

Oct. 8, 1935.

H. A. WINTERMUTE

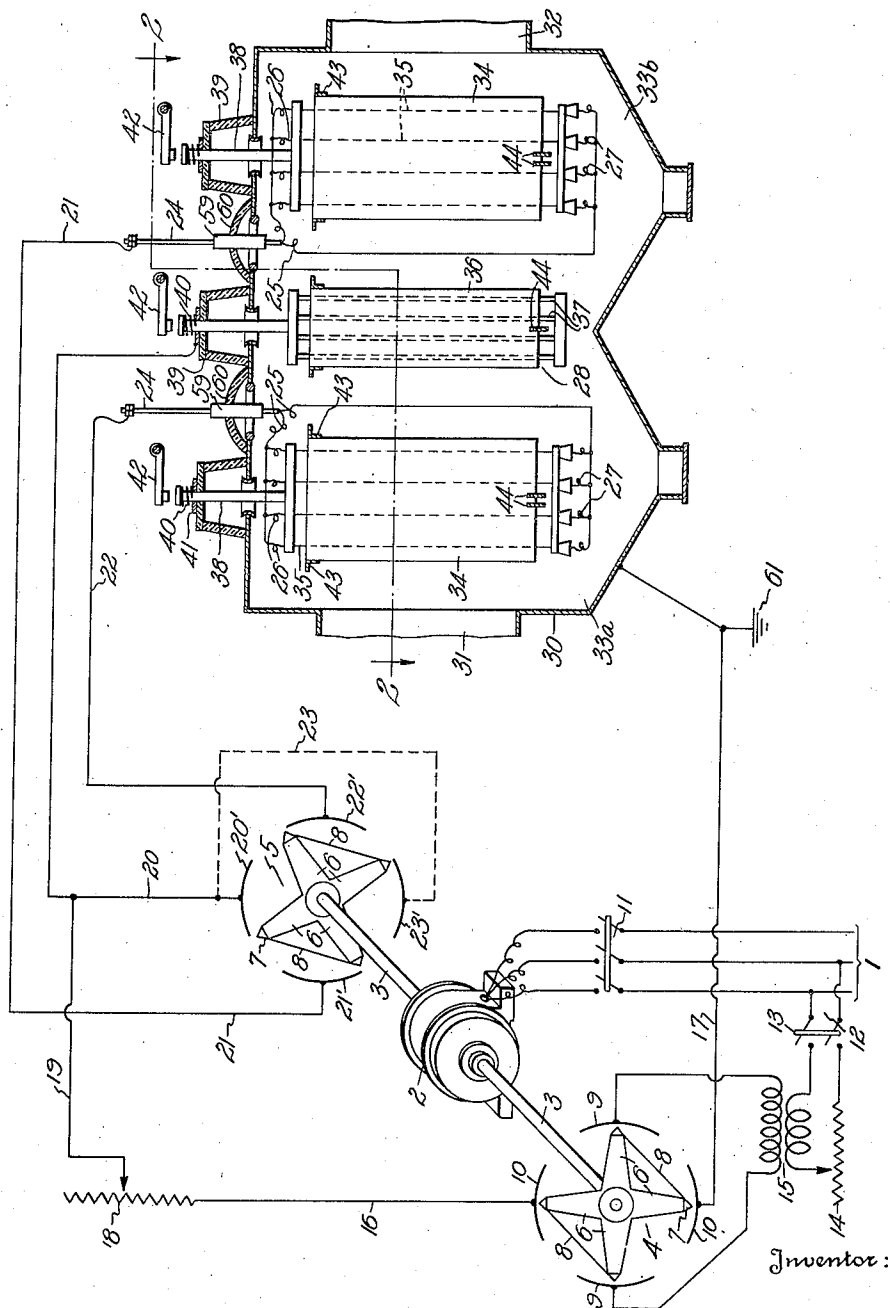
2,016,531

ELECTRICAL TREATMENT OF FLUIDS

Filed May 8, 1934

3 Sheets-Sheet 1

Fig. 1.



Oct. 8, 1935.

H. A. WINTERMUTE

2,016,531

ELECTRICAL TREATMENT OF FLUIDS

Filed May 8, 1934

3 Sheets-Sheet 2

Fig. 2.

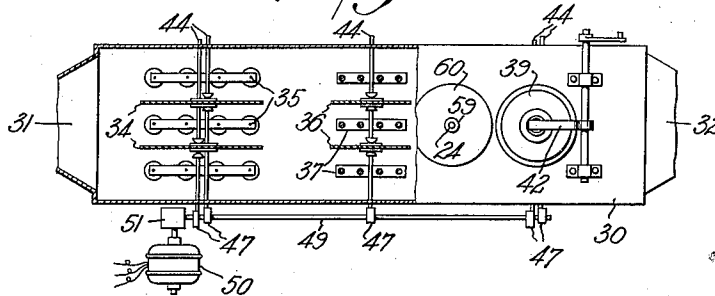


Fig. 3.

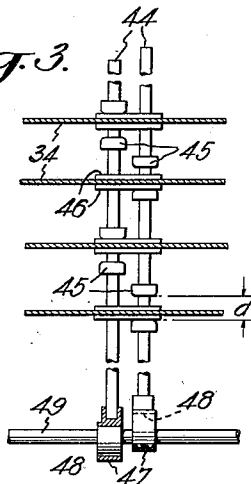


Fig. 4.

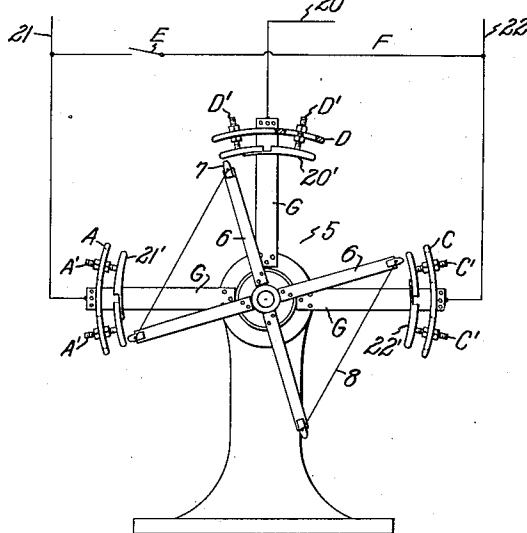
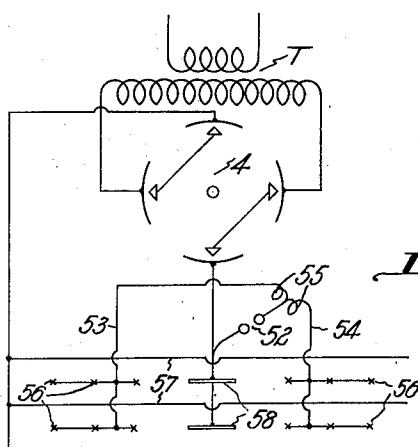


Fig. 5.



Inventor:
Harry A. Wintermute

Potter, Pierce & Scheffler

By

Attorneys.

Oct. 8, 1935.

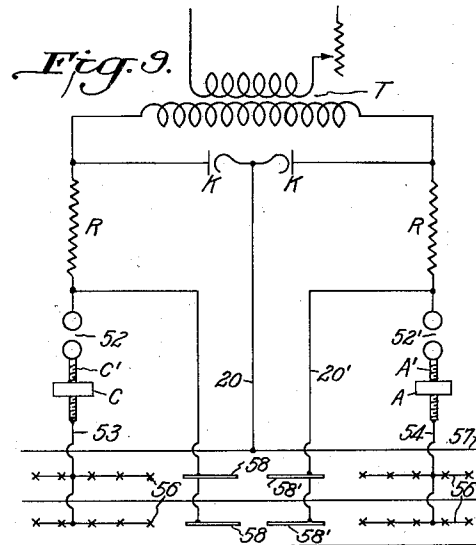
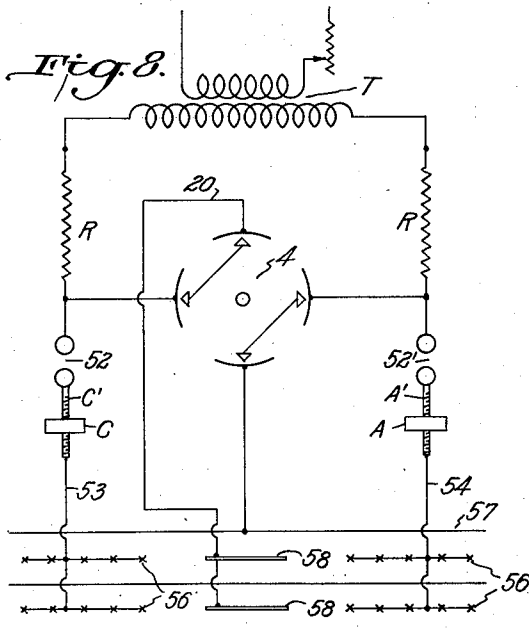
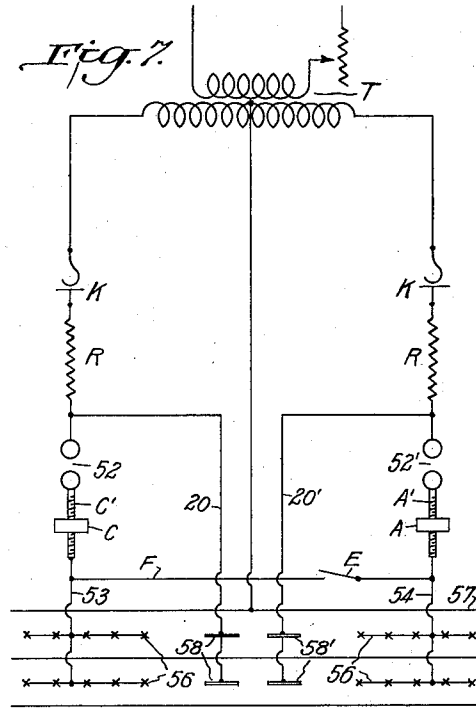
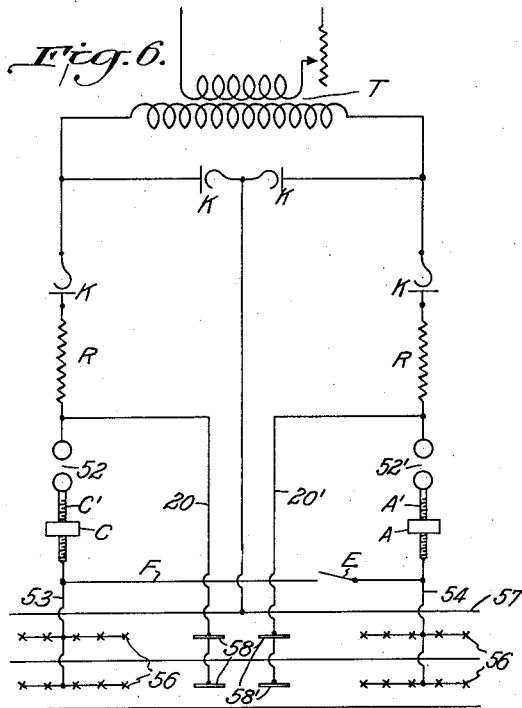
H. A. WINTERMUTE

2,016,531

ELECTRICAL TREATMENT OF FLUIDS

Filed May 8, 1934

3 Sheets-Sheet 3



Inventor:

Harry A. Wintermute

By *Potter, Pierce & Scheffler*
Attorneys.

UNITED STATES PATENT OFFICE

2,016,531

ELECTRICAL TREATMENT OF FLUIDS

Harry A. Wintermute, Plainfield, N. J., assignor
to Research Corporation, New York, N. Y., a
corporation of New York

Application May 8, 1934, Serial No. 724,579

17 Claims. (Cl. 183—7)

This invention relates to a new and improved electrical circuit for operating fluid treaters such as electrical precipitators of the Cottrell type which are used in removing suspended particles from gases. It further relates to means for maintaining the circuit in satisfactory operating condition.

A principal object of the invention is to provide means which receive current from a high tension alternating supply source, which rectify the current so that all half wave impulses can be impressed upon a fluid treating circuit at the same polarity, and which bring about changes in the characteristics, especially as regards frequency, wave shape and duration, of the impulses or energization periods so that the benefits of such changes and the control thereof can be realized in the treatment of fluids.

The invention is more particularly directed to the provision of means for electrically treating a fluid whereby the fluid is subjected successively to electrical impulses of different characteristics; that is, the means provide the treating circuit at one instant with an impulse or energization period possessing certain characteristics and follows this, in rotation or in alternation or successively, with impulses possessing different characteristics.

Another object is to provide a high tension electrical circuit for the energization of a plurality of fluid treater units whereby one of the units can be energized from the circuit with impulses of certain characteristics and another unit can be energized from the same circuit with impulses possessing different characteristics.

Electrical precipitators of the Cottrell type comprise a casing with inlet and outlet for the gases to be treated and two groups of opposing electrodes within the casing which are insulated from each other. In operation, the opposing electrodes are maintained at a high potential difference while the gases to be treated are passed through the strong electric fields thus created. It is common practice to have the electrodes of one group of relatively flat contour, while the opposing electrodes are wires or chains which are insulated from the flat electrodes and maintained at high potential difference from them. The flat electrodes are termed collecting electrodes because most of the suspended material removed from the gases collects upon them. The wire electrodes, or other electrodes of small cross section, are called discharge electrodes because the electric field in their immediate vicinity is very intense and "corona discharges" emanate from

their surface. The gases are subjected to electronic bombardment as they pass through the strong electric fields and become ionized. The free electrons and ions moving under the force of the electric fields become attached to, and are instrumental in removing, the suspended particles in the gases.

The manner in which the objects of the invention can be realized will be illustrated with the accompanying drawings, in which:

Fig. 1 shows more or less diagrammatically the electric circuit including a treater in sectional elevation;

Fig. 2 shows a plan partly in section of the treater shown in Fig. 1;

Fig. 3 is a fragmentary view of a portion of the treater shown in Figs. 1 and 2;

Fig. 4 is a detailed view of an adjustable synchronous switch;

Fig. 5 is a diagram showing certain alternative arrangements of the connections shown in Fig. 1; and

Figs. 6, 7, 8 and 9 are diagrams showing other arrangements embodying the principles of the invention.

In Fig. 1 the low voltage supply circuit designated by numeral 1 is shown as a three phase circuit, although two phase and even single phase can be used. The low voltage circuit 1, controlled by switch 11, energizes synchronous motor 2 which is connected by shaft 3 to mechanical rectifying switch 4 and distributing switch 5. Also energized from the low voltage circuit is transformer 15, which receives current through the single phase branch circuit 12, taken off two wires of circuit 1. Switch 13 and ohmic resistance 14 permit this circuit to be suitably controlled. Rectifying switch 4 is of the familiar type wherein the rotor comprises four insulating arms 6 with metallic tips 7 which support two jumper wires 8. When this rotor is revolved in synchronism with the current supplied through transformer 15, for example, at 1800 R. P. M. for 60 cycle current, all half waves of electrical energy of one polarity alternately impressed upon first one and then the other of shoes 9 are directed to the adjacent shoe 10 which is connected to conductor 16. Similarly all half waves of electrical energy of opposite polarity are directed to the other stationary shoe 10 which is connected to conductor 17. Conductor 16 is connected through conductors 18, 19 and 20 to a condenser 21, to be later described, which temporarily stores the electrical energy which is supplied by transformer 15. Conductor 16 is also connected to switch 5 which revolves in synchro-

nism with the half waves and distributes them to the precipitator units as desired after they are given the desired steep wave front characteristic by the condenser. Switch 5 also functions as a spark gap for making and breaking the circuit in a manner conducive to the building up of impulses having steep wave fronts. The resistance 18, which may include reactance, is for protecting switch 4 and transformer 15 from the high frequency oscillations occurring periodically in conductor 20. It is shown as having a variable ohmic resistance which permits it to be used in controlling the voltage in that part of the circuit including the condenser and precipitator units.

The gas treater is included in casing 30 which has inlet 31 and outlet 32. It includes two units of the usual plate type which are marked 33a and 33b. These comprise collecting electrode plates 34 and discharge electrodes 35. Intermediate the treater units 33a and 33b is a condenser unit 28 which is made up of plates 36 and rods 37. The rods 37 are of appreciable diameter as compared with the wires or edges which make up discharge electrodes 35, because it is desirable that no corona discharges emanate from these rods and permit electrical energy temporarily held by the unit to leak away. Unit 28 functions, therefore, as a condenser with a gaseous dielectric and in the present circuit it is used for temporarily storing the electric impulses that energize the ionizing electrodes of the treater. It functions also as an electrical precipitator of the non-ionizing type and removes from the gases passing through it those particles which carry free electric charges of appreciable magnitude.

The circuit is completed by means of conductor 17 which connects shoe 10 with casing 30 of the gas treater. The casing is in mechanical and electrical connection with the various collecting electrodes. This side of the circuit is usually grounded as shown at 61.

In the operation of the circuit, a half wave of electrical energy from transformer 15, say of negative polarity, is directed by switch 4 to conductor 16 and reaches unit 28 through conductors 19 and 20. This energy is released when the rotor of switch 5 assumes a position which will permit the passage of current from conductor 20 to conductor 21 through switch shoe 20', jumper 8 and shoe 21'. This impulse rapidly built up (or rebuilt) by the release of the energy stored in condenser 28, through the two air gaps on switch 5 which are included in the circuit between conductors 20 and 21, has a very steep wave front, and when this is impressed upon the electrodes of treater 33b, the gases passing through that treater become highly ionized. A half cycle later when the rotor of switch 5 has revolved 90 mechanical degrees, condenser 28, which in the meanwhile has absorbed another half cycle of electrical energy of negative polarity supplied by transformer 15, will be again discharged and this impulse will pass through shoe 22' and conductor 22 to unit 33a. If the units 33a and 33b are alternately energized as indicated, the result will be a saving in energy, although the precipitating efficiency of the units may be slightly less than if every impulse was sent to each unit. The latter condition may be obtained by inserting a jumper wire 23 between shoe 22' and an added shoe 23'. With this conductor added to the circuit every impulse passing through conductor 16 and temporarily stored up in condenser 28 will be used in energizing both of the units 33a and 33b. The same result may be obtained by inserting a spark gap in place of

switch 5. Fig. 5 shows such a circuit with spark gap 52 taking the place of the rotating gaps of switch 5.

It has been found advisable, in operating the equipment just described and in using the high wave front impulses that result from it, to design the equipment with consideration of the characteristics of this type of impulse. It has been found advantageous to eliminate sharp turns in the conductors as far as possible, and where air insulation has been used it has been increased over common practice for sine wave current to prevent corona losses. It has also been found advantageous to insert choke coils in parallel circuits in order to obtain a better distribution of the energy in the various conductors. The manner of using these choke coils is shown in Fig. 1 where coils 25 slightly check the rush of current as it leaves the inlet conductor 24 and divides in order to energize discharge electrodes 35 from 20 both top and bottom. Mounted near the top of each discharge electrode is a small choke coil 26 which may be of one or more turns, but preferably is a very simple air choke of few turns which is not appreciably affected by dust falling upon it and which retards only high frequency or very steep wave front oscillations. Similar coils are provided at the bottom of the discharge electrodes as shown at 27.

As is well known, the electrical characteristics of electrodes change when they become covered with material removed from the gases. This is particularly true when the material is of a non-conducting nature or is a heterogeneous mixture of particles having different electrical characteristics. It is desirable that the electrodes of the precipitator shown in the figures be kept clean in order that the efficiency of the precipitator be maintained and because certain of the electrodes—those designated as 36 and 37—constitute a condenser which is a vital part of the electric circuit and must be kept free of precipitated material if the condenser is to have a constant capacitance. It is important, therefore, that efficient cleaning means be provided to maintain the electrodes free from the precipitated material. Referring to Fig. 1, the discharge electrodes are suspended from a central vertical support 33 which depends from and passes through an insulating chamber 39 which may be of insulating terra-cotta of considerable mechanical strength. The enlarged upper end of support 38 is mounted on a spring 40 which in turn rests on a substantial plate 41, which may be of metal, on top of chamber 39. A hammer mechanism 42 is periodically raised and dropped to impart blows to the support 38 and this causes a jarring of electrodes 35 which effectively removes any material that may collect upon them. The collecting plates 34 of units 33a and 33b depend from transverse members 43 which are positioned transversely in casing 30 and are supported at the sides of that casing. While these electrodes are adequately supported and spaced by members 43, they are free to vibrate when rapped. Near the lower ends of the electrodes, where movement of the same is more readily possible, transverse rapping means are provided. The rapping means may be at or near the bottom of the electrodes, as shown in Fig. 1, and may consist of stiff members 44 upon which are held rigidly the hammer means 45 shown in Fig. 3. The electrode surfaces, where the hammers 44 strike, are reinforced by stiffening plates 46. The distance "d" between the faces of opposing hammer means is slightly

greater, for example $\frac{1}{4}$ ", than the thickness of a plate 34 with two reinforcing plates 46 upon it. If then a member 44 can be made to rapidly move back and forth transversely of the plates, the plates will receive a jarring which will effectively dislodge deposits of dust and the like that are clinging to it. This movement of members 44 is accomplished by securing them to eccentric straps 47 which in turn ride on eccentrics 48 on revolving shaft 49 which is revolved by motor 50 through reduction gear 51. It has been found beneficial to make the movement of the eccentric slightly greater than the distance between the faces of the hammer members. For example, if member 44 is moved $\frac{3}{8}$ of an inch and if the distance the hammer can move before striking plate 46 is only $\frac{1}{4}$ ", the hammer means will have to move the plate $\frac{1}{8}$ " after striking it. This insures a positive striking and jarring of the plates by the hammer means on rods 44.

When only a few light plates are to be jarred a single member 44 will jar the rods without detrimental effect to the precipitator structure generally, but when the plates are large, especially when there are many of them in parallel across the casing of the precipitator, it has been found that to hit all the plates on one side simultaneously not only requires considerable power but it tends to move the precipitator laterally to a detrimental degree. In the present construction this is avoided by dividing the plates into two approximately equal groups and jarring the groups separately. This is shown in Fig. 3 where one member 44 is jarring half the plates from one side, while another member 44 is jarring the other half of plates from the opposite side. This tends to neutralize the side motion of the plates with the result that the precipitator as a whole receives no lateral motion.

Switch 5 in Fig. 1 can be adjusted angularly on shaft 3 which makes it possible to discharge condenser 28 at the desired instant in the energization cycle, and the shape and spacing of tips 7 can be altered thereby changing the characteristics of the spark gaps between tips 7 and the stationary shoes 20', 21' and 22' of the switch. When jumper 23 is removed the switch can be made to distribute the energy so that two units will receive energy separately, which is an especially useful condition when the units have different electrical characteristics.

Fig. 4 is a detailed showing of an adjustable distributing switch suitable for use at 5 in Fig. 1, and shows means for independently varying the length of the spark gap and the relative position of the contact in each of the energized circuits. The shoes 20', 21' and 22' of the switch are carried by bolts A', C' and D' mounted in slots in the supporting members A, C, and D. The length of the spark gaps may be varied by moving the shoes towards or away from the tips 7 by means of the bolts. It is to be noted that spark gaps of different lengths may be provided at each of the shoes, so that impulses of different characteristics may be applied to successive treater units or successively to the same treater unit according to the electrical circuit used, as was described with reference to Fig. 1.

The relative position of the spark gaps in the cycle may be varied by angularly rotating the shoes along the slots in the supporting members A', C', and D' so that one circuit may be closed at a point of lower voltage during one half wave than the other circuit during the succeeding half wave.

The movable shoes 20', 21' and 22' are advantageously split into two portions which slide over each other, so that the length of the shoes may be varied individually.

It will be seen that this synchronous spark gap switch, makes it possible to supply impulses of widely varying characteristics either to successive circuits or successively to the same circuit. The provision of the connection F, including switch E provides an advantageous means for connecting precipitator discharge elements of one or more units in parallel. This permits the energization of one or more units with impulses of a given duration and intensity during one half wave and with impulses of a different duration and/or intensity during a succeeding half wave. When the switch E is open the electrodes connected to the two circuits operate independently thus permitting one set of electrodes to be energized from one half of the wave with impulses having different characteristics from those applied to the other set of electrodes during the succeeding half wave.

If the top shoe and one of the other shoes are adjusted to contact with the rotor tips normal energization will be provided during one half wave and impulse or steep wave front energization during the succeeding half wave when the discharge takes place across the gap between the third shoe and the rotor tips.

In many installations there is no particular advantage gained through the use of such a distributing switch and an ordinary spark gap can be substituted for it as shown in Fig. 5. In this arrangement of the circuit the members and connections are quite similar to those shown in Fig. 1, except that spark gap 52 replaces rotating switch 5 and conductors 53 and 54 replace conductors 21 and 22, but the characteristics of the circuit are not now so fully under control because the only possibilities in spark control are to change the size and spacing of the terminals of spark gap 52. Choke coils 55 prevent the impulses from rushing undamped down one particular conductor and not supplying energy to the other conductor, a condition which has been found to exist in varying degrees when steep wave front impulses are utilized in circuits of the nature described. The discharge electrodes are indicated as wires in cross-section at 56, and the collecting electrodes 57 are common to all the units. The numeral 58 identifies insulated non-discharging electrodes which are a part of the condenser unit. They are shown in this figure as plate-like members.

Fig. 6 shows a diagram of a system embodying the invention wherein four thermionic rectifiers are utilized to provide impulses of different characteristics during successive half waves or cycles. The system is shown operatively connected with two precipitator units and an intervening condenser unit as in Fig. 5. In the figure T indicates a high voltage transformer connected at each end to the discharge electrodes of one of the units through thermionic rectifier K, resistance R, adjustable spark gap 52 (52') and by means of screw mechanism C, C' (A, A') and conductor 53 (54). The ends of the transformers are likewise connected to the collecting electrodes through thermionic rectifiers, while the circuits to the discharge electrodes are separately connected to the condenser plates 58 (58') between the thermionic rectifier and the spark gap in each circuit.

A direct connection F with high voltage switch E is provided between each circuit.

With both spark gaps open and switch E open, each treater unit will be supplied with steep wave front impulses of independently variable characteristics, in alternate half wave periods. If switch E is closed, both treater units will be energized simultaneously, with impulses of alternating characteristics.

If one of the spark gaps is closed and switch E is open, one of the treater units will be normally energized while the other will be energized with steep wave front impulses in the succeeding half wave periods. If switch E is closed, the treater units will be simultaneously energized normally and with steep wave front impulses in successive half wave periods.

Fig. 7 shows a system of energization utilization, a middle transformer top and two thermionic rectifiers K. The connections between the transformer and the treater units are the same as in Fig. 6, except that instead of connecting the ends of the transformer with the collecting electrodes through thermionic rectifiers, the mid point of the transformers is directly connected with the collecting electrodes. This system may be operated similar to that shown in Fig. 6. However, the potentials available in the system of Fig. 7 will only be half those available in the system of Fig. 6, if all other conditions are the same.

In Fig. 8 is shown a system utilizing a rotary switch 5 for connecting alternate half waves to successive treater units. With this system the different treater units may be energized with impulses of different frequencies (if one of the spark gaps 52, 52' is closed one of the treater units will be normally energized), but does not permit energizing a single treater with successive impulses of different characteristics.

Fig. 9 shows a system having similar operating characteristics to that of Fig. 8, but utilizing two thermionic rectifiers K in place of the rotary switch 4.

The parts of condenser 28, as shown in Fig. 1, are spaced and supported in much the same way as those in units 33a and 33b, but, whereas separate electrical connections are made to the high voltage electrodes in the latter units, as indicated by conductors 24 passing through insulating bushings 59 and insulating plates 60, connection 20 is connected to the mechanical support provided for the insulated members of unit 28. It will also be noted that only one rapping member 44 is shown. When the plates of this unit are small and not many in number, a unidirectional rapping is satisfactory, but in large units the two-way rapping indicated in Fig. 3 has the definite advantages described above.

From a consideration of the construction of the gas treating apparatus and the connections making up the present circuit, it can be seen that definite advantages are involved in making up the condenser as shown and incorporating it within the precipitator casing, although the invention is not limited to such an arrangement as in all of the embodiments described herein condensers of different type may be used. High voltage condensers, especially when they include a gaseous dielectric, require a great deal of space, and because of the necessity of placing a safeguarding structure around such condensers the space required is often more than can be provided adjacent an electrical treater. An advantage of the gaseous type condenser is that it is simpler than the condenser with oil or wax as a

dielectric and if kept clean is not likely to puncture. However, should it puncture, no damage is done as the dielectric is self-healing. Another advantage of this type of condenser is the rapidity with which it takes a charge and discharges the same. As illustrated, the condenser functions as part of the precipitating apparatus and has a definite part in the removal of suspended particles from the gases. If in a particular problem there is no great advantage in having it function in this way, it can be placed in any position in the gas stream. In the use of a revolving switch to furnish spark gaps and to distribute the energy impulses great flexibility is afforded. Not only can the gaps be changed in length and the time when breakdown is effected be controlled, but its use makes easy the energization of precipitator units every other half cycle, which tends to decrease the amount of energy required for the operation of a precipitator with a plurality of units.

It has been found that the capacitance of a condenser used in the manner described should preferably be at least as great as the capacitance of all the precipitating units to which it is connected. For example, if the rods in unit 28 in Fig. 1 are $\frac{3}{8}$ " in outside diameter and spaced 2" apart along the flue, the discharge electrodes can be .05" in diameter and positioned 6" apart along the flue. The collecting plates 34 can be 8" apart in all units, but this is not necessary if there is any reason for changing the spacing in the condenser unit. It is preferable that with the dimensions above given there should be one non-ionizing rod in the condenser for every discharge electrode in the ionizing units. In Fig. 1 only one rod is shown for every two discharge wires, but that is because only one set of discharge wires is being energized at a given time. If both units were energized at the same time, which would be true if jumper 23 was in place, then the capacity of the condenser should be doubled over that shown.

It is, of course, not necessary that the apparatus be constructed exactly as shown in the drawings or described in the above specifications. Many changes in size, shape, and arrangement of parts may be possible or desirable. For instance, while it is pointed out that satisfactory results are obtained when the capacitance of the condenser is equal to the capacitance of the ionizing units to which it is at any one time connected, it is advisable at times to increase the capacitance of the condenser to at least twice that of the ionizing units. The energy directing means may be a thermionic valve or several such valves connected to permit only unidirectional flow of electric current. A spark gap of great flexibility is made possible by the described synchronously rotated mechanical switch with so-called stationary shoes on adjustable supports which permit the shoes to be individually moved radially and angularly with respect to the axis of rotation; and the shoes may be of different lengths. Other changes will be obvious to those skilled in the art which can be made without departing from the scope of the invention, which broadly comprises means for impressing high tension electrical impulses of steep wave front and short duration across the complementary electrodes of a device for subjecting fluids to electrical treatment, said means essentially comprising a source of high tension alternating current, means for rectifying such current, means for setting up steep wave front impulses and means for distributing such impulses so as to energize fluid treating means with steep

wave front impulses having successively different characteristics.

This application is a continuation-in-part of application Serial No. 670,558, "Fluid treaters", filed May 11, 1933.

I claim:

1. An electrical circuit for impressing electrical potentials across the complementary electrodes of devices for subjecting fluids to electrical treatment comprising means providing high tension alternating current, means including a spark gap and a condenser to convert successive half waves of said current into steep wave front impulses of alternately different characteristics and energy directing means for impressing said impulse across said complementary electrodes.

2. An electrical circuit for impressing electrical potentials across the complementary electrodes of devices for subjecting fluids to electrical treatment comprising means providing high tension alternating current, means to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing means for impressing said impulse across the complementary electrodes of a plurality of treating devices in succession.

3. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including a spark gap and a condenser to convert successive half waves of said current into steep wave front impulses of alternately different characteristics and energy directing devices adapted to impress said impulses across said electrodes.

4. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including means to convert successive half waves of said current into steep wave front impulses of alternately different characteristics and energy directing devices comprising thermionic rectifiers adapted to impress said impulses across said electrodes.

5. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including means to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices comprising rotating switch rectifiers operated in synchronism with the variation in voltage of the current adapted to impress said impulses across said electrodes.

6. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including a rotary spark gap rotatable in synchronism with the variations in voltage of the current and a condenser to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses across said electrodes.

7. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode

members, and means connecting said electrodes with said source of high voltage alternating current including an adjustable spark gap and a condenser to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses across said electrodes.

8. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including an adjustable rotary spark gap rotatable in synchronism with the variations in voltage of the current and a condenser to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses across said electrodes.

9. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including a rotary spark gap rotatable in synchronism with the variations in voltage of the current and having means to vary the width of the gap to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses across said electrodes.

10. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including a rotary spark gap rotatable in synchronism with the variations in voltage of the current and having means to vary the duration of the spark to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses across said electrodes.

11. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current including a rotary spark gap rotatable in synchronism with the variations in voltage of the condenser and having means to vary the time of discharge relative to said variations in voltage to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses across said electrodes.

12. A system for electrically treating fluids comprising a source of high voltage alternating current, a plurality of treater units each including spaced electrode members, means connecting said electrodes with said source of high voltage alternating current including means to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses of varying characteristics across said electrodes.

13. A system for electrically treating fluids comprising a source of high voltage alternating current, a plurality of treater units each including spaced electrode members, means connecting said

electrodes with said source of high voltage alternating current including means to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses of varying characteristics alternately across the electrodes of successive units.

14. A system for electrically treating fluids comprising a source of high voltage alternating current, a plurality of treater units each including spaced electrode members, means connecting said electrodes with said source of high voltage alternating current including means to convert successive half waves of said current into steep wave front impulses of alternately different characteristics, and energy directing devices adapted to impress said impulses of varying characteristics across the electrodes of a plurality of units.

15. A system for electrically treating fluids comprising a source of high voltage alternating current, a treater unit including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current, including means to convert alternate half waves of said current into steep wave front impulses and energy directing devices adapted to

impress said impulses and the unconverted half waves across said electrodes.

16. A system for electrically treating fluids comprising a source of high voltage alternating current, a plurality of treater units including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current, including means to convert alternate half waves of said current into steep wave front impulses, and energy directing devices adapted to impress said impulses and the unconverted half waves alternately across the electrodes of a plurality of treater units in succession.

17. A system for electrically treating fluids comprising a source of high voltage alternating current, a plurality of treater units including spaced electrode members, and means connecting said electrodes with said source of high voltage alternating current, including means to convert alternate half waves of said current into steep wave front impulses and energy directing devices adapted to impress said impulses and the unconverted half waves across the electrodes of a plurality of units.

HARRY A. WINTERMUTE.