Jan. 6, 1953

E. R. WILLIAMS

2,624,462

APPARATUS FOR SIPHONING WATER FROM OIL TREATING STRUCTURE

Filed Feb. 10, 1950

2 SHEETS—SHEET 1

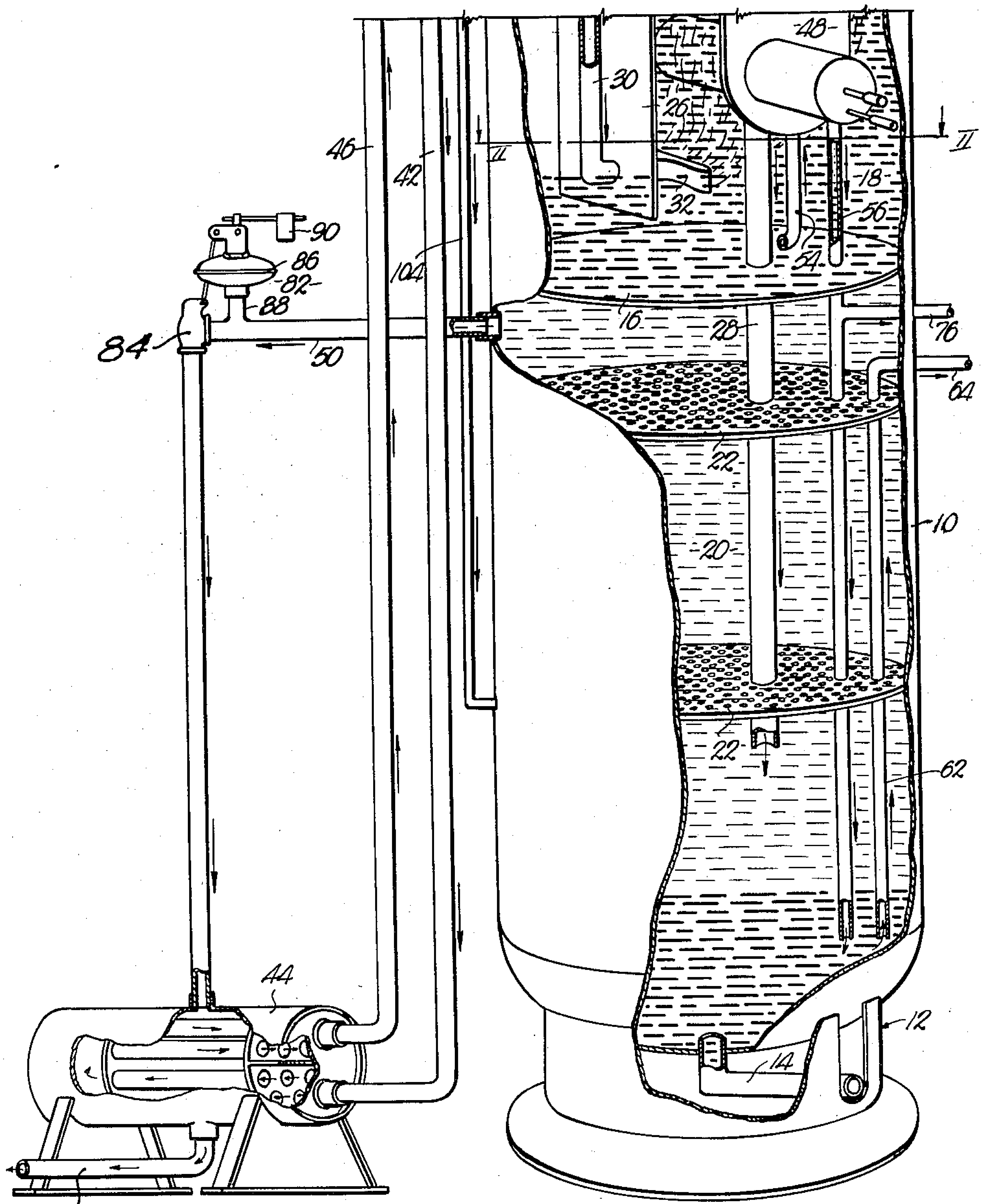

Fig. 1.

INVENTOR.
Elmer R. Williams
BY
ATTORNEY.

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2 SHEETS—SHEET 2

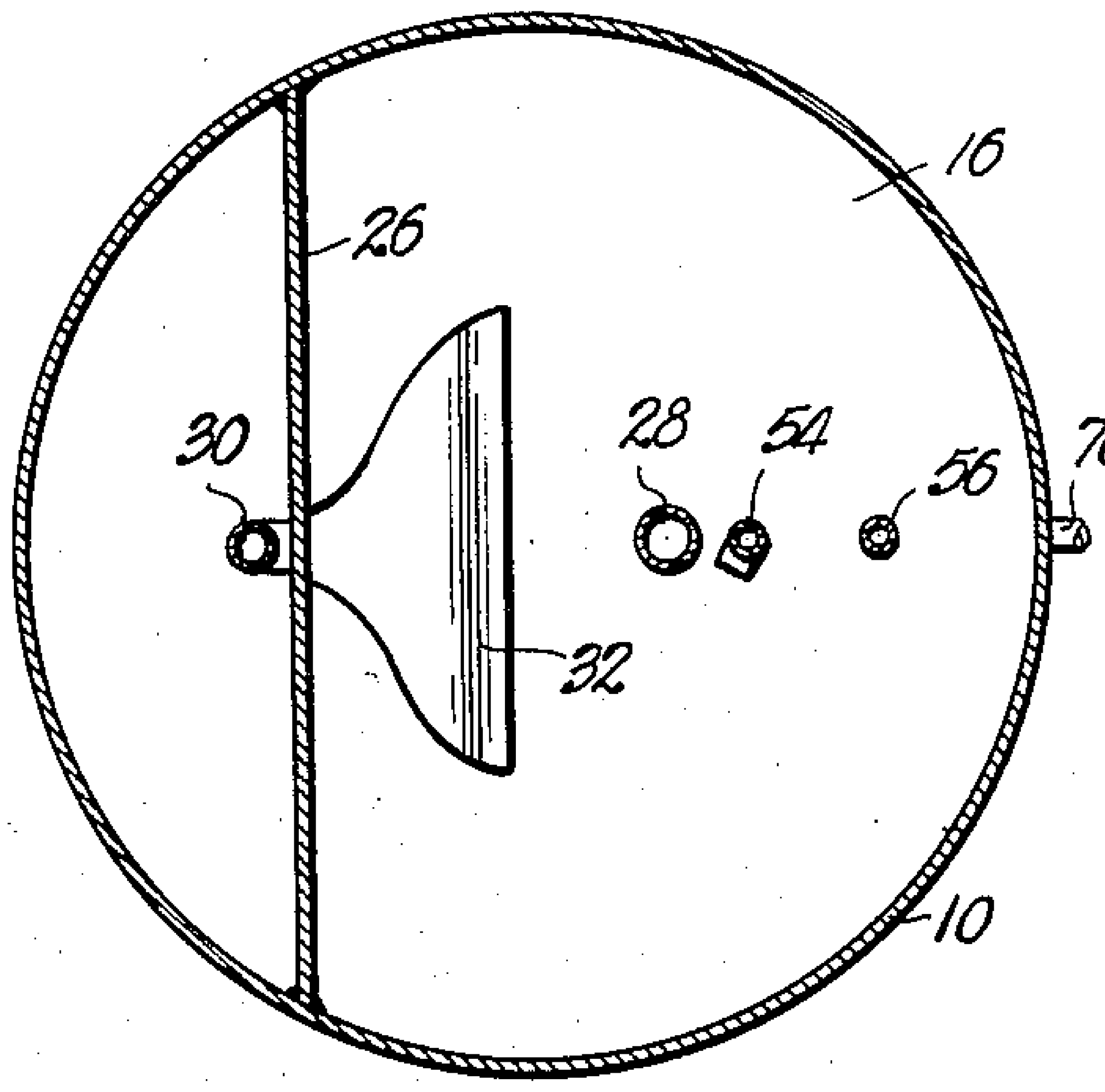

Fig. 2.

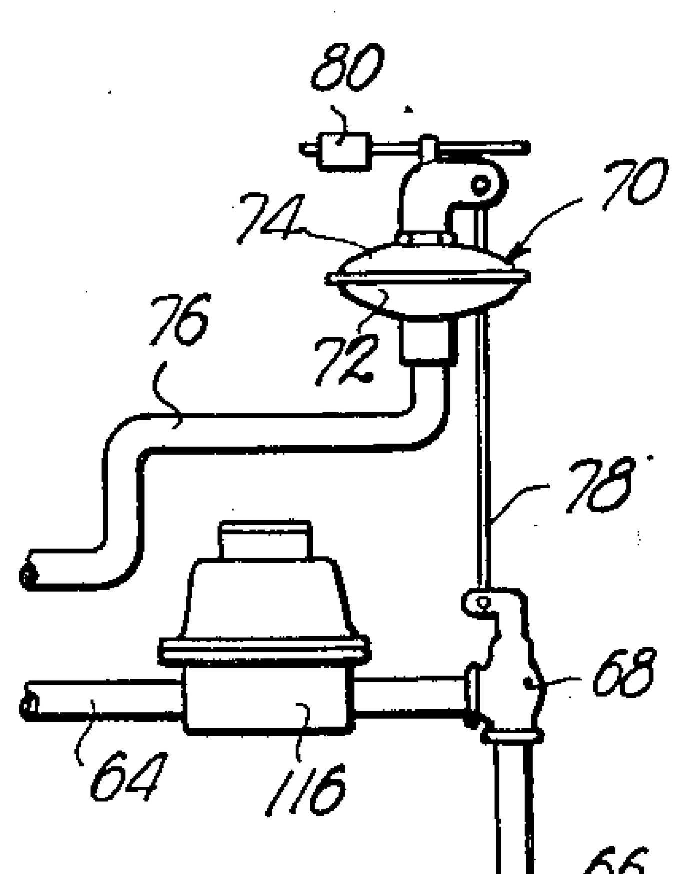

Fig. 1b.

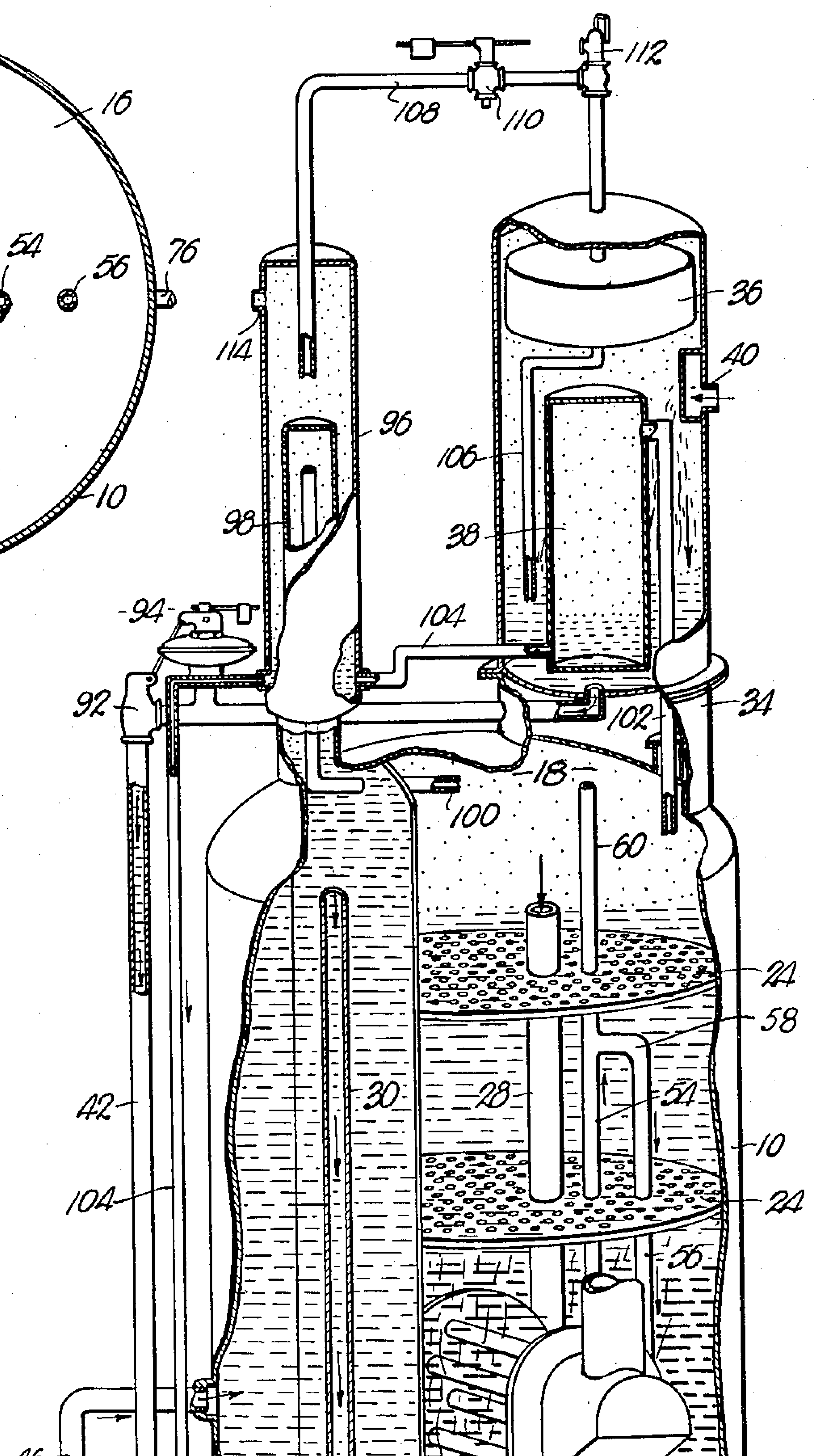

Fig. 1a.

INVENTOR.
Elmer R. Williams
BY
Carl Hovey
ATTORNEY.

Patented Jan. 6, 1953 2,624,462

UNITED STATES PATENT OFFICE

2,624,462

APPARATUS FOR SIPHONING WATER FROM OIL TREATING STRUCTURE

Elmer R. Williams, Springfield, Mo.

Application February 10, 1950, Serial No. 143,478

4 Claims. (Cl. 210—51)

This invention relates to the production, handling, refining and treating of petroleum and related products and has for its primary object the provision of apparatus for and a method of draining from a treater, water that has been removed from the petroleum products in the treater, all automatically and at a rate dependent accurately upon the amount of water initially contained by the treated products and removed in the treater.

It is the most important object of the present invention to provide a method of removing water together with apparatus for removing such water from a treater for petroleum products that improves upon the water siphoning system disclosed in my co-pending application, Serial No. 46,496, filed August 27, 1948 and entitled "Method and Apparatus for Treating Emulsion Emanating from Natural Oil Wells," this being a continuation in part of said co-pending application.

Water siphoning systems and like systems for draining water from oil treaters are generally not entirely satisfactory because of the fact that such valves as may be used to control the out-flow of the water, develop leaks and other mechanical defects from time to time resulting in a drainage of the water faster than is desired and thereby overcoming the necessary balance or equilibrium of the entire system. Furthermore, because of such leakage and because of the overall arrangement of parts of conventional systems of this character, it is virtually impossible to measure the amount of water through use of water meters presently available on the open market.

Accordingly, it is one of the most important objects of the present invention to provide an automatic siphoning or removal system capable of permitting the use of a suitable water meter whereby the user may accurately determine the amount of water within the oil being pumped and being removed therefrom by the treater.

Another important object of the present invention is to provide a water removal system for petroleum treaters wherein valve leakage and defects occurring therein, will be of no significance and have no adverse effects upon the overall operation of the siphoning system.

Another object of the present invention is to provide a water removal system for petroleum treaters operable upon the differential indensities of oil and water within the treater and having parts for automatically draining water from the bottom of one compartment of the treater when the proportion of water to oil in the said one compartment increases as a result of removal

thereof from the petroleum passing into the compartment.

A further object of the present invention is to provide a water drainage system as above set forth wherein the same principle of difference in densities is utilized to remove the water from a second compartment as the same flows thereinto from the aforementioned first compartment, operable to vary the level of water in one branch of a siphoning system joining the compartments, all to the end that upon any change in the proportion of oil to water in the second compartment, more or less water will be drained entirely from the system automatically and without operator attention.

A further object of the present invention is to provide diaphragm controlled stop valves, not only for the ultimate water outlet but for the discharge end of the oil, both dependent upon the head of liquid in the system and the changes thereof, to drain the water from the system at a constant rate, dependent upon the rate of flow of water into the system along with the petroleum products being treated.

All of the aforesaid principles of operation are set forth in the following specification and other objects will, therefore, become necessarily apparent, reference being had to the accompanying drawings, wherein:

Fig. 1 is a fragmentary, side elevational view of substantially the lower half of an oil treater having apparatus for siphoning water from the oil made in accordance with the present invention, parts being broken away to reveal details of construction.

Fig. 1*a* is a side elevational view of the uppermost half of the treater and water siphoning apparatus therefor, parts being broken away for clearness.

Fig. 1*b* is a side elevational view of the water drainage control normally coupled with parts shown in Fig. 1; and

Fig. 2 is a transverse, cross-sectional view taken on line II—II of Fig. 1 looking in the direction of the arrows.

In the drawings there is illustrated a treater for petroleum products having in part conventional elements and in part structure as set forth in my aforesaid co-pending application. The overall operation of the treater however, is varied through employment of an improved water draining system therefor. Accordingly, it is obvious that while a particular type of treater has been illustrated, such water siphoning means might well be adapted for use with treaters varying from that herein illustrated.

The treater per se has an elongated, upright tank 10 that is preferably cylindrical in cross-section and as will hereinafter appear, is connected in with all of the component parts thereof to present an entirely closed pressurized system.

Tank 10 may be mounted in any suitable manner upon a base 12 and is provided with a normally closed drain 14 at the bottom thereof. A rigid circular partition 16 is provided within the tank 10 intermediate its ends, presenting an upper compartment broadly designated by the numeral 18, and a separate lower compartment that is designated generally by the numeral 20.

A plurality of hay sections are optionally provided in each compartment 18 and 20 that includes circular perforated panels 22 for the compartment 20 and a pair of spaced apart parallel foraminous panels 24 within the compartment 18. A vertical partition 26 is provided in the compartment 18 extending entirely transversely thereacross in chord-like manner and terminating at its lowermost end in spaced relationship with respect to the uppermost face of the solid partition 16. The foraminous panels 24 accordingly are not fully circular and abut the proximal face of the vertical partition 26.

A vertical, tubular downcomer 28 within the tank 10 extends through all of the panels 22 and 24 as well as through the partition 16, the uppermost end of downcomer 28 being in spaced relationship with respect to the uppermost end of tank 10 above the uppermost panel 24 and the lowermost end of downcomer 28 terminating above the bottom of tank 10 below the lowermost panel 22.

A vertical pipe 30 on one face of the partition 26 opposite to the panels 24 extends at its uppermost end above a horizontal plane through the uppermost end of downcomer 28 and spaced below the top of tank 10. Pipe 30 at its lowermost end extends through the partition 26 just above the lowermost end of the latter and terminates in a diverter box 32 within the compartment 18 and on the same side of partition 26 as the panels 24.

A separator tank 34 on the uppermost end of the tank 10 is similar in construction to that disclosed in my aforesaid co-pending application and while the details of construction and operation thereof form no part of this invention, and need not be described, such separator has a mist extractor 36 therewithin, together with a condenser 38 for gas vapors. Separator 34 removes free gas vapors from the emulsion entering the separator 34 through inlet opening 40. Such gas vapors rise from the emulsion as the same enters the separator 34 while the emulsion falls by force of gravity and is directed downwardly from separator 34 by a line 42. Line 42 communicates at its lowermost end with a heat exchanger 44 from which the pressurized emulsion is again directed upwardly through a conduit 46 into the compartment 18 intermediate the uppermost and lowermost ends thereof and on that side of partition 26 having pipe 30 thereon.

The emulsion is free to rise within the compartment 18 on the last mentioned side of partition 26 and the same obviously overflows into the pipe 30 after the level thereof has reached such height. From pipe 30, the emulsion is directed into the compartment 18 immediately below a furnace, broadly designated by the numeral 48, disposed beneath the lowermost panel

24. Obviously, some water contained within the emulsion will descend in the compartment 18 as the same enters through conduit 46 and the level of such water within compartment 18, on that side of partition 26 having pipe 30, will normally be maintained adjacent the lowermost end of pipe 30 as will hereinafter appear. Furthermore, through use of the water draining system forming the subject matter hereof and about to be described, the level of water within compartment 18, on that side of partition 26 having furnace 46 therein, will be maintained immediately below the lowermost panel 24.

Consequently, emulsion entering and passing through the diverter 32 will immediately rise within the water in compartment 18 and a relatively long bath for the emulsion will result as the same passes over and impinges upon the heated walls of furnace 48. The emulsion will continue to rise within the compartment 18, while water removed therefrom will settle until the emulsion attains a level adjacent the uppermost end of downcomer 28 where the same will overflow and be directed into the compartment 20.

A tube 50 communicating with the compartment 20, slightly below the partition 16, drains the water-free petroleum products from the tank 10 and directs the same to the heat exchanger 44. From heat exchanger 44, the treated oil products are directed to stock tanks or other storage means through a pipe 52. It is clear that the relatively hot petroleum products entering heat exchanger 44 by way of tube 50 will be cooled within the heat exchanger 44 inasmuch as the cooler emulsion entering heat exchanger 44 by way of line 42 will absorb a substantial amount of the heat from the finished products. Consequently, the emulsion is pre-heated prior to entrance into separator 34 resulting in an immediate separation of free gas from the emulsion as the same passes through inlet 40.

The water siphoning or draining system forming the subject matter hereof includes, first, means for evacuating the water in compartment 18 and directing the same into the compartment 20. Such means includes a substantially U-shaped conduit having a short vertical branch 54 and a longer vertical branch 56. The lowermost end of the branch 54 terminates adjacent the uppermost face of partition 16 while the uppermost ends of branches 54 and 56, and the bight 58 of the U-shaped conduit, are disposed just below the uppermost panel 24 and within a horizontal plane spaced below a second horizontal plane through the uppermost end of the downcomer 28.

A short, vertical pipe 60 places the bight portion 58 into communication with the compartment 18 at the uppermost end of the latter. A second U-shaped conduit has a relatively long leg 62 within the compartment 20, a bight 64 extending through the tank 10 and a shorter, vertical leg 66 exteriorly of the tank 10. The lowermost end of the leg 62 is adjacent the lowermost end of branch 56 while the uppermost ends of the legs 62 and 66, as well as the bight 64, are above the panel 22 and spaced below the lowermost face of partition 16. The leg 66 may be coupled with any suitable means (not shown) for conveying water from the tank 10 to a suitable salt water disposal or other use as desired.

A shut-off valve 68, disposed preferably between bight 64 and leg 66, is provided with an automatic control, broadly designated by the numeral 70. Such control includes a housing 72 having a partitioning flexible diaphragm 74 therewithin. Housing 72 is placed into communication with branch 56 on one side of diaphragm 74 by an L-shaped conduit 76.

Conduit 76 is interposed between the partition 16 and the bight 64 for legs 62 and 66. A link 78 operably connects the valve 68 and the control assembly, there being suitable toggle mechanism not detailed, and of any common structure for causing opening of valve 68 as diaphragm 74 is caused to flex in a direction away from the conduit 76. Normally, with diaphragm 74 substantially horizontal and unflexed, valve 68 is held closed by means of a weight 80 connected within such toggle mechanism. A similar control, broadly designated by the numeral 82, is provided for a shut-off valve 84 interposed within the tube 50. Control 82 is likewise provided with a diaphragm 86 communicating with tube 50 by means of a short pipe extension 88 and a weight 90 holds valve 84 normally closed.

The line 42 is similarly provided with a shut-off valve 92 having an automatic control 94 connected within the line 42 in the same manner as control 82 is interposed in tube 50. Gas vapors rising from the emulsion as the same enters tank 10 by way of conduit 46, are free to pass upwardly into a tank 96 on the uppermost end of tank 10, there being a second tank 98 within tank 96 for receiving gas vapors rising above downcomer 28 and passing into tank 98 by means of an L-shaped pipe 100. Gas vapors from tank 10, also pass into condenser 38 by means of a conduit 102. Condensate is directed from condenser 38 and from the tank 96 by means of a line 104 that communicates with the compartment 20 of tank 10 immediately below the lowermost panel 22. Emulsion emanating from extractor 36 is returned to the separator 34 by means of a drain 106. A conduit 108 having a back pressure valve 110 and a safety relief valve 112 interposed therein, directs gas vapors from separator 34 to the tank 96.

Tank 96 has an outlet 114 for gas vapors that may have connection with furnace 48 if desired or communicate with other points of use or storage for the vapors emanating from tank 96.

It is seen therefore, that the entire system is closed and that equalization of pressure is provided for throughout. Such pressure equalization includes the uppermost ends of branches 54 and 56 where gas vapors are free to enter pipe 60 and create an equalization of pressure upon the level of liquid in both of branches 54 and 56 as the system is placed into automatic operation.

Obviously, the level of water within the branch 54 is directly dependent upon the combined head of oil and water within the compartment 18. With the distance between the uppermost end of downcomer 28 and the uppermost ends of branches 54 and 56 properly chosen, the aforesaid level of water within compartment 18 above furnace 48, will be maintained immediately below the lowermost panel 24. As long as such water in compartment 18 maintains such level, the level of water in branch 54 will be adjacent to the bight 58, but no flow of water will be present from branch 54 to branch 56. As the emulsion impinges upon the furnace 48 however, water will be removed therefrom and settle within the compartment 18, raising the water to a higher level approaching the lowermost panel 24 and even extending thereabove. Because of the differential in densities of the oil and the water in compartment 18, as soon as an increase of water in proportion to oil occurs in compartment 18, the level of water in branch 54 will rise and overflow into bight 58 and into the branch 56. Such overflow of water into branch 56 will continue until such time as the aforesaid predetermined level of water in tank 18 below the lowermost panel 24, is again reached.

Gas pressure above the uppermost liquid level adjacent the top of downcomer will not cause a raising of the water level in branch 54 because this same pressure is directed to branch 54 via pipe 60. As will hereinafter appear, said uppermost liquid level will be maintained substantially at a predetermined point with respect to downcomer 28. Consequently there will at no time be any appreciable variance of the overall volume of liquid in compartment 18 to affect the water level in branch 54.

As oil continues to flow into the compartment 20, by way of downcomer 28, it will flow therefrom through tube 50 under control of valve 84 and diaphragm 86. Since diaphragm 86 is sensitive only to the head of oil in downcomer 28 above diaphragm 86 combined with any head of oil in compartment 18 above the upper end of downcomer 28, valve 84 will be moved toward the open condition as the volume of liquid increases in compartment 18 and will be moved toward the closed position as the liquid level in compartment 18 drops.

Accordingly, as above explained with respect to the water level in branch 54, there will be a predetermined volume of liquid maintained in compartment 18 at all times, eliminating any effect on the water level in branch 56 that would otherwise be present if valve 84 were not provided to control the liquid level in compartment 18.

It is contemplated that the normal water level in compartment 20 be maintained between the lower end of downcomer 28 and the lower ends of branch 56 and leg 62. The head of oil and water in compartment 20, plus the head of oil in downcomer 28 above partition 16, together with the head of any oil above downcomer 28, will normally maintain the water level in branch 56 at a point above partition 16 when the water level in compartment 20 is at the aforesaid normal level.

With the proper closing of weight 80, as soon as the water in branch 56 rises above its normal level therein, the increased head on diaphragm 74, through conduit 76, will flex diaphragm 74 upwardly to open valve 68. Manifestly, as such level in branch 56 continues to rise, valve 68 will, as a result, be moved further toward the fully open position.

It is understood that such rising of water level in branch 56 is occasioned by a rise of the water level in compartment 20, which is in turn occasioned by flow of water from compartment 18 to compartment 20 via branches 54 and 56. As long as water flows into compartment 20 at a constant rate, valve 68 will remain open to drain water from compartment 20 at the same rate by way of leg 62, bight 64 and leg 66. As soon as the rate of flow of water from compartment 18 to compartment 20 decreases, the water level in compartment 20 will fall, decreasing the proportion of water to oil in compartment 20. This results in a lowering of the water level in branch 56, a decrease in head pressure on diaphragm 74, a progressive movement of valve 68 to a closed position, and a decrease in the rate of flow of water from leg 66.

As above pointed out, gas pressure on the liquid level in compartment 18 will not cause a drainage of all water from compartment 18 because such pressure is equalized on the water level in branch 54. By the same token, such pressure acting through downcomer 28 will not raise the level of water in branch 56 with a consequent drainage of all water from compartment 20 since pipe 60 also communicates with branch 56 and the gas pressure is equalized on the water level in branch 56.

Obviously, diaphragm 86 should be sensitive to slight changes in the liquid level in compartment 18 so that such changes will not effect diaphragm 70. In other words, an increased head because of rising of the liquid level above downcomer 28, would also cause a slight raising of the water level in branch 56. However, valve 84 will respond immediately to lower the level in compartment 18 to normalcy, preventing a water level rise in branch 56.

Manifestly, diaphragm 74 is directly sensitive to the head changes in branch 56 which head is in addition to any liquid heads acting on diaphragm 86. Since diaphragm 86 is only remotely effected by head changes in branch 56, i. e. that above the level of diaphragm 86, the latter will not respond upon a mere rise or lowering of the water level in branch 56.

It is seen that through such system, a water meter 116 of any conventional character, may be interposed in bight 64 between valve 68 and tank 10 to accurately measure the amount of water that is contained in the emulsion initially pumped from a well. It is further apparent, that leakage of valve 68 is immaterial since such leakage will be measured by the meter 16, and further since leg 62 and branch 64 are always filled with water. Unless the leakage of valve 68 is extreme, such leakage will not be greater than the amount of water contained in the emulsion as the same is pumped into the inlet 40.

It is seen further that the rate of outward flow of the clean oil through tube 50, is controlled by the valve 84 and its control means 82.

The level of water in the compartment 20 will always be below the tube 50 and, therefore, only clean oil will flow from the treater to heat exchanger 44 by way of tube 50. By the same token, the level of water in compartment 20 will always be above the lowermost end of branch 56 and leg 62, whereby only water flows through leg 62, bight 64 and leg 66. The entire system properly pre-set and adjusted with respect to the various valve controls, will operate automatically for an indefinite period of time and the various bodies of water and oil within the tank 10, will always be maintained at a substantially constant level. Water will flow from the compartment 18 to the compartment 20 by slowly dumping through the bight 58 immediately upon any slight rise in the water level within compartment 18 below the lowermost panel 24. By the same token, such dumped water passing downwardly into the branch 56 and thence into the compartment 20, will immediately cause a rise of the water level in branch 56 with a consequent immediate operation of control 70 and opening of valve 68. As the flow of water from branch 54 to branch 56 increases in volume, valve 68 will be progressively opened by the control 70 until the full capacity of leg 66 is approached. Conversely, slight decreases in the volume of water flow from branch 54 to branch 56 will cause a progressive closing of the valve 68 and consequent decrease in the volume of water flow through leg 66.

Accordingly, there has been provided a water siphoning or drainage system for oil treaters that is completely balanced and operable to maintain a balance or equilibrium during continuous operation irrespective of drastic variances in the water content of the emulsion as the same is pumped from a well or number of wells.

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

1. Siphoning apparatus for separating oil and water comprising an upright tank having a horizontal partition, presenting an upper and a lower compartment, an inlet for oil and water to be separated communicating with the upper compartment, and an oil outlet communicating with the lower compartment; a vertical tube in the tank, extending through said partition and disposed to receive oil from the upper compartment for gravitation into the lower compartment; a first vertical pipe in the upper compartment having a lowermost, open end; a second vertical pipe extending through said partition and connected with the first vertical pipe at the uppermost end of the second pipe for draining water from the upper compartment to the lower compartment; a third vertical pipe in the lower compartment having a lowermost open end and extending through the tank at the uppermost end of the third pipe to a point of discharge exteriorly of the tank; a valve in said third vertical pipe; and pressure responsive means in said second vertical pipe and coupled with said valve for controlling the latter to maintain a predetermined level of water in the compartments.

2. Siphoning apparatus as set forth in claim 1, wherein the lowermost end of said tube is disposed above the lowermost ends of the second and third pipes.

3. Siphoning apparatus as set forth in claim 1, wherein the point of connection between the first and the second vertical pipes is disposed below the uppermost end of said tube.

4. Siphoning apparatus as set forth in claim 1, wherein said oil outlet is provided with a conduit having a valve provided with pressure responsive means coupled therewith for controlling the level of oil in the compartments.

ELMER R. WILLIAMS.

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