Oct. 7, 1958 W. WOELFLIN 2,855,359

ELECTRIC TREATER

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Fig. 1.

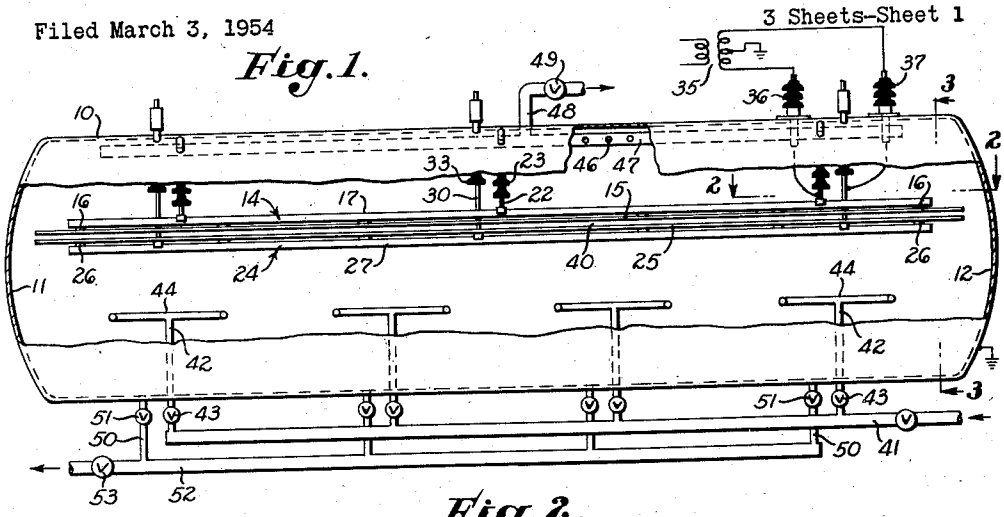
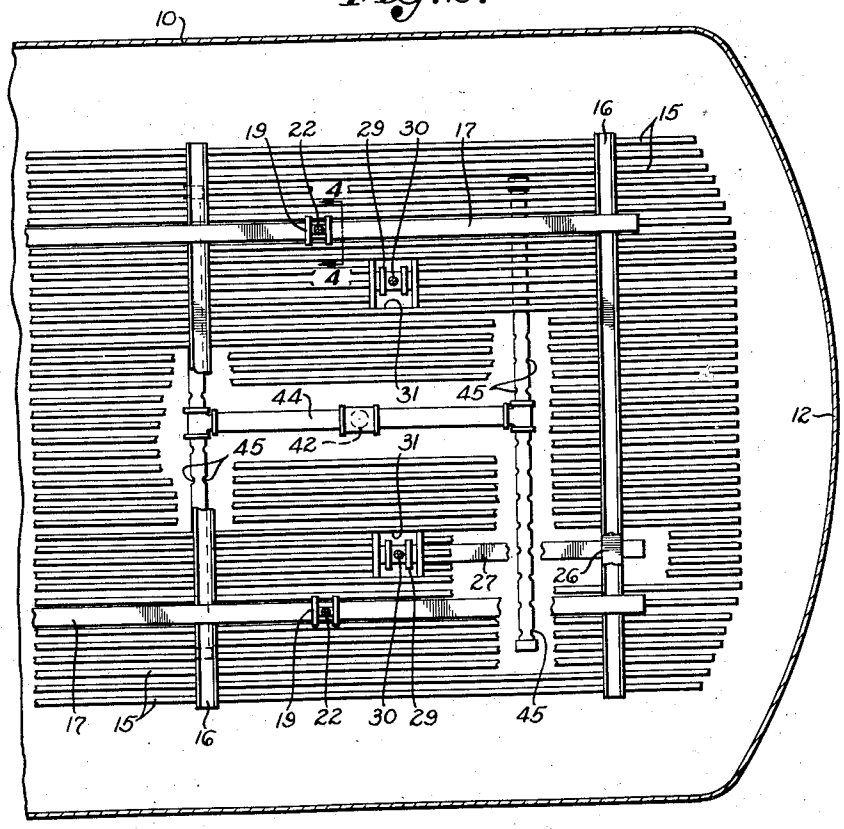


Fig. 2.



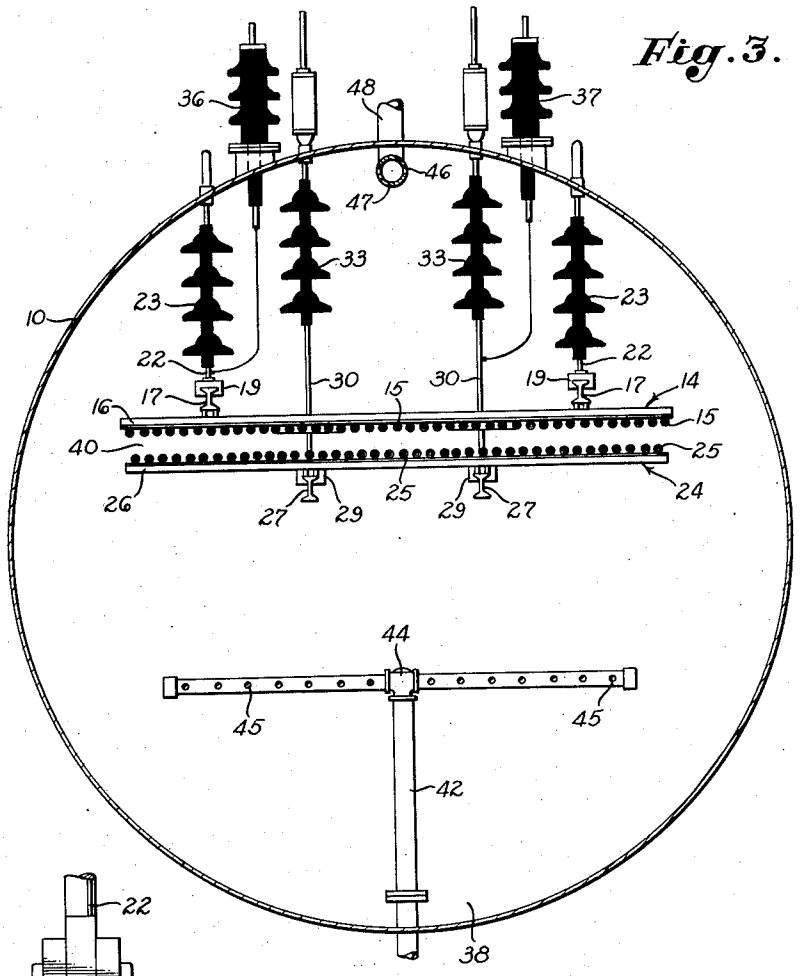
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Fig. 3.



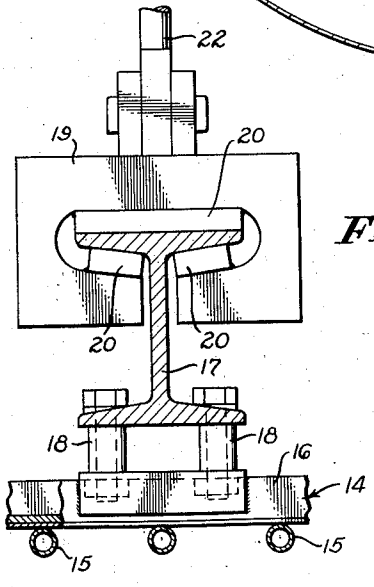
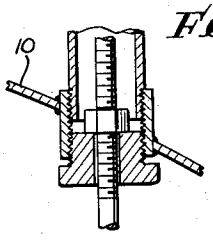


Fig. 4.

Fig. 5.



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Fig. 6.

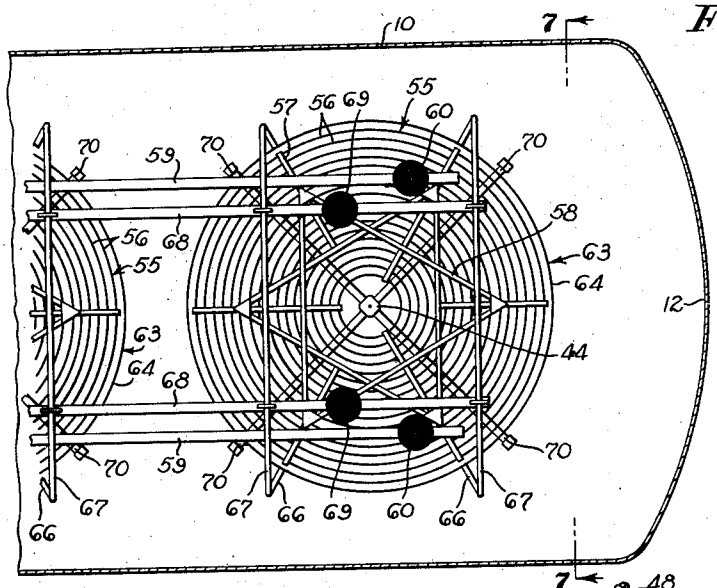
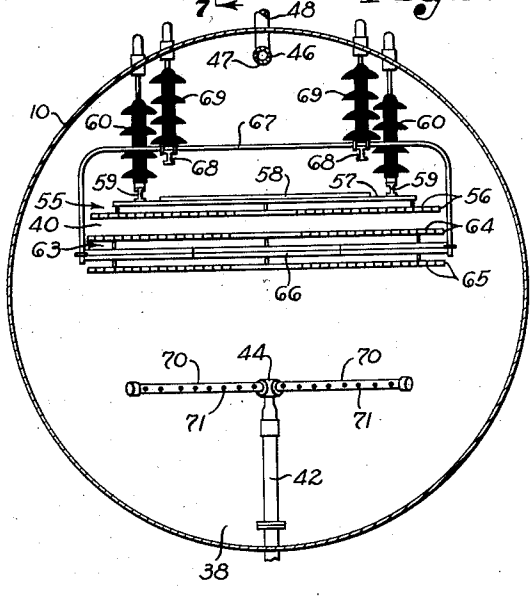


Fig. 7.



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ELECTRIC TREATER

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13 Claims. (Cl. 204—302)

The present invention relates to the electric treatment of emulsions. More particularly, it relates to a new and improved electric treater which is primarily useful in the dehydration of crude oils and in electric purification processes, the treater being particularly suited to the treatment of heavier oils.

Prior electric emulsion treaters have been manufactured in a great many shapes and sizes. A type of treater which experience has proved to be practical from a commercial standpoint consists of an upright cylindrical tank; that is, a cylindrical tank disposed with its axis vertically located with respect to the ground. Usually these tanks are about 10 ft. in diameter and are about 12 ft. tall. Within such treaters various electrode constructions have been disposed. Cylindrical tanks of this category have proved advantageous, but, unfortunately, for large installations the cost of a series of these treaters becomes an important limiting economic factor.

Very effective electric treaters in the form of spheres have been manufactured. Both theoretically and practically, such constructions offer many important advantages, but their application tends to be limited by the cost of installation. When they are to be of any comparatively large diameter, they cannot be assembled at a factory and then transported to a desired location by railroad or by truck because of size limitations. This makes it necessary to assemble these devices where they are to be used, and such assembly, being often away from skilled workers and specialized equipment, is usually both difficult and expensive.

A broad object of the present invention is to teach the construction of new and improved electric treaters which are a substantial improvement over the aforesaid and related types of treaters and which give particularly good results if energized by a higher-capacity transformer, e. g., one which gives about .33 kva. or more per sq. ft. of electrode area, as compared with about .18 kva. per sq. ft. as is common on upright electric treaters. Another object is to provide electric treaters which are characterized by their effectiveness per unit volume and their low cost per unit of capacity.

The term "thruput" is generally used in industry to designate the capacity of an electric treater utilized either in the dehydration of crude oils or in the removal of aqueous material in various electric purification processes. A major problem in designing apparatus for electric treatment of emulsions is how to design a treater having a high thruput per unit cost and size and which is extremely effective in removing water or other dispersed material from oil. Devices as herein set forth have proved in practice to be extremely advantageous in solving this problem. In practice they have proved to have much higher capacity per unit volume than would be expected from prior treaters; also they have been comparatively cheap to construct.

The broad general purposes of this invention are achieved by constructing an electric emulsion treater which consists of an elongated substantially horizontally

disposed tank, having much greater length than width, within which there are disposed electrodes for establishing electric fields substantially throughout the horizontal length of such tank and within which there are disposed appropriate inlets and outlets for oil, aqueous material, and emulsion suitably positioned along the length of such tank. Another object of the invention is to provide constructions of such type.

A more specific object of the invention is to provide an emulsion treater as indicated in which the top and the bottom sections of the horizontally disposed tank are of smaller horizontal cross section than the center portion of said tank, and within which the electrodes are located in what may be broadly termed the center portion of said tank, albeit they may actually be disposed slightly above or below the geometric center of the tank. A further object is to provide a device of the class described in which the tank possesses curved side walls as are found in a common cylinder.

The construction of the electrodes utilized within an electric treater as herein described is important with respect to the mechanism by which electric treaters operate. An effective electrode arrangement consists of upper and lower electrodes insulated from one another and from the tank disposed within the tank so as to be capable of being used in establishing electric fields substantially throughout the horizontal length of such tank within the central portion thereof. An object of the invention is to provide such an electrode and tank arrangement as indicated in this preceding sentence. A related object is to produce a construction of the class described in which the electrodes utilized are horizontally disposed. Such electrodes can be horizontal grids or horizontally disposed annular conductors.

Another and important feature with respect to the operation of the electric treaters herein described is the location of the inlets utilized to distribute an oil emulsion substantially throughout the horizontal length of such treaters. The preferred inlet means employed in accordance with this specification are located within the tank beneath the electrodes and above the bottom of the tank, and are employed to introduce emulsions into the treater at a comparatively low velocity.

Once in the tank, such emulsions tend to travel upwardly in an unresolved state towards the electrodes. Normally this travel is through a layer of material termed in the trade as "sludge" because of its mixed composition. As it progresses upwardly this emulsion tends to decrease in velocity and is contacted by downwardly moving droplets or masses of aqueous material which have been coalesced by action of the electric fields and which settle out of the emulsion by gravity. A certain amount of aqueous material of the incoming emulsion will join with such coalesced masses, particularly if there is an electric field present. The major portion of the aqueous material of the incoming emulsion is, however, coalesced by the fields in the interelectrode space or in the vicinity of the electrodes.

It is theorized that the improved results obtained in accordance with this invention are directly concerned with control of the velocity of the unresolved emulsion in an upward direction. With a horizontally disposed cylindrical treater having emulsion inlets between the bottom and the center portion of the tank and having electrodes disposed within such center portion, the upward velocity of the emulsion varies so as to decrease as the horizontal cross-sectional area of the tank increases. Within the vicinity of the central portion of the tank, the velocity of flow upward tends to be at a minimum and the rate at which the aqueous droplets coalesce and settle tends to be at a maximum as a result of the proximity of the electrodes. These factors are theorized to give rise to a com-

paratively quiescent area in this central portion in which the flow is sufficiently slow to allow aqueous droplets to remain in the electric field until adequately coalesced. The absence of a great deal of agitation also prevents coalesced or incipiently coalescing droplets from being hydraulically severed. This explanation of the effectiveness of operation of treaters of the invention is, however, not limiting.

Further details with respect to the present invention, as well as further objects and advantages of it will be apparent from the balance of this specification, the appended claims, and the accompanying drawings, in which:

Fig. 1 is a longitudinal view, partially in section, of one embodiment of the invention;

Figs. 2 and 3 are sectional views taken along corresponding lines of Fig. 1;

Fig. 4 is a sectional view taken along the line 4—4 of Fig. 2;

Fig. 5 is an enlarged sectional view showing how an electrode arrangement as used in the construction of Fig. 1 can be adjustably mounted;

Fig. 6 is a detail of an alternative embodiment; and

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

Figs. 1–3 show a substantially horizontal cylindrical tank **10** closed at its ends by domed head members **11** and **12** and capable of withstanding considerable internal pressure. Electrodes are positioned in this tank to establish electric fields substantially throughout the length of the tank.

The upper electrode arrangement **14** includes a grid-like upper electrode formed of a plurality of metallic members **15** which may be rods or pipes and which here extend longitudinally of the tank. The metallic members **15** are supported by a framework shown as including a number of cross members **16**, to which the metallic members **15** may be welded or otherwise connected, this framework also including two longitudinal members **17** which may be I-beams shaped as in Fig. 4 and secured to the cross members **16** by spacers **18**. The longitudinal members **17** are supported at intervals throughout their lengths by hanger members **19** which partially encircle the upper flange of the corresponding longitudinal member with spacers **20** therebetween. Each hanger member is supported by a hanger **22** connected to an insulator **23** adjustably supported from the tank **10** as suggested in Fig. 5.

The lower electrode arrangement **24** includes similar metallic members **25** supported by a framework including cross members **26** and longitudinal members **27** supported by hanger members **29** and hangers **30** which extend upwardly through openings **31** of the upper electrode arrangement **14**. The hangers **30** are connected to insulators **33** which in turn are adjustably hung from the tank by an arrangement similar to that shown in Fig. 5.

Both electrode arrangements are thus insulated from the tank and may be energized from a high-voltage source such as a transformer **35** with the midpoint of the secondary winding grounded, as is also the tank **10**. The high-voltage leads are connected through suitable bushings **36** and **37** and are connected respectively to the upper and lower electrode arrangements. One important advantage of the invention relates to the fact that a comparatively small number of such bushings and insulators are required for a comparatively large installation. An electric field is thus established between each electrode arrangement and the tank; also between the lower electrode arrangement **24** and any body of aqueous medium in a trough-like collection zone **38** in the bottom of the tank **10**. A double-voltage field is established in the main treating space **40** between the electrode arrangements.

The emulsion is pumped through a single emulsion-supply pipe **41** which acts as a manifold for a plurality of riser pipes **42** each containing a valve **43** and feeding a distributor **44** below one zone of the electrodes. Each distributor **44** is shown as an H-shaped pipework with arms having sidewardly facing openings **45** for discharging the emulsion into the tank. The distributors **44** are spaced along the length of the tank so that the emulsion is discharged at a number of horizontally spaced positions.

The electric fields coalesce the dispersed material of the emulsion into masses which gravitate to the collection zone **38**, leaving a treated oil which rises to the top of the tank. The treated oil enters horizontally facing openings **46** in an oil draw-off pipe **47** which preferably extends throughout a major portion of the length of the tank. This pipe **47** connects with a pipe **48** extending through the tank and containing a back-pressure valve **49**. The separated aqueous material is withdrawn from the collection zone **38** through a plurality of draw-off pipes **50** each equipped with a valve **51**, these pipes **50** being connected to a manifold **52** having a back-pressure valve **53** which also regulates the level of the separated aqueous material in the tank **10**.

In the embodiment of Figs. 6 and 7, the upper electrode arrangement includes a plurality of circular upper electrodes **55** spaced side-by-side substantially throughout the length of the tank **10**. Each upper electrode is formed of concentric or parallel ring-like metallic members **56** supported by a framework including radial members **57**, diagonal members **58** and longitudinal members **59** which may be I-beams extending substantially throughout the length of the tank. The longitudinal members **59** are suspended by insulators **60**, as before.

Similarly, the lower electrode arrangement in Figs. 6 and 7 includes a plurality of lower electrodes **63** having upwardly facing concentric or parallel ring-like metallic members **64** and similar lower metallic members **65** supported from a framework **66** connected to the depending arms of U-shaped members **67** supported by longitudinal members **68** hanging from insulators **69**. The upper and lower electrodes **55** and **63** may be connected to a source of potential as previously described. Likewise, the manners of withdrawing treated oil and separated aqueous material from the tank may be as previously described.

The emulsion to be treated may be introduced into the tank **10** in this embodiment by using riser pipes **42** connected to a distributor **44** including radial arms **70** having openings **71** drilled horizontally through opposite sides of the pipe forming each arm.

It will be realized by those skilled in the art that various modifications can be made within the invention as herein described without departing from the spirit of the teachings thereof. Such modifications of this character as are within the skill of the art and are defined by the appended claims are to be considered as part of the invention.

I claim as my invention:

1. An electric treater for emulsions of the type having a continuous oil phase and droplets of dispersed-phase material dispersed therein, said treater comprising: a generally cylindrical tank disposed with its axis in a substantially horizontal position, the horizontal length of said tank being much greater than its diameter, said tank providing a shallow horizontal zone near the axis of the tank of a height only a small fraction of the radius of the tank, said tank having a shallow inlet zone spaced below said horizontal zone, said zones extending substantially throughout the length and width of the tank at the respective levels of said zones; means for establishing droplet-coalescing electric fields throughout substantially the entire horizontal length of said horizontal zone, said means including spaced foraminous electrodes disposed entirely within said horizontal zone of said tank and electrically insulated from each other, the spacing of said electrodes being no more than a very small fraction of said radius, and means for electrically energizing at least one of said electrodes; inlet means at a level substantially below said electrodes and below said axis of said container, said inlet means having a plurality of discharge openings in said inlet zone at said level substantially be-

low said electrodes, said discharge openings being spaced from each other in a pattern occupying substantially the entire length of said inlet zone below said electrodes, and said inlet means being constructed to distribute the emulsion over at least half the width of the inlet zone, all portions of said electrodes being above said inlet means; means for supplying the emulsion to be treated to said inlet means to flow from said discharge openings, the discharged emulsion forming a mass of liquid rising from said inlet means to and through said shallow horizontal zone to an oil zone thereabove with decreasing upward velocity from said inlet means to said axis so that electric treatment of said emulsion takes place near the level where said upward velocity is a minimum whereby droplets of dispersed-phase material coalesced by said electric fields settle through said mass of liquid while rising at a reduced rate, said coalesced droplets settling to a trough-like collection zone below said inlet means and formed by the extreme lower end of said substantially horizontal tank; and outlet means for separately withdrawing liquids from said oil zone and said collection zone.

2. An electric treater as defined in claim 1 in which said inlet means comprises a foraminous pipe network within said inlet zone, a manifold and a plurality of branch pipes opening on said manifold at positions spaced longitudinally of said tank and communicating with said pipe network at positions spaced longitudinally of the tank.

3. An electric treater as defined in claim 2 in which said pipe network includes a plurality of H-shaped pipe structures each having two pipe legs providing discharge openings therein and joined by a cross pipe, said branch pipes communicating respectively with said cross pipes to supply the emulsion thereto.

4. An electric treater as defined in claim 1 in which said outlet means for withdrawing liquid from said oil zone includes a plurality of outlet openings communicating with said oil zone at a plurality of positions spaced from each other longitudinally of said tank and simultaneously withdrawing such liquid from said oil zone, and a conduit for joining into a single stream the liquid withdrawn from the plurality of outlet openings.

5. An electric treater as defined in claim 1 in which said electrodes consist of two superimposed substantially flat rectilinear grids, each grid comprising horizontally spaced substantially parallel metallic members electrically connected together, the metallic members of the electrodes facing each other in spaced relation to establish said fields in the space therebetween, said treater including means for insulating one of said grids from said tank, the length of said one grid being only slightly less than the length of said horizontal zone of said tank and the width of said one grid being only slightly less than the width of said horizontal zone.

6. An electric treater as defined in claim 5 in which said spaced metallic members of said one of said grids extend longitudinally of said tank.

7. An electric treater as defined in claim 6 in which said tank is closed at its ends by outwardly domed head members, and in which said metallic members of said one of said grids provide ends compositely forming the end contours of such grid, and in which said metallic members of such grid toward the center of said horizontal zone are of greater length than the metallic members toward the sides of said horizontal zone to provide end contours substantially conforming to the contours of said doomed head members.

8. An electric treater for emulsions of the type having a continuous oil phase and droplets of dispersed-phase material dispersed therein, said treater comprising: a generally cylindrical tank disposed with its axis in a substantially horizontal position, the horizontal length of said tank being much greater than its diameter, said tank providing a shallow horizontal zone near the longitudinal axis of said tank extending substantially throughout the length and width of the tank at the level of such zone, at least a portion of said horizontal zone lying above said axis; means for establishing electric fields throughout substantially the entire horizontal length of said zone, said means including a flat foraminous electrode means comprising a large number of metallic horizontal members and a plurality of horizontal cross members at different positions along the length of the tank mounting said metallic members in spaced relationship and electrically connecting same; a framework comprising a pair of beams extending longitudinally of said tank on opposite sides of the vertical midplane thereof throughout a major portion of the length of the tank, said beams being of sufficient length to traverse said cross members; means spaced from each other along the length of said tank interconnecting said cross members and said beams at the junctions thereof; two series of insulators respectively on opposite sides of said vertical midplane of the tank, each series of insulators comprising at least two suspension insulators; means for suspending said framework from said insulators to dispose said electrode means in said stratum, said means for establishing said fields including means for supplying a high-voltage potential to said electrode means; inlet means at a level substantially below said electrode means and below the axis of said container comprising a plurality of horizontally spaced orifices for introducing the emulsion to be treated at a plurality of points throughout the length of said tank for treatment in said electric fields, said treatment coalescing said droplets of dispersed-phase material into larger masses settling to a trough-like collection zone formed by the bottom of said tank; and outlet means for respectively withdrawing treated oil from the top of said tank above said horizontal zone and separated material from said collection zone.

9. An electric treater as defined in claim 8 in which each means for suspending said framework from said insulators includes a hanger depending from a corresponding one of said insulators and a hanger member connected to said hanger and shaped to interlock releasably with a corresponding one of said beams.

10. An electric treater for emulsions of the type having a continuous oil phase and droplets of dispersed-phase material dispersed therein, said treater comprising: a generally cylindrical tank disposed with its axis in a substantially horizontal position, the horizontal length of said tank being much greater than its diameter, said tank providing a horizontal zone near the axis of said tank extending substantially throughout the length and width of the tank at the level of such zone, at least a portion of said horizontal zone lying above said axis; upper and lower pairs of beams extending longitudinally of said tank throughout a major portion of the length thereof at upper and lower levels in said zone, the beams of the upper pair being laterally offset from the beams of the lower pair; means for establishing electric fields throughout substantially the entire horizontal length of said horizontal zone, said means including sets of spaced electrode members, means for respectively supporting said sets of electrode members from said pairs of beams, with said sets spaced from each other to define treating spaces therebetween compositely occupying a large portion of the horizontal cross-sectional area of said zone, and energizing means for supplying to at least one of said sets of electrodes a high-voltage potential to energize same; a plurality of suspension insulators spaced from each other longitudinally of said tank; means for supporting from said suspension insulators the pair of beams corresponding to said one of said sets of electrode members, said last-named means including hangers interconnecting said insulators and the beams of such pair, said hangers being laterally offset from the beams of the other pair; means for supporting the other pair of beams; inlet means below said axis of said tank for introducing the emulsion to be treated at a plurality of points throughout the length of said tank for treatment in said electric fields, said treatment coalescing

said droplets of dispersed-phase material into larger masses settling to a trough-like collection zone formed by the bottom of said tank; and outlet means for respectively withdrawing treated oil from the top of said tank above said zone and separated material from said collection zone.

11. An electric treater as defined in claim 10 in which said means for supporting the other pair of beams includes a second plurality of suspension insulators spaced from each other longitudinally of said tank, supporting means for supporting from such second plurality of insulators the pair of beams corresponding to the other of said sets of electrode members, such supporting means including hangers interconnecting said second plurality of insulators and the beams of said last-named pair.

12. An electric treater for emulsions of the type having a continuous oil phase and droplets of dispersed-phase material dispersed therein, said treater comprising: a generally cylindrical tank disposed with its axis in a substantially horizontal position, the horizontal length of said tank being much greater than its diameter, said tank providing a horizontal zone near the axis of the tank extending substantially throughout the length and width of the tank at the level of such zone, at least a portion of said horizontal zone lying above said axis; means for establishing electric fields throughout substantially the entire horizontal length of said zone, said means including a flat foraminous electrode means comprising a large number of metallic members spaced side by side in said zone and means for supplying a high voltage potential to said electrode means; a rectilinear framework in said zone connected to and supporting said electrode means along the length thereof, said framework including a pair of beams extending longitudinally of said tank on opposite sides of the vertical midplane

thereof, said beams extending throughout a major portion of the length of said zone; two series of insulators respectively on opposite sides of said vertical midplane of said tank, each series of insulators comprising at least two suspension insulators; means for supporting the upper end of each suspension insulator from the tank; means for suspending said beams respectively from the suspension insulators of said two series thereof; inlet means for introducing the emulsion to be treated at a plurality of points below the axis of said tank spaced from each other throughout the length of said tank for treatment in said electric fields, said treatment coalescing said droplets of dispersed-phase material into larger masses settling to a trough-like collection zone in the bottom of said tank; and outlet means for respectively withdrawing treated oil from the top of said tank above said horizontal zone and separated material from said collection zone.

13. An electric treater as defined in claim 12 in which said means for suspending said beams includes a plurality of hangers each connected at one end to one of said insulators, and a hanger member connected to the other end of each hanger, each of said beams including an upper flange, each hanger member partially encircling one of said upper flanges in supporting relation.

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