L. W. CHUBB.

ELECTRICAL PRECIPITATING SYSTEM.

APPLICATION FILED MAR. 14, 1918.

1,396,811. **Patented Nov. 15, 1921.**

Fig. 1.

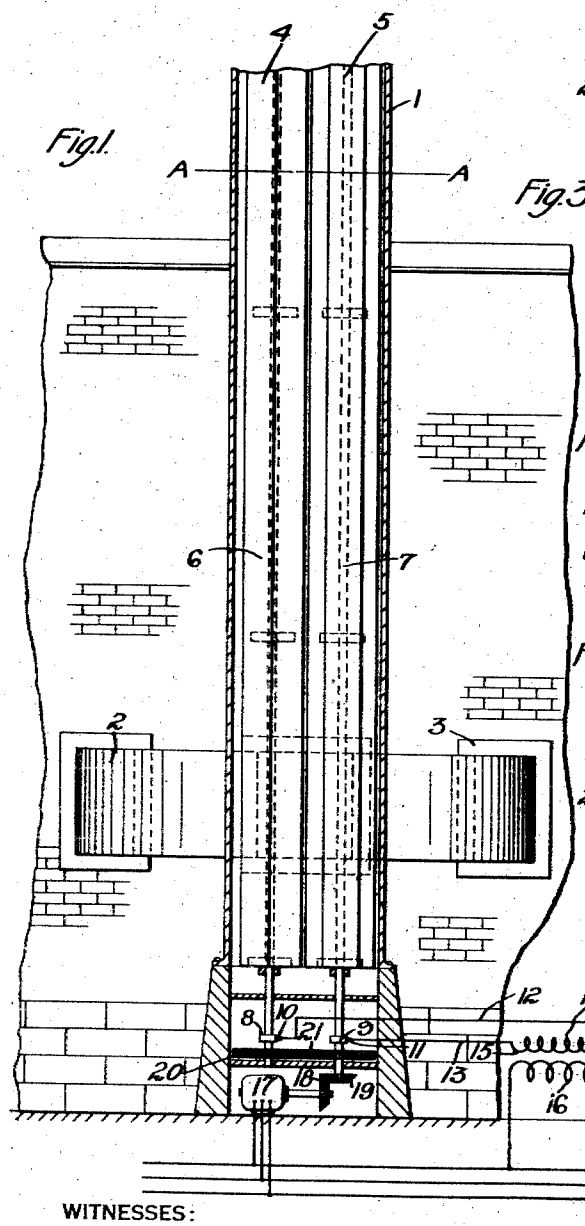


Fig. 2.

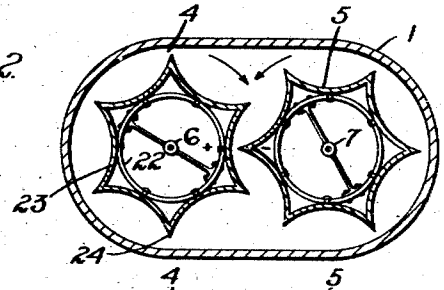


Fig. 3.

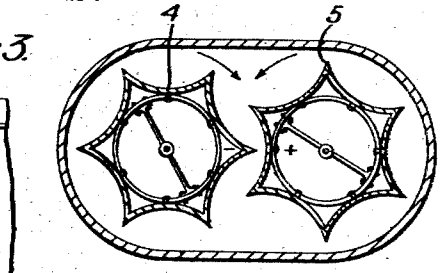


Fig. 4.

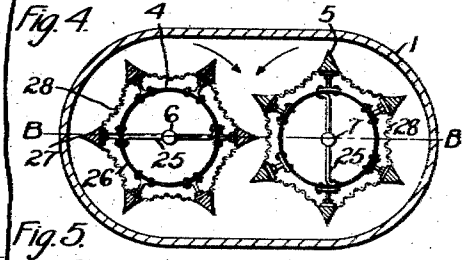
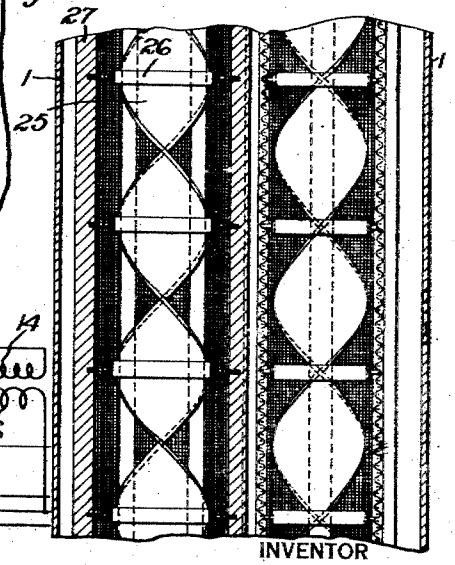


Fig. 5.



WITNESSES:

John T. Murray

A. A. Brand

INVENTOR

Lewis Warrington Chubb.

BY

Wesley G. Carr

ATTORNEY

UNITED STATES PATENT OFFICE.

LEWIS WARRINGTON CHUBB, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

ELECTRICAL PRECIPITATING SYSTEM.

1,396,811. Specification of Letters Patent. Patented Nov. 15, 1921.

Application filed March 14, 1918. Serial No. 222,491.

To all whom it may concern:

Be it known that I, LEWIS WARRINGTON CHUBB, a citizen of the United States, and a resident of Pittsburgh, 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 precipitating systems and particularly to those systems which are employed for precipitating finely divided suspended matter or smoke particles from bodies of gases or vapors by the passage therethrough of electrical discharges.

In systems of the above-mentioned character, it is usual to provide a discharge electrode capable of emitting non-disruptive discharges, opposed to a collecting electrode, and to adapt the discharge electrode for the impression thereon of a high negative potential. It is likewise the usual practice to impress on the collecting electrode a positive potential, whereupon the particles which are charged by the aforementioned electrical discharges are attracted to said collecting electrode. Such collecting electrode is usually the wall of a flue or treating chamber.

For the service conditions indicated and to obtain the non-disruptive discharges, it is therefore necessary to employ a very high value of potential, and this is generally obtained by the use of an alternating-current system. In order, therefore, to provide the required negative potential for the discharge electrode, it has been the usual practice to employ a mechanical rectifier. The difficulties attendant upon the use of a mechanical rectifier in connection with potentials of extremely high values are numerous and well known.

My invention, therefore, proposes to avoid the use of a mechanical rectifier by positioning in the treating chamber, through which the gas or vapor is passed, electrodes which may have impressed thereupon alternating potentials of a high value, without the necessity of initially passing through a rectifying system.

Moreover, in systems which have heretofore been used for the precipitation of particles from gases or vapors a great deal of difficulty has been experienced in so collecting the precipitated particles that, after their dislodgment from the wall of the collecting electrodes to which they have been attracted, they will not be again drawn into the stream of gas or vapor.

By the use of my device, means are provided whereby, after the particles are precipitated and attracted to the collecting electrode, they are urged in a direction opposite to that of the stream of gas or vapor passing through the treating chamber and are carried out of the path of said gas or vapor and deposited at the bottom of said treating chamber.

Furthermore, my invention provides means whereby the gas or vapor to be treated is constrained to pass across the path of the aforementioned non-disruptive electrical discharges several times before emerging from the treating chamber. This is extremely advantageous in that it prevents particles from being forced upward through the treating chamber by an extremely heavy draft without being acted upon by the non-disruptive discharges emitted from the discharge electrode.

For a better understanding of a specific construction which embodies my invention, reference may be had to the drawings in which Figure 1 is a view, partially in elevation and partially in section, of apparatus constructed in accordance with my invention. Fig. 2 is a cross sectional view taken on line A—A of Fig. 1 and Fig. 3 is a like view showing the positions of the electrodes at a predetermined later time period. Fig. 4 is a cross sectional view also taken on line A—A of Fig. 1 but illustrating electrodes of a different construction from those shown in Figs. 2 and 3 which will hereinafter be described, and which constitute a preferred embodiment of my invention. Fig. 5 is a longitudinal sectional view of a portion of the treating chamber, taken on line B—B of Fig. 4.

Referring more particularly to Fig. 1, a stack or treating chamber is shown at 1, while means of admitting gas or vapor thereto are indicated at 2 and 3. Positioned in the stack 1 are rotatable electrodes 4 and 5, said electrodes being mounted on shafts 6 and 7, respectively. At the lower ends of the shafts 6 and 7 are mounted slip-

rings 8 and 9 upon which bear brushes 10 and 11, said brushes being attached by lead wires 12 and 13, respectively, to a secondary winding 14 of a transformer 15. A primary winding 16 of the transformer 15 is attached to a source of alternating current, as indicated.

At 17 is shown a motor that may be energized from the same current source as the primary winding 16. A bevel gear 18 is attached to the shaft of the motor 17 and meshes with a similar gear 19 attached to the end of the shaft 7. One-to-one gears 20 and 21 are mounted on the shafts 6 and 7, respectively, in such manner that, upon rotation of the shaft of the motor 17, the electrodes 4 and 5 are caused to rotate in opposite directions.

Referring to Fig. 2, the specific construction of the electrodes and the manner of their rotation are set forth. Since the electrodes 4 and 5 are alike, only one of them will be described.

A spider 22 is mounted on the shaft 6 of the electrode 4, and, attached thereto, are channel portions 23 composed of conducting material. The channel portions 23 are so attached to said spider 22 that longitudinally extending rib portions 24 are formed, as shown.

The electrodes 4 and 5 are initially mounted in such manner that a channel portion of one electrode is disposed opposite to the rib portion of the opposed electrode.

Fig. 3 shows the positions of the electrodes 4 and 5 after each of them has been rotated through a 30° angle. It will be seen that, whereas, in Fig. 2, a channel portion on the electrode 4 is disposed opposite a rib portion of the electrode 5, in this figure, a rib portion on the electrode 4 is disposed opposite a channel portion of the electrode 5.

In this connection, it will be observed that the rib portions formed on the electrodes are adapted for use as discharge electrodes, while the channels formed on said electrodes are adapted for use as collecting electrodes. It will further be observed in this connection that, by suitable rotation of the electrodes 4 and 5, a rib portion of a discharge electrode may always be maintained substantially opposite a channel portion or a collecting electrode and vice versa.

Although I have shown my dimorphous electrodes as composed of two or more rib and channeled sections and capable of being rotated in synchronous relationship, it is apparent that said electrodes may comprise one rib section and one section of optimum shape for use as a collecting electrode and that said electrodes may be either oscillated or rotated in synchronism.

In Figs. 4 and 5 is shown a preferred embodiment of my invention in which an interiorly mounted ribbon member 25 is so twisted as to have helical convolutions formed on its surface and is so positioned, that when the same is rotated, any particle impinging thereon will be urged in the direction of the convolutions thereof. The helical member 25 is mounted on the shaft 6 and is further secured in the desired position by means of rings 26 which are uniformly spaced along the electrode structure 4. In this embodiment of my invention, the rib portions 27 are secured to the rings 26 in any suitable manner, and the intermediate channel portions 28 are reticulated in order that suspended particles may readily pass therethrough when having a velocity such as may be imparted thereto by reason of being charged by the non-disruptive discharges taking place from the rib portions of the opposite electrode but will be restrained from passing therethrough when possessing only the upward velocity imparted to it by the natural draft of the stack.

The operation of my device is as follows:

The electrodes 4 and 5 are rotated, in synchronous relationship to the potential impressed thereon, by means of the motor 17 and the gear train 18, 19, 20, 21. It will be apparent that, if a high negative potential is impressed upon either one of the electrodes 4 and 5 when one of the rib portions of one of them is opposed to one of the channel portions of the other, silent non-disruptive discharges will take place from the rib portion. If a gas or vapor is admitted to the treating chamber 1 by means of the flues 2 and 3, the rotation of electrodes 4 and 5, in the directions indicated, will cause the aforesaid gas or vapor to move in substantially helical paths during its passage through the treating chamber 1. The gas will, therefore, be brought into the path of said silent discharges several times before its emergence from the treating chamber, and all of the particles therein will be charged and deposited thereby.

Assuming that the electrodes are in the positions shown in Fig. 2 and a stream of gas or vapor is led therebetween, a silent non-disruptive discharge will take place from the rib portion of the electrode 5, and particles suspended in the gas or vapor will thereupon be charged negatively. If, as shown, the opposed channel portion of the electrode 4 has residing thereon a positive charge, the aforementioned negatively-charged particles will be attracted thereto, and, when a sufficient number of them have lodged thereon, the resultant mass will detach itself and will fall to the bottom of the treating chamber.

In Fig. 3, the electrodes 4 and 5 are shown after they have been rotated through 30° from the positions shown in Fig. 2. It will be noted that a rib portion of the electrode 4 is opposed to a channel portion of the elec-

trode 5 and that the particles will, therefore, be precipitated on electrode 5 in contra-distinction to their collection on electrode 4, as shown in Fig. 2.

It will readily be apparent, therefore, that the electrodes 4 and 5 are of a dimorphous character and alternately perform the functions of a discharge electrode and of a collecting electrode.

As has been hereinbefore set forth, it is exceedingly difficult to prevent the mass of smoke particles which collect on the collecting electrode from falling back into the stream of vapor or gas being treated, and thereby nullify the desired effect of the precipitator. In the electrodes shown in Fig. 4, I provide means for the avoidance of this difficulty.

Assume, for instance, that the electrode 4 has impressed thereon a negative charge and that, therefore, the rib portion is emitting non-disruptive electrical discharges. A particle, being charged by said discharges, will be attracted by the positive charge which is now residing on channel screen portion 28 and the interior member 25 of electrode 5, since the helical portion 25, as well as said screen portion 28, will always have impressed thereon a positive charge during the same period that a negative charge is residing on the rib portion of the opposed electrode.

The screen portion 28, shown herein, for the purposes of illustration, as composed of heavy wire gauze, is of such character that, when a smoke particle impinges thereon with sufficient velocity, it will pass therethrough and collect on the helical collecting electrode 25. The helical portion 25 is so rotated that a particle impinging thereon is urged in a downward direction, or a direction opposite to that of the gas or vapor being treated.

Furthermore, said screen member 28 is of such a character that, while it will allow a particle, having a velocity imparted to it by the silent electrical discharge, to pass therethrough, it will not admit gas or vapor passing through the treating chamber, to the interior of the electrode. This is because the gas or vapor is flowing upwardly during substantially the entire time that it is within the treating chamber. Therefore, little or no tendency will exist for the same to pass through the screen, since the flow is at right angles to the perforations in the screen member. The smoke particles which are charged, however, are propelled in a direction perpendicular to the screen by reason of the attraction exerted upon the particles by the oppositely charged electrode.

It will be observed, therefore, that, by use of my device I am able to maintain, in one treating chamber, two oppositely-directed streams of particles, one stream carrying finely divided and suspended material in a spiral path and on its way to treatment, while the other stream is composed of precipitated particles which are finally deposited at the bottom of the treating chamber and may be withdrawn therefrom by any suitable method.

While I have shown, for convenience, the helically shaped interior member 25 as fastened to the outer portion of electrode 5 and, therefore, rotating at the same speed, it is obvious that, if a greater counter draft is desired, said helical member may be separately mounted in the interior of the electrode structure and so connected to a gear train that it may be rotated at a speed higher than that of the containing structure and thus give the desired draft. Moreover, it will be observed that, in the appended claims, I have not confined myself to this specific method of inducing a counter draft in the treating chamber, since it is obvious that other means may be employed to accomplish the same result without departing from the scope of my invention.

It will be understood also that many further modifications may be made in my invention without departing from the spirit and scope of the appended claims.

I claim as my invention:

1. In an electrical precipitating system, the combination with a treating chamber, of dimorphous electrodes positioned therein, a source of current supply therefor, and means whereby each electrode is constrained to alternately perform the functions of either a discharge electrode or of a collecting electrode only.

2. In an electrical precipitating system, the combination with a treating chamber, of relatively movable dimorphous electrodes positioned therein, a source of current supply therefor, and means whereby said electrodes are constrained to alternately perform the functions of a discharge electrode and of a collecting electrode.

3. In an electrical precipitating system, the combination with a treating chamber, of rotating electrodes therein which are so positioned that, by their rotary movement, the fluid being treated is constrained to move in substantially helical paths, and between said electrodes several times, during its passage through the treating chamber.

4. In an electrical precipitating system, the combination with a treating chamber, of rotatable electrodes positioned therein, a source of fluctuating current supply therefor, and means for moving said electrodes in synchronous relationship to said current supply.

5. In an electrical precipitating system, the combination with a treating chamber, of rotatable electrodes positioned therein, a source of fluctuating current supply there-

for, and means for rotating said electrodes in such synchronous relationship to the current in said supply circuit that one of said rotatable electrodes performs the function of a discharge during the period in which another of said rotatable electrodes performs the function of a collecting electrode.

6. In an electrical precipitating system, the combination with a treating chamber, of rotatable electrodes positioned therein, a source of fluctuating-current supply therefor, and means for rotating said electrodes in synchronous relationship to the current in said supply circuit, said electrodes being so constructed that, when they are rotated, the gas or vapor being treated is constrained to move in substantially helical paths while passing through said treating chamber, and is thereby caused to pass repeatedly between said electrodes.

7. In an electrical precipitating system, the combination with a treating chamber, of a pair of rotatable electrodes positioned therein, a source of fluctuating-current supply therefor, each of said electrodes being adapted to emit silent non-disruptive discharges and to function as a collecting electrode for the other electrode, whereby the suspended particles, during their passage between said electrodes, are charged and thereafter attracted by the electrode having an opposite charge to that which has been imparted to said particles.

8. In an electrical precipitating system, the combination with a treating chamber, of a pair of rotatable electrodes positioned therein, a source of fluctuating-current supply therefor, each of said electrodes being adapted to emit silent non-disruptive discharges and to function as a collecting electrode for the other electrode, and means for rotating said electrodes in synchronous relationship to the current in said supply circuit, said electrodes being so constructed that, upon rotation of the same, a gas or vapor, during its passage through said treating chamber, is constrained to move across the path of said non-disruptive discharges, whereby the particles suspended in said gas or vapor are charged by said non-disruptive discharges.

9. An electrical precipitator including, in combination, a pair of electrodes, means whereby said electrodes may be alterntely raised to positive and negative potentials, each of said electrodes being provided with rib portions and channel portions, said electrodes being disposed in coöperative relationship such that the rib portions of each one will coöperate with the channel portions of the other, whereby an electric discharge will be given off from the respective rib portions and the charged particles will be attracted toward the respective channel portions.

10. In an electrical precipitating system, the combination with a treating chamber, of rotatable electrodes positioned therein, a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said rib portions being adapted for use as discharge electrodes and said channel portions being adapted for use as collecting electrodes, and means for rotating said electrodes so that they alternately assume the functions of a discharge electrode and of a collecting electrode.

11. In an electrical precipitating system, the combination with a treating chamber, of rotatable electrodes positioned therein, a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said rib portions being adapted for use as discharge electrodes and said channel portions being adapted for use as collecting electrodes; and means for rotating said electrodes, said electrodes being so positioned and so rotated that said rib portions are opposed to said channel portions in synchronous relationship to said current supply.

12. In an electrical precipitating system, the combination with a treating chamber, of rotatable electrodes positioned therein, a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said rib portions being adapted for use as discharge electrodes and said channel portions being adapted for use as collecting electrodes; and means for rotating said electrodes, said electrodes being so positioned and so rotated that said rib portions are opposed to said channel portions during substantially the same period that a negative potential is impressed on said rib portions from said source of current supply.

13. In an electrical precipitating system, the combination with a treating chamber, of electrodes positioned therein and a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said channel portions comprising screen members extending between said rib portions.

14. In an electrical precipitating system, the combination with a treating chamber, of a pair of hollow, relatively movable electrodes positioned therein, and a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said channel portions comprising screen members extending between said rib portions, and the rib portions of each electrode being so energized from said source of current supply that silent electric discharges are emitted therefrom during substantially the same period that the screen portions of the other electrode are

opposed to said rib portions, whereby particles passing between said electrodes are charged and thereafter forced through said screen into the interior of said electrode.

15. In an electrical precipitating system, the combination with a treating chamber, of dimorphous electrodes positioned therein, and a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said rib portions being so energized from said current source that silent electric discharges are emitted therefrom, said channel portions consisting of screen members extending between said rib portions, and said electrodes being further provided with an interior conducting member which is adapted to have a potential impressed thereon from said current source.

16. In an electrical precipitating system, the combination with a treating chamber, of dimorphous electrodes positioned therein, and a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said rib portions being so composed and being so energized from said current source that silent electric discharges are emitted therefrom, said channel portions consisting of screen members extending between said rib portions and said electrodes being further provided with an interior conducting member which is adapted to have a positive potential impressed thereon from said current source, said interior member having said positive potential impressed thereon during substantially the same period that said rib portion of the opposed electrode is emitting electric discharges, thereby charging particles passing between said opposed electrodes and attracting the same to the positive or collecting electrode.

17. In an electrical precipitating system, the combination with a treating chamber, of dimorphous electrodes positioned therein, and a source of current supply therefor, said electrodes being provided with longitudinally extending rib and channel portions, said rib portions being so composed and being so energized from said current source that silent electric discharges are emitted therefrom, said channel portions consisting of screen members extending between said rib portions; and said electrodes being further provided with interior conducting members which are adapted to have a positive potential impressed thereon from said current source, said interior members having said positive potential impressed thereon during substantially the same period that said rib portion of the opposed electrode is emitting electric discharges, thereby charging particles passing between said opposed electrodes and attracting the same to the positive or collecting electrode through said screen members; said interior members further having such convolutions that, when said particles are attracted thereto, they are urged in a direction opposite to that of the gas or vapor passing through said treating chamber, by the rotation of said interior members.

18. In an electrical precipitating system, the combination with a treating chamber, of rotatable discharge and collecting electrodes positioned therein, and a source of current supply therefor, said discharge electrode being adapted to emit silent non-disruptive discharges, whereby particles passing between said electrodes are charged with a potential of the same sign as that impressed on said discharge electrode and are thereafter attracted to said collecting electrode by the charge residing thereon; and means integral with said electrodes to urge said collected particles in a direction opposite to the direction of flow of the gas or vapor being treated.

19. In an electrical precipitating system, the combination with a treating chamber, of electrodes therein, means for directly connecting an alternating potential thereto, and means for causing the respective electrodes to emit corona of the same polarity irrespective of the impression thereupon of said alternating potential.

20. A precipitator as specified in claim 9, in combination with means for rendering the rib portions of each electrode relatively inactive during the intervals when said electrode is positively charged with respect to the other electrode.

21. The method of precipitating suspended particles from a fluid which consists in charging said suspended particles by a corona discharge, attracting said charged particles to collecting surface and thereafter causing said particles to move in a direction opposite to that of the fluid in which they are suspended.

22. The method of electrically precipitating suspended particles from a fluid which consists in establishing an active electric field, repeatedly passing said fluid through said field and thereby charging the particles suspended therein, attracting said charged particles to a collecting surface and thereafter urging said particles in a direction substantially opposite to that in which the fluid being treated is moving.

23. In an apparatus for separating suspended particles from gases, a pair of spaced electrodes, channel means for causing said gases to pass in the space between said electrodes, means whereby said electrodes may be alternately raised to positive and negative potentials, each of said electrodes being provided with discharge-emitting portions and screen portions, said electrodes being disposed in coöperative relationship such that the discharge-emitting portions of each one

will coöperate with the screen portions of the other, each electrode having charged portions placed back of said screen portions, whereby particles passing between said electrodes are charged and thereafter forced through said screen portions out of the main path of said gases.

24. An apparatus as specified in claim 23, in combination with means for urging said removed particles in a direction opposite to the gas stream.

25. In an apparatus for separating suspended particles from gases, a channel through which said gases pass, the side walls of said channels having screen portions, means for causing said suspended particles to be attracted through said screen portions out of the main gas stream and mechanical means for urging said removed particles in a direction opposite to the gas stream.

26. In an electrical precipitating system, the combination with a treating chamber, of dimorphous electrodes positioned therein, a source of current supply therefor, and means whereby said electrodes are constrained to alternately perform the functions of a discharge electrode and of a collecting electrode, each discharge portion of an electrode being relatively inactive while a portion of that electrode is active as a collecting electrode.

In testimony whereof, I have hereunto subscribed my name this 12th day of March, 1918.

LEWIS WARRINGTON CHUBB.