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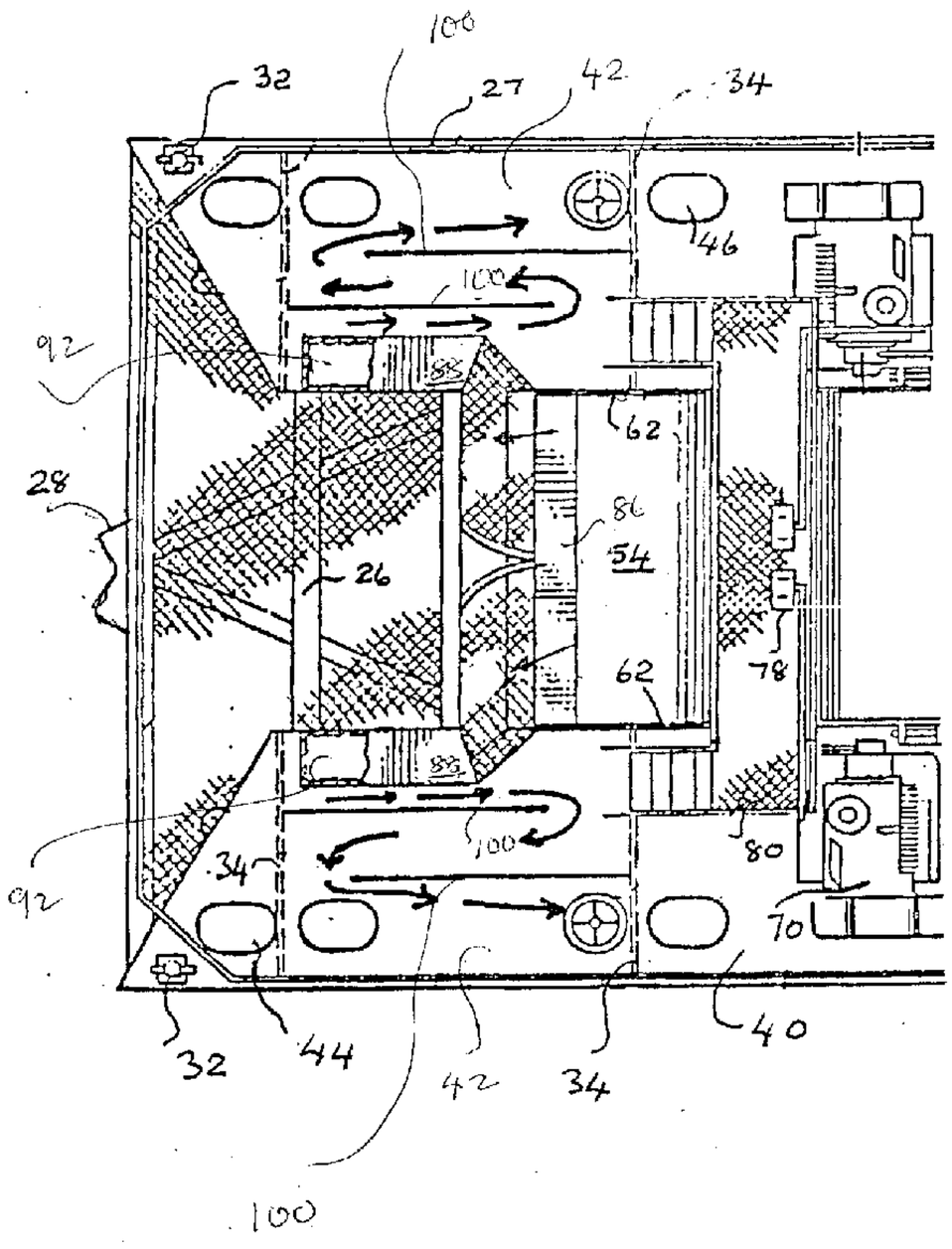
(54) **NAVIRE POUR LA RECUPERATION DES DEVERSEMENTS D'HUILE**

(54) **OIL SPILL RECOVERY VESSEL**



(57) La présente invention a trait à un appareil de récupération du pétrole déversé accidentellement et traite plus particulièrement d'une embarcation de style catamaran pouvant aller en mer et capable d'enlever la nappe de pétrole de la surface de l'eau, séparer le pétrole de l'eau de mer et stocker temporairement le pétrole récupéré pour le transférer ensuite à un navire plus grand ou une installation de stockage. L'appareil utilise des tambours tournant en sens contraires pour récupérer le pétrole, l'écoulement de pétrole étant dirigé pour venir en contact avec la surface extérieure des tambours par des moyens posés dans les coques du catamaran.

(57) The present invention relates to apparatus for oil spill recovery and more particularly, concerns a catamaran style sea-going vessel capable of lifting an oil spill or slick from the surface of the sea water, separating the oil from the sea water and storing the recovered oil temporarily for transfer to a larger vessel or storage facility. The apparatus utilizes contra-rotating drums for oil pick-up, the flow of oil being directed to come into contact with the outer surface of the drums by means positioned within the catamaran hulls.

ABSTRACT

The present invention relates to apparatus for oil spill recovery and more particularly, concerns a catamaran style sea-going vessel capable of lifting an oil spill or slick from the surface of the sea water, separating the oil from the sea water and storing the recovered oil temporarily for transfer to a larger vessel or storage facility. The apparatus utilizes contra-rotating drums for oil pick-up, the flow of oil being directed to come into contact with the outer surface of the drums by means positioned within the catamaran hulls.

This invention relates to methods and equipment for oil spill recovery and more particularly, it concerns a unique seagoing vessel capable of lifting an oil spill or slick from the surface of sea water, separating the oil from the sea water and storing the recovered oil temporarily for transfer to a larger vessel or storage facility in a highly efficient manner.

More particularly, the present invention is directed to improvements to Canadian Patent 1,063,039 issued September 1979, to Petroclearance Ltd.

During the past decade, numerous efforts have been made to develop equipment and techniques for the containment and recovery of oil spills at sea resulting either from the collision of oil transporting ships or accidents in the drilling and operation of off shore wells. Although many significant technology developments have resulted from these efforts, the presently intense exploration for sources of petroleum products at remote points of the glove will obviously increase tonnage of petroleum products to be transported or handle at sea. The increased likelihood of oil spills attendant to these activities, therefore, creates a need for oil spill containment and recovery capabilities far in excess of the current state-of-the-art. For example, the type of equipment most commonly used at the present time

incorporates one or more oleophilic endless belts extending forwardly of a supporting barge and which operate to lift an oil slick from the surface of sea water for transfer in the belt to a wringing device and storage in tanks on the barge. While such equipment has shown promise in calm water, it is not efficient in choppy water nor is a vessel capable of supporting such equipment sufficiently seaworthy for effective operation in unprotected waters. Also the speed at which this type of equipment can operate is limited by the high percentage of sea water picked up with the oil thus requiring frequent interruptions to empty the tanks of the recovery vessel. In addition, such equipment is prone to frequent breakdowns as a result of debris interfering with operating components of the system.

Another class of oil spill recovery equipment in current use employs a floating suction intake or weir by which oil floating on the surface of sea water is essential decanted and pumped to storage tanks. This type of equipment is both inefficient in choppy waters and is particularly vulnerable to breakdown due to debris entering the suction system. In another form of apparatus of this general type, an adjusted weir is provided at the base of the U-shaped vessel such that as the vessel is advanced through an oil spill, a wave of

oil-water mixture builds up against the weir with the oil spilling over and water passing under the weir. Not only are large amounts of water picked up with the oil, thus reducing the efficiency of such equipment, but height adjustment of the weir to avoid interference by floating debris makes difficult a complete collection of the surface oil slick. Also it will be appreciated that the use of such a device in other than calm water is accompanied a significant reduction in efficiency due to a collection of large amounts of water which is tantamount to a significant reduction in collection efficiency.

These exemplary types of equipment in current use are by no means all inclusive of the various approaches that have been taken to the problems associated with oil spills. Experience with these types of devices, however, indicates a critical need for increased speeds of operation; capability for efficient operation in rough or choppy waters; capability for handling floating debris in the oil without potential damage to the equipment; increased efficiency in the separation of the floating oil slick from sea water to minimize energy requirements for fluid handling; increased oil storage capacity in the recovery vessel to avoid operating interruptions for the transfer of recovered oil to a storage vessel; and

increase mobility from the standpoint of both transporting the recovery equipment to the site of the spill and from the standpoint of effective recovery operation at the spill site.

Broadly speaking, the invention disclosed in Canadian Patent 1,063,039 provides an oil spill recovery vessel comprising: a pair of transversely spaced longitudinal hulls each having a plurality Of discrete internal chambers to establish buoyancy tanks and storage chambers; means for opening the bottoms of the storage chambers to allow ingress and egress of liquid to and from the storage chambers; and means for picking up a mixture of oil and water between the hulls and for introducing the mixture to the top of the storage chambers thereby to effect in the chambers a layer of oil superimposed above water until a sufficient quantity of oil has been introduced into the chambers to displace the water through the bottoms of the chambers, the last mentioned means including a pair of transversely extending, counter-rotatable, cylindrical drums spaced longitudinally to establish a gap between the peripheries thereof, both the drums being movable from an elevated inoperative position when the storage chambers are empty of liquid to a lowered operative position so that the peripheries of both drums will be in contact with the

surface of water in which the hulls are floated when the bottoms of the storage chambers are open, the space between the hulls being unobstructed except for the drums at and below the surface of the water.

In the operation of the prior art vessel, the vessel is first floated to the site of an oil spill in a light condition; that is, with the cargo chamber valves closed and empty of ballast so that the cargo chambers at this time also contribute to the buoyancy of the vessel. On reaching the spill, the cargo chambers valves are opened to flood the cargo tanks with sea water thereby increasing the draft of the vessel until the lower peripheral portion of the counter-rotating pick-up drums are submerged slightly beneath the surface of the oil slick. The vessel is then advanced through the oil slick with the drums rotating in opposite directions and such that tangential movement of the drum peripheries at the gap between them is upward. As a result of liquid adhesion to the drum peripheries in combination with the counter-rotating peripheral movement of the drums, oil or a mixture of oil and sea water is advanced over the top of each drum and directed to the flooded cargo holding chambers by the aforementioned scavenger blades and trough-like ducting. Because of its low specific gravity, the oil delivered to the cargo holding chambers

will float on the sea water with which the holding chambers have been ballasted to a head slightly above the level of sea water on the hull exterior. As additional oil is fed to the upper portion of each of the cargo chambers, however, it will displace sea water downwardly through the open valves in the bottom of these spaces or tanks. Accordingly, an effective separation of oil and sea water occurs within the cargo chambers such that their capacity for retaining the recovered oil spill is maximized. Once the tanks are filled with oil, of course, the ballasting valves will be closed and the oil transferred to a larger capacity storage vessel.

The present invention, however, seeks to improve the apparatus heretofore described in a number of significant ways.

Firstly, to increase the effective separation of oil and sea water with the cargo chambers baffles are provided in each cargo chamber effectively dividing the area of each chamber into a number of interconnected chambers such that oil delivered to the cargo chambers follows a torturous route through the system of baffles.

Secondly, structure has been devised which will substantially increase the recovery of oil by ensuring that the fluid, ie: the mixture of oil and water is recovered directly from the front of each contra-rotating

drum and not from below the drums. With the system disclosed in Canadian Patent 1,063,039 a portion of the oil-on-surface could flow through the apparatus without contacting or even coming close to contacting the surface of each drum. Accordingly, the present invention provides for the placement of a plate or series of plates located below the drums, the plates being configured such that the water and oil mix is caused to be directed upwardly to the drums. These plates are height adjustable.

Finally, again in order to improve the oil recovery it has been found that by maximizing the pressure differential in area between the bottom of the rotating drums and atmospheric pressure, a strong upward suction effect is created, thus ensuring maximum flow of oil/water to the drum surface. This is achieved by sealing the gap between the inner sides of the hulls and the ends of the transversely placed drums and directing the fluid drawn by the counter rotation of the drums upwardly towards the gap between the drums, and then setting the gap between the drums and the rpm of the drums at the optimum for the viscosity of the oil recovered.

This suction effect can be increased by localizing the volume of fluid presented to the drums by using the

plate or series of plates previously mentioned.

Other objects and further scope of applicability of the present invention will become apparent from the detailed description to follow taken in conjunction with the accompanying drawings in which like parts are designated by like reference numerals.

Figures 1 through 5 of the accompanying drawings and the description relating thereto form a substantial part of the prior art Canadian Patent 1,063,039 and are necessarily included within the body of this specification to assist in defining the inventive improvements thereover, consequently:-

Fig. 1 is a plan view of the oil spill recovery and containment vessel of the present invention;

Fig. 2 is a side elevation of the vessel shown in Fig. 1;

Fig. 3 is an end elevation of the vessel shown in Figs. 1 and 2;

Fig. 4 is a longitudinal cross-section taken on line 4-4 of Fig. 3;

Fig. 5 is a fragmentary perspective view illustrating the oil scavenging and transfer ducting system incorporated in the vessel of the invention; and

Fig. 6 is a perspective view showing one method of employing the vessel of the invention to recover an oil spill.

Figure 7 is a partial plan view of the oil spill recovery and containment vessel of the present invention including the provision of baffles with the cargo chambers.

Figure 8 is a longitudinal cross-section taken on line 4-4 of Figure 3; disclosing a first embodiment of the plate means according to the present invention.

Figure 9 is a further longitudinal cross-section taken on line 4-4 of Figure 3; disclosing schematically a second embodiment of the plate means according to the present invention;

Figure 10 is an end elevational view of the vessel shown in Figs. 1 and 2 schematically showing the location and extent of the seal between the drums and the hull;

Figure 11 is an end elevational view of the vessel shown schematically in Figure 9;

Figure 12 is a more detailed longitudinal cross-section of the inventive improvements according to Figure 9, the plates being in their lowest operating position;

Figure 13 is a schematic diagram of the adjusting mechanism for the plates according to Figure 12, the plates being in the uppermost operating position;

Figure 14 is a detailed side elevational view of the adjustment plate according to detail 'A' of Figure 12;

Figure 15 is a part side elevational view of the

height adjusting mechanism for the plates as shown in Figure 12;

Figure 16 is a detailed view of the upper portion (Detail 'B') of the mechanism according to Figure 15;

Figure 17 is a detailed view, side elevation of the interconnection between the plates and the height adjustment mechanism (Detail 'C' of Figure 13);

Figure 18 is a side and end elevational views of the interconnected between components (Detail 'D' Figure 13).

As shown in Figs. 1-3 of the drawings, the oil spill recovery and retention vessel V of the present invention is in the nature of a catamaran having a pair of transversely spaced longitudinal hulls designated generally by the reference numerals 10 and 12, respectively. Each of the hulls is of generally rectangular cross-section to establish a deck-like top wall 14, essentially and a flat bottom 20. As shown most clearly in Fig. 1, the longitudinal configuration of each of the hulls 10 and 12 is symmetrical about a transverse medial line and further that the opposite end walls 22 and 24 of each hull are established by essentially planar vertical walls disposed at an angle of approximately 60 degrees with respect to the longitudinal center-line of the vessel. Although the aforementioned angle in itself is not critical, it will be noted that the direction of

end wall inclination with respect to the vessel length is opposite in the two hulls 10 and 12 to establish a funnel-like or converging hull confirmation extending from the outboard side wall 18 to the inboard side wall 16 at opposite ends of the vessel. The vessel hull structure is physically integrated by a plurality of transverse beams 26 extending between and interconnecting the two hulls 10 and 12 near the upper portion of each. Conventional deck screening supported by the transverse beams 26 extends the top walls 14 of the hulls to provide a working deck circumscribed by appropriate guard rails 27.

Although it is contemplated that the vessel may be equipped with its own source of marine propulsion and steering, the disclosed embodiment is in the nature of a barge or raft adapted to be advanced longitudinally by towing or pushing vessels such as conventional tug boats T. To this end, the endmost of the transverse beam 26 at opposite ends of the vessel are fitted with V-shaped bumpers 2 to accommodate a pushing tug boat T for advancing the disclosed vessel in either direction. Steerage of the vessel when pushed by a single tug boat in this manner is effected by the tug boat steerage system by way of snubbing lines 30 extending from post bollards 32 at the extreme ends of each of the hulls 10

and 12. In some instances it may be desired to pull the vessel using one or more towing tug boats in which case the post bollards will facilitate this form of propulsion.

It will be appreciated that each of the hulls 10 and 12 can be constructed using conventional materials and assembly techniques to provide a substantially fluid tight enclosure of a strength commensurate with the requirements of sea-going hull structures. In accordance with an important feature of the present invention, however, it will be noted that each of the hulls 10 and 12 are divided longitudinally by transverse walls or bulk heads 34 (Fig. 1 and 2) to establish in the disclosed embodiment five discrete fluid chambers36, 38, 40, 42 and 44. Such chambers provide in each hulls alternating buoyancy tanks (36, 40 and 44) and cargo holding chambers or tanks (38 and 42). Although each of the interior chambers is provided with a hatch closure 46 of sufficient size to enable access to the interior of each chamber, it will be noted that the cargo holding chambers 38 and 42 are also provided with flooding or ballasting valves 48 in their bottom wall 20 and adapted to be actuated by appropriate means such as hand wheels 50 accessible at the deck of the vessel. The importance of this interior hull structure will become more apparent

from the description to follow.

It is to be noted that while no provision is shown in the drawings for ballasting the buoyancy tanks 36, 40 and 41, it is contemplated that these tanks may be equipped with conventional ballast valves and pumps to enable controlled adjustment of vessel draft and freeboard. Such equipment is not essential to operation of the vessel nor to practicing the invention, and has been omitted in the interest of clarity.

As shown in the drawings, a pair of cylindrical drums 52 and 54 are carried by axles 56 and 58, respectively, the respective axles in turn being journalled at opposite ends in bearing blocks 60 and 62 positioned in deck wells 64 in each of the hulls 10 and 12 near the inboard walls 16 thereof. As shown in Figs. 1 and 4, the cylindrical drums 52 and 54 span fully the space between the inboard walls 16 of the hulls and are of such a diameter that the lower peripheral edge of each drum is elevated substantially about the bottom 20 of the hulls 10 and 12. However, the bearing blocks 60, on which the drum 52 is rotatably supported, are adjustably positioned for fore and aft movement by adjustment of feed screws 66. In light of this organization of the bearing blocks 60, it will be appreciated that the gap between the periphery of the drums 52 and 54 may be

varied from a position of contact with each other to a spacing of several inches.

Each of the drums 52 and 54 is adapted to the rotated independently of each other in the disclosed embodiment by internal combustion engines 68 and 70, respectively. Although the drive transmission by which the output of each of the internal combustion engines is only generally illustrated in the drawings, it is preferred that the transmission include a hydraulic pump 72 coupled directly to the output shaft of each of the internal combustion engines for supplying hydraulic fluid under pressure to a hydraulic motor 74 coupled by a spline connection (not shown) directly to the axle 60 and 62 of the respective drums. The transmission of motive force from the pump 72 to the motor 74 for each drum 52 and 54 is regulated by appropriate hydraulic control components 76 and 78. The control components are preferably positioned for access from a command bridge 80 extending between the hulls 10 and 12 and elevated above the drums 52 and 54. Although complete detail of the drive system for the drums 52 and 54 is not shown in the drawings, it will be appreciated by those skilled in the art that the speed and direction of rotation of the drum 52 may be controlled by manipulation of the control unit 76 whereas rotational direction and speed of the drum 54

may be controlled by manipulation of the control console 78. Also, adjustable fore and aft movement of the drum 52 and its drive motor 74 may be accommodated very easily in the disclosed system by flexible hydraulic fluid conduits extending between the pump 72 and the motor 74.

As shown most clearly in Figs. 4 and 5 of the drawings, associated with each drum 52 and 54 is a scavenger or scraper blade and oil distribution trough assembly generally designated by the reference numerals 82 and 84. Each of the assemblies 82 and 84 is identically constructed to include an inclined scraper blade 86 extending the length of the associated drum 52, 54 and displaced from the point of the narrowest gap between the drums by approximately 120 degrees. This angular displacement or location of the blade 86 with respect to drum rotation enables liquid on the surface of each of the drums to flow by gravity along the inclined blade 86 and into a trough-like distributing duct 88 as shown most clearly in Fig. 4. To avoid the possibility of sparking, the blades are preferably formed or coated with a resinous material such as teflon though other non-sparking materials such as aluminum may be used. The duct 88 is divided by a central baffle 90 and extends to an opening 92 through the top of each of the cargo storage chambers 38 and 40 in the respective hulls 10 and

12. It is to be noted further that the location of the openings 92 are located s remotely as possible from the flooding or ballasting valves 48 in the chambers 38 and 42. A coarse screening or grating 94 extending across the distribution trough 88 prevents the admission of debris to the tanks 38 and 42.

The operation of the vessel thus described may now be appreciated by reference to Figs. 4 and 6 of the drawings. As shown in Fig. 4, the draft of the vessel V with the chambers 36, 38, 40, 42 and 44 empty of liquid is depicted by the line designated L in Fig. 4. Because of the low draft of the vessel in its "light condition", it is readily transported to the site of a spill without interference by the rotatable drums 52 and 54. Upon reaching the site of an oil spill, the valves 48 for each of the storage chambers 38 and 42 in each of the hulls 10 and 12 are opened, allowing sea water to enter the storage chambers and to lower the hulls 10 and 12 to a working water line W. In this condition, the storage chambers 38 and 42 in each of the hulls will be filled with sea water to the level of the water line W.

With the valves 48 opened, the vessel is advanced longitudinally over the area of an oil spill with the drums 52 and 54 rotating in opposite directions as depicted by the arrows R in Fig. 4. As a result of such

drum rotation, a mixture of oil and water is pumped upwardly through the gap between the drums and deposited in the respective distribution trough 88 for discharge to the top of the four storage chambers 38 and 42. Because the storage chambers are opened at their bottom and also because the specific gravity of the oil picked up is less than the sea water, water previously introduced to the storage chambers 38 and 42 will be displaced outwardly through the valves. Simultaneously the chambers 38 and 42 will operate in the manner of settling tanks so that water introduced with the oil through the openings 92 will settle out of the oil ultimately to be discharged through the open valves 48 as additional oil is introduced to the storage chambers.

The gap between the drums will vary with the conditions under which an oil slick is to be recovered. For example, if the oil slick contains a large amount of relatively heavy debris such as logs or the like, the gap between the drums will be increased to a maximum. Other types of debris such as sticks, cans, bottles and the like will have little effect on the operation of the vessel inasmuch as debris of this type will be crushed between the rotating drums and collected on the screening 94 for removal from the oil and water mixture passed to the cargo chambers. Because of the independent drive

train for rotating the drums 52 and 54, the speed of rotation may be varied to optimize the recovery operation.

Looking now to the improvements contemplated by the present invention and with particular regard to Figure 7, only one half of the system is shown. Drum 54 as described before in relation to Figures 4 and 5, is fitted with an inclined scraper blade 86 extending the length of drum 54. Liquid namely oil/water mix is removed from drum 54 by blade 86 into each trough or distribution duct 88 and thence through inflow or opening 92 into storage chamber 42. In each storage chamber 42 and 38, are provided baffles 100, in this embodiment, two such baffles are shown in each chamber 42 extending longitudinally from each transverse wall or bulkhead 34. Each baffle is fixed to the floor and to the bulkhead as by bolts or rivets, and the height of each baffle will be governed by the depth of the storage chamber, but will be less than the full height thereof. The oil/water mix will flow in the direction of the arrows. By providing this torturous path, more effective separation will occur as between the water and the oil, as would have occurred had no baffles been provided.

Looking now to Figure 8, a further improvement or modification to the prior apparatus is shown, namely the

provision of an arcuate plate 101 which is located central to and below the contra-rotating drums 52 and 54. It is envisaged that this plate 101 would be attached to extend transversely between the hulls 10 and 12, between inboard walls 16. As will be seen and understood, plate 101 could be raised or lowered in relation to the rotating surface of the drums 52 and 54 and in relation to the depth of oil on the water surface, such that the oil/water flow is driven into the triangular space 102, in the direction as shown by the arrows, to be picked-up on the surface of the contra-rotating drums. No mechanism to facilitate the adjustment in height of plate 101 has been shown.

As will be appreciated, there is a gap between the ends of each drum 52 and 54 and the inboard wall 16 of hulls 10 and 12. This gap does allow of the oil/water mixture to by-pass the drum surface. In order to effectively reduce this escape of oil, the present invention contemplates the addition of a seal 103 (Figure 10).

Seal 103 could be in the form of a layer of plastic applied to each end of drums 52 and 54 and to the surface of the inboard walls 16 of hulls 10 and 12. The composition of the plastic used would obviously be chosen to permit for surface contact without affecting the

rotation of the drums. The object, however, would be achieved, namely the sealing of that previously open space.

Shown schematically in Figures 9 and 11, and referenced in more detail in Figures 12 through 17 is a further embodiment of the present invention, which can be considered to be an extension of the embodiment shown in Figure 8. The plate 101 of Figure 8, has been replaced in this embodiment by a hinged plate assembly comprising at least three plates 104, 105 and 106, hingedly attached at 107. The three plates 104, 105 and 106, in a similar fashion to plate 101 in Figure 8 span the area between hulls 10 and 12 in the space below the hulls, and like plate 101, are utilized to direct or guide the flow of surface oil to the rotating drums 52 and 54. The direction of flow being shown schematically in Figure 9.

In operation, it will be appreciated that it will be necessary to compensate for different depths of oil spills and hence differing working water levels.

Therefore, with both embodiments disclosed adjustments will be required as to the positions of plates 104 through 106 of Figures 9 through 18 and also the single plate 101 of Figure 8. To allow for the depth below the surface of the oil/water mix. Therefore, with regard to Figures 9 and 12, we have a substantially

stationary plate 105 and adjustable side plates 104 and 106. These side plates will regulate the amount of flow to the area 108 immediately adjacent the drums 54 and 57. As fluid is recovered from area 108, flow is created from each end causing a current in the direction of the arrows (Figure 9) to be free flowing into area 108. As will be appreciated, this will permit surface oil to be recovered while the device is stationary.

The mechanism utilized to effect the height adjustment of plates 104 and 106, can of course be effected in a number of ways, however, one specific arrangement is shown diagrammatically in Figures 12 through 18. In this embodiment, four hand operated mechanisms 109 are utilized, each mechanism comprising a central screw 110 which is actuated by a hand wheel 111. The screwed shaft passes through a housing and is attached by way of a universal joint 112 to a lower shaft 113, which itself is adapted to interconnect with a slotted angled plate 104. Plate 104 is attached to the upper surface of plate 104/106. The bottom of shaft 113 (Figure 17) is shown as bolted such that the shaft of the bolt is free to slide in the slot 106 as the height of the plate or the angle of the plate relative to the central plate 105 is adjusted.

Therefore, manual actuation of each separate

mechanism, raises or lowers the outer edges of hinge plates 104 and 106 from an upper position as seen in Figure 12, to its maximum lower position as shown in Figure 13. This lower position is also indicated by broken line 115 of Figure 12.

Each mechanism is, of course, mounted firmly to an adjacent bulkhead.

While manual actuation of each separate mechanism is contemplated, it will be appreciated that all units could be actuated simultaneously by means of hydraulics or electric motors. Additionally, other mechanism could be utilized to operate the movement of each plate, for example, a cable and pulley system might be deemed an equivalent structure. Therefore, the form of mechanism shown here is purely exemplary and not in any way limiting.

A preferred technique for transversing a relatively small oil spill is shown in Fig. 6 of the drawings. Here the recovery vessel V is towed by a pair of tug boats T connected to one end of the recovery vessel by floating booms B. By advancing the recovery vessel slowly against wind and current, it is possible that the entire oil slick be recovered in one pass of the vessel.

Alternatively, and particularly where larger oil spills are incurred, it may be desirable to circumscribe

the oil spill first with a circular or closed boom to assure its containment with a defined area. The recovery vessel is maneuvered into the oil spill and then transversed back and forth until all of the oil has been recovered. The vessel of the invention is particularly suited to this type of operation inasmuch as it may be reversed without loss of time for turning operations and without changing the direction of rotation of the drums inasmuch as they continue to rotate in the directions of the arrows are irrespective of the direction of longitudinal movement.

Still another use of the vessel particularly where oil spill has drifted wharves and like structures which are not accessible by the recovery vessel of the invention. In this situation, the vessel is placed against the pier or wharf under which the oil spill has spread and both of the drums 52 and 54 initially rotated in the same direction to initiate a current of the spill between the two hulls 10 and 22. As the current becomes established, the rotation of the drum which is downstream in relation to that current can be rotated oppositely from the upstream drum to effect a pumping action similar to that described above with respect to Fig. 4 of the drawings.

Although the design of the oil spill recovery and

storage vessel of the invention is adaptable to a wide variation in sizes, the following exemplary dimensions are given to enable a complete understanding of the operating parameters of the vessel.

Length overall - 40 ft. 0 in.

Beam overall 1- 26 ft. 0 in.

Depth of hulls 10 and 12 - 10 ft. 0 in.

Width of each hull - 8 ft. 0 in.

Draft (light) - 2 ft. 3 in.

Draft (working) - 5 ft. 0 in.

Drum diameter - 8 ft. 0 in.

Drum length - 10 ft. 0 in.

Axle height above working water line (W) - 4 ft. 0 in.

Gap size - 0 in. to 6 in.

Given a vessel of of the above dimensions, the approximate storage capacity of the four chambers 38 and 42 is approximately 50 short tons of oil having a specific gravity approximating 0.87.

As an example of the rate at which the vessel may recover an oil slick, if the drum gap in the above vessel is set to produce a surface film on each drum of approximately one-quarter of an inch in thickness and the drums rotated at a speed of approximately 30 r.p.m., approximately 315 cubic feet of liquid will be picked up

by the vessel per minute. While this represents a rate of approximately 10 short tons per minute, it is to be understood that a substantial percentage of the liquid picked up will be sea water particularly in complete collection of all oil is to be assured. A conservative estimated percentage might be assumed 10% oil. At this rate, the storage chambers 38 and 40 will be filled in approximately 50 minutes to one hour. At this rate, a major oil spill of approximately 200 short tons can be recovered in approximately five to six hours. It is contemplated that because of its relative simplicity, the recover vessel of the present invention could be carried aboard large oil tankers as tenders as for use in the event of oil spills even in the open sea. Smaller versions than the example given could be handled by life boat davits and lowered onto the sea for spill recovery. With large size tankers having a capacity of 300,000 short tons or more, it is possible that a vessel having the exemplary dimensions given above could be carried and readily handled by equipment available on the deck of such tankers.

Thus it will be appreciated that by the present invention there is provided an improved vessel and method for effective recovery and containment of oil spills. It also will be appreciated by those skilled in the art that

various modifications and/or changes in the disclosed embodiment can be made without departure from the concept manifested by the disclosed embodiment. It is extremely intended, therefore, that the foregoing description is illustrative of a preferred embodiment only, not limiting, and that the true spirit and scope of the present invention be determined by reference to the appended claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. An oil spill recovery vessel comprising:

a pair of transversely spaced longitudinal hulls each having a plurality of discrete internal chambers to establish buoyancy tanks and storage chambers;

means for opening the bottoms of said storage chambers to allow ingress and egress of liquid to and from said storage chambers;

means for picking up a mixture of oil and water between said hulls and for introducing said mixture to the top of said storage chambers thereby to effect in said chambers a layer of oil superimposed above water until a sufficient quantity of oil has been introduced into said chambers to displace the water through the bottoms of said chambers, said last mentioned means including a pair of transversely extending, counter-rotatable cylindrical drums spaced longitudinally to establish a gap between the peripheries thereof, both said drums being movable from an elevated inoperative position when said storage chambers are empty of liquid to a lowered operative position so that the peripheries of both drums will be in contact with the surface of water in which said hulls are floated when the bottoms of

said storage chambers are open;

means located within the space between the hulls and below said drums for directing said mixture to the surface of said drums to be picked up thereby.

2. The apparatus recited in claim 1 including baffle means in each said storage chamber to assist in the gravitational separation of oil and water from said mixture.

3. The apparatus recited in claim 1 wherein said buoyancy tanks and storage chambers are symmetrically alternated in said hulls.

4. The apparatus recited in claim 1 including scraper means for removing oil and water from the surface of said drums.

5. The apparatus recited in claim 1 including means to adjust the longitudinal position of at least one of said drums thereby to adjust the width of the gap between the drum peripheries.

6. The apparatus recited in claim 1 including independently controlled and separate torque developing means for rotating each drum.

7. The apparatus recited in claim 5 wherein said torque developing means comprises an independent internal combustion engine for driving each drum.

8. The apparatus recited in claim 1 wherein said means for directing said mixture to the surface of said drums

comprises an arcuate plate mounted to extend transversely of said vessel between said hulls.

9. The apparatus recited in claim 8 wherein said arcuate plate is adjustable in respect to its proximity to said drums.

10. The apparatus recited in claim 1 wherein said means for directing said mixture comprises at least three transversely positioned plates, hingedly attached one to the other in a longitudinal direction of said hulls said plates being mounted below said drums, and at least one of said plates being angularly adjustable in relation to a central one of said plates, to control the flow of fluid between said hulls into the immediate vicinity of said drums.

11. The apparatus recited in claim 1 wherein the space between the ends of each said drum and an adjacent hull is sealed to substantially prevent the flow of liquid thereto.

12. An oil spill recovery vessel comprising:

a pair of transversely spaced longitudinal hulls each having a plurality of discrete internal chambers to establish buoyancy tanks and storage chambers;

baffle means adapted to subdivide each said storage chamber to allow for gravitational separation of oil and water therein;

means for opening the bottoms of said storage chambers to allow ingress and egress of liquid to and

from said storage chambers;

a pair of cylindrical drums of essentially the same diameter supported for rotation on longitudinally spaced transverse axes between said hulls, the longitudinal spacing of said axes being equal at least to the combined radii of said drums to provide a gap at the periphery of said drums, said drums being movable with said hulls from an elevated inoperative position when said storage chambers are empty of liquid to a lowered operative position to be in contact with the surface of water in which said hulls are floated when the bottoms of said storage chambers are open, the space between said hulls be unobstructed except for said drums at and below said surface of water;

means for rotating said drums in opposite directions and to effect upward peripheral movement thereof at said gap;

means located within the space between said hulls and below said drums for directing said mixture to the surface of said drums, to be picked up thereby;

means to remove liquid carried upwardly through said gap from the periphery of each of said drums; and

means to transfer said removed liquid to the top of said storage chambers.

13. The apparatus recited in claim 12 wherein said means

for directing said mixture to the surface of said drums comprises an arcuate plate extending transversely of said vessel between said hulls.

14. The apparatus recited in claim 13 wherein said arcuate plate is adjustable in respect of its proximity to said drums.

15. The apparatus recited in claim 12 wherein said means for directing said mixture comprises at least three transversely positioned plates, hingedly attached one to the other in longitudinal direction of said hulls, said plates being mounted in the space immediately below said hulls, at least one of said plates being angularly adjustable relative to a central one of said plate to control the flow of fluid between said hulls into the immediate vicinity of said drums.

16. The apparatus recited in claim 12 wherein the space between the ends of each drum and an adjacent hull is sealed to substantially prevent the flow of liquid therethrough.

17. The apparatus recited in claim 2 wherein said hulls are longitudinally symmetrical about a transverse medial line thereby to enable longitudinal advance of said hulls in fore and aft directions with equal efficiency.

18. The apparatus recited in claim 12 wherein said buoyancy tanks and storage chambers are symmetrically alternated longitudinally of said hulls.

19. The apparatus recited in claim 12 including means to

adjust the longitudinal position of at least one of said drums thereby to adjust the width of the gap between the peripheries of said drum.

20. The apparatus recited in claim 12 wherein the lower peripheries of said drums are elevated above the bottoms of said hulls so that when the bottoms of said storage chambers are opened to allow the ingress of sea water, the draft of said vessel is increased to the level of the lower peripheries of said drums.

21. The apparatus recited in claim 12 wherein said means to remove liquid carried upwardly through said gap comprises an inclined scraper blade extending the full length of each of said drums, said scraper blade extending the full length of each of said drums, said scraper blades being located to engage said drums at approximately 120 degrees of drum rotation from said peripheral gap.

22. The apparatus recited in claim 21 wherein said means to transfer said removed liquid to the top of said storage chambers comprises a trough merging with each of said scraper blades, said trough being screened to prevent the entrance of debris thereinto.

23. The apparatus recited in claim 12 comprising independent internal combustion engines for developing torque to rotate said drums respectively, one such engine being supported on each of said hulls.

24. The apparatus recited in claim 23 including a hydraulic transmission system for transmitting torque from said internal combustion engines to said drums, each of said hydraulic systems including a hydraulic pump driven by the internal combustion engine, a hydraulic motor supplied by said pump and attached to each of said drums and separate hydraulic system control components for each of said drums.

25. The apparatus recited in claim 23 including a control bridge extending between said hulls and elevated above said drums, said control components being located on said control bridge.

Fig 1 (PRIOR ART)

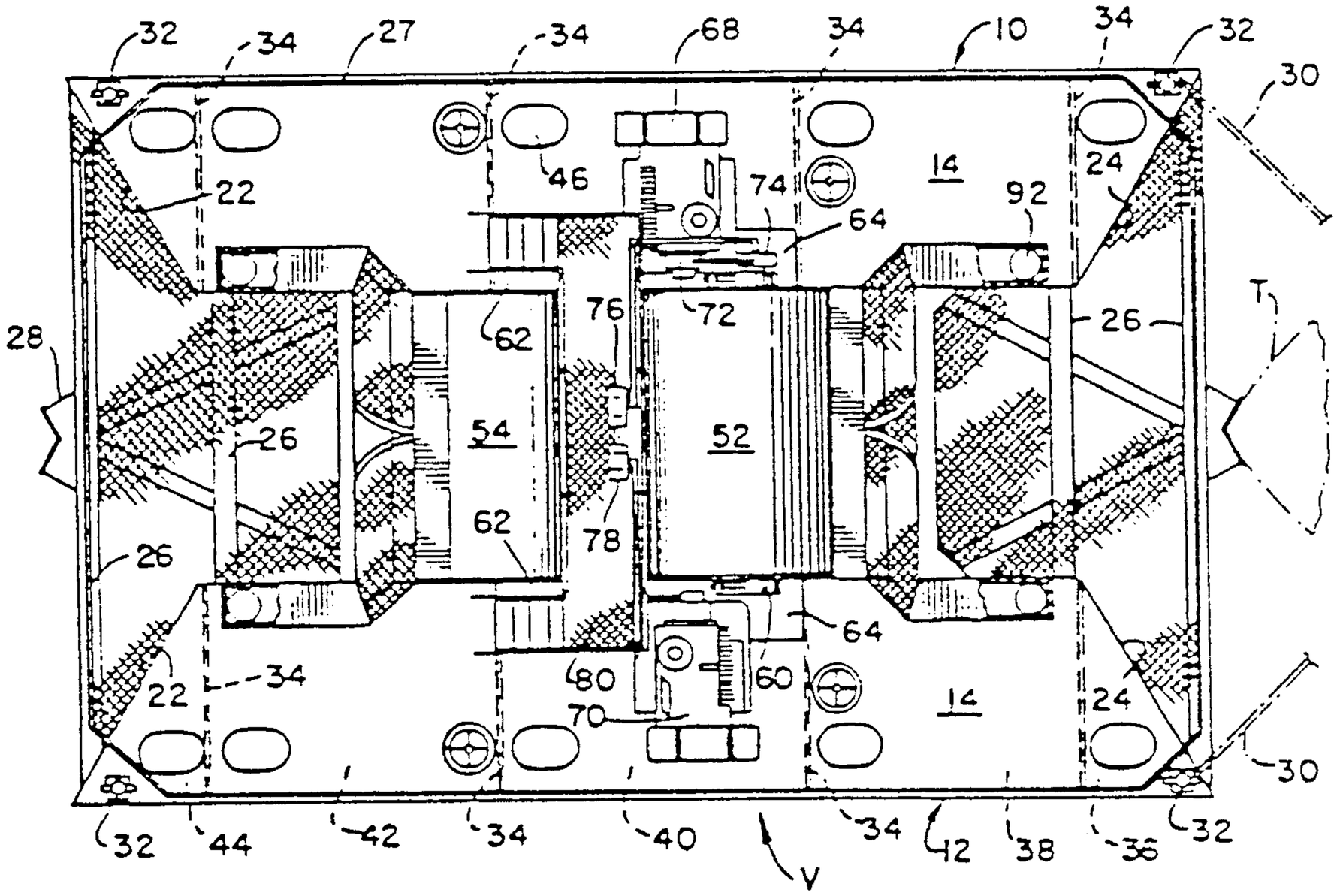


Fig 2 (PRIOR ART)

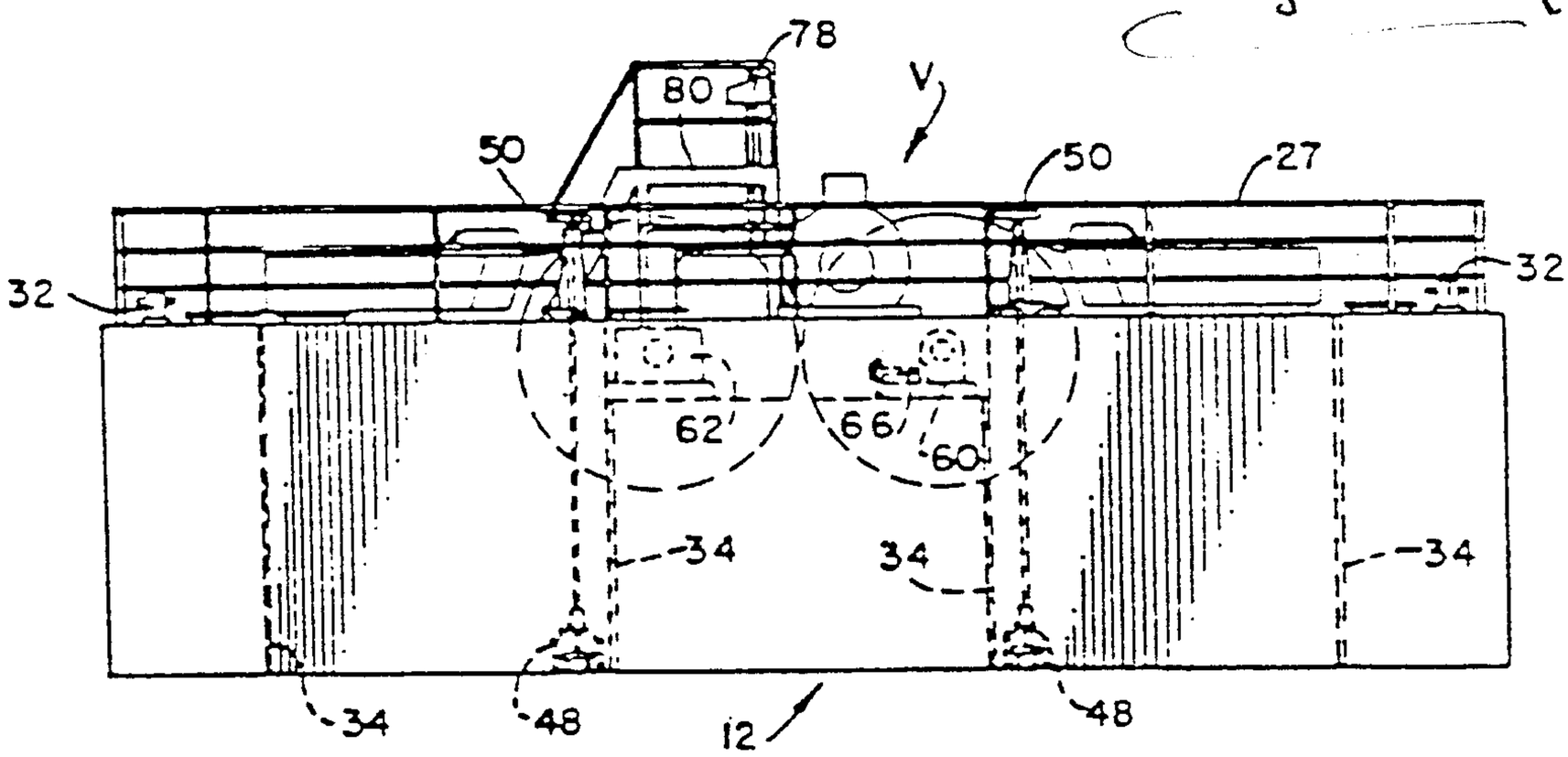


Fig 3 (PRIOR ART)

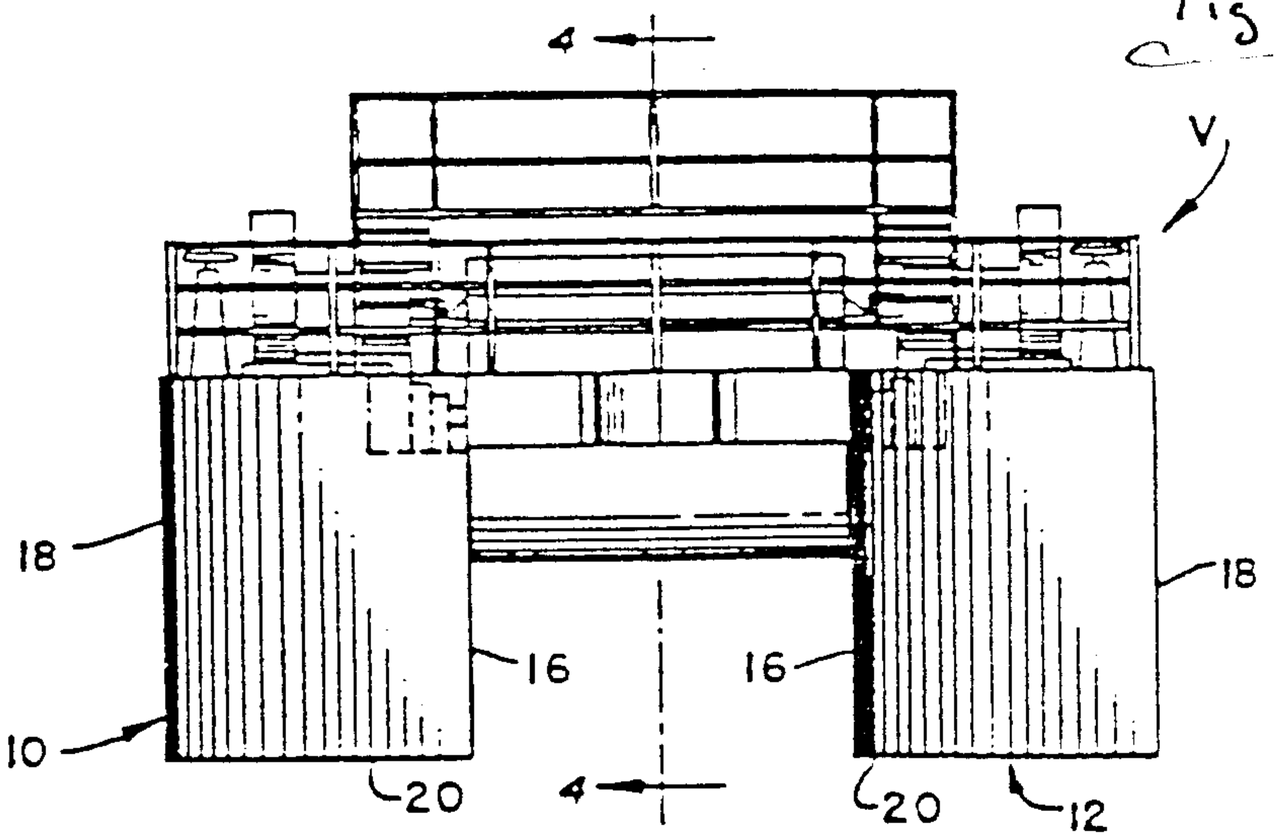


Fig 4 (PRIOR ART)

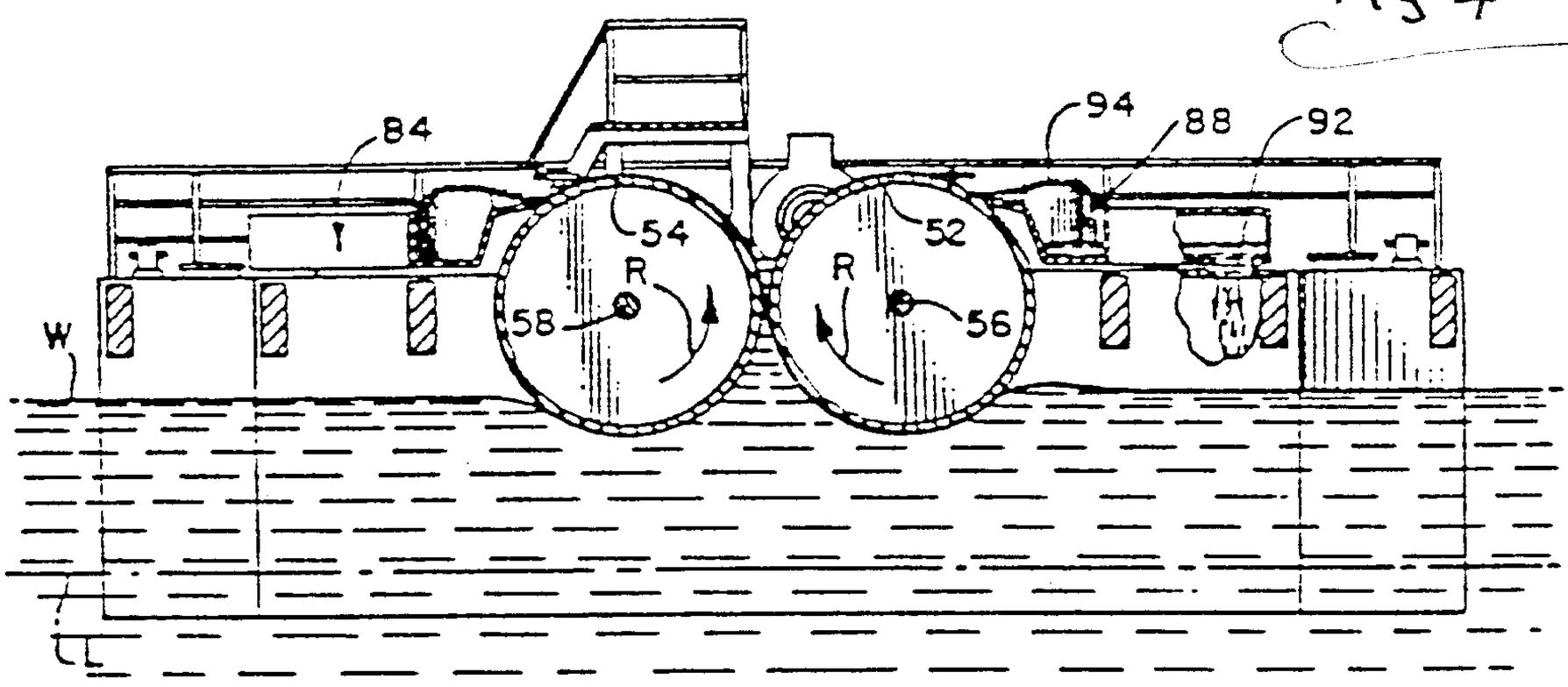


Fig 5 (PRIOR ART)

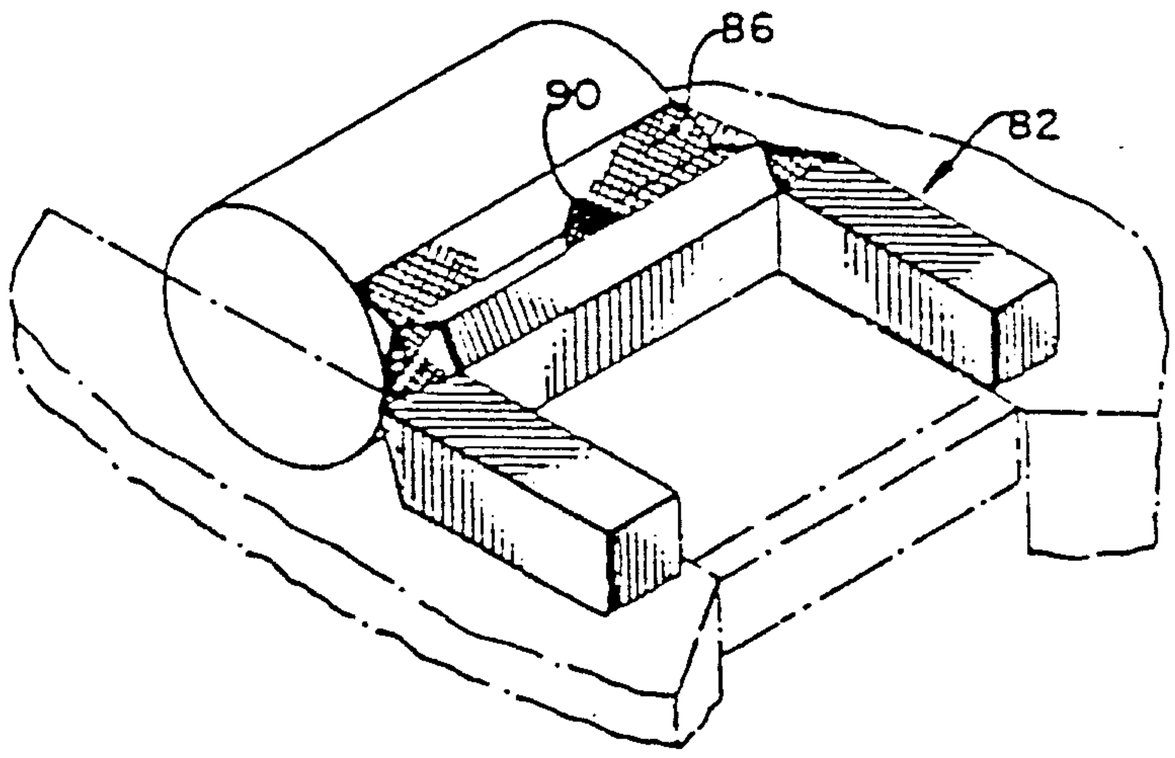


Fig 6 (Prior Art)

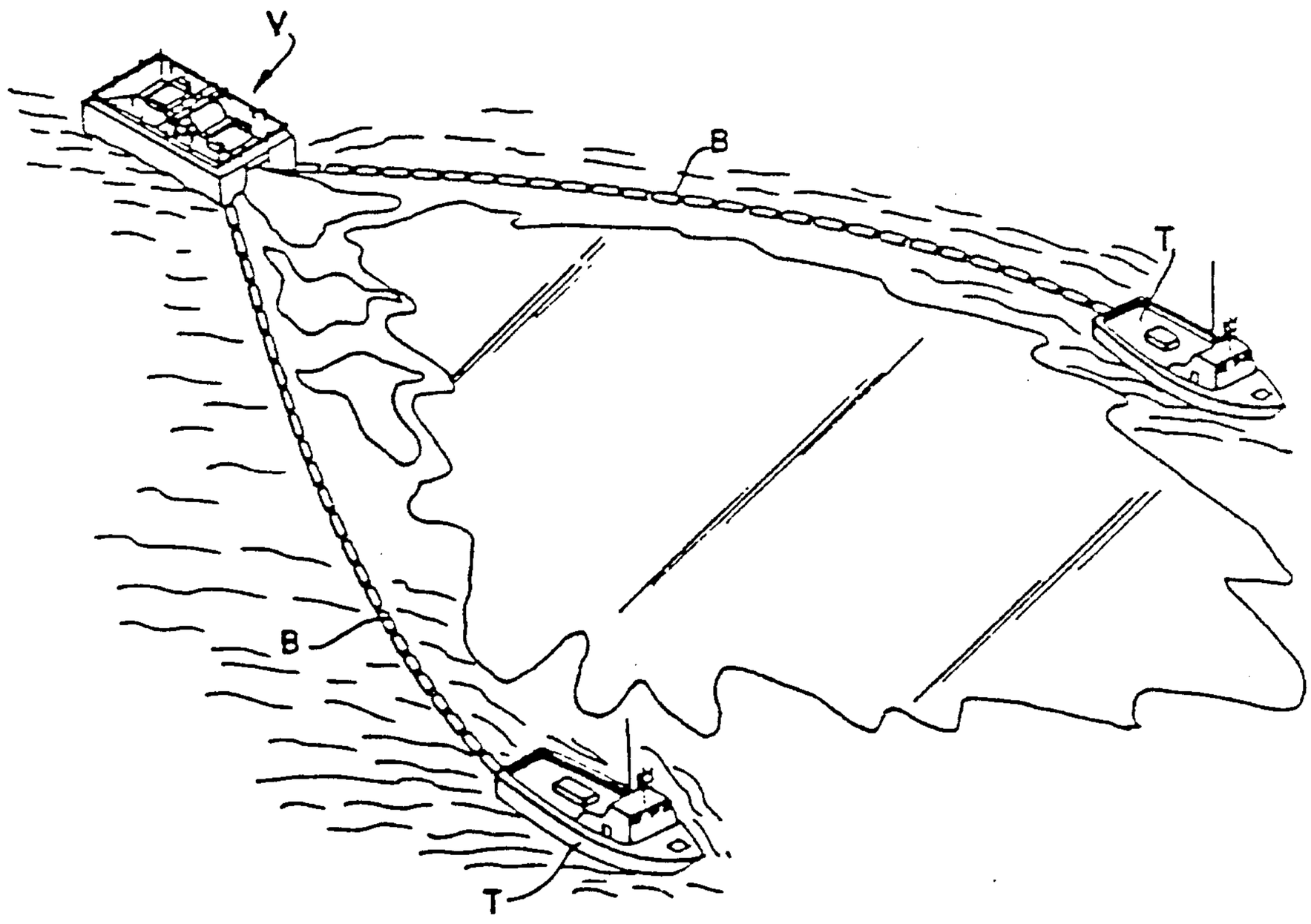


Fig 7

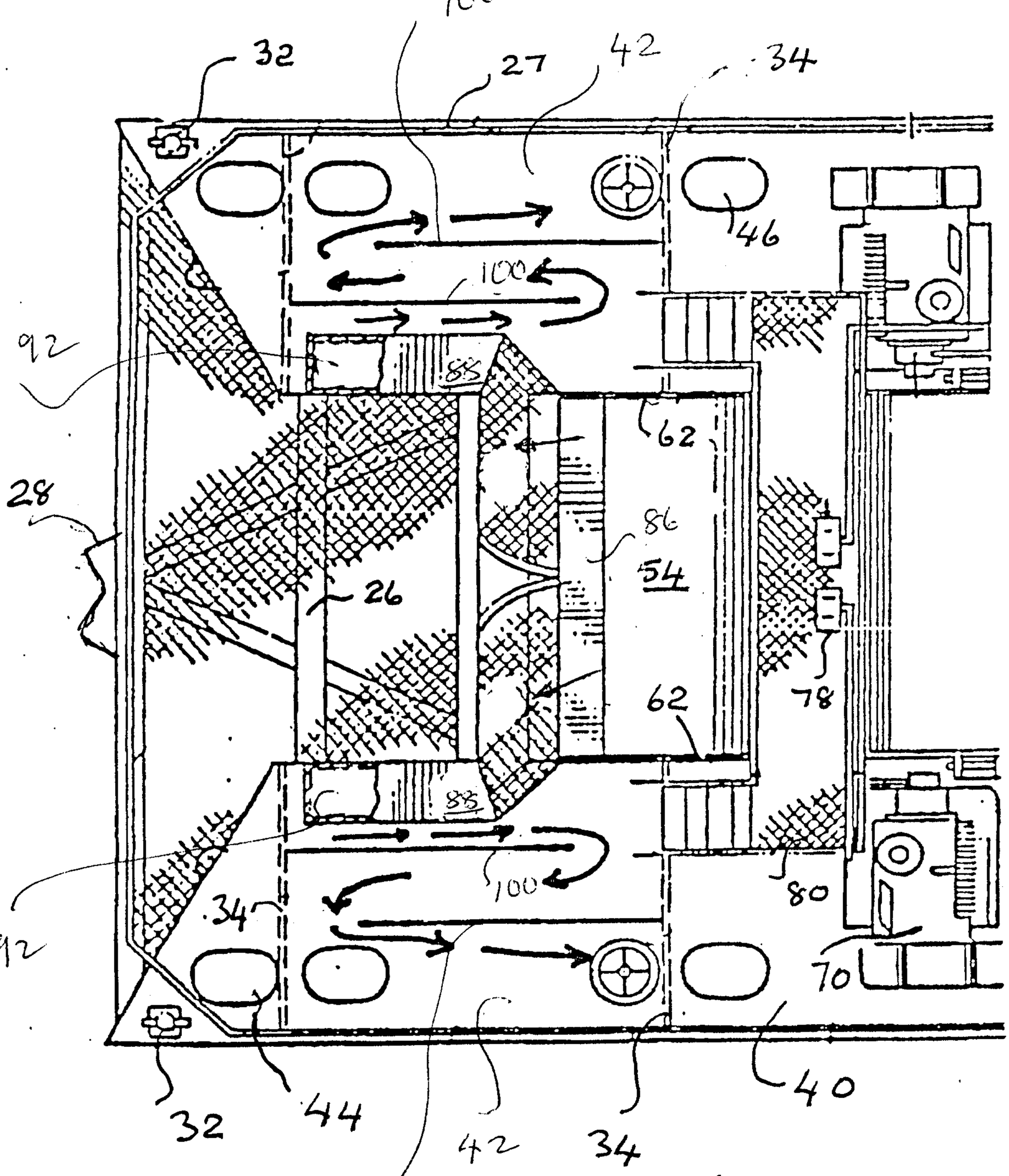

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Fig 8

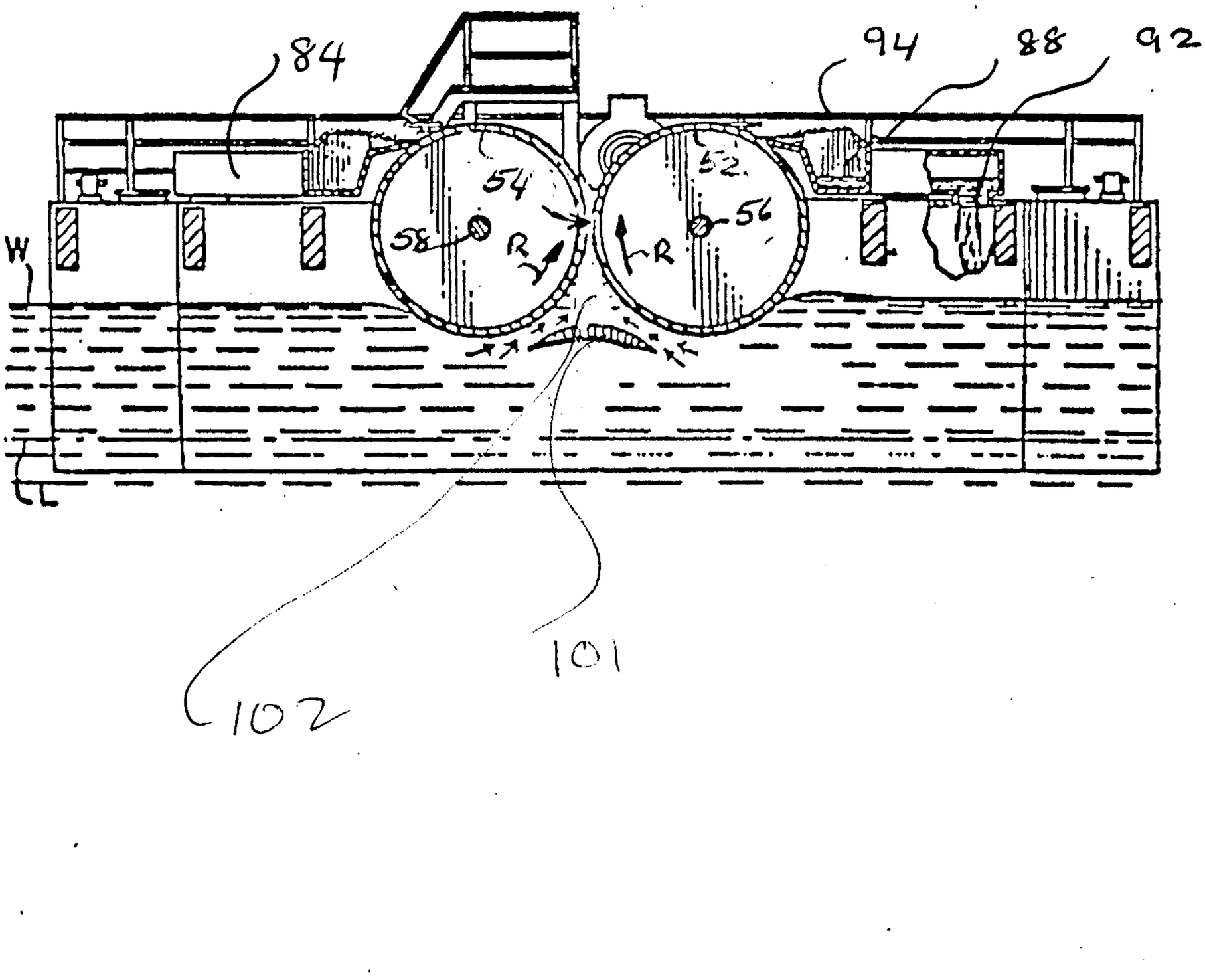


Fig 9

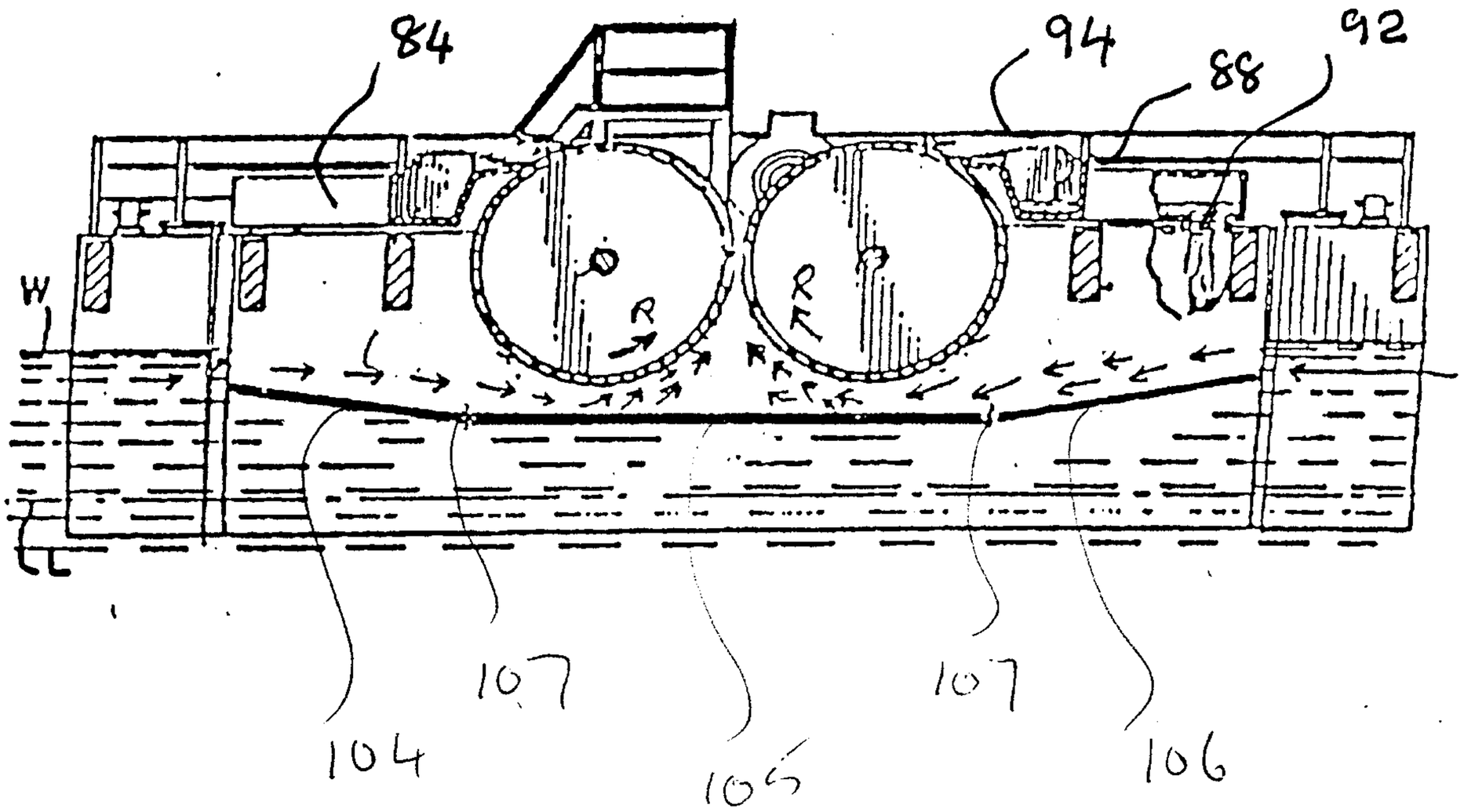


Fig 10

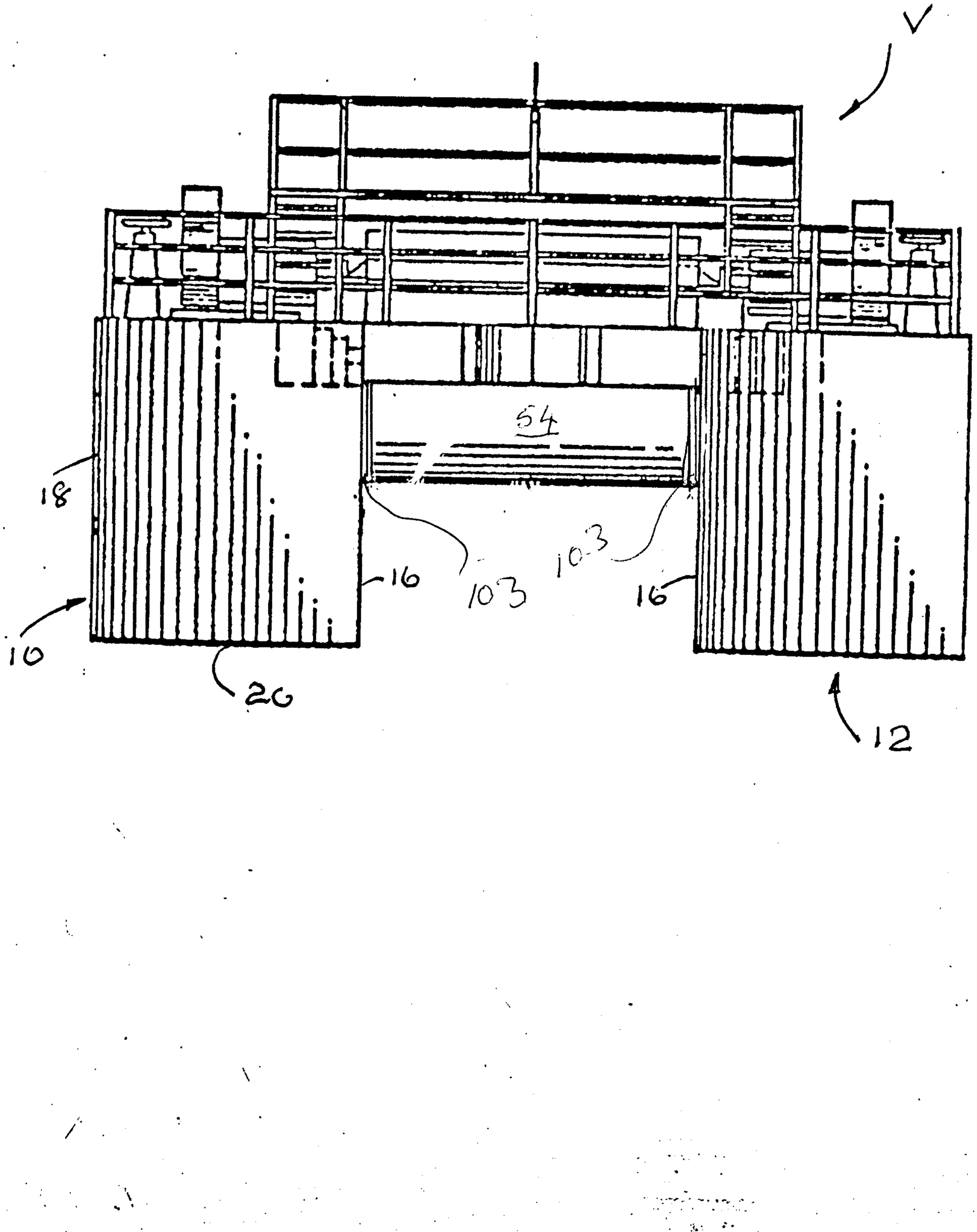
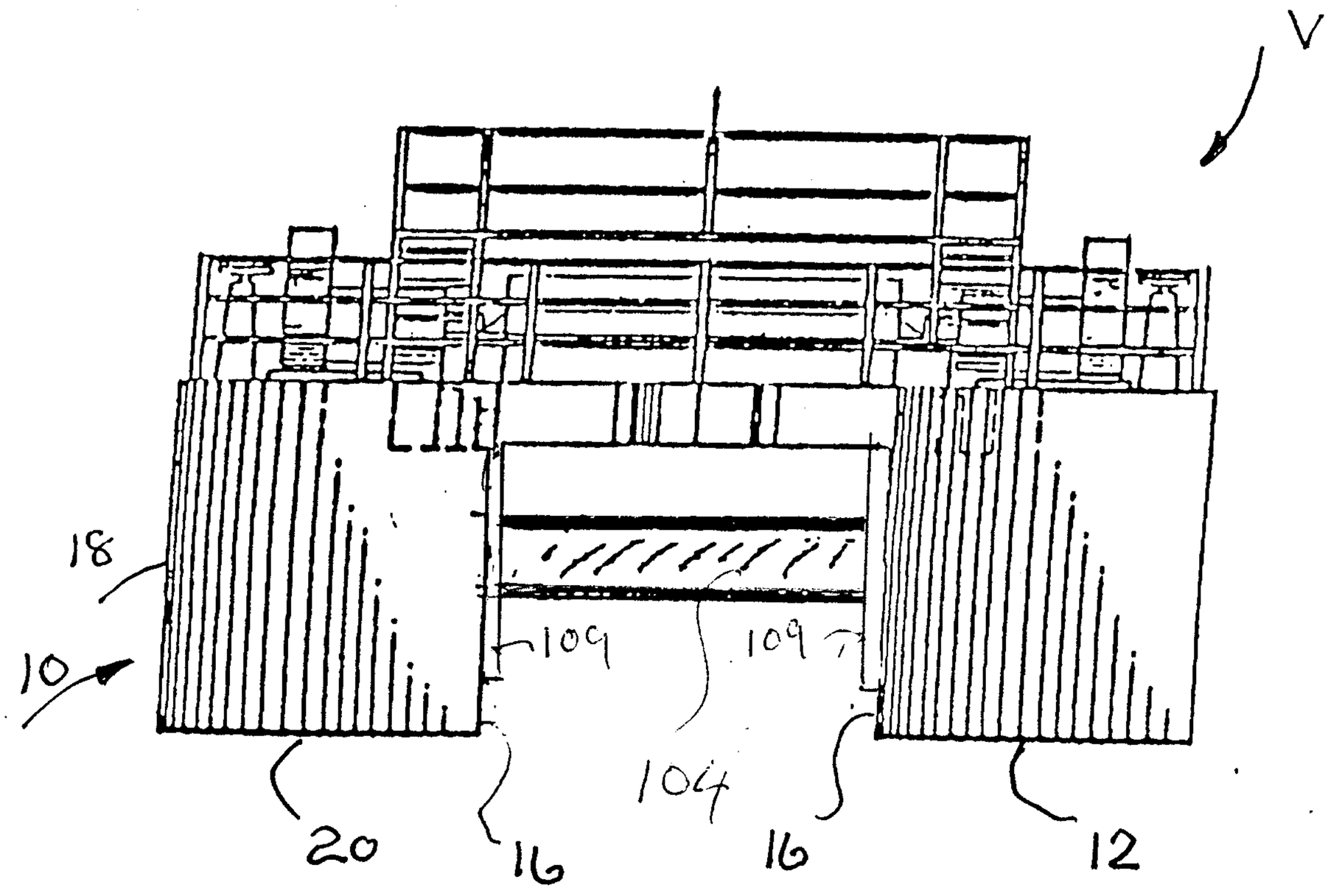


Fig 11



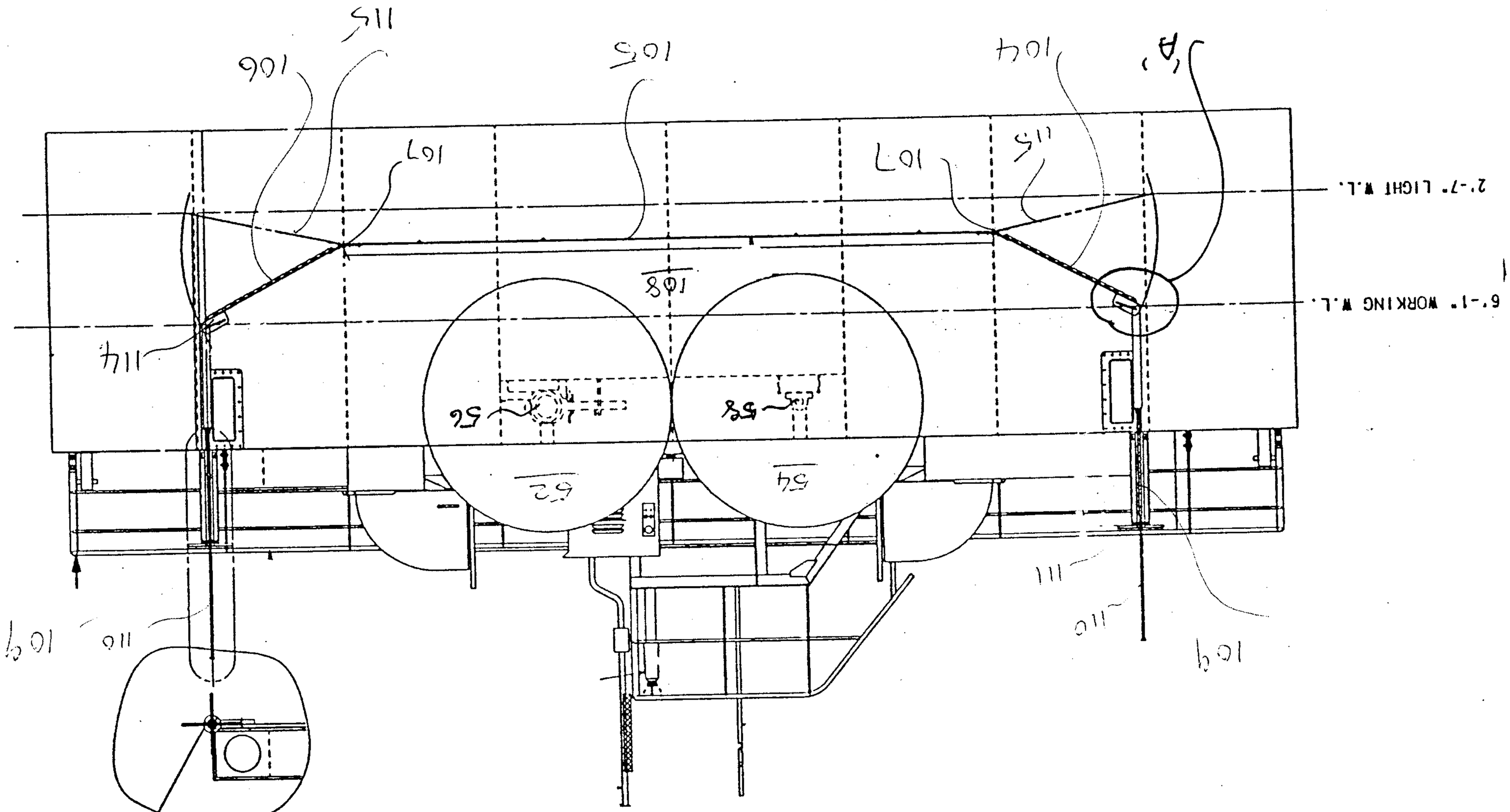

2'-7" LIGHT W.L.
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Fig 12

Fig 13

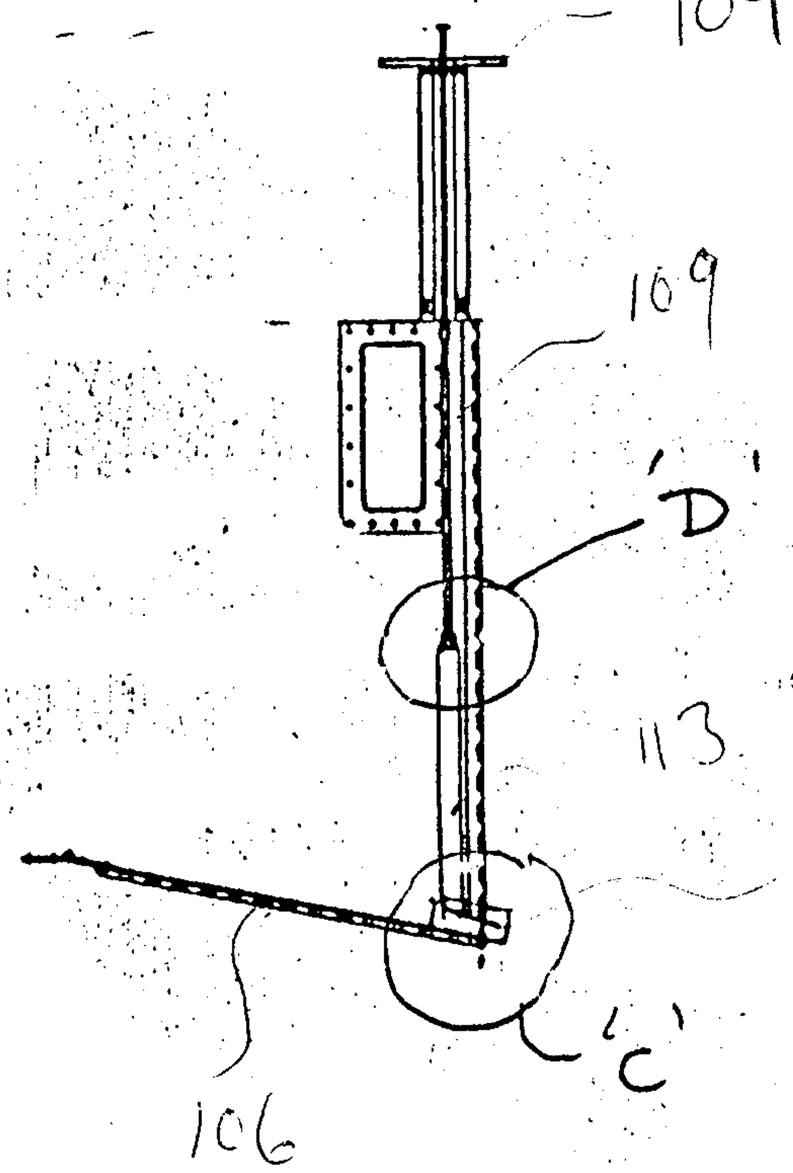


Fig 18

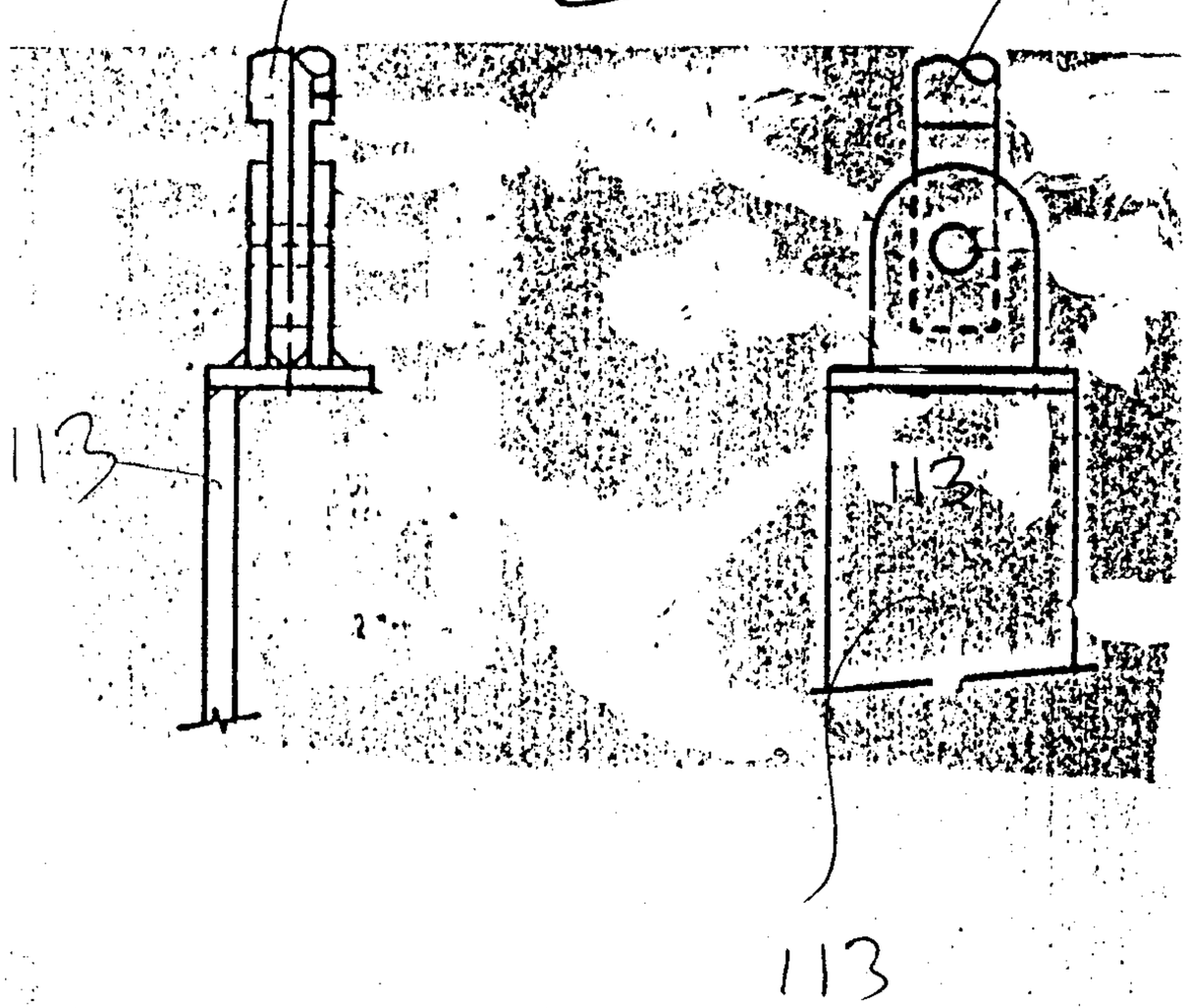


Fig 17

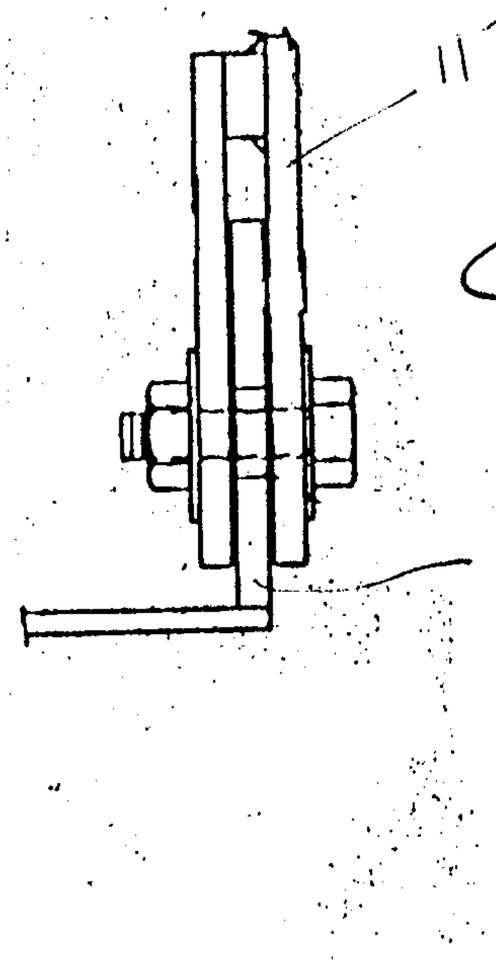
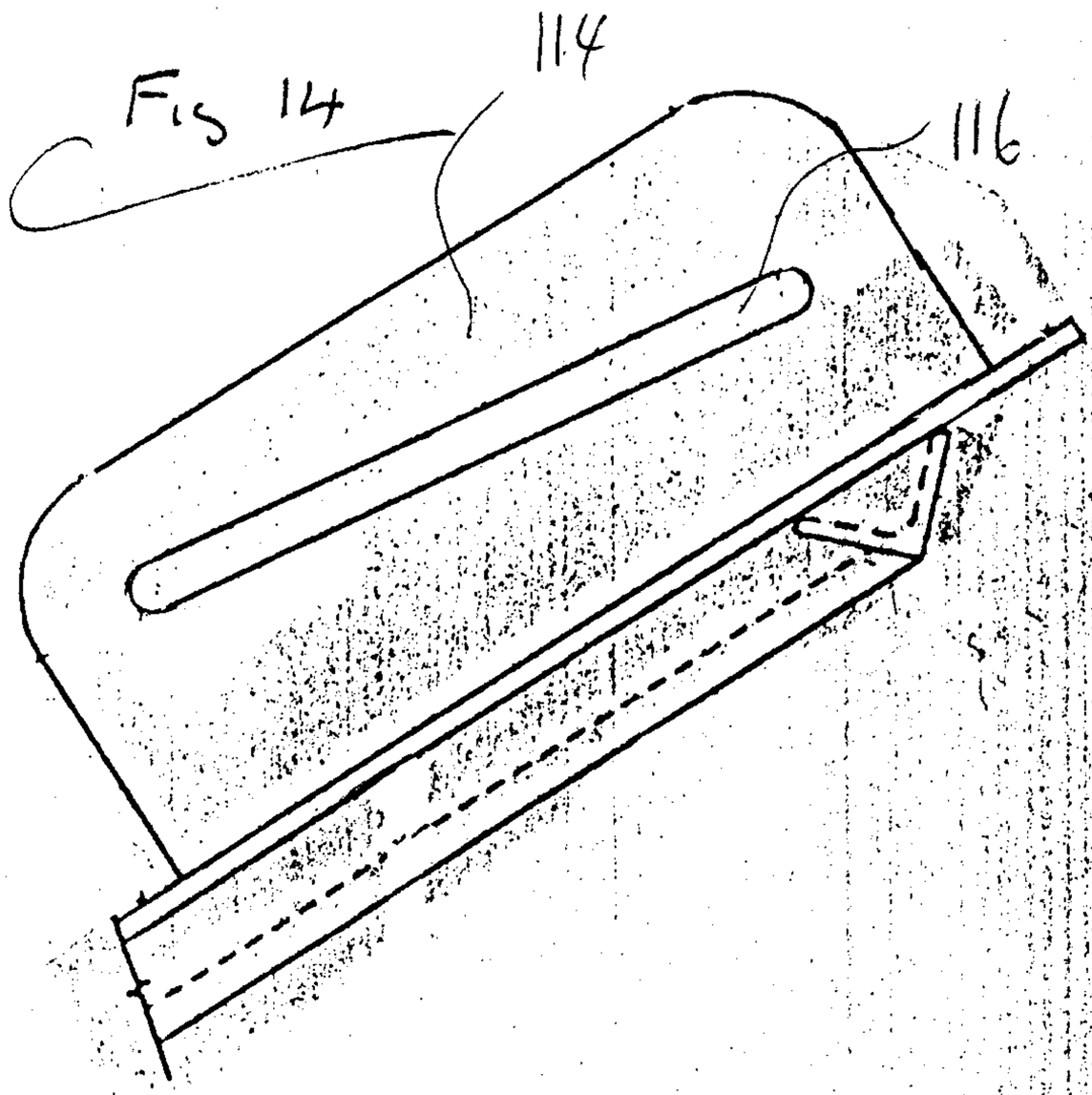


Fig 14



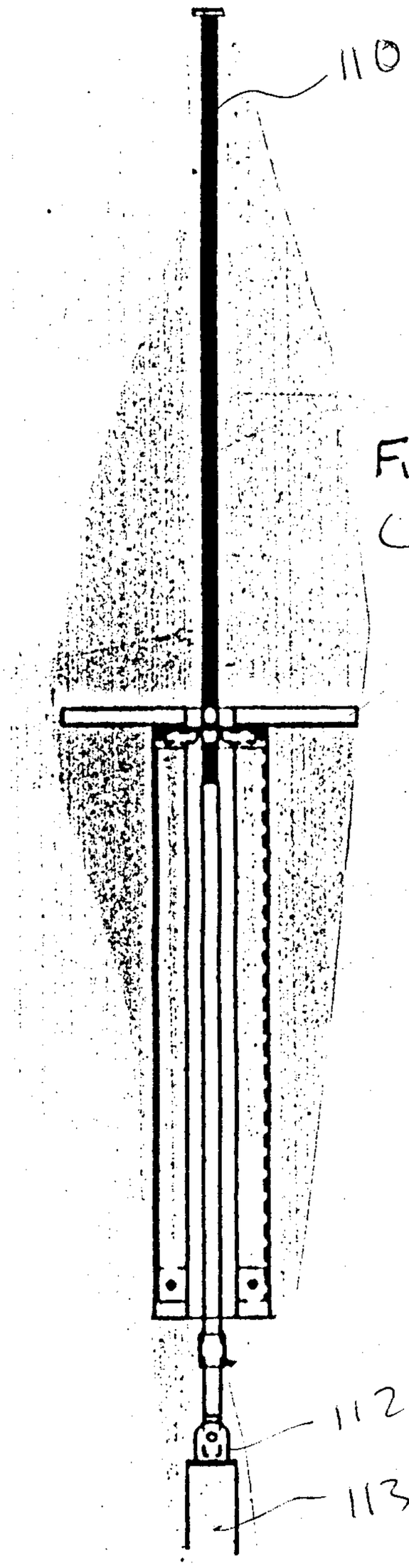


Fig 15

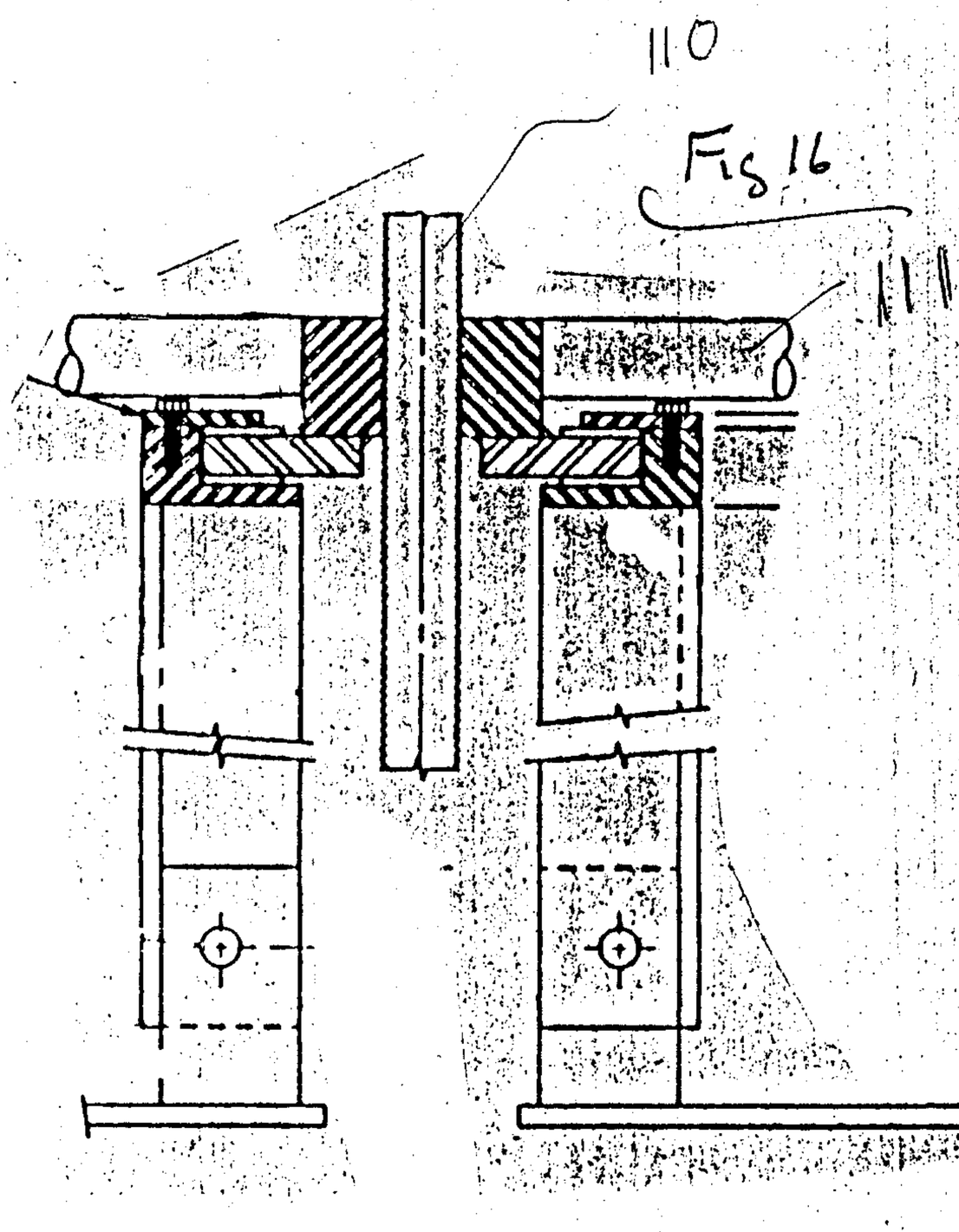
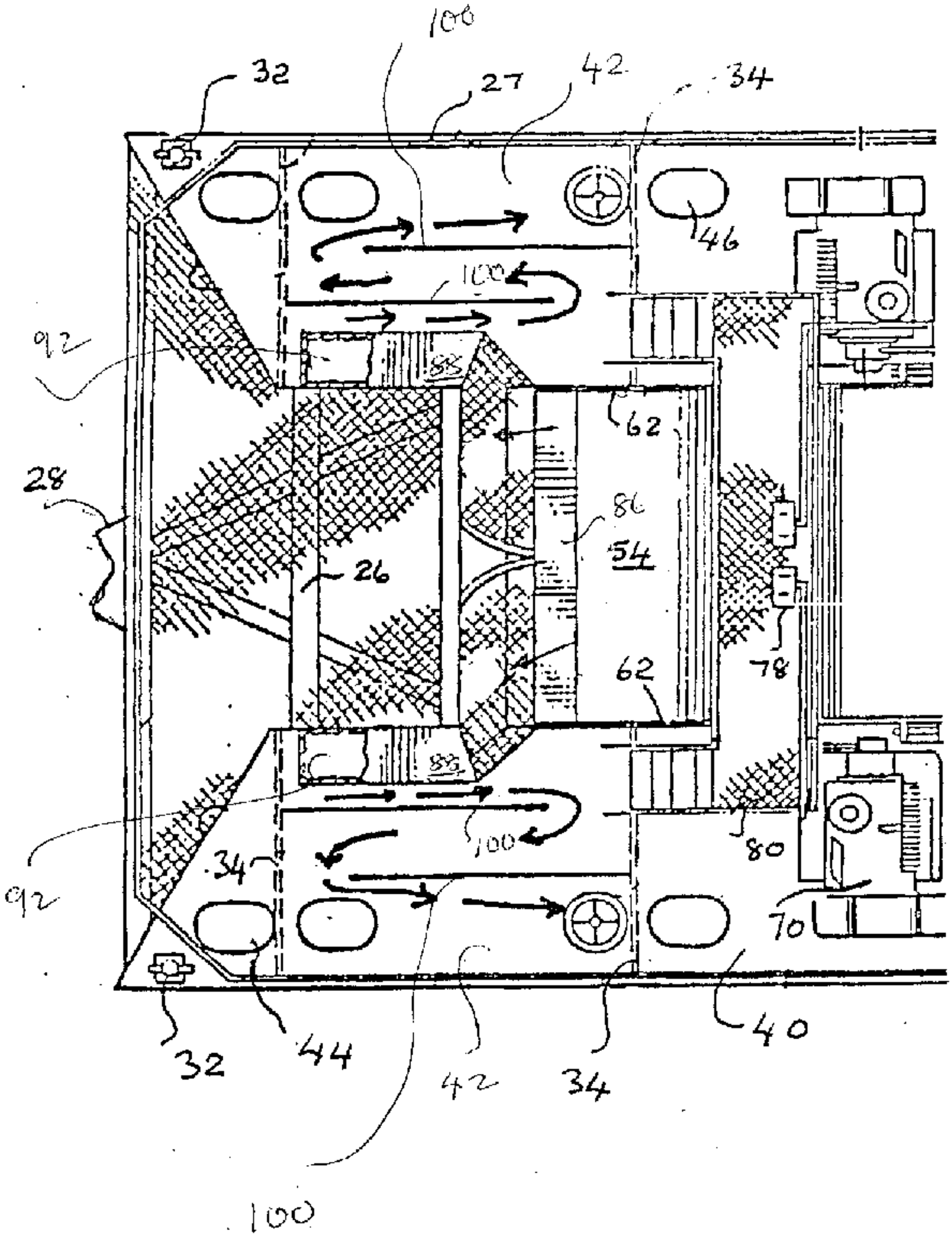


Fig 16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