July 14, 1959 D. W. TURNER 2,894,895

DUAL ELECTRIC TREATER FOR EMULSIONS

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FIG. 1.

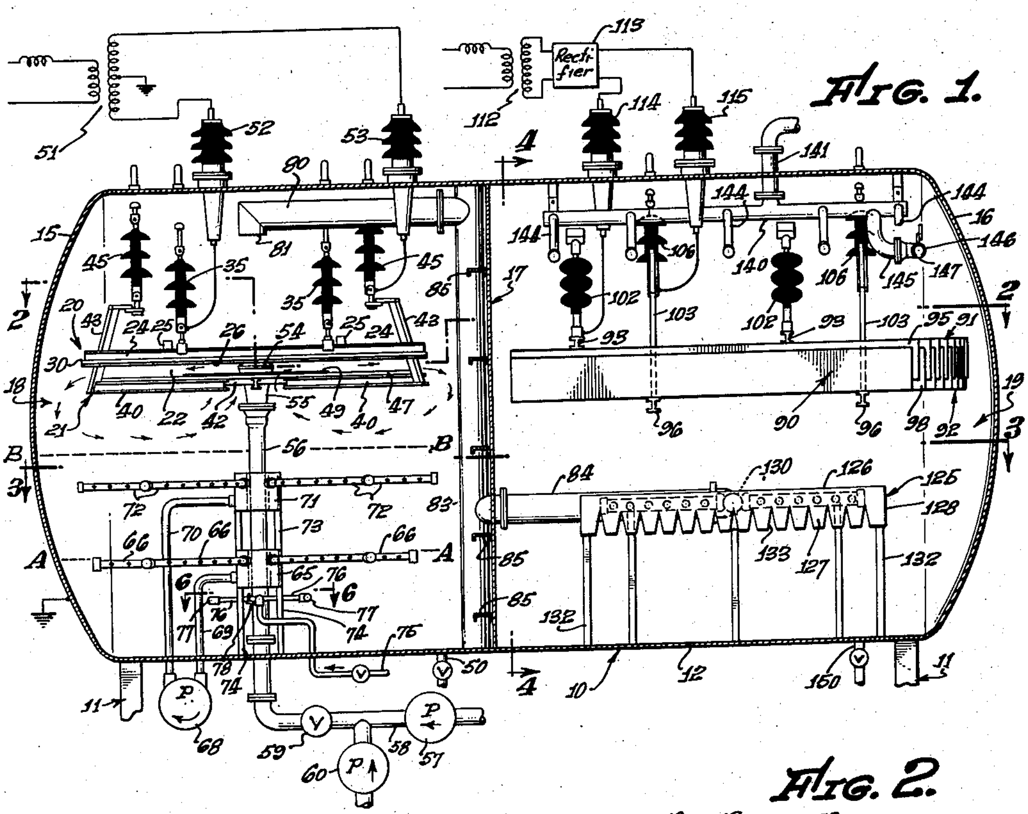

FIG. 2.

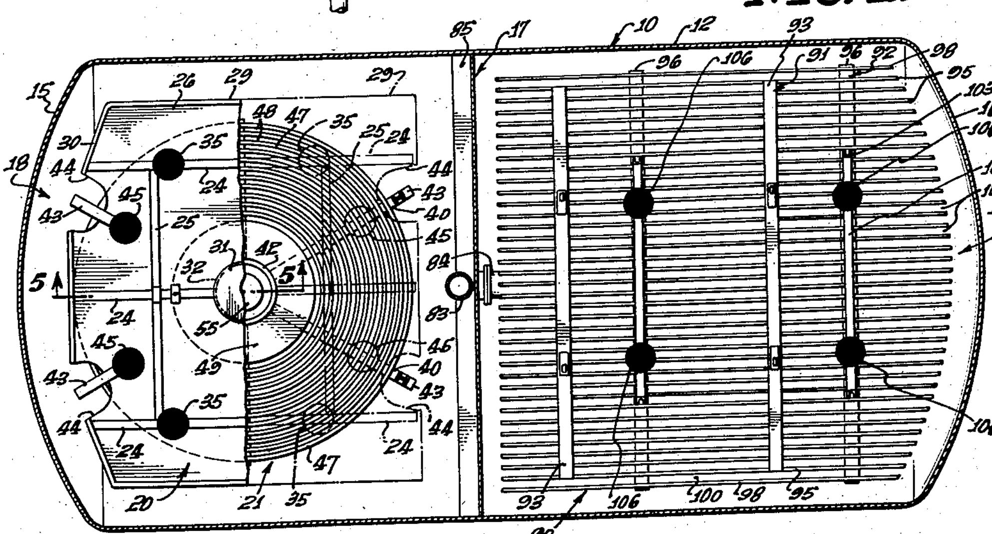

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FIG. 3.

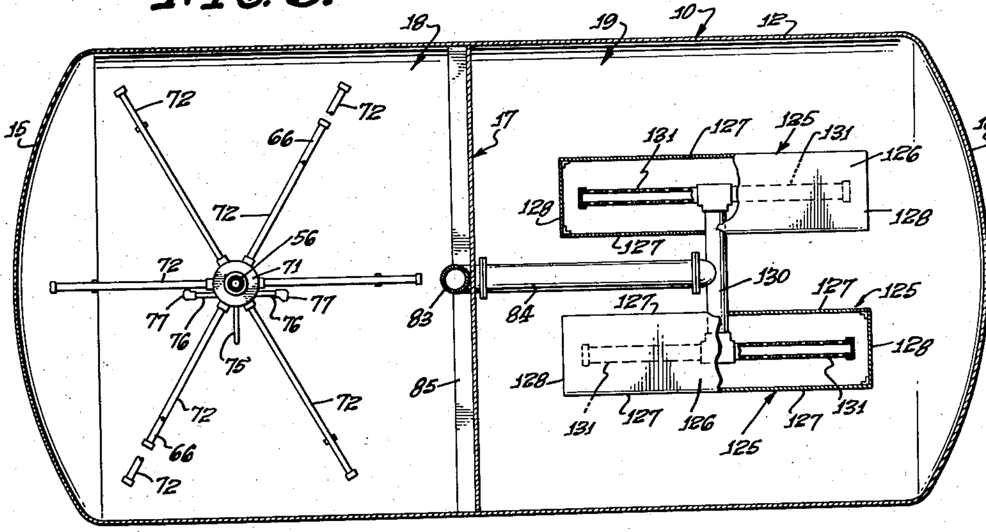

FIG. 4.

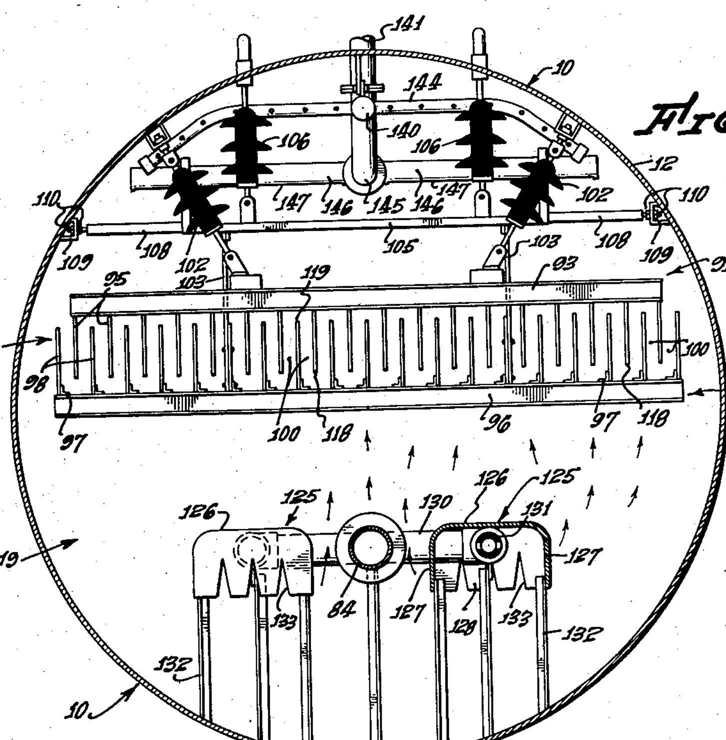

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FIG. 5.

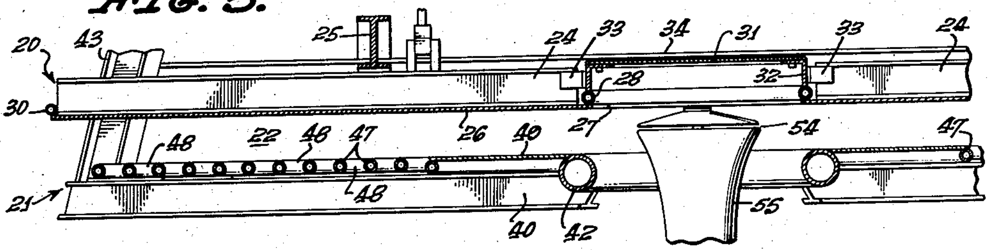


FIG. 6.

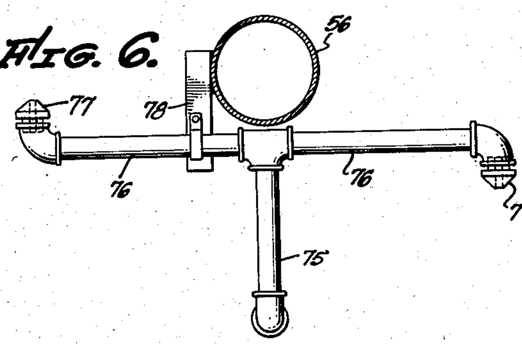
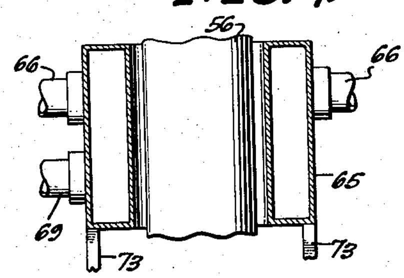


FIG. 7.



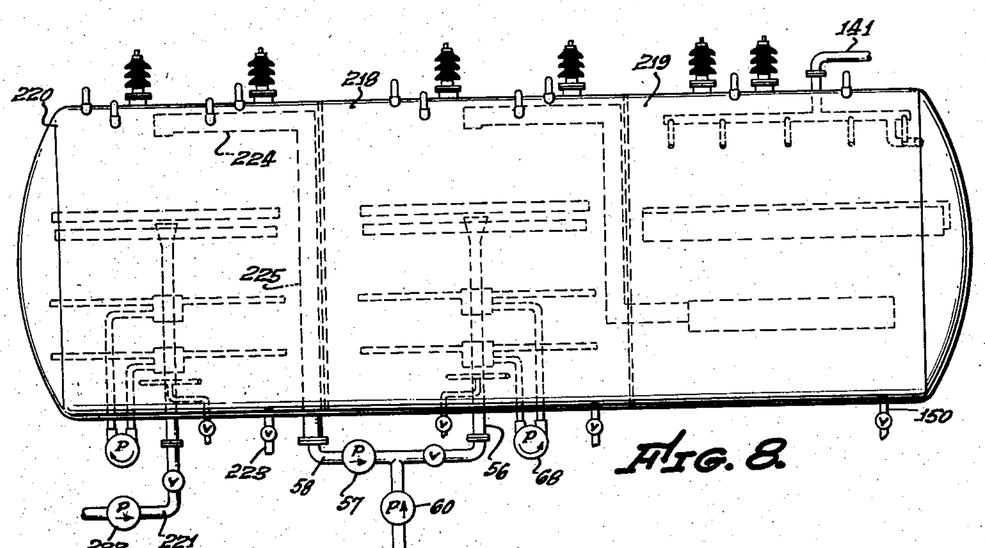


FIG. 8.

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United States Patent Office

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2,894,895

DUAL ELECTRIC TREATER FOR EMULSIONS

Delber W. Turner, Houston, Tex., assignor to Petrolite Corporation, Wilmington, Del., a corporation of Delaware

Application February 11, 1955, Serial No. 487,551

12 Claims. (Cl. 204—302)

This invention relates to the electric treatment of emulsions and to a novel electric treater and novel electrode arrangements useful in this connection.

The emulsions with which this invention is concerned are generally classified as oil-continuous emulsions. They have a continuous phase of oil and a dispersed phase of oil-immiscible particles dispersed throughout the oil and usually held therein as a rather stable emulsion. Most commonly the dispersed-phase particles are aqueous droplets, e. g., droplets of water or aqueous solutions of acidic, alkaline, or substantially neutral substances. The invention is well adapted to the dehydration of crude oil emulsions but will be exemplified as applied to the electrical desalting of a pipeline or already-dehydrated crude oil.

The salty oil received by present day electrical desalting processes for treatment is actually an oil-continuous emulsion, often resulting from a dehydration process, containing from a fraction of one percent up to about three percent of residual brine. These salts must be largely removed before distillation or cracking if corrosion and other undesirable effects are to be avoided. If about 3–20% of relatively fresh water is emulsified with the salty oil, the resulting emulsion can be largely resolved in a high-voltage alternating-current electric field. This process is widely practiced at the present time and is usually capable of removing 80–95% of the salt. It is an object of the present invention to provide a multi-zone electric treater in which such a desalting operation can be carried out in one zone thereof.

It is often desirable, however, that even more of the salt should be removed from the salty oil before it is subjected to high temperatures in the refining or cracking operation. It is a general object of the present invention to provide a unitary electric treater capable of super-desalting crude oils or of treating oil-continuous emulsions to reduce the content of residual dispersed-phase material to a value far below that possible by passage through a conventional alternating-current electric treater.

Reduction in the amount of residual dispersed-phase material in oils already subjected to electric treatment is difficult. The amount of residual material is usually substantially less than one percent, representing the most refractory of the particles present in the emulsion already treated by the use of an electric field or by other methods of resolution. Merely subjecting the treated oil with its residual dispersed-phase material to a second alternating-current field will have little if any beneficial effect. It is often undesirable to add additional relatively fresh water at this point and it would be very desirable if the residual emulsion could be directly resolved. It is an object of the present invention to provide an electric treater capable of such resolution. A further object is to provide a multi-stage electric treater of novel construction in which an oil-continuous emulsion can be progressively resolved, the last stage producing a treated oil containing no more than a few hundredths and often no more than a few thousandths of a percent of residual dispersed-phase material.

These results are possible if high-voltage unidirectional electric fields are employed in a properly-designed final treating stage and if the emulsion reaching this last stage has been suitably conditioned for the treatment it is to receive therein. It is an object of the invention to provide such last-stage treatment and such conditioning treatment in unitary apparatus.

It is an object of the present invention to treat an oil-continuous emulsion in stages as it flows in a substantially zig-zag or up-and-down path as it advances along a substantially-horizontal container. A further object is to provide a substantially-horizontal container much greater in length than height and which is compartmented to provide at least two zones in which an emulsion is successively treated. Another object is to provide a novel arrangement for conducting the treated emulsion from one zone to a succeeding zone.

Further objects of the invention reside in the provision of novel electrode arrangements and novel emulsion-distribution systems for electric treaters. Further objects and advantages will be evident to those skilled in the art from the following description of exemplary embodiments.

Referring to the drawings:

Fig. 1 is a vertical sectional view of a double-compartment electric treater of the invention;

Fig. 2 is a horizontal sectional view taken along the broken line 2—2 of Fig. 1;

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

Fig. 4 is a vertical sectional view taken along the line 4—4 of Fig. 1;

Fig. 5 is an enlarged fragmentary sectional view taken along the line 5—5 of Fig. 2;

Fig. 6 is a fragmentary sectional view taken along the line 6—6 of Fig. 1;

Fig. 7 is an enlarged fragmentary sectional view through one of the sludge-breaker manifolds; and

Fig. 8 is an elevational view of a three-stage treater of the invention.

Referring particularly to Figs. 1–4, the treater includes a container **10** much greater in longitudinal length than width, mounted substantially horizontally by supports indicated generally at **11**. The container **10** is shown as including a substantially-horizontal cylindrical member **12** traversed by a plurality of head means, shown as including domed end members **15** and **16** and a partition **17**, these head means being spaced from each other to define separate cylindrical zones designated as a first zone **18**, where preliminary treatment takes place, and a second zone **19**, in which the final or clean-up treatment is effected.

If the treater shown in Fig. 1 is to be used for the super-desalting of a crude oil, as will be assumed for purpose of explanation, the initial electric desalting operation in the first zone **18** may be by use of conventional techniques and equipment, for example, those described in the patent of Harold C. Eddy, No. 2,182,145. However, Figs. 1–7 illustrate novel apparatus arrangements in this connection described as follows.

Suspended in the first zone **18** are substantially horizontal upper and lower electrodes **20** and **21** spaced to define a treating space **22** extending horizontally outward from a central vertical axis. The upper electrode **20** includes a framework made of longitudinal beams **24** and transverse beams **25**, as shown in Figs. 2 and 5, supporting a plate **26** presenting a smooth lower surface which forms the upper boundary of the treating space **22**. This plate has a central opening **27**, the plate being reinforced and rigidified adjacent this circular opening by a circular pipe 28 welded thereto. The shape of the periphery of the plate 26 conforms generally to the adjacent walls of the first zone 18, being substantially rectangular, as best shown in Fig. 2 by the full lines and by the dotted lines 29, but bowing adjacent the end member 15 to conform substantially to the shape thereof. This periphery may be reinforced by a small pipe 30 welded thereto. The opening 27 is closed by an inverted cup-like member including a transverse wall 21 and a circular lip 32 which is held in contact with the circular pipe 28 as by brackets 33 (Fig. 5). This structure provides a relieved space 34 for the emulsion distributor to be described. The upper electrode 20 is insulated from the container 10 by suspension insulators 35.

The lower electrode 21 includes a framework 40 consisting of radially extending members joined at their inner ends by a circular pipe 42 welded thereto, and supported at their outer ends by suspension members 43 which extend through cut-out portions 44 of the periphery of the upper electrode 20, being supported by suspension insulators 45. Secured concentrically to the radially-extending members of the framework 40 are rings 47 spaced from each other by spaces 48 which permit coalesced material to drop from the treating space 22. Bridging the space between the innermost ring 47 and the circular pipe 42 is an annular plate 49 which forms the lower boundary of an inner portion of the treating space 22.

Means is provided for establishing an electric field in the treating space 22 of sufficient intensity to coalesce at least some of the dispersed particles of the emulsion into masses of sufficient size to gravitate from the oil and collect as a body below the level A—A from which it can be withdrawn through a valved pipe 50. This field-establishing means may be a source of alternating or unidirectional potential, being illustrated as a conventional high-voltage transformer 51 with its high-voltage terminals connected through bushings 52 and 53 to the upper and lower electrodes 20 and 21. The container 10 is grounded, as is also a central point of the high-voltage transformer winding, whereby electric fields are established between each of the electrodes 20, 21 and the container 10 or any grounded element therewithin, a double-voltage field being established in the treating space 22.

The emulsion to be treated is preferably introduced directly into the treating space 22 as a thin outwardly-flowing high-velocity sheet of emulsion discharging from an annular orifice 54 of a distributor 55, supported on a riser pipe 56. In the desalting process, the salty oil may be pumped into the riser pipe 56 by a pump 57 through a line 58 including a mixing valve 59. Relatively fresh water is pumped into the line 58 by a pump 60, the mixing valve 59 forming the emulsion which is treated by the electric field in the treating space 22. The emulsion is confined to flow outwardly beneath the plate 26 of the upper electrode, but electrically coalesced material can settle therefrom through the spaces 48 or at positions outwardly beyond the electrodes. The treated oil or residual emulsion rises to the top of the first zone 18.

A layer of sludge comprising unresolved emulsion, much of it in the form of a coarse oil-continuous emulsion in the process of separation, tends to form above the body of the separated material. The upper boundary of such a sludge layer is suggested by the line B—B, the lower boundary being suggested by the previously-mentioned line A—A, these boundaries being in the nature of transition zones. The sludge in this sludge zone must be resolved at a rate substantially corresponding to the rate at which the sludge layer receives sludge constituents, otherwise the sludge layer may build up to short circuit the electrodes. Figs. 1, 3, 6 and 7 illustrate two sludge-resolving means which can be used individually or collectively to increase the rate of sludge resolution.

The first sludge-resolving means is of the recirculation type. It includes an inlet manifold 65 surrounding the riser pipe 56 with six radial pipes 66 extending therefrom and capped at their outer ends. These pipes provide sidewardly-opening perforations through which are drawn a mixture of a relatively small percentage of sludge, drawn from above the line A—A, and a relatively large percentage of separated dispersed-phase material, usually brackish water, drawn from the zone beneath the line A—A. The pressure within the manifold 65 is reduced by a circulating pump 68 which intakes from the manifold 65 through a pipe 69.

The pump 68 is of any suitable type which will induce a turbulence aiding the resolution of the sludge. A centrifugal pump operating under a very low pressure differential, usually not more than about 4 p.s.i., is illustrative. The pump-induced turbulence appears to help resolve the sludge, possibly by disrupting the membranes surrounding the coalesced aqueous masses but which have not yet broken to release such masses.

The pump 68 discharges through a pipe 70 of an outlet manifold 71 similar in construction to the manifold 65 but having perforated pipes 72 extending outwardly near the upper boundary of the sludge zone to distribute the treated sludge constituents. The pipes 72 are similar to the pipe 66 but are usually somewhat longer. The manifold 65 is spaced from the manifold 71 by posts 73 and from the container 10 by posts 74.

The second sludge-resolving means is of the steam-introduction type. It is shown as including a valved steam-delivery line 75 (Figs. 1 and 6) with branch pipes 76 terminating in oppositedly-directed nozzles 77 discharging substantially horizontally. The piping is supported by a bracket 78 which may be welded to the riser pipe 56, as best shown in Fig. 6. Steam introduced into the body of separated liquid below the level A—A tends to resolve the sludge both because of thermal action and because the steam may establish thermal circulations causing portions of the sludge to rise into the zone between the line B—B and the lower electrode 21. An electric field is present in this zone. Also, the distributor 55 establishes a pronounced recirculation of a toroidal nature traversing this zone, as indicated by the arrows of Fig. 1, this circulation drawing sludge or unresolved emulsion into the main treating space 22 for re-treatment.

The general movement of the emulsion in the first zone 18 is upward and it is desirable that the treated emulsion in the upper interior thereof should be collected and moved downwardly before being discharged into the second zone 19 to follow a zig-zag or up-and-down path. This is accomplished by a collector pipe 80 which preferably has a downwardly facing opening 81 coaxial with the riser pipe 56 and into which the treated emulsion is moved under the action of the pumps 57 and 60. The collector pipe 80 discharges the treated emulsion into an upright conduit 83 and thence into an outlet conduit 84 communicating with the lower interior of the second zone 19. The upright conduit 83 is preferably a relatively large pipe directly adjoining and secured to the partition 17, thereby serving to reinforce this partition. Its ends may be welded to the inner wall of the container 10. The portion of the upright conduit 83 below the outlet conduit 84 may be blocked off internally or may comprise a trap which may fill with any dispersed-phase material separating in the upright conduit 83. For further reinforcement of the partition 17, horizontal bracing members 85 are welded thereto on opposite sides of the upright conduit 83, see Figs. 1 and 2.

The final, super or clean-up treatment in the second zone 19 should be of a character well suited to remove additional amounts of the residual dispersed-phase material from the treated emulsion discharging from the conduit 83. Unidirectional electric fields produce unexpectedly superior results in this connection if the amount of residual dispersed-phase material is low and if the unidirectional fields have zones of substantially uniform voltage gradient through which the emulsion flows tranquilly and without substantial turbulence. Local circulations induced thermally or otherwise are to be avoided in the second zone **19** if maximum resolution is to be effective. The emulsion is preferably treated in a single pass through a grid of interspaced electrodes.

This grid of interspaced electrodes is indicated by the numeral **90** and preferably occupies substantially the entire cross section of a horizontal zone near the horizontal midsectional plane of the second zone **19**. This grid of electrodes is preferably positioned slightly above the horizontal axis of the container **10**. It includes first and second electrode assemblies **91** and **92** best shown in Figs. 1, 2 and 4.

The first electrode assembly **91** includes a framework **93** of transverse members and a plurality of equally-spaced parallel electrodes **95** secured thereto and depending therefrom. The second electrode assembly **92** includes a framework **96** formed of transverse members to which are secured, by welding or by brackets **97**, a plurality of parallel electrodes **98** spaced to nest with and bisect the spaces between the electrodes **95**. The electrodes **95** and **98** are substantially straight metal strips extending parallel to the longitudinal axis of the container **10**. The electrode assemblies are inter-nested to define a plurality of upright side-by-side treating spaces **100** open at their upper and lower ends to the upper and lower internal portions of the second zone **19**. Best results will be obtained if these treating spaces are of equal width and if this width is less than about 6 inches. The electrodes **95** and **98** should preferably overlap a distance substantially greater than the width of each treating space so that each treating space **100** is of a height at least twice and preferably several times its width.

The first electrode assembly **91** is supported from suspension insulators **102** depending from the cylindrical member **12** of the container **10** and angling toward each other, the axes of the suspension insulators being substantially radial. The inner ends of these insulators are suitably connected to the framework **93**. The angular disposition of the suspension insulators rigidifies the first electrode assembly **91** both laterally and vertically.

The second electrode assembly **92** is suspended by thin hangers **103** which extend along corresponding treating spaces **100** with their upper ends secured to a U-shaped support **105**. This support is shown as being hung from suspension insulators **106**, thus permitting the second electrode assembly **92** to be insulated from the container **10** if desired. If the second electrode assembly **92** is to be at ground potential, rods **108** can be extended between the support **105** and brackets **109** inside the container, serving both as an electrical connection and as a spacing means rigidifying the second electrode assembly **92** against lateral displacement. Additionally, by interconnecting the rods **108** and the brackets **109** by adjustable nuts **110**, threaded to neck-like extensions of the rods, it becomes possible to adjust the lateral position of the second electrode assembly **92** to equalize the width of adjacent treating spaces **100**. If the second electrode assembly **92** is to be maintained at above-ground potential, the rods **108** may be formed of insulating material.

In the equipment shown, high-voltage unidirectional electrical fields are established in each of the treating spaces **100** by a high-voltage source of unidirectional potential indicated as including a high-voltage transformer **112** connected to a full-wave or half-wave rectifier **113**. The high-voltage output of the rectifier is conducted through bushings **114** and **115** to the first and second electrode assemblies **91** and **92**. The resulting electric fields in the treating spaces **100** are of substantially uniform voltage gradient, being formed between parallel electrodes. The zones of substantially uniform voltage gradient extend from a level just above the lowermost edges **118** of the electrodes **95** to a level just below the uppermost edges **119** of the electrodes **98**. Adjacent and below each of the edges **118** the field is substantially non-uniform and serves to treat the emulsion entering the uniform-field zones to remove therefrom any excess dispersed-phase material. It is desirable that the emulsion entering such zones should contain no more than 1% of dispersed-phase material and preferably no more than a fraction of 1% thereof.

It is desirable that the grid of electrodes **90** should extend rather close to the adjacent walls of the second zone **19**. For this reason, the outermost electrodes are usually spaced from the cylindrical wall of the container **10** a distance not substantially greater than the width of the treating spaces **100**. If such outermost electrodes are at a potential above ground, fields of substantially uniform voltage gradient will be established between each of such electrodes and the adjacent container wall. Likewise, it is desirable that there be a minimum of space between the ends of the electrodes **95** and **98** and the adjacent head means formed by the end member **16** and the partition **17**. The lengths of the electrodes **95** and **98** may thus be made progressively longer toward the center of the container, forming a pattern best shown in Fig. 2. It will be apparent that any large stream of emulsion rising in the second zone **19** must traverse the grid of electrodes **90** and that substantially all portions of such a stream will be subjected to unidirectional fields of substantially uniform voltage gradient, the fields in the horizontal zone of the treating spaces **100** being substantially uniform at all positions except at the ends of the electrodes **95** and **98** where the fields will be less uniform, tending to concentrate at such ends. On the other hand, the zones between such ends and the adjacent walls of the second zone **19** are of very small horizontal cross-sectional area, as compared with the area in which electric fields of substantially uniform voltage gradient are established, wherefore very little emulsion escapes treatment in the substantially uniform fields of the invention.

It is desirable that the emulsion should traverse the treating spaces **100** in a single pass, as distinct from moving repeatedly through said treating spaces in ring-like circulations. For this reason it is desirable that the emulsion entering the second zone **19** from the conduit **84** should be formed into a single slowly-rising stream advancing upwardly toward the electrodes to be split sequentially by the lowermost edges of the electrodes **95** and **98**, which serve as a flow-straightening means insuring that the emulsion will rise through the treating spaces **100** tranquilly or substantially free of turbulence or in substantially laminar flow. Above the electrodes, the individual streams join to form a larger stream advancing to the upper interior of the container.

To develop this type of flow, it is desirable that the incoming emulsion be introduced into the second zone **19** at a large number of positions and that the treated oil be removed from the upper interior at a large number of positions. To accomplish the multi-position discharge, the invention includes a distribution means including a pair of distributor units **125** best shown in Figs. 1, 3 and 4. The distributor units are positioned side-by-side in spaced relation in a horizontal zone below the electrodes, each unit being shaped similar to an inverted rectangular pan, providing a top wall **126** and depending peripheral walls including side walls **127** and end walls **128**. The conduit **84** ends in a branch conduit **130** having opposite ends extending into the distributor units **125**. Perforated branch pipes **131** are connected to such ends and lie parallel to the longitudinal axis of the distributor unit, having sidewardly-directed openings through which the treated emulsion is discharged into the interior of the distributor unit. The bottom of each distributor unit is preferably open to receive supporting posts **132**. The peripheral walls provide openings spaced horizontally from each other for exuding small streams which rise at the periphery of the distributor unit, combining thereabove to form the large stream rising to the electrodes, These openings are preferably provided in the side walls 127 and end walls 128 and are best formed by notching the lower edges of these walls to produce deep V-shaped notches 133 wider at their lower ends than at their upper ends. The peripheral walls thus act somewhat as a weir, the notches dividing any volume of incoming emulsion into equal volume streams corresponding in number to the total number of notches.

Above the electrodes in the second zone 19 the treated oil is collected at a plurality of points by a manifold system best shown in Figs. 1 and 4. This includes a pipe manifold 140 closed at its ends and having a single treated oil outlet 141. This pipe manifold extends longitudinally of the container 10 and receives treated oil through a plurality of branch pipes 144 each having horizontal and inclined portions (Fig. 4) and being sidewardly perforated so as to receive treated oil at a large number of spaced positions, thus assisting the action of the distributor means in maintaining substantially equal velocities in all of the treating spaces 100. To insure this effect even in the domed end of the container, the adjacent end of the pipe manifold 140 may carry an elbow 145 fed by branch pipes 146 each having a longitudinal slot 147 in its lowermost portion through which the treated oil enters. The pipe 141 may be suitably valved to maintain a back pressure in both of the zones 18 and 19.

The action of the unidirectional electric field in the second zone 19 is to coalesce the residual dispersed-phase particles into masses which can settle against the low-velocity stream of emulsion rising toward the electrodes. The coalesced material collects in the lower interior of the second zone and is continuously or periodically removed therefrom through a pipe 150 which is also suitably valved or restricted so as to maintain a super-atmospheric pressure in both zones 18 and 19.

In Fig. 8 is illustrated an alternative embodiment in which electric dehydration, desalting and clean-up functions can be performed sequentially in the same substantially horizontal container. This container provides three compartments, the last two corresponding to the zones 18 and 19 previously described but being here designated as zones 218 and 219. The left-hand zone, designated by the numeral 220, contains electrodes and sludge-resolving equipment similar to that described with reference to the zone 18. The riser pipe thereof receives a pressured stream of crude oil through a pipe 221 from a pump 222. This crude oil may contain 5–20% of water in the form of rather stable droplets. The electric fields in the zone 220 may be of the alternating-current type and will serve to coalesce much of the dispersed water into masses which will settle and which can be withdrawn continuously or intermittently through a valved pipe 223. The dehydrated oil moves along a collector pipe 224 similar to the collector pipe 80 previously described and thence into an upright conduit 225. This last conduit is similar to the conduit 83 but discharges externally of the container into the pipe 58 previously described.

In general, it has been found that multi-stage treaters effect savings not only in cost of equipment and ground space but also in control pumping, heating and electrical equipment, as well as in current and heating media. As to the savings in current and electrical equipment, the electrodes of the first and second stages of Fig. 8 can be energized from the same high-voltage transformer. Even the rectifier 113 can be energized by a high-voltage transformer that establishes the electric fields in a preceding stage. Horizontal staging is desirable as simplifying the problem of introducing the high potentials into the various stages, centralizing the high-voltage equipment and minimizing cost. Side-by-side staging is very desirable because it permits use of standard-sized tanks of such dimension as to be transportable by rail or truck.

Various changes can be made without departing from

the spirit of the invention, as defined in the following claims.

I claim as my invention:

1. An electric treater for emulsions having a continuous phase of oil and a dispersed phase of oil-immiscible particles therein, said electric treater including in combination: a closed container; a set of electrodes in said container comprising a first electrode assembly having a plurality of depending equally-spaced electrodes and a second electrode assembly having upstanding electrodes of the same spacing substantially bisecting the spaces between the electrodes of the first electrode assembly to define a plurality of upright side-by-side open-ended treating spaces each bounded on opposite sides by electrode surfaces of said first and second electrode assemblies; a high-voltage unidirectional source of potential and means for connecting same to said electrode assemblies to establish unidirectional electric fields in said treating spaces; a distributor unit in said container below said set of electrodes and providing a top wall and peripheral walls depending therefrom; pipe means opening on the interior of said distributor unit below said top wall thereof for delivering thereto the emulsion to be treated, said peripheral walls providing openings spaced horizontally for exuding the emulsion as small streams at the periphery of said distributor unit, said small streams combining above said distributor unit, the combined stream rising to said set of electrodes and being thereby divided into individual streams rising through said treating spaces and rejoining thereabove in the upper interior of said container, said electric fields coalescing the dispersed particles into masses of sufficient size to settle against the rising combined stream and collect in the lower interior of said container; and means for separately withdrawing treated oil and the collected dispersed phase material from the upper and lower interiors of said container.

2. An electric treater as defined in claim 1 in which said peripheral walls provide notched lower edges, the notches forming said horizontally spaced openings.

3. An electric treater as defined in claim 1 including at least two distributor units positioned side-by-side in a horizontal zone below said set of electrodes, each distributor unit being substantially rectangular, the peripheral walls of each unit comprising side walls and end walls, the side walls of adjacent distributor units being parallel but spaced from each other to provide a space therebetween through which the emulsion exuding from said openings may rise.

4. An electric treater for emulsions having a continuous phase of oil and a dispersed phase of oil-immiscible particles therein, said electric treater including in combination: a substantially horizontal container comprising a substantially horizontal cylindrical member and head means closing same and spaced from each other to define a closed cylindrical zone having a substantially horizontal axis, said closed cylindrical zone providing a substantially rectangular horizontal zone, said spaced head means constituting one set of side boundaries of said substantially horizontal zone, the longitudinal walls of said cylindrical member constituting another set of side boundaries of said substantially horizontal zone; a first flat electrode assembly comprising a first framework and a plurality of substantially straight metal strips depending edgewise therefrom in equally spaced parallel relation; a second flat electrode assembly comprising a second framework and a plurality of substantially straight metal strips mounted edgewise thereon in parallel relation and spaced to nest within and substantially bisect the spaces between the metal strips of said first electrode assembly, the metal strips of both electrode assemblies being each of a length many times its height; means for supporting said electrode assemblies substantially horizontally in said substantially rectangular horizontal zone of said closed cylindrical zone with their metal strips thus nested and form-

ing a grid of interspaced strips defining a plurality of upright side-by-side treating spaces open at their upper and lower ends to upper and lower portions of said cylindrical zone, said grid substantially completely filling said substantially rectangular horizontal zone, the peripheral sides of said grid substantially conforming in shape to said side boundaries of said horizontal zone and being spaced small and substantially equal distances from such side boundaries; means for introducing emulsion into said lower portion of said cylindrical zone at a position below said grid while spreading such emulsion to flow as a rising stream of emulsion through the nested electrode assemblies from said lower to said upper portions of said cylindrical zone; means for maintaining a high-voltage potential difference between said electrode assemblies to treat the emulsion rising through said treating spaces; means for removing treated oil from said upper portion of said cylindrical space; and means for removing separated dispersed phase material from said lower portion of said cylindrical space.

5. An electric treater as defined in claim 4 in which said horizontal zone of said container is near said horizontal axis and in which the strips of both electrode assemblies are parallel to said axis and provide ends substantially aligned with each other along lines conforming to the shape of the respective head means.

6. An electric treater for emulsions having a continuous phase of oil and a dispersed phase of oil-immiscible particles therein, said electric treater including in combination: a closed container much greater in longitudinal length than width; means for mounting said closed container with its longitudinal dimension substantially horizontal, said container providing a horizontally elongated treating zone therein; a set of electrodes in said treating zone comprising a first electrode assembly including a framework and a plurality of equally-spaced parallel straight metal strips depending edgewise from said framework, each of said strips being of a length many times its width, said set of electrodes comprising also a second electrode assembly including another framework and a plurality of equally spaced parallel straight metal strips each likewise of a length many times its width and supported by said other framework in positions to substantially bisect the spaces between the strips of the first electrode assembly to define a plurality of upright side-by-side open-ended treating spaces each bounded on opposite sides by electrode surfaces of said first and second electrode assemblies, said set of electrodes constituting a horizontal grid of interspaced electrodes occupying substantially the entire horizontal cross section of a horizontal zone of said treating zone; a high-voltage unidirectional source of potential and means for connecting same to said electrode assemblies to establish unidirectional electric fields in said treating spaces; a distributor unit in said treating zone below said set of electrodes and providing a large number of discharge passages spaced horizontally from each other; means for delivering the emulsion to be treated to said distributor unit to flow as small streams from said discharge passages, said small streams combining above said distributor unit to form a combined stream rising to said set of electrodes and being thereby divided into individual streams rising through said treating spaces and rejoining thereabove in the upper interior of said treating zone; and means for separately withdrawing treated oil and dispersed phase material respectively from the upper and lower interiors of said treating zone.

7. An electric treater as defined in claim 6 in which one of said frameworks comprises a plurality of members extending transverse to said straight metal strips of the corresponding electrode assembly, and hanger means within said container for supporting such framework.

8. An electric treater as defined in claim 7 having adjustable means interconnecting said transverse members and said container for adjusting and fixing the lateral position of the corresponding electrode assembly with relation to the other electrode assembly.

9. An electric treater as defined in claim 6 in which said means for withdrawing treated oil from the upper interior of said treating zone includes a manifold pipe extending longitudinally of said container in such upper interior, and a plurality of branch pipes extending laterally from said manifold, said branch pipes providing openings receiving said treated oil and delivering same to said manifold.

10. An electric treater as defined in claim 9 in which each of said branch pipes provides a closed end and a plurality of side openings for ingress of the treated oil into such branch pipe.

11. An electric treater for emulsions having a continuous phase of oil and a dispersed phase of oil-immiscible particles therein, said electric treater including in combination: a closed container having between its upper and lower ends a relatively shallow horizontal zone; a set of electrodes in said relatively shallow horizontal zone comprising a first electrode assembly including a framework and a plurality of equally spaced metal strips depending edgewise from said framework, said set of electrodes comprising also a second electrode assembly including another framework and a plurality of metal strips supported edgewise thereon and spaced equally from each other in positions to substantially bisect the spaces between the strips of the first electrode assembly to define therewith a plurality of upright side-by-side open-ended treating spaces each bounded on opposite sides by surfaces of said strips of said first and second electrode assemblies, said set of electrodes constituting a horizontal grid of interspaced electrodes occupying substantially the entire horizontal cross section of said horizontal zone of said closed container; means for electrically insulating one of said electrode assemblies from the other and for applying thereto a high-voltage potential to establish electric fields in said treating spaces; an emulsion distributor below said set of electrodes providing a plurality of openings spaced horizontally from each other; means for delivering the emulsion to be treated to said distributor to flow as small streams from said openings, said distributor including a shielding means having portions positioned above said openings and terminating in peripheries laterally beyond said openings, said shielding means spreading said emulsion to such peripheries before the emulsion rises in said closed container to said side-by-side upright treating spaces; pipe means for withdrawing treated oil from said upper end of said container above said horizontal zone; and pipe means for withdrawing dispersed phase material from the lower end of said container, said last-named pipe means having an influent means positioned below said distributor.

12. An electric treater for emulsions having a continuous phase of oil and a dispersed phase of oil-immiscible particles therein, said treater including in combination: a closed cylindrical container much greater in longitudinal length than width; means for mounting said cylindrical container with its longitudinal dimension substantially horizontal; an upright circular partition corresponding in diameter to the interior of said container and secured thereto at a position intermediate the ends of the latter, said partition physically and pressurally dividing the interior of said container into first and second horizontally spaced zones separated by said partition; a first set of electrodes and support means for mounting same in spaced and electrically insulated relation to each other in said first zone; a second set of electrodes and support means for mounting same in spaced and electrically insulated relation to each other in said second zone; means respectively energizing said electrode sets to establish high-voltage electric fields in said first and second zones; pump means discharging the emulsion to be treated under pressure into said first zone for electric treatment by the high-voltage electric field therein; conduit means comprising a relative-

ly large upright pipe having upper and lower ends, said lower end terminating outside said container, said conduit means including an upper pipe means interconnecting the upper interior of said relatively large pipe with the upper interior of said first zone to conduct electrically treated emulsion from the latter; a pump having an inlet connected to said lower end of said relatively large pipe, said pump having a discharge; an emulsion distributor in said second zone; a supply pipe extending from said distributor to said discharge of said pump; means for introducing another liquid into said supply pipe, said last-named means including a side pipe connected to said supply pipe and a pump discharging into said side pipe to supply said other liquid thereto; means for withdrawing treated oil from the upper interior of said second zone at a position above said second set of electrodes therein; and pipe means for withdrawing separated dispersed phase material from the lower interiors of each of said zones.

References Cited in the file of this patent

UNITED STATES PATENTS

1,281,952	Harris	Oct. 15, 1918
1,440,828	Harris	Jan. 2, 1923
2,377,565	McDonald	June 5, 1945
2,395,011	Perkins	Feb. 19, 1946
2,681,311	De Wit	June 15, 1954

FOREIGN PATENTS

1,059,804	France	Nov. 18, 1953