July 12, 1938.

H. C. ENGELMAN

2,123,464

ELECTRODE RAPPING

Filed Aug. 28, 1936

3 Sheets-Sheet 1

FIG. 2.

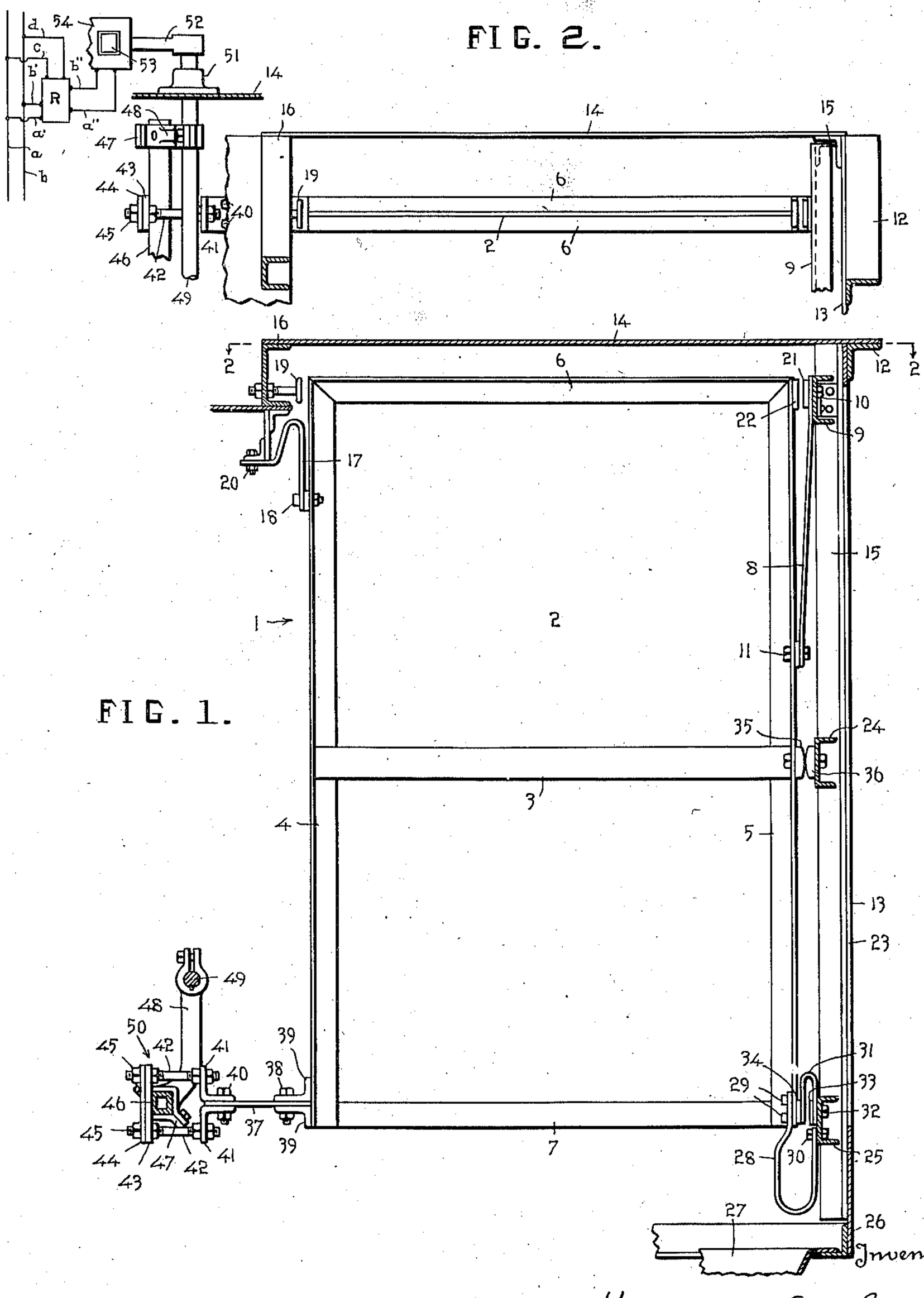

FIG. 1.

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FIG. 4.

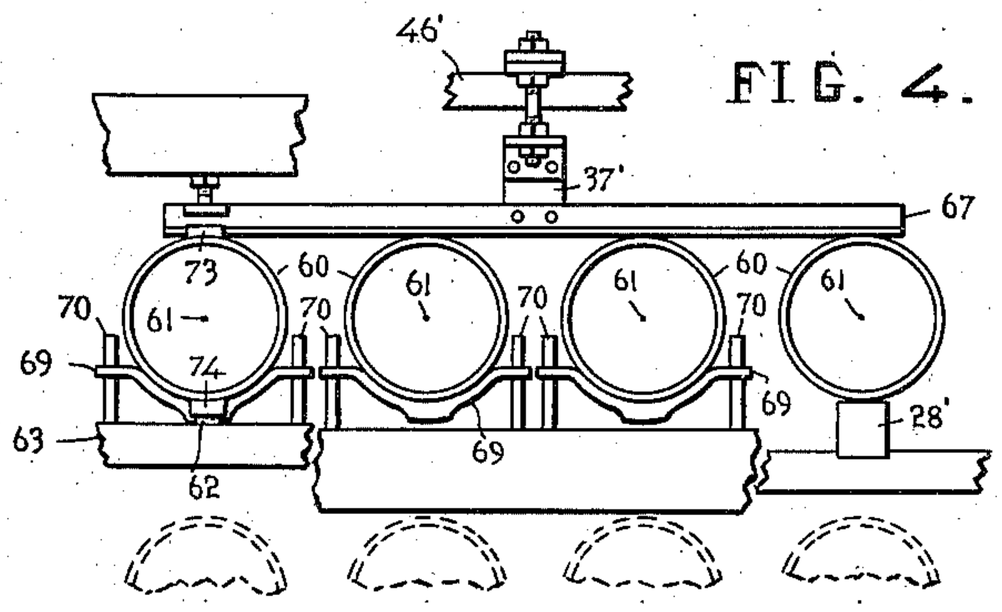

FIG. 3.

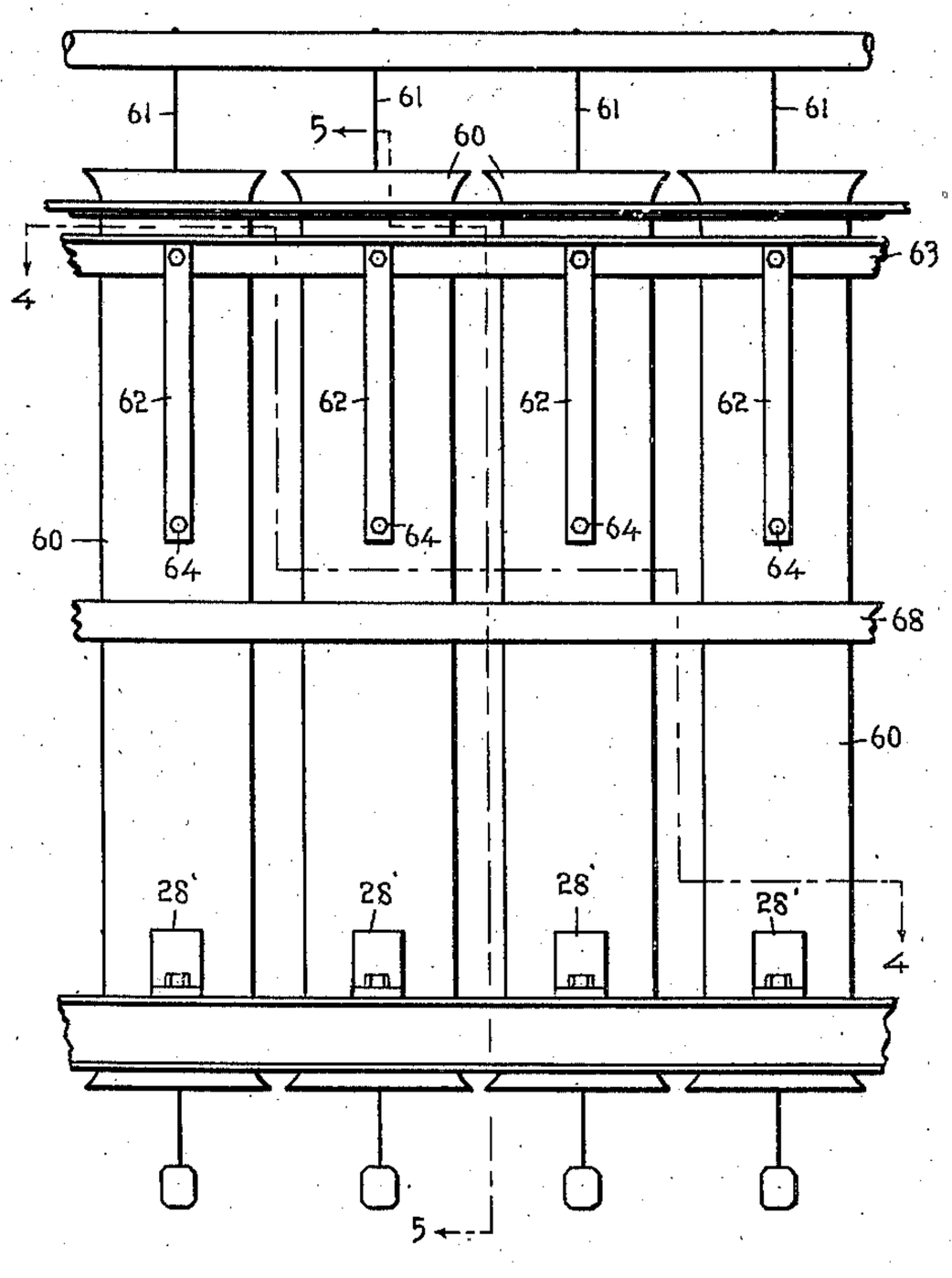

FIG. 5.

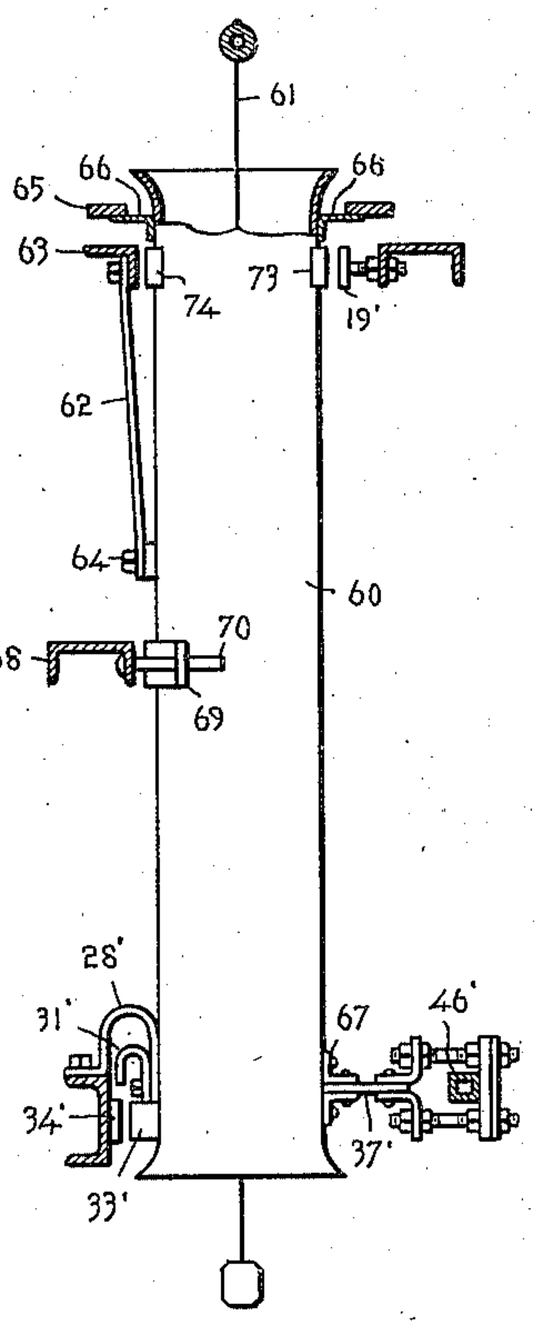

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FIG. 6.

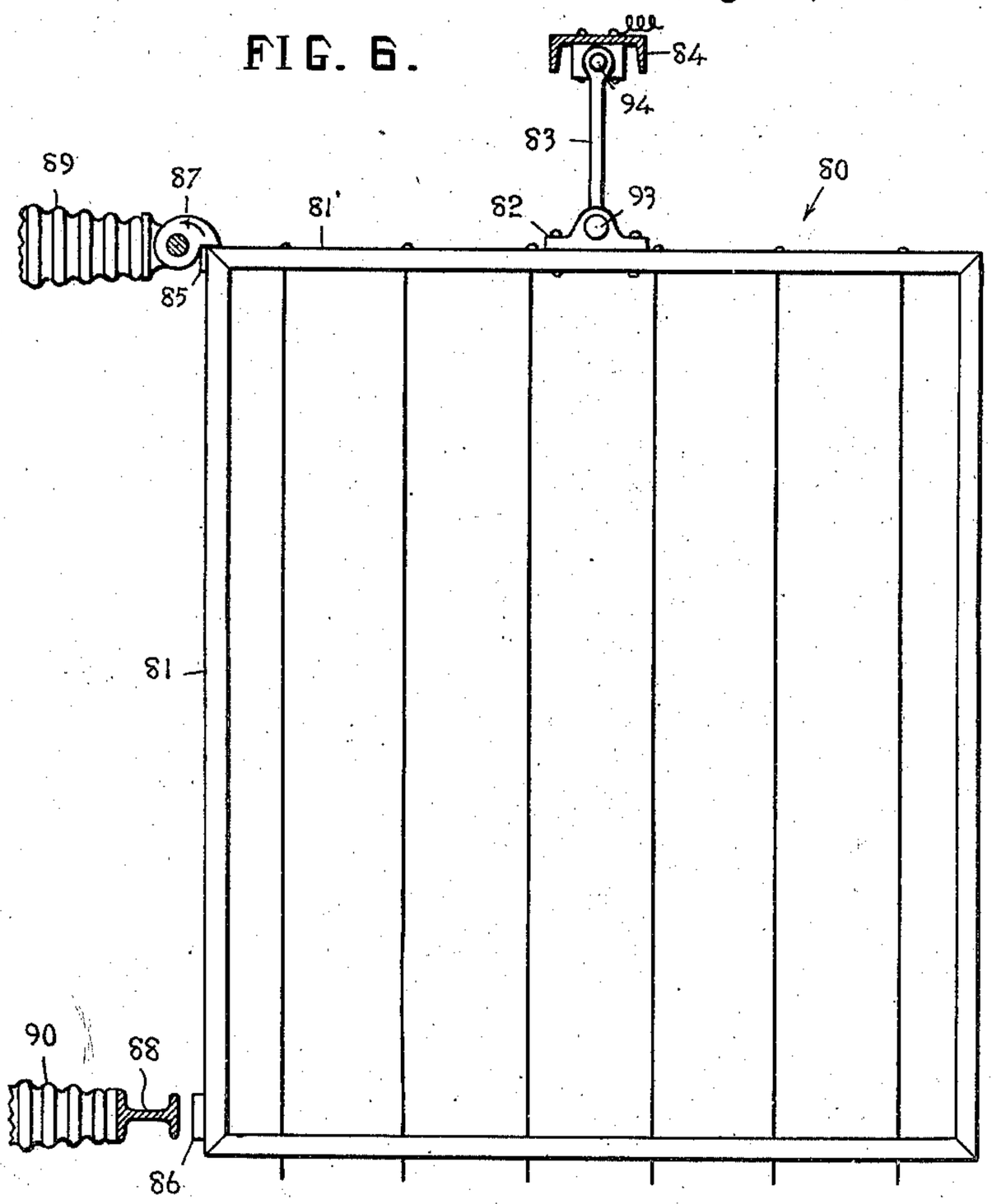


FIG. 7.

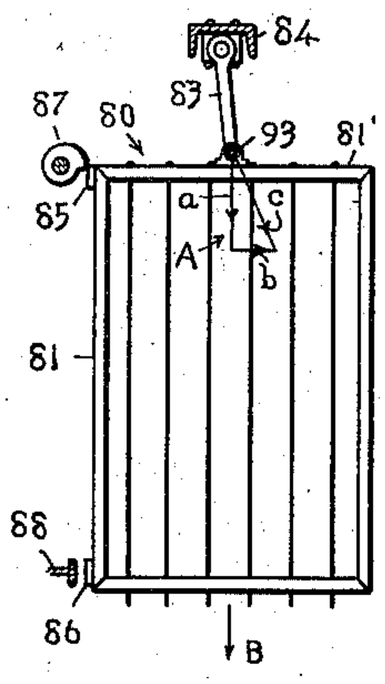


FIG. 8.

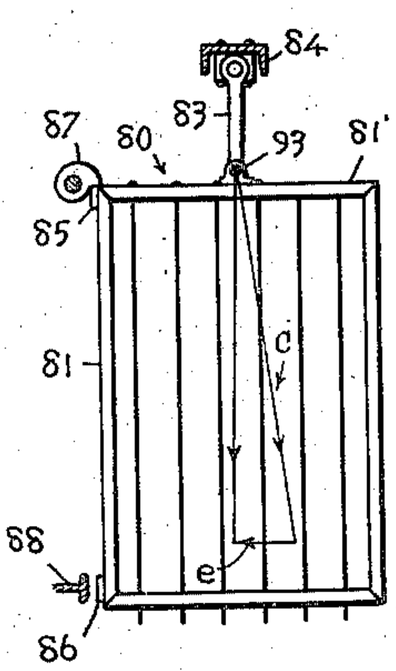


FIG. 10.

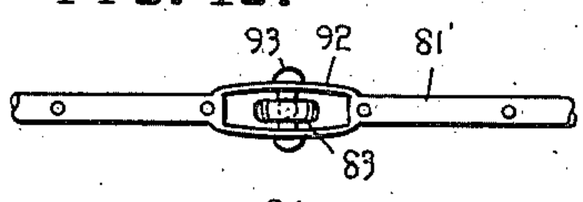


FIG. 9.

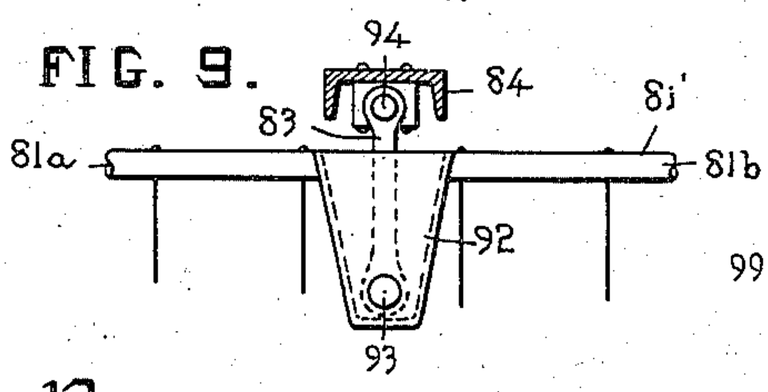


FIG. 11.

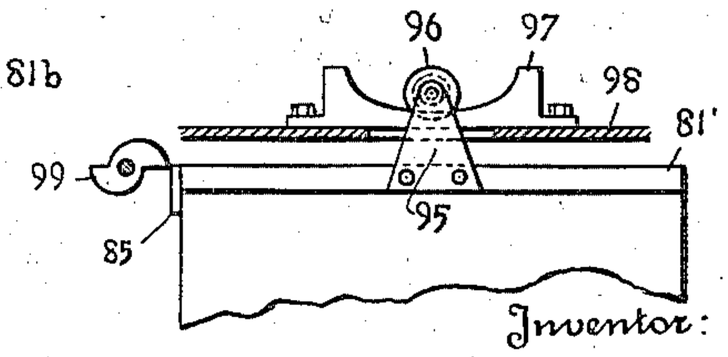
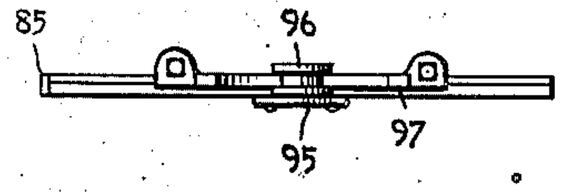


FIG. 12.



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UNITED STATES PATENT OFFICE

2,123,464

ELECTRODE RAPPING

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Application August 28, 1936, Serial No. 98,419

12 Claims. (Cl. 183—7)

This invention relates to electrodes for apparatus commonly referred to as electrical precipitators and utilized for removing suspended particles from fluids. It is particularly directed at improvements in the suspending and jarring of electrodes to bring about the dislodgement of the material that is electrically deposited on the surfaces of the electrodes.

It is common practice at the present time, where it is desirable to remove the deposits in dry condition, to pass scraping means across the surfaces upon which material has been deposited, or to rap the electrodes by striking them with hammers or similar jarring means with manually or mechanically operated mechanisms, or to lift them a short distance and then let them drop upon suitable anvils.

Scrapers that operate satisfactorily are complicated and expensive and usually necessitate shutting off the power before they can be operated. Where rappers have been used it has been customary to have them directed at one or two points on the frame of the electrode where it is structurally able to sustain repeated shocks. But the vibrations imparted at these local positions are seldom severe enough to produce movement over the entire surface of the stiffened electrode. Most electrodes are made up of several members of different weight and shape and nodes of little movement with relation to vibrations set up at distant points commonly exist. At such nodes the removal of the deposit is not satisfactory.

It is an object of the present invention to provide means for imparting vibrations to an electrode or electrode assembly in such manner that several trains of effective vibrations will proceed over the surface of the electrode from several points thus eliminating the possibility of a node exisiting at any point on the electrode throughout the rapping cycle.

Another object of the invention is to provide a non-rigid and preferably flexible support for an electrode so that the electrode can be readily moved, rapped and vibrated in a manner conducive to the removal of material clinging thereto.

Still another object of the invention is to provide an improved mechanism for imparting movement to an electrode so that especially effective jarring is furnished for removal of deposits from the surface of the electrode.

The manner of realizing the above mentioned and further objects of the invention is set forth in the description that follows, reference being had to the appended drawings in which:

Fig. 1 shows a plate type collecting electrode, in side elevation, supported in accordance with the invention;

Fig. 2 is a plan view of the electrode shown in Fig. 1;

Fig. 3 shows a group of pipe collecting electrodes, in side elevation, arranged to be shaken in accordance with the invention;

Fig. 4 shows, in a horizontal section taken along 4—4 of Fig. 3, the electrodes and supporting means shown in Fig. 3;

Fig. 5 is an end elevational view of the assembly shown in Fig. 3;

Fig. 6 is a side elevational view of an assembly comprising discharge electrodes, a supporting frame, and means for supporting and jarring the electrodes in accordance with the invention;

Figs. 7 and 8 are diagrammatical views of the assembly shown in Fig. 6 to illustrate the utilization of the forces that jar the assembly;

Figs. 9 and 10 are fragmentary views in side elevation and plan, respectively, of an alternate suspension for the assembly shown in Fig. 6; and

Figs. 11 and 12 are fragmentary views in side elevation and plan respectively of a further suspension for the assembly shown in Fig. 6.

Referring to Figs. 1 and 2, 1 is the general identifying symbol of the electrode assembly comprising plate 2, reinforcing strip 3 and framing members 4, 5, 6 and 7. Electrode assembly 1 is located in an enclosure through which gas passes while being electrically cleaned, the enclosure being indicated in part in Fig. 1 by side plates 14, end plate 13 with exit (or entrance) opening 23. Structural members 9, 12, 15, 16, 24, 25 and 26 reinforce the enclosure and furnish supports for the hopper, indicated by 27, and for the electrodes, and rapping means as will be explained more in particular later. Electrode assembly 1 is shown attached to supporting or shaking members at four points. Depending member 8, preferably a flexible strap, is attached to member 5 by fastening 11 and to supporting member 9 by fastening 10. Member 8 sustains most of the weight of assembly 1 and, because of its flexibility and because the point of attachment, at member 11 is well down the side of the frame—usually from one-fourth to one-half of the length of the frame, member 8 sets up little resistance to movements of the assembly. The assembly is also guided and given further support by spring member 17 attached

with fastening 20 to local members which in turn are supported by structural member 16 and to frame member 4 by fastening 18. A stop 19 adjustably attached to member 16 limits the movement of the electrode at this corner of the assembly. Another spring member 28 is fastened to the electrode assembly by screws 29 and to structural member 25 by fastening 30. Member 31 is a bumper attached at one end to member 25 by screw 32 and free at the other end where it contacts anvil 34 on member 5 as anvil 34 approaches complementary anvil member 33 and thereby cushions the jar that would otherwise be imparted to the structural members of the enclosure if unyielding members 5 and 25 hit together strongly through members 33 and 34.

Other anvil means are provided in complementary members 35 and 36, the former being attached to frame member 5 of the electrode and the latter to structural member 24 of the precipitator proper. These members terminate the movement of the electrode at this point but also act as a fulcrum about which the electfode may turn in the plane of its maximum surface. The face of one or both anvils is curved to admit more readily such turning movement.

A strap 37 is fastened to frame member 4 by bolts 38 and clip angles 39, the latter being preferably welded to member 4, and the strap is fastened by bolts 40 to a yoke 50 comprising angle pieces 41, bolts 42, cushioning pad 43, pad supporting strap 44 and nuts 45. A crank 48 with vise end 47 supports and moves a flat sided rod 46 which projects through yoke 50 and exerts a pushing force against pad 43 when crank 48 is swung by shaft 49 upon which it is mounted. Shaft 49 projects through wall 14 and rotates in bearing 51. Rotation is brought about by the energization of solenoid 54 which pulls upwards on plunger 53 and crank 52. Energization of solenoid 54 may be accomplished by manual control but, preferably, an automatic relay and time control means of commercially available type indicated by symbol R is used. Control R is operated by a local electric circuit *c*, *d*, and control R, in turn, controls the flow of current from power source *a*, *b*, through leads *a'*, *b'*, and *a''*, *b''* to solenoid 54. For simplicity, only one electrode has been indicated as being rapped by bar 46 through the energization of solenoid 54. In practice, several electrodes are rapped by a single solenoid and the energization of as many as eight solenoids may be controlled by a single time control and relay.

The embodiment of the invention illustrated in Figs. 1 and 2 operates as follows. Assuming that observations have indicated that the electrodes become sufficiently coated with material to require rapping once an hour, time control R is set to energize solenoid 54 every hour for a period just long enough to pull plunger 53 up into the field of the solenoid. Plunger 53, acting through crank 52, shaft 49 and crank 48 causes bar 46 to strike pad 43 of yoke 50 and thereby shake electrode 1. The energization of solenoid 54 is so timed that after the current is discontinued there is a small travel of the parts mentioned and the final position of electrode 1 at clip angle 39 is, for example, one half inch away from its normal position. Following the movement of the electrode assembly just described and the de-energization of actuating means 54, the assembly swings in the opposite direction, due partly to the force of gravity and partly to the tension in spring 28, and anvil members 35 and 36 strike together. The bottom of the assembly continues to move, because of inertia and the continued tension in spring 28, and turns about member 36 as a fulcrum. Almost immediately after the contact of members 35 and 36, member 33, the free end of spring 31 and member 34 strike together, the impact being cushioned somewhat by spring 31. Simultaneous with, or immediately after, the impact at anvil 34 the top end of assembly 1 swings over and member 4 strikes against stop or anvil member 19 and there is usually sufficient rebound from this impact to cause members 21 and 22 to strike together.

It is impossible to anticipate exactly the nature and amplitude of the movements set up but it is possible to vary the movements somewhat by changing the characteristics of springs 28 and 17, changing the length of member 8, the position of member 19, and the movement of strap 37. But while the motions may differ in degree, the overall results of suspending the electrode in non-rigid manner and imparting jarring impacts to it at a plurality of separated points are very satisfactory. Portions of the surface which do not receive vibrations from an impact at one point vibrate when other points are struck.

In Figs. 3, 4 and 5, pipes 60 serve as collecting electrodes in an electrical precipitator with axially positioned wires 61 functioning as discharge electrodes. Each pipe 60 is separately suspended by flexible, or non-rigidly fastened, straps 62 to a common supporting member 63, the straps 62 being fastened to the outside surface of the respective pipes 60 by tap bolts 64, or other suitable means, at positions about one third down the side of the pipes. Along the side of the pipes near the bottom a common member 67 is fastened in a horizontal position, four pipes being shown connected together by such a member in Fig. 4. A strap 37' is attached to member 67, preferably at the mid position, and a bar 46' comprised in actuating mechanism similar to that described in connection with Fig. 1, is for exerting a pull on strap 37' and initiating the movements that result in jarring the pipes. Anvils 33', 73 and 74 are fastened to each pipe and strike against restraining members 34', 19' and 63 respectively. A member 69 fastened to the outside of each pipe at approximately the mid point of its length contacts restraining member 68 and permits rocking of the pipe at this point. The ends of member 69 project out from the pipe and have holes in them through which guide pins 70 project. The pins 70 are only necessary if straps 62 and 37' and spring 28' are so yieldable that they do not maintain pipes 60 in proper position with regard to discharge electrodes 61. To permit motion of the upper end of the pipes, the opening in header plate 65 is made larger than the pipe and the annular space is closed with a flexible sheet 66 for instance, of canvas, or of asbestos.

The pipes shown in Figs. 3, 4 and 5 are jarred in much the same way as is the plate in Figs. 1 and 2. Referring to Fig. 5, the pipes 60 are pulled over out of their normal position by strap 37' and permitted to swing back, the voltage across the electrodes being preferably lowered during rapping. Members 68 and 69 strike together and at almost the same time members 33' and 34' strike together, the jar being tempered, if advisable, by a cushioning spring 31'. There is then a reaction that permits the top of the pipe to swing over so that pad 74 strikes member 63 followed usually by rebounds that alternately cause anvil pad 73 to strike restraining member 19' and pad 74 to strike structural member 63.

The discharge electrode assembly identified by numeral 80 in Fig. 6 comprises a frame 81 with horizontal top member 81', a bearing retaining member 82 attached to member 81' and carrying a bearing with pin 93, and anvil pads 85 and 86. Assembly 80 depends from a structure 84, electrically insulated from grounded parts by means not shown, by link 83, with rotatable means, such as pins, at 93 and 94 allowing movement of link 83. In the operation of electrical precipitators, the discharge electrodes are usually maintained at high potential above ground. All members in contact with assembly 80 must, therefore, be insulated from the grounded shell and the collecting electrodes comprising the precipitator of which assembly 80 is a part. To fulfill this requirement, the bearings supporting the cam shaft which revolves cam 87 are mounted on insulators 89 and restraining member 88 is mounted on insulators 90, a fragmentary portion of one of each of these insulators being shown in Fig. 6.

Where it is desired to save head room, supporting structure 84 can be lowered by using the construction shown in Figs. 9 and 10. In this construction, member 81' of frame 81 is made up of two pieces 81*a* and 81*b* joined by a structurally strong sleeve 92 with a hole in the bottom to let dust fall through. Bearings held in the sides of pocket 92 near the bottom thereof support pin 93 to which link 83 is fastened and about which it may rotate.

In the form of suspension shown in Figs. 11 and 12, as in those shown in Figs. 6, 9 and 10, the electrode member is supported for pivotal movement about a movable pivot point symmetrically positioned with respect to the electrode.

In this construction the top member 81' of the electrode frame has fastened thereto a member 95, bent at right angles at its upper end to form a bearing for roller 96 which runs in curved track 97 supported directly upon the roof 98 of the precipitator. The electrode is displaced from its normal position by means of double cam 99.

The manner in which the invention as embodied in Figs. 6, 9 and 10 functions will now be explained with reference to Figs. 7 and 8. As cam 87 is rotated to bring the "high" surface of the cam in contact with pad 85 on frame 81, the electrode assembly 80 moves to one side. The force now acting in link 83, represented in diagram A by *c* may be considered the resultant of the force of gravity pulling directly downwards as represented by *a* and a horizontal component, due to the action of the cam, as represented by *b*. The electrode frame proper hangs vertically and the force acting upon it below pin 93 is that of gravity represented by arrow B. Now when the high point of cam 87 slips off pad 85, the forces are no longer in equilibrium and the unbalanced horizontal pull on pin 93 represented by *b* causes the top end of the frame to move quickly towards cam 87 and hit strongly the bottom surface of the cam. The bottom end of the frame, because of inertia, does not move over simultaneously with the top end with the result that the center of gravity of the mass making up the electrode assembly is now off center with regard to a perpendicular line passing through point of suspension 93 and integrated forces with a horizontal component represented by *e* in diagram C pull the bottom of the frame over and cause it to strike stop 88. In fact, a set of jerky, oscillatory, movements are set up which cause the frame to strike first at 87 and then at 88.

The support shown in Figs. 11 and 12 operates in the same manner as that described for Figs. 6, 9 and 10, except that the pivot point of the electrode suspension moves along curved track 97 when the electrode is moved to one side by a cam or other means. The resulting forces may be represented by diagrams similar to Figs. 7 and 8 and a similar series of jerky, oscillatory motions will be set up.

It will be seen that a common characteristic of the electrode supporting and rapping devices of the invention is that the electrodes are supported so as to provide for an essentially gyratory motion in the plane of vibration as distinguished from a translatory or simple oscillatory motion of the devices of the prior art and that this gyratory motion in cooperation with striking members or anvils results in a highly effective jarring of the electrodes at a plurality of points. The term "gyratory" in the specification and claims is intended to define simultaneous curvilinear motion about at least two separate points.

I claim:

1. In an electrical precipitator, an electrode, means suspending said electrode for gyratory motion, anvil members positioned adjacent said electrode, at least one of said anvil members providing a fulcrum about which the electrode may oscillate when in contact therewith, and means for displacing said electrode from its normal position.

2. In an electrical precipitator, an electrode, means suspending said electrode for gyratory motion, anvil members positioned adjacent said electrode, means for displacing said electrode from its normal position, and releasing the electrode in its displaced position.

3. In an electrical precipitator, an electrode, means suspending said electrode for gyratory motion in a vertical plane, anvil members positioned adjacent said electrode, means for displacing said electrode from its normal position and for releasing the electrode in its displaced position.

4. In an electrical precipitator, an electrode assembly comprising an electrode, means suspending said electrode for gyratory motion, means for displacing said electrode and for releasing the electrode in its displaced position and anvil members positioned adjacent said electrode to provide a plurality of successive blows at different points on said electrode.

5. In an electrical precipitator, an electrode assembly comprising an electrode, means suspending said electrode for gyratory motion, means for displacing said electrode and for releasing the electrode in its displaced position and anvil members positioned adjacent said electrode to provide a plurality of successive blows at different points on said electrode at least one of said anvil members being adjustable in position with respect to said electrode.

6. In an electrical precipitator, an electrode assembly comprising an electrode, resilient means suspending said electrode for gyratory motion, means for displacing said electrode and for releasing the electrode in its displaced position and anvil members positioned adjacent said electrode to provide a plurality of successive blows at different points on said electrode.

7. In an electrical precipitator, an electrode, resilient members unsymmetrically attached to said electrode for positioning the same, anvil members positioned adjacent said electrode, and means for displacing said electrode from its normal position.

8. In an electrical precipitator, an electrode, means for suspending said electrode in predetermined position in said precipitator comprising a resilient member connecting said electrode with a supporting element and attached to said electrode at a point outside the vertical axis passing through the center of gravity of said electrode, anvil members positioned adjacent said electrode, means for displacing said electrode from its normal position and for releasing it in its displaced position.

9. A method of cleaning the electrodes of an electrical precipitator which comprises suspending an electrode for gyratory motion in a vertical plane and subjecting it to a succession of blows at at least two different points on said electrode.

10. A method of cleaning the electrodes of an electrical precipitator which comprises resiliently suspending an electrode in a predetermined position and subjecting it to a succession of blows at at least two different points on said electrode.

11. In an electrical precipitator, an electrode, means suspending said electrode for gyratory motion, anvil members positioned adjacent said electrode, and solenoid-operated means for displacing said electrode from its normal position.

12. In an electrical precipitator, an electrode, means suspending said electrode for gyratory motion, anvil members positioned adjacent said electrode, and solenoid-operated means for intermittently subjecting said electrode to a blow and for displacing it from its normal position.

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