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2,663,687

ELECTRIC TREATER

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Fig. 1.

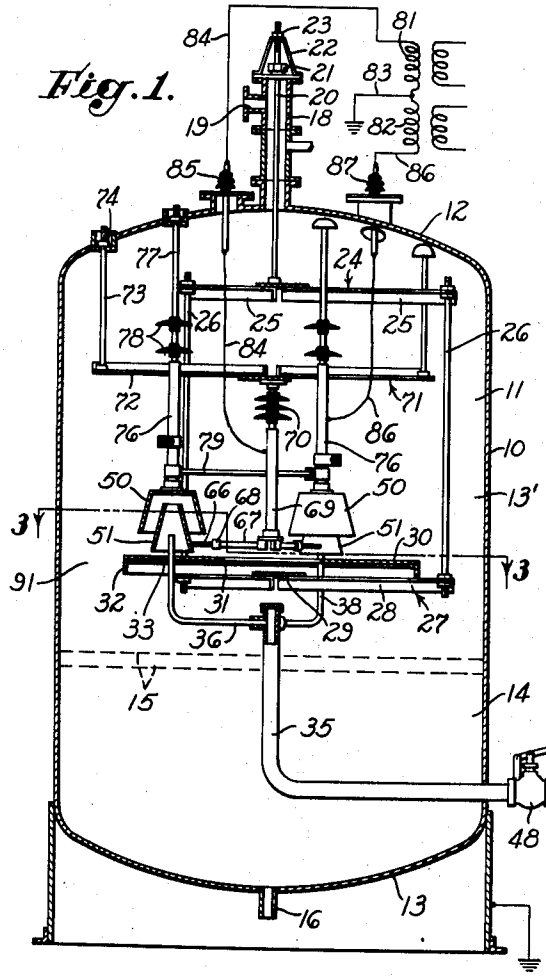


Fig. 2.

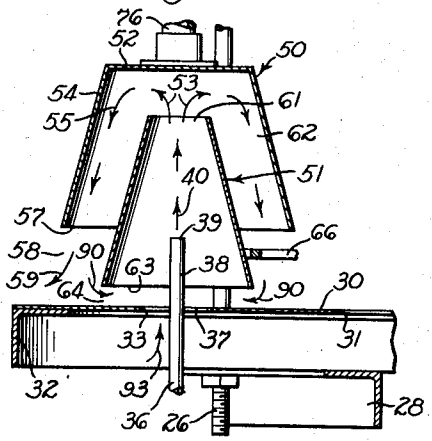


Fig. 4.

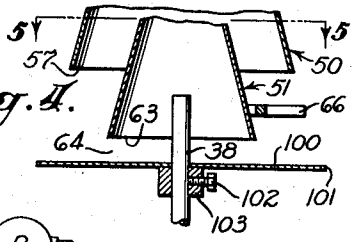


Fig. 3.

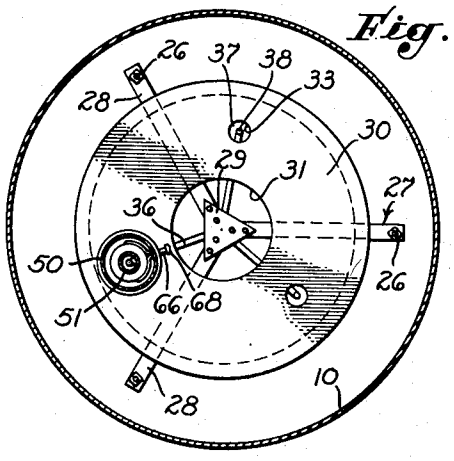
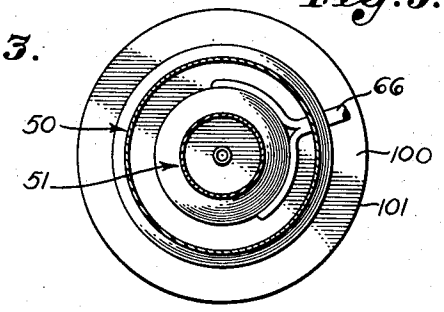


Fig. 5.



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ELECTRIC TREATER

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7 Claims. (Cl. 204—302)

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My invention relates to electric treaters and more particularly to an electric treating unit useful for the resolution of water-in-oil type emulsions.

In my previous Patent No. 2,320,059 I have disclosed and claimed an electric treating apparatus in which a sleeve electrode extends upwardly within an inverted cup electrode, the emulsion discharging upwardly into the sleeve electrode in a manner tending to aspirate large quantities of oil-continuous material thereinto from the surrounding environment.

It has now been found that improved treatment of many emulsions is possible by restricting the flow of oil-continuous material into the sleeve electrode and thence into the main treating space between the sleeve electrode and the skirt of the inverted cup electrode. This is true both as concerns the use of the treating unit in the electrical dehydration of naturally-produced crude oil emulsions and in the electrical purification of pipe-line oils of low water content. In the former process, the crude oil emulsion usually contains from 10% to 50% of water, the electrical treatment coalescing the water into gravitationally-separable masses and producing a dehydrated or pipe-line oil of relatively low water content. The amount of water in the effluent oil usually does not exceed 3% and commonly is much lower. Even if such dehydrated or pipe-line oil contains less than 1% of water, it may still contain objectionable amounts of water-soluble or water-wettable impurities not removed in the dehydration process. For example, it may contain salts detrimental to refinery equipment. Such impurities can be very largely removed by mixing relatively fresh water with the oil of low water content and subjecting the resulting mixture to the action of a high-voltage coalescing electric field, as taught in my patent supra.

My invention is particularly useful in such electrical purification of oils of low water content to remove water-soluble or water-wettable impurities. In this connection, the improved treating unit herein disclosed makes possible a substantial reduction in the amount of relatively fresh water used in the process. It also produces better treatment and often produces effluent oils of lower impurity content than the apparatus of my prior patent.

It is an object of the present invention to employ a baffle to restrict the aspiration of oil-continuous material into the inter-electrode space.

It is another object of the invention to provide a treating unit in which a baffle is disposed in

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novel relationship with concentric or nested electrodes.

A further object is to discharge the emulsion in a direction away from the baffle and into an electrode structure which deflects the emulsion and returns the electrically treated constituents to a position adjacent the baffle.

Further objects and advantages of the invention will be evident to those skilled in the art from the following exemplary embodiments of the invention which will be particularly described as applied to the electrical purification process in which relatively fresh water is mixed with a typical pipe-line oil of low water content and containing no more than a few per cent of water, e. g., to those oils more particularly described in my prior patent.

Referring to the drawing:

Fig. 1 is a vertical sectional view of a treater employing several treating units of the invention,

Fig. 2 is an enlarged sectional view of one of these treating units,

Fig. 3 is a horizontal sectional view taken along the broken line 3—3 of Fig. 1,

Fig. 4 is a fragmentary sectional view of an alternative form of the invention, and

Fig. 5 is a sectional view taken along the line 5—5 of Fig. 4.

Referring particularly to Fig. 1, the treater is shown as including a tank 10 providing a chamber 11 closed at its upper and lower ends by heads 12 and 13. Initially or after the treater has been in operation for a period, the tank 10 contains a body of oil-continuous material 13' and a body of water-continuous material 14, the zone of transition being indicated between dotted lines 15 and representing a zone in which a layer of sludge or unresolved emulsion may be present. Water-continuous material may be drawn from the lower end of the tank through a pipe 16, this material being usually brackish water substantially free of oil to present no serious disposal problem.

Extending upwardly from the tank 10 is a pipe structure 18 providing an outlet 19 from which the treated oil may be withdrawn. The flow of the treated oil through the outlet 19 and of the water-continuous material discharging through the pipe 16 may be controlled, by any suitable means known in the art, to maintain the transition zone, indicated between dotted lines 15, in approximately the position shown and preferably in such way as to maintain a back pressure on the tank 10.

A rod 20 extends through a gland 21 at the

top of the pipe structure 18 and through a saddle member 22 where it is supported by a nut 23. By turning the nut the vertical position of the rod 20 may be adjusted.

The lower end of the rod 20 extends into the chamber 11 and carries an upper frame 24 which may include three radially extending arms 25. Rods 26 depend from these arms and carry a similarly formed lower frame 27 likewise including three radial arms 28 joined at their inner ends by a plate 29.

A baffle 30 is supported from the lower frame. In the embodiment shown in Figs. 1–3, the baffle 30 is a large annular plate having a central opening 31 and attached to a ring 32 formed of angle iron and resting on the arms 28. Equally spaced around the baffle 30 are openings 33.

The incoming emulsion moves through a capped riser pipe 35 and is divided between a number of smaller emulsion-delivery pipes 36 which are bent upwardly to extend respectively through the openings 33, leaving an annular space 37 around each pipe. The upwardly bent portion of each pipe comprises an emulsion discharge pipe 38 having an upwardly directed discharge orifice 39 from which the stream issues at considerable velocity as indicated by the arrow 40 of Fig. 2.

In the dehydration of crude oil emulsions of high water content, the emulsion may be pumped by an oil pump 42 directly to the riser pipe 35. In the electrical purification process, the oil reaching the pump 42 contains no more than a few per cent of water, usually being a pipe-line or already-dehydrated oil. In this instance, relatively fresh water is advanced from a pipe 43 by a pump 44 to meet the oil stream in a T fitting 45 where the oil and water preliminarily mix and move through a pipe 46 to the riser pipe 35. Additional mixing will take place during this flow, during flow through the emulsion delivery pipes 36 and/or during discharge from the orifices 39. Some oils require additional mixing in which event a weight-loaded valve 48 may be disposed in the pipe 46.

The object of the mixing, wherever performed, is to produce an emulsion which can be continuously and substantially completely resolved with the aid of the electric fields to be described, into two components, namely, an oil of low water content and a substantially oil-free water with no progressive building up or accumulation of any sludge layer such as would tend to short-circuit the electrodes. Too intimate a mixing will, on most oils, cause the continued building up of a layer of sludge in the transition zone, indicated between the dotted lines 15. A sludge layer which does not progressively build up in thickness or accumulate can be tolerated but the mixing should be such that the sludge layer will not build up to the electrodes nor build downwardly to the draw-off pipe 16.

In the treater shown, three treating units are employed, each comprising a cup-like electrode 50 a sleeve-like electrode 51 and the adjacent portion of the baffle 30. As best shown in Figs. 1 and 2, each cup-like electrode 50 is in the form of an inverted cup having a deflector 52 disposed transversely of the stream flowing as indicated by the arrow 40 to spread this stream as indicated by arrows 53. Each electrode 50 includes also a skirt 54 which further deflects the resulting annular stream as indicated by the arrows 55 and which guides same downwardly. The skirt 54 is preferably, though not invariably, flared downwardly, as suggested. The lower portion of the electrode 50 provides an annular lip or edge 57 spaced above the baffle 30 to provide an annular passage 58. The baffle 30 guides or deflects the annular stream to flow outwardly through the annular passage 58, as suggested by the arrow 59.

Each sleeve-like electrode 51 extends into the corresponding electrode 50 and provides an upper end 61 spaced a distance below the deflector 52. The sleeve-like electrode 51 preferably extends downwardly at substantially the same angle as the skirt 54 to provide an annular treating space 62 therebetween. The lower end of the sleeve-like electrode 51 provides an annular edge 63 which is spaced a small distance from the baffle 30 to provide an auxiliary annular passage 64. The electrodes 50 and 51 are mounted concentrically with respect to the axis of the discharge pipe 38 and are electrically insulated from each other.

To accomplish this result, each of the sleeve-like electrodes 51 is welded to bifurcations of an arm 66. The three arms 66 slide adjustably in three sleeves 67, being secured in proper angular and radial position by a lock means 68, as described more fully in my patent supra. The inner ends of the sleeves 67 are secured to a rod 69 supported centrally of the tank 10 by a suspension insulator 70 carried by an intermediate frame 71. This frame may be constructed similarly to the frames 24 and 27, providing arms 72 which are suspended from rods 73. These rods preferably extend through the end member 12 and are threaded to receive nuts 74. By turning the nuts, the position of the intermediate frame 71 can be varied as can also the vertical position of each of the electrodes 51.

Each electrode 50 is connected to a support 76 hung from a rod 77 by a suspension insulator 78, the rod 77 being adjustable from the exterior of the tank as previously described with reference to the rods 73. The three supports 76 are joined by spacing members 79 to hold them in fixed positions relative to each other and to connect electrically each of the supports 76 and their corresponding electrodes 50.

A high-voltage source is connected to one or the other or both of the electrodes 50, 51 to establish a coalescing electric field therebetween. The preferred energizing system is shown in Fig. 1 as including a double-transformer system including transformers 81 and 82 with secondary windings additively connected, the common terminal of these windings being grounded as indicated at 83. The high-voltage terminal of the transformer 81 is connected by a conductor 84 through an inlet bushing 85 to the rod 69 to energize the several electrodes 51. Similarly, the high-voltage terminal of the transformer 82 is connected by a conductor 86 through an inlet bushing 87 to one of the supports 76 for energizing the several cup-like electrodes 50. The tank 10 and the emulsion discharge pipes 38 are preferably grounded. By this connection, the potential between the electrodes 50 and 51 is represented by the sum of the voltages of the transformers 81, 82 but the potential between either electrode and any grounded portion of the equipment will be only one-half this value if the transformers are of equal voltage. This gives attendant advantages as mentioned in my patent supra.

In the embodiment of the invention shown in Figs. 1–3, the baffle 30 is also grounded through its supporting structure. With this arrangement half-voltage fields will be established in the

annular passage 58 and in the auxiliary annular passage 64, respectively between the annular edges of the electrodes 50, 51 and the baffle 30. A half-voltage field will also be present in the annular space 37 and between the emulsion discharge pipe 38 and the electrode 51 of each treating unit.

In the operation of this embodiment in the electrical desalting of pipe-line oils, operating conditions may be as defined in my prior patent, except that the amount of relatively fresh water can be substantially reduced and often cut in half as compared with the same treatment without the baffle 30. On certain oils as little as 5% of relatively fresh water by volume can be employed, as compared with prior uses of 10–15% water on these oils. A typical voltage of each of the transformers 81, 82 is 16,000 volts with spacings across the annular treating space 62 of about four inches.

It has been found desirable to minimize the spacing between the annular edge 63 and the baffle 30. A spacing of about 2'' will be found satisfactory and in some instances this distance may be reduced to about 1⅜'' without causing short-circuiting, erratic operation or too high a current drain.

With this system, the incoming emulsion discharging from the discharge orifice 39 as a relatively high-velocity stream, is first subjected to a half-voltage field between the discharge pipe 38 and the electrode 51.

This stream is deflected or spread by the deflector 52 to enter a full-voltage field between the upper edge of the electrode 51 and the deflector 52. The resulting annular stream flowing downwardly through the annular treating space 62 is also subjected to a full-voltage field. When this downwardly moving stream nears the baffle 30 it is again deflected outwardly through a half-voltage field in the annular passage 58. A small portion of the downwardly flowing annular stream will be aspirated inwardly through the auxiliary annular passage 64, as suggested by arrows 90, to move through a half-voltage but relatively high-gradient field in the auxiliary annular passage, thus re-entering the interior of the electrode 51 to be recycled therearound.

In passing through the electric fields, the water droplets of the emulsion are coalesced into masses of sufficient size to gravitate from the oil and to the body of water-continuous material 14. The baffle 30 apparently aids in this separation either through deflection of the downwardly moving stream of treated constituents or through displacement of the coalesced masses away from the immediate vicinity of the treating unit to drop through the oil either in an annular passage 91 between the periphery of the baffle 30 and the tank 10 or through the opening 31 of the baffle. This gives an opportunity for the oil immediately beneath the baffle 30 to be relatively dry so that any such oil aspirated upwardly through the annular space 37 of each treating unit, as indicated by the arrow 93 of Fig. 2, will contain less water than would such aspirated material in the absence of the baffle 30. The amount of such aspirated material flowing as indicated by the arrow 93 can be controlled by changing the diameter of the corresponding opening 33 or its emulsion discharge pipe 38.

In an alternative embodiment of the invention, illustrated in Figs. 4 and 5, each treating unit includes the same arrangement of electrodes 50 and 51 except that an individual baffle 100 is used as a part of each treating unit. In this embodiment the baffle 100 is a circular plate having a periphery 101 somewhat larger in diameter than the annular edge 57 of the electrode 50. It can be supported directly on the emulsion discharge pipe 38 of this treating unit as by use of a set screw 102 extending through a hub 103 of the baffle 100. This arrangement permits adjustment of the position of the baffle relative to the annular edge 63 of the electrode 51 with corresponding adjustment of the width of the auxiliary annular passage 64.

With this arrangement shown in Figs. 4 and 5 there is substantially no aspiration of oil-continuous material into the electrode 51 from beneath the baffle 100 which aspiration-induced flow is indicated in Fig. 2 by the arrow 93. In addition, the baffles 100 are individually adjustable and the double-frame support for the baffle 30, shown in Fig. 1, is eliminated. Except for these differences, the mode of operation of the embodiment of Figs. 4 and 5 is substantially the same as that previously described, the coalesced water masses being guided by the baffles 100 to their peripheries before settling to the water-continuous body 14.

Various changes and modifications can be made without departing from the spirit of the invention as defined in the appended claims.

I claim as my invention:

1. In an electric treater for emulsions, the combination of: a tank adapted to contain a body of oil-continuous material; an inverted cup-like electrode in said tank; a sleeve-like electrode extending upwardly within said inverted cup-like electrode, said sleeve-like electrode having an entrance end; an emulsion discharge pipe discharging upwardly into said entrance end of said sleeve-like electrode and tending to aspirate oil-continuous material into said entrance end; a baffle having a central opening of substantially smaller cross-sectional area than said entrance end and having an outer periphery at least as large as said entrance end; and means for mounting said baffle to extend across said entrance end but spaced from said sleeve-like electrode and with said pipe extending through said central opening.

2. An electric treater as defined in claim 1 in which said baffle tightly surrounds said pipe to eliminate any aspiration of oil-continuous material into said sleeve-like electrode through the junction of said baffle and said pipe.

3. In an electric emulsion treater having a sleeve electrode providing open ends bounded by annular edges and adapted to be positioned in an oil-continuous environment, said treater having a pipe jetting a stream of the emulsion to be treated into one open end of the sleeve electrode and toward the other open end thereof in a manner to aspirate oil-continuous material from around said sleeve electrode into the interior thereof to flow therethrough in the direction of emulsion flow in said pipe, said emulsion and said oil-continuous material moving from the other open end of said sleeve electrode and said pipe and sleeve electrode being at different potentials to establish an electric field therebetween, a structure for reducing such aspiration of oil-continuous material into said sleeve electrode, said structure including: a substantially flat baffle of substantially larger size than said annular edge bounding said one open end of said sleeve electrode, said baffle providing an opening of sufficient size to receive said pipe but substan-

tially smaller in diameter than said one open end of said sleeve electrode; and means for mounting said baffle at a position closely adjacent but spaced from said annular edge bounding said one open end of said sleeve electrode and in a position to traverse a substantial portion of said one open end of said sleeve electrode to define a restricted annular passage between such edge and said baffle, said restricted annular passage throttling the flow of such aspirated material entering said one open end of said sleeve electrode, said mounting means mounting said baffle to extend around said pipe with said pipe extending through said opening.

4. An electric emulsion treater as defined in claim 3, including a cup-like electrode in which said sleeve electrode is nested to guide the emulsion and aspirated oil-continuous material to flow as a stream in a substantially reverse direction along the exterior of said sleeve electrode toward said baffle and past said restricted annular passage whereby the material aspirated through said restricted annular passage is drawn from such reverse-flowing stream, said cup-like electrode providing an annular lip spaced from said baffle a greater distance than the spacing between said annular edge and said baffle to provide a larger annular passage for discharge of the non-aspirated portion of the reverse-flowing stream, and including means for establishing an electric field in said restricted annular passage.

5. In an emulsion treating unit adapted to be submerged in a body of oil-continuous material, the combination of: a baffle having an opening therein; a discharge pipe extending through said opening in said baffle and providing a forwardly directed stream-discharging orifice positioned a short distance beyond said baffle; a sleeve-like electrode; means for mounting said sleeve-like electrode spaced from said baffle and concentrically with respect to the stream discharged forwardly from said discharge pipe, said sleeve-like electrode providing an open exit end through which said stream moves, said sleeve-like electrode providing an open entrance end into which said orifice discharges, said baffle being of greater diameter than said open entrance end and traversing said open entrance end and said opening in said baffle being substantially smaller than said open entrance end so as to restrict aspirated flow of oil-continuous material into said entrance end; a cup-like electrode including a deflector disposed transversely of said stream at a position beyond said open exit end, said cup-like electrode including a skirt extending angularly toward said baffle but spaced therefrom, said cup-like electrode surrounding said sleeve-like electode to define an annular treating space therebetween, said deflector spreading said stream to form an annular stream moving through said annular treating space in a reverse direction toward said baffle, said skirt of said cup-like electrode providing an annular lip spaced from said baffle to define an annular passage through which the material of said annular stream flows outwardly; and means for electrically insulating said sleeve-like electrode from said cup-like electrode to permit establishment of a high voltage field in said annular treating space.

6. A treating unit as defined in claim 5 in which said sleeve-like electrode provides an annular edge spaced from said baffle to define an auxiliary annular passage, and including means for electrically insulating said sleeve-like electrode from said baffle to permit establishment of an electric field in said auxiliary annular passage whereby any material moving through said auxiliary annular passage is subjected to an electric field.

7. A treating unit as defined in claim 5 in which said sleeve-like electrode provides an annular lip spaced from said baffle to define an auxiliary annular passage through which a portion of said annular stream may return to the interior of said sleeve-like electrode and in which said annular lip of said sleeve-like electrode is closer to said baffle than said annular lip of said cup-like electrode.

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