

Sept. 28, 1965

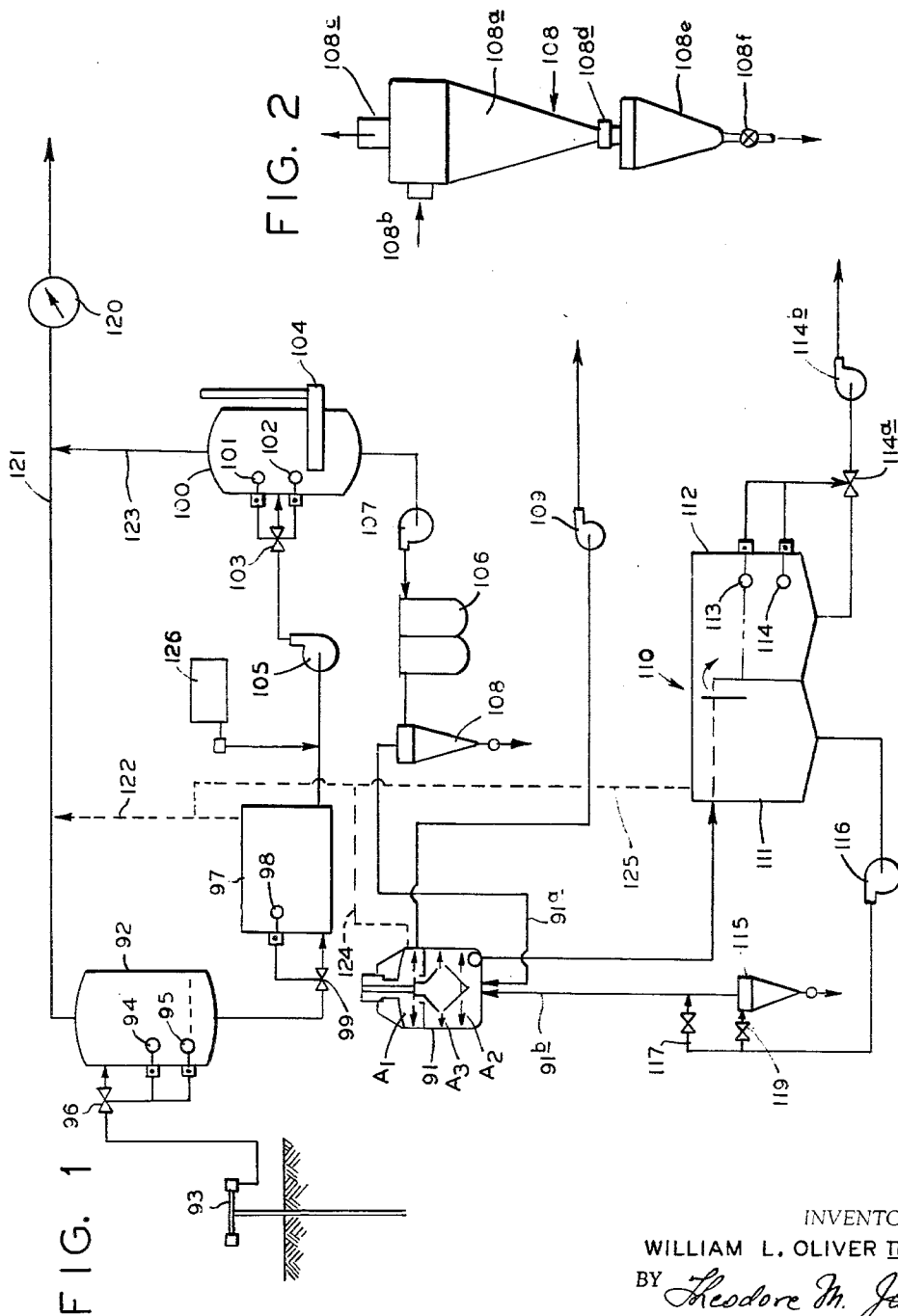
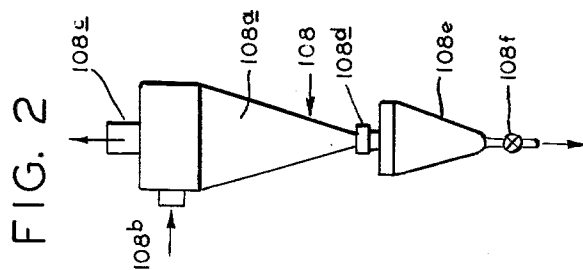
W. L. OLIVER III

3,208,201

CRUDE OIL SEPARATING TREATMENT

Filed Sept. 27, 1960

3 Sheets-Sheet 1



Sept. 28, 1965

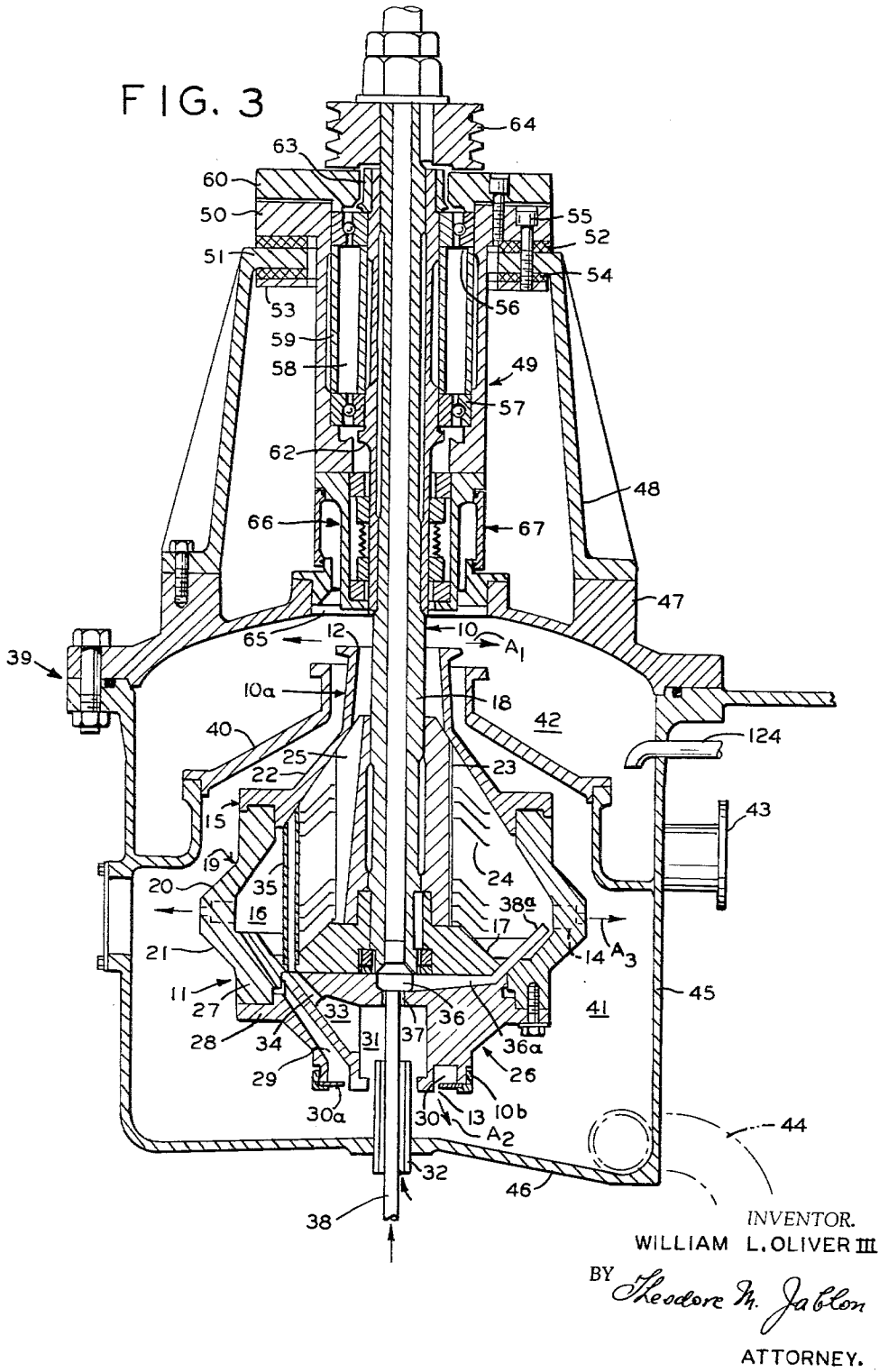
W. L. OLIVER III

3,208,201

CRUDE OIL SEPARATING TREATMENT

Filed Sept. 27, 1960

3 Sheets-Sheet 2



Sept. 28, 1965

W. L. OLIVER III

3,208,201

CRUDE OIL SEPARATING TREATMENT

Filed Sept. 27, 1960

3 Sheets-Sheet 3

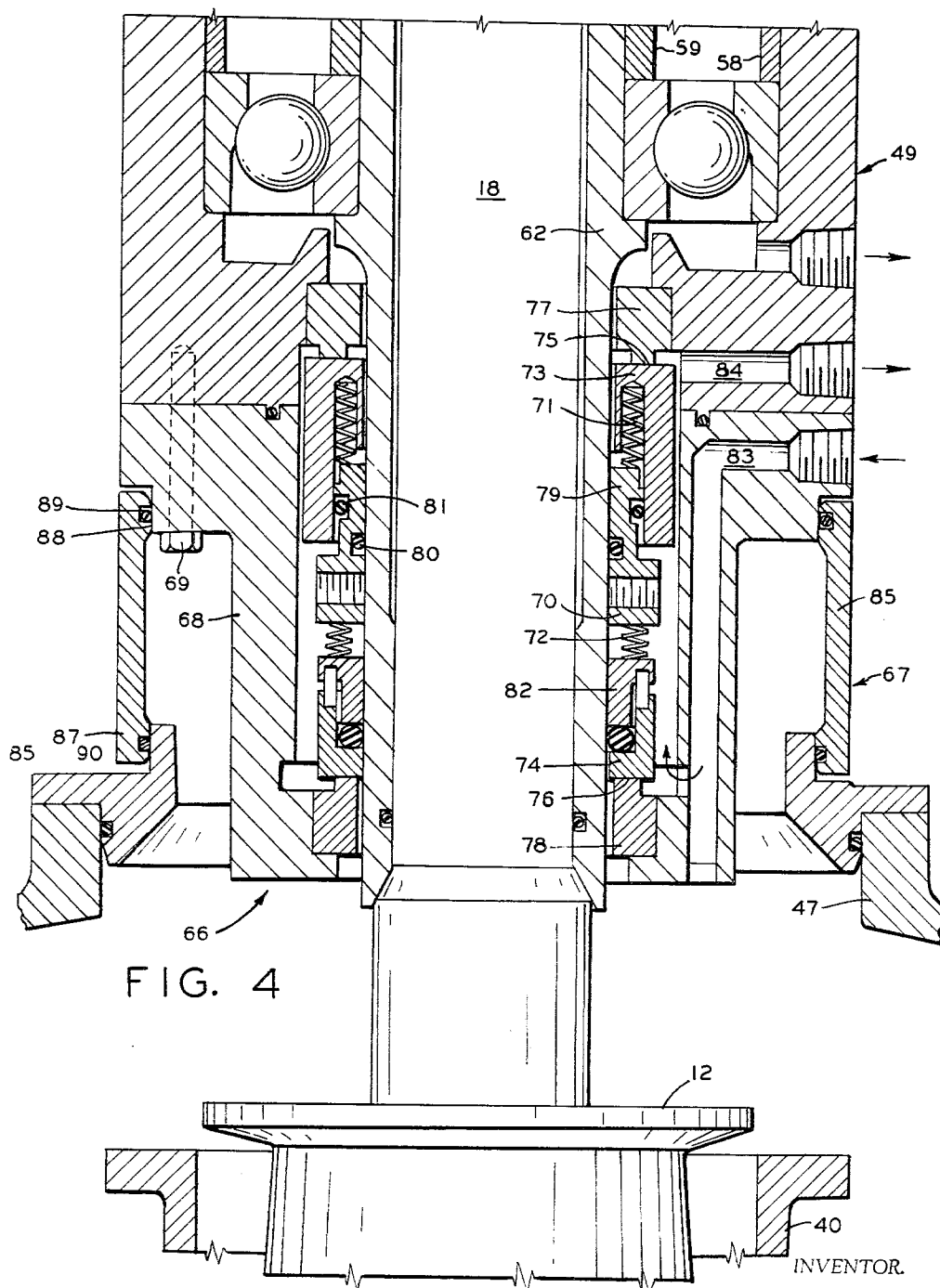


FIG. 4

INVENTOR.
WILLIAM L. OLIVER III
BY *Theodore M. Jablon*
ATTORNEY.

1

3,208,201

CRUDE OIL SEPARATING TREATMENT

William L. Oliver III, Houston, Tex., assignor to Dorr-Oliver Incorporated, Stamford, Conn., a corporation of Delaware

Filed Sept. 27, 1960, Ser. No. 58,708
13 Claims. (Cl. 55—166)

This invention relates to the purification treatment of crude oil in a separating operation whereby the oil itself is separated from water and from sludge-forming impurities, prior to pumping the oil into the trunk line that leads to the refinery for fractionation and for by-product recovery and the like.

It is among the objects of this invention to provide crude oil purification treatment whereby various drawbacks of conventional separating treatment carried out by means of present-day oil separating heating units are avoided, in particular the considerable loss of light oil fractions that are wasted into the atmosphere by the evaporation of these fractions from these heater units.

Thus, it is an object to provide a mode of operation and an apparatus system whereby the light fractions are substantially retained in their liquid phase in the separated oil, with the dual advantage gained of salvaging these fractions and at the same time of lowering by their presence the viscosity and thus improving the pumpability and power required for pumping the separated oil over distances.

The usual oil separating heater units now in use are the so-called Heater-Treaters which are relatively large tanks provided with an indirect heating system which may be oil- or gas fired, including banks of heating tubes, wherein the crude oil is heated sufficiently to bring about the lowering of its viscosity while effecting gradual separation of oil from the mixture or emulsion as it is received from the well, with the heavy constituents discharging from the bottom and the separated crude oil discharging from the top of this tank. Such Heater-Treater tanks are bulky tower units of considerable size inasmuch as they must provide adequate detention as well as storage capacity to satisfy the requirements of the operation as a whole.

Normally, these conventional oil separating heater tanks operate under atmospheric pressure, thus allowing gasified oil components or light oil fractions in vapor state to escape to waste. In view of fire hazard attached to these conventional heater units they are designed for operation under atmospheric pressure and safety rules require that these units be installed a safe distance from the oil producing well, making it necessary, for instance, that the oil from an off-shore well be pumped to a Heater-Treater unit located on shore, unless a separate off-shore structure is erected for supporting the Heater-Treater spaced safely from the oil producing well.

Hence, it is furthermore among the objects to provide an operating method as well as apparatus arrangement and operating system whereby the crude oil separation-purification treatment can be carried out economically and without the aforementioned disadvantages and hazards of the present-day Heater-Treaters, and without the space-and-maintenance requirements of the Heater-Treaters, and whereby the oil separation treatment at the same time is rendered highly effective as well as accurately controllable in a much more compact apparatus arrangement to be located wherever most convenient for a given situation and preferably in close proximity to the oil-producing well.

With the foregoing objects in view, the invention provides a closed and pressurized separation-purification treatment system, with the operating pressure through a gaseous pressure medium in this system kept such that the light oil fractions will remain in liquid phase in the oil

2

while being separated, the separated oil thereafter to be pumped further against the line pressure to the refinery. In addition to avoiding this loss of the light oil fractions, their presence in the separated oil reduces the viscosity thereof and thus the cost of pumping it over long distances. The pressure in the pressurized treatment system may be derived from the pressure of the crude available at the head of the well, the gas pressure in the treatment system itself being controllable and maintainable at the desired magnitude by means of suitable pressure regulating means.

Within this pressurized oil separating treatment system the invention features a pressurized centrifugal oil separating machine to which the impure crude preferably after de-gassing is fed under the required operating pressure, while separated oil may be discharged from this machine against the pipeline pressure which is high enough to keep the light oil fractions in their liquid phase especially while still hot. Preferred for this purpose is a centrifugal machine of the nozzle type adapted for three-fraction separation, namely separation into overflows of oil and water respectively from the rotating bowl of the centrifuge, and as a third fraction discharging underflow of sludge-forming matter through the peripherally located nozzles of the bowl into the housing of the centrifuge the interior of which is part of the aforementioned pressure system.

Another feature lies in the provision of a simple one-point pressure control arrangement for this pressurized treatment system, employing a single pressure regulating discharge valve the setting of which maintains and controls the desired pressure in this system. In this connection, self-sealing receiver means are provided as part of the system effective to discharge the separated water and the sludge from this system into the atmosphere.

Preferably the pressurized crude oil treatment system of this invention comprises a pressurized gas separator located between the oil well and the oil separating centrifugal machine, for effecting the immediate removal from the oil of the naturally present gas mixture usually comprising methane, butane, and propane recoverable separately for different purposes in a gas treatment plant. From this gas separator the gas mixture is delivered as through a pressure regulated valve controlling the operating pressure in the system and also in the centrifugal machine which has pressure equalizing connection with the gas separator. This pressure regulated valve constitutes a simple one-point control for the pressurized treatment system, with de-gasified crude oil passing through the pressurized system and thus through the pressurized oil separating centrifuge to undergo purification. Self-sealing means are provided as part of this pressurized system, through which the resulting separated water and sludge-forming impurity constituents of the crude may discharge from the pressure treatment system into the atmosphere. A self-sealing pressurized receiver tank means is preferred.

Other features lie in the cooperative relationship between the pressurized centrifugal machine with various other separating and conditioning units, preferably including a hydrocyclone unit for intercepting or scalping off coarse solids such as sands or the like from the de-gasified crude before entering the pressurized centrifugal oil separating machine.

Other features and advantages will hereinafter appear.

As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within the metes and bounds of the claims, or equiva-

3

lents of such metes and bounds, are therefore intended to be embraced by the claims.

FIG. 1 is a flowsheet embodying the invention in a pressurized treatment system, featuring the pressurized oil separating centrifugal machine with pressure control, and cooperating with other treatment units preferably including a hydrocyclone unit.

FIG. 2 is an enlarged detail of the hydrocyclone unit, illustrating a manner of preliminary removal of coarse solids from the crude.

FIG. 3 is a greatly enlarged vertical sectional view of one embodiment of a pressurized centrifugal machine suited for the separating operation of this invention providing a three-product separation.

FIG. 4 is a further enlarged detailed view of sealing means embodied in the centrifugal machine, effective to maintain the required super-atmospheric pressure in the housing of the centrifugal machine.

Inasmuch as the invention is mainly concerned with subjecting the crude oil to a separation treatment operation carried out under pressurized conditions, and at a viscosity reducing elevated temperature there will now be first described a pressurized centrifugal machine adapted for carrying out this treatment operation under the conditions called for by the invention.

In a preferred embodiment illustrated in FIG. 3, the pressurized continuous centrifugal machine is of the nozzle type, designed for three-product separation. Such a machine comprises a rotor turnable in a housing, where the rotor bowl has one overflow for separated oil, and another overflow for separated water, and discharge nozzles provided along the outer periphery of the rotor bowl for delivering and through which the third separated fraction flows as underflow which may comprise the sludge-forming constituents of the crude.

This centrifugal machine is pressurized in a sense that there is maintainable in the housing thereof a gaseous medium at the required operating pressure to retain the light oil fraction in the liquid phase, while the centrifugally separated fraction discharges continuously from the machine. The required operating gas pressure in this machine is maintainable by the provision of a suitable sealing means between the rotor shaft and the housing, comprising an outer end and inner seal as will be furthermore explained below, further comprising means for feeding the crude into the rotor bowl against such operating pressure, a means for maintaining the operating pressure itself in the machine by having the housing thereof communicate with a supply of gaseous pressure medium regulated by a pressure responsive means or valve, a means for discharging the separated oil against the higher pipeline pressure, and a means for discharging the separated water preferably together with the sludge underflow to a locality of lower pressure which may be that of the atmosphere. Furthermore, in this machine, provision is made for returning or pumping separated water together with or without the sludge at a controlled rate back into the bowl as a means of maintaining desired and proper centrifugal separating conditions within the rotor bowl, all as will be furthermore described and explained below.

In the embodiment of FIG. 3, the rotor 10 of the centrifugal machine has a portion 11 of generally double-cone shaped configuration, having a constricted top end portion 10a which provides overflow 12 for the separated oil, and a constricted bottom end portion 10b which provides the overflow 13 for the separated water, the intermediate outer peripheral portion having mounted therein underflow discharge nozzles 14 the construction and function of which is exemplified in the patent to Millard No. 2,695,748.

More in particular, the rotor 10 comprises the rotor bowl 15 proper defining an annular centrifugal separating chamber 16. The bowl has a hub portion 17 con-

4

nected rigidly to a rotor shaft 18 extending upwardly centrally through the area defined by the top end oil overflow 12 and operatively supported from above not only for rotation but also in a manner to allow for slight angular displacement of the rotor axis due to the gyrations of the axis peculiar to centrifuge operation. The bowl further comprises a body portion 19 consisting of two trunco-conical portions 20 and 21 with their wide ends joining one another so as to provide the extreme peripheral portion of the bowl wherein the aforementioned underflow discharge nozzles are located. A conical member 22 constitutes the top end portion of the bowl, being removably fastened to the body portion and providing the aforementioned oil overflow from the top end of the bowl. Within the bowl a sleeve member 23 is fitted over the rotor shaft, to be held confined between the hub portion 17 and the conical top end member 22. Around this sleeve member in turn are fitted a stack of separator discs 24 which induce and aid in the separation of water particles from the oil in a manner known of itself, the thus separated oil being displaced radially inwardly through the interstices between the discs into vertical grooves or recesses 25 provided in the sleeve member, and thus directed upwardly to overflow at 12.

The rotor 10 in the present example further comprises a complementary member 26 removably fastened to the underside of the hub portion of the bowl, which member provides the aforementioned overflow 13 for the separated water discharging from an intermediate zone in the centrifugal separating chamber through downwardly divergent conduits 27 formed in the bowl, then through an interconnecting annular space 28 formed between the hub portion of the bowl and the complementary member 26, and then through other downwardly convergent conduits 29 formed in the complementary member, into an annular discharge chamber 30 having an annular ring dam member 30a defining the aforementioned overflow 13.

The complementary member 26 further has an outer centrally disposed feed receiving chamber 31 cooperating with an upwardly direct feed pipe 32 for the crude oil to be impelled by vanes 33 into and through upwardly divergent conduits 34 formed in the complementary member and communicating with respective perforated vertical feed pipes 35 located in the separating chamber of the bowl and preferably arranged outside of, although adjacent to, the outer peripheral edges of the aforementioned separating discs.

The complementary member 26 has a recess 36 facing the outer face of the hub portion of the bowl and constituting therewith an inner receiving chamber communicating with the outer receiving chamber 31 through an opening 37 through which extends a return feed pipe 38 for introducing into the rotor a control liquid such as a separated water from the centrifuge itself together with or without the underflow from the nozzles. This control liquid is introduced into the rotor at a controlled rate for regulating the separating operation in the bowl with the return feed pipe 38 located within the crude oil feed pipe 32 and also extending through the opening 37. Control liquid will thus enter the inner receiving chamber 36 which has radial conduits 36a communicating with outwardly divergent tubes 38a that terminate within the separating chamber close to the nozzles for delivering the control liquid centrifugally in the extreme outer zone of the separating chamber in the region of the nozzles.

The rotor operates in a housing 39 which has an annular partition 40 defining a lower discharge chamber 41 and an upper discharge chamber 42. The upper chamber 42 receives separated oil from overflow 12 and has an oil discharge outlet 43, while the lower chamber 41 receives the separated water from the aforementioned overflow 13 together with the underflow material from the nozzles, and has an outlet 44 through which the mixture of separated water and underflow material is discharged.

The housing 39 as herein illustrated comprises a substantially cylindrical body portion 45 having a relatively shallow bottom 46 sloping down towards the outlet 44. A removable top cover member 47 is bolted tightly to the body portion, and in turn carries a bracket structure 48 from which the rotor is suspended, being operatively mounted in such a manner as to allow for slight angular displacement of the rotor shaft thereby enabling the rotor to perform a slight gyratory motion while being rotated, such mounting to allow for equilibration of the rotating mass.

Means for thus mounting the rotor in the present embodiment of the centrifugal machine comprises a substantially cylindrical bearing cage member 49 formed with an upper terminal external flange 50 whereby it rests upon an in-turned flange 51 of the bracket structure 48 with suitable cushioning means such as a flat rubber ring 52 interposed between the associated flanges 50 and 51. The cage member 49 is secured yieldably in this position by means of a retainer ring 53 located at the underside of the in-turned flange 51, with a cushioning means such as a rubber ring 54 interposed between the flange 51 and the retainer ring so that the flange 50 is held yieldably between the two rubber rings.

This assembly of the cage member upon the in-turned flange of the bracket structure including the retainer ring and the two rubber rings, is held together as by bolts 55, enabling the cage member to be subjected to the aforementioned angular displacement or gyration when the rotor mounted in the cage member is in motion.

Within the cage member 49 there is provided an upper and lower ball bearing 56 and 57 respectively spaced a suitable distance vertically from each other by means of inner and outer spacer sleeves 58 and 59 respectively, and held in place by a retaining flange member 60 bolted as at 61 to the flange 50 of cage member 49 and by a retainer nut or thrust collar 63 mounted or threaded on the bearing sleeve 62 of the rotor shaft. The rotor shaft is mounted in the two ball bearings 56 and 57 by means of a bearing sleeve 62 fitted over and secured to the rotor shaft, the vertical downward thrust or weight of the rotor itself being absorbed by the thrust collar 63.

The rotor shaft and with it the rotor bowl may be rotated by a drive arrangement here indicated merely by a pulley 64 fixed to the top end of the shaft, which shaft in turn extends downwardly through an opening 65 provided in the top cover member of the housing.

For pressurizing this centrifugal machine in accordance with the requirements of this invention, there is provided an inner pressure seal device 66 effective between the rotor shaft and the ball bearings aforementioned, so that the gaseous pressure medium within the machine cannot escape along the shaft and through the cage member 49. Furthermore, an outer pressure sealing device 67 is effective between the cage member 49 and the top cover member of the housing, thus sealing off the opening 65 therein against the cage member yet allowing for the aforementioned slight angular or gyratory movements of the cage member 49 relative to the bracket structure and thus relative to the housing of the machine.

As shown more clearly in the greatly enlarged detail FIG. 3, the inner sealing device 66 has its sealing elements properly contained in an auxiliary cage member 68 secured to the lower end of the bearing cage member 49 as indicated by fastening bolts 69. Arrangement of the inner sealing elements is similar to those of the sealing devices shown in the Manual of Dura-Metallic Corp., Kalamazoo, Mich., Form 464.

In the present example, the arrangement comprises an anchoring member or collar 70 fixed to the bearing sleeve 62 to provide a base, an upper and a lower set of springs 71 and 72 respectively associated with this base, which sets of springs urge respective pressure slide rings 73 and 74 into sliding sealing contact with transverse

sealing faces 75 and 76 of respective stationary upper and lower abutment rings 77 and 78.

The base collar 70 has an upward extension 79 telescoping into the upper slide ring 73 through the intermediary of the upper set of springs 70, which springs also act to maintain the slide ring 73 in pressure sealing contact with the upper stationary abutment ring 77 when the rotor is in motion. One O-ring 80 provides sealing relationship interiorly as between the extension 70 of the base and the bearing sleeve 62, while another O-ring 81 seals the extension 79 exteriorly as against the slide ring 73.

The lower set of compression springs 72 transmits rotation to an intermediate slide ring 82 which has a close sliding fit upon the bearing sleeve 62, and which in turn exerts pressure from the springs upon as well as transmits rotation to the lower slide ring 74 maintaining the same in pressure sealing contact with the associated lower stationary abutment ring 78 while the motor is in motion. Cooling oil for the sliding parts of this sealing device is supplied to the elements thereof through an inlet conduit 83, while spent oil is allowed to pass from the sealing device through conduit 84.

The outer pressure sealing device 67 in this example consists mainly of a loosely mounted cylindrical cuff element or sleeve member 85 effective to close the annular space between the auxiliary cage member 68 and the surrounding edge of the opening 65 in the top of the housing. An adaptor ring member 86 is mounted on the edge portion of the opening 65 providing an external lower cylindrical sealing face 87 concentric with an upper similar cylindrical face 88 spaced vertically upwardly from and being of substantially the same diameter as the face 87. The cylindrical cuff element 85 has upper and lower end portions that fit loosely over the respective external cylindrical sealing faces 87 and 88, the sealing relationship between the cuff element and the cylindrical sealing faces being maintained by means of respective O-ring seals 89 and 90. It will be understood that in this outer sealing device 67 the mounting of the sleeve element 85 is such as to allow for the aforementioned slight angular or gyratory displacement of the rotor shaft, while capable of maintaining the required pressure of the gaseous medium in the interior of the housing of the centrifugal machine.

The invention may be embodied in a pressurized operating system such as is illustrated and exemplified in the flow sheet of FIG. 1, featuring a pressurized centrifugal machine 91 preferably similar to the one illustrated in FIGS. 3 and 4 and described above.

In a practical embodiment, this flowsheet comprises various pressurized treatment units which may cooperate directly or indirectly with the pressurized centrifugal machine. By way of example, such an operating system may comprise the following treatment units: (a) a gas-separating unit 92 receiving the crude oil directly from the producing well indicated at 93, and having float type level control devices 94 and 95 determining the maximum and a minimum liquid level in the gas-separator tank, by controlling a supply valve 96, which unit is effective to separate from the crude oil any naturally present gases, for example methane, butane and propane for further treatment as in a gas processing plant; (b) a pressurized surge or storage tank 97 of adequate size to provide a reservoir for fluctuation, receiving the de-gasified crude preferably under a static pressure from the gas-separator unit sufficiently high to effect the transfer, and provided with level control devices 98 governing a valve 99 for admitting de-gasified crude into the storage tank; (c) a pressurized heating unit 100 provided with level control devices 101 and 102 which govern the operation of a supply valve 103 in determining a maximum and minimum liquid level in this unit, and with an indirect heating system 104 which may be oil or gas fired, for reducing the oil viscosity preparatory to the centrifugal oil-water separating operation; (d) a pump 105 preferably employed for transferring de-

gasified crude from the storage tank 97 to the heating unit 100; (e) a strainer unit 106 constructed for removing the coarser type of particles or impurities which may have resulted as from the well pumping operation; (f) a pump 107 preferably employed for moving heated oil from the heating unit under pressure through subsequent treatment units and into the pressurized centrifugal machine; (g) a first pressurized hydrocyclone unit 108 arranged functionally between the strainer unit 106 and the pressurized centrifugal machine to effect removal of the more abrasive particles such as sand and the like so they will not wear out the interior of the rotor and especially the nozzles of the centrifugal machine, the cyclone having an overflow with connection for feeding the crude containing sludge-forming dirt and fine sediment and the like into the rotor of the centrifugal machine; (h) a pump 109 for discharging the separated oil fraction from the centrifugal machine against the pipe line pressure; (i) a pressurized receiver tank arrangement 110 receiving the combined fractions of the separated water and the separated nozzle underflow, and providing a primary tank 111 with overflow into a second tank 112 which latter has level control devices 113 and 114 acting upon discharge valve 114a which determines upper and lower liquid levels in tank 112, with a pump 114b sending the water to useful disposal or to waste; (k) a second pressurized hydrocyclone unit 115 functionally interposed between the first receiver tank 111 and the centrifugal machine to provide control water from the tank for this machine free of certain contaminating solids; (l) a pump 116 adapted to force control water from the receiver tank 111 into the rotor of the centrifugal machine will by-pass connection 117 and respective valves 118 and 119; (m) a pressure regulating discharge valve 120 in a gas discharge line 121 leading from the gas separator unit 92; (n) pressure equalizing vent connections 122, 123, 124, 125 leading respectively from the storage tank 97, from the heater unit 100, from the housing of the centrifuge, and from the receiving tanks 111, 112 to the gas discharge line 121, so the pressure in the entire pressurized treatment system is maintained and controlled by the pressure regulating gas discharge valve 120 constituting a single-point control; (o) a chemical feeder apparatus 126 located between storage tank 97 and pump 105 providing an emulsion breaking chemical which is introduced into the pressure system, conditioning the crude for separation.

The operation of the hydrocyclone units included in this pressurized treatment system, is more clearly illustrated in the detail showing of FIG. 2. Having reference for example to the hydrocyclone unit 108, this comprises the cyclone 108a proper into which the solids carrying mixture enters tangentially under pressure through the inlet 108b while liquid freed of certain solids by the cyclone action passes therefrom through the upper discharge neck 108c, whereas underflow material containing the separated solids is displaced downwardly through the conical constriction 108d into a closed receiver 108e where the solids settle into a cone and from where they may be dumped periodically or batchwise by the operation of a valve 108f.

The operation according to the foregoing treatment system as exemplified in FIG. 1 may be as follows:

Crude oil may flow from the producing well 93 at the rate of say 10 gallons per minute, appearing as a mixture or emulsion of oil and water together with various solids as impurities, and also containing naturally occurring entrained gas such as methane, butane, and propane. According to a practical operating arrangement herein exemplified, this flow of crude is first separated from the naturally occurring gas, then preliminarily from certain types of solids, and thereafter centrifugally from the finer sludge-forming solids as well as fractionated into oil and water in the pressurized centrifuge, with the result that each overflow fraction is obtainable at a high degree of purity relative to the other.

Through valve 96 controlled by the level-responsive float devices 94 and 95 this emulsion is forced into the gas-separator 92, for example by the oil pressure available at the head of the well, with the pressure regulating gas discharge valve 120 set to maintain the gas pressure, for instance at about 75 to 100 lbs. in the treatment system and particularly in the centrifugal machine for maintaining the light oil fractions in the liquid phase at the elevated viscosity-reducing temperature of about 150° F.-200° F. at which the oil is being centrifuged.

Preferably, the gas-separator unit 92 is located at an elevation above the storage or holding tank 97, high enough to provide sufficient static head for effecting the transfer of the de-gasified crude into the holding tank 92 which latter for the conditions herein contemplated may have a capacity of say 600 gallons to accommodate fluctuations in the supply including periodical stoppages of the oil producing oil well pump. In this holding tank the emulsion is likely to cool off, but the subsequent heating unit 100 to which the crude is pumped by pump 105 will re-heat the emulsion to a temperature of about 150° to 200° F. sufficient to provide the desired low-viscosity conditions in the subsequent pressurized separating units, namely in the strainer unit 106, in the hydrocyclone unit 108, and mainly in the centrifugal machine 91, through which units the heated oil is forced by the operation of pump 107.

In the pressurized centrifugal machine 91, as may be seen from the example thereof in FIG. 3, the oil-water mixture or emulsion is separated centrifugally into the oil fraction overflow designated by arrow A₁ both in FIGS. 1 and 3, the water fraction overflow designated by arrow A₂, and the sludge or underflow fraction from the nozzles designated by arrow A₃. The oil fraction freed of water down to a tiny fraction of one percent is delivered from this pressurized treatment system by the pump 109, for example against the pressure of the oil line to the refinery. The separated water fraction and the underflow however may jointly gravitate from the pressurized interior of the housing of the centrifuge into the receiver tank arrangement 110 which is similarly pressurized constituting a seal against the atmosphere by virtue of the operation of the level-controlled float devices 113 and 114 governing the discharge valve 114a.

The receiver tank 111 also provides the supply of control water that is to be returned or recirculated into the rotor of the centrifuge at a rate regulated to insure the proper establishment of various liquid separating zones in the centrifugal separating chamber of the bowl. It may be preferable to have this control water free of possible pipe scale deposits or the like acquired while in transit from the centrifuge to the receiver tank, and also free at least of certain of the solids separated by the centrifuge. This condition is accomplished when pump 116 forces the water-solids mixture from the receiver tank 111 through the hydrocyclone unit 115 which may however be by-passed by the operation of the valves 118 and 117.

With respect to the operation of the centrifuge of FIG. 3, it will be seen that feed mixture or emulsion such as crude from the hydrocyclone unit 108 enters the rotor under pressure through the upwardly directed stationary feed or induction pipe 32 which corresponds to the supply line 91a in FIG. 1. From the receiving chamber 31 in the rotor the vanes 33 force the emulsion centrifugally through the upwardly divergent conduits 34 into the perforated or slotted vertical feed distributing tubes 35 located in the separating chamber of the bowl and cooperating with the separating discs 24, so that separated oil is displaced inwardly into an inner zone to pass out through overflow 12 at the top, while separated water is displaced outwardly so that from an intermediate zone located outwardly from the oil zone it will reach the bottom overflow 13 via the downwardly convergent passages 27 and 29 interconnected at their

mutually adjoining ends by the annular space 28. Control water enters the rotor through the upwardly directed stationary induction pipe 38 which corresponds to the return line 91b in FIG. 1. Control water thus entering the chamber 35 in the rotor is forced centrifugally through radial conduits 35a and then upwardly through divergent tubes 38a into the extreme outer zone of the separating chamber in the region of the underflow discharging nozzles outwardly from the aforementioned water separating zone. The rate of control water recirculation is regulated as directed by the nozzle flow requirements so that the presence of an adequate zone of separated water is insured in the separating chamber preventing the escape and loss of oil through the nozzles. Thus, if the water content in the crude oil supply should fluctuate, such variations can be compensated for by corresponding changes in the control water recirculation rate. Furthermore, by providing the respective overflows opposite to one another, with the underflow discharging from the extreme outer periphery therebetween, any commingling of separated oil with separated water as through windage effect between the rotor and the housing is avoided, as the extreme peripheral nozzle section of the rotor bowl acts as a barrier or interceptor zone, even as windage effects themselves are minimized or practically eliminated in the simplified construction of the pressurized housing 39 above described.

From the foregoing it will be seen that the pressurized oil separating system of this invention featuring the pressurized centrifuge operation, provides new technical results and advantages heretofore not obtainable in the operation of older treatment systems operating at atmospheric pressure, and heretofore not obtainable in the operation of the Heater-Treaters aforementioned and now generally in use. The improvements and advantages derived from this invention comprise, the salvaging of the light oil fractions by retaining them in the liquid phase even at an elevated viscosity reducing temperature, with the concurrent advantage that the reduction in viscosity due to the presence of those light oil fractions will benefit long distance pumping operations; the improvements in the quality of the respective fractions and the factor that intermingling of the fractions is substantially avoided. Furthermore, the ease of maintenance and operating controls, and finally the structural compactness of the pressurized treatment plant which avoids the use of bulky units such as the conventional Heater-Treaters, and is capable of being designed as a "package" readily removable from one oil well or location to another.

It will be understood that each of the elements described above, or two or more together, may also find useful application in other types of pressurized treatment systems differing from the types described above.

While the invention has been illustrated and described as embodied in a treatment system wherein all the component units herein shown are pressurized, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of this invention.

For example, additional receiver-or holding tanks as well as pumps may be employed or interposed at various points of the system herein shown between respective treatment units, and the flow through the system may be effected in an arrangement operating by gravitational flow, or by the use of pumps, or it may operate partially by gravitation and partially with pumps.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalents of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A crude oil purification treatment system associated with an oil producing well, which comprises a pressurized separating station for separating gases from the crude, means for supplying crude at a controlled rate from said well against the pressure maintained in said separating station; a pressurized oil heating station; means for transferring the degasified crude from said separating station under pressure to said heating station for delivering heated crude therefrom; a centrifugal treatment station including a centrifugal machine having a rotor bowl providing a centrifugal separating chamber for separating said degasified crude into water and separated oil, with one overflow provided for the water and another overflow for the oil, and further having a pressurized housing wherein said rotor is mounted for rotation, means for rotating said rotor, said housing having means to provide around said rotor bowl receiving chambers for receiving oil overflow and water overflow respectively; means for transferring heated crude from said heating station under pressure into said rotor of the centrifugal machine, means for discharging the separated oil from the respective receiving chamber of said housing against pressure at least high enough to maintain the liquid phase of light fractions in the separated oil; a pressurized receiver station for the separated water; means for supplying water into the separating chamber of said rotor bowl for controlling the location of the oil-water interface; means for transferring separated water from the respective receiving chamber of said housing to said receiver station; means for releasing water from said pressurized receiver station at a controlled rate into the atmosphere; gas pressure equalizing conduit means for connecting all of said stations with one another in a common pressure equalizing system, and pressure regulating gas discharge means for said equalizing system, said pressure regulating means including means for maintaining in said system a gas pressure at least high enough to maintain the liquid phase of light fractions in the oil.

2. The treatment system according to claim 1, wherein said gas separating station, said heating station, and said receiving station each comprise a pressurized tank equipped with means for controlling the liquid level in the respective tanks.

3. The treatment system according to claim 1, wherein said means for transferring degasified crude comprise a pressurized storage tank for said crude equipped with means for controlling the level in said tank, and with a connection to said pressure equalizing conduit means.

4. A crude oil purification treatment system associated with an oil producing well, which comprises a pressurized separating station for separating gases from the crude; means for supplying a crude at a controlled rate from said well against the pressure maintained in said separating station; a pressurized oil heating station; means for transferring the degasified crude from said separating station to said heating station for delivering heated crude therefrom; a centrifugal machine having a rotor bowl providing a centrifugal separating chamber for separating said degasified crude into water and separated oil, with one overflow provided for the water and another overflow for the oil, and also provided with nozzle means for discharging underflow, and further having a pressurized housing wherein said rotor is mounted for rotation, means for rotating said rotor, said housing having means to provide around said rotor bowl receiving chambers for receiving oil overflow and water overflow respectively; means for transferring heated crude from said heating station into said rotor of the centrifugal machine; means for discharging the separated oil from the respective receiving chamber of said housing against pressure at least high enough to maintain the liquid phase of light fractions in the separated oil; a pressurized re-

11

ceiver station for the separated water; means for transferring separated water from the respective receiving chamber of said housing to said receiver station; recirculating means for returning water from said receiver station into the separating chamber of said rotor bowl; means for removing underflow material including solids from the system; means for releasing water from said pressurized receiver station at a controlled rate into the atmosphere; gas pressure equalizing conduit means connecting all of said stations with one another in a common pressure equalizing system, and pressure regulating gas discharge means for said equalizing system, said pressure regulating means including means for maintaining in said system a gas pressure at least high enough to maintain the liquid phase of light fractions in the oil.

5. The treatment system according to claim 4, wherein said gas separating stations, said heating station, and said receiver station each comprise a pressurized tank equipped with means for controlling the liquid level in the respective tanks.

6. The treatment system according to claim 4, wherein said means for transferring degasified crude comprise a pressurized storage tank for said crude equipped with means for controlling the level in said tank, and with a connection to said pressure equalizing system.

7. The treatment system according to claim 4, wherein said means for transferring heated crude to the centrifugal machine comprise a strainer station for effecting the removal of coarse particle solids from the heated crude, and a cyclone station for effecting the removal of abrasive particle solids from the crude and arranged down flow from said strainer station, and pump means effective to insure passage of said crude through said strainer station and said cyclone station.

8. The treatment system according to claim 4, wherein said housing of the centrifugal machine is compartmented for joint discharge therefrom of underflow and the separated water into said receiver station.

9. The treatment system according to claim 4, with means provided for delivering the underflow as well as the separated water from the centrifugal machine to said receiver station.

10. The treatment system according to claim 4, with means provided for delivering both the underflow and the separated water into said receiver station, wherein said receiver station comprises a pressurized tank arrangement having a primary section with overflow and a sec-

12

ondary section receiving said overflow and equipped with means for controlling the liquid level therein, wherein said recirculating means comprise a recirculating pump having its intake end connected to said primary section and its delivery end connected to said centrifugal machine, and wherein said solids are removed while the liquid is transferred from said primary section to the centrifugal machine.

11. The treatment system according to claim 4, wherein separator means are provided for separating coarse solids and abrasive solids from the heated crude while in transit from the heating station to the centrifugal machine.

12. The treatment system according to claim 4, wherein separator means are provided for separating coarse solids and abrasive solids from the heated crude while in transit from the heating station to the centrifugal machine, and wherein said recirculating means lead from said receiver station to said centrifugal machine, including a pump and solids separator means between said pump and the centrifugal machine.

13. The treatment system according to claim 4, with means providing for delivering both the underflow and the separated water into said receiver station, wherein said receiver station comprises a pressurized tank with outlet means operable to control the liquid level in the tank, and wherein said recirculating means lead from said tank to said centrifugal machine.

References Cited by the Examiner

UNITED STATES PATENTS

1,474,629	11/23	Hall	252—347
1,600,030	9/26	Ballard	211—78
1,948,481	2/34	Turner.	
2,188,018	1/40	Stewart	55—175
2,261,100	10/41	Erwin.	
2,261,101	10/41	Erwin	55—175
2,365,256	12/44	Edvarson	252—347
2,773,556	12/56	Meyers et al.	
2,780,304	2/57	Pew et al.	
2,816,490	12/57	Boadway et al.	
2,973,896	3/61	Peltzer	233—19

HARRY B. THORNTON, *Primary Examiner.*

WALTER BERLOWITZ, HERBERT L. MARTIN,
GEORGE D. MITCHELL, *Examiners.*