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K. M. WOLFE

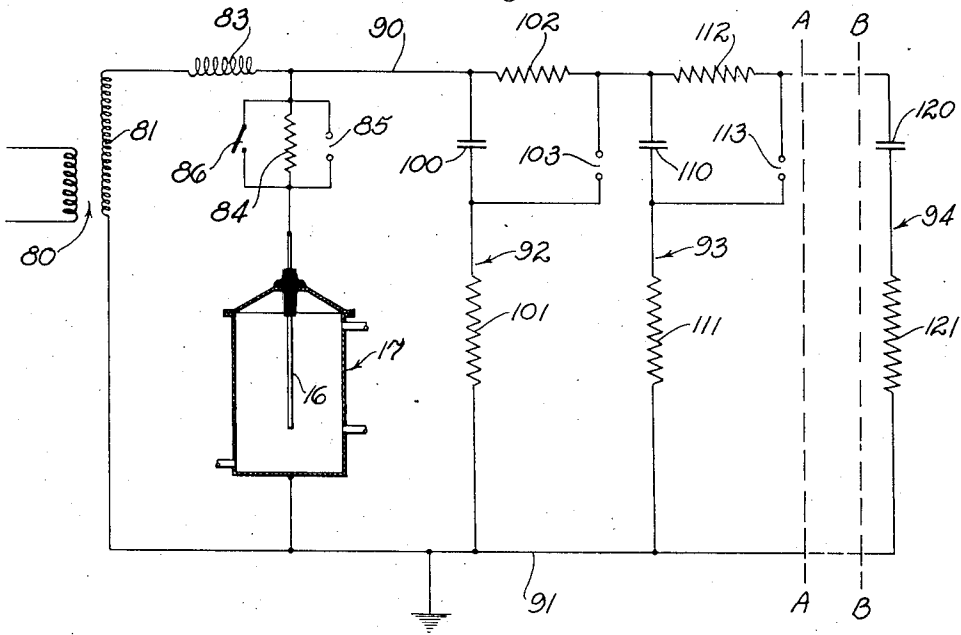
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ELECTRICAL DEHYDRATION SYSTEM

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Fig. 6.



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ELECTRICAL DEHYDRATION SYSTEM

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My invention relates to the electric treatment of mixtures, and more particularly to the electric dehydration of petroleum emulsions. It is in the latter capacity that the invention will be particularly described without limiting myself to this use.

The conventional mode of electrically treating petroleum emulsions is to impress a commercial-frequency alternating potential between a pair of electrodes bounding a treating space in which is positioned the emulsion to be treated. Conventional wave forms are used, these wave forms being sinusoidal or varying only minutely from sinusoidal form.

Such a system is very successful with certain types of emulsions. Certain other types, however, are very difficult, if not impossible to treat in this manner. With almost all emulsions considerable trouble has been experienced with the formation of low-resistance paths through the emulsion and bridging the electrodes, thus resulting in a sharp decrease in the potential across the field, and usually reducing this potential to a value much below that necessary for electric treatment. Forcing an emulsion of high water content through such an electric field will almost inevitably result in the formation of such low-resistance paths tending to short-circuit the electrodes. Further, a treater will often bog down when an over-abundance of moisture is present, and under these circumstances it is very difficult to again put the unit into successful operation, for the water content must be materially reduced before it is possible to build up a field of sufficient intensity to coalesce the dispersed droplets forming the dispersed phase. This sometimes requires the draining of the treater tank, and in other instances requires the use of auxiliary apparatus before the treater can again be put on commercial production.

It is an object of the present invention to provide a method and apparatus for overcoming these difficulties, thus permitting the commercial treatment of emulsions having a water content higher than the emulsions heretofore susceptible of electric treatment, my system also tending to prevent bogging down of the treater, and acting to quickly clear up a treater which has already become bogged down.

My experiments lead me to the conclusion that the effectiveness of the electric treatment is dependent upon the voltage gradient impressed across the emulsion. Previous attempts to increase this gradient have been along the lines of either increasing the overall potential applied

to the electrodes or changing the shapes of the electrode structures themselves. In either event the time interval of application of the gradient has not been considered. Thus, if the potential between a pair of electrodes is built up, the maximum potential possible is the potential which exists just before the formation of the disruptive current paths which tend to bridge the electrodes. Once these low resistance paths have formed the potential difference decreases almost to zero and any attempt to increase the voltage across the electrodes merely results in the flow of an even higher current through the emulsion, and does not effect the desirable treating action which takes place when high potentials are maintained between the electrodes. It will thus be apparent that the gradient which it is possible to build up in a treating space is also limited.

In my system of treating, a plurality of surges are utilized, each surge lasting only a few microseconds. With such a system it is possible to build up instantaneous potential differences between the electrodes which are many times higher than would be possible if attempts were made to maintain these potentials for a longer period of time. The result is that it is possible to build up extremely high voltage gradients in the electric field. Surges of such short duration have extremely steep wave-fronts, and my experiments lead me to conclude that many of the advantages accruing from the present invention result directly from the utilization of such steep wave-fronts.

It is an object of the present invention to provide an impulse treating system wherein the emulsion is subjected to one or more surges of extremely steep wave-front and having a maximum potential which may be, if desired, many times higher than the potentials at present used in commercial dehydration systems.

Such surges can most conveniently be set up by means of condenser discharges, and it is another object of the present invention to treat an emulsion by the use of the discharge of one or more of such condensers.

However, on certain emulsions it has been found that surges formed by condenser discharges will not alone reduce the water content of the emulsion to the low value required in present-day practice. Thus, while treatment with a condenser discharge can usually be made to reduce the water content to 3%, it is sometimes difficult with certain emulsions to reduce the water content to less than one-half of one per cent

as often required. In overcoming this difficulty the system herein set forth in detail utilizes a combined treating action which can most conveniently be described as comprising a somewhat conventional alternating current treatment on which is superimposed the surge treatment previously described. A method and apparatus whereby such results can be attained forms one part of the present invention.

Another important object of the present invention is to utilize a plurality of condensers which, after being suitably charged, are discharged in series relationship whereby the potentials of the condensers are additive, thus setting up a surge of extremely high voltage, this surge being in fact represented by the summation of the potentials utilized in charging the electrodes.

Further objects of the invention lie in the particular type of circuit utilized for accomplishing this result, including one or more spark gaps through which the condensers are interconnected.

Still further objects lie in the particular circuits shown, especially as applied to systems for treating emulsions.

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

Referring to the drawings,—

Fig. 1 is a wiring diagram of the preferred embodiment of the invention.

Figs. 2, 3, and 4 diagrammatically represent wave forms derivable from a system such as shown in Fig. 1, these wave forms not being drawn to scale, but being illustrative of the action which takes place.

Fig. 5 is a wiring diagram of a circuit similar to Fig. 1 but including a larger number of series circuits.

Fig. 6 is a wiring diagram of an alternative form of the invention.

Referring particularly to Fig. 1 there is shown a conventional treater or dehydrator 10 including a container 11 into which emulsion may be supplied through a pipe 12, the dry oil being removed through a pipe 13 and water being removed through a pipe 14. Any suitable electrode system may be utilized. In the treater shown an insulator 15 extends through the top of the container 11 and supports a central or primary electrode 16. The container itself forms an outer or secondary electrode 17, the space between these electrodes comprising a treating space 18 wherein the actual treatment takes place. This treatment agglomerates the dispersed droplets and the agglomerated droplets drop downward in the container 11 and are withdrawn through the pipe 14, the dry oil moving upward in the container and being removed through the pipe 13 in the usual manner.

In the preferred embodiment of the invention the electric field set up between the electrodes 16 and 17 has two components. The first of these is a rather conventional alternating current component such as is obtainable by the use of commercial transformers, such as indicated by the numeral 20 of Fig. 1. The second is a surge component obtainable by a surge-generating means 21 illustrated in the right-half of Fig. 1. In the preferred embodiment these components are superimposed to form a resultant electric field, but this is not necessarily the case as will be hereinafter set forth. In the form shown in Fig. 1 the transformer 20 is utilized for the dual purpose of setting up this first or alternating current of the field, and also charging

the condensers in the surge-generating means 21.

As shown, the transformer 20 includes a primary winding 23 connected to a source of alternating current which may be of commercial frequency or higher frequency if desired. A high-tension secondary winding 24 is provided, one terminal of which is grounded through a conductor 25. The container 11 is also grounded as by a conductor 26 so that this terminal of the high-tension winding 24 is electrically connected to the outer or secondary electrode 17. The remaining high-tension terminal is connected through a conductor 28 to a reactance 29, a conductor 30 being connected to the load side of the reactance 29. A conductor 31 connects the conductor 30 to the central or primary electrode 16. In the preferred embodiment of the invention this conductor includes in series therewith a condenser 32 which may be shunted from the circuit by a switch 33. It will thus be clear that the high-tension winding of the transformer 20 is connected across the electrodes of the treater 10.

Also connected across this high-tension winding 24, and in parallel with the electrodes 16 and 17 are primary, secondary, and tertiary series circuits 35, 36, and 37, the upper portions of each of these circuits being connected to the conductor 30 at a junction 38, the lower portions of each of these circuits being grounded and thus connected to the electrode 17 and to the grounded side of the high-tension winding 24.

The primary series circuit 35 is shown as comprising a condenser 40 hereinafter termed a first condenser, connected in series with an impedance 41 hereinafter termed a first impedance. In the preferred embodiment of the invention the impedance 41 is in the form of a resistance, usually having a value of several thousand ohms, for a purpose to be hereinafter described.

The secondary series circuit 36 includes in series a first blocking impedance 44, a second condenser 45, and a second impedance 46. The second impedance 46 is, in the preferred embodiment of the invention, in the form of a resistance similar to the first impedance 41 though it may have a somewhat lower value. The blocking impedance 44 may be either a resistance or a reactance, but in the preferred embodiment it includes both resistance and reactance components, respectively indicated by the numerals 48 and 49. By proper design these components can be incorporated in a single unit.

The tertiary series circuit 37 includes a second blocking impedance 50 and a third condenser 51 connected in series. The second blocking impedance 50 may be of a form identical with the first blocking impedance 40 and is shown as including a reactance 52 and a resistance 53. The third condenser 51 is directly connected to ground through a conductor 54. In the preferred embodiment of the invention this conductor need not include an impedance corresponding to the impedances 41 and 46 shown in the primary and secondary series circuits 35 and 36.

A spark gap 55, hereinafter termed a first spark gap, is connected between the primary and secondary series circuits 35 and 36 in such a way that one ball or terminal of this gap is connected to the primary series circuit at a point between the condenser 40 and the first impedance 41, while the other ball or terminal of the spark gap is connected to the secondary series circuit 36 at a point between the second con-

denser and the first blocking impedance 44, as shown.

Another spark gap 56 hereinafter termed a second spark gap, is connected between the secondary and tertiary series circuits, one ball or terminal of this spark gap being connected to the secondary series circuit 36 at a point between the secondary condenser 45 and the second impedance 46, and the other ball or terminal of the spark gap 56 being connected to the tertiary series circuit 37 at a point between the second blocking impedance 50 and the third condenser 51.

The spacing between the balls or terminals of one spark gap is less than the spacing of the other gap though it is immaterial, for the operation of the surge circuit, which spark gap is set with the smaller spacing. I have shown the terminals of the second spark gap 56 as being spaced a distance apart less than the spacing of the first spark gap 55, and so spaced that the spark gap 56 will break down at or near the instant when the peak voltage of the transformer 20 is impressed thereacross.

When the treater is in operation, it will be clear that the transformer 20 not only impresses an alternating potential across the electrodes 16 and 17, but also builds up an alternating potential across each of the primary, secondary, and tertiary series circuits 35, 36, and 37 respectively. This will tend to charge the condensers 40, 45, and 51 with potentials substantially corresponding to the instantaneous potential developed by the transformer 20 disregarding the slight voltage drops which take place in the impedances.

When this potential nears its peak value, the second spark gap 56 will break down. This, in effect, connects the second and third condensers 45 and 51 in series and impresses across the first spark gap 55 a potential represented by the sum of the potentials with which the condensers 45 and 51 were charged. The first gap 55 is adjusted to break down at this double potential, and when this occurs it will be clear that the condensers 40, 45, and 51 are in series circuit across the electrodes. Tracing this series circuit, and starting from the electrode 17, the surge may flow through the conductor 26 to ground, thence through the conductor 54, the third condenser 51, the second spark gap 56, the second condenser 45, the first spark gap 55, the first condenser 40, the conductor 30, and to the central electrode 16 through the conductor 31, and through either the switch 33 or the condenser 32 depending upon whether this switch is closed or open. The potential thus impressed between the electrodes 16 and 17 has a peak value which is substantially three times the value of the peak of the alternating current developed by the secondary winding 24 of the transformer 20, for the potentials of the condensers 40, 45, and 51 are additive when thus connected in series.

It will be clear that the time interval between the break down of the second spark gap 56 and of the first spark gap 55 is infinitesimal. Further, the condensers 40, 45, and 51 discharge very quickly, the whole surge being completed in a few microseconds. This extremely quick discharge is what makes possible the use of the circuit shown in Fig. 1. Under slower conditions the breaking down of the second spark gap 56 would allow the third condenser 51 to discharge through a closed circuit including the third spark gap 56, the impedance 46, and the conductor 54. However, this

action does not take place in actual practice, for the entire time duration of the surge is far less than the time required for the condenser to discharge through such a high impedance as indicated by the numeral 46. In this connection it will be clear that this impedance must have a sufficiently high value so as to prevent such a discharge of the condenser 51 to ground. In practice this impedance may be in the form of a pure high resistance with substantially no reactance. On the other hand, this impedance may have a high reactive component or may include both resistance and reactance in various ratios so long as it offers sufficient impedance to prevent a quick discharge of the condenser 51 to ground.

The first impedance 41 is similarly designed, though it need not be identical with the impedance 46. In the preferred embodiment, however, it is desirable to maintain the voltages of the condensers 40, 45, and 51 approximately in phase, though this is not in all events necessary.

These conditions are diagrammatically represented in Fig. 2. In this figure the substantially sinusoidal potential developed by the transformer 20 is indicated by the numeral 60. When this potential nears its peak value, the spark gaps 56 and 55 discharge in quick succession, the condensers 51, 45, and 40 thus combining to form a steep wave-front surge indicated by the peak 61. The peak potential of this surge is shown as being many times greater than the peak potential of the curve 60. It will further be apparent that the peak potential of the surge can be increased to almost any desired extent by utilizing additional series circuits similar to those indicated by the numerals 35 or 36, and connected in parallel therewith, using additional spark gaps interconnecting these circuits in substantially the same manner as shown with respect to the series circuits disclosed in Fig. 1. Such a circuit is shown in Fig. 5. In any event it will be clear that the peak surge voltage will be approximately equal to the product of the number of series circuits, such as the circuits 35, 36, and 37, and the voltage to which the condensers are charged when the spark gaps break down. It is to be noted that there usually is no blocking impedance in the primary series circuit and no impedance such as 41 and 46 in the last series circuit; this insures that most of the voltage and most of the energy of the surge will be dissipated in the treater.

In Fig. 1, I have shown but one surge for each half cycle of the alternating potential developed by the transformer, one surge being on the positive half cycle and the other being impressed on the negative half cycle of the wave. It should be understood, however, that the system is not limited to such a wave form. By properly proportioning the elements, and by adjusting the second spark gap 56 to break down at a potential somewhat lower than the peak developed by the transformer, it is possible to provide a number of surges on each half cycle of the alternating current wave. In this event these surges will follow each other in quick succession. The curve diagrammatically illustrating this action is set forth as Fig. 3 wherein the alternating current wave is indicated by the numeral 65, and three steep wave-front surges 66, 67, and 68 are superimposed on each half cycle. The number of these surges depends not only upon the elements of the circuit of the surge generator, but also upon the type of wave form developed by the transformer. If this wave form is quite flat, it will

be clear that it is possible to greatly increase the number of surges per half cycle.

Furthermore, in Figs. 2 and 3, I have shown each surge as being aperiodic. This is not necessarily the case, however, for by suitable adjustment of the elements of the circuit, it is possible to obtain an oscillatory discharge of high frequency which is superimposed upon each half cycle. Such an oscillating frequency, of course, develops extremely steep wave-fronts, and the reversal of polarity which is possible by the use of such a circuit is advantageous in certain installations. A typical wave form in which each surge sets up an oscillatory high frequency potential is shown in Fig. 4. For the purpose of clearness this figure illustrates but one surge per half cycle, it being understood that such a surge will result in an oscillatory potential in the event that the elements of the circuit are properly designed.

In the circuit shown in Fig. 1 two oscillatory circuits are shown. The first of these includes the second blocking impedance 50, the second spark gap 56, the second condenser 45, and the first blocking impedance 44. The second of these oscillatory circuits includes the first blocking impedance 44, the first spark gap 55, and the first condenser 40. By designing these circuits so they are not critically damped it is possible to greatly accentuate this high frequency phenomena. So also oscillatory characteristics can be imparted to the wave form by suitably designing the impedances 41 and 46 so that they have reactive components.

In the event that the high frequency characteristic is not desired it is only necessary to increase the ohmic component of the circuits so as to dissipate and damp the high frequency oscillation. Thus, the resistances 48 and 53 may be made variable, if desired, so as to control the degree of such oscillations. By increasing the values of these resistances the oscillation can be completely prevented and a wave form similar to that shown in Fig. 3 will be developed.

In some instances it is possible to dispense with the reactances 49 and 52 respectively forming a part of the blocking impedances 44 and 50, thereby preventing the formation of resonant circuits. In any event it will be apparent that the blocking impedances 44 and 50 act to block the surges developed by the condensers 45 and 51 from flowing directly to the terminal 38, thus insuring that all three condensers will be placed in series to set up a surge across the electrodes which is of maximum intensity.

It is usually desirable to keep the surges from the windings of the transformer, and the reactance 29 inserted in the circuit connecting the transformer to the electrode serves this purpose. This reactance chokes back any steep wave-front surge or oscillatory frequency such as developed by the surge generator means 21. At the same time this reactance offers little impedance to the relatively low frequency alternating potential developed by the transformer.

Great difficulty has often been encountered in putting a treater into operation, especially if the treating space is filled with a comparatively wet emulsion. Further, the water content of the emulsion is not the only controlling factor, for many emulsions seem to have greater short-circuiting tendencies than others having substantially the same water content. If the electrodes 16 and 17 are substantially short-circuited it will be clear that closing the switch 33 will substantially short-circuit the secondary winding of the

transformer and excessive currents will flow, being limited only by the impedance of the circuit including the electrodes and the reactance 29. Under such circumstances no appreciable treating action takes place. Further, under such conditions the surge generating means 21 will not function, for the potential impressed across the series circuits will never reach a value sufficient to break down the spark gap 56 due to the fact that the potential across the electrodes is substantially zero. To obviate these difficulties the condenser 32 is utilized. If the switch 33 is open it will be clear that the current reaching the electrodes from the transformer will be limited by the impedance of the condenser 32. Thus, this condenser acts to limit the amount of low frequency current which can reach the electrodes. The condenser is of such a character, however, that it offers little impedance to the high frequency surge set up by the surge generating means 21. In addition, however, this condenser prevents the excessive lowering of the potential supplied to the surge generator means, thereby permitting this means to function even when a wet emulsion is present in the treating space. In this connection it will be clear that when the electrodes are substantially short-circuited by a wet emulsion the potential of the transformer will appear almost entirely across the condenser 32. If, however, the treating space is filled with a dry oil, the potential of the transformer will be mainly impressed across the electrodes and the voltage drop across the condenser 32 will be nominal.

Experiments have shown that the action of the surge generating means 21 is very effective in clearing up a treater which has become bogged down and in starting a treater containing emulsion of rather high water content. The steep wave-front surges set up extremely high gradients in the treating space between the electrodes, even though these gradients exist only for a few microseconds. Such surges apparently have a very desirable action on this type of emulsion and appear to have no material short-circuiting tendency because of the extremely short period during which they are applied. The result is that the treater can be put into normal operation in a relatively short period of time. Once normal conditions have been established it is possible to close the switch 33, thus impressing the full potential of the transformer across the electrodes. If desired this switch can be controlled by a time-delay means 70 acting to close the switch 33 after the treater has been set into operation for a predetermined time. Operation of such a time-delay means is started, for instance, when the transformer is first energized. One type of time-delay means is shown comprising a plunger 71 operating the switch and moved by a solenoid 72 connected across the primary winding 23. A dash pot 73 retards the closing action of the plunger 71 to allow the switch to remain open until sufficient time has elapsed to permit the treater to clear up.

If desired, another type of operating mechanism can be used to actuate the switch 33. For the purpose of clearness this system has been illustrated in Fig. 5 and includes a current transformer 74 responsive to the current flowing through some part of the circuit, and preferably to the current flowing through the primary winding of the transformer. This current transformer sends current through a solenoid winding 75 acting to move a plunger 76 leftward 75

against the action of a spring 77 to open the switch 33. Normally the force exerted by the spring holds this switch closed, but if excessive current is drawn the action of the solenoid winding 75 will overbalance the spring action and open the switch. It will be understood that this system is only diagrammatically shown and can be modified by the use of quick opening switches, trip mechanism, etc., without departing from the spirit of the invention. So also, this type of current responsive system for the switch 33 can be combined with the system shown in Fig. 1 for operating this switch in which event the time-delay circuit will close the switch 33 only if the current is at or below a predetermined minimum value.

A slightly modified form of the invention is shown in Fig. 6. In this system a transformer 80 provides a secondary winding 81 connected across the electrodes 16 and 17 through a choke coil 83 and an impedance 84 which may be in the form of a resistance. This resistance is short-circuited by a spark gap 85 and by a switch 86. The surge generating means is of slightly different form and includes a high potential conductor 90 and a grounded conductor 91 respectively connected to the electrodes 16 and 17. A plurality of surge circuits are positioned in parallel with each other between these conductors. In Fig. 6, three of such surge circuits are shown, indicated respectively by the numerals 92, 93, and 94. Any number of additional surge circuits can be inserted in like manner into the circuit between the dotted lines A-A and B-B. The primary surge circuit includes a first condenser 100 and a first impedance 101 connected in series between the conductors 90 and 91. It also includes a blocking impedance 102 connected in series with a first spark gap 103, this series circuit being connected around the first condenser 100. The secondary surge circuit 92 includes similar elements including a second condenser 110 and a second impedance 111 connected in series, there being a second blocking impedance 112, a second spark gap 113 connected in series with each other and across the second condenser 110. The tertiary surge circuit 94 may include a third condenser 120 connected in series with a third impedance 121 across the conductors 90 and 91.

In this form of the invention one of the spark gaps, in the form shown the second gap 113, is set to break down at a potential at or near the peak of the voltage wave produced by the transformer. When this occurs the condensers 110 and 120 are connected in series through the gap 113 so that the combined potentials thereof are impressed across the gap 103. This causes the gap 103 to break down, thus allowing the first, second, and third condensers 100, 110, and 120 to be connected in series across the electrodes, these series circuits including the ground conductor 91, the third impedance 121, the third condenser 120, the second spark gap 113, the second condenser 110, the first spark gap 103, and the first condenser 100, as well as the conductor 90 and the impedance 84. This circuit thus sends a surge of very short duration to the electrodes in a manner previously described, this surge being repeated one or more times for each half cycle of the alternating current wave by proper design of the circuit.

In this circuit, as in Fig. 1, the impedances 101 and 111 effectively prevent the surge from merely flowing to the grounded conductor 91.

So also, the blocking impedances 102 and 112 prevent this surge from flowing therethrough thereby insuring that all of the condensers will be connected in series with respect to the electrodes the instant that the spark gaps 103 and 113 have broken down. By proper design of the blocking impedances 102 and 112 it becomes possible to set up oscillatory conditions similar to those described with respect to Fig. 1.

In this form of the invention the impedance 84 limits the current flowing to the electrodes in somewhat the same manner as did the condenser 32 shown in Fig. 1. Thus, this impedance prevents a drop in voltage applied to the surge generating means which would prevent functioning thereof. In addition, however, when the switch 86 is open this impedance tends to choke back the steep wave-front surge developed by the surge generating means. Thus, at the instant that the gaps 103 and 113 break down there will be impressed across the gap 85 a high potential corresponding to the additive potentials of the condensers 100, 110, and 120. The gap 85 is adjusted to break down at or near this potential, and in thus breaking down forms a low resistance path for the steep wave-front surge whereby this surge is directly transmitted to the electrodes. This type of circuit wherein the current-limiting means is shunted by a spark gap offers a convenient means of removing the impedance from the circuit to allow the surge to reach the electrodes. As soon as the surge has been thus transmitted, and the potential of the transformer has been lowered, the gap 85 will not longer conduct current and the impedance 84 will again be effective in limiting the current to the electrodes.

This mode of operation is especially desirable in starting up a treater and in treating certain types of wet emulsions. In other instances it is possible to close the switch 86 thereby shunting the impedance 84 and the spark gap 85 from the circuit. In other instances it is desirable to close the switch 86 by a long time-delay means set into operation by the energization of the transformer 80 so that this switch will close after the normal period required for drying the emulsion present in the treater at start.

The combined action of the alternating current and the superimposed surges has been found to be much more desirable than the treating action taking place when surges alone are utilized. Such surges when used by themselves are often ineffective in reducing the water content to the desired degree. If, however, these surges are superimposed upon an alternating potential, the water content can be lowered to pipe-line requirements. In other instances, however, only the surges need be used in which event the potential across the electrodes will be zero between the surges. Such a mode of operation can be effected by slight changes in the circuits shown. In fact, such conditions are closely approached when the condenser 32 is made small or when a high impedance 84 is utilized, for such a system prevents high voltages of commercial frequency being impressed across the electrodes.

It will be understood that I am not limited to a commercial frequency source to which the transformer is connected. The potential impressed across the transformer may be higher or lower than the commercial 50 or 60 cycle alternating current.

It will further be clear that I am not limited to the exact connections shown. In view of the

broader concepts of the invention set forth and in which condenser discharges are utilized in effectively treating emulsions.

I claim as my invention:

1. A method of electrically treating an emulsion by the use of a plurality of condensers, which method includes the steps of: charging all of said condensers with a high potential; then quickly discharging said condensers by connecting said condensers in series only after all of said condensers have been charged in order to produce a steep wave-front surge of potential magnitude substantially corresponding to the additive high potentials with which said condensers were charged; utilizing said surge in setting up an electric field; subjecting said emulsion to said field to coalesce the dispersed emulsion phase; and separating said coalesced material from the balance of said emulsion.
2. A method of treating an emulsion by the use of a plurality of condensers, which method includes the steps of: charging said condensers in parallel relation; then connecting the charged condensers in series circuit thus discharging said condensers in series relationship to set up a steep wave-front surge; subjecting said emulsion to said steep wave-front surge to coalesce the dispersed phase of said emulsion; and separating the coalesced phase from the balance of said emulsion.
3. A method of treating an emulsion positioned in a treating space by the use of a plurality of condensers, which method includes the steps of: simultaneously building up an electric alternating-current field in said treating space and charging said condensers by connecting an alternating-current potential source to the electrodes and across each of said condensers in parallel; then connecting the charged condensers in series circuit to discharge said condensers in series relationship during the application of said electric field to said emulsion thereby adding the discharges of said condensers to produce a potential much greater than the potential across said electric field and greater than the maximum potential of said potential source; and applying this high potential to said treating space during the time said electric field is established in said treating space.
4. In combination in a system for electrically treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; a plurality of condensers connected to said electrodes; potential supply means connected across said electrodes and connected across said condensers in parallel relation for simultaneously energizing said electrodes and charging said condensers in parallel relation; means for discharging said condensers in quick succession in additive relation to build up a steep wave-front surge; means for transmitting said surge to said electrodes to coalesce the dispersed phase of said emulsion; and means preventing said steep wave-front surge from reaching said potential supply means.
5. In combination in a system for electrically treating emulsions: a pair of electrodes defining a treating space in which is positioned the emulsion to be treated; a transformer providing a high-tension winding one terminal of which is electrically connected to one of said electrodes; a choke coil connected to the other terminal of said high-tension winding; a conductor connecting the other of said electrodes to said choke coil whereby said high-tension winding is in series circuit with said choke coil and said electrodes;

condenser means connected to said one of said electrodes and to said conductor and thus being in parallel with said electrodes and with said high-tension winding whereby said condenser means is charged by said high-tension winding when said electrodes are energized; and means for periodically discharging said condenser means to said electrodes to set up a steep wave-front surge to said electrodes which coalesces the dispersed phase of said emulsion in said treating space, said last-named means including a circuit in parallel with said condenser means and a spark gap in said circuit.

6. In combination in a system for electrically treating emulsions: primary and secondary electrodes defining a treating space containing the emulsion to be treated; a plurality of condensers; a plurality of spark gaps set at different spacings; means for connecting said spark gaps and said condensers in series across said electrodes so that when said spark gaps break down the charges in said condensers form a steep wave-front surge flowing to said electrodes to coalesce the dispersed phase of said emulsion; and potential means for charging said condensers during the time that said spark gaps are not broken down.

7. In combination in a system for electrically treating emulsions: a pair of electrodes defining a treating space in which is positioned the emulsion to be treated; a transformer providing a high-tension winding connected across said electrodes; a condenser; an impedance; means connecting said condenser and said impedance in series circuit across said electrodes whereby said condenser is charged when said electrodes are energized; and means for periodically discharging said condenser to send a steep wave-front surge to said electrodes to agglomerate the dispersed phase of said emulsion.

8. In combination in a system for electrically treating emulsions: a pair of electrodes defining a treating space in which is positioned the emulsion to be treated; a transformer providing a high-tension winding connected across said electrodes; a condenser; an impedance; means connecting said condenser and said impedance in series circuit across said electrodes whereby said condenser is charged when said electrodes are energized; a blocking impedance; a spark gap; and means connecting said blocking impedance and said spark gap in series circuit across said condenser whereby when said spark gap breaks down a steep wave-front surge is set up by the discharge of said condenser and is transmitted to said electrodes to agglomerate the dispersed phase of said emulsion.

9. In combination in a system for electrically treating emulsions: a pair of electrodes defining a treating space in which is positioned the emulsion to be treated; a transformer providing a high-tension winding connected across said electrodes; a spark gap set to break down at a potential developed across said electrodes; and an impedance connected in series with said spark gap, the series circuit including said spark gap and said impedance being connected across said electrodes, said impedance limiting the current flowing through said gap when it breaks down, thereby preventing hot gases from being formed in said gap which would short-circuit said gap for a material length of time.

10. In combination in a system for electrically treating emulsions: a pair of electrodes defining a treating space in which is positioned the emulsion to be treated; a transformer providing a high-

tension winding connected across said electrodes; a condenser; an impedance; means connecting said condenser and said impedance in series circuit across said electrodes whereby said condenser is charged when said electrodes are energized; a first blocking impedance one terminal of which is electrically connected to one of said electrodes and to one terminal of said condenser; a first spark gap connected to the other terminal of said condenser; conductor means connecting the remaining terminal of said blocking impedance to said first spark gap to connect said blocking impedance and said first spark gap in series across said condenser; a second blocking impedance one terminal of which is connected to the circuit including said condenser, said first spark gap and said first blocking impedance; a second condenser one terminal of which is connected to said last-named circuit; a second spark gap connected between the other terminal of said second condenser and the remaining terminal of said second blocking impedance; and a second impedance connecting said other terminal of said second condenser to the other of said electrodes.

11. A combination as defined in claim 10 including an impedance in series with said electrodes and allowing the surges set up by the discharge of said condensers to pass to said electrodes but limiting the current from said transformer to said electrodes to a low value thereby preventing drop in transformer voltage to such extent that said spark gaps would not break down.

12. In combination in a system for electrically treating emulsions: primary and secondary electrodes defining a treating space in which is positioned the emulsion to be treated; a transformer providing a high-tension winding connected across said electrodes; a first condenser; conductor means connecting one terminal of said first condenser to said primary electrode; a first impedance connecting the other terminal of said first condenser to said secondary electrode; a first blocking impedance one terminal of which is electrically connected to said conductor means; a first spark gap connected between the other terminal of said first blocking impedance and said other terminal of said first condenser; a second condenser one terminal of which is connected to said other terminal of said first blocking impedance; a second impedance connected to the other terminal of said second condenser and to said secondary electrode; a second blocking impedance one terminal of which is connected to said conductor means; a third condenser, one terminal of which is connected to the other terminal of said second blocking impedance; means connecting the other terminal of said third condenser to said secondary electrode; and a second spark gap connected between said other terminal of said second blocking impedance and said other terminal of said second condenser.

13. In combination in a system for electrically treating emulsions: primary and secondary electrodes defining a treating space in which is positioned the emulsion to be treated; a primary series circuit connected in parallel with said electrodes and including a first impedance and a first condenser connected in series with each other; a secondary series circuit also connected in parallel with said electrodes and including a second impedance, a second condenser and a first blocking impedance connected in series with each other; a tertiary series circuit also connected in parallel with said electrodes and including a third

condenser and a second blocking impedance connected in series; a first spark gap connected to said primary series circuit at a point between said first impedance and said first condenser and connected to said secondary series circuit at a point between said first blocking impedance and said second condenser; a second spark gap connected to said secondary circuit at a point between said second condenser and said second impedance and connected to said tertiary circuit at a point between said third condenser and second blocking impedance whereby said condensers are connected in series when said spark gaps break down to supply a steep wave-front surge to said electrodes; and potential supply means connected across said electrodes.

14. In combination in a system for electrically treating emulsions: a pair of electrodes defining a treating space containing emulsion to be treated; a potential source; circuit means connecting said potential source to said electrodes, said circuit means including an impedance; a switch by-passing said impedance; means responsive to the amount of current flowing to said electrodes; and means mechanically connecting said last-named means and said switch for closing said switch to by-pass said impedance.

15. In combination in a system for electrically treating emulsions: a pair of electrodes defining a treating space containing emulsion to be treated; a potential source; circuit means connecting said potential source to said electrodes, said circuit means including an impedance; a switch by-passing said impedance; a time-delay means for actuating said switch; and means for setting said time-delay means into operation when said electrodes are first energized.

16. A combination as defined in claim 10 in which said one terminal of said second blocking impedance is connected to said circuit including said condenser, said first spark gap, and said first blocking impedance at a point between this first blocking impedance and said first spark gap.

17. In combination in a system for electrically treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; a plurality of condensers; means for charging said condensers; means for electrically connecting said condensers only when in charged condition in series circuit to build up a steep wave-front surge the potential of which at any instant of time is determined by the additive potentials of the charged condensers connected in series at this instant of time; and circuit means transmitting to said electrodes the surge established by the discharge of all of said condensers to set up an electric field between said electrodes coalescing the dispersed phase of said emulsion.

18. In combination in a system for electrically treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; a plurality of condensers; means for charging said condensers; means for successively connecting said condensers in series circuit to build up a steep wave-front surge the potential of which at any instant of time is determined by the additive potentials of the charged condensers connected in series at this instant of time; circuit means transmitting to said electrodes the surge established by the discharge of all of said condensers to set up an electric field between said electrodes coalescing the dispersed phase of said emulsion; and means preventing discharge of said condensers to said electrodes until such time as all of said condensers are connected in series.

19. In combination in a system for treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; a potential source; a condenser charged by said potential source; a spark gap set to break down only at a potential difference higher than the potential developed by said source, said spark gap transmitting to said electrodes a surge resulting from a discharge of said condenser; and means periodically developing across said spark gap a potential greater than the potential of said source and sufficient to cause an arc to form across said spark gap whereby said condenser can discharge to said electrodes.

20. In combination in a system for treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; a series circuit connected across said electrodes and including alternately connected condensers and spark gaps; a potential source connected to said series circuit to charge said condensers and break down said spark gaps to set up a steep wave-front surge through said series circuit to said electrodes when said condensers discharge; impedance means connecting one terminal of each of said condensers to one of said electrodes; and impedance means connecting the other terminal of at least certain of said condensers to the other of said electrodes, all of said impedance means thus acting to confine the condenser discharges in said series circuit to reach said electrodes through this series circuit rather than through any of said impedance means.

21. In combination in a system for treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; a plurality of condensers; a plurality of spark gaps set at different spacings; means for connecting said condensers and spark gaps alternately in series circuit across said electrodes; and an alternating-current potential source connected across said electrodes and to said condensers for applying a potential difference across said electrodes and developing a sufficient potential to break down the smallest of said spark gaps thus increasing the potential across the remaining spark gaps to cause break down thereof and to discharge said condensers to said electrodes through said series circuit during the time that a field is developed between said electrodes by said potential source.

22. A method of treating an emulsion positioned between electrodes, which method includes the steps of: first exclusively delivering to said electrodes a series of steep wave-front surges to partially treat said emulsion to remove excessive quantities of the dispersed phase; and later delivering to said electrodes a low-frequency alternating current to further treat said emulsion.

23. A method of electrically treating an emulsion, which method includes the steps of: introducing said emulsion into a treating space formed between a pair of electrodes; forming a high-potential surge by successively superimposing in additive relation a plurality of electric impulses in such quick succession that the potential does not drop to zero before the next succeeding im-

pulse is applied whereby the resulting peak potential successively increases to form said high-potential surge which is of higher potential than any of said impulses; transmitting said high-potential surge to said electrodes whereby an electric field is established in said treating space which represents the additive effect of said electric impulses whereby said emulsion is subjected to a steep wave-front surge to coalesce the dispersed phase thereof; and separating the coalesced material from the balance of said emulsion.

24. In combination in a system for electrically treating emulsions: a source of potential; a plurality of condensers; a first circuit means connecting said condensers in parallel relationship with each other and to said source of potential to charge said condensers; a second circuit means for connecting said charged condensers in series relationship to produce a surge of steep wave front, said second circuit means including a spark gap means which when electrically broken down connects said condensers in series relationship; a pair of electrodes; means for transmitting said surge to said electrodes to coalesce the dispersed phase of said emulsion; and means for separating said coalesced phase from the balance of said emulsion.

25. In combination in a system for treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; surge means producing successive electric surges; means transmitting said surges to said electrodes, said means including a condenser in series circuit between one of said electrodes and said surge means and readily transmitting said surges to said electrodes to coalesce the dispersed phase of said emulsion but impeding the passage of low-frequency currents to said electrodes; and a source of low-frequency alternating potential connected to said surge means and connected to said electrodes through said condenser whereby said condenser impedes the passage of low-frequency currents to said electrodes.

26. In combination in a system for treating emulsions: a pair of electrodes between which is positioned the emulsion to be treated; surge means producing successive electric surges; means transmitting said surges to said electrodes, said means including a condenser in series circuit between one of said electrodes and said surge means and readily transmitting said surges to said electrodes to coalesce the dispersed phase of said emulsion but impeding the passage of low-frequency currents to said electrodes; a source of low-frequency alternating potential connected to said surge means and connected to said electrodes through said condenser whereby said condenser impedes the passage of low-frequency currents to said electrodes; and switch means connected in parallel with said condenser to make possible removal of said condenser from said circuit thereby connecting both said surge means and said source of low-frequency alternating potential to said electrodes.

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