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METHOD AND APPARATUS FOR ELECTRICAL TREATMENT OF GASES OR LIQUIDS

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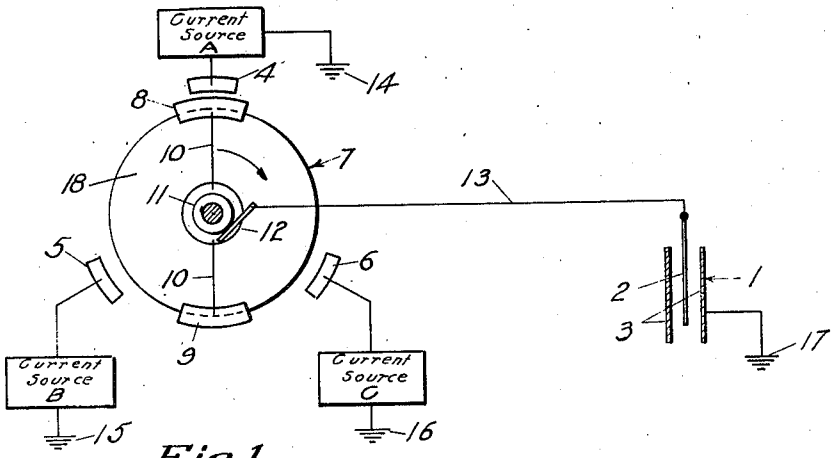


Fig. 1

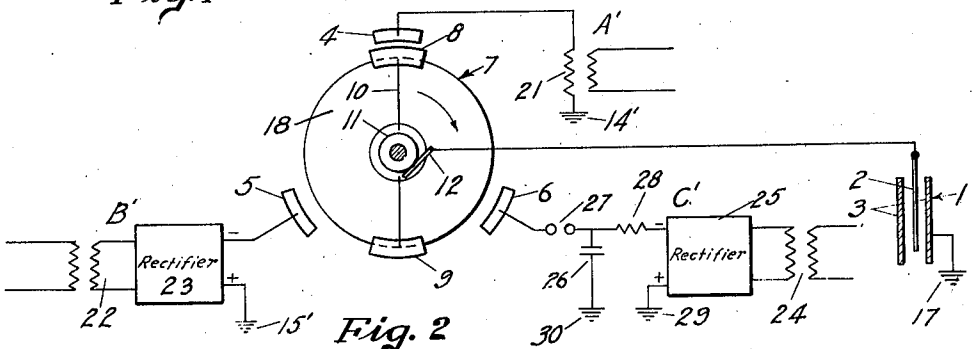


Fig. 2

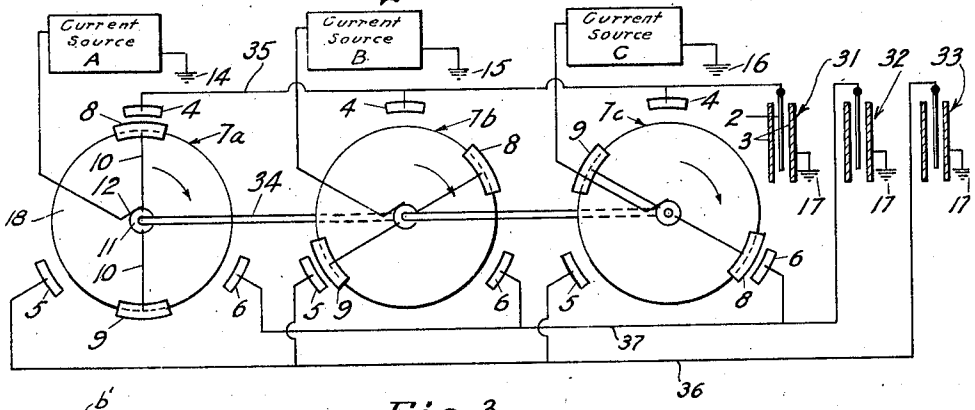


Fig. 3

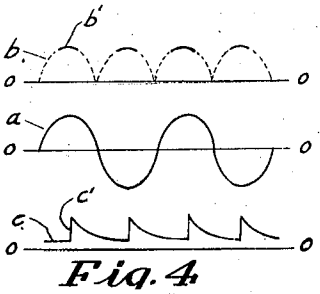


Fig. 4

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METHOD AND APPARATUS FOR ELECTRICAL TREATMENT OF GASES OR LIQUIDS

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7 Claims. (Cl. 183—7)

This invention relates to methods and apparatus for the electrical treatment of fluids, and is applicable either to the electrical treatment of a gas such as in the electrical precipitation of suspended solid or liquid particles from gas, or to the electrical treatment of a liquid such as in the electrical separation of emulsions.

In the electrical treatment of gases or liquids having relatively high resistance or dielectric properties, with high tension electric current or voltage, as for example in the electrical precipitation of suspended particles from gases or gas mixtures or in the electrical separation of emulsions, particularly in the dehydration of petroleum emulsions, it has been found advantageous in certain cases to subject the fluid medium (gas or liquid) in the electrical treatment chamber to successive treatments with different types of electric current, in order to increase the efficiency of the treatment. In such cases, it has been found particularly advantageous to successively and periodically subject the fluid medium to the action of electric currents or voltages of widely differing characteristics, particularly with respect to the manner of variation of current or voltage with respect to time. For example, it may be found advantageous to subject the fluid successively and separately to unidirectional current (including either continuous or intermittent direct current or rectified alternating current), to alternating current, and to current applied in the form of intermittent sharp impulses of relatively short duration such as may be produced for example by the intermittent discharge of energy from a condenser through a spark gap or the like.

The principal object of this invention, therefore, is to provide an increased efficiency of operation in the electrical treatment of fluids, by successively and separately subjecting the fluid within a single treating chamber or apparatus to treatment with different types of electric current or voltage, and particularly to treatment with types of electric current which differ from one another in the manner of variation of current or voltage with respect to time.

A further object of the invention is to provide a simple apparatus for successively and separately applying the several different types of electric current or voltage to the electrode means of the electrical treating apparatus, such apparatus preferably comprising a plurality of contact members connected to the plurality of sources of different types of electric current, and movable switching means operable to successively and separately establish connection between the respective contact members and the electrode means of the treating apparatus, at regular intervals.

The accompanying drawing illustrates apparatus embodying this invention, and referring thereto:

Figs. 1, 2 and 3 are diagrammatic representations of such apparatus; and

Fig. 4 is a graphic representation of different types of electric current which may be employed.

In Figs. 1 and 2 an electrical treating apparatus is indicated diagrammatically at 1, consisting for example of an electrical precipitator for removing suspended particles from gases or an electrical apparatus for separating emulsions. Said apparatus is shown as comprising opposing electrode means 2 and 3 between which the fluid is passed and subjected to the action of the electric field between said electrodes. For example, in the case of electrical precipitation, the electrode means 2 may constitute a discharge electrode member such as a wire or rod of small diameter, and the electrode means 3 may constitute a collecting electrode or electrodes of relatively extended surface, such as plates or pipes, in the usual manner of such apparatus.

I have shown three separate sources of electric current, indicated at A, B and C in Fig. 1 and at A', B' and C' in Fig. 2. Switching means 7 is provided for successively connecting said sources of current to the electrical treating apparatus, and said switching means may comprise fixed contact members 4, 5 and 6 connected respectively to the current sources A, B and C or A', B' and C', and a rotating disc 18 formed of suitable insulating material and rotated at suitable speed in any desired manner, for example by means of an electric motor connected thereto in such manner as to provide the desired speed of rotation. Said disc is provided with two diametrically opposed contact members 8 and 9 at the periphery thereof, electrically connected as by conductor 10 to a contact ring 11 engaged by a brush 12 which is connected by conductor 13 to one of the opposing electrode means, such as electrode means 2, of the treating apparatus.

In Fig. 1, A, B and C may represent sources of any desired different types of electric current or voltage, and particularly, types of electric current which differ from one another in the manner of variation of current or voltage with respect to time. Said current sources are, as above stated, connected respectively at one side to the fixed contact members 4, 5 and 6, and are grounded at the other side as indicated at

14, 15 and 16, and the collecting electrodes 3 are also grounded as at 17 so as to complete the electric circuit through the respective current sources.

With disc 18 in the position shown, the rotating contact member 8 is in effective contacting relation (by spark contact) with the fixed contact 4, so that current will pass from A through said contacts and through contact ring 11, brush 12 and conductor 13, to the electrode means 2, thus subjecting the fluid between the electrodes to the action of current from A. As the disc 18 is rotated in a clockwise direction, as indicated by the arrow, contact will be broken between contact members 8 and 4, and at this instant or shortly thereafter contact will be established between contact members 9 and 5, permitting current to flow from source B to the electrical treating apparatus. In the continued rotation of said disc, contact will be broken between contact members 9 and 5 and established between contact members 8 and 6, thus permitting current to flow from source C to the treating apparatus. Thus, the respective current sources A, B and C are successively connected, at regular intervals and for definite periods of time, to the electrode means of the treating apparatus, and the fluid therein is successively subjected to the different types of electric current. It will be understood that the gaseous or liquid fluid to be subjected to treatment is continually passed through the treating apparatus 1 and between the electrode means 2 and 3. The disc 18 may be rotated at any suitable speed so as to provide any desired duration of treatment with each type of electric current, and, if desired, the contact members 4, 5 and 6 may be made of different lengths, so as to provide different durations of treatment with the respective types of current. Also, by varying the angular extent of the fixed and rotating contact members, the duration of contact with each current source may be varied so that, if desired, intervals of no current supply may be provided between the periods of connection to the several current sources.

In the specific example shown in Fig. 2, A' represents a source of alternating current, such as transformer 21. One side of the secondary winding of said transformer is connected to contact member 4 and the other side is grounded as at 14'. B' is shown as a source of unidirectional current and, more particularly, of rectified alternating current, comprising a transformer 22 and a rectifier 23 of any suitable type, such as a mechanical, thermionic, or copper oxide rectifier. The input terminals of said rectifier are connected to the secondary winding of transformer 22, while the output or rectified current terminals thereof are connected respectively to contact member 5 and to ground as indicated at 15'.

C' represents a source of unidirectional current of the intermittent impulse type, comprising, for example, a transformer 24, a suitable high voltage rectifier 25, condenser 26 and spark gap 27. One of the rectified current terminals of rectifier 25 is connected through impedance means 28 (consisting of inductance or resistance or both) to condenser 26 and spark gap 27, while the other of said terminals is grounded as indicated at 29. The other side of condenser 26 is also grounded as at 30, while the other side of spark gap 27 is connected to the fixed contact member 6. In the operation of this form of current supply means, the unidirectional energy from rectifier 25 is stored in condenser 26 until said condenser is charged to a sufficient voltage to cause a breakdown to occur at spark gap 27, whereupon the stored energy is delivered from the condenser through said spark gap. This energy is therefore discharged in the form of a sharp unidirectional impulse of extremely steep wave front and short duration. Due to the sudden discharge of energy from condenser 26, the voltage falls until the spark is extinguished at gap 27, and the operation is then repeated, thus providing a series of sharp impulses with relatively long intervals therebetween. Since condenser 26 is charged by means of unidirectional current, it is apparent that the intermittent discharges occasioned by the breakdown of gap 27 will also be essentially unidirectional; however, I may in some cases omit the rectifier 25 and charge said condenser by means of alternating current, in which case intermittent discharges of alternating or opposite polarities may be obtained. The function of the impedance means 28 is to prevent high frequency oscillations resulting from the sudden discharges occurring in the circuit including the condenser and spark gap, from reaching the current supply means including transformer 24 and rectifier 25. It will be understood that the above mentioned intermittent discharges take place only during those periods in which the fixed contact member 6 is in effective contact with one of the rotating contact members 8 or 9 and that, during the intervals between these periods of contact, the circuit will operate only to charge condenser 26 to the full voltage delivered by the transformer and rectifier.

The operation of the system shown in Fig. 2 is similar to that shown in Fig. 1, the electrode means 2 and 3 being periodically and successively energized by means of alternating current from source A', rectified alternating current from source B', and intermittent unidirectional impulse current from source C'. The wave forms of the voltage, for these three different types of electric current, are illustrated graphically in Fig. 3, in which time is plotted horizontally and voltage vertically. The horizontal lines o—o represent zero voltage; the sine wave curve indicated at *a* represents the alternating voltage delivered by current source A'; the curve *b* represents the rectified voltage delivered by current source B', the solid portions *b'* of this curve indicating the portions of the peaks of the successive half-waves which are picked off and delivered to the fixed contact member 5 in case the rectifier 23 is of the ordinary type of mechanical rectifying apparatus such as commonly employed in connection with electrical precipitation of suspended particles from gases; and the curve *c* represents the voltage produced by the impulse type current source C', in which the voltage rises sharply at the time of each discharge of the condenser 26, as indicated at *c'*, and then falls to a relatively low value, providing a succession of intermittent high potential impulses of steep wave front and sharp peak. The alternating and rectified voltages *a* and *b* may be of any desired frequency and, in the case of the intermittent impulse voltage, the constants of the circuit may be so adjusted as to provide any desired interval between the successive impulses *c'*. Furthermore, the speed of rotation of the distributing disc 18 may be such as to provide for any desired duration of contact with the respective fixed contact members 4, 5 and 6, so that any desired number of alternating current waves, rectified half waves, or intermittent sharp impulses

such as shown at c', may be delivered to the electrode means of the treating apparatus 1 during each of these periods.

In Fig. 3 I have shown an electrical treating apparatus, such as an electrical precipitator or an electrical de-emulsifying apparatus, comprising three electrical treating units or sections indicated at 31, 32 and 33, each comprising opposing electrode means 2 and 3. Separate rotary distributing switches 7a, 7b and 7c are provided for the respective current sources A, B and C. Each of these switches is similar to that shown in Fig. 1, with the exception that the rotating contact members 8 and 9 of each switch are connected to the corresponding current source, as by means of conductors 10, contact ring 11 and brush 12, while the fixed contact members 4, 5 and 6 of all of the switches are connected respectively, as by conductors 35, 36 and 37, to the electrode means 2 of the respective treating units 31, 32 and 33. The rotating contact members 8 and 9 of the respective switches 7a, 7b and 7c are offset 60° from one another, in such manner that the respective current sources are, at any given time, electrically connected to the electrode means of different treating units. Thus, in the position shown, current source A is connected by its distributing switch 7a to the electrode means 2 of the treating unit 31, current source B is connected through its distributing switch 7b to the electrode means 2 of treating unit 33, while current source C is connected by its distributing switch 7c to the electrode means 2 of treating unit 32, and the several switches act to simultaneously shift the connections between the several current sources and the several treating units, so that each current source is successively connected to the respective treating units at different times. Since each half revolution of the distributing switches serves to successively connect each current source successively to the several treating units, it will be seen that this apparatus provides for a more efficient utilization of the several current sources and also enables a plurality of electrical treating units to be energized from one source of each type of electric current employed. The distributing switches 7a, 7b and 7c may be driven in any suitable manner, and I have diagrammatically indicated all of these switches as being mounted upon a common shaft 34 which may be rotated at any desired speed. The fluid to be treated may be passed either in series or in parallel between the electrode means of the respective treating units 31, 32 and 33, or different fluids may be passed through said units for treatment therein.

I claim:

1. An apparatus for electric treatment of fluids comprising: a plurality of electrical treating units each provided with opposing electrode means and with means for passing fluid between said electrode means; a plurality of sources of different types of electric current, the types of electric current produced by the respective current sources differing from one another in the manner of variation of current or voltage with respect to time; and switching means operable to successively and separately connect each of said current sources to the electrode means of each of said treating units, at regular intervals.

2. An apparatus for electrical treatment of fluids comprising an electrical treating apparatus provided with opposing electrode means, a plurality of sources of different types of electric current including a source of intermittent sharp impulse current providing a succession of short unidirectional high potential impulses of steep wave front and sharp peak, and switching means operable to connect successively and separately each of said current sources to said electrode means at regular intervals.

3. An apparatus for electrical treatment of fluids comprising an electrical treating apparatus provided with opposing electrode means, a plurality of sources of different types of electric current including a source of intermittent sharp impulse current providing a succession of short high potential impulses of steep wave front and sharp peak, and a source of unidirectional current, and switching means operable to connect successively and separately each of said current sources to said electrode means at regular intervals.

4. An apparatus for electrical treatment of fluids comprising an electrical treating apparatus provided with opposing electrode means, a plurality of sources of different types of electric current including a source of intermittent sharp impulse current providing a succession of short high potential impulses of steep wave front and sharp peak, and a source of alternating current, and switching means operable to connect successively and separately each of said current sources to said electrode means at regular intervals.

5. A method for electrical treatment of fluids comprising passing a fluid to be treated between opposing electrode means, and successively supplying to said electrode means at regular intervals a plurality of types of electric current including intermittent sharp impulse current supplied as a succession of short unidirectional high potential impulses of steep wave front and sharp peak.

6. A method for electrical treatment of fluids comprising passing a fluid to be treated between opposing electrode means, and successively supplying to said electrode means at regular intervals a plurality of types of electric current including intermittent sharp impulse current and unidirectional current, said intermittent sharp impulse current comprising a succession of short high potential impulses of steep wave front and sharp peak.

7. A method for electrical treatment of fluids comprising passing a fluid to be treated between opposing electrode means, and successively supplying to said electrode means at regular intervals a plurality of types of electric current including intermittent sharp impulse current and alternating current, said intermittent sharp impulse current comprising a succession of short high potential impulses of steep wave front and sharp peak.

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