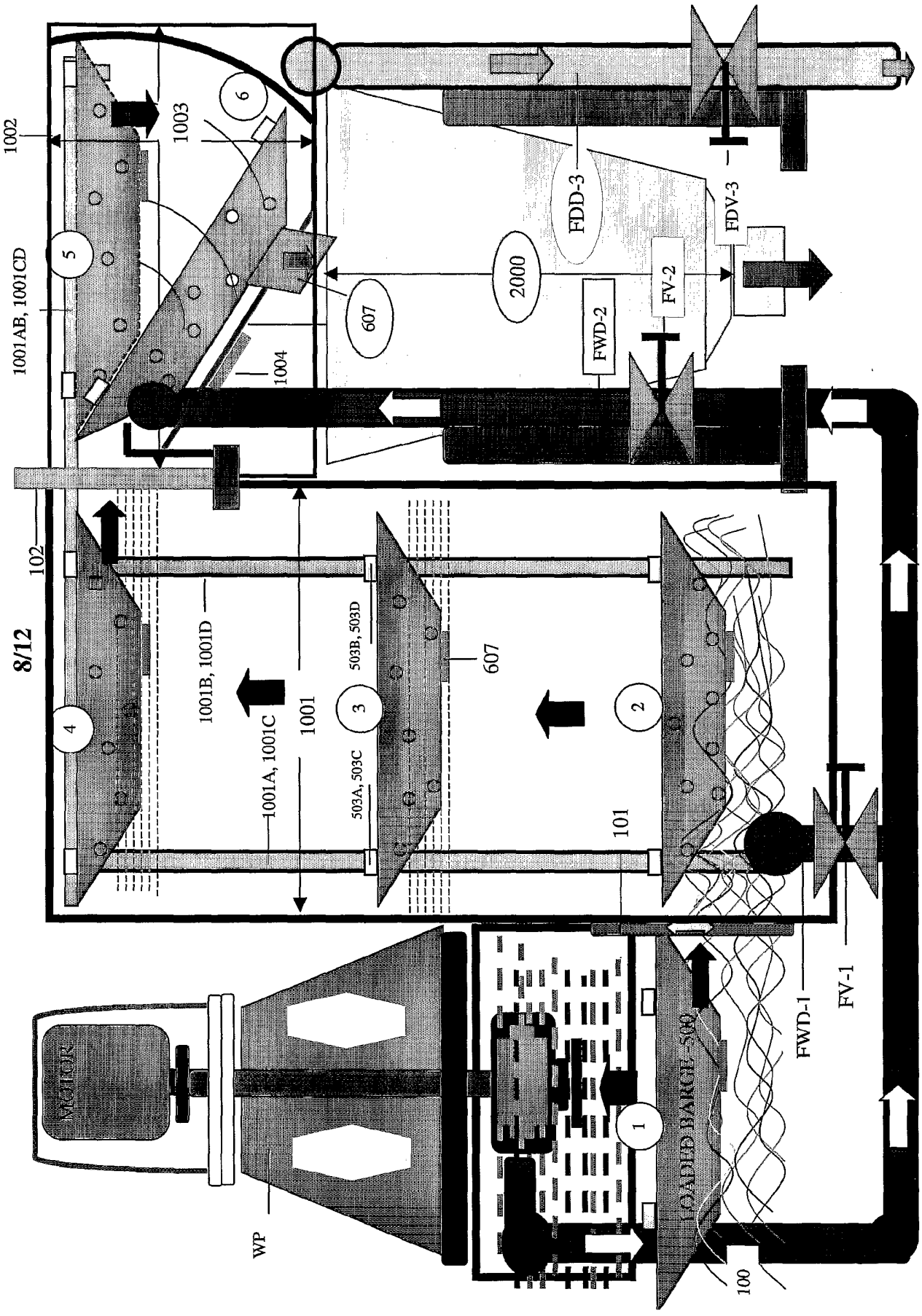

FDD3
Ref. Fig.7
1004
1002
2000
1003
1005
Ref. Fig.5
102
FWD-2
1001
FWD-1
100
101

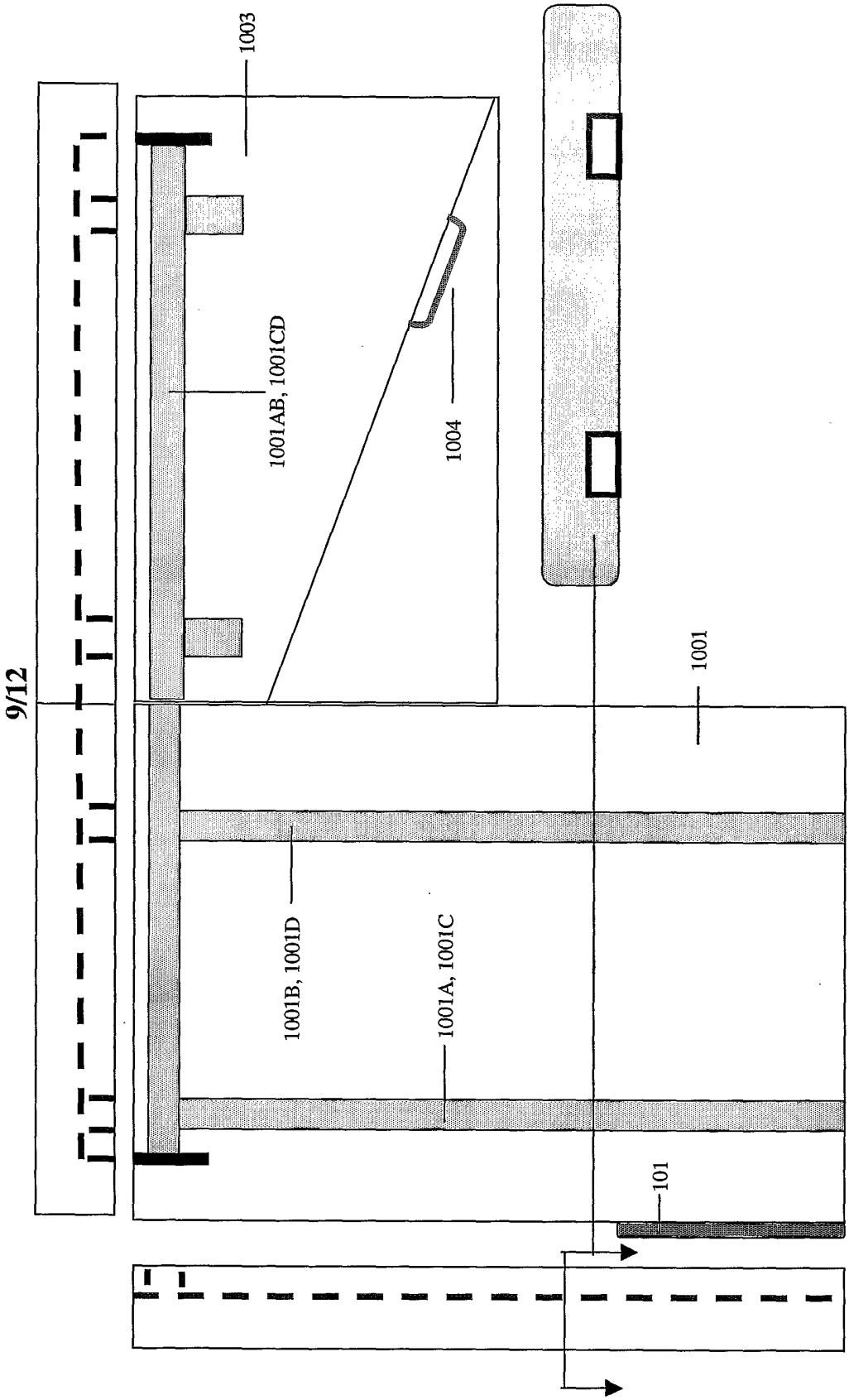
4/12

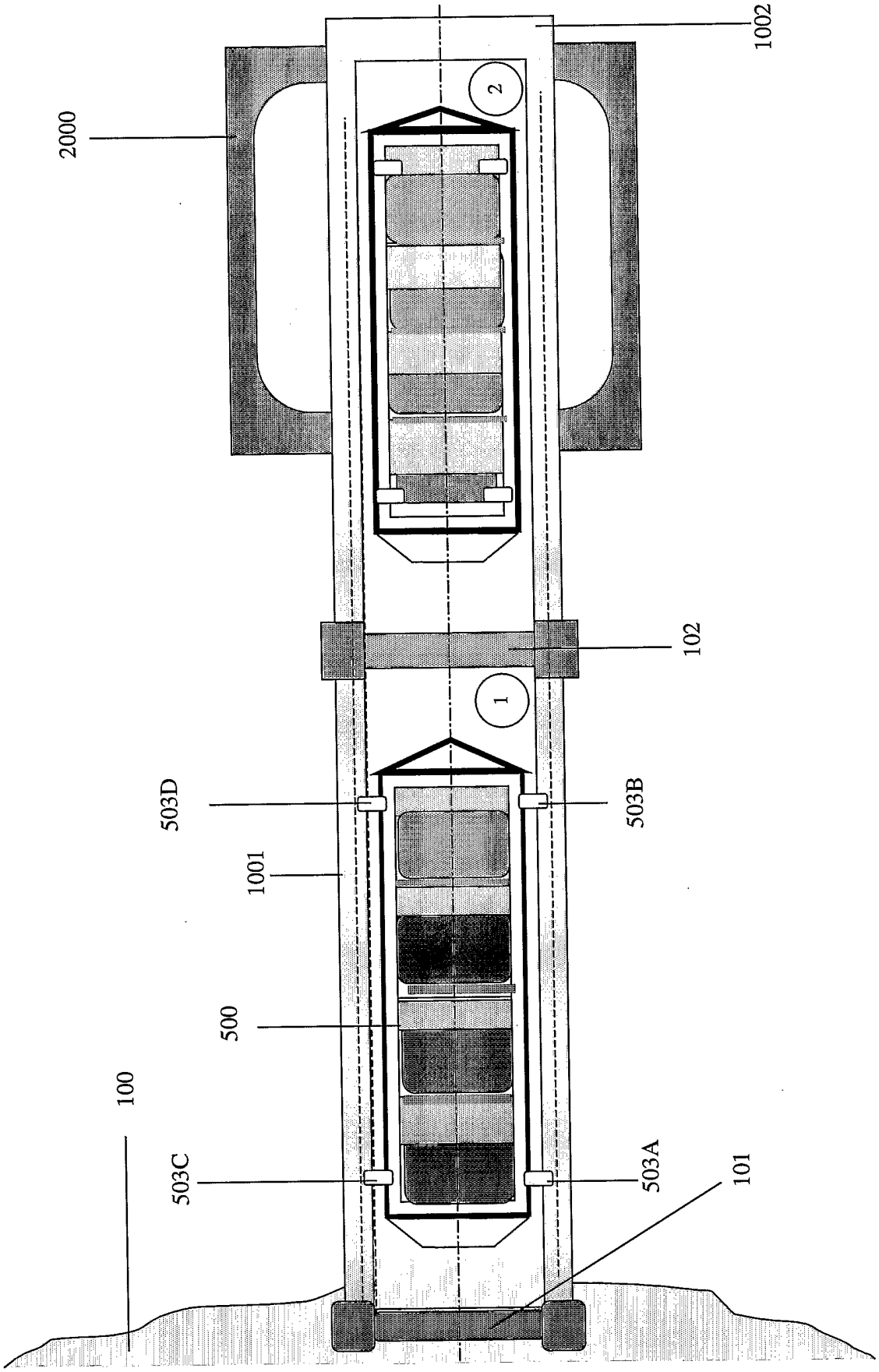

5/12
1002
1003
1005
FDD-3
FDV3
2000
1007
1004
EWR-3
EWP-3
102
EW-3

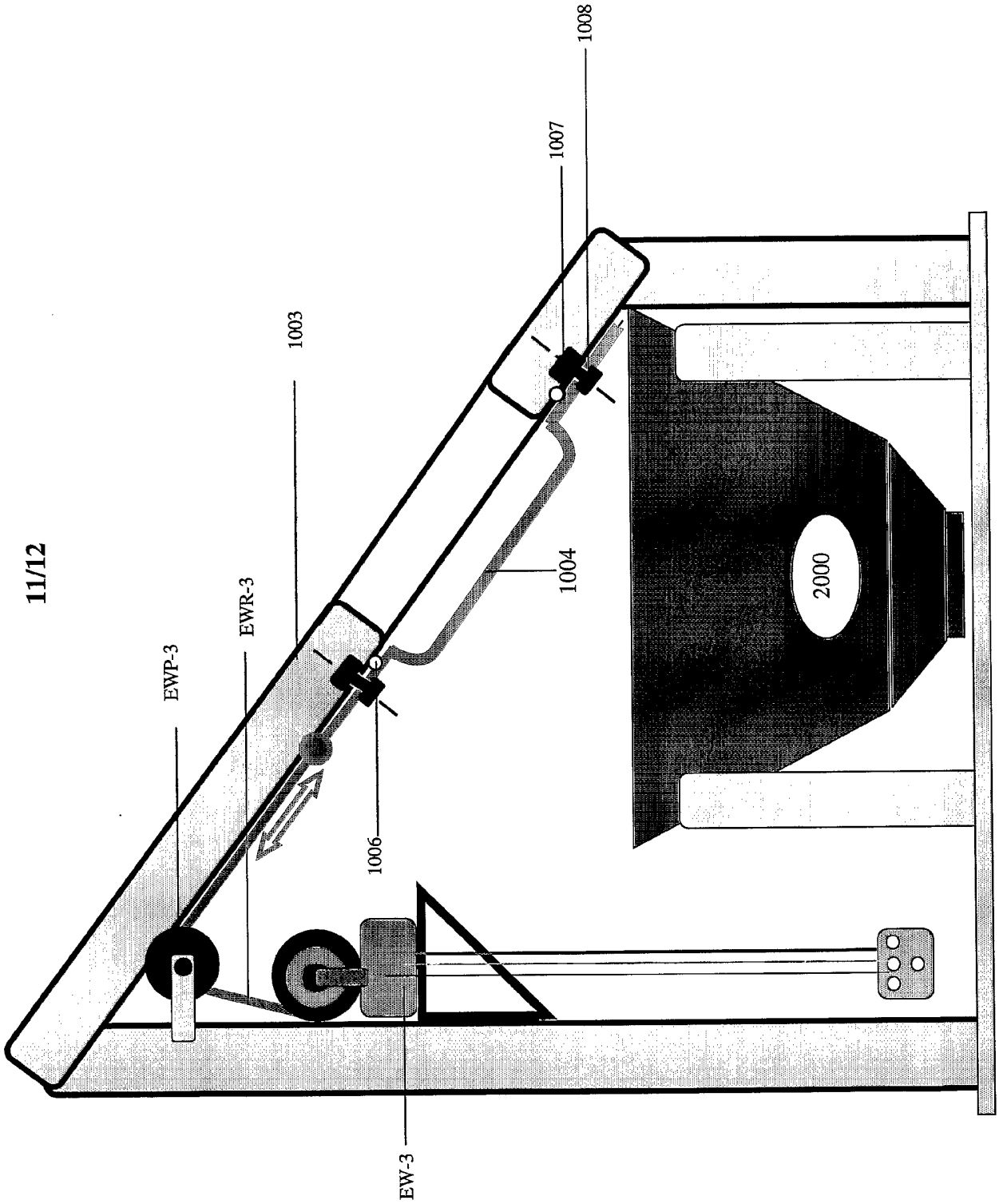

500
504
502
501
1005

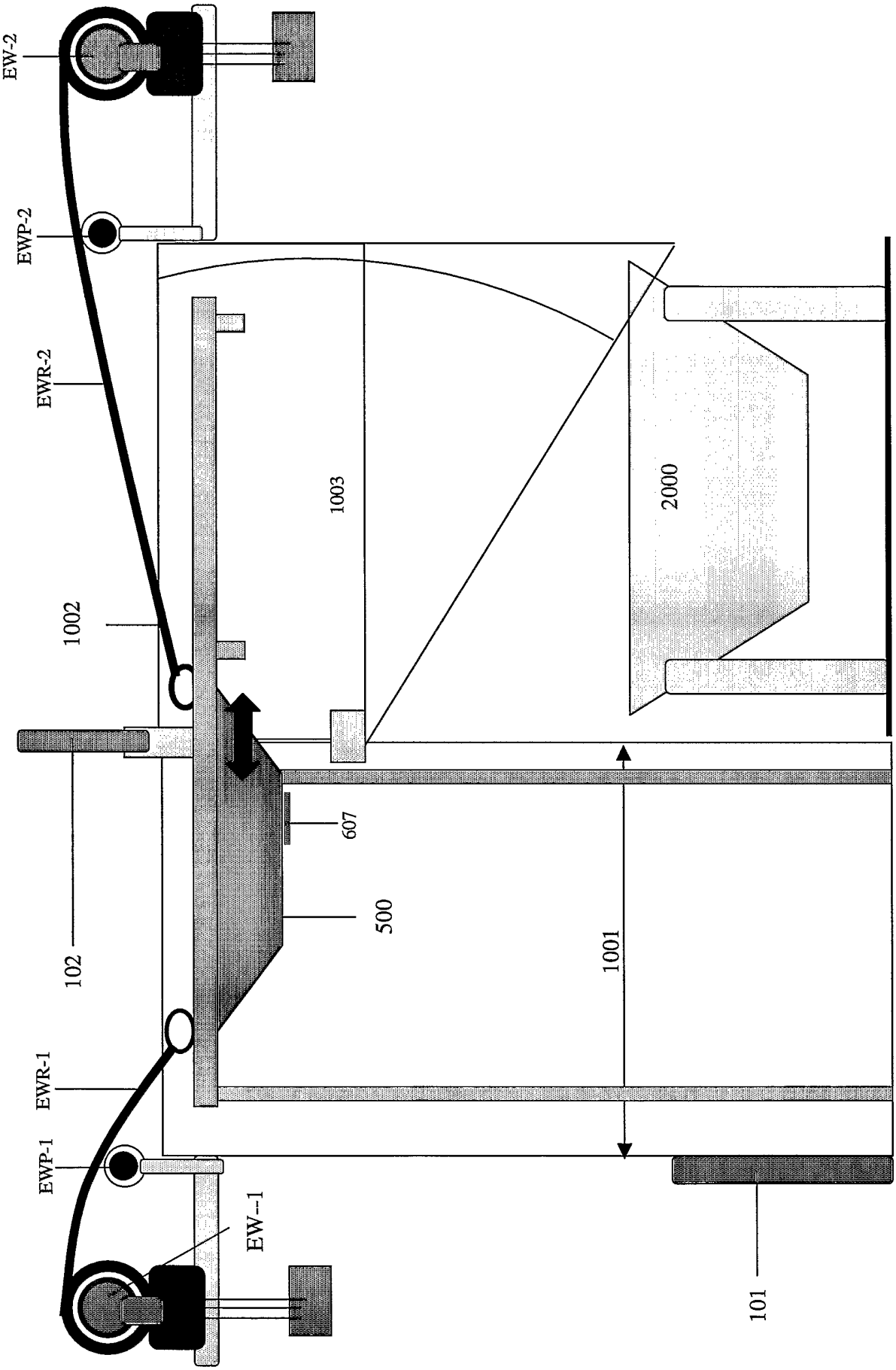

7/12
1006
1010
1004
1003
1007
1008


8/12
1002
1003
6
1001AB, 1001CD
5
607
2000
FDD-3
FDV-3
FV-2
FWD-2
1004
102
1001B, 1001D
1001
503B, 503D
607
4
3
2
1001A, 1001C
503A, 503C
101
MOTOR
WP
1
LOADED BARGE – 500
FWD-1
FV-1
100


9/12
1003
1001AB, 1001CD
1004
1001
1001B, 1001D
1001A, 1001C
101


1002
2000
2
102
1
503D
503B
1001
500
100
503C
503A
101


1008
1007
1003
1004
2000
EWR-3
EWP-3
1006
EW-3


EW-2
EWP-2
EWR-2
1003
2000
1002
607
500
102
1001
EWR-1
EWP-1
EW--1
101