L. W. CHUBB.

ELECTRICAL PRECIPITATING SYSTEM.

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1,389,126. Patented Aug. 30, 1921.

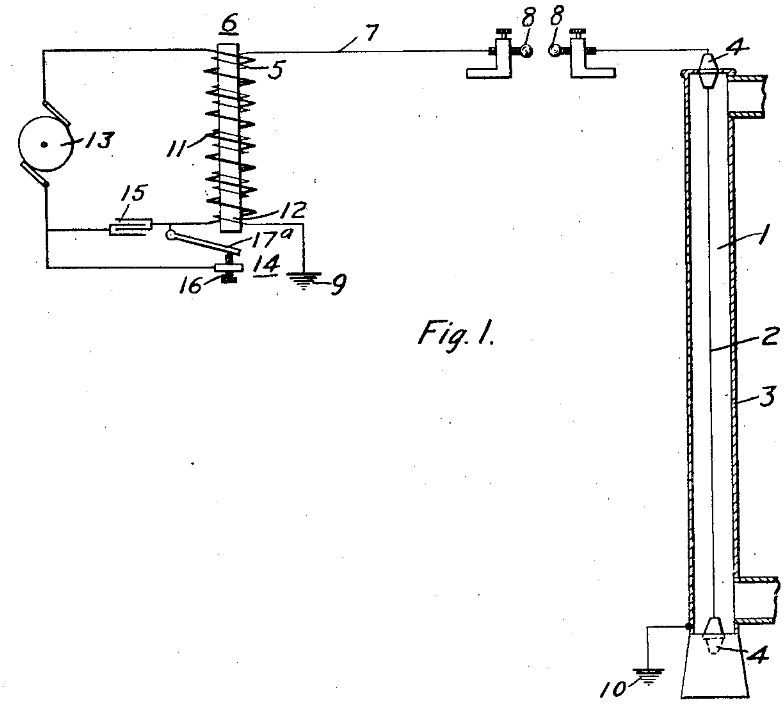

Fig. 1.

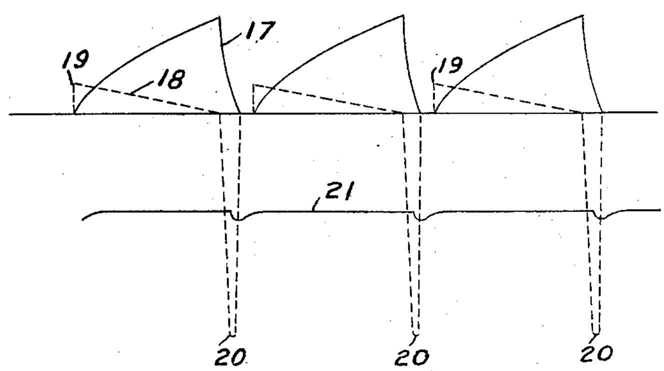

Fig. 2.

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ELECTRICAL PRECIPITATING SYSTEM.

1,389,126. Specification of Letters Patent. Patented Aug. 30, 1921.

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To all whom it may concern:

Be it known that I, Lewis W. Chubb, a citizen of the United States, and a resident of Edgewood Park, in the county of Allegheny and State of Pennsylvania, have invented a new and useful Improvement in Electrical Precipitating Systems, of which the following is a specification.

My invention relates to electrical distributing systems and more especially to those that may be employed for precipitating finely divided matter from bodies of gases or vapors by electrical discharges.

More particularly, my invention relates to electrical systems in which it is desired to produce continuously persisting electrical discharges in one direction only. Besides employing the system of the present invention for producing continuous electrical discharges in an electrical precipitator, it may be employed for exciting Roentgen-ray and similar tubes and for other service utilizing high-potential electrical discharges.

For the service conditions indicated and, more particularly, for separating suspended particles from gaseous bodies, it is desirable to operate at such voltages as will insure the production of electrical discharges. One method of electrical precipitation necessitates the production of silent electrical non-disruptive discharges or corona emanations. In accordance with the principles disclosed in U. S. Patent No. 1,067,974 to F. G. Cottrell, a non-disruptive discharge at maximum potential is maintained through the gaseous body undergoing treatment, the negative potential being applied, preferably, at the surface from which the corona discharges emanate and being of such value as to be in excess of that which may be maintained when the positive potential is applied to said surface. Consequently, the surface of the discharge electrode should be maintained at a very high electrical potential, preferably negative, in order to produce persistent corona or silent electrical discharges in one direction only.

Inasmuch as it is difficult to accomplish the aforementioned result by applying a direct-current voltage of the requisite potential, the desired result has heretofore been obtained by employing an alternating-current, high-potential source of power in combination with a rectifier which, in practice, has been almost without exception, a mechanical rectifier. The difficulties involved in subjecting mechanical rectifiers to service conditions involving such high voltages are numerous and well known. As a substitute for such a system, I, therefore, propose the system herein described.

In the system of the present invention, means are employed whereby alternating-currents of a symmetrical wave-form are generated, the wave which periodically develops the greater potential accession of the two waves comprising each cycle, being the one utilized for creating the electrical discharges. While these discharges are to occur in one direction only, each electrode is, in turn, periodically impressed with both positive and negative charges, since no mechanical rectifier is employed. Means are also provided for preventing electrical discharges from occurring in the wrong direction in the apparatus or device in which the unidirectional electrical discharges take place. Again, it is desired to maintain the unidirectional discharges substantially continuous. To this end, the time-interval between successive impressions of potential of the same sign on the discharge electrode of the apparatus, is regulated or controlled. This control of the time-interval between successive maximum-potential accessions of the same sign is also useful in preventing discharges from occurring in the wrong direction in the treating apparatus.

In the present system, no commutating devices or alternating-current rectifiers are employed. Furthermore, all moving contact members are inserted in the low-potential circuits comprising the system. As a consequence, a very simple and effective arrangement results which is reliable in operation and not subject to rapid deterioration.

For a better understanding of the nature and scope of my invention, reference may be had to the following description and the accompanying drawing in which Figure 1 is a diagrammatic view of an electrical system embodying a form of my invention, and Fig. 2 is a graph showing the relation between the exciting current supplied to, and the resulting electrical voltage induced in, a device which imparts electrical charges to a consuming device or electrical precipitator of the system shown in Fig. 1.

Referring to Fig. 1, an electrical precipitating device 1 utilizes high-potential electrical charges which generate silent electrical discharges that occur in one direction only. For certain purposes, negative-corona emanations are more effective in precipitating suspended particles than positive-corona emanations and, for the purpose of illustration only, it is to be assumed that the present system utilizes negative-corona emanations. In accordance therewith, a central conductor or discharge electrode 2 of the precipitator 1 is located within a flue or tubular member 3 and insulated therefrom by means of insulating bushings 4. The centrally disposed discharge electrode 2 is connected to one terminal of a high-tension winding 5 of an induction coil 6 by means of a conductor 7. Adjustable and spaced spark gap members 8 are connected in circuit between the high-tension winding 5 and the discharge electrode 2. The other terminal of the secondary winding 5 is connected to ground 9. The flue 3 which, in this instance, is preferably made of a conducting material, serves as a collecting electrode of the precipitator 1 to coöperate with the discharge electrode 2 and is connected to ground 10.

The induction coil 6 may be of any of the usual forms in which the time intervals between successive excitations of the primary winding may be controlled. In the present instance, a primary winding 11 is wound on a magnetizable core 12 that also constitutes the core for the secondary winding 5. A source of direct-current supply 13 is connected, through an interrupter 14, to the primary winding 11. A condenser element 15 is connected in shunt to the contact members of the interrupter 14.

In order to control the time-intervals between successive makes and breaks in the primary circuit of the induction coil, a stationary contact member 16 of the interrupter is made in the form of an adjustable terminal by means of which the position of a vibrating contact member 17^a may be varied.

In Fig. 2, a graph 17 represents the charging or primary current flowing through the primary winding 11 of the induction coil 6. The voltage induced in the secondary winding 5 is represented by the graph 18. When the interrupter 14 is closed, the primary current gradually increases in value and stores magnetic energy in the iron core 12. When the interrupter opens the primary circuit, the magnetic flux traversing the iron core 12 dies down quickly and induces a very high voltage in the secondary winding 5. The positive waves of the secondary voltage possess relatively low maximum values which are represented by the ordinates 19. The negative waves of the secondary voltage possess relatively high maximum values or potential accessions which are represented by the ordinates 20. As hereinbefore mentioned, negative-corona emanations are employed in the electrical precipitator 1 and, therefore, the negative portions of the alternating-current voltage waves induced in the secondary winding 5 are employed for generating these corona emanations by charging the discharge electrode 2 with these maximum potentials of negative sign.

When the high-potential negative electromotive forces obtain in the secondary winding 5, the spark-gap between the members 8 is disrupted, thereby permitting a negative electrical charge to flow into the precipitator 1 and accumulate on the discharge electrode 2. The spark bridging the members 8 will be extinguished when the precipitator 1 is raised by this current inflow to the same potential as the voltage then obtaining in the secondary wave. As a consequence, the current flow into the precipitator 1 will cease.

The potential to which the precipitator 1, which may be considered as the equivalent of a condenser, may be charged is only one-half of the difference between the negative maximum and the positive maximum of the secondary voltage wave, as will be hereinafter explained. If the precipitator 1 is charged to a voltage substantially equal to the maximum negative potential of the secondary wave rather than a voltage equal to, or less than, one-half of the difference between the positive and the negative maxima, as indicated above, there will be a back-spark and discharge of the chamber to the supply circuit when the interrupter 14 of the spark coil subsequently closes. To prevent this back discharge from occurring, the spark gap members 8 must be properly adjusted, as well as the time interval between successive engagements of the contact members of the interrupter 14.

In this connection, it should be observed that the spark gap 8 is only illustrative of many other voltage-absorbing means.

As will be hereinafter shown, the breakdown voltage of the spark-gap between the members 8 must be not less than one-half of the sum of the positive and negative maxima of the secondary voltage wave. With the proper adjustments made, the electrical charges intermittently and, in this case, periodically applied to the discharge electrode 2 will cause the corona emanations therefrom to persist. In other words, the corona emanations from the discharge electrode will continue between successive impressions of the negative potential wave. The curve 21 of Fig. 2 represents the potentials maintained on the electrode 2 or the resultant potential occasioned by the electrical charges recurrently imparted thereto by the asymmetrical potential waves.

Of course, the intensity of the corona discharge will vary, reaching its maximum slightly after the break-down of the spark-gap. The time-interval between the extinguishing of the arc in the spark-gap and the closing of the interrupter 14 is to be so adjusted that the discharge electrode 2 will dissipate its charge to such extent that its voltage will be equal to, or less than, one-half of the difference between the positive and negative maxima of the secondary voltage wave. With these adjustments made, negative electrical charges may be periodically applied to the discharge electrode 2, while the corona emanations therefrom will continue or persist, thereby subjecting the gas or vapor undergoing treatment to a continuous supply of electrical charges. This persistent electrical charge on the electrode 2 is represented by the curve 21.

To demonstrate the value of the potential to which the treating chamber or precipitator 1 may be raised, let G denote the break-down voltage of the spark-gap between the electrodes 8, and C denote the potential of the charge obtaining on the electrode 2. Also, let P denote the maximum value of the positive wave of the induced secondary electromotive force, and N denote the maximum value of the negative wave. As shown in Fig. 2, the maximum negative voltage N is greater than the maximum positive voltage P. When the negative voltage N is equal to the potential C of the discharge electrode 2 plus the breakdown voltage of the spark gap, the spark-gap between the electrodes 8 will be disrupted. This condition may be represented by the equation $N=C+G$. On the reversal of the secondary voltage wave, the following condition must obtain in order to preclude the precipitator 1 from discharging back to the supply circuit. This condition is represented by the equation $G=C+P$. Solving these two equations simultaneously, the following equations result, namely $C=\frac{N-P}{2}$ and $G=\frac{N+P}{2}$.

From the foregoing equations the following deductions are drawn:—(1) The potential of the electrical charge absorbed by the precipitator 1 is equal to one-half of the difference between the positive and negative maxima of the secondary voltage-wave and (2), the break-down voltage of the spark gap formed by the members 8 is not to be less than one-half of the sum of the positive and negative maxima of the secondary voltage wave. Therefore, it is evident that a great difference is desired between the positive and negative maxima values of the secondary wave. To obtain this great difference, I have used the spark coil 6 but it will be understood that an impulse generator or a magneto provided with an interrupter whose time of make and break may be controlled, may be employed. A structure comprising a magneto and a time controlled interrupter is shown in U. S. Patent 1,068,152.

The above equations obtain only when the spark-gap members 8 are similar, thereby forming a symmetrical discharge path. If the spark-gap members 8 form an unsymmetrical spark-gap, which will be disrupted at a lower potential difference in one direction than in the other direction, the potential C of the discharge electrode may be slightly greater than $\frac{N-P}{2}$.

While I have shown and described one embodiment of my invention, many modifications may be made therein without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. A source of intermittent voltage, a translating device, transforming means therebetween producing an unsymmetrical wave-form voltage, and means whereby said translating device is charged to a potential equal to not more than one-half the difference between the peak values of the opposite lobes of said wave.

2. A source of intermittent voltage, a translating device, transforming means therebetween producing an unsymmetrical wave-form voltage, and means capable of absorbing a voltage equal to not less than one-half the sum of the peak values of the opposite lobes of said waves, the translating device being charged to a potential equal to not more than one-half the difference between the peak values of the opposite lobes of said wave.

3. A source of voltage having an unsymmetrical wave-form, the maximum negative value of said wave being relatively greater than the maximum positive value thereof, a translating device adapted to operate upon substantially continuous negative voltage, and voltage-absorbing means connected betwen said source and said translating device whereby the latter is supplied with said continuous negative potential from said unsymmetrical voltage source.

4. A source of voltage of unsymmetrical wave form, having a maximum negative value of N and a maximum positive value of P, N being greater than P, a translating device adapted to be continuously charged to a value equal to not more than $\frac{N-P}{2}$, and voltage-absorbing means therebetween having a disruptive voltage equal to not less than $\frac{N+P}{2}$.

5. A source of voltage having an unsymmetrical wave-form, the maximum nega-

tive value of said wave being relatively greater than the maximum positive value thereof, a translating device adapted to operate upon substantially continuous negative voltage, and voltage-absorbing means whereby the negative lobe of said unsymmetrical wave is reduced to a value not greater than the potential of said translating device prior to the positive accession of said wave.

In testimony whereof, I have hereunto subscribed my name this 27th day of Dec., 1916.

LEWIS W. CHUBB.