Sept. 19, 1967 D. W. TURNER 3,342,720

ELECTRIC TREATER

Filed July 28, 1964 4 Sheets-Sheet 1

FIG. 1.

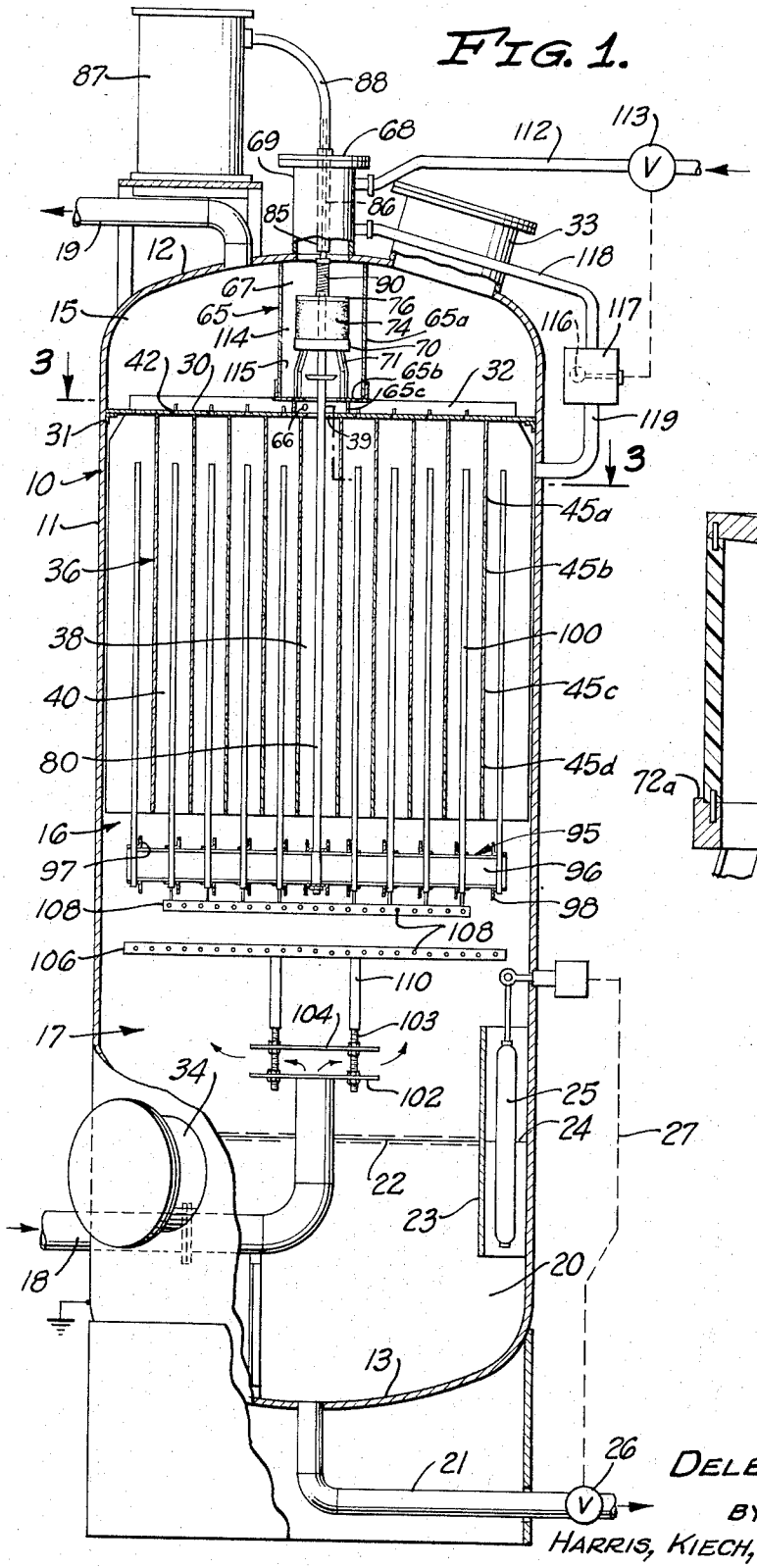
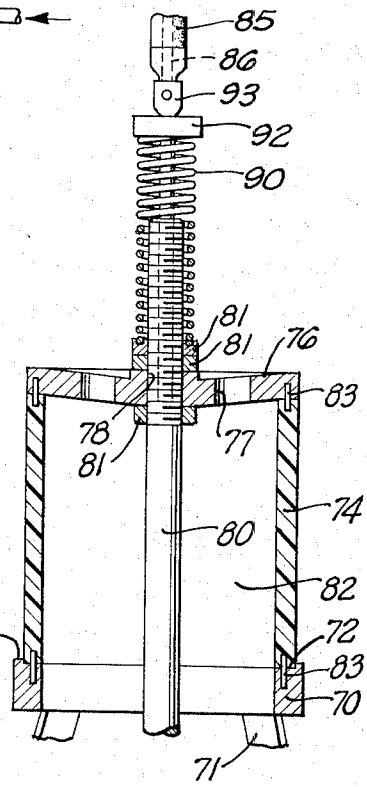


FIG. 2.



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Filed July 28, 1964 4 Sheets-Sheet 2

FIG. 3.

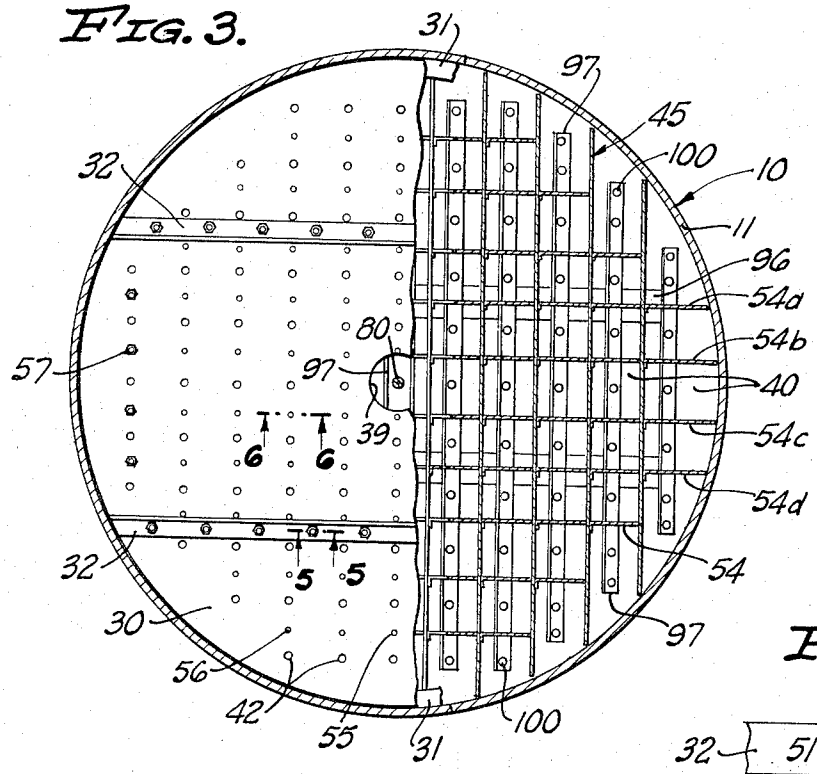


FIG. 5

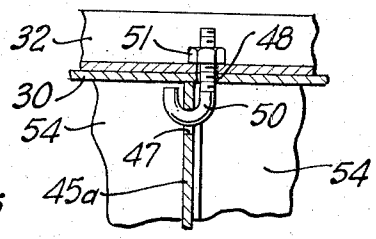


FIG. 4.

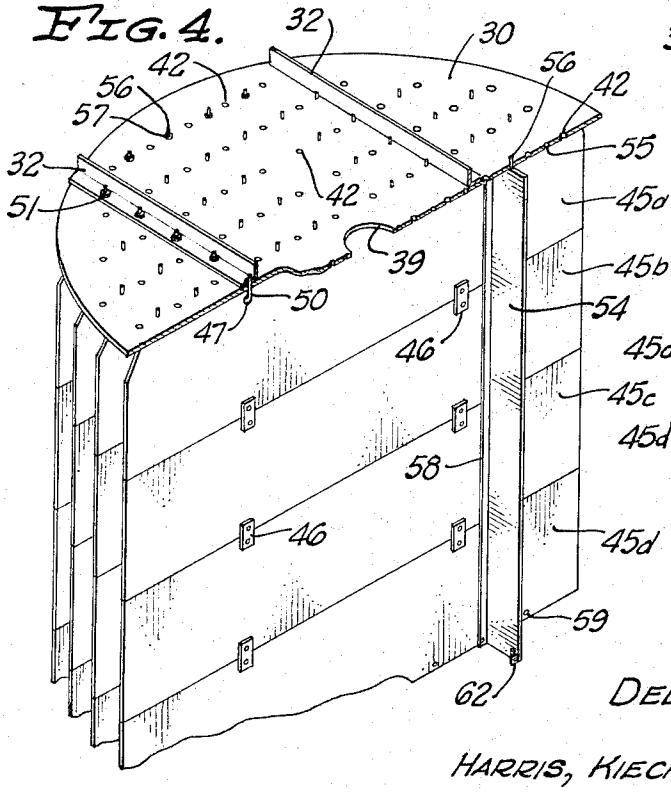
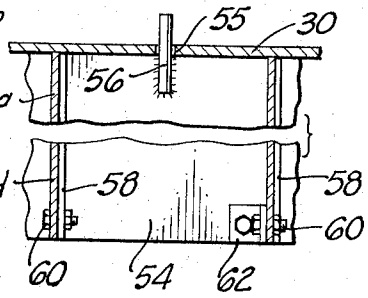


FIG. 6.



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ELECTRIC TREATER

Filed July 28, 1964 4 Sheets-Sheet 3

FIG. 7.

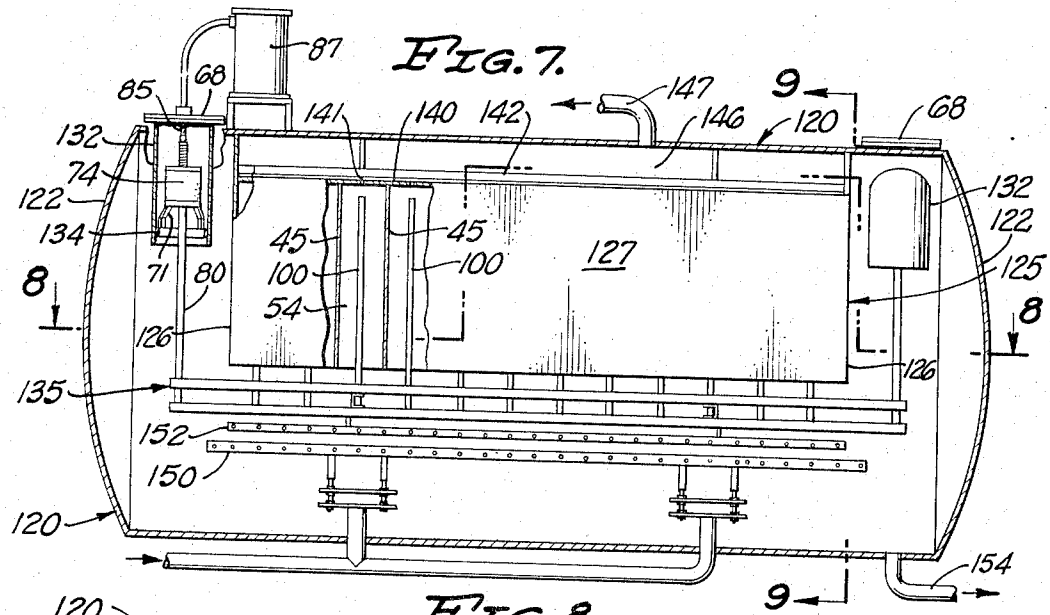


FIG. 8.

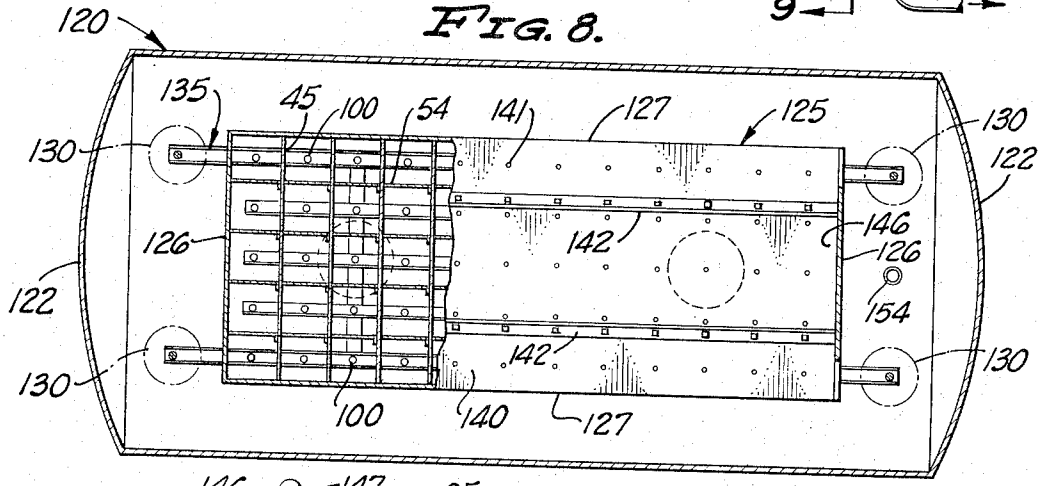
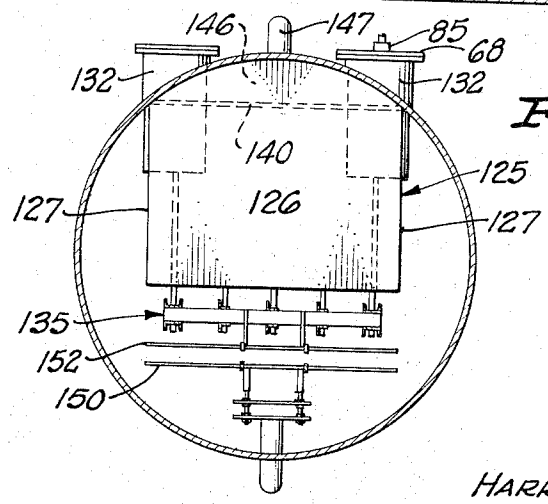


FIG. 9.



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ELECTRIC TREATER

Filed July 28, 1964 4 Sheets-Sheet 4

FIG. 10.

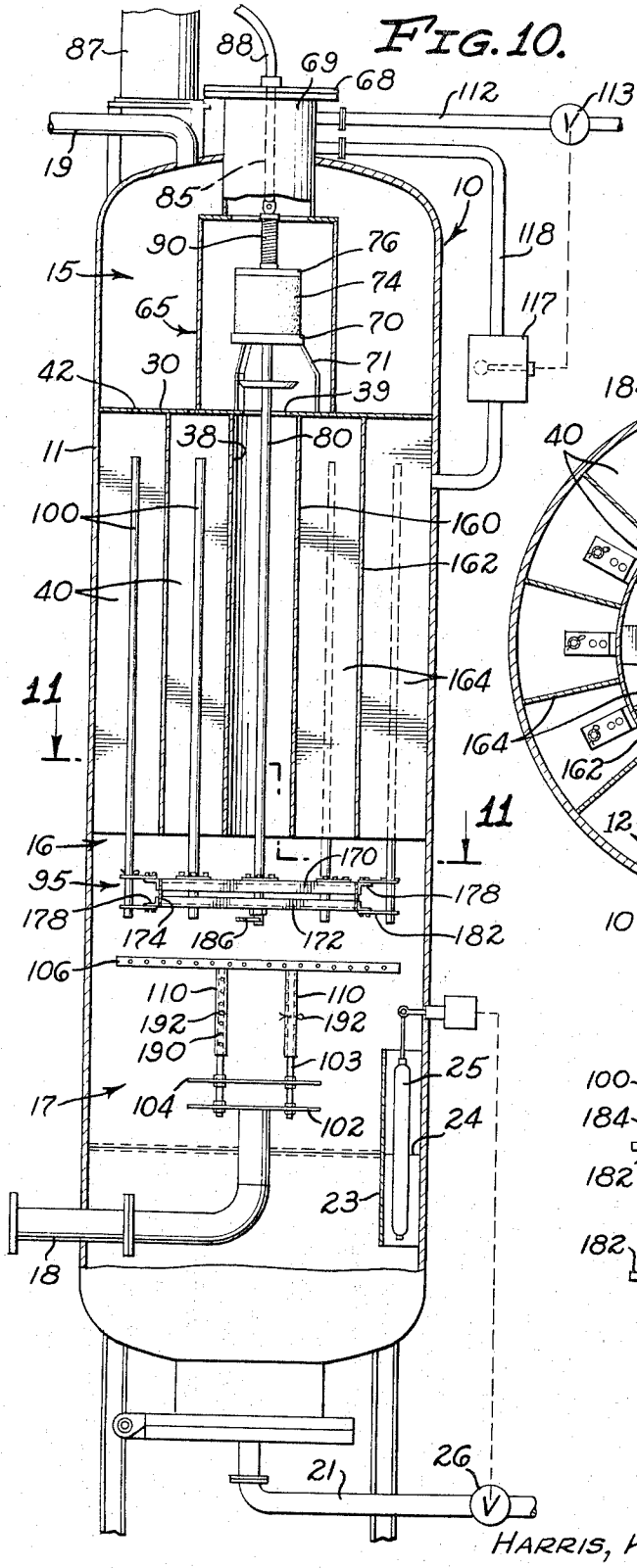


FIG. 11.

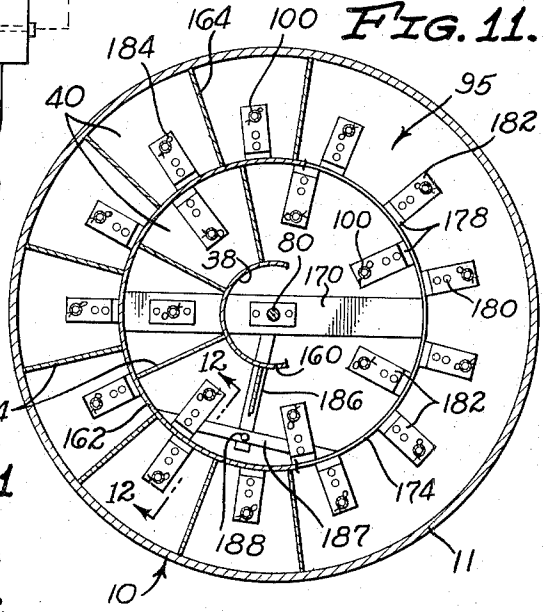
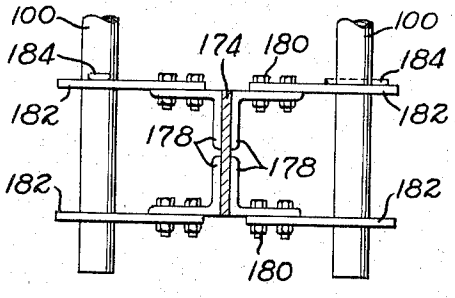


FIG. 12.



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3,342,720

ELECTRIC TREATER

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Filed July 28, 1964, Ser. No. 385,654
22 Claims. (Cl. 204—302)

This invention relates to electric treaters for treating oil-continuous dispersions to separate therefrom dispersed-phase material present as dispersed particles therein. Electric treaters of this type employ gravity effects to separate the dispersed-phase material following coalescence and/or electrophoresis of such particles in a high-voltage electric field. The invention relates particularly to a new dispersion-treating electrode structure for such a treater and to an arrangement of elements electrically insulating and stabilizing the energized electrode of an electric treater while supplying access to the insulation from the exterior of the treater.

The dispersion to be treated may be any oil-continuous dispersion of relatively high resistivity containing particles of dispersed-phase material therein. Such dispersions may be naturally occurring or the result of various processing steps. The dispersed material is relatively immiscible in the oil and may be an aqueous material or reatcion products resulting from prior chemical treatment of the oil. The continuous phase of the incoming dispersion is an oil of relatively high resistivity. The word "oil" is used in a broad sense and includes materials of the type of crude oil, petroleum distillates and other chemical compounds of relatively high resistivity.

The invention will be exemplified as applied to an electric treater in which the dispersion is resolved during advance along a plurality of long cells or treating passages arranged side by side and having energized electrodes therein. A treater of this type is disclosed in my copending application Ser. No. 175,688, now Patent No. 3,205,-161, which discloses a deep grid of square cells having upstanding rod electrodes therein attached to a foraminous structure below the grid. This foraminous structure is hung from hangers each of which is pivoted at its top to a suspension insulator which in turn is pivotally connected at its upper end to a bracket in one of the cells. This arrangement permits undesirable swinging of the foraminous structure with consequent displacement of the rod electrodes from the centers of the cells. Also the suspension insulators are accessible for inspection or replacement only if the container is drained. The prior arrangement is also unduly costly, bulky and troublesome in providing energization of the rod electrodes through an inlet bushing disposed in a separate tubular structure outside the container. This tubular structure opens on the interior of the container at a position where the oil is relatively more conductive than in the top of the container.

It is an object of the present invention to support an energized electrode structure from one or more tubular insulators of relatively large diameter in a manner to prevent swinging and provide lateral stability to the electrode structure so that the rod or other electrodes of such structure are retained correctly oriented relative to electrodes of opposite polarity.

Another object is to suspend such an energized electrode structure through one or more rigid elongated members each rigidly connected to an electrode support plate across the top of a corresponding cylindrical insulator, thus supporting the weight of the electrode in a manner to prevent tipping of the electrode support plate on the insulator while inducing compressive forces in the insulator as distinct from tension forces therein.

A further object of the invention is to support the lower end of such a cylindrical insulator in the entrapment space

of an insulator housing structure depending from the top of the container. In instances where flow of treated oil from the treating passages of the grid electrode is metered by the holes of a metering plate, as in my prior application, it is an object to employ an insulator housing structure that traverses the upper or treated-oil zone of the treater and extends between the metering plate and the top wall of the container.

Another object of the invention is to position the one or more suspension insulators of an electric treater in such manner as to be readily accessible for inspection or replacement from a position outside the container. Another object is to provide a high-voltage inlet bushing in the same entrapment space as a suspension insulator so that either may be inspected or replaced from a position outside the container. In those instances where an inert gas is used to protect the bushing a single body of inert gas can be employed to protect both the bushing and the suspension insulator.

The construction and installation of a large grid or bank of cell-forming electrodes presents various problems. In forming treating passages of square cross-section planar members must be secured together at right angles. If these members are assembled outside the container the resulting grid can be placed therein only if the container is open at one end, requiring subsequent welding of a head on the container to close it. Later repair or replacement of such a grid usually requires cutting the container and rewelding the head.

It is an object of the invention to provide a grid-like electrode structure that is made up of elements sized to pass through a man-hole of the container and that can be assembled therein into the desired grid-like form. In this and other connections it is an object to provide an electrode structure made up of a plurality of spaced partition panels bridged by divider members dividing the spaces between adjacent panels into side-by-side cells. A further object is to provide means detachably connecting such panels and divider members. In accordance with one embodiment of the invention, this means is preferably such that the grid-like electrode structure can be assembled in the container largely from one end of the structure, e.g. by a single workman present in the entrance zone of the container. Each partition panel is preferably made up of partition members that can be progressively assembled edge to edge within the container to form a complete partition panel.

Other objects of the invention reside in the provision of novel means for supporting the partition panels at their edges and for locating the ends of the divider members that are positioned between such partition panels.

In another or smaller embodiment of the invention it is an object of the invention to employ one or more cylindrical partitions with substantially radial divider members dividing annular spaces into cellular treating passages having outwardly diverging side walls.

Further objects and advantages of the invention will be evident to those skilled in the art from the following exemplary embodiments.

Referring to the drawings:

FIG. 1 is a vertical sectional view of an electric treater incorporating one embodiment of the invention;

FIG. 2 is an enlarged vertical sectional view of the cylindrical insulator of FIG. 1;

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

FIG. 4 is a fragmentary perspective view illustrating the preferred construction of the grid-like electrode structure;

FIGS. 5 and 6 are fragmentary sectional views at the tops of the cells, taken along corresponding lines of FIG. 3;

FIG. 7 is a vertical sectional view of the invention as installed in a horizontal electric treater;

FIG. 8 and 9 are sectional views taken along corresponding lines of FIG. 7;

FIG. 10 is a vertical sectional view of another embodiment of the invention;

FIG. 11 is a sectional view taken along the line **11—11** of FIG. 10; and

FIG. 12 is an enlarged fragmentary view of a portion of the foraminous electrode support of FIG. 10 taken along the line **12—12** of FIG. 11.

The electric treater illustrated in FIGS. 1–6 includes a closed container **10** having an upright cylindrical side wall **11** closed by top and bottom walls **12** and **13**. The container provides an upper exit or treated-oil zone **15**, an intermediate or electrode zone **16** and a lower, entrance or inlet zone **17**.

The dispersion to be treated is delivered under pressure to an inlet pipe **18** and is treated in high-voltage fields in the intermediate or electrode zone **16** as will be described. The treated oil leaves the container through an effluent pipe **19** in known manner and the dispersed particles of the emulsion that are coalesced or electrophoresed by the fields gravitate to the bottom of the container, forming a body **20** of separated dispersed-phase material. The separated material is withdrawn through a pipe **21** preferably under the control of a flow-control means adapted to maintain at a constant level the interfacial zone **22** at the top of the body **20**. This control system may include a float housing or shield **23** with its upper and lower ends respectively open to the material above and below the interfacial zone **22** so as to establish an interface **24** therein. A float **25** is operatively connected to a valve **26** in the pipe **21** through any suitable connection indicated by the dotted line **27**.

During fabrication of the container **10** a circular plate **30** is inserted. This plate is of a diameter to separate spacially or pressurally the upper and intermediate zones **15** and **16**. It can be welded to the side wall **11** or attached thereto by brackets **31**. It is desirably a relatively thin metal plate rigidified by two parallel angle-iron members **32**. Closed man-hole nozzles **33** and **34** respectively provide access to the upper and lower ones **15** and **17** disposed on opposite sides of the plate **30**.

A deep grid-type electrode structure **36** is later installed in the intermediate or electrode zone **16**. It provides a plurality of upright side-by-side passages separated by thin metal walls. The lower ends of these passages open on the lower or inlet zone **17** and the upper ends thereof terminate at the plate **30**. In the embodiment illustrated the central upright passage constitutes an electrode-support passage **38** aligned with and open at its top through a central opening **39** of the plate **30**. In larger-size treaters three or more electrode-support passages **38** grouped around the central axis may be employed. All of the upright passages other than the one or more electrode support passages constitute treating passages **40** having their upper ends communicating with the upper zone **15** through metering holes or orifices **42** in the plate **30**.

As will be apparent from FIG. 3, all of the treating passages **40** that are inward of the periphery of the electrode structure **36** are substantially square in cross-section. Those treating passages at the periphery are of less regular cross-section as the result of the curvature of the cylindrical side wall **11** which bounds them. All of the treating passages **40** are long in their axial dimension being typically several feet in length and ranging commercially from about 2–8 feet or more in length. Conversely the width of the square passages is a matter of inches, typically ranging commercially from about 4–16 inches across.

The electrode structure **36** includes a plurality of parallel spaced partition panels each preferably segmented and made up of a plurality of partition members *45a–45d* that can be progressively assembled and bolted together by use of straps **46**. The partition members are held together

edge to edge, preferably in a single plane although the edges may overlap if desired. Each partition member is of a width to pass through the man-hole nozzle **34**.

The uppermost partition member *45a* is suitably bolted to the plate **30** by suitable attachment members each of which may be an angle bracket, clip or a J-bolt shown in FIG. 5. Each of the uppermost partition members provides a pair of openings **47** inwardly of the top edge thereof spaced laterally a distance equal to paired electrode-attachment openings **48** through the plate **30**. The latter openings preferably continue through the angle-iron members **32** so that these members and the plate **30** provide electro-attachment openings arranged in pairs along equally spaced parallel lines. A J-bolt **50** has its hook portion extending through a corresponding opening **47** and its threaded shank portion extending through the electrode-attachment opening **48** with a nut **51** threaded thereon. The nuts **51** are turned to bring the tops of the partition members *45a* closely adjacent the bottom of the plate **30**, e.g., into contact therewith or within ⅛" thereof. All of the upper partition members *45a* are thus first installed after which the one or more lower partition members of each partition panel are installed. The partition members are attached in progressive tiers or layers until the partition panels **45** are completed. The resulting partition panels extend between opposite portions of the side wall **11** and are chordal if this side wall is cylindrical.

A plurality of divider members **54** are then inserted upward in the space between each pair of partition panels to divide this space into the aforesaid upright passages. Each divider member is of a width equal to the distance across such space and of a length generally equal to the height of the partition panels **45** although it may be slightly shorter or longer than such height without departing from the spirit of the invention.

The upper end of each divider member **54** is preferably held in place by providing means thereon extending through locating openings **55** through the plate **30**, these locating openings being arranged in parallel lines between the lines of the electrode-attachment openings **48**. In the preferred arrangement pins **56** are welded to the tops of the divider members **54** and slip upward through the locating openings **55** to locate and space the tops of the divider members. Similar pins are mounted on the outermost four divider members *54a–54d* of FIG. 3 that are of different width to extend to the cylindrical side wall **11**. The pins on these four divider members are preferably threaded and receive nuts **57** (FIG. 3) to provide additional support.

Each of the divider members **54** is preferably a sheet metal strip having a flange **58** along one edge. Near its bottom end this flange provides an opening aligning with one of a series of openings **59** (FIG. 4) in the lowermost partition member *45d*. A bolt **60** (FIG. 6), accessible from the inlet zone **17** passes through the aligned openings and determines the spacing of the lower ends of the divider members **54**. Optionally an angle bracket **62** at the opposite side of each divider member may be employed to bolt its lower end to the adjacent partition panel **45**. Similar angle brackets can be used at the top to substitute for the J-bolts **50**. Each divider member is thus removably bridged between adjacent partition panels and extends substantially at right angles thereto. It will thus be apparent that the entire grid-type electrode structure **36** can be progressively assembled and disassembled within the container **10**.

An insulator housing structure **65** (FIG. 1) is welded or otherwise secured to the top wall **12** and extends to the plate **30** coaxial with the corresponding opening **39** of the this plate being secured to the plate by welding or other means. This structure may be made of one piece or may comprise upper, intermediate and lower sections or members *65a*, *65b* and *65c* as shown. A laterally-extending metering or flow-control passage **66** may be provided through the lower member *65c* to permit a small

flow of the dispersion upward through the electrode-support passage **38** but is usually not required or desired whether or not such a passage **66** is used.

The interior of the insulator housing structure **65** provides the lower end of an entrapment space **67** that opens on the electrode-support passage **38** through the opening **39**. The top of this entrapment space is closed by a removable cover **68** secured to the top of a flanged nozzle **69** extending upward from the top wall **12** with its interior forming a continuation of the entrapment space **67**.

An insulator support ring **70** is mounted within the entrapment space **67**, as by being supported on legs **71** extending upward from the intermediate member **65***b*. This insulator support ring **70** provides an upper face **72** which may be formed with a centering flange **72***a*. A cylindrical insulator **74** of relatively large diameter provides a lower annular face resting on the upper face **72** and an upper annular face supporting an electrode-support plate **76** bridged thereacross. This support plate may have side openings **77** and a central opening **78**. Its upper surface preferably slopes toward the openings **77** to drain away from the inner surface of the insulator any material or condensates dropping on the support plate. An elongated electrode support member **80** extends through the central opening **78** and is rigidly connected to the support plate **76** as by nuts **81**. The outer diameter of the cylindrical insulator **74** is at least several inches so as to provide lateral stability for the electrode support plate **76** against tipping. The wall thickness of the cylindrical insulator is only a small fraction of such outer diameter. The inner diameter of the cylindrical insulator **74** is also a matter of several inches and provides a wide annular space **82** around the elongated electrode-support member **80**. In commercial practice cylindrical insulators of an external diameter of 8 inches or more and a wall thickness ranging from a fraction of an inch to one inch or slightly more are preferred. Any weight hung on the elongated electrode-support member **80** induces compressive stresses in the cylindrical insulator **74**, a feature which is particularly desirable when this member is made of fluoro-type plastic material such as "Teflon" or "Kel-F."

To provide accurate angular orientation and to prevent any turning of the support plate **76** or its support member **80** relative to the tubular insulator **74** or the support ring **70** the invention provides means for locking the elements against turning. In this connection the isulator support ring **70** is shown as providing opposed upstanding pins **83** fitting into corresponding holes at the bottom of the cylindrical insulator. Likewise the electrode support plate **76** provides opposed pins **83** depending into corresponding holes at the top of the insulator.

A high-voltage entrance bushing **85** (FIG. 1) traverses and is connected to the removable cover **68** and has its lower end exposed to the entrapment space **67**. The central conductor **86** of this bushing has its upper end connected to a high-voltage source **87** through any suitable cable or conduit **88**. The lower end of the central conductor **86** is connected to the elongated electrode-support member **80** by any suitable detachable conductor means, shown as including a spring **90** compressed between the uppermost nut **81** and a floating head **92** which is movable relative to the electrode support member **80** and connected in telescoping relationship therewith. The spring **90** maintains the floating plate **92** in engagement with a contact **93** electrically connected to the bottom of the central conductor **86** of the inlet bushing. Both the cylindrical insulator **74** and the bushing **85** are accessible from a position outside the container by removing the cover **68**.

The elongated electrode support member **80** is desirably a rigid member of a length to extend through the corresponding electrode-support passage **38** into the lower zone **17** where it supports a foraminous structure **95**. The latter may comprise transverse bars **96** with pairs of upper and lower angles **97** and **98** respectively thereabove and therebelow. Holes are drilled through the angles in vertical alignment to receive upstanding rod electrodes **100** extending upward in the treating passages and having upper ends terminating below the plate **30**. Each treating passage of square cross section is shown as having one rod electrode **100** at its center. Some treating passages at the periphery are laterally elongated and are shown as containing two rod electrodes side by side and relatively closely spaced, creating a field pattern very similar to that which would be created by a round-sided bar occupying the same cross section as the two rods and the space therebetween. A single metering orifice suffices for any such laterally elongated treating passage.

The foraminous structure **95** and the rod electrodes **100** constitute an energized electrode maintained by the source **87** at a potential several thousand volts higher than the potential of the grounded container **10**. Voltage gradients in the treating passages **40** are usually in the range of about 6–30 kv./inch. The rod electrodes **100** may be solid or tubular and may range in diameter from about .25 inch to a large fraction of the cell width. The treating spaces within the cells around the rod electrodes should desirably have a large length-to-gap ratio. This ratio will usually be in the range of about 12–25 in commercial treaters but can be in the range of about 8–30 or more. Treating rates and other relationships can be as disclosed in the prior application supra which also discloses typical examples of the operation of a treater of the type herein disclosed.

In the embodiment of the invention disclosed in FIGS. 1–6 it will be apparent that the large cylindrical insulator **74** prevents lateral swinging of the energized electrode. This is due in part to the large-diameter support provided by the cylindrical insulator for the electrode support plate **76** and in part due to the rigid connection of the latter to the rigid elongated support member **80**. Likewise the pins **83** lock the cylindrical insulator against turning relative both to the insulator support ring **70** and the electrode support plate **76**. The rod electrodes **100** thus remain accurately aligned with the treating passages because the structure resists disalignment that would result from lateral shifting of the foraminous structure **95** or turning thereof about the longitudinal axis of the container **10**.

The inlet pipe **18** turns upward in the inlet zone **17** and carries an annular plate **102**. Threaded rods **103** are bolted thereto and to a disc **104** which deflects the incoming dispersion outwardly as shown by the arrows of FIG. 1. The resulting distributor spreads the dispersion while inducing thereon no more than an extremely small pressure drop. The enclosed space formed by the two plates reduces the velocity of the incoming stream so it will flow into the lower zone **17**, FIG. 1, with a minimum of turbulance in this zone. The dispersion rising in the container **10** fills the cross section thereof and is divided between the treating passages **40** for electric treatment therein. The treated oil leaves the top of the passages through the metering holes **42** which developed a significant pressure drop on the rising liquid to equalize the forward flow in the various treating passages. This pressure drop should be substantially higher than any small pressure drop induced by the distributor. Normally there will be a pressure drop of about 2–24 oz./sq. in. across the metering plate **30**.

It is often desirable to establish a preliminary electric field in the inlet zone **17** to treat the dispersion before it is divided between the treating passages **40**. The foraminous structure **95** may itself establish an electric field between it and the interfacial zone **22**, as in FIG. 10 to be described. However it is desirable to employ a pretreating electrode **106** adjustable in vertical position relative to another pretreating electrode **108** attached to the foraminous structure **95**. The electrodes **106** and **108** may be constructed as in my application supra, includ-

ing spaced parallel pipes or rods **109**. The pretreating electrode **106** is adjustably mounted either as shown in FIG. 10 or by using internally-threaded sleeves **110** receiving the threaded rods **103**. By turning these rods in these sleeves the electrode **106** can be raised and lowered while being electrically connected to the grounded container **10** through the distributor.

The lower end of the entrapment space **67** has access to the liquid within the upper interior of the electrode-support passage **38**. Due in part to the fact that there is a pressure differential across the plate **30** this liquid will tend to rise in the entrapment space **67** and the pressure therein will be higher than the pressure outside the insulator support structure **65** unless a flow control passage **66** is formed in the lower member **65***c* as mentioned above. If this liquid is relatively free of contaminants it can be permitted to rise in the entrapment space to surround the insulator **74** or to a level therebelow determined by any body of gas entrapped in the top of the entrapment space **67** and compressed therein by the rising liquid. It will be apparent that an electric field will be present in the electrode-support passage **38** around the support member **80** and that this field will tend to purify any liquid reaching the entrapment space whether or not a passage **66** is employed.

However if the liquid still contains contaminants that might cause failure of the cylindrical insulator **74** it is desirable to maintain such liquid below the bottom of the insulator. To accomplish this an inert gas may be supplied to the top of the entrapment space through a small line **112** equipped with a valve **113**. A body of gas **114** will thus surround and protect the insulator **74** and the inwardly exposed portion of the inlet bushing. A gas-liquid interface **115** will thus be established in the lower portion of the insulator support structure **65**. The level of this interface can be controlled and maintained substantially constant by establishing a related gas-liquid interface **116** in a level-control structure **117** outside the container, employing small lines **118** and **119** to connect the level control structure to the gas zone of the entrapment space **67** and to the oil within the interior of the container **10**. The line **119** may open on one of the treating passages, as shown, or may open on the lower interior of the insulator housing structure **65** below the interface **115**.

FIGS. 7, 8 and 9 illustrate how the invention can be applied to electric treaters of the horizontal-container type. Here the container **120** is a cylindrical vessel much longer in horizontal length than in diameter being closed at its ends by heads **122**. A quadrilateral skirt **125** is suspended in an intermediate zone of the container above an inlet zone thereof and is made up of paired end walls **126** and paired side walls **127** connected together at the corners of the skirt and forming therewithin a quadrilateral electrode space. While four of the insulator housing structures **65** of FIG. 1 can be employed the embodiment of FIGS. 7, 8 and 9 contemplates that at least one of such pairs of walls should be spaced from the corresponding adjacent walls of the container **120** to provide two or more insulator housing spaces **130** (FIG. 8) outside the skirt. Four of these spaces are preferably provided near the corresponding four corners of the skirt. Insulator housing structures **132** depend from the top of the container respectively in these housing spaces. Each of these can be constructed as previously described but are shown with the legs **71** extending upward from a ring **134** mounted in the housing **132**. Each housing contains one of the cylindrical insulators **74** with a corresponding elongated electrode support member **80** depending from the open lower end of the housing to support one portion or corner of a quadrilateral foraminous structure **135** from which the rod electrodes **100** rise as previously described. All of the housings **132** are closed by respective covers **68** and one of these covers mounts the high-voltage inlet bushing **85**. Bodies of inert gas may be employed to protect the insulation in each of the housings **132**.

The quadrilateral electrode space within the skirt **125** is divided into cellular treating passages by use of partition panels **45**, here all of equal length, with divider members **54** bridged therebetween at positions spaced therealong. The entire volume of the quadrilateral electrode space can thus be divided into cellular passages. The tops thereof are closed by a quadrilateral metering plate **140** having metering holes **141** opening upon the respective passages. This metering plate can be rigidified by angle iron members **142**, corresponding to the members **32** previously described, and the segmented partition panels **45** attached thereto by J-bolts or angle brackets as previously described. Either the metering plate **140** or the side or end walls of the quadrilateral skirt **125** should extend to the walls of the container **120** to provide a closed upper or treated-oil zone **146** from which treated oil can be withdrawn through a pipe **147**. As shown, both the paired end walls **126** and the paired side walls **127** extend upward to the arcuate interior face of the container **120** to form the confined treated oil zone **146**.

Quadrilateral pretreating electrodes **150** and **152**, corresponding to the electrodes **106** and **108**, can be employed with the electrode **150** supported at positions along its length by two or more of the distributors previously described. The incoming dispersion is divided between these distributors and is forced to rise at equal rates through the treating passages for electric treatment as aforesaid. Separated dispersed-phase material is withdrawn from the container through a pipe **154**. The large-diameter cylindrical insulators **74** prevent lateral swinging of the suspended energized electrode structure and maintain the rod electrodes **100** accurately positioned in the respective treating passages.

The embodiment of the invention illustrated in FIGS. 10–12 is generally similar to that shown in FIGS. 1–6 except for differences in electrode constructions that can be used in smaller-size treaters of diameters up to about 40". Here the electrode-support passage **38** is formed within a central tubular electrode member **160** of circular cross-section. At least one intermediate cylindrical electrode member **162** coaxial with the side wall **11** of the container **10** and the central tubular member **160** divides the annular space therebetween into smaller annular spaces that are traversed by radial divider members **164**. These divide the smaller annular spaces into the aforesaid treating passages **40**. The inner edges of the two circular series of the radial divider members **164** may be welded to the intermediate cylindrical electrode member **162** and to the central tubular electrode member **160** respectively with their outer edges lying closely adjacent the inner circular walls of the container and the intermediate member **162**. The upper edges of the members **162** and **164** may be welded to the bottom of the circular plate **30** which, as before, contains metering holes or orifices **42** through which treated oil moves from the treating passages to the upper or treated-oil zone **15**. The treating passages are here somewhat pie-shaped in section being bounded inwardly and outwardly by the curved members **11**, **162** and **160** and being bounded laterally by opposed divider members **164**.

In this embodiment the lower end of the electrode-support member **80** extends through holes in upper and lower channels **170** and **172** welded diametrically across a large-diameter but short-length ring **174** (FIGS. 10 and 12). Welded to the outer and inner surfaces of this ring are superimposed paired angle brackets **178**. Attached thereto by bolts **180** are electrode support strips **182** arranged in superimposed pairs having holes of a diameter to receive the lower ends of the rod electrodes **100**, here shown as small pipes. Each rod electrode provides an opening receiving a cotter-pin **184** resting on the uppermost electrode support strip **182** of the pair.

A lever means is employed to center the rod electrodes **100** in their respective treating passages by adjusting the relative angular orientation of the foraminous electrode support **95** relative to the lower end of the electrode support member **80**. This means includes a lever **186** having its inner end pinned or otherwise rigidly attached to the lower end of the electrode support member **80**. The outer end of the lever **186** traverses a bar **187** welded chordally across the ring **174**. When the angular orientation is correctly adjusted the outer end of the lever is fixed to the bar **187** as by a bolt **188**.

The foraminous electrode-support structure **95** is here employed as the upper pretreat electrode. The lower pretreating electrode **106** can be constructed as previously described. It is shown with a series of vertically spaced holes **190** through the sleeve **110**. Cotter-pins **192** may be placed through these holes at any desired level to be engaged by the tops of the rods **103**, which here slide in the sleeve **110**. The electrode **106** is thus adjustable in vertical position by changing the position of the cotter-pins **192**. The construction of the foraminous electrode support **95** shown in FIGS. 10–12 and the manner of adjusting the position of the electrode **106** therein shown can if desired be used with the other embodiments of the invention herein described.

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

I claim:

1. An electric treater for treating oil-continuous dispersions to separate particles of a dispersed-phase material dispersed therein, said treater comprising:

a container having upper, intermediate and lower zones, said container providing means for introducing the dispersion into said lower zone, means for withdrawing separated dispersed-phase material from the bottom of said lower zone and means for withdrawing treated oil from said upper zone;

upright electrode members in said intermediate zone electrically connected to said container providing upright side-by-side passages between said lower and upper zones, at least one of said upright passages being an open-top electrode-support passage, the other upright passages being treating passages, all of said passages opening downwardly on said lower zone;

means for metering the flow of treated oil from said treating passages into said upper zone comprising a plate electrically connected to said container traversing the tops of said upright electrode members, said plate providing metering holes for the treated oil moving from said treating passages to said upper zone;

an insulator housing structure interconnecting and extending between the top of said container and said plate in axial alignment with each electrode-support passage providing therein an entrapment space opening on such electrode-support passage through the open top thereof;

an insulator support ring mounted within the entrapment space of each insulator housing;

a cylindrical insulator of relatively large diameter having a central passage coaxial with the corresponding insulator support ring and having upper and lower annular faces respectively at its upper and lower ends, said lower face being supported on said insulator support ring;

an electrode support plate bridging across said central passage and supported by said upper annular face;

an elongated electrode support member hung from the center of said electrode support plate of a length to extend therefrom completely through the corresponding electrode-support passage into said lower zone, the outer diameter of said cylindrical insulator being at least several inches to provide lateral stability for said electrode support plate against tipping, the diameter of said elongated electrode support member being substantially less than the inner diameter of said cylindrical insulator;

a foraminous structure in said lower zone below the lower ends of said passages electrically connected to and supported by the lower end of such support member;

a plurality of upstanding rod electrodes attached rigidly to said foraminous structure extending upward in said treating passages having upper ends terminating below said plate; and

a high-voltage source of potential having terminals respectively connected to said electrode support member and said upright electrode members establishing high-voltage electric fields in said treating passages.

2. An electric treater as defined in claim **1** in which said insulator housing structure is impervious throughout its length between the top of said container and said plate thereby separating said entrapment space completely from said treated oil in said upper zone.

3. An electric treater as defined in claim **1** in which said insulator housing structure provides a section at the lower end of said entrapment space immediately above said plate, said section having a small flow-control passage opening outwardly on that portion of said upper zone around said insulator housing structure and opening inwardly on the interior of said insulator housing structure at a level substantially below the lower end of said cylindrical insulator.

4. An electric treater as defined in claim **1** in which said container provides a flanged nozzle above each entrapment space and a removable cover therefor providing access to said cylindrical insulator in such entrapment space.

5. An electric treater as defined in claim **4** in which at least one removable cover includes a bushing opening therein, and including a high-voltage inlet bushing attached to such cover extending through said bushing opening having a central conductor connected to one terminal of said source, and a conductor means detachably electrically connecting said central conductor and the elongated electrode support member of the corresponding entrapment space.

6. An electric treater as defined in claim **1** in which said electrode support plate provides a central opening, in which said elongated electrode support member is a rigid elongated member extending through said central opening of said electrode support plate, and including means rigidly connecting said rigid elongated member to said electrode support plate, such rigid connecting means and said large-diameter cylindrical insulator resisting swinging of the lower end of said elongated member and the attached foraminous structure.

7. An electric treater for treating oil-continuous dispersions to separate particles of a dispersed-phase material dispersed therein, said treater comprising:

a container having upper, intermediate and lower zones, said container providing means for introducing the dispersion into said lower zone, means for withdrawing separated dispersed-phase material from the bottom of said lower zone and means for withdrawing treated oil from said upper zone;

upright electrode members in said intermediate zone electrically connected to said container providing upright side-by-side passages between said lower and upper zones, the central of said passages being an open-top electrode-support passage, the other upright passages being treating passages surrounding said electrode-support passage, all of said passages opening downwardly on said lower zone;

means for metering the flow of treated oil from said treating passages into said upper zone comprising a plate electrically connected to said container traversing the tops of said treating passages, said plate pro-

viding metering holes for the treated oil moving from said treating passages to said upper zone, said plate providing a central opening coaxial with said electrode-support passage;

a single insulator housing structure coaxial with said electrode-support passage interconnecting and extending between the top of said container and said plate providing therein an entrapment space opening on such electrode-support passage through the open top thereof;

a foraminous structure in said lower zone below the lower ends of said passages;

a plurality of upstanding rod electrodes attached rigidly to said foraminous structure extending upward in said treating passages having upper ends terminating below said plate;

a support member extending upward from the center of said foraminous structure through said electrode-support passage into said entrapment space;

an insulator in said entrapment space and means for connecting same to said electrode support member, said insulator supporting the weight of said foraminous structure and its upstanding rod electrodes; and

means for supplying a high-voltage current to said electrode support member to establish high-voltage electric fields in said treating passages, said last-named means including a high-voltage inlet bushing extending into said entrapment space and having a conductor electrically connected to said electrode support member.

8. An electric treater as defined in claim **7** in which said upright electrode members comprise a plurality of parallel spaced partition panels in said electrode zone extending between opposed sides of said container, and a plurality of divider members bridging the space between adjacent partition panels forming said treating passages, the outermost treating passages being bounded by said container.

9. An electric treater as defined in claim **7** in which said container is an upright cylinder having a circular inner wall, and in which said upright electrode members include a central tubular electrode member providing said electrode-support passage and providing a circular outer wall, at least one intermediate cylindrical electrode member coaxial with said central electrode member and said container dividing the space between said circular outer and inner walls into annular spaces, said intermediate electrode member having inner and outer circular walls, and a plurality of radial divider members bridging said annular spaces dividing same into said treating passages, each treating passage being bounded laterally by two opposed radial divider members and radially by opposed segments of two of said circular walls, the outermost treating passages being bounded by said circular inner wall of said container.

10. An electric treater as defined in claim **7** including lever means for adjusting the angular orientation of said foraminous structure and said support member, said lever means including a lever having one end fixed to said support member and another end movable relative to said foraminous structure to change said angular orientation, and means for attaching said other end to said foraminous structure to fix said angular orientation.

11. An electric emulsion treater for treating oil-continuous dispersions to separate particles of a dispersed-phase material dispersed therein, said treater comprising:

a closed container providing an upper wall and an insulator housing structure depending therefrom, said housing structure providing an entrapment zone therein;

an insulator support ring mounted within said entrapment zone having an annular surface at its upper end;

a cylindrical insulator of relatively large diameter having a central passage coaxial with said insulator support ring and upper and lower annular faces respectively at its upper and lower ends, said lower annular face being supported by said annular surface;

an electrode support plate bridged across said central passage and supported by said upper annular face of said insulator, the outer diameter of said cylindrical insulator being at least several inches, the wall thickness of said cylindrical insulator being only a small fraction of such outer diameter and the diameter of said central passage being several inches, any weight hung from said support plate inducing axial compression forces in said cylindrical insulator;

an elongated electrode support member made of metal hung from the center of said electrode support plate extending downward in said entrapment space into the interior of said container, said support member being of a diameter much less than the inner diameter of said cylindrical insulator providing a wide annular space within the latter around said support member;

a high-voltage electrode supported by and electrically connected to the bottom of said electrode support member; and

means for energizing said electrode by applying a high voltage thereto to establish a dispersion-treating electric field in said container, said container providing means for delivering the dispersion to said electric field, means for withdrawing separated dispersed material from the bottom of said container and means for withdrawing treated oil from the top tof said container.

12. An electric treater as defined in claim **11** in which said annular surface and said upper and lower faces lie in parallel planes transverse to the axis of said entrapment space, and including interengaging lock means between said annular surface and said lower face preventing turning of said insulator on said support ring and interengaging lock means between said upper face and said support plate preventing turning of the latter relative to said cylindrical insulator.

13. An electric treater as defined in claim **11** in which said upper wall of said container provides an opening coaxial with and opening on the top of said entrapment space, and including closure means for said wall opening, said closure means including a removable plate having an opening therein, said energizing means including a high-voltage bushing connected to and traversing said removable plate with its inner portion exposed to said entrapment space, said bushing having a conductor therethrough, and means for detachably connecting said conductor electrically to said elongated electrode support member.

14. An electric treater as defined in claim **13** in which said electrode support plates provides a central opening, and in which said elongated electrode support member is an elongated rigid metallic member traversing such central opening of said support plate having an upper end terminating short of said conductor of said inlet bushing, said detachably connecting means connecting such upper end and such conductor, and including means for rigidly attaching said elongated rigid metallic member to said electrode support plate.

15. An electric treater as defined in claim **13** in which said lower end of said inlet bushing and said cylindrical insulator are in open communication with each other, the lower end of said insulator housing structure being open to the interior of said container whereby oil-continuous material tends to rise therein, and including means delivering inert gas to said entrapment zone to form a body of gas therein surrounding both said cylindrical insulator and said lower end of said inlet bushing forming a gas-oil interface in said entrapment zone, said last-named means including a valve controlling the delivery of said inert gas to said entrapment zone, means responsive to changes in level of said gas-oil interface and means operatively

connecting said responsive means and said valve means maintaining the gas-oil interface at a level below said lower end of said cylindrical insulator.

16. An electric treater for treating oil-continuous dispersions to separate particles of a dispersed-phase material dispersed therein, said treater comprising:

a closed container having side walls laterally bounding upper, intermediate and lower zones that are large in horizontal cross-sectional area, said container providing means for introducing the dispersion into said lower zone, means for withdrawing separated dispersed-phase material from the bottom of said lower zone and means for withdrawing treated oil from said upper zone;

a quadrilateral skirt suspended in said intermediate zone having paired end walls and paired side walls connected together at the corners of said skirt forming within said skirt a quadrilateral electrode space, at least one of said pairs of walls being spaced from the side walls of said container to form insulator housing spaces outside said skirt;

upright electrode members dividing said quadrilateral electrode space into upright side-by-side treating passages openly communicating at their lower ends with said lower zone;

means for metering the flow of treated oil from the tops of said treating passages into said upper zone and for blocking any significant up-flow of dispersion from said lower zone to said upper zone except through said treating passages, said last-named means including a metering plate traversing the top of said quadrilateral skirt closely adjacent the tops of said upright electrode members therein, said metering plate providing restricted metering holes at the tops of said treating passages providing the sole egress of treated oil therefrom to said upper zone;

insulator housing structures extending downwardly from the top of said container respectively in said insulator-housing spaces, each insulator housing structure providing an entrapment space open at its lower end;

an insulator support ring mounted within each entrapment space of each insulator housing structure;

a cylindrical insulator of relatively large diameter in each insulator housing structure having a central passage coaxial with the corresponding insulator support ring and having upper and lower annular faces respectively at its upper and lower ends, said lower face being supported on said insulator support ring;

an electrode support plate for each cylindrical insulator bridged across its central passage and supported by its upper annular face, the outer diameter of each cylindrical insulator being at least several inches to provide lateral stability for its electrode support plate against tipping;

a rigid elongated member connected to the center of each electrode support plate and of a length to extend through said central passage of said cylindrical insulator and through and from the lower open end of the corresponding insulator housing structure;

a quadrilateral foraminous support structure in said lower zone below the lower ends of said treating passages electrically connected to and supported by the lower ends of said rigid elongated members;

a plurality of upstanding rod electrodes attached rigidly to said foraminous structure extending upward in said treating passages having upper ends terminating below said metering plate; and

a high-voltage source of potential having terminals respectively connected to said upright electrode members and to one of said electrode support members establishing high-voltage electric fields in said treating passages.

17. A grid-like electrode structure for an electric treater for treating oil-continuous dispersions to separate particles of a dispersed-phase material therefrom, said electrode structure including:

walls defining an electrode space having an entrance end and an opposed exit end;

an orificed plate extending across said exit end of said electrode space having electrode-attachment openings therethrough along equally spaced parallel lines;

a plurality of partition panels each having openings inwardly of one edge thereof spaced to correspond to the electrode-attachment openings of a corresponding line;

a plurality of attachment members connecting said partition panels to said plate in spaced parallel relation; and

a plurality of divider members parallel to each other bridged between said partition members at right angles thereto and means for detachably connecting said divider members to said partitions, said divider members dividing the spaces between adjacent partition panels into side-by-side treating passages that are substantially square in cross section, that end of each treating passage adjacent said plate being an exit end, the other ends of said treating passages being open entrance ends, said plate including at least one small flow-metering orifice at the exit end of each treating passage.

18. In combination in an electric treater for oil-continuous dispersions, said treater having a closed container providing entrance and exit zones with a side-wall-bounded intermediate electrode zone therebetween having entrance and exit ends respectively facing said entrance and exit zones, a grid-like electrode structure comprising:

a plate closing the exit end of said intermediate electrode zone and separating same spacially from said exit zone, said plate having metering holes therethrough which said electrode zone communicates with said exit zone, said plate having also a plurality of locating openings therethrough arranged in parallel rows;

a plurality of parallel spaced partition panels in said electrode zone extending from side to side thereof parallel to said rows at positions between such rows, each partition panel having an edge adjacent said plate;

a plurality of divider members bridging the space between adjacent partition panels and dividing such space into side-by-side treating passages, each divider member having one end adjacent said plate;

means extending through said locating openings attaching said ends of said divider members to said plate; and

means at the opposite ends of said divider members detachably attaching same to said partition panels.

19. A combination as defined in claim 18 in which said means for attaching said one end of each divider member to said plate includes an end projection extending through a corresponding one of said locating openings.

20. A combination as defined in claim 18 in which each divider member provides a longitudinal flange on one side thereof, and in which said means for connecting said other end of said divider member to corresponding partition panels includes bolt means extending through said flange and one of such partition members and means for connecting the other side of such divider member to the other of such partition panels.

21. In combination in an electric treater for oil-continuous dispersions, said treater having a closed container providing entrance and exit zones with a side-wall-bounded intermediate electrode zone therebetween having entrance and exit ends respectively facing said entrance and exit zones, said closed container providing a man-hole nozzle opening on said entrance zone, a grid-like electrode structure comprising:

a plate closing the exit end of said intermediate electrode zone and separating same spacially from said exit zone, said plate having metering holes therethrough through which said electrode zone communicates with said exit zone;

a plurality of parallel equally spaced partition panels in said electrode zone extending from side to side thereof, each partition panel terminating in an edge adjacent said plate, each partition panel including a plurality of partition members and means for detachably connecting same edge to edge each, partition members being of a width to pass through said man-hole nozzle; and

means for electrically connecting said partition panels and said plate.

22. A combination as defined in claim **21** in which said means for detachably connecting said partition members

edge to edge includes at least two straps traversing the edge-to-edge junction of each pair of adjacent partition members and bolts extending through such straps and at least one of such adjacent partition members of such pair.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,342,720 September 19, 1967

Delber W. Turner

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 27, for "reatcion" read -- reaction --; column 3, line 43, for "ones" read -- zones --; column 4, line 70, for "of the this plate" read -- of this plate --; column 5, line 47, for "isulator" read -- insulator --; column 12, line 32, for "tof" read -- of --; line 54, for "plates" read -- plate --; column 14, line 38, for "therethrough which" read -- therethrough through which --; column 15, line 11, for "edge to edge each," read -- edge to edge, each --; line 12, for "members" read -- member --.

Signed and sealed this 22nd day of October 1968.

(SEAL)

Attest:

Edward M. Fletcher, Jr.

Attesting Officer

EDWARD J. BRENNER

Commissioner of Patents