

June 2, 1964

J. P. WALKER ETAL
METHODS AND MEANS FOR TREATING AND AUTOMATICALLY
TRANSFERRING CUSTODY OF PETROLEUM

3,135,113

Filed July 13, 1959

6 Sheets-Sheet 1

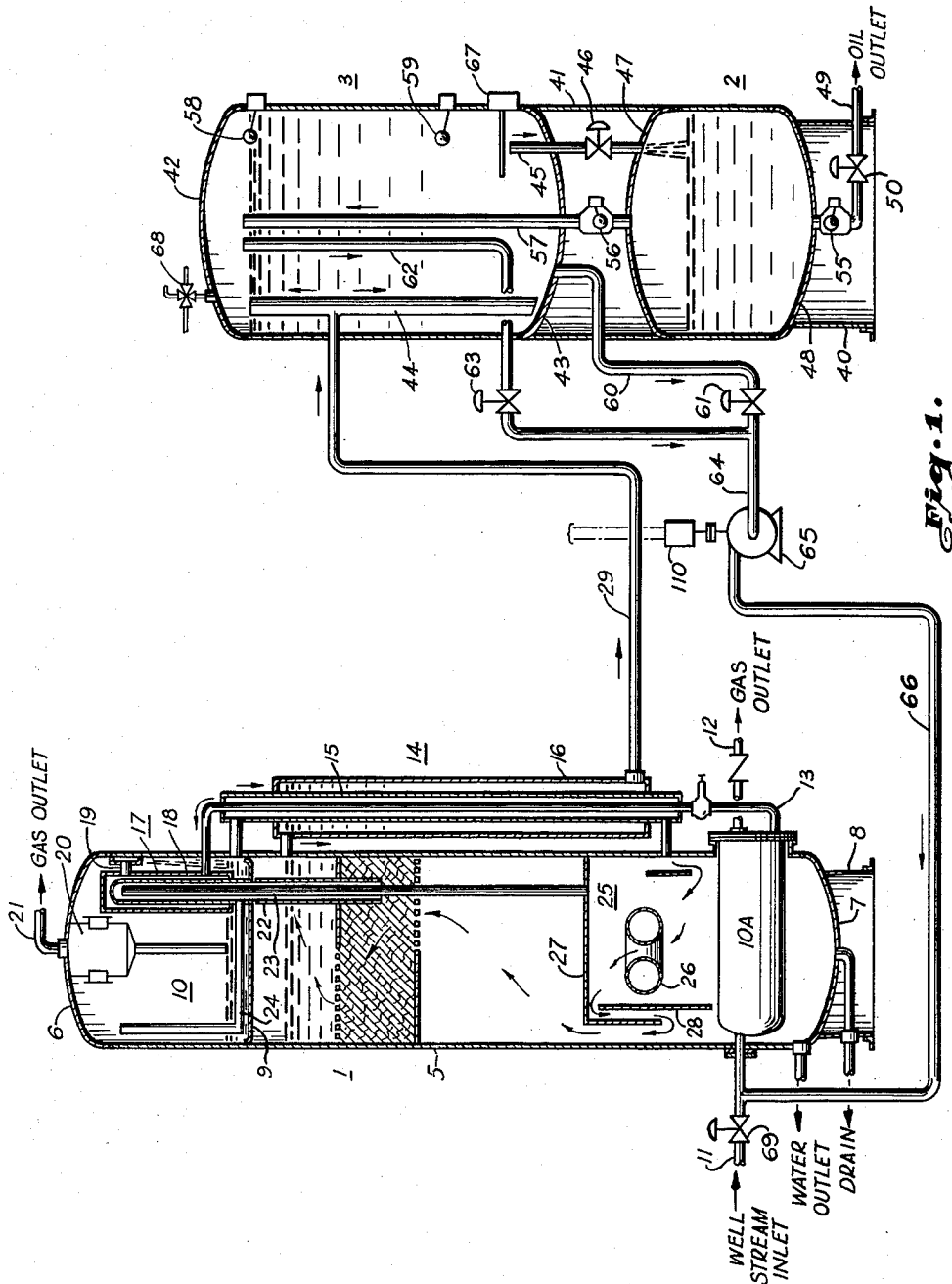


Fig. 1.

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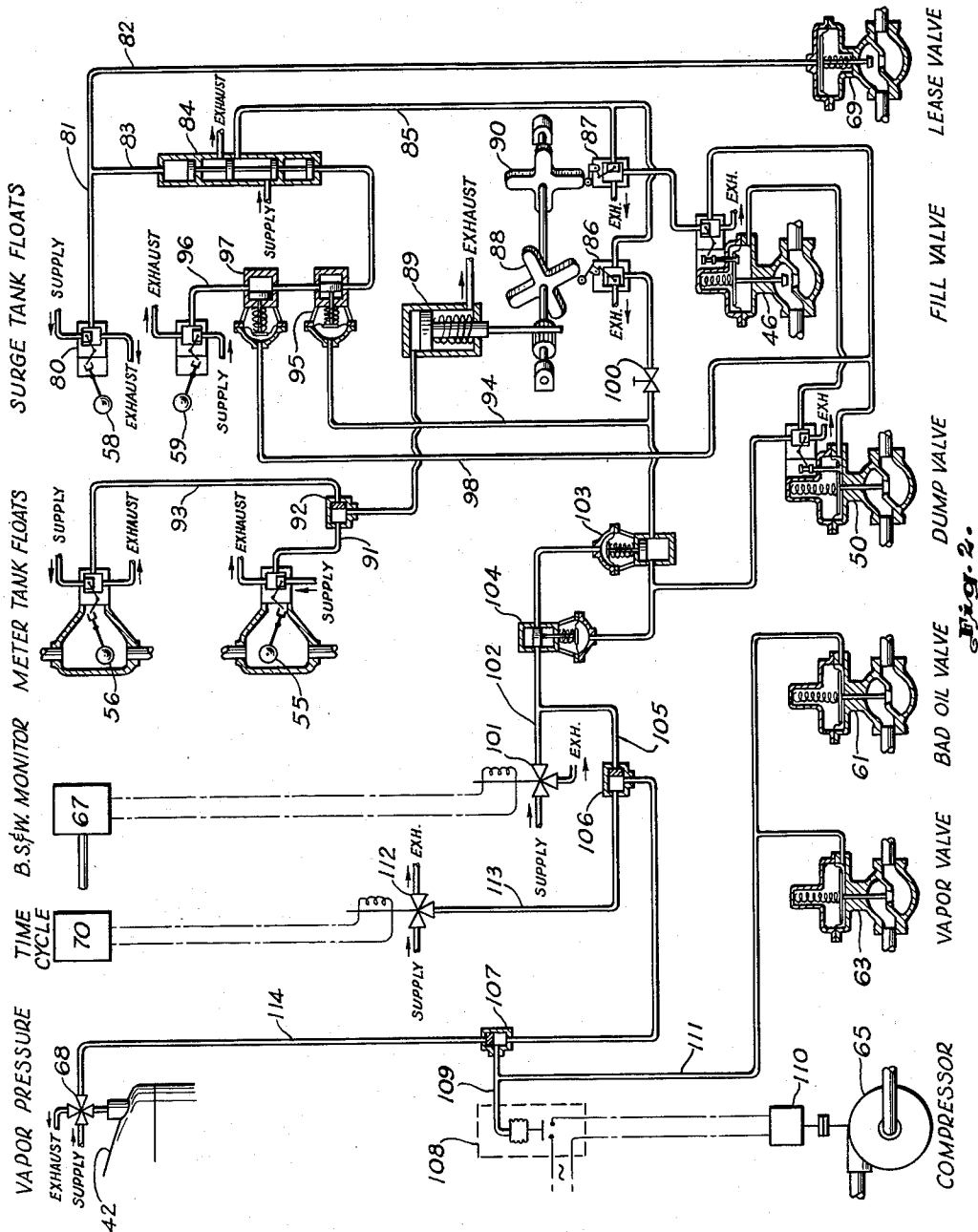


Fig. 2.

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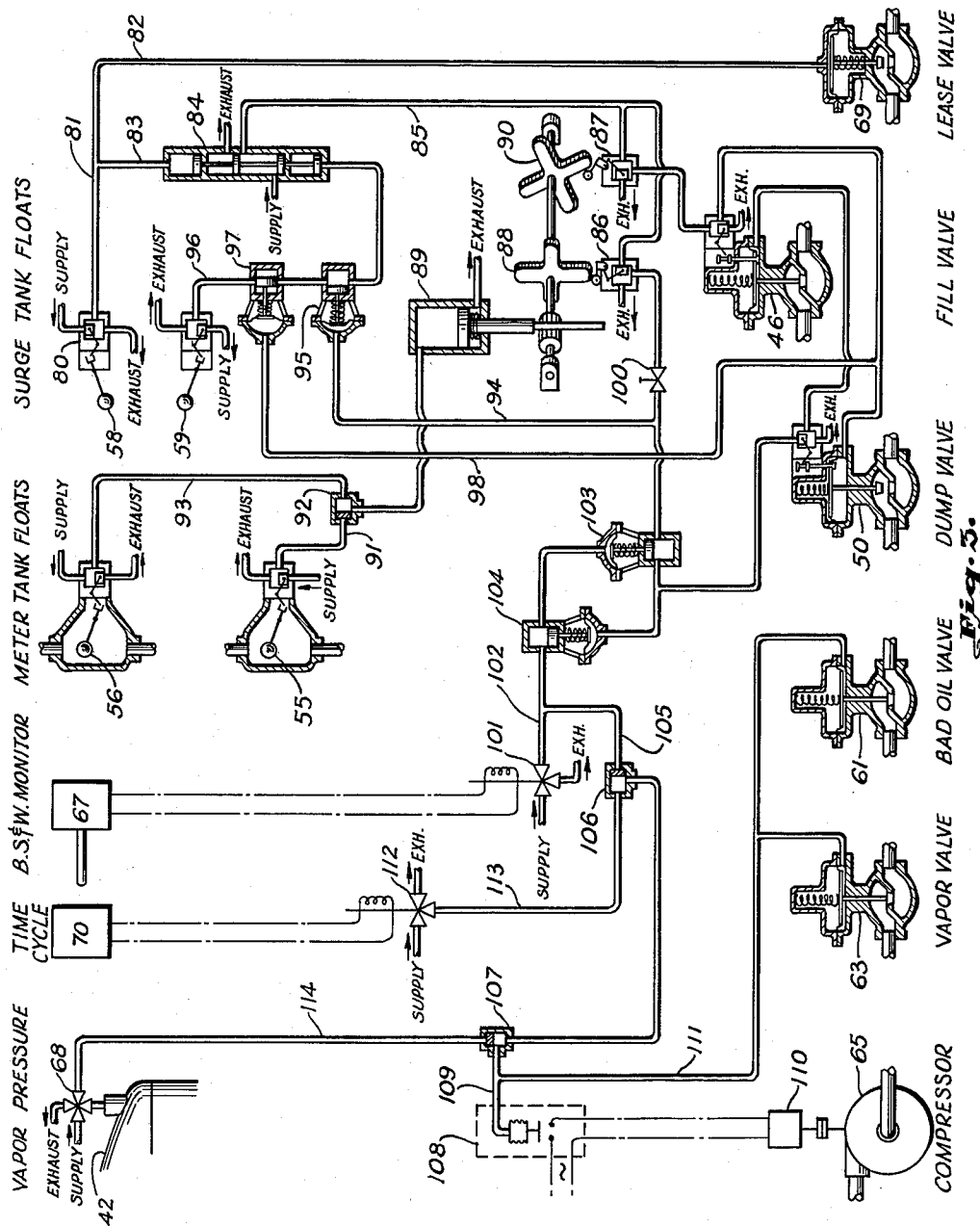
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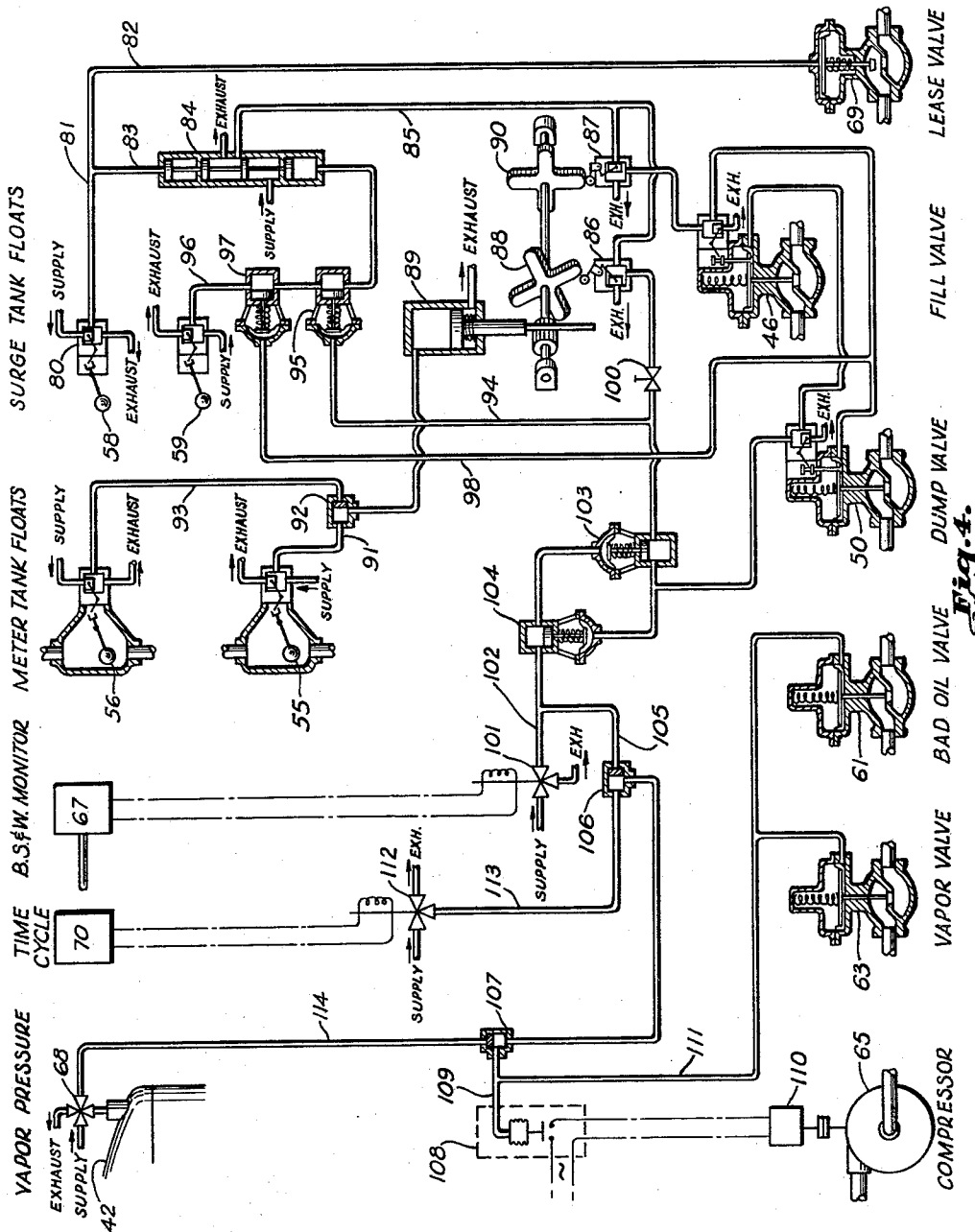
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6 Sheets-Sheet 4



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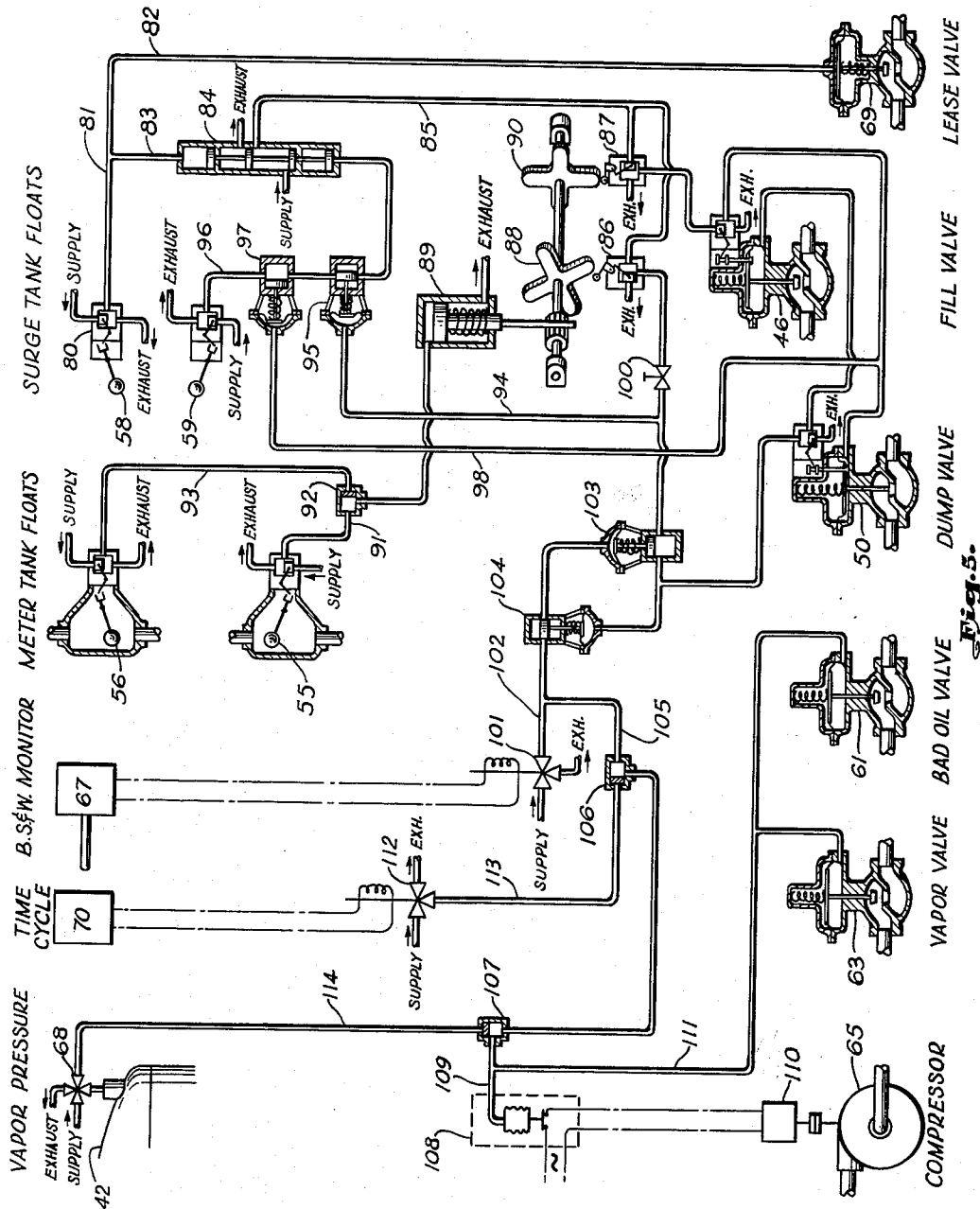
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6 Sheets-Sheet 5



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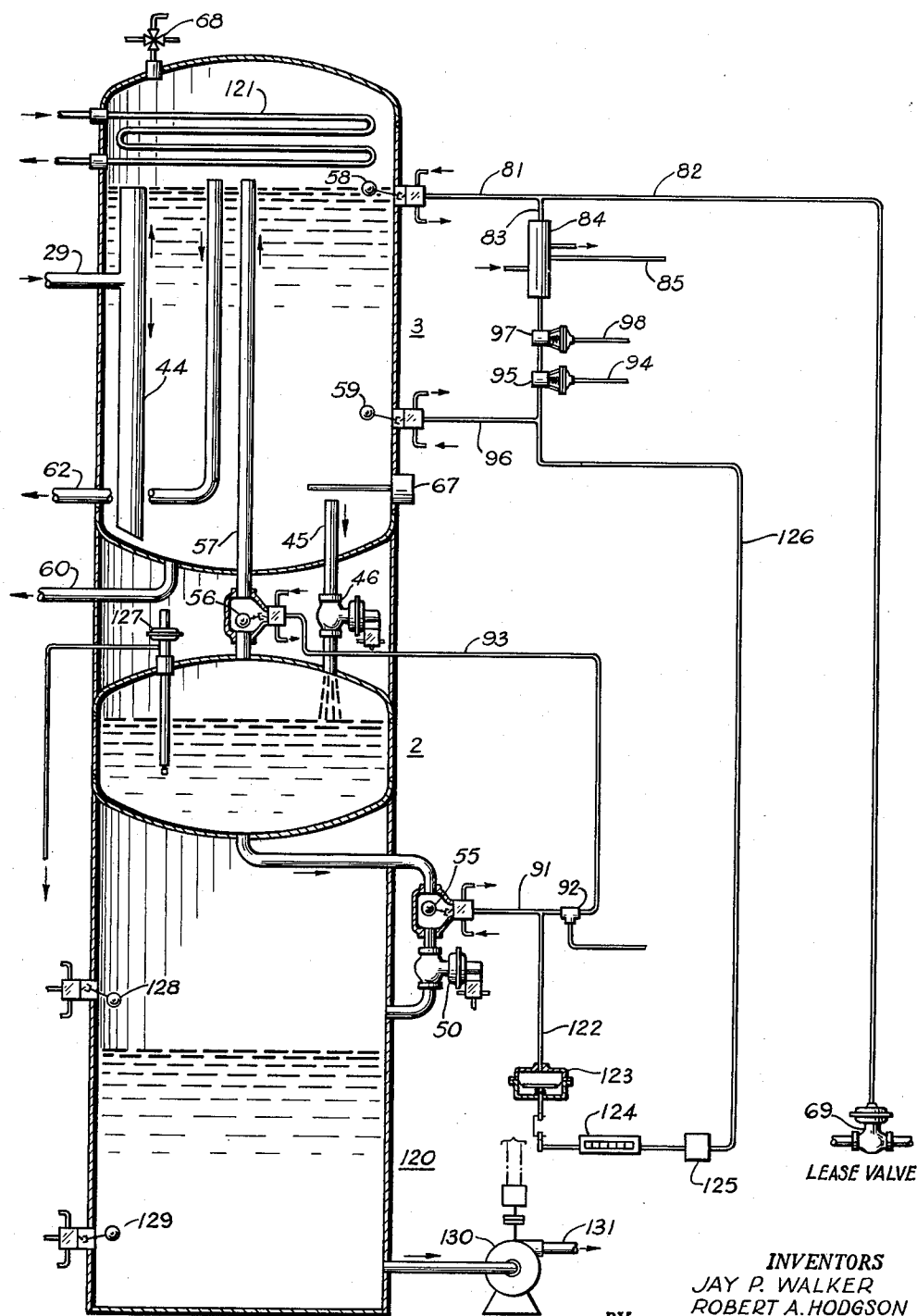


Fig. 6.

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3,135,113

METHODS AND MEANS FOR TREATING AND AUTOMATICALLY TRANSFERRING CUSTODY OF PETROLEUM

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Filed July 13, 1959, Ser. No. 826,556

10 Claims. (Cl. 73-200)

The present invention relates to treating crude petroleum and transferring the oil produced to a point of sale. More specifically, the invention relates to a combination of treating apparatus for crude petroleum and means for measuring the clean oil produced and conserving liquefiable hydrocarbons evolved as vapors and insuring the clean oil produced is of desired quality.

It has been customary to treat crude petroleum on a lease and store the clean oil produced by the process in run tanks. Periodically, the purchaser of the oil tests the percent basic sediment and water in the oil. If the oil is of merchantable quality, having only a basic sediment and water percent in the order of .1 to .5, the tank is measured and emptied into a pipe line controlled by the purchaser. Oil has been produced, sold, and its custody transferred, in this manner for many years.

Several systems have been adopted to make some, or all, of the conventional procedures, presently in use, automatic to reduce the manpower required, maintain the quality standards of the oil transferred, conserve the quantity and gravity of the liquid oil transferred, and increase the accuracy of the measurement of the oil transferred. The present invention is directed to accomplishing all of these results with one unitized combination of apparatus.

A primary object of the present invention is to treat crude petroleum and measure the clean oil produced while recovering evolved vapors from the clean oil.

Another object is to prevent the measuring of treated oil by recirculating the oil through the treating process if the treated oil to be metered falls below a specified quality.

Another object is to maintain the bottom of a storage vessel for clean oil free of bottom sediment and water.

Another object is to shut in well production to the treating process if treated oil is not being metered and transferred at least as fast as the treated oil is produced.

The present invention contemplates a treater, a storage-surge vessel and meter combination. The relatively hot, treated, oil product of the treater weathers, or evolves, vapors above its surface, in the storage-surge vessel, the vapors containing hydrocarbons which can be liquefied at storable conditions. These vapors are reduced in temperature in order that the liquefiable hydrocarbons may be recovered and returned to the liquid metered.

The present invention further contemplates the evolved vapors above the surface of the relatively hot treated oil in the storage-surge vessel being withdrawn for liquefaction when the pressure of the vapors reaches a predetermined value.

The invention further contemplates the vapors being reduced in temperature by heat exchange with a cooler fluid.

The present invention contemplates a treater, storage-surge vessel and meter combination in which hydrocarbon vapors are evolved in the storage-surge vessel above the treated oil and the cooler portions of the oil from the storage-surge vessel are used as a liquid piston in a compressor, or pump, to absorb, condense and compress the vapors; the mixture being returned to the treater to recover the liquefiable components of the vapors.

The invention further contemplates the vapors being

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reduced in temperature by both a heat exchanger and a liquid, cooler than the vapors, which liquid is used as a piston to absorb, condense and compress the vapors.

The invention also contemplates a treater-storage-vessel-meter combination in which a pump is used to continually draw off treated oil from the bottom of the storage oil and recirculate the oil through the treater. The bottom portion of the oil in the storage is generally cool enough to be used as an efficient liquid piston in a compressor to absorb, condense and compress the vapors evolved above the treated oil in the storage-surge vessel when the pressure of the evolved vapors reaches a predetermined value.

The invention also contemplates a treater-storage-vessel-meter combination in which the bottom sediment and water in the treated oil in storage is detected and used to control recirculation of the treated oil from the storage vessel to the treater when the percent of bottom sediment and water in the treated oil reaches a predetermined value.

The invention further contemplates means for detecting when the treated oil in the storage tank increases to a predetermined maximum amount and provision to interrupt the flow of production from the well to the treater until the storage tank quantity reduces below the maximum amount.

Other objects, advantages and features of this invention will become apparent to one skilled in the art upon consideration of the written specification, appended claims, and attached drawings wherein;

FIG. 1 is a diagrammatic illustration of a combination of a treater, surge tank and metering vessel as a part of the system in which the invention is embodied;

FIG. 2 is a diagrammatic illustration of the control system for the combination of FIG. 1 as positioned to fill the meter tank;

FIG. 3 is a diagrammatic illustration of the control system of FIG. 2 as positioned to empty the meter tank;

FIG. 4 is a diagrammatic illustration of the control system as positioned to interrupt the metering when the level in the surge tank is at a predetermined minimum;

FIG. 5 is a diagrammatic illustration of the control system as positioned to interrupt the metering when the quality of the oil in the surge tank is not merchantable; and

FIG. 6 is a diagrammatic illustration of another form of surge tank and metering vessel with a pipe line surge tank.

Referring to FIG. 1, there is illustrated a combination of oil well emulsion treater 1, metering tank 2 and surge tank 3 which, together with its control system embodies the present invention. The broad function of the combination is to receive oil and emulsion into treater 1 and continually produce a merchantable product into surge tank 3 which may then be metered to a purchaser. Properly controlled, this combination of treater, surge tank, metering tank and control system is a novel form of lease automatic custody transfer unit.

Treater 1 is illustrated in vertical tank form. However, this form is not to be taken as a limitation for a treater to function in this combination. The treater could be horizontal, or the process could be carried out in a plurality of vessels. The specific form of treater illustrated forms the subject matter of Walker et al. SN 806,000, filed April 13, 1959, now Patent 3,043,072.

Treater 1 is basically identified by elongated, cylindrical tank 5, extending vertically, its upper end closed by a domed head 6 and its lower end closed by a dished bottom 7. The tank is set on a suitable support 8 and has an internal, transverse, horizontal partition 9 near its upper end. This transverse partition 9 forms, with head 6, a gas separation chamber 10.

Also internal of the vessel-tank 5 and near its bottom

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is mounted a relatively small, separate, removable, shell 10A. Actually, shell 10A characterizes a small, horizontal, separator into which a well stream to be processed is introduced through inlet 11. The gaseous phase of the well stream introduced into separator 10A is removed through conduit 12. The liquid phase is removed through conduit 13. Conduit 13 is valved within separator 10A by a float on the liquid level therein.

Separator 10A is mounted so that it may be removed from the shell 5 as a unit. This arrangement facilitates cleaning and servicing the separator and replacing it with one having a different pressure capacity. Liquid conduit 13 is extended upward, from separator 10A, through heat exchanger 14.

Although not illustrated in FIG. 1, separator 10A is normally expected to be part of a complete system for staging the pressure reduction of the well stream from the well head to the treating process within tank 5. Several pressure ranges could be recited to illustrate the relation between the structures. However, these ranges would be relative, depending upon subjective characteristics of the well stream and the equipment available to process the well stream. It must also be understood that treater 1 may have a much simpler pressure system than illustrated. The treater 1, as far as the present combination is concerned, is only one of many possible forms of a source of merchantable oil to be transmitted to surge tank 3 for metering by meter 2.

To continue tracing the flow of well fluids through the treater, heat exchanger 14 is seen to be composed of essentially, three tubes telescoped within each other concentrically. Liquid conduit 13 is arranged as the inner tube. Arranged concentrically about conduit 13 is conduit 15 which removes liquid from the separation chamber 10 downwardly through heat exchanger 14. The liquids removed from separator 10 by conduit 15, are taken to a heat treating process in the lower part of tank 1 and just above the location of separator 10A. Arranged concentrically about both conduit 13 and conduit 15 is conduit 16. Downcomer conduit 16 removes the clean, merchantable oil produced by the heat treating process within tank 5 and heat exchanges it with the well stream of conduit 15 to conserve heat introduced into the heat treating process.

Conduit 13 is extended out of the top of the other conduits 15 and 16 of heat exchanger 14 to connect with heat exchanger 17. Heat exchanger 17 is made up of three concentric tubes. Tube 18 constitutes the outer shell of heat exchanger 17 and receives conduit 13 at its lower end. Conduit 19 is connected to the upper end of tube 18 and to a diverter plate mounted on the inner wall of chamber 10. This particular arrangement of tube 18, as the external shell heat exchanger 17, provides heat exchange between the incoming well stream and all the gaseous products developed in the subsequent heat-treating of this same well stream within shell 1. The liquids of conduit 13 are thus passed up through heat exchanger 17 and diverted upon the walls of the upper part of the shell of the tank 5 in chamber 10. A portion of the gas of the well stream is separated from the well stream by this action and carried out of the tank 1 through a mist extractor structure 20 and outlet conductor 21.

Within external tube 18 a tube 22 is concentrically telescoped within the third tube in order that all gas evolved in the treatment of the liquid well stream will be brought into indirect contact with the well liquids before these liquids are heat-treated. Specifically, tube 22 extends downwardly from heat exchanger 17, through transverse partition 9, to a point well below the surface of the clean oil produced by the process.

Telescoped up inside of tube 22 is another tube 23 which brings the gases evolved directly from heat treating up into exchanger 17. Holes are provided in the wall of tube 22, just below partition 9, to bring gaseous vapors

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developed above the surface of the clean oil up into the separation chamber 10.

Just below the heat exchanger 17, connected to tube conduit 22, is a conduit 24. Conduit 24 takes all of the uncondensed vapor, from both conduits 22 and 23, into heat exchange with the well stream liquids which have collected on the bottom of chamber 10. After this heat exchange, the gasses which still are not condensed are ejected into the gaseous phase of chamber 10, passing out mist extractor 20 and gas conduit 21.

Attention is now redirected to the well stream liquids collected on the bottom of chamber 10 and which flow down conduit 15. The liquids in conduit 15 are introduced into a heating zone 25 in the lower portion of vessel 1, directly above separator 10A. A firetube 26 is the source of heat for zone 25.

Heating zone 25 is formed about firetube 26 by a hood 27, baffle 28 and the sides of tank 5. Hood 27 has a depending skirt, or lip, closely positioned to vertical baffle 28. Baffle 28 is extended well below firetube 26 in order to form the heating zone 25 about firetube 26 which will contain only emulsified oil and water to be directly heated by firetube 26. The emulsion is broken by the heat in zone 25 and separated into oil and water. A coalescing section above the heating zone completes the separation of the oil and water. The function of these structural elements within treater 1, to produce a clean oil product of low water content, is adequately explained in co-pending Walker et al. SN 806,000. This clean oil product is withdrawn from shell 5 into heat exchanger 14 and conducted to surge chamber 3 by conduit 29.

METERING TANK 2-SURGE TANK 3

Surge tank 3 is an intermediate depository of the clean oil product of treater 1, between the producer and the purchaser to whom the oil is metered. This intermediate depository, represented by surge tank 3, provides several salient features of the inventive combination herein disclosed.

Both surge tank 3 and metering tank 2 are illustrated as a unit. Metering tank 2 is mounted beneath surge tank 3 so that oil to be metered may flow from tank 3 into tank 2 by gravity. A base is illustrated at 40 for direct support of metering tank 2. Intermediate support 41 is illustrated between metering tank 2 and surge tank 3.

Surge tank 3 is shown in the form of a vertically elongated tank having dished head 42 and dished bottom 43. Conduit 29 enters the side of tank 3 and the clean oil product from treater 1 is flowed into a vertically elongated pipe extension 44. Oil is withdrawn from tank 3, for metering, through pipe 45. Fill valve 46, in pipe 45, is opened to begin the filling operation of metering tank 2, connected to the lower end of pipe 45.

Metering tank 2 is illustrated as the same general type of vertically elongated tank as is surge tank 3, having dished head 47 and dished bottom 48. Oil flows into meter tank 2 through pipe 45 and is delivered to a point of sale by conduit 49. Dump valve 50 controls the delivery of metered oil by conduit 49. It can be appreciated that the measured volume of tank 2, between dump valve 50 and fill valve 46 constitutes the unit which with clean oil is metered and delivered from the well to a point of sale.

Part of the invention lies in the system controlling fill valve 46 and dump valve 50. Some of the control impulses for these valves are generated by lower float 55 and upper float 56. Lower float 55 is located in a chamber-enlargement of conduit 49. Upper float 56 is located in the chamber-enlargement of conduit 57. Conduit 57 extends from dished head 47, up through dished bottom 43 of surge tank 3, to the vapor space beneath the dished head 42.

Other impulses of the control system in which the invention is embodied are generated by top level float 58 and bottom level float 59 in surge tank 3. The level of

clean oil product in surge tank 3 is normally controlled between the levels established by floats 58 and 59.

A bad-oil drawoff conduit 60 communicates with the lower strata of liquids in surge tank 3, through dished bottom 43. Bad-oil valve 61 is established in conduit 60 to control the amount of non-merchantable oil withdrawn from surge tank 3 through conduit 60. A vapor drawoff conduit 62 is also extended through the side of surge tank 3 to communicate with the vapor space below dished head 42. Vapor valve 63 is established in conduit 62 to control the withdrawal of vapor from the top of tank 3 through conduit 62.

Both conduits 60 and 62 are illustrated as branches of conduit 64. Conduit 64 removes both this liquid and vapor to compressor 65 which utilizes the liquid as a piston to compress, condense and absorb the vapor. The liquid and compressed vapor product of compressor 65 is delivered to conduit 66 for introduction into conduit 11 and recirculation through the treating system.

A detector 67 is mounted on the side of tank 3, near its bottom. Detector 67 has a primary element, or probe, inserted into the liquid contents of tank 3 so the water content of the oil may be sensed and an electric signal established in accordance with this so-called water cut. The plan is for the bottom sediment and water level to raise to probe level and control action to be taken on the system.

A pressure regulator 68 is mounted on the head 42 of tank 3. Regulator 68 responds as a primary sensing element to the vapor pressure in the top of tank 3 so a fluid pressure may be established in accordance with the vapor pressure. The plan is for this vapor pressure to increase to a value which will establish a control action in the system with the fluid pressure.

In general, the control system in which the invention is embodied, has control actions established on it with surge tank floats 58 and 59, meter tank floats 55 and 56, bottom sediment and water monitor 67, pressure regulator 68 and time-cycle controller 70. Time-cycle controller 70 is not illustrated in FIG. 1. The control system then regulates fill and dump valves 46 and 50, lease valve 69, bad-oil valve 61, vapor valve 63 and motor-compressor 65 to carry out objectives of the invention.

NORMAL METERING—FIG. 1

It is contemplated that, normally, the well stream will be supplied to treater 1 and processed into a clean oil product which will be acceptable for sale on the market. This merchantable oil will be produced from treater 1 into surge tank 3. The clean oil will then be withdrawn from surge tank 3 into metering tank 2 to form a series of increments which are integrated as the total volume of oil passed to a consumer. It is intended that the increments be withdrawn at a rate which will keep the level of oil in surge tank 3 between floats 58 and 59.

Lease valve 69 will be open, and clean oil will flow into surge tank 3 through conduit 29. Fill valve 46 will then be opened, while dump valve 50 is kept closed, to fill meter tank 2 until float 56 is actuated to close fill valve 46 and open dump valve 50. The fall of float 55 will indicate meter tank 2 has been emptied and valve 50 will close and fill valve 46 will open. The number of meter tank 2 dumps will be integrated by a simple counting mechanism to give the total amount of clean oil delivered to a consumer in sale.

DEPARTURE FROM NORMAL METERING AND OPERATION

The many variables of the treating process may result in an increase in the water cut of the clean oil delivered to surge tank 3. The oil becomes non-merchantable at a certain percentage of water content. Surge tank 3 then becomes a convenient means of determining this departure from conditions predetermined as normal. The normal

metering will then be interrupted for the period necessary to return the oil to acceptable standards.

The level of oil in surge tank 3 may lower to float 59 because of some slowing, or interruption, of the flow through conduit 29. Tank 3 again becomes a convenient means of determining this departure from conditions predetermined as normal. The normal metering will then be interrupted for the period necessary to return the level to the top float 58.

The level of oil in surge tank 3 may rise to upper float 58 because of high production output of treater 1 into tank 3. The lease production may then be shut in until the metering function lowers the level in tank 3 below float 58.

The vapor pressure in the top of tank 3, beneath head 42, may increase to a value approaching that maintained on the treater 1. This will threaten to stop the flow through conduit 29, from treater 1. Pressure regulator 68 will monitor this vapor pressure and start the control action which will draw off vapor and oil from the bottom of tank 3 to return the pressure to predetermined limits. At the same time, the liquefiable components of the vapor are conserved, returned to the oil of tank 3, to conserve both the gravity and quantity of the oil to be metered. It is not to be overlooked that the heat exchange between atmosphere and head 42 can also be depended upon to condense vapors on the top of the oil in the tank 3, returning the condensate to the oil to maintain its quantity and gravity.

Time-cycle controller 70, not shown in FIG. 1, may also be used to periodically draw vapors and oil from the bottom of tank 3 into treater 1. In this re-cycling there is the insurance against the build-up of bottom sediment and water in the bottom of tank 3 under predetermined conditions. Should these conditions be exceeded, the monitor 67 or regulator 68 will keep the compressor going to keep the vapor pressure and bottom sediment and water of tank 3 under control.

It can now be appreciated that surge tank 3, with treater 1 and metering tank 2 performs several general and specific functions to insure that merchantable oil is delivered to a consumer from the well at a rate compatible with the operation of the treater 1 and metering system including tank 2.

THE CONTROL SYSTEM

In FIG. 1 only the devices responsive to variables, and the valves controlled by the impulses established by the devices, are illustrated. This enables the overall combination of treater 1, surge tank 3 and meter 2 to be more clearly comprehended. FIG. 2 is established to show the details of the control system actuated by the variables to control the valves and compressor to carry out the objects of the invention.

FILLING OF METER TANK 2

It must be clearly understood that the elements of the control system as illustrated in FIG. 2 are shown in the positions they have following the level of oil to be metered in surge tank 3 having reached float 58, actuated the float 58, established a fluid control pressure and thereby closed lease valve 69 and supplied fluid pressure power to open fill valve 46. The positions of the elements are shown just after the level in tank 3 has lowered by reason of draw-off into tank 2 to cause float 58 to lower enough to permit lease valve 69 to open.

Float 58 is illustrated diagrammatically as actuating a three-way valve 80. Valve 80 is representative of all similar valves illustrated throughout the drawings. Valve 80 is shown as supplied a fluid pressure which is established in conduit 81 when float 58 is raised by the level of treated oil in surge tank 3. The fluid pressure in conduit 81 is also established in conduit 82 and imposed upon the top of spring-opening lease valve 69. A valve suitable for the service performed by valve 80, and all simi-

lar valves in the disclosure, is disclosed in the patent to Swatsworth 2,860,660.

Pipe 83 is also connected to pipe 81 as a branch and is the means by which the fluid pressure generated by float 58 is used to shift piston-operated valve 84. Valve 84 has its own fluid pressure supply which is applied to pipe 85 when the fluid pressure of pipe 83 is applied to valve 84. In FIG. 1, pipes 81, 82 and 83 are at atmospheric pressure, valve 80 having been actuated by float 53 to connect pipe 81 to atmosphere.

Pipe 85 is branched to simultaneously supply fill pilot valve 86 and dump pilot valve 87. Both valve 86 and valve 87 are three-way valves, similar to valve 80, and mechanically actuated between their alternate positions by cams. As illustrated in FIG. 2, fill pilot valve 86 establishes the fluid pressure of pipe 85 on fill valve 46 to open it. The fact that the output of valve 86 interlocks with control signals developed by float 59, detector 67 and the position of dump valve 50 is presently incidental to the fact that fill valve 46 is actuated to begin filling meter tank 2 with clean merchantable oil from surge tank 3.

As heretofore indicated, FIG. 2 illustrates the control system at that point in its cycle of operation at which pilot valve 86 passes the fluid pressure of pipe 85 to open valve 46. Pilot valve 86 was positioned for this function by cam 88. Cam 88 was positioned through gear-linkage with piston 89. Piston 89 is spring-loaded to return to the position illustrated in FIG. 2 and moved to its alternate position when a fluid pressure impulse is applied to it. The gearing between piston 89 and the shaft of cam 88 and the cam 90 is of the ratchet type whereby each fluid pressure impulse which moves piston 89 advances the cams in one direction only. The cams are cut and spaced on their shaft so they will alternately open and close valves 86 and 87 as they are advanced with each fluid pressure impulse.

In FIG. 2, float 55 is assumed to have signaled the completion of dumping from meter tank 2 by establishing a fluid pressure impulse in conduit 91. The fluid pressure impulse in pipe 91 has been applied through double-check valve 92 to position piston 89 so cam 88 will open valve 86 and cam 90 will close valve 87. As float 55 is raised by liquid filling meter tank 3, it actuates its three-way pilot valve and reduces the pressure in pipe 91 to atmosphere, no change takes place in the position of double-check valve 92, piston 89 or cams 88 and 90. This, then, is the portion of the cycle FIG. 2 represents. Meter tank 2 is filling, no impulse is applied to piston 89, and the next normal sequence will be the raising of float 56 to establish a fluid pressure in pipe 93. The fluid pressure established in pipe 93 will then shift double-check valve 92 to its alternate position, actuate piston 89 to actuate cams 88 and 90 and close fill pilot valve 86 and open dump pilot valve 87.

DUMPING OF METER TANK 2

The actuation of valve 46 and valve 50, alternately, continues without interruption as long as the level of merchantable oil in surge tank 3 remains between the predetermined limits established by the position of floats 58 and 59. FIG. 3 shows the alternate position of pilot valves 86 and 87. The fluid pressure impulse of pipe 85 is applied to the underside of the diaphragm of valve 50 to open valve 50. Note may now be made that the valves 50 and 56 are interlocked with each other by having their opening impulses routed through a three-way valve mounted on each valve to insure that when one valve is open the other is closed.

The raising of float 56, as shown in FIG. 3 starts the dumping function of the cycle. The depression of spring-loaded piston 89 is indicated, by the fluid pressure output of the three-way valve actuated by float 56. The piston will return to its up position when float 56 lowers as the

dumping proceeds, leaving pilot valves 86 and 87 as shown.

Dump pilot valve 87 now passes the fluid pressure of pipe 85 to the underside of dump valve 50. With dump valve 50 open, meter tank 3 empties to the consumer through conduit 49. At the time the output of pilot valve 87 is applied to valve 50, the output is also applied to blocking valve 97 by means of pipe 98.

Although the blocking valve 95 no longer prevents an impulse from float 59 being applied to shuttle valve 84, blocking valve 97 now takes over this function during the dumping period. If float 59 signals the surge tank level is low, it will not effect the filling-dumping function of the control system until both pipes 98 and 94 are at atmospheric pressure.

It is best if a low-supply signal from float 59 be applied to interrupt the metering function after the dumping, and before filling, of meter tank 3. Then oil will not be left standing in the tank 2 to deposit paraffin, etc. on the tank 2 walls.

LOW LEVEL IN SURGE TANK 3

FIG. 4 is used to illustrate precisely what happens in the system when the level of measurable oil in tank 3 is so low as to necessitate shutdown of the metering. Both floats 55 and 56 are down. Float 55 calls for fill pilot valve 86 to pass the pressure of pipe 85 to fill valve 46 to open it. If this valve 86 pressure were passed immediately blocking valve 95 would take over the job of preventing the pressure of pipe 96 from passing to shift valve 84. However, valve 100 slows the development of valve 86 pressure on the pipe to valve 46 long enough to keep blocking valve 95 in the position shown in FIG. 4 so valve 84 will be shifted by the pressure output of pipe 96 and reduce the pressure of pipe 85 to atmosphere.

Valve 100 in this system is of the type that passes the pilot valve 86 output at a controlled rate, but relieves the pressure past it, to fill valve 46, with substantially no restriction. Study of the cycle of operation will show that the actuating pressure on valve 46 must be removed quickly, and that the exhaust through pilot valve 86 is the only provision shown as available. Access to this bleed through valve 86 must be made by having a minimum restriction through valve 100 toward valve 86. Of course, an extra valve could be employed directly in the pipe to valve 46 which would be sensitive to a pressure decrease of a predetermined amount to quickly relieve the actuating pressure. In the present disclosure, it is simpler to regard valve 100 as having the differential desired between its two bleed rates.

When supply pressure to both pilot valves 86 and 87 is removed, the dump and fill valves 46 and 50 remain closed until float 58 raises, indicating a full surge tank 3 of fluid to be metered is available. Shift valve 84 will then be positioned to pressure pipe 85 and the metering will continue by fill valve 46 being opened. The system operation will then shift to that portion of its cycle represented by FIG. 2 in which meter tank 2 is filling.

RECIRCULATION OF BAD OIL FROM TANK 3

By Monitor 67

FIG. 5 is established to illustrate how the bottom sediment and water monitor 67 controls the system to recirculate the oil from the bottom of surge tank 3. The control action by monitor 67 is taken at any time the monitor detects the need. However, the system is illustrated to show the metering function as not interrupted during a filling cycle of meter tank 2. This provision recognizes the desirability of reducing the standing time of oil in meter tank 2 to a minimum. The reduced standing time militates against paraffin, etc. fouling the walls of the tank with a layer of solids which will make the metering progressively inaccurate.

Monitor 67 is shown specifically establishing an electric signal output on solenoid-operated fluid pressure valve

101. Valve 101 establishes a control fluid pressure in pipe 102. The fluid pressure is applied to blocking valve 103 if fill valve 46 is opened by the control fluid pressure of pilot valve 86. However, blocking valve 103 normally passes the control fluid pressure from pilot valve 86. If this control pressure is passed to fill valve 46 to place the meter tank 2 on its filling cycle, the control pressure is also placed on blocking valve 104. Blocking valve 104 is placed in pipe 102 and when energized by the control pressure passed by blocking valve 103, isolates the output of monitor solenoid valve 101 from blocking valve 103. Thus, when fill valve 46 is opened, the monitor 67 cannot stop the filling operation. Only after the fill-dump system for meter tank 2 has gone into its dumping cycle can the monitor 67 signal halt the metering operation.

However, the monitor 67 does start the immediate recirculation of the bad oil it detects in surge tank 3. Pipe 105 branches from pipe 102 and the output of valve 101 shuttles double check valve 106 and double check valve 107 to energize fluid pressure operated electric switch 108. Switch 108 is essentially a transducer of the control fluid pressure in pipe 109 into the electrical power applied to the motor 110. Motor 110 powers compressor 65. Compressor 65 takes the bad oil of conduit 60 and the vapor of conduit 62 and uses the oil as a liquid piston to compress, absorb and condense the vapor of conduit 62. The resulting mixture of liquid and vapor is introduced into treater 1 through conduit 11. A compressor suitable for this service is manufactured by Nash Engineering Company, South Norwalk, Connecticut, as Type MD.

To make the bad oil of conduit 60 and the vapor of conduit 62 available to compressor 65 at the time motor 110 actuates compressor 65, pipe 111 branches from pipe 109 to open valves 61 and 63. The control fluid pressure developed by bottom sediment and water solenoid valve 101 is, therefore, used directly to open valves 61 and 63 and transduced to electric power to drive compressor 65.

By Time-Cycle Controller 70

The concepts of the control system encompass a high degree of flexibility. Bottom sediment and water monitor 67 may be regarded as a sentinel, taking the proper control action to eliminate bad oil at a certain level of concentration, whenever it appears. However, an anticipatory, or preventive, measure is also available. The oil from the bottom of surge tank 3 can be recirculated on a time schedule to take care of bottom sediment and water accumulation to a degree.

Time-cycle controller 70 is representative of well-known devices which can be set to generate a control impulse on a time schedule. Controller 70 is illustrated here as periodically energizing solenoid valve 112 to develop a control fluid pressure in pipe 113. The pressure in pipe 113 shuttles the double check valves 106 and 107 to start compressor 65 and open valves 61 and 63.

By Vapor Pressure Regulator 68

Recovery of the hydrocarbon components of the vapor evolved above the oil in surge tank 3 can be very important. Condensation may occur on head 42 if the ambient temperature is cooler than the vapors. A cooler fluid can be used to heat exchange with the vapors evolved.

FIG. 1 illustrates how these vapors can be drawn off with conduit 62 and compressed, condensed and absorbed by the cooler fluid from the bottom of tank 3. This recovery step is taken every time monitor 67 or controller 70 recirculates bad oil. On the other hand, the system is shown as so flexible that the pressure of the vapors can start this type of recovery.

Regulator 68 is disclosed as responsive to the vapor pressure beneath head 42. When the vapor pressure reaches a predetermined value, the regulator 68 develops a control fluid pressure in pipe 113. The control pressure in pipe 114 shuttles double check valve 107 to take over

control of compressor 65 and open valves 61 and 63 just as controller 70 and monitor 67 did.

SUMMATION

The foregoing disclosure has been limited to certain structure to keep from obscuring the features of automatically metering available, merchantable, oil from surge tank 3, keeping the bottom of tank 3 clean and recovering vapor from the top of the oil in tank 3. The cooling of the vapors evolved above the tank 3 oil, to condense these vapors, can be done in a number of ways. FIG. 6 illustrates one way which has been heretofore indicated. Other functions of a custody transfer unit, such as sampling, integrating, limiting the metering to an allowable amount and providing a pipe line surge, are also shown in FIG. 6.

Cooling

FIG. 6 shows the surge tank 3 mounted on top of the meter tank 2. This unit is further shown mounted on top of a pipe line surge tank 120. Part of the control system of FIGS. 2-5 is shown connected to floats 58 and 59 in surge tank 3 and floats 55 and 56 in meter tank 2.

FIG. 6 shows a cooling coil 121 mounted in the top of surge tank 3. The cooling coil 121 is not shown attached to a source of fluid. However, it is intended that a fluid, cooler than the evolved vapors on the top of the oil in tank 3, be forced through coil 121 to provide a cool surface on which hydrocarbons will condense from the vapors so they will be recovered into the tank 3 as merchantable oil to be metered.

Of course, there are other forms of heat exchangers for the vapors in tank 3. Coil 121 is intended to merely represent one of the many possible means with which heat exchange is used to lower the temperature of the vapors, condense them and recover them as liquids. The use of a cooler liquid in a compressor, to recover the vapors by recirculation through the treating process, was illustrated in FIG. 1. The cooling coil 121 can complement the compressor, or under some conditions of operation, substitute for the compressor, in this process.

Counting—Integrating—Allowable

The portion of the control system disclosed in FIG. 6 can be compared to that of FIGS. 2-5. The pipe 91 from float 55 is noted as being pressured each time a dump of meter tank 2 is completed. This impulse can be used to actuate a counting, or integrating, mechanism to indicate and/or record the total amount of oil passed through the meter.

A pipe 122 is branched from pipe 91 to apply the fluid pressure impulse generated by float 55 to a diaphragm operator 123. Operator 123 is mechanically linked to a counter, or totalizer, 124 which cumulates the number of tank 2 units dumped. Although not shown, compensation of the counter, is easily provided from temperature of the oil measured.

An allowable counter 126 is also indicated as driven by operator 123. Counter 125 is designed to establish a control fluid pressure in pipe 126 after a predetermined amount of oil has been metered through tank 2. The control pressure in pipe 126 is then applied to pipe 96. Therefore, when passed by blocking valves 97 and 95, the allowable counter impulse shifts valve 84 and shuts down the metering and custody transfer operation. The surge tank 3 will fill and shut in the lease with valve 69.

Sampling

It is generally desired that a sample be taken of each unit of tank 2 oil. A sampling mechanism 127 is shown mounted on the top of tank 2. This sampler could take the form of that disclosed in the Pitts Patent 2,872,817.

The actuation of the sampling system, and its details, has not been shown. The system may be quite important to a complete custody transfer unit, but its illustration in FIG. 6 has been held to the simplicity which will enable

the embodiments of the invention to be illustrated with clarity.

Pipe Line Surge

The tank 120 on which the surge tank-meter tank unit is mounted is desirable to provide a regular, consistent, delivery to the pipe line of the purchaser of the oil. Floats 128 and 129 can control the amount of oil held in this reservoir. A control system, not illustrated in FIG. 6, can control motor 130 to pump the metered oil into a pipe line, through conduit 131. The intended operation is that, with tank 120 as a reservoir between the meter 2 and the pipe line, delivery will be relatively steady and uninterrupted during the allowable period of production.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the method and apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. The method of treating and transferring crude petroleum, including,
 - heating the crude to break any emulsion of oil and water in the crude,
 - removing and collecting clean oil remote from the heating step,
 - measuring the collected clean oil and delivering the clean oil to a point of use,
 - removing vapor evolved from the clean oil collected,
 - removing clean oil from a relatively cool section of the clean oil collected,
 - utilizing the relatively cool clean oil to condense and absorb and compress the vapor evolved from the clean oil collected,
 - and mixing the relatively cool clean oil and condensed and absorbed and compressed evolved vapors with the crude petroleum which is heated to break any emulsion of oil and water in the crude,
 - whereby the evolved vapors are restabilized.
2. A system for treating and transferring crude petroleum, including,
 - a shell,
 - means for bringing the crude to the shell for treatment,
 - a heat means in the shell arranged to heat the crude until any emulsion of oil and water in the crude is broken,
 - a coalescing means within said shell for agglomerating the clean oil into a product for transfer and water into a body for disposal,
 - a collecting vessel connected to the coalescing means of the shell,
 - means for transferring the clean oil to the collecting vessel from the coalescence means,
 - a measuring means for receiving the clean oil of the collecting vessel to measure and transfer the clean oil to a point of use,
 - a first conduit means for removing evolved vapors from above the clean oil in the collecting vessel,
 - a second conduit means for removing cool clean oil from the collecting vessel,
 - a compressor employing the oil of the second conduit means to condense and absorb and compress the vapors of the first conduit means,
 - and a third conduit means for transferring and mixing the mixture of vapors and oil of the compressor with

the crude petroleum which is heated, whereby the evolved vapors are restabilized.

3. The method of treating crude oil and changing custody of the clean oil produced, including,
 - heating the crude oil to break any emulsion of oil and water in the crude,
 - agglomerating the clean oil and water into separate collections,
 - removing the collected oil to a point remote from the treating process and holding the collected oil under a pressure less than the pressure under which the crude was treated,
 - removing measured quantities of oil from the clean oil collected and depositing the measured quantities at a point of use,
 - removing vapors evolved from above the clean oil collected when the pressure of the vapors exceeds a predetermined value,
 - removing oil from a relatively cool section of the clean oil collected,
 - mixing the oil withdrawn from the relatively cool section and vapors evolved from above the clean oil collected to condense and absorb and compress the vapors,
 - and introducing the mixture of condensate and absorbed vapors and compressed vapors and relatively cool oil into the crude oil to be heated, whereby the liquefiable portions of the vapors are recovered as liquids.
4. A system for treating crude oil and changing custody of the clean oil produced, including,
 - a treating vessel,
 - means for bringing the crude to the vessel for treatment,
 - a heat means in the vessel arranged to heat the crude until any emulsion of oil and water in the crude is broken,
 - a coalescing means within said vessel for agglomerating the clean oil into a body for transfer and the water into a separate body for disposal,
 - a tank located separately from the treating vessel and connected to the coalescing means of the treating vessel for receiving the clean oil body produced by the treating vessel under a pressure less than the pressure in the treating vessel,
 - a measuring means connected to the tank for registering the quantity of the clean oil as it flows from the body of clean oil in the tank into the custody of a purchaser,
 - means for transferring the clean oil body to the tank from the coalescing means,
 - means for detecting the pressure of the vapors evolved from the clean oil body in the tank and removing these vapors when their pressure exceeds a predetermined value,
 - means for removing oil from the body of clean oil in the tank at a point substantially below the top of the tank and mixing the oil withdrawn with the evolved vapors to condense and absorb and compress the evolved vapors,
 - and means for mixing the mixture of withdrawn oil and condensate and vapors with the crude oil to be heated for recovery and conservation of the liquefiable portions of the vapors.
5. A system for treating and transferring crude petroleum, including,
 - means employing heat to reduce crude petroleum produced from an oil well into clean oil and water,
 - a collecting vessel connected to the means employing heat to receive the clean oil,
 - a compressor connected to the upper portion of the collecting vessel to remove vapors evolved from the surface of the clean oil and employ a liquid cooler than the vapors to condense and absorb and compress the vapors,

a first valve in the connection between the upper portion of the collecting vessel and the compressor,
 a second valve arranged to control the cool liquid to the compressor,
 means for detecting the pressure of the vapors in the upper portion of the collecting vessel,
 a control system between the pressure detector and the compressor and the first and second valves, whereby the compressor is started and the valves are opened when the pressure of the vapors exceeds a predetermined value,
 a conduit connected to the compressor output with which the vapor and oil of the compressor output is mixed with the crude petroleum received by the means employing heat,
 and a measuring means connected to the lower portion of the collecting vessel receiving the clean oil and measuring and transferring the clean oil to a point of use.

6. A system for treating and transferring crude petroleum, including,
 means employing heat to reduce crude petroleum produced from an oil well into clean oil and water,
 a collecting vessel connected to the means employing heat to receive the clean oil,
 a compressor connected to the upper portion of the collecting vessel to remove vapors evolved from the surface of the clean oil and employ clean oil cooler than the vapors to condense and absorb and compress the vapors,
 a first valve in the connection between the upper portion of the collecting vessel and the compressor,
 a second valve arranged to control the cool oil to the compressor,
 means for detecting the pressure of the vapors in the upper portion of the collecting vessel,
 a detector-controller connected to the lower portion of the collecting vessel and responding to the percent basic sediment and water in the oil received into the vessel,
 a time-cycle controller with which to establish a control signal output at predetermined intervals,
 a control system between the pressure detector and the basic sediment and water detector-controller and time-cycle controller and the compressor and the first and second valves,
 whereby the compressor is started and the valves are opened when the pressure of the vapors exceeds a predetermined value and when the basic sediment and water exceeds a predetermined value and when the time-cycle controller establishes its output control signal,
 a conduit connected to the compressor output with which the vapor and oil of the compressor output is mixed with the crude petroleum received by the means employing heat,
 and a measuring means connected to the lower portion of the collecting vessel receiving the clean oil and measuring and transferring the clean oil to a point of use.

7. A system for treating and transferring crude petroleum, including,
 means employing heat to reduce crude petroleum produced from an oil well into clean oil and water,
 a collecting vessel connected to the means employing heat to receive the clean oil,
 a compressor connected to the upper portion of the collecting vessel to remove vapors evolved from the surface of the clean oil and employ clean oil cooler than the vapors to condense and absorb and compress the vapors,
 a first valve in the connection between the upper portion of the collecting vessel and the compressor,
 a second valve arranged to control the cool oil to the compressor,

means for detecting the pressure of the vapors in the upper portion of the collecting vessel,
 a detector-controller connected to the lower portion of the collecting vessel and responding to the percent basic sediment and water in the oil received into the vessel,
 a control system between the pressure detector and the basic sediment and water detector-controller and the compressor and the first and second valves, whereby the compressor is started and the valves are opened when the pressure of the vapors exceeds a predetermined value and when the basic sediment and water exceeds a predetermined value,
 a conduit connected to the compressor output with which the vapor and oil of the compressor output is mixed with the crude petroleum received by the means employing heat,
 and a measuring means connected to the lower portion of the collecting vessel receiving the clean oil and measuring and transferring the clean oil to a point of use.

8. A system for treating and transferring crude petroleum, including,
 means employing heat to reduce crude petroleum produced from an oil well into clean oil and water,
 a lease valve between the means employing heat and the well which can be closed to shut down the lease,
 a collecting vessel connected to the means employing heat to receive the clean oil,
 means for detecting a predetermined upper liquid level in the collecting vessel and closing the lease valve when the upper liquid level is detected,
 a compressor connected to the upper portion of the collecting vessel to remove vapors evolved from the surface of the clean oil and employ clean oil cooler than the vapors to condense and absorb and compress the vapors,
 a first valve in the connection between the upper portion of the collecting vessel and the compressor,
 a second valve arranged to control the cool oil to the compressor,
 means for detecting the pressure of the vapors in the upper portion of the collecting vessel,
 a control system between the pressure detector and the compressor and the first and second valves, whereby the compressor is started and the valves are opened when the pressure of the vapors exceeds a predetermined value,
 a conduit connected to the compressor output with which the vapor and oil of the compressor output is mixed with the crude petroleum received by the means employing heat,
 a dump-type measuring means connected to the lower portion of the collecting vessel receiving the clean oil and measuring and transferring the clean oil to a point of use,
 a third valve in the connection between the dump-type measuring means and the lower portion of the collecting vessel which can be closed to terminate the measuring and transferring of the clean oil,
 and means for detecting a predetermined lower liquid level in the collecting vessel and closing the third valve when the lower liquid level is detected as an indication that the collecting vessel does not contain sufficient oil to fill the dump-type measuring means.

9. A system for treating and transferring crude petroleum, including,
 a supply of crude petroleum,
 a container connected to the supply in which the crude is received,
 a heat means mounted in the shell of the container and raising the temperature of the crude until any emulsion of oil and water in the crude is broken,
 a collecting vessel connected to the shell of the con-

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- tainer and receiving the clean oil produced from the shell,
- a compressor employing a liquid cooler than vapor with which it condenses and absorbs and compresses the vapor,
- a connection removing vapor from the vapor space of the collecting vessel to the input of the compressor,
- a source of liquid which is at a temperature less than the vapors evolved from the surface of the clean oil in the collecting vessel connected to the compressor,
- a conduit connected to the compressor output through which the mixture of condensate and vapors is removed from the output and returned to the container connected to the supply of crude petroleum, and measuring means connected to the collecting vessel to receive clean oil from the collecting vessel and measure and transfer the clean oil to a point of use.
10. A system for treating and transferring crude petroleum, including,
- a supply of crude petroleum,
- a container connected to the supply in which the crude is received,
- a heat means mounted in the shell of the container and raising the temperature of the crude until any emulsion of oil and water in the crude is broken,
- a collecting vessel connected to the shell of the container and receiving the clean oil produced from the shell,
- a heat exchanger mounted within the vapor space of the collecting vessel and circulating a fluid cooler than vapors evolved from the clean oil in indirect heat exchange with the vapors to reduce the temperature of evolved vapors until hydrocarbons in

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- the vapors which can be held as a liquid under storageable conditions are liquified,
- a compressor employing a liquid cooler than vapor with which it condenses and absorbs and compresses the vapor,
- a connection removing vapor from the vapor space of the collecting vessel to the input of the compressor,
- a source of liquid which is at a temperature less than the vapors evolved from the surface of the clean oil in the collecting vessel connected to the compressor,
- a conduit connected to the compressor output through which the mixture of condensate and vapors is removed from the output and returned to the container to the supply of crude petroleum,
- and measuring means connected to the collecting vessel to receive clean oil from the collecting vessel and measure and transfer the clean oil to a point of use.

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