Feb. 15, 1938. H. F. FISHER 2,108,258

ELECTRIC DEHYDRATOR

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Fig. 3.

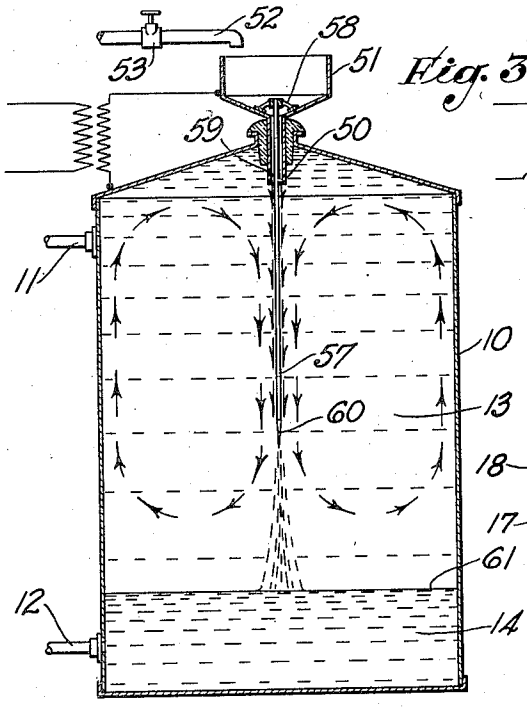


Fig. 1.

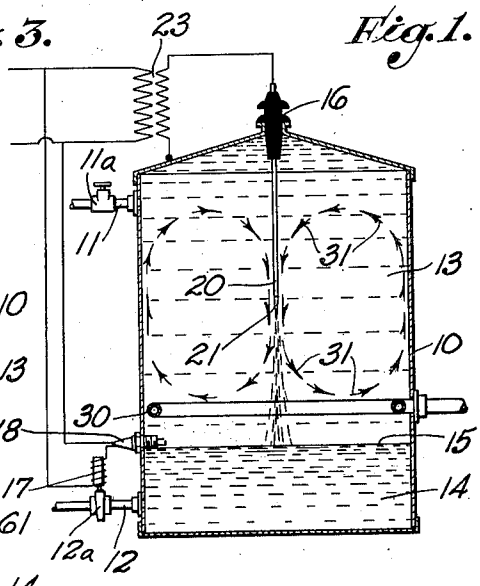


Fig. 4.

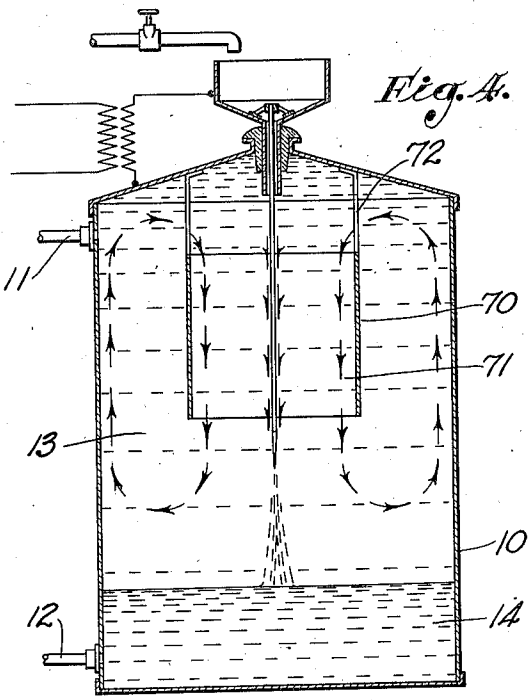
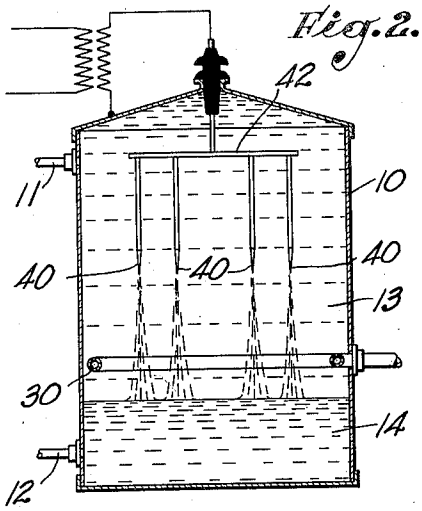


Fig. 2.



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Fig. 5.

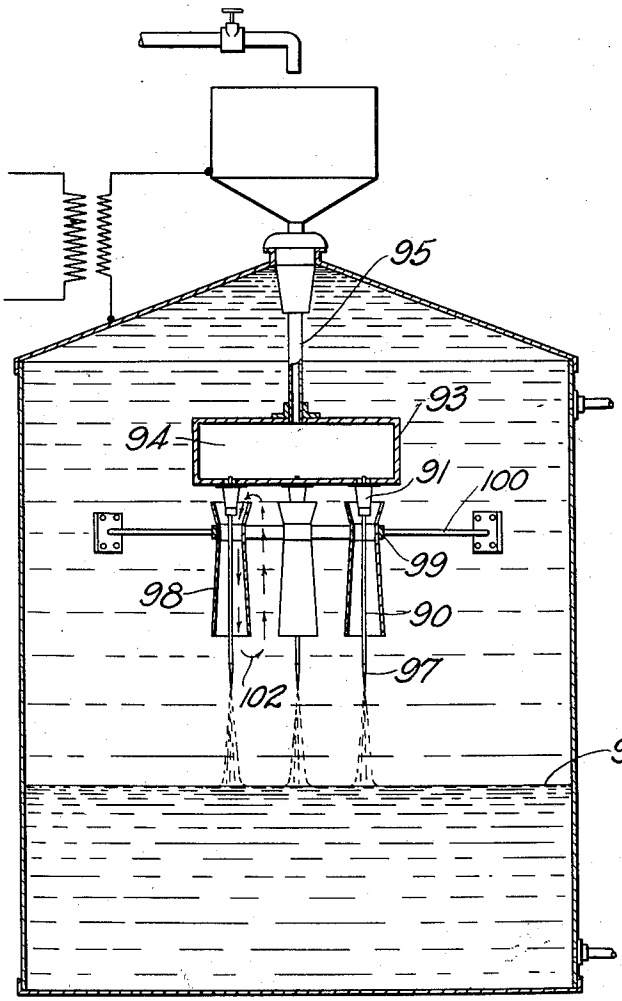
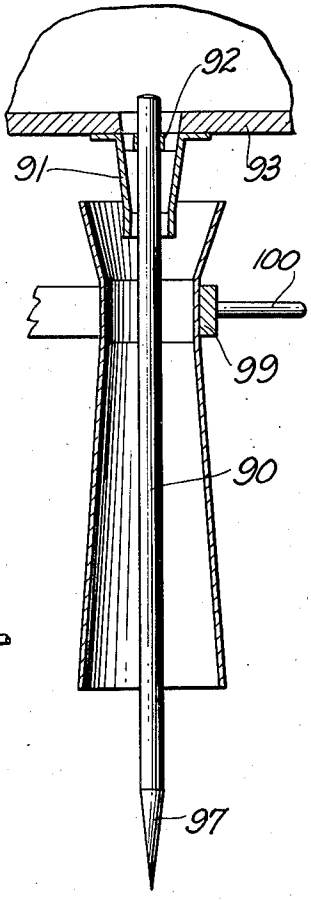


Fig. 6.



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UNITED STATES PATENT OFFICE

2,108,258

ELECTRIC DEHYDRATOR

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Application November 30, 1931, Serial No. 577,997

15 Claims. (Cl. 204—24)

My invention relates to the electrical dehydration of emulsions, and finds particular utility when treating petroleum emulsions of oil and water wherein minute water droplets are held suspended in a continuous oil phase.

It is well-known in the art of electric treatment of such emulsions that the minute water particles suspended in such an emulsion can be agglomerated or coalesced into larger drops of sufficient size to gravitate from the oil by subjecting the emulsion to the action of a high intensity electric field, usually set up by an alternating potential impressed across a pair of electrodes. Many emulsions show quite undesirable tendencies to form low-resistance paths between the electrodes which results in excessive current consumption and consequent reduction of the potential across the electrodes to such an extent that the desirable treating action is seriously impeded.

One of the objects of the present invention is to use the very intense field from a relatively sharp point for effecting the treating action, my experiments having taught that the electric blast or brush discharge set up adjacent such a point is effective in this regard without the excessive current flow resulting by the use of certain other types of electrodes.

The most effective action has been found to result when the blast or brush discharge takes place to a water surface. and another of the objects of the invention is to maintain a water level in a dehydrator below an electrode having a terminal portion which is sufficiently sharp to produce a brush discharge or electric blast directed toward the water level. The effect taking place when the discharge takes place to a water level is usually superior to that taking place when the discharge takes places to a metallic electrode surface. In addition, the type of field produced when a pointed electrode is used in conjunction with a water surface has been found to effectively treat emulsions which cannot be readily treated by the use of conventional plate electrodes.

While the brush discharge itself sets up a slight circulation of the emulsion in which the pointed electrode is immersed, I have found an increased action takes place if the emulsion is directed to move along the surface of the rod which here provides a point. Following the teaching of my copending applications Serial No. 135,804, filed September 16, 1926, now Patent No. 1,838,924 and No. 203,253, filed July 2, 1927, now Patent No. 1,838,928 the rod electrode can be surrounded by another electrode of different potential so that a field of non-uniform gradient is produced in which the higher gradient portion immediately adjacent the rod electrode is effective to the coalesce in greater or lesser degree the dispersed water droplets therein, while the lower gradient portion nearer the surrounding electrode may be of too low intensity to effect this degree of coalescence. The present invention differs from my copending applications in various respects among which is the fact that the emulsion is, in certain embodiments, flowed along a small electrode and toward and from an end of the electrode which is pointed, the preliminary flow along the electrode surface being effective in supplying to the brush discharge large quantities of the emulsion, this emulsion being in some instances preliminarily treated by the field around the rod. A treater of these characteristics forms a part of the present invention.

Other objects and advantages will be apparent to those skilled in the art from the following detailed description of certain preferred embodiments of my invention.

Several embodiments are disclosed in the accompanying drawings wherein—

Fig. 1 is a sectional view of a simple form of treater having a single pointed electrode.

Fig. 2 is a similar view of another form of the invention including a plurality of pointed electrodes on a single electrode support.

Fig. 3 is a sectional view of a treater including a pointed electrode along which the incoming emulsion is introduced.

Fig. 4 is a view of another form wherein an auxiliary sleeve is utilized to set up the field around the central electrode.

Figs. 5 and 6 are sectional views of still another form of treater.

The simplest mode of practicing the present invention is to cover the bottom of a metallic tank with a layer of water or other conducting liquid, filling the remainder of the tank with emulsion. If now a pointed rod-like electrode is positioned in the emulsion and maintained at a potential of several thousand volts above the potential of the tank, the discharge taking place from the point and toward the water surface is very intense and the emulsion therebetween will be effectively treated without excessive current flow. This treatment consists of an agglomeration of the minute water droplets in the emulsion to such an extent that separation will take place when the emulsion is allowed to stand. So also, the discharge itself tends to force the agglomerated water particles toward the water surface, certain of these particles being thus projected into the body of water.

This mode of treatment may be embodied in a continuous process treater such as shown in Fig. 1 and including the customary tank 10 with draw-off pipes 11 and 12 respectively communicating with the upper and lower ends of the tank to withdraw oil and water therefrom, these pipes providing valves 11a and 12a for controlling the

amount of water and oil withdrawn. Inside the tank the constituents of the treated emulsion gravitationally separate to form stratified bodies of oil and water respectively designated by the numerals 13 and 14, the body of water providing a surface 15. It is usually preferable to provide one or both of the valves 11a and 12a with automatic control means which so regulates the flow of liquid therethrough as to keep the water level in the tank substantially constant. Such level control means are well known in the art. Such a control device applied to the valve 12a is diagrammatically shown in Fig. 1, and may be of the type described in the United States patent to John T. Worthington, 1,762,538, in which case it will include a solenoid 17 adapted when energized to open the valve 12a, the energization being effected through current flowing between the terminals of a conventional spark plug 18 which extends through the walls of the treater. The current flowing through the solenoid 17 is thus dependent upon the conductivity of the liquid bridging the terminals of the spark plug so that if the water surface 15 rises to short-circuit these electrodes of the spark plug, the valve 12a will open until the level again drops. A similar device may be included in the oil draw-off pipe 11.

Extending through a suitable insulator 16 mounted in the top of the tank 10 is a live central or rod-like electrode 20 providing a lower terminal portion which, in the preferred embodiment, is in the form of a relatively sharp point 21 positioned a distance above the water surface 15. A step-up transformer 23 or other potential supply means is utilized for establishing a potential difference between the central electrode 20 and the tank 10. The body of water 14, being a good conductor, forms an additional electrode surface and because of the pointed terminal portion of the central electrode a very intense electric field is set up between this point and the water surface 15. So intense is this field that it tends to violently propel liquid particles downward toward the water surface 15 and this very intense field is utilized in itself or in conjunction with an auxiliary field to be hereinafter described to effect the desirable treating and separating action. Apparently the discharge is of such a character that excessive currents do not flow between the central electrode and the water surface, yet agglomeration of the water particles is rapid and good treating action obtained, as evidenced by the very satisfactory and complete separation of the oil and water which takes place. Experience has shown, however, that the action of this discharge from a point is much more effective when the bottom of the tank is covered with a layer or body of water than when no water is present and when the discharge takes place to the metallic surface of the bottom of the tank, though the reason for this fact is not definitely known.

The treater shown in Fig. 1 may be used as a batch treater merely by filling the tank with a batch of emulsion and covering the bottom of the tank with a layer or body of water. It is usually preferable, however, to continuously introduce the emulsion into the tank by any suitable means such as a spray pipe 30 and continuously withdraw the separated oil and water through the pipes 11 and 12. In either event several factors enter which tend to circulate the liquid in the tank as indicated by the arrows 31, thereby setting up a closed circulation path which is downward around the central electrode and upward immediately inside the tank. The brush discharge from the point 31, for instance, causes an actual downward flow of water particles from the area immediately around the point, thus tending to draw an additional supply of emulsion downward along the central electrode and toward the point. So also, this circulation is assisted by the natural tendency for the water particles agglomerated in the discharge from the point 21 to settle downward. The emulsion introduced through the spray pipe can also be used to assist this circulation by forming the perforations in this spray pipe to discharge upwardly. Finally, this circulation is increased due to thermal conditions, for the incoming emulsion is usually heated. This causes the incoming emulsion to be slightly hotter than the liquid in the tank which liquid has had an opportunity to cool slightly, the result being that the incoming emulsion tends to move upward immediately inside the tank, thus setting up a downward flow immediately around the central electrode.

I have also used a plurality of pointed rod electrodes as shown in Fig. 2, the points 40 of which terminate in the same horizontal plane, these rod electrodes being mounted on an electrode support 42. The large number of discharges thus set up increase the effectiveness of the treatment.

In all cases the agglomeration of the dispersed water particles is extremely rapid when these particles enter the high intensity discharge adjacent the point of the live electrode. In some instances the capacity of the treater can be increased many fold by still further increasing the downward movement of emulsion along the central live electrode, thus supplying a greater quantity of the emulsion directly into the brush discharge for treatment. Fig. 3 shows such a system, the emulsion being introduced through a pipe 50 extending through the insulator and communicating with an emulsion storage means 51. Emulsion may be continuously or intermittently supplied to the storage means 51 by any suitable means such as a pipe 52 the flow through which is controlled by a valve 53. The central or live electrode in this embodiment of the invention is indicated by the numeral 57 and extends upward in the pipe 50, being secured to and electrically connected to this pipe by a spider 58. The pipe 50 thus acts as a nozzle and cooperates with the central electrode in defining an annular discharge space 59 through which the emulsion moves downward around the live electrode in the form of a fluid envelope contacting and flowing longitudinally along this electrode. The lower end of this electrode also provides a terminal portion which, in the preferred embodiment, may take the shape of a sharp point 60 setting up a brush discharge therefrom and to the water level 61, as previously described. The emulsion thus flows downward around the central electrode until it moves from the terminal portion thereof and into the brush discharge.

This mode of introducing the emulsion has several advantages. Not only does it increase the amount of emulsion supplied to the brush discharge, but it increases the circulation of liquid in the tank along the path indicated by the arrows 31 of Fig. 1.

It will be noted that in all of the forms of the invention thus far described an electric field is set up between the live central electrode and the grounded tank. This field is very highly concentrated immediately around the central electrode

in view of the concentric nature of the tank and central electrode and because the surface area of the central electrode is so much smaller than the area of the cylindrical wall of the tank. The field intensity adjacent any electrode surface, other things being equal, is a function of the radius of curvature of this surface, the smaller this radius of curvature, or, in other words, the sharper the edge or point, the greater will be the intensity of the field there adjacent. For this reason the field adjacent the point of the central electrode will be much more intense than the field immediately around the central electrode. This last mentioned field can, however, be made strong enough to exert a preliminary treating action on the emulsion which tends to coalesce or agglomerate the water particles prior to the time that movement into the intense brush discharge adjacent the point takes place, and it is apparently this preliminary treatment combined with the treatment adjacent the point which gives in an optimum degree the improved results resulting from the use of the treaters such as herein described. In this connection, the highly concentrated portion of the field immediately around the central electrode can thus exert a coalescing or agglomerating action on the water particles therein, as pointed out in my application supra, and the action in this high intensity field will be much more pronounced than in the lower intensity portion of the field more removed from the central electrode.

The control of the intensity of this field around the central electrode is dependent upon a number of factors, such as the size of the central electrode, previously mentioned, the diameter of the tank, the potential of the potential supply means, etc. Economic and space considerations control many of these factors. In other instances they are controlled by the necessary characteristics of the treater. For instance, the tank should be made large enough to allow an effective separation to take place therein, a result impossible if the circulation paths are so small that the circulation tends to agitate the constituents rather than to allow them to settle when moving through the circulation path.

In some instances the desirable diameter of the tank may be too large to set up the type of field desired around the central electrode and in such instance the treater shown in Fig. 4 may be used. In this form of the invention an auxiliary sleeve electrode **70** surrounds the central electrode and is spaced therefrom to define a treating space **71** open at its ends to freely communicate with the liquid in the tank. This sleeve electrode is usually, though not invariably, grounded to the tank, the form shown being supported on hangers **72**. Not only does this sleeve thus bound the field set up around that portion of the central electrode therein, but in addition the sleeve serves to guide the liquid in the tank through the desired circulation path. The injector action of the incoming emulsion causes a portion of the dry oil at the top of the tank to be drawn into the top of the sleeve electrode **70** thus tending to maintain a dielectric barrier in the outer portion of the annular treating space and around the emulsion stream to prevent any possible formation of low resistance paths bridging the central and sleeve electrodes and resulting in excessive current flow. Regardless of whether or not a sleeve electrode is used, however, the water content of the liquid positioned between the central electrode and the tank varies with the distance from the central electrode, the driest oil being near the central portion of the closed circulation path indicated, for instance, by the arrows **31** of Fig. 1. This driest body of oil, being between the live central electrode and the grounded shell, thus serves to prevent excessive current flow therebetween, even in the absence of the sleeve electrode **70**.

In still another form of the invention illustrated in Figs. 5 and 6 I prefer to utilize a plurality of rod-like electrodes **90**, each of which extends centrally through a nozzle **91**, being held in place by a spider **92**. Each nozzle **91** is mounted on a drum **93** providing a distributing chamber **94** which receives emulsion through a pipe **95** extending through the insulator as previously described, the emulsion being thus equally distributed to the nozzles **91** and flowing downward around the electrodes **90** as previously described. This emulsion flows downward along the electrodes **90** and from the lower end thereof, thus being subjected to the field between the lower end of this electrode and the water surface **96**. This field may be intensified by forming the lower ends of the rod-like electrodes **90** in the form of points **97**, as previously set forth. Around each of these rod-like electrodes **90** is a sleeve **98** secured to a ring **99** and grounded to the shell through a support **100**. The actions previously described, as well as the jet action of the incoming emulsion, tend to circulate the liquid around the sleeve electrodes, as indicated by the arrows **102**, the shape of the sleeve electrodes accentuating this circulation. The liquid thus drawn into the upper end of the sleeve electrodes is substantially dry and acts as an effective dielectric barrier preventing any excessive current flow between the rod-like electrodes **90** and the sleeve electrodes **98**.

The present application is a continuation in part of an application Serial No. 216,884, filed September 1, 1927 now Patent No. 1,838,930. So also, certain of the features shown and described herein are claimed in my copending applications Serial No. 135,804 and Serial No. 203,253, supra.

I claim as my invention:

1. A method of treating an emulsion by the use of a rod-like electrode having a terminal portion, which method includes the steps of: establishing an electric field at the end of said terminal portion and around said electrode, which field around said electrode is much more intense adjacent said electrode than at a position spaced therefrom; moving the fluid to be treated in the most intense portion of said field around said electrode and in a direction toward said terminal portion whereby said fluid moves from said terminal portion and is influenced by said field at the end of said terminal portion; and maintaining a dielectric material in a portion of said field around said electrode, which portion is less intense than that portion of the field through which said fluid to be treated is moved, said dielectric material being of higher dielectric strength than said fluid to be treated.

2. In an electric treater, the combination of: a tank containing a body of a conducting liquid in the lower portion thereof; a live rod-like electrode in said tank and insulated therefrom, said electrode extending downward and terminating in a sharp point disposed a distance above the surface of said body of conducting liquid; means for establishing a potential difference between said rod-like electrode and said body of conducting liquid whereby a discharge takes place from said point to said surface of said body of conducting

liquid; a sleeve around said rod-like electrode and providing a lower end which terminates above said point of said rod-like electrode, said means establishing a potential difference between said sleeve and said rod-like electrode to form an auxiliary field; and means for flowing an envelope of emulsion downward around said rod-like electrode toward said sharp point so that it is treated by said auxiliary field before flowing from said sharp point, said envelope of emulsion being of insufficient thickness to bridge the distance between said rod-like electrode and said sleeve.

3. A method of treating an emulsion by the use of a vertically extending rod-like electrode providing a pointed lower end, which method includes the steps of: maintaining a body of conducting liquid below the pointed lower end of said electrode; establishing a potential difference between said body of conducting liquid and said electrode whereby an intense electric blast takes place from said pointed lower end and toward said body of liquid; moving an envelope of emulsion constituents downward around said rod-like electrode whereby the liquid in said envelope feeds into said blast and is therein treated and discharged downward toward said body of conducting liquid; and maintaining in a zone around said envelope a liquid of higher dielectric strength than the emulsion to be treated.

4. A method as defined in claim 3 including the steps of: establishing an auxiliary field around said rod-like electrode; moving the lighter phase of said emulsion upward in the space around said downward-flowing envelope whereby this lighter phase acts as said liquid of higher dielectric strength and prevents excessive current flow through said downward-flowing envelope due to said auxiliary field.

5. A method of separating the phases of an emulsion containing an oil phase and a conducting phase, which method includes the steps of: setting up an electric blast in a direct path toward a body of the liquid forming said conducting phase; introducing the emulsion into said electric blast whereby the emulsion is treated and violently propelled toward said body of liquid, whereby the conducting phase enters and becomes associated with said body of liquid and thus separates from said oil phase; and removing the separated oil phase from the vicinity of said body of liquid.

6. The method of dehydrating petroleum emulsions, that includes introducing raw emulsion to a container wherein is suspended a relatively small smooth-surfaced inner electrode having a downwardly directed point on the lower end thereof, establishing an electrostatic field between the electrode and container and an intense electric blast from said point thereby causing water particles in the emulsion to coalesce adjacent the inner electrode and then to be projected downwardly from the electrode point toward the bottom of the container, maintaining in the lower part of the container a body of water toward which said blast is directed and into which said blast projects the water from the electrode point, withdrawing water from the lower part of the container, and withdrawing oil from the upper part of the container.

7. In an electric treater for emulsions of oil and water the combination of: a live electrode comprising a downward-extending rod of relatively small diameter and providing a lower terminal portion having a radius of curvature less than that of the periphery of the rod itself; a body of water below said terminal portion to be intersected by the projected axis of said rod; electrode means extending around said rod electrode and of relatively large diameter thereby defining an annular treating space therebetween and containing the emulsion to be treated; means for establishing an auxiliary field in said annular treating space and for establishing an intense blast from said terminal portion toward the surface of said body of water, said auxiliary field being more concentrated in a zone immediately adjacent the periphery of said rod than at a position nearer said surrounding electrode means to selectively treat said emulsion in said zone to coalesce the dispersed conducting particles thereof and said blast being of higher gradient than the voltage gradient in said zone due to the smaller radius of curvature adjacent said terminal portion whereby said emulsion is selectively treated in said zone and the treated constituents are drawn downward by said blast and enter said blast for further treatment and for violent and blast-produced projection toward said body of water to facilitate the water entering said blast reaching and entering said body of water; means for introducing the emulsion to be treated into said auxiliary field and above said terminal portion; and means for withdrawing water from said body of water.

8. In an electric treater for emulsions of oil and water the combination of: a live electrode comprising a downward-extending rod of relatively small diameter and providing a lower terminal portion having a radius of curvature less than that of the periphery of the rod itself; a body of water below said terminal portion to be intersected by the projected axis of said rod; electrode means extending around said rod electrode and of relatively large diameter thereby defining an annular treating space therebetween and containing the emulsion to be treated; means for establishing an auxiliary field in said annular treating space and for establishing an intense blast from said terminal portion toward the surface of said body of water, said auxiliary field being more concentrated in a zone immediately adjacent the periphery of said rod than at a position nearer said surrounding electrode means to selectively treat said emulsion in said zone to coalesce the dispersed conducting particles thereof and said blast being of higher gradient than the voltage gradient in said zone due to the smaller radius of curvature adjacent said terminal portion whereby said emulsion is selectively treated in said zone and the treated constituents are drawn downward by said blast and enter said blast for further treatment and for violent and blast-produced projection toward said body of water to facilitate the water entering said blast reaching and entering said body of water; means for withdrawing water from said body of water; and means for supplying emulsion to said annular treating space in a manner to flow an envelope of said emulsion downward around said rod electrode to receive treatment in said high intensity zone immediately therearound.

9. A method as defined in claim 1 including the step of maintaining a body of water below said terminal portion and toward which said field at the end of said terminal portion propels the fluid entering said field after treatment in the most intense portion of the field around said electrode.

10. A method of separating the phases of an emulsion containing an oil phase and a dispersed

phase of a conducting liquid, which method includes the steps of: setting up an electric blast directed vertically downward and directly toward the horizontal surface of a body of said conducting liquid; coalescing droplets of said dispersed conducting liquid in a zone vertically above said blast by establishing an auxiliary electric field above said blast; and moving the liquid containing said coalesced masses downward from said auxiliary electric field and into said blast whereby said blast projects said conducting liquid violently toward said horizontal surface of said body of conducting liquid.

11. A method of electrically treating an emulsion present in a chamber and containing a continuous phase and a dispersed phase of conducting liquid, which method includes the steps of: selectively coalescing the dispersed droplets of said emulsion in a relatively small vertically-extending zone by establising an electric field which radiates outward and which is of sufficient voltage gradient in said zone to coalesce said dispersed droplets, the coalesced material moving downward along said zone and toward the lower end of said chamber; maintaining a body of said conducting liquid in the lower end of said chamber; and violently jetting the coalesced constituents downward from the lower end of said zone in a direct path toward said body of conducting liquid to greatly accelerate the downward gravity-induced movement toward said body of conducting liquid by establishing an electric blast toward said body of conducting liquid and into which blast said zone feeds the coalesced droplets for further treatment and downward propulsion.

12. A method of electrically treating an emulsion present in a chamber and containing a continuous phase and a dispersed phase of conducting liquid, which method includes the steps of: establishing an electric field in said chamber which is of greater intensity and higher voltage gradient in a central annular zone than in a concentric zone therearound whereby said emulsion is selectively treated in said field to produce a pronounced coalescing of the dispersed droplets of said conducting liquid in said central annular zone rather than a uniform coalescing action throughout said field; establishing a downward directed blast immediately below said central annular zone of high voltage gradient whereby the coalesced masses move downward in said zone of high voltage gradient and into said electric blast for further treatment and accelerated repulsion in a downward direction; and maintaining a body of said conducting liquid in the lower part of said chamber, said blast being directed downward in a direct path toward the surface of this body of conducting liquid.

13. A method of electrically treating an emulsion present in a chamber and containing a continuous phase and a dispersed phase of conducting liquid, which method includes the steps of: establishing an electric field in said chamber which is of greater intensity and higher voltage gradient in a central annular zone than in a concentric zone therearound whereby said emulsion is selectively treated in said field to produce a pronounced coalescing of the dispersed droplets of said conducting liquid in said central annular zone rather than a uniform coalescing action throughout said field, the voltage gradient in said central annular zone of high intensity being substantially identical at different horizontal planes throughout the height of said central annular zone whereby the material including said coalesced masses moves downward as an annular stream in said central annular zone of high voltage gradient and is subjected during this downward movement to a field of substantially constant character until moving from the lower portion of said central annular zone of high voltage gradient; establishing a downward directed blast immediately below said central annular zone of high voltage gradient whereby the coalesced masses move downward in said zone of high voltage gradient and into said electric blast for further treatment and accelerated repulsion in a downward direction; and maintaining a body of said conducting liquid in the lower part of said chamber, said blast being directed downward toward the surface of this body of conducting liquid.

14. A method of separating the phase liquids of an emulsion containing a continuous phase of oil and a dispersed phase of a conducting liquid, which method includes the steps of: establishing in an annular space an annular electric field which radiates sideward and which extends into all portions of said annular space, said annular field being substantially identical in character in all horizontal planes of said annular space but being of non-uniform voltage gradient in any particular horizontal plane due to the radiating nature of said field, the voltage gradient of said annular field being sufficiently high in a central high-intensity annular zone to coalesce the dispersed droplets of said conducting liquid; maintaining a body of said conducting liquid below said annular space; establishing a downward-directed electric blast below said annular space and directed downward toward the surface of said body of conducting liquid, the voltage gradient in the upper portion of said blast being even higher than the voltage gradient in said central high-intensity annular zone; subjecting the emulsion to be treated to the action of said radiating field in said annular space to coalesce said droplets in said central high-intensity annular zone; and moving a stream of liquid including the coalesced material downward in said central high-intensity annular zone and into said blast to subject same to an even higher voltage gradient field, said blast being of sufficient intensity to project the conducting liquid violently downward toward said body of conducting liquid thus accelerating gravity-induced downward movement of said conducting liquid toward and into said body of conducting liquid.

15. A method of separating the phases of an emulsion containing an oil phase and a dispersed phase of a conducting liquid, which method includes the step of: setting up an electric blast directed downwardly; coalescing droplets of said dispersed conducting liquid in a zone vertically above said blast by establishing an auxiliary electric field above said blast; moving the material including said coalesced droplets downward from said auxiliary electric field and into said electric blast for further treatment and accelerated repulsion in a downward direction.

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