June 15, 1937. H. C. EDDY 2,083,801

METHOD AND APPARATUS FOR DEHYDRATING PETROLEUM

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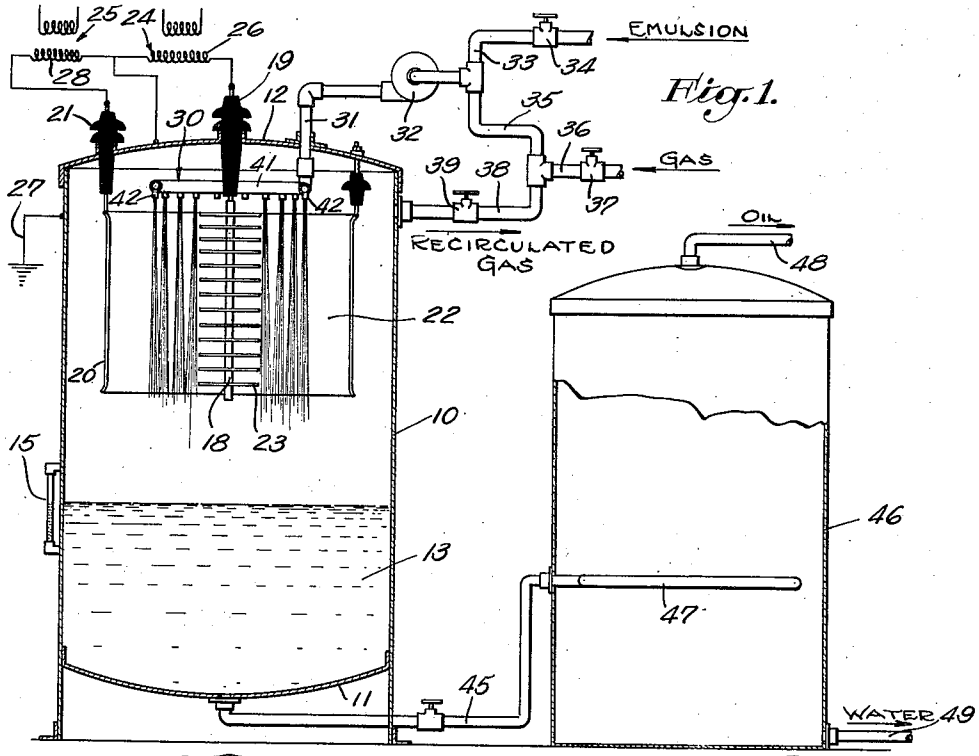

Fig. 1.

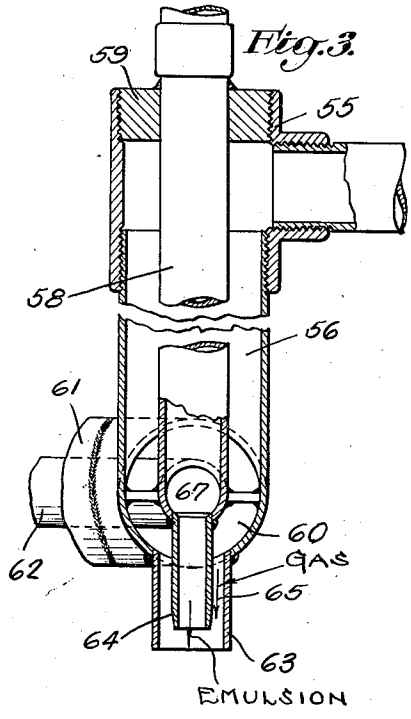

Fig. 3.

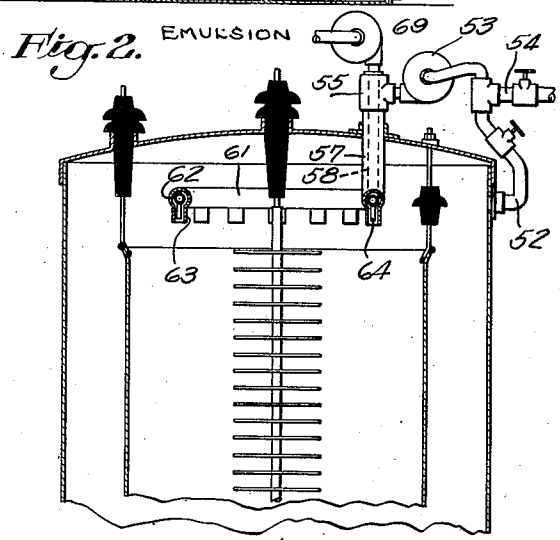

Fig. 2.

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Fig. 4.

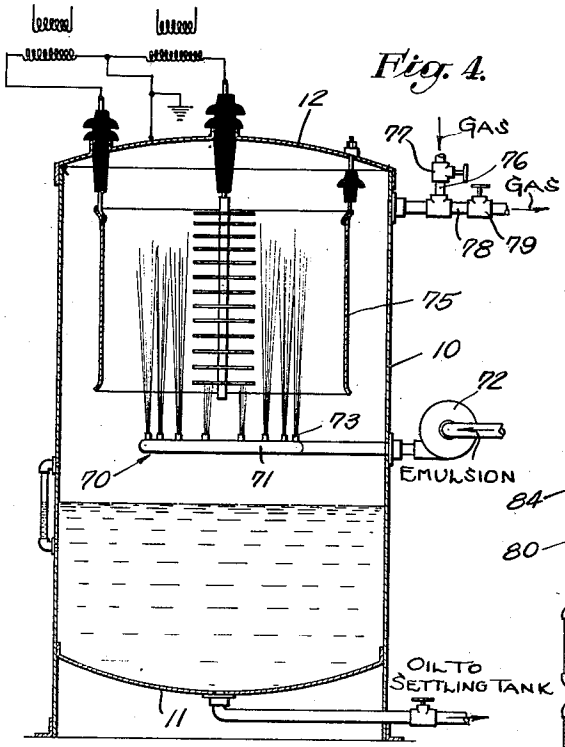


Fig. 5.

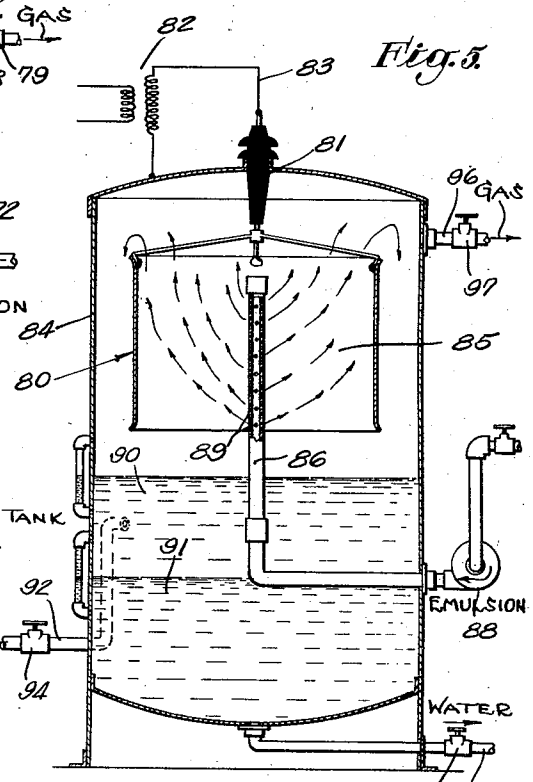


Fig. 6.

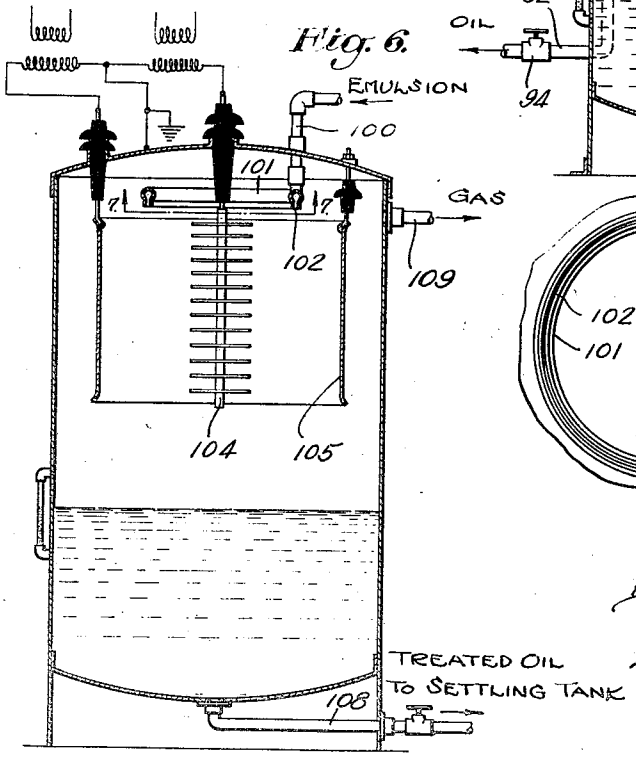
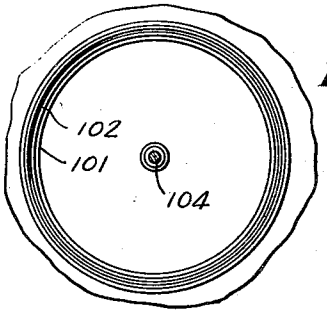


Fig. 7.



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METHOD AND APPARATUS FOR DEHYDRATING PETROLEUM

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Application September 6, 1932, Serial No. 631,785

16 Claims. (Cl. 204—24)

My invention relates to a novel method of electrically treating emulsions to separate these emulsions into their constituent phases and to an apparatus of novel character for effecting this treatment. The invention is particularly applicable to the treatment of petroleum emulsions, and it is in this capacity that the preferred embodiment will be described, though it should be understood that the utility of the process and apparatus is not limited to this type of emulsion.

Petroleum emulsions are essentially of two types,—(1) the type having a continuous phase of oil in which particles of water are suspended, usually termed a water-in-oil emulsion, and (2) the type having a continuous phase of water in which minute oil particles are suspended, usually termed an oil-in-water emulsion. The present invention is applicable in both types.

With regard to emulsions of the first type in which the oil is the continuous phase, one conventional method of separating these phases is to subject the emulsion to the action of a high potential electric field, usually of alternating character. In such a field the dispersed particles are coalesced into droplets of sufficient size to gravitate from the oil. This coalescence is, however, retarded by the viscosity of the oil forming the continuous phase, it being clear that before two dispersed particles can coalesce, they must be moved at least a short distance through the oil. I have found that the action of coalescence can be greatly facilitated if the emulsion particles are suspended in a medium of less viscous character than the oil. In the preferred embodiment of the invention it is preferable to position the particles to be coalesced in a gaseous phase.

In the second type of emulsion the external phase may be formed of a body of conducting liquid such as water. Electrical treatment of such an emulsion has heretofore been impossible in view of the fact that the water phase bridges between the electrodes and in effect short circuits the electrodes to such an extent as to prevent a building up of potential difference requisite to electric treatment. I have found that this type of emulsion may be treated by subdividing the emulsion into rather minute particles which are separated from each other by a gas, these minute particles and the gas being subjected to an electric field whereby coalescence takes place. Thus, the material between the electrodes is essentially a gas with minute particles suspended therein, and although certain of these particles are conducting, the gas prevents excessive current flow.

It is an object of the present invention to electrically treat an emulsion by subdividing this emulsion into minute liquid particles separated from each other by a gas, and to subject these minute particles to the action of an electric field. The gas acts as a dielectric barrier to prevent excessive current flow between the electrodes, and at the same time furnishes a low-viscosity medium which does not unduly retard the movement of the particles therethrough.

It is a further object of the invention to suspend such minute liquid particles in a gaseous atmosphere and to establish an electric field of sufficient intensity to ionize the gas. It is usually impossible to maintain voltage gradients sufficiently high to ionize any portion of the space between the electrodes when this space is filled with a continuous phase of oil in which emulsion particles are suspended. If, however, a gaseous medium is substituted for the continuous phase of liquid, this ionization can be readily established and apparently has a very desirable action on the emulsion particles thus suspended in the ionized gas.

I have found that very satisfactory results are obtained by atomizing the emulsion, and it is an important object of this invention to provide a method and apparatus whereby emulsions are electrically treated by being introduced into an electric field in an atomized state.

This atomization may be effected by any one of a number of means. One method of atomizing such an emulsion is by the use of an atomizer of the mechanical type. Such atomizers are often used in conjunction with fuel-supply systems of oil-burning boilers. In such an atomizing system the liquid is broken up by centrifugal or mechanical forces without the use of a high velocity jet of air or other gas.

It is an object of the present invention to minutely subdivide the emulsion into an atomized state and to introduce this atomized emulsion into a gas-filled electric field.

Another type of atomizing system which can be very successfully used in conjunction with the present invention atomizes the emulsion by the use of a jet of gas delivered to the device under pressure. A high velocity stream of the gas is ordinarily moved into contact with a stream of the emulsion in such a manner that atomization takes place, the material issuing from the atomizer comprising a high velocity mixture of minute emulsion particles in a gaseous atmosphere.

It is an object of the present invention to utilize a stream of gas for atomizing the emul-

sion, and to introduce the gas and the atomized emulsion into an electric field.

A further object of the invention is to atomize the emulsion by forcing this emulsion under high pressure through small orifices so designed as to effect atomization.

One well-known type of petroleum emulsion, when viewed under a microscope, discloses an emulsion in which the oil is the continuous phase and in which the dispersed phase comprises a large number of emulsion particles, each emulsion particle being formed of an emulsion of the oil-in-water or water-in-oil type, the latter type of emulsion predominating. This physical set-up can be found in both loose emulsions and in the fine-grained, tight emulsions, even the extremely minute dispersed particles being composed of an emulsion of oil and water. It is sometimes desirable to regulate the atomizing process so that the minute particles expelled from the atomizing device will be smaller than the emulsion particles in the original emulsion. In other words, each emulsion particle may be further subdivided in the atomizing step, thus forming new interfaces. Such a mode of operation often results in the formation of a mixture which is much more susceptible of electric treatment than was the original emulsion, and it is another object of the invention to provide a method and apparatus utilizing this mode of operation wherein new interfaces are formed by such subdivision.

While it is usually desirable to atomize the incoming emulsion and thus secure a maximum effect from the ionization of the gas, this is not always necessary. In one embodiment of the invention a sheet of the emulsion is moved into the electric field in spaced relationship with each of the electrodes, this emulsion being separated from each electrode by a body of gas. If a sufficient potential is maintained between the electrodes, this gas will be ionized on each side of the emulsion, thus approaching the desirable action which takes place if the emulsion is completely atomized.

It is a further object of the invention to provide a method and apparatus for treating an emulsion by the use of an electric field set up between two electrodes, the emulsion being introduced into this field in spaced relationship with the electrodes and being separated from these electrodes by an ionized gas.

Further objects of the invention lie in a system of recycling the gas from the treater into the incoming emulsion to assist atomization. Other objects of the invention lie in the structure of the apparatus to be hereinafter described.

Still further objects and advantages of the invention will be made evident hereinafter.

Referring to the drawings,

Fig. 1 is a diagrammatic view illustrating in section one form of the invention.

Fig. 2 is a fragmentary view illustrating another form of the invention.

Fig. 3 is an enlarged sectional view of a portion of Fig. 2 and illustrates the atomizing system.

Figs. 4, 5, and 6 are diagrammatic views illustrating alternative forms of the invention.

Fig. 7 is a view taken on the line 7—7 of Fig. 6.

Referring particularly to Fig. 1, I have illustrated a dehydrator tank 10 of conventional construction and including a lower head 11 and an upper head 12. The interior of this tank is partially filled with a body of liquid 13, the interior of the tank above this body of liquid being filled with a body of gas. A conventional gauge 15 may be used to indicate the level of the body of liquid 13.

Suitable electrodes are provided in the upper portion of the tank 10 to set up an electric field therein. In the form of the invention shown in Fig. 1, this electrode system comprises a central live electrode 18 supported by an insulator 19, and an outer live electrode 20 supported by an insulator 21. Other types of electrode structures may, however, be utilized without departing from the spirit of the invention. As shown, the central and outer live electrodes 18 and 20 cooperate in defining a treating space 22 which is open at its upper and lower ends. If desired, plates 23 may be positioned on the central live electrode 18 so as to concentrate the discharge from the edges thereof. These plates are not, however, essential to the operation of the invention.

An electric field is set up in the treating space 22 by a suitable source. In Fig. 1 this source takes the form of two transformers 24 and 25. A secondary winding 26 of the transformer 24 is connected to the tank 10 and to the central live electrode 18, this tank being grounded as indicated by the numeral 27. In addition, a secondary winding 28 of the transformer 25 is connected to the tank and to the outer live electrode 20. It is preferable that the secondary windings 26 and 28 be connected in additive relation so that the potential between the central live electrode 18 and the outer live electrode 20 will be much greater than the potential between either of these electrodes and the tank. Such a system thus offers a convenient means for establishing electric fields of extremely high gradient without requiring the use of large and expensive insulators.

The emulsion is introduced into the treating space 22 by an atomizing means 30. The gas and the emulsion are supplied in intermixed state to the atomizing means 30 through a pipe 31 which communicates with the discharge of a pump 32, diagrammatically shown. Emulsion is supplied to the intake of this pump through a pipe 33 including a valve 34, while gas is supplied thereto through a pipe 35 including a branch 36 communicating with an external source of gas. A valve 37 controls the flow of such gas through the pipe 36. A pipe 38 communicates between the upper end of the tank 10 and the pipe 35 and includes a valve 39 for controlling the flow of gas recirculated from the upper end of the tank and into the intake of the pump 32. A major portion of the gas utilized may be gas which is thus recirculated, only sufficient gas being supplied through the pipe 36 to compensate for losses in the system.

In the form of the invention shown in Fig. 1, the atomizing means 30 is shown as comprising an annular pipe 41 communicating with the pipe 31. This annular pipe provides a plurality of atomizers 42 which may be of any well known type and which minutely subdivide the emulsion into an atomized state, discharging this emulsion downwardly in the treating space 22. In some instances it is possible to utilize atomizers 42 in the form of suitably designed nipples which receive the intermixture of gas and emulsion, the gas assisting in atomizing the emulsion as it moves through these nipples.

In the operation of this form of the invention the atomized emulsion and the gas discharged from the atomizers 42 moves downwardly in the treating space 22 and is subjected to the action of

the electric field therein. This field has two rather distinct tendencies. In the first place, it will be clear that if each minute emulsion particle contains both oil and water, the microscopic dispersed particles in this emulsion particle will be acted upon by the electric field and will tend to coalesce without necessarily moving from the emulsion particle. In the second place, the electric field will tend to coalesce adjacent emulsion particles, as well as to act upon the emulsion comprising these particles. Thus the treating action is a dual one,—the internal structure of each emulsion particle is changed, and adjacent emulsion particles are coalesced.

The coalescence of adjacent emulsion particles takes place more readily than the coalescence of dispersed particles of oil which may be in the field. Thus, if there are present in the field three constituents, namely, gas, minute particles of oil, and minute emulsion particles, more of the emulsion particles will be coalesced than the oil particles. This is due primarily to the difference in dielectric qualities of the constituents, it having been found that the predominating coalescence is between the particles of different dielectric strength. The dielectric strength of the gas and oil particles is of the same order of magnitude, but the dielectric strength of the emulsion particles is quite different from that of the gas. It follows that the major action taking place in the field will be a coalescence of emulsion particles rather than oil particles.

The coalesced material drops downward to the body of liquid 13. If desired, the coalesced constituents may be allowed to settle in the bottom of the tank 10, as will be hereinafter set forth. In the form of the invention shown in Fig. 1, however, these constituents are removed from the tank 10 before any material stratification takes place. This is accomplished by withdrawing the liquid through a pipe 45 which discharges into a settling tank 46 through a spray pipe 47 in the usual manner. The oil and water stratify in the tank 46, the oil rising to the upper end and being withdrawn through a pipe 48, while the water drops to the lower end of the tank and is withdrawn through a pipe 49. It will be apparent that the gas separates from the liquid in the upper portion of the tank 10, this gas being withdrawn through the pipe 38 and recycled, as previously set forth.

Another type of atomizing system is disclosed in Figs. 2 and 3. Here a pipe 52 recycles gas from the upper portion of the tank to the intake of a pump 53, a pipe 54 delivering a new supply of gas to the pump to compensate for losses in the system. The pump 53 may be of any desired type which will greatly increase the pressure on this gas, this pump discharging into a T 55 and into an annular space 56 between an outer pipe 57 and an inner pipe 58 extending downward from this T. The upper end of the T 55 is closed by a plug 59 so that the gas is forced downward in the annular space 56. This gas enters a manifold chamber 60 formed between an outer annular pipe 61 and an inner annular pipe 62. This manifold chamber distributes the gas to a plurality of nipples 63. A nozzle 64 extends downward in each nipple and cooperates therewith in defining a discharge space 65 through which the gas passes at high velocity. The nozzles 64 terminate short of the ends of the nipples 63 and communicate with the interior of the inner annular pipe 62, which forms a manifold chamber 67 for supplying emulsion thereto. Emulsion is supplied to the chamber 67 through the pipe 58 by a pump 69 shown in Fig. 2. An electrode system similar to that shown in Fig. 1 is utilized.

The gas is usually delivered to the manifold chamber 60 at a pressure substantially greater than the pressure of the incoming emulsion, though this is not necessary to the operation of the invention. In this event, a high velocity stream of the gas moves through the discharge space 65 and surrounds the nozzles 64. As this fast-moving gas comes into contact with the stream of emulsion flowing through the nozzles 64, it atomizes this emulsion in a well-known manner, the spray being moved downward into the upper end of the treating space and being acted upon by the electric field therein in the manner previously described. In some instances the pump 69 can be dispensed with, the fast-moving jet of gas flowing through the discharge space 65 acting to draw the emulsion through the pipe 58.

In Fig. 4 I have illustrated a treater similar to that shown in Fig. 1 but equipped with a different type of atomizing means indicated in general by the numeral 70. This means takes the form of an annular pipe 71 communicating with the discharge of a pump 72 which supplies emulsion thereto under pressure. Positioned on this pipe 71 and communicating therewith are a plurality of atomizers 73 of the mechanical or centrifugal type. Such atomizers are well known in other arts and act to break up the emulsion into a mist or spray either by mechanically agitating the emulsion or by impinging a high velocity jet of the emulsion on a stationary or moving body. Atomizers of the centrifugal type wherein the emulsion is subjected to a whirling action to effect atomization may also be utilized.

It will be noted that in this form of the invention the atomized emulsion moves upward through the treating space. Two modes of operation are possible. The atomized emulsion may be forced upward into the treating space at such a velocity that it will not drop therein under the action of gravity but will move from the upper end thereof and downward around the outer live electrode indicated by the numeral 75. On the other hand, the pressure may be reduced to such an extent that a portion of this atomized emulsion drops from the lower end of the treating space against the movement of the incoming atomized emulsion.

The upper end of the tank is filled with a body of gas, as previously described. This gas may be supplied through a pipe 76 controlled by a valve 77. Sometimes a certain amount of gas is generated during treatment, and any excess gas can be withdrawn through a pipe 78 controlled by a valve 79.

In Fig. 5 still another form of the invention is disclosed. Here a single live electrode 80 in the form of a sleeve is utilized, this sleeve being supported by an insulator 81. A transformer 82 supplies high potential current to this electrode through a conductor 83, this transformer being also connected to a tank 84 to set up an electric field between the tank and the electrode 80. The main treating space is, however, formed inside the electrode 80 and is indicated by the numeral 85. An inner grounded electrode 86 cooperates with the electrode 80 in defining this main treating space. In this form of the invention the electrode 86 is in the form of a pipe which receives emulsion under pressure from a pump 88, the pipe providing a plurality of atomiz-

ing means for atomizing the emulsion and introducing it into the treating space 85. Any suitable atomizing means may be utilized. In the form shown in Fig. 5 I provide a plurality of orifices 89 which atomize the emulsion as it moves therethrough. Whether orifices 89 are utilized in this capacity or whether other types of atomizing means are utilized, it is desirable to so position these atomizing means that they discharge into the treating space in an upwardly inclined direction. If these means discharge radially outward, the atomized emulsion will drop downward in the treating space 85. If, however, these means are inclined upward, the speed of movement of the subdivided emulsion through the treating space 85 can be controlled by the amount of inclination. If the atomizing means are sufficiently inclined, it is possible to reverse the flow of the subdivided emulsion through the space 85 and move this emulsion upward therethrough. In this event the treated particles will move downward between the tank 84 and the electrode 80 and will be subjected to a further electric treatment therein.

The treated emulsion moves downward through the body of gas in the upper end of the tank 84 and enters the body of liquid in the lower end of this tank. In the form shown in Fig. 5 this body of liquid comprises stratified bodies of oil and water indicated respectively by the numerals 90 and 91. The constituents of the treated emulsion thus stratify and enter these bodies of oil and water. The oil may be continuously withdrawn through a pipe 92, while the water may be withdrawn through a pipe 93, valves 94 and 95 respectively positioned in these pipes acting to control the flow therethrough. Gas may be withdrawn from or forced into the upper end of the tank through a pipe 96 providing a valve 97.

In all of the forms of the invention previously described it is usually desirable to ionize at least a portion and preferably all of the gas in the treating space. Contact between this ionized gas and the emulsion usually facilitates treatment, though it should not be understood that it is always necessary to utilize ionizing potentials. The desirable action between the ionized gas and the emulsion can be obtained without atomization, though usually to a less effective degree. In the form of the invention shown in Fig. 6 the incoming emulsion is contacted on two sides by the ionized gas, rather than being subdivided into minute particles each of which is completely surrounded by the gas. One mode of effecting this end is to introduce the emulsion through a pipe 100 communicating with an annular discharge pipe 101. An annular slot is cut in the lower face of the pipe 101, this slot communicating with an annular discharge opening 102 formed between a pair of concentric rings secured to the annular pipe 101. The result is that an annular jet of the emulsion is moved downward through the gas in the treating space in spaced relationship with the electrodes so that a body of gas is positioned on each side of this emulsion and separates the emulsion from the adjacent electrode surface. Any suitable electrodes may be utilized, but in the preferred embodiment it is desirable to utilize an electrode system such as shown in Fig. 1 the inner and outer electrodes being indicated by the numerals 104 and 105 and being insulated from the tank to define the treating space, the emulsion introduction system being grounded to the tank. The treated constituents can be removed from the lower end of the tank through a pipe 108 as previously described, while gas may be supplied to and withdrawn from the upper end of the tank through a pipe 109.

Various gases may be utilized in each form of the invention. Ordinarily natural gas from which air has been removed can be used to good advantage, being readily available. It is usually desirable that the gas or gaseous mixture be non-explosive, but in the event that air is excluded from the tank it will be clear that no danger of explosion exists when natural gas is utilized. Other gases may, however, be substituted and, if desired, may be wholly or partially inert. They should be of such character that they are substantially non-condensable at the temperature existing in the treater; otherwise condensation will take place and the condensate may unite with the body of liquid in the lower portion of the tank and thus fail to maintain the gaseous atmosphere in the upper portion of the tank.

I claim as my invention:

1. A method of electrically treating an emulsion, which method includes the steps of: subdividing substantially the entire quantity of said emulsion to be treated to form a plurality of minute particles positioned in a gaseous atmosphere; and subjecting the gaseous atmosphere and said minute particles positioned therein to an electric field of sufficient intensity to coalesce the dispersed phase liquid of said emulsion; and separating the coalesced phase liquid from the liquid forming the continuous phase of said emulsion.

2. A method of treating an emulsion composed of a continuous phase of oil and a dispersed phase formed of emulsion particles of emulsified oil and water, which method includes the steps of: atomizing said emulsion to form minute oil particles and minute emulsion particles each emulsion particle containing emulsified oil and water and being of smaller size than the emulsion particles in the original emulsion, each of the minute emulsion particles and the minute oil particles formed by said atomization being surrounded by a gas; subjecting said minute emulsion particles and oil particles and said gas surrounding these minute particles to the action of an electric field; and separating said oil and said water of said emulsion from each other and from said gas.

3. A method of electrically treating an emulsion, which method includes the steps of: moving into a treating space a stream of gas carrying minute droplets of emulsion; establishing an electric field in said treating space whereby said minute droplets are agglomerated; separating said gas from said agglomerated droplets; and recycling the separated gas into the incoming emulsion.

4. A method of treating an emulsion by the use of a pair of electrodes defining a treating space, which method includes the steps of: maintaining in said treating space a gas; impressing a potential difference between said electrodes sufficient to ionize said gas; introducing said emulsion in a subdivided state into the ionized gas; and subsequently separating the constituents of said emulsion from each other and from said gas.

5. A method of electrically treating an emulsion, which method includes the steps of: bringing a high-velocity jet of gas in contact with a flowing stream of said emulsion to atomize said emulsion; introducing both said gas and the atomized emulsion into an electric field; and

subsequently separating the constituents of said emulsion and said gas.

6. A method of treating an emulsion by the use of a pair of electrodes spaced from each other to define a treating space, which method includes the steps of: maintaining said treating space filled with a gas; introducing a stream of the emulsion to be treated into said treating space in spaced relation with each of said electrodes whereby a body of gas lies on each side of said emulsion and between said emulsion and said electrodes; setting up a potential difference between said electrodes to establish an electric field in said treating space acting on said emulsion; and separating the treated constituents of said emulsion and said gas.

7. In combination in an electric treater for treating emulsions: an atomizing means providing an orifice and capable of subdividing an emulsion delivered thereto; means for supplying gas and the emulsion to be treated to said atomizing means, said gas atomizing said emulsion and being discharged from said orifice along with the atomized emulsion; a tank into the upper end of which said orifice of said atomizing means discharges, said upper end of said tank containing a body of gas and the lower end of said tank containing a body of liquid; means for setting up an electric field in the gas in the upper end of said tank, the constituents discharged from said atomizing means moving into said electric field; means for withdrawing the emulsion constituents from said tank; and means for withdrawing from the upper end of said tank an amount of gas substantially corresponding to the gas introduced into said tank with said emulsion.

8. A combination as defined in claim 7 in which said last-named means includes a pump means for withdrawing gas from the upper end of said tank and recycling the gas thus removed into said atomizing means.

9. A method of electrically treating an emulsion of the oil-in-water type, which method includes the steps of: setting up an intense electric field between a pair of electrodes; atomizing said emulsion to break the water phase into minute water particles suspended in a gas; subjecting said gas and said atomized emulsion to the action of said electric field, said gas preventing bridging of said electrodes by said water particles; and separating the phases of said emulsion.

10. A method of electrically treating an emulsion to cause separation of the constituent phase liquids thereof, which method includes the steps of: substantially filling a treating space with a gaseous atmosphere in which is suspended atomized particles of the raw emulsion to be treated, said atomized particles being separated by gas; establishing in said treating space an electric field of sufficient intensity to ionize said gas and treat said atomized particles of said emulsion; and separating the treated phase liquids of said emulsion from each other and from said gas.

11. A method of electrically treating an emulsion to cause separation of the constituent phase liquids thereof by the use of a restricted orifice, which method includes the steps of: atomizing said emulsion by moving a stream thereof through and from said restricted orifice to subdivide same into minute masses spaced from each other; introducing the atomized emulsion into an electric field containing a gaseous atmosphere whereby said minute masses are separated from each other by the gaseous atmosphere in said field, said electric field being of sufficient intensity to treat said masses; and separating the treated phase liquids of the treated emulsion from each other and from the gas forming said gaseous atmosphere.

12. A method of electrically treating an emulsion to cause separation of the constituent phase liquids thereof, which method includes the steps of: moving a stream of emulsion upward in a treating space; atomizing all of the emulsion contained in said stream to form a gaseous atmosphere in which is positioned the atomized masses of the emulsion; subjecting the gaseous atmosphere and its contained atomized masses of emulsion to the action of an electric field in said treating space; and separating the treated phase liquids of said emulsion from each other and from the gas of said gaseous atmosphere.

13. A method of electrically treating an emulsion to cause separation of the constituent phase liquids thereof, which method includes the steps of: moving into a treating space a stream of gas carrying minute droplets of emulsion; establishing an electric field in said treating space of sufficient intensity to coalesce said minute droplets; first separating the gas from the treated phase liquids; and then collecting and separating the treated phase liquids of said emulsion from each other.

14. In combination in an electric treater for emulsions: a pair of electrodes defining a treating space containing gas; means for setting up an electric field between said electrodes; an atomizing means providing an emulsion passage and a gas passage communicating therewith; and means for supplying emulsion and gas respectively to said passages of said atomizing means to subdivide said emulsion into minute masses separated by said gas, said minute masses and the gas separating same moving from said atomizing means into said electric field.

15. A method of treating an emulsion of oil and water by use of two vertically-extending electrodes bounding a treating space, which method includes the steps of: moving a stream of emulsion downward in said treating space between said electrodes; maintaining a body of gas on opposite sides of said stream between said stream and said electrodes; establishing an electric field in said treating space to act upon the downward-moving stream; and separating the constituents of the treated emulsion in a zone exterior of said treating space containing said gas.

16. In combination in an electric treater for emulsions: a pair of electrodes defining a treating space containing gas; means for setting up an electric field between said electrodes; a high-velocity-discharge atomizing means discharging into said electric field and capable of breaking up emulsion delivered thereto into minute masses which are discharged into said field, said atomizing means including an orifice discharging into said electric field; means for supplying the emulsion to be treated to said atomizing means; and means for delivering gas under pressure to said atomizing means, said atomizing means subdividing said emulsion and discharging the subdivided emulsion along with said gas through said orifice and into said field.

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