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METHOD AND APPARATUS FOR ELECTRICAL PRECIPITATION

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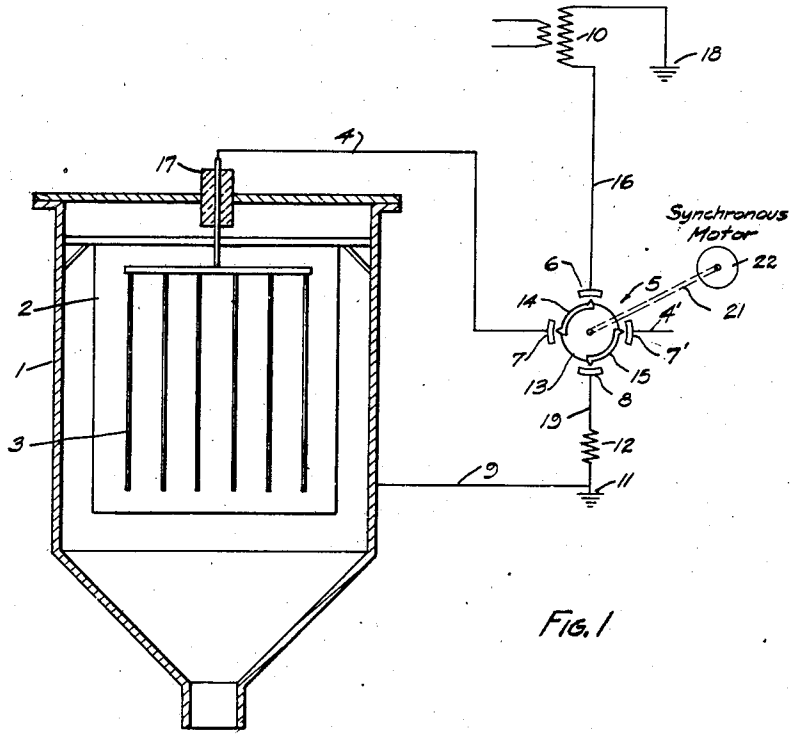


FIG. 1

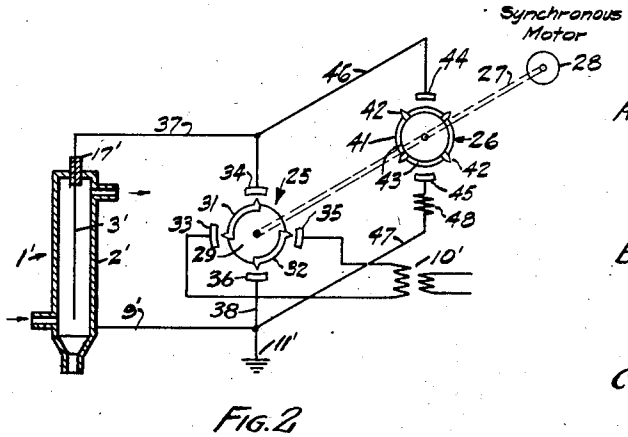
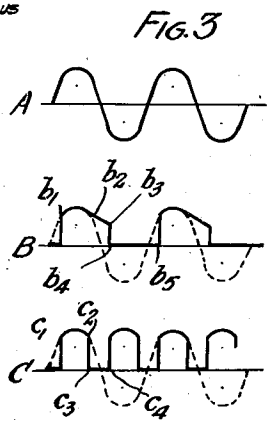


FIG. 2

FIG. 3



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METHOD AND APPARATUS FOR ELECTRICAL PRECIPITATION

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13 Claims. (Cl. 183—7)

This invention relates to electrical precipitation of suspended particles from gases, and particularly to a novel and advantageous method and means for supplying electrical energy to the electrodes of electrical precipitation apparatus.

In the operation of electrical precipitation apparatus, it is customary to use rectified high tension alternating current for maintaining the desired electrical potential between the discharge electrodes and the collecting electrodes. Thus, unidirectional current impulses are delivered to the electrodes, which follow one another at regular intervals and at a frequency dependent upon the frequency of the alternating current. Between these impulses the potential difference between the electrodes falls somewhat below the potential which is reached at the peak of each impulse, but does not ordinarily fall below the discharge potential, so that there is a substantially continuous discharge maintained between the electrodes. In some cases, this continuous discharge has been found to be disadvantageous, and it has been found that the maximum potential between electrodes, at each impulse, may be materially increased, and more efficient electrical precipitation secured, if the voltage between the electrodes is caused to fall below the discharge potential between successive charging impulses. In United States patent application Serial No. 383,741 (Patent #1,878,024, issued Sept. 20, 1932) there is described an improvement in electrical precipitation apparatus, in which the desired reduction of the voltage below the discharge potential is attained by connecting a resistance in parallel with the precipitator, which resistance draws sufficient current to cause the voltage to fall below the discharge potential between successive impulses.

According to the present invention, the high tension electrodes, which are ordinarily the discharge electrodes, are alternately connected to a source of high potential current and to the grounded opposing electrodes, the latter connection being preferably made through a resistance sufficient to prevent undue lowering of the potential. In this manner, the means used for reducing the voltage between the electrodes does not draw energy from the power supply source itself, but only serves to dissipate energy from the electrodes between the successive high potential impulses in sufficient amount to bring about the desired reduction of potential.

A particularly advantageous apparatus for this purpose comprises a mechanical rectifier, in which rotating contact means are employed to establish connection at the proper time between the high tension electrodes and the power supply source, and in which the same rotating contact means also serves, upon disconnection of the high tension electrode means from the power supply source, to connect said high tension electrode means to the opposing electrodes, which are ordinarily grounded. This latter connection is preferably made through a resistance in order to prevent too great a lowering of the voltage between electrodes.

The mechanical rectifier may be so designed as to provide for only half-wave rectification, in which case the high tension electrodes of the precipitator are connected through the rotating contact means of said rectifier to the alternating current power supply means during alternate half-wave impulses of the alternating current, and are connected through said rotating contact means to the grounded opposing electrodes during the times of the intervening half-wave impulses. If desired, however, the rectifier may be designed to provide full-wave rectification, in which case the high tension electrode means of the precipitator are connected through the alternating current power supply means during the crest portion of each half-wave of the alternating current, the connections being reversed at each successive half-wave so as to deliver unidirectional impulses to the precipitator, and said electrode means are connected to the grounded opposing electrodes between these successive crest portions. It will be understood that, in either case, the rotating contact means of the mechanical rectifier are rotated in synchronism with the alternating current power supply so as to cause the connections to be made and broken at the proper time intervals with respect to the alternating current frequency.

The accompanying drawing illustrates practical embodiments of the invention and referring thereto:

Fig. 1 is a wiring diagram, showing a form of rotating contact means adapted for half-wave rectification.

Fig. 2 is a wiring diagram, showing a form of rotating contact means adapted for full-wave rectification.

Fig. 3 is a wave form diagram, showing the wave form of the alternating high potential supplied by the transformer or other power supply source and the wave forms of the potential impressed upon the electrodes, according to the two forms of the invention illustrated.

In Fig. 1 an electrical precipitating apparatus

is indicated diagrammatically at 1, in which the precipitating or collecting electrodes 2 and the discharge electrodes 3 are suspended, and insulated from one another. The collecting electrodes 2 are shown as directly supported upon the precipitating housing and are connected through conductor 9 to a ground connection 11, while the discharge electrodes are insulated from the housing of said precipitator and from the collecting electrodes by insulating means 17 and are connected by conductor 4 to a fixed contact member 7 of mechanical switching means 5.

Said mechanical switching means is shown as comprising a rotating disc 13 of insulating material provided with diametrically opposed contact segments 14 and 15. In addition to the fixed contact member 7, fixed contact members 6 and 8 are provided, at opposite sides of said member 7 and preferably substantially diametrically opposite one another. The contact member 6 is connected through conductor 16 to one end of the secondary winding of high potential transformer 10, while the other end of said secondary winding is grounded as indicated at 18. The contact member 8 is connected through conductor 19 to the ground connection 11, and a resistance 12 is preferably inserted in said conductor. The insulating disc 13 is diagrammatically indicated as driven through a shaft or other suitable connection 21, by means of synchronous motor 22, and the speed of rotation of said disc is such as to provide for connection of the contact member 7 to contact member 6, through one or the other of the contact segments 14 and 15 during each alternate half-wave of the alternating current. For this purpose, the speed of rotation of said disc is equal to one-half the frequency of the alternating current. During the times between these alternate half-waves, the connection between contact members 6 and 7 is interrupted, and connection is established between contact members 7 and 8, through one or the other of the contact segments 14 and 15. In this manner, the high tension electrodes 3 are alternately connected to the high tension power supply means during alternate half-waves, so as to deliver high potential charging impulses thereto, all of said impulses being of the same polarity, and between the times of these impulses said high tension electrode means are disconnected from the power supply means and connected to the grounded opposing electrodes 2. During the periods of connection to the power supply means, the high tension electrodes become charged to a sufficient potential with respect to the opposing electrodes to produce a silent or corona discharge therefrom and cause effective electrical precipitation of suspended particles from gases passed between said electrodes. During the periods between these charging impulses, however, the potential between the electrodes is dissipated by flow of current through the resistance means 12, to a sufficient extent to cause the potential therebetween to fall below the discharge potential. As above stated, it has been found that in some cases this method of operation provides for more effective precipitation than is obtained when the potential between the electrodes is caused to remain continually at or above the discharge potential. This improved operation may be due in part at least to the fact that by causing the discharge between the electrodes to be repeatedly interrupted, the tendency to creation of arcing or disruptive discharge between the electrodes is overcome.

If desired, another fixed contact member 7' may be provided diametrically opposite contact member 7, and may be connected by conductor 4' to the high tension electrode of another precipitator (not shown), in such manner as to cause charging potential impulses to be delivered to said other precipitator during the alternate half-waves when precipitator 1 is disconnected from the power supply source, the switching means 5 thus serving alternately to charging and grounding of the high tension electrode means of the respective precipitators.

In Fig. 2 the electrical precipitator is again indicated diagrammatically at 1'. In this case the housing of the precipitator itself is shown as constituting a collecting electrode means 2', while the discharge electrode 3' is insulated therefrom by insulating means 17'. As before, the collecting electrode means 2' is connected through conductor 9' to a ground connection 11'. The mechanical switching means is shown as comprising a well known form of rotating full-wave rectifier 25 and a rotating grounding switch 26, both driven at the same speed, through a shaft indicated diagrammatically at 27, by means of a synchronous motor 28. The rectifier 25 comprises a rotating disc 29 of insulating material provided with diametrically opposed contact segments 31 and 32. Four fixed contact members 33, 34, 35 and 36 are provided, one pair of diametrically opposed contact members such as 33 and 35 being connected to the secondary winding of transformer 10'. One of the remaining fixed contact members such as 34 is connected through conductor 37 to the high tension electrode 3', while the other fixed contact member 36 is connected through conductor 38 to the ground connection 11'.

The grounding switch 26 may also comprise an insulating disc 41 provided with four equally spaced contact members 42 all connected together by conducting means 43. The respective contact members 42 are disposed at angular positions intermediate the angular positions of the ends of the respective contact segments 31 and 32 of the rectifier 25. Fixed contact members 44 and 45 are provided in position of contact making relation with respect to contact members 42. Contact member 44 is connected by conductor 46 to the high tension line 37, while contact member 45 is connected by conductor 47, preferably through resistance 48, to the ground connection 11'.

In the operation of this form of the invention the shaft 27 and the rotary devices 29 and 41 carried thereby are rotated at a speed equal to half the frequency of the alternating current supplied through transformer 10'. With the parts in the position shown, contact segment 31 establishes connection with contact member 33 and thence to one side of the transformer secondary winding and also with contact member 34 and thence to the high tension electrode means 3'. The other contact segment 32 coöperates in a similar manner with contact members 35 and 36 to establish connection from the other side of the transformer to the grounded collecting electrodes 2'. Said contact segments are so disposed as to establish this relationship during the crest portion of one half-wave of the alternating current. A charging potential impulse is thus applied to the high tension electrode means. Upon further rotation, the contact segments 31 and 32 move out of engagement with the respective contact members, thus disconnecting the precipi-

tator electrodes from the power supply source. After rotation through an angle of approximately 45° from the position shown, two of the opposing contact members 42 of the grounding switch are brought into engagement with the contact members 44 and 45, thus establishing a connection from the high tension electrode means through conductors 37 and 46, contact members 44 and 42, conducting means 43, contact members 42 and 45, resistance 48 and conductor 47 to the ground connection 11', and sufficient current will flow through the above path to cause the potential of the discharge electrode means 3' to fall below the discharge potential. This connection is then broken and at the time of the next half-wave crest, the contact segments 31 and 32 establish connection between the precipitator electrodes and the transformer secondary winding in the reverse direction to that above described, the contact segments 31 and 32 being at that time displaced approximately 90° from the positions shown in Fig. 2.

It will, therefore, be seen that the operation in this case is substantially the same as above described, with the exception that a charging potential impulse is supplied to the electrodes at the time of each half-wave crest of the alternating current, and the grounding of the high tension electrode means is effected during the periods between these crests. Due to the reversal in the direction of connection to the transformer during successive half-waves, the high potential impulses delivered to the high tension electrodes are all of the same polarity.

In Fig. 3, the wave form diagram shown at "A" represents the alternating high potential supplied by transformer 10 or 10', voltage being plotted vertically and time horizontally, in the usual manner. The diagram 'B" illustrates the general wave form of the potential impressed upon the electrodes in the form of the invention illustrated in Fig. 1. In this diagram the dotted line indicates the wave form of the original alternating potential, while the heavy solid line indicates the potential between the electrodes. At the point b_1 a connection is established by one of the contact segments, such as 14, of the mechanical switching means 5, between the high tension electrode means 3 and the transformer, so that the full instantaneous voltage of said transformer is impressed upon the electrodes, until such connection is broken, as at b_2. The potential then falls gradually due to leakage between the electrodes, to the point b_3, at which time the other contact segment, such as 15, establishes a connection from the high tension electrode means to the ground connection 19. The potential between the electrodes then falls rapidly, to some such point as indicated at b_4, which is below the ionization potential. In the drawing, this drop in voltage is represented as an instantaneous drop to ground potential, but it will be understood that the drop may not occur instantaneously and may not go completely to ground potential, depending upon the value of the resistance 12 in the ground connection. At the point b_5, the other contact segment, such as 15, establishes connection from the high tension electrode means to the transformer, and the impressed voltage again rises to the full voltage of the transformer. This rise is also shown as occurring instantaneously, but it will be understood that it may be retarded somewhat, depending upon the relation between the size of the transformer and the capacity of the precipitator. The cycle is then repeated, in the same manner as before.

Diagram "C" represents, in a similar manner, the potential impressed upon the electrodes in the form of the invention shown in Fig. 2. In this case, at the point c_1, the high tension electrode means are connected through one of the contact segments, such as 31, to one side of the transformer 10', for example, to the terminal thereof which is of negative polarity, and the full potential of said transformer is thereupon impressed upon the electrodes, until this connection is broken, as at c_2. Shortly thereafter, the high tension electrode means are grounded through switch 26, and the impressed potential rapidly falls below the ionization potential, for example, to the point c_3, this drop in potential being subject to the same conditions as mentioned above in connection with diagram "B". This ground connection is then broken, and at the point c_4, one of the contact segments 31 or 32 establishes a connection from the high tension electrode means to the other terminal of the transformer, which is then of the same polarity as before, for example, of negative polarity, and the full potential is again impressed upon the electrodes, this same cycle being repeated during each half wave of the alternating current.

I claim:

1. In a method of electrical precipitation of suspended particles from gases containing the same by passage of such gases between electrode means charged at high potential and opposing electrode means maintained at substantially ground potential, the steps which comprise alternately connecting the high potential electrode means to a source of electric current at high potential and to ground.

2. In a method of electrical precipitation of suspended particles from gases containing the same by passage of such gases between electrode means charged at high potential and opposing electrode means maintained at substantially ground potential, the steps which comprise intermittently connecting the high potential electrode means to a source of electric current at high potential, and connecting said high potential electrode means through resistance means to ground between successive periods of connection to said high potential source.

3. In a method of electrical precipitation of suspended particles from gases containing the same by passage of such gases between electrode means charged at high potential and opposing electrode means maintained at substantially ground potential, the steps which comprise periodically connecting the high potential electrode means to a source of electric current at high potential in such manner as to cause high potential impulses of like polarity to be applied to said high potential electrode means, and connecting said high potential electrode means to ground between successive times of connection thereof to said high potential source.

4. In a method of electrical precipitation of suspended particles from gases containing the same by passage of such gases between electrode means charged at high potential and opposing electrode means maintained at substantially ground potential, the steps which comprise connecting said high potential electrode means to an alternating current supply means at times of half-wave crests of the alternating current and in such manner as to deliver to the high potential electrode impulses of like polarity, and in the

intervening periods disconnecting said high potential electrode means from said supply means and connecting said high potential electrode means to ground.

5. In a method of electrical precipitation of suspended particles from gases containing the same by passage of such gases between electrode means charged at high potential and opposing electrode means maintained at substantially ground potential, the steps which comprise connecting said high potential electrode means to an alternating current supply means during alternate half-wave periods of said supply means, and in the intervening periods disconnecting said high potential electrode means from said supply means and connecting said high potential electrode means to ground.

6. In a method of electrical precipitation of suspended particles from gases by passage of such gases between electrode means charged at high potential and opposing electrode means maintained at substantially ground potential, the steps which comprise connecting said high potential electrode means to an alternating current supply means during each half-wave crest of said supply means in such manner as to cause high potential impulses of like polarity to be applied to said high potential electrode means, and in the intervals between said half-wave crests disconnecting said high potential electrode means from said supply means and connecting said high potential electrode to ground.

7. In the electrical precipitation of suspended particles from gases containing the same by passage of such gas between high potential electrode means and grounded opposing electrode means while supplying successive unidirectional high potential charging impulses to said high potential electrode means, the method of lowering the potential of the high potential electrode means below the discharge potential between successive charging impulses which comprises disconnecting said high potential electrode means from the power supply means, and connecting said high potential electrode means to ground, between successive charging impulses.

8. In the electrical precipitation of suspended particles from gases containing the same by passage of such gases between high potential electrode means and grounded opposing electrode means while supplying successive unidirectional high potential charging impulses to said high potential electrode means, the method of lowering the potential of the high potential electrode means below the discharge potential between successive charging impulses which comprises connecting said high potential electrode means to ground between successive charging impulses and disconnecting said high potential electrode means from ground during such charging impulses.

9. An apparatus for electrical precipitation comprising high tension electrode means, grounded electrode means opposing said high tension electrode means, a source of electric current at high potential, an electric circuit connected to said electrode means and said current source, and switching means connected in said circuit and operable to connect said high tension electrode means alternately to said current source and to ground.

10. An apparatus as set forth in claim 9, said current source comprising alternating current supply means, and said switching means being operable in synchronism with said alternating current and being so arranged as to deliver rectified high potential impulses of the same polarity to the high tension electrode means at each time of connection thereof to said current source.

11. An apparatus as set forth in claim 9, and also comprising resistance means in the ground connection established by said switching means.

12. An apparatus for electrical precipitation comprising high tension electrode means, grounded electrode means opposing said high tension electrode means, a source of high potential alternating current, an electric circuit connected to said electrode means and to said current source, and a mechanical rectifier connected in said circuit and operable to establish connection between said high tension electrode means and said current source at times of alternate half-waves of said alternating current so as to supply unidirectional charging impulses to said high tension electrode means, said rectifier being also operable to disconnect said high tension electrode means from said current source and connect the same to ground between said alternate half-wave impulses.

13. An apparatus for electrical precipitation comprising high tension electrode means, grounded electrode means opposing said high tension electrode means, a source of high potential alternating current, an electric circuit connected to said electrode means and said current source, and a mechanical rectifier connected in said circuit and operable in synchronism with said alternating current so as to establish unidirectional connection between said current source and said high tension electrode means during each half wave crest of said alternating current, and means operatively associated with said rectifier to disconnect said high tension electrode means from said current source and connect said high tension electrode means to ground between successive half-wave crests.

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