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APPARATUS FOR ELECTRICAL TREATMENT OF FLUIDS

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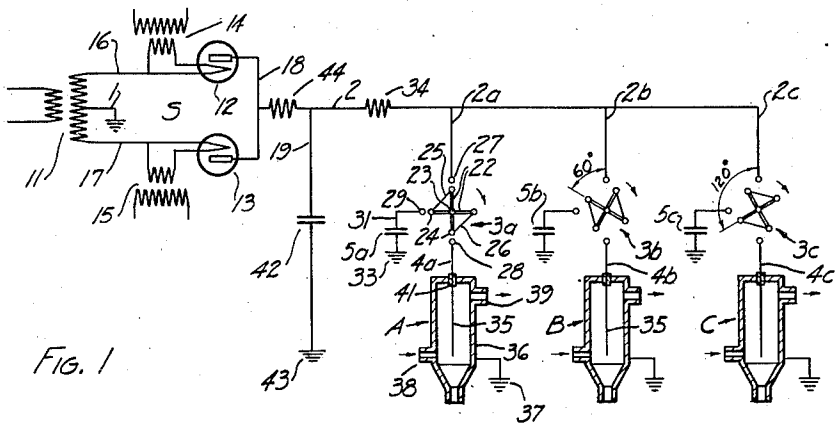


FIG. 1

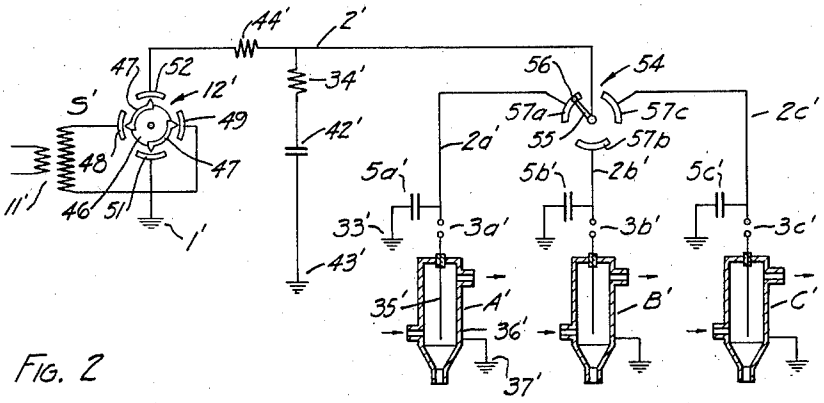


FIG. 2

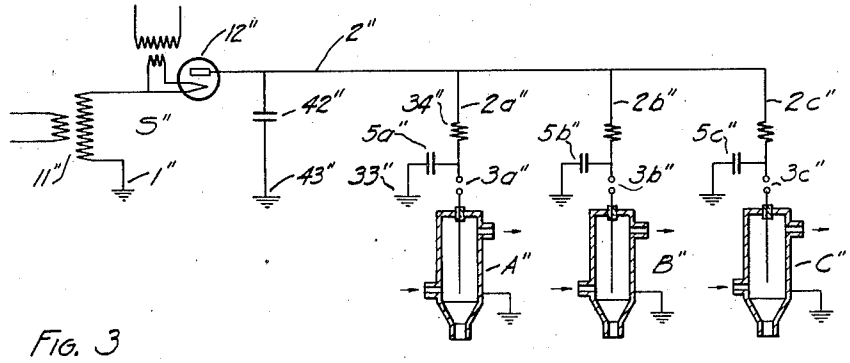


FIG. 3

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APPARATUS FOR ELECTRICAL TREATMENT OF FLUIDS

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6 Claims. (Cl. 183—7)

This invention relates to the electrical treatment of gases or liquids, for the purpose of removing suspended particles therefrom or for other purposes.

The invention is particularly applicable for use in electrical precipitation of suspended particles from gases, or in the electrical treatment of petroleum emulsions or other liquid emulsions for the purpose of separating the emulsified constituents. However, it may be utilized in any process in which a fluid is subjected to the action of a high potential electric discharge between opposing electrode means.

It has already been proposed in United States patent applications, Serial Nos. 527,690 and 613,783, to improve the efficiency of apparatus of this type by applying to the opposing electrode means of such apparatus, impulse potentials of extremely short duration and extremely steep wave front, while providing intervals of relatively long duration between successive impulses. The utilization of potential impulses of this type provides for copious production of ions, at the instant of each impulse, to effect charging of the suspended particles or other desired result, and also serves, in the case of electrical precipitating or separating processes, to maintain the necessary effective potential between the electrodes to cause migration of the charged particles toward the electrode surfaces and precipitation of such particles thereon, while at the same time substantially preventing arcing or disruptive discharge between the electrodes, owing to the fact that before the resistance of the fluid between the electrodes is sufficiently reduced, by ionization or other phenomenon incident to the impulse discharge, to permit arcing or disruptive discharge, the impulse energy is substantially dissipated and the inter-electrode potential has decreased to such a low value as to prevent the formation of an arc, disruptive discharge or short circuit between the electrodes. Said patent applications have also disclosed suitable apparatus for producing potential impulses of the type above described, such apparatus comprising in general, capacity means connected to the source of electric power supply and a spark gap or similar device connected between said capacity means and the electrodes of the fluid treating apparatus, said spark gap being adapted to break down when the capacity means becomes charged to a certain potential, and thus discharge the energy stored in said capacity means to said electrode means and suddenly apply a high potential across said electrode means, which potential thereafter decreases rapidly due to the discharge of said condenser and the extinguishing of the spark across said gap.

Also, in patent application Serial No. 578,830, it is proposed to connect a plurality of sections or parts of an electrical fluid treating installation to a common source of potential impulses of the type above described, and to provide means for successively and separately connecting the respective sections or parts of such installation to said potential impulse source.

A principal object of the present invention is to provide an apparatus in which the above-described advantages are obtained at a minimum cost of installation and operation, and with increased efficiency.

A further object of the invention is to provide advantageous means for supplying intermittent high potential impulses of extremely short duration to a plurality of electrical treating units or a plurality of sections or portions of an electrical treating apparatus, in which the electrical energy for all of said units, sections or portions, is obtained from a common source of high potential unidirectional current.

According to this invention, the electrical circuit connecting the common source of high potential unidirectional current to the electrical treating apparatus comprises a plurality of branch circuits leading from said source to the several units, sections or portions of such apparatus, and a separate impulse producing means, such as a condenser and spark gap, connected to each of said branch circuits. Furthermore, means are preferably provided for controlling the operation of the respective impulse producing means so as to cause the potential impulses to be delivered to the respective units, sections or portions at different times.

The accompanying drawing illustrates apparatus in accordance with this invention and referring thereto:

Fig. 1 is a diagrammatic representation of one form of such apparatus.

Fig. 2 is a similar view of another form of apparatus.

Fig. 3 is a similar view of another form of apparatus.

In Fig. 1, S indicates, in general, a source of high potential unidirectional electric current, one side of which is grounded as indicated at 1 and the other side of which is connected through supply line 2 and through branch circuit connections 2a, 2b and 2c to a plurality of electrical treating units A, B and C. Said electrical treating units may consist of any devices adapted to

subject a fluid to the action of a high potential electrical discharge for the purpose of separating suspended particles therefrom or for other purpose, such as electrical precipitators, electrical emulsion-breaking devices etc. Said units may also consist of different portions or sections of an electrical treating apparatus.

The supply source S is shown as comprising a transformer 11 for stepping up the supply voltage to the desired value, and rectifying means 12 connected to the secondary winding of said transformer. Said rectifying means may, for example, comprise two thermionic rectifiers, whose filaments are energized through suitable transformers 14 and 15. The respective rectifiers are connected by wires 16 and 17 to the opposite terminals of said transformer secondary winding, while the mid-point of said winding is grounded at 1. The output terminals of said rectifiers are connected by wires 18 and 19 to the supply line 2. Said rectifiers are so connected as to permit electric current to pass from the transformer to the supply line 2 in one direction only. For example, when used in connection with electrical precipitation apparatus, said rectifiers are preferably so connected as to permit passage of electric current from each transformer terminal during only the alternate half waves when said terminal is at negative potential with respect to ground.

Each of the electrical precipitators or other treating units A, B and C is shown as comprising a high tension electrode 35, an opposing electrode member 36 electrically grounded at 37, and inlet and outlet connections 38 and 39 by means of which the fluid to be treated may be passed between said electrodes 35 and 36. Suitable insulation 41 is provided between electrode members 35 and 36.

Rotary spark gap devices 3*a*, 3*b* and 3*c* are connected between the branch conductors 2*a*, 2*b* and 2*c* and the corresponding treating units. Each of said spark gap devices is shown as provided with four insulating arms 22, mounted on a rotating shaft 23 driven at any suitable speed, and each of said arms is provided at its extremity with an electrode element 24, preferably of spherical or rounded shape. Said electrode elements are connected in two diametrically opposed pairs by means of conductors 25 and 26. Diametrically opposite to one another with respect to said spark gap devices and in sparking relation with respect to the elctrode elements 24, are provided fixed electrode elements 27 and 28, the former being connected to the corresponding branch conductors 2*a*, 2*b* and 2*c*, and the latter being connected by conductors 4*a*, 4*b* and 4*c* to the high tension electrode element 35 of the corresponding electrical treating unit. At a point approximately midway between the electrode elements 27 and 28 there is provided another electrode 29 connected by wire 31 to an impulse condenser or capacity means 5*a*, 5*b* or 5*c*, the other side of which is grounded as indicated at 33.

The contact members 24 of each rotary spark gap device are preferably off-set angularly with respect to those of the other devices, so as to cause said devices to operate at different times, as hereinafter described. In the particular construction shown, said contact members in the respective spark gap devices are set at an angle of 60° with respect to one another, so that said devices will operate successively at equal intervals.

A charging condenser 42 is preferably connected to the power supply circuit between the source S and the rotary spark gap devices above described, one side of said condenser being connected to the main supply line 2 and the other side thereof being grounded as indicated at 43. A resistance or inductance 34 is preferably provided in line 2 between condenser 42 and the rotary spark gap devices, and another resistance or inductance 44 may be inserted between rectifier means 12 and condenser 42.

In the operation of the above-described apparatus, a unidirectional high potential is supplied by source S to the supply line 2. When the rotary spark gap devices are in the position shown, with the electrode elements 27 and 29 of device 3*a* in sparking relation with respect to one of the diametrically opposed pairs of electrode elements 24, the corresponding impulse condenser 5*a* is charged by energy received from the supply source S and also from the charging condenser 42. As this spark gap device 3*a* passes somewhat beyond this position the spark is extinguished at the gaps between electrode elements 27—24 and 24—25, and when the commutator has rotated through 90° the other pair of electrode elements 24 is brought into position of sparking relation with the fixed electrodes 28 and 29. The impulse condenser 5*a* then discharges through conductor 4*a* to the high tension electrode member 35 of the treating unit A, causing a high potential impulse of extremely steep wave front and short duration to be applied between said electrode 35 and the opposing electrode 36.

This results in a uniform and intense electrical discharge from the high tension electrode. For example, in the case of electrical precipitation apparatus, an intense negative corona is thus produced over the entire surface of the electrode 35, and the ions thus produced cause suspended particles contained in the gas to become electrically charged and to be precipitated toward the opposing electrode 36. However, before any disruptive discharge or arcing can occur, the electrode elements 24 of the spark gap device pass out of sparking relation with the fixed electrodes 28 and 29, so that the supply of electrical energy to the electrodes of the treating unit ceases and the potential between said electrodes falls below the discharge potential.

It will be evident that each impulse condenser, such as 5*a*, is successively charged from the supply line 2 and discharged through the corresponding electrical treating unit, such as A, twice during each revolution of the corresponding spark gap device, such as 3*a*, and that said impulse condenser and electrical treating unit are entirely disconnected from the power supply source during the time of discharge of such condenser, so that the sharp potential impulse created upon such discharge is prevented from reaching the power supply means.

The operations of the respective spark gap devices 3*a*, 3*b* and 3*c*, follow one another at intervals of 60° in the rotation thereof, so that energy is delivered from the supply source S and charging condenser 42, through line 2, successively to the respective impulse condensers 5*a*, 5*b* and 5*c*, and the energy thus stored in said impulse condensers is successively discharged through the corresponding treating units A, B and C.

The charging condenser 42 serves to store electrical energy from the source S during the short time intervals when none of the impulse condensers 5*a* etc. are in connection with the supply

line 2 and to discharge this energy to said impulse condensers when they are so connected.

The resistances or impedances 34 and 44 serve to prevent high frequency transients during the charging of any one of the impulse condensers 5*a* etc., and to prevent any oscillations which may occur in this part of the circuit from reaching the power supply source S.

It will thus be seen that the conductors 2*a* and 4*a*, 2*b* and 4*b*, and 2*c* and 4*c* define a plurality of branch circuits leading from the common source S to the respective treating units A, B and C. In each of these branch circuits, means are connected for creating sharp unidirectional potential impulses of extremely short duration and delivering such impulses to the respective treating units, such means comprising the respective impulse condensers and spark gaps, such as 5*a* and 3*a*. These impulses are substantially confined, in each case, to a local impulse circuit including the condenser, spark gap, and treating unit, and high frequency oscillations or transients are substantially suppressed in all other parts of the circuit by the resistances or inductances 34 and 44. Furthermore, the operations of the respective impulse producing means are so controlled as to cause the impulses to occur at different times in the respective impulse circuits, this control being accomplished by the angular offsetting of the electrodes of the respective rotary spark gap devices.

In the apparatus shown in Fig. 2, the rectifying means 12' of the power supply source S' is shown as a mechanical rectifier, comprising a disc 46 of insulating material adapted to be rotated in synchronism with the alternating current supplied to transformer 11', opposing contact segments 47 mounted on said disc, two diametrically opposed fixed contact segments 48 and 49 connected to the respective terminals of the secondary winding of said transformer, and two additional diametrically opposed fixed contact segments 51 and 52 disposed between the segments 48 and 49. The contact segment 51 is electrically grounded at 1', while the segment 52 is connected to supply line 2'. The rotation of disc 46 and contact segments 47 serves to reverse the connections between the associated fixed contacts at each half cycle of the alternating current supplied to transformer 11', and thus maintain a unidirectional high potential between supply line 2' and ground.

Charging condenser 42' is connected as before, between said supply line 2' and a ground connection 43'. A rotary distributing switch 54 serves to successively connect supply line 2' to the respective branch conductors 2*a*', 2*b*', and 2*c*'. Said distributing switch is shown as comprising a rotating contact arm 55, adapted to be rotated at any suitable speed and provided with a contact member 56 making contact successively with contact segments 57*a*, 57*b* and 57*c*.

The several branch conductors 2*a*', 2*b*' and 2*c*' are connected to one electrode of the corresponding spark gaps 3*a*', 3*b*' and 3*c*', while the other side of said gaps is connected to the high tension electrode member 35' of the corresponding treating units A', B' and C'. Each of said treating units is provided, as before, with opposing electrode means 36', which is electrically grounded at 37'. Each of said branch conductors is also connected to an impulse condenser 5*a*', 5*b*' or 5*c*', the other side of which is electrically grounded at 33'.

Resistances or inductances 34' and 44' may also be provided, either in the positions shown in Fig. 2 or in the same positions as shown in Fig. 1, for suppressing high frequency oscillations in all parts of the circuit outside of the impulse circuits of the respective treating units, said impulse circuits including the respective impulse condensers, spark gaps and treating units, such as 5*a*', 3*a*' and A'.

In the operation of this form of apparatus, the supply line 2' is maintained, as before, at a unidirectional high potential with respect to ground, by operation of rectifier 12', and charging condenser 42' is also kept charged at substantially this potential. The distributing switch 54 causes the supply line 2' to be successively connected to the respective impulse condensers 5*a*', 5*b*' and 5*c*'. When any one of these condensers, such as 5*a*', is so connected, it is charged until the voltage across the corresponding spark gap such as 3*a*' becomes sufficient to cause a break-down of said gap, whereupon said condenser discharges through said spark gap and the corresponding treating unit such as A'. The dimensions of the spark gaps and impulse potentials may be so proportioned with respect to the size of the treater units and the characteristics of the power supply, as to cause any desired frequency of repetition of the impulses thus delivered to the treater unit. Thus, each of the spark gaps, such as 3*a*', may be caused to break down once or any desired number of times during each period when said gap is connected to the power supply source through switch 54. Furthermore, the total period during which said switch establishes connection to each spark gap and its associated impulse condenser may be determined by regulating the speed of rotation of contact arm 55. Also, the circuit may be so adjusted as to cause breakdown of one or the other of the several spark gaps to occur once or more than once during each rectified half-wave voltage impulse delivered by the rectifier 12', or at an interval greater than the period of each such half-wave impulse, in which case several of such half-wave voltage impulses are required to charge each impulse condenser, such as 5*a*', to a sufficient voltage to cause such break-down of the associated spark gap, such as 3*a*'.

Fig. 3 illustrates still another modification of the invention. In this case, the supply line 2'' is again charged at unidirectional high potential by means of transformer 11'' and rectifier 12''. The rectifier is shown as comprising a single thermionic rectifier connected between one terminal of the secondary winding of transformer 11'' and the supply line 2'', while the other terminal of said transformer winding is grounded as indicated at 1''. However, it will be understood that either of the above described forms of rectifying means may also be used in connection with this form of the invention. Branch conductors 2*a*'', 2*b*'' and 2*c*'' lead from the supply line 2'' to the respective spark gaps 3*a*'', 3*b*'' and 3*c*'', while the other side of said gaps is connected to the corresponding treating units A'', B'' and C''. Impulse condensers 5*a*'', 5*b*'' and 5*c*'' are also connected to the respective branch conductors 2*a*'' etc., and are connected at the other side to ground, as indicated at 33''. A resistance or inductance 34'' is also provided in each of said branch conductors, at a point in advance of the connection of the impulse condenser thereto, so as to prevent any high frequency oscillations which may occur at the time

of break-down of any one of the spark gaps from reaching the supply line 2'' and the power supply source.

In this case also, a charging condenser 42'' is preferably connected to the supply line 2'', the other side of said condenser being grounded as indicated at 43''.

The operation of this form of the invention is substantially the same as described above in connection with Fig. 2, with the exception that all of the impulse condensers and spark gaps are at all times electrically connected to the source of electric power. However, by making the condensers 5a'', 5b'' and 5c'' of different capacities, or by making the spark gaps 3a'', 3b'' and 3c'' of different lengths, the break-down of the respective gaps will be caused to take place at different time intervals, due to the difference in time required to charge the respective condensers sufficiently to cause break-down of the corresponding gaps. The resistances or inductances 34'' are preferably of sufficient magnitude to prevent disturbance in any one of the impulse circuits at the time of break-down and discharge in any one of the other impulse circuits. If desired, these resistances or inductances may also be made of different magnitudes in the respective branch circuits, so as to provide the desired difference in time of discharge in the corresponding impulse circuits.

It will be seen that, in each of the circuits above-described the high tension electrode means of each treating unit is free from connection to the source of high potential unidirectional current, other than through the spark gap means associated with that particular unit, and since an electrical connection across the spark gap means is established only at the time of break-down thereof, the electrical energy is delivered to each treating unit wholly in the form of the high potential impulses of steep wave front and short duration, which occur at the time of such break-down.

I claim:

1. In combination with an apparatus for electrical treatment of fluids comprising a plurality of electrical treating units, an energizing circuit comprising a common source of unidirectional high voltage, a plurality of branch circuits leading from said common source to the respective treating units, electrical capacity means connected to said circuit, and separate spark gap means connected in each of said branch circuits for causing sharp unidirectional potential impulses of extremely short duration to be delivered at different times through the respective spark gap means to the respective treating units.

2. In combination with an apparatus for electrical treatment of fluids comprising a plurality of electrical treating units, an energizing circuit comprising a common source of unidirectional high voltage, a plurality of branch circuits leading from one side of said common source to one side of the respective treating units, a separate capacity means connected to each of said branch circuits to receive energy from said common source, and a spark gap means connected in each of said branch circuits between said capacity means and said one side of the corresponding treating unit so as to deliver unidirectional potential impulses of extremely short duration to said treating unit upon break-down of said spark gap means, due to the discharge of said capacity means across said gap said one side of each of said treating units being free from connection to said source other than through the corresponding spark gap means, and the other side of all of said treating units being connected to the other side of said source.

3. In combination with an apparatus for electrical treatment of fluids comprising a plurality of electrical treating units, an energizing circuit comprising a common source of high potential unidirectional current, a plurality of branch circuits leading from said common source to the respective treating units, separate capacity means connected to each of said branch circuits to receive energy from said common source, separate spark gap means connected in each of said branch circuits between the corresponding capacity means and the corresponding treating unit so as to deliver unidirectional potential impulses of extremely short duration to said treating unit upon break-down of said spark gap means, by discharge of said capacity means across said spark gap, and means included in said energizing circuit for controlling the time of operation of the respective spark gap means, so as to cause break-down of the respective spark gap means and delivery of impulses to the corresponding treating units to occur at different times.

4. In combination with an apparatus for an electrical treatment of fluids comprising a plurality of electrical treating units, an energizing circuit comprising a common source of high potential unidirectional current, a plurality of branch circuits leading from said common source to the respective treating units, separate capacity means associated with each of said branch circuits, and rotary spark gap means included in each of said branch circuits and operable when in one position to provide spark gap connection of the associated capacity means to said common source and when in another position to provide spark gap connection from said capacity means to the corresponding treating unit, the rotary spark gap means for the respective treating units being angularly offset with respect to one another so as to cause such spark gap connections to be established at different times in the respective branch circuits.

5. In combination with an apparatus for electrical treatment of fluids comprising a plurality of electrical treating units, an energizing circuit comprising a common source of high potential unidirectional current, a plurality of branch circuits connected to the respective treating units, separate capacity means connected to each of said branch circuits, separate spark gap means connected in each of said branch circuits between said capacity means and the corresponding treating unit so as to deliver unidirectional potential impulses of extremely short duration to said treating unit upon break-down of said spark gap means, and switching means connected between said common source and the respective branch circuits and operable to successively establish connection from said common source to the respective branch circuits.

6. In combination with an apparatus for electrical treatment of fluids comprising a plurality of electrical treating units, an energizing circuit comprising a common source of unidirectional high voltage, a plurality of branch circuits leading from said common source to the respective treating units, impedance means in each of said branch circuits, separate capacity means connected to each of said branch circuits to receive energy from said common source, separate spark

gap means connected in each of said branch circuits between said capacity means and the corresponding treating unit so as to deliver unidirectional potential impulses of extremely short duration to said treating unit upon break-down of said spark gap means, by discharge of the corresponding capacity means across said spark gap, the relation between the impedance means, capacity means, and the length of the spark gap means being different in the respective branch circuits, so as to cause break-down of the respective spark gap means and delivery of impulses to the corresponding treating units to occur at different times.

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