

July 26, 1932.

L. DAY

1,869,335

ELECTRIC PRECIPITATOR

Filed Dec. 13, 1926

3 Sheets-Sheet 1

Fig.1

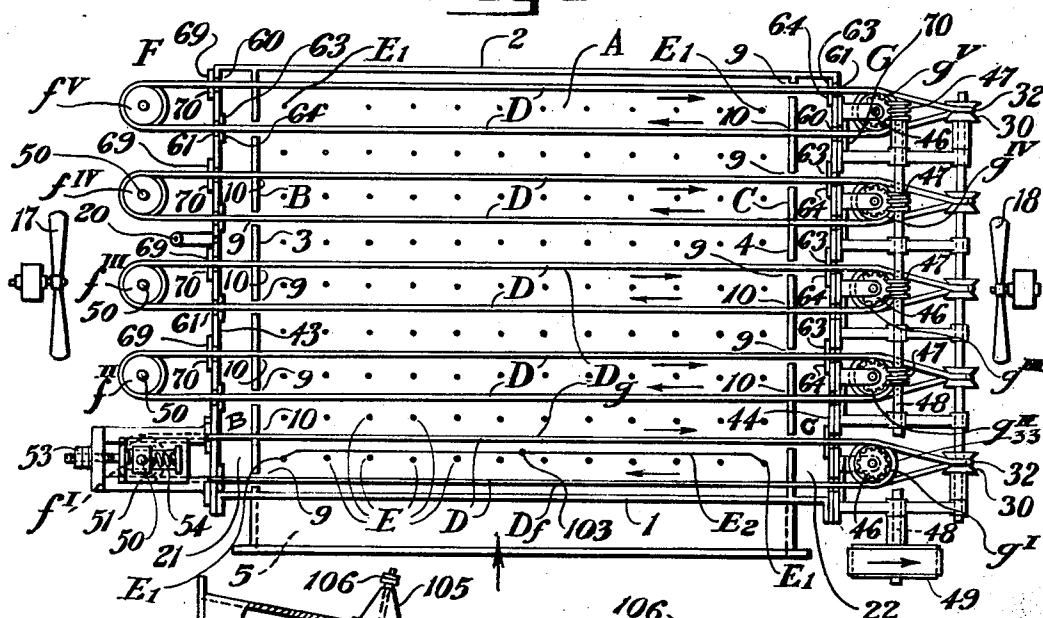
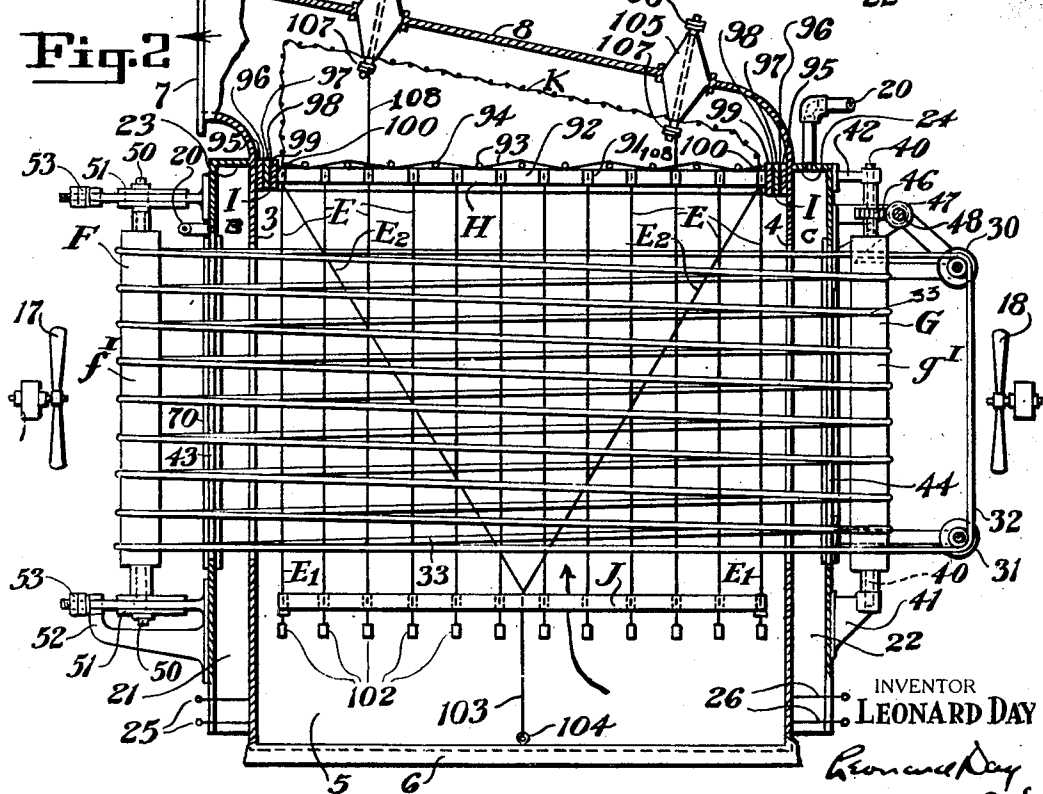


Fig.2



INVENTOR
LEONARD DAY

Leonard Day
ATTORNEY *Pro Se*

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L. DAY

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3 Sheets-Sheet 3

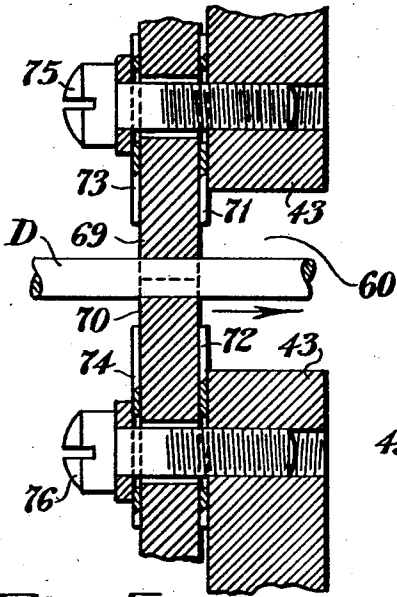


Fig. 5

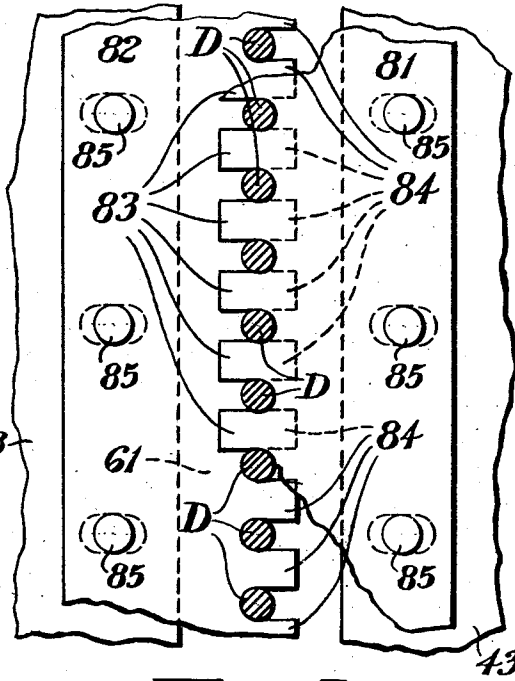


Fig. 6

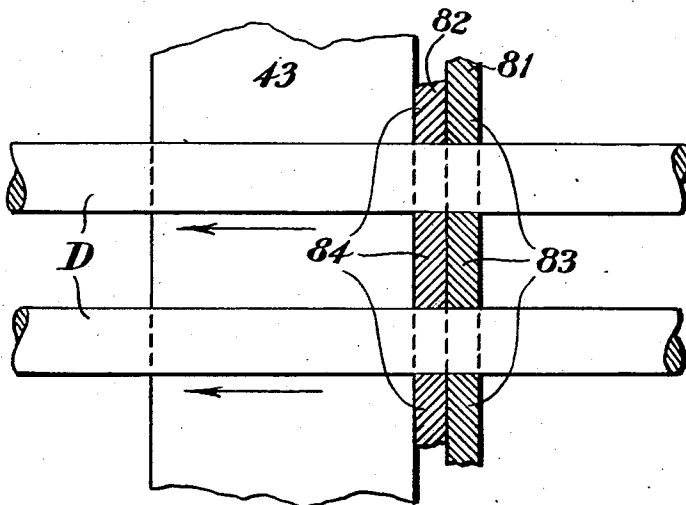


Fig. 7

INVENTOR
LEONARD DAY

BY
Leonard Day
ATTORNEY *PwL*

UNITED STATES PATENT OFFICE

LEONARD DAY, OF NEW YORK, N. Y.

ELECTRIC PRECIPITATOR

Application filed December 13, 1926. Serial No. 154,605.

This invention relates to electrical collectors or precipitators.

One of the principal objects of the invention is to provide practical means whereby an electric collector may operate continuously without shut-down both for the uniform collection and the uniform discharge of both the collected dust and the dust-freed gases. A further object of this invention is to accomplish the aforementioned purpose positively and without the use of liquid to wash off the collected dust. A further object of the invention is to increase the electrical efficiency of an apparatus of this type, which feature of the invention is based upon the understanding and belief that dust particles carried by a gas between two conductors one positive and the other negative for the most part collect upon the positive conductor by reason of the fact that negative charges of electricity are more rapid in their motion than are positive charges and therefore more negative charges reach more dust particles than do positive charges, and further upon the theory and belief that it is really an electron discharge from the negative plate which effects the desired result.

To this end it is an objective not to rely solely upon a high difference of electric potential but to utilize two unlike electrodes for the charging of the dust particles, one an ordinary conductor in this instance preferably steel piano wires for the ground or positive electrode and the other a rare earth oxide coated or covered conductor. The outflow of electrons is partially excited by having the negative electrode partially excited by heating to throw off an increased and in fact great quantity of electrons to effect the negative charging of the dust particles and cause them to adhere to the ground conductor. Thus the negative electrode is deliberately an electron emitting substance.

A further object of the invention is to provide means which will carry the collected particles out of the heat zone into a non-injurious zone before injurious action upon the collected particles can take place, which is of most importance in connection with the powder from dehydrated fruit juices. A

further object of the invention is to provide discharge pocket chambers for the collected powders which are located out of the main stream of powder laden gas. It is a further object of the invention to subject the collected powder in these pocket chambers to preservative conditions almost immediately after the powder is collected, for example, to a safely low temperature; to a substantially dry atmosphere; to an atmosphere incapable of oxidation. It is a further object of the invention automatically to lead the collected powder as directed by gravity to packaging apparatus and this while the collected powder is constantly subjected to the most favorable conditions for its preservation. A further object of the invention is to maintain all parts accessible to human contact at the potential of the earth and particularly it is an object to maintain all mechanical parts at the earth's potential.

It is also a further object of the invention to maintain a substantial hermetical seal between the outer atmosphere and the interior of the precipitation apparatus while permitting the exit therefrom of a collection screen.

Pocket chambers are provided for the discharge of the collected dust and it is an object of the invention to prevent the circulation of air currents between these pocket chambers and the main collection chambers.

The above will be pointed out more in detail in the following claims which are directed to illustrative embodiments of my invention solely for the purpose of illustration and not limitation. Illustrative embodiments of the invention are described in the following specification and shown in the accompanying drawings, which form a part hereof and in which like characters designate corresponding parts in the several figures.

In the drawings, Fig. 1 is a diagrammatic plan view with parts removed of one form of my invention;

Fig. 2 is a diagrammatic front elevation with parts broken away and parts in vertical section;

Fig. 3 is a fragmentary perspective view in detail of the electric ceiling and the grids;

Fig. 4 is a fragmentary horizontal section, partly shown in plan and drawn to an enlarged scale, of the preferred form of sealing means for the exit of the collection screen;

Fig. 5 is a similar view of the preferred form of sealing means for the entrance of a collection screen;

Fig. 6 is an interior enlarged fractional elevation, parts shown in section, of a modified means for sealing the exit for a collection screen; and

Fig. 7 is transverse vertical section of the parts shown in Fig. 6.

A is the main collection chamber and is demarked laterally by sheet metal walls, front wall 1, back wall 2, and the left pocket chamber wall 3 and the right pocket chamber wall 4. The induction mouth for the chamber A is indicated by 5 which is the entrance opening into a hood 6 discharging and expanding upwardly into the chamber A. The effluent opening 7 is the mouth of a similar hood 8 for discharging the dust-freed gases.

These hoods 6 and 8 hermetically seal off the chamber A from the outer atmosphere as far as they extend. The chamber A however, is in free gaseous connection with the lateral pocket chambers B and C through vertical slots 9 and 10 of a size to permit the passage of the collection screens D together with their loads of collected powder. The slots 9 are larger because it is through these that the powder loads are conveyed out of the main chamber into the pocket chambers. The slots 10, however, need be just wide enough to pass the collection screens and virtually do not constitute openings between the chamber A and the chambers B and C. In practice when the apparatus is running under load the charge of powder on this travelling screen very nearly fills the larger slots 9 so that the virtual opening between the main chamber A and the pocket chambers B and C is only sufficient to maintain an equalization of gas pressure between them. Thus no circulation of the main stream of dust laden gas passing upwardly through the main chamber A has a tendency to flow into the lateral pocket chambers or vice versa. In fact, it is possible to maintain a totally different atmosphere in these pocket chambers from that in the main chamber A. This is easily accomplished by introducing at appropriate localities pipes 20 leading from a source under pressure of suitably conditioned gas preferably absolutely dry carbon dioxide gas, which may readily be obtained by expansion from a cylinder of liquid carbon dioxide, freezing out all water content by the expanding process, and then quietly allowing the discharge of the dry cold carbon dioxide gas into the pocket chambers B and C at such a rate as to maintain these

chambers and the bottom discharge chutes 21 and 22 constantly filled with this non-oxidizing absolutely dry cool gas. By regulating the inflow of this carbon dioxide gas a slow discharge of gas through the slots 9 and 10 into the main chamber A is effected. But this inflow should not be at a sufficient rate materially to upset the pneumostatic balance between the main chamber and the two pocket chambers. In fact it is necessary only to insure its existence in the pocket chambers. The partitions 3 and 4 are respectively closed at the top by the walls 23 and 24 while the chutes 21 and 22 are closed by the complete filling of the collected powder. Control of its down flow may be effected, if desired, by a pair of slide gates 25 and 26. The chamber A constitutes the collecting zone of the apparatus; the pockets B and C, the discharge zone or zones; and the exterior of the apparatus, the driving zone.

Cooperating with the movable screens D are vertical pendant electrodes E adapted to be connected to the negative terminal of a high tension source of D. C. electricity while the screens D and all metal walls are connected to the ground and to the positive terminal of the same source. The source is preferably rectified A. C. Each of the conductors E is formed preferably from a length of braided wire ordinarily known as picture cord the interstices and surfaces of which, are imbedded and covered with an adherent substance readily emitting electrons such as a mixture of the rare earth oxides, such as the oxides of strontium, barium and calcium. These electron emitting substances are selected particularly with regard to their ability to be excited by heat. The dust particles in the dust laden gas moving on between the screens D and the charged conductors E are negatively charged and move to and adhere upon the moving screens D as collectors upon which they are carried out into the collecting zone of pocket chambers B and C scraped off and dropped by gravity into the chutes 21 and 22, this process taking place continuously and commensurately with the flow of gas through the collector.

For the driving of the collector screens left and right hand sets F and G of vertically mounted rotatable drums are provided, drums f' and g' constituting a pair of drums for the screens D f and D g . For each of the drums G that is for each pair of drums such as f' and g' is provided one pair of idlers 30 and 31 vertically spaced corresponding to the beginning and ending convolutions of the wire 32. Many convolutions 33 go to make up the screens. In fact, in the preferred form, the convolutions are side by side in actual contact extending side by side upwardly in vertical planes for as much as 10 feet while the horizontal span of each wire

between partitions 3 and 4 may be 10 or more feet, it being borne in mind that these movable collection screens are not subject to buckling or distortion because of the fact that each elemental part thereof is a stretched wire, preferably a steel piano wire, of small cross section, although if desired braided steel wire like picture cord may be employed. But one joint in all the wire constituting two entire screens is theoretically necessary to carry the beginning convolution across to the ending convolution as indicated by 32. This minimum number of joints are readily made by butt welding or splicing so that the uniform cross section of the wire is unaltered. This results in a movable screen the cross section of which is uniform throughout, that is, practically jointless. This enables the screen to lend itself to hermetical sealing as it passes through a partition. This could not be the case were a piece of netting or fabric employed, for the screens with their necessary lap joints. It is, however, to be understood that all features of the invention are not limited to screens made up of horizontal convolutions of wire.

Each of the drums G has a suitable axle mounted in suitable bearings 41 and 42 which in turn may be mounted directly upon the wall 44 of the pocket chamber C. Each drum shaft is preferably provided with a worm gear 46 meshing with a worm 47, all worms being fixed to a horizontal drive shaft 48 taking power from the belt driven pulley 49 or any other suitable power source, or the drums may be driven in groups of one or more, each group at an elected different speed to accord with the rate of collection on the screens. The drums on the opposite side of the structure likewise have suitable axles or spindles 50 which may be power driven like the shafts 40, if desired or with sprockets and chains, but they are preferably undriven and are mounted at top and bottom in adjustable spring journal bearings 50 and 52, which in turn may be mounted directly upon the outer wall 43 of pocket chamber B. The nuts 53 may be adjusted to cause the compression springs 54 to assert any degree of resilient force outwardly from the wall 43 which is applied to the corresponding screens through the corresponding drum such as f' . Although in Figs. 1 and 2 but one set of these adjustable spring bearings is shown, and that for the drum f' it is to be understood that similar ones are to be provided for the other drums f' , f'' , f''' , f^{iv} , f^v . It should also be understood that the showing on account of the nature of the apparatus is largely diagrammatic and that the numbers of drums may be increased substantially indefinitely. Although the exterior of the apparatus has been called a driving zone on account of the fact that it is here that the driving mechanism is located,

it might well be called a safety zone because of the fact that all externals of the apparatus within reach of human contact are at ground potential. In fact, only the lead-in wires outside of the apparatus are at high potential.

The relative spacing of all of the parallel screens D is dependent in amount upon the difference of potential maintained between the negative electrodes E mid-positioned between two contiguous screens D and these two contiguous screens. In the present apparatus these screens on account of at least three advantages in the design of the apparatus may be positioned and maintained relatively close together and to the intermediate electrodes E. The first reason is that large loads of collected powder are not permitted to build up on the screens because the screens are constantly moving and constantly being freed from their collected load. When stationary screens are employed it is expedient to run the apparatus before a shut down, until a maximum load has been collected. The second reason is that the screens are made up preferably of a number of independently supported elements, the individual wires, and are therefore not subject to buckling, which buckling would at some localities disastrously shorten the spark gap between electrodes, the same as would the building up of a large load of powder. The third reason is that with this apparatus a very efficient discharge of electrons can be effected at low potential which permits the charging electrodes and the collecting electrodes to be close together.

For economy of space it is preferred that the diameter of the drums F and G correspond to the spaces between two contiguous collector screens, although this is not a structural necessity. If the spacing of the screens becomes so close as to render the bending of a wire about a drum of the same diameter too sharp, all that is necessary is to use larger drums with alternate drums in laterally spaced rows, that is, stagger the drums.

It has been described how the travelling screens, contiguous screens travelling in opposite directions as indicated by the arrows, convey the collected powder into the pocket chambers B and C. It will now be described how the load of powder on the screens is actually dislodged from the screens and discharged in the pocket chambers. The outer walls 43 and 44 of the pocket chambers are formed with entrance and exit slots 60 and 61 vertically of an extent equal to the vertical extent of the screens and of any convenient width. Mounted preferably on the inside of the walls 43 and 44 and for each exit slot is comb means serving three important functions:—One maintaining the arrangement of wires making up the screen in proper spacing, proper vertical position and against creepage on the drums F and G; two, sealing

the interior of the apparatus substantially hermetically against the outer atmosphere; and three, positively scraping off the charge of powder on the screens.

5 In Fig. 4, the most practical embodiment of these comb means is illustrated. Two sheet metal lips preferably sheet spring steel 62 and 64 vertically co-extensive with slots 61 are adjustably applied to the edges of the wall 43 forming the slot 61 as by bolt screws 65 passing through suitable notches. With the screen of wires 32 in position it is preferred that these lips 63 and 64 be forced against the wire screen D until they spring outwardly a slight amount as shown particularly in Fig. 4. The spring is in the direction of the travel of the wires 32. The wires E themselves lie side by side in vertical arrangement are driven and permitted to wear notches 10 leaving intermediate teeth in the edges 67 and 68 of the lips 63 and 64, until ultimately these lips due to their inherent resilience spring back as shown in dot dash lines in Fig. 4. Obviously, if desired, the lips may initially be formed as combs with the semicircular notches to space the wires of the screen but this is unnecessary.

For the entrance slots 60, it is preferred that the hermetical closure be effected as shown in Fig. 5, by securing to the edges of the slot 60 a pair of felt strips 69 and 70, which may be re-enforced by metal strips 71, 72, 73 and 74 and which are preferably adjustably secured to the walls 43 and 44, as by screws 75 and 76. These felt strips are pressed against the incoming wire screen D sufficiently to fill the interstices between wires.

In Figs. 6 and 7 is illustrated a formation for the comb structure modified over the showing in Fig. 4, particularly in that the combs are fabricated before application into engagement with the screens D. Two similar combs 40 81 and 82 the teeth 83 and 84 of which overlap are adjustably secured to the walls 43 and 44 to bridge each slot 61 and completely encircle each of the wires. The teeth 83 and 84 in their roots terminate in semi-circular formations so that the two combs together form a series of metal circles completely embracing the wires. The adjustable mounting may be through the medium of suitable screws passing to the outside of the walls 43 and 44 through suitable slots as indicated for the screws 85.

These combs are preferably fabricated 55 from sheet metal such as saw-steel. For both types of combs the loaded powder on the screen D is positively scraped off into the discharge zone of the pockets B and C just as the screen emerges into the exterior wall. It is possible to adjust these combs so that the entire load of collected powder is discharged into the pocket chambers, but if this is not desired and looser fitting combs are employed, it may be desirable to clean 60 the screens after they have emerged from the

apparatus. This may be done easily by the application of brushes to the screens as they pass over or before they pass over the drums F and G or this function may be delegated to the entrance felt strips 69 and 70 which may here function as wipers to prevent anything but a clean screen entering the collection apparatus. It should be noted that the combs are electrically connected with the metal walls of the apparatus, therefore positively insure that each wire of each screen be grounded before it emerges from the apparatus. Likewise, all the driving mechanism for the drums is grounded and it is preferred that the drums themselves be metal preferably chilled cast iron with smooth outer surfaces so that no special co-ordination between the wires of the screens and the surfaces of the drums is required.

The negative electrodes E are preferably 8 pendant from the top grill work H one electrode pendant from each crossing 90 of the bars 91 and 92 making up the grill work. These bars are preferably overlaid or underlaid by a wire meshed fabric 93 of the same mesh as the grill work but with the crossings 94 of the wires centrally positioned in the openings between the bars of the grill work, so that the grill work together with the wire mesh will constitute an electrical ceiling or repulsion screen immediately above the collection chamber A functioning electrostatically to repel downward all negatively charged particles of dust which have not been collected on the moving collector screens. The space beneath the repulsion screen 93 and between it and the collector screens is open and free so that these gleanings or final particles readily fall and are deflected sidewise to be collected by the moving collector screens. In this way, although the stream of dust laden gas may be flowing at a high rate of speed, the closeness of the collector screens to the negative electrodes together with this repulsion ceiling insures substantially complete elimination of all dust from the flowing gas.

This top grill work H is preferably mounted on the upper extension of the pocket chamber partitions 3 and 4 and outer walls 1 and 2 of the collector. The interior faces of these walls are first covered with a strip 95 of sheet insulation extending all around the interior of the collection chamber like a molding. Upon this strip of insulation is applied a narrower strip 96 of thin sheet metal, etc., so that alternate strips of the same insulating and conducting material are built up, care being taken that the spark gap distance from the inner strip of metal, which may be a bar of grid H, to the nearest grounded part of the structure, such as the wall 4, is more than enough to maintain the potential difference. The alternate layers of insulation and sheet metal elim-

inate local electrostatic stress at any point by distributing or grading the potential between the repulsion ceiling and the grounded walls. This elimination of localized electrostatic stress is important to prevent local building up of precipitated dust. Although in the drawings, for the sake of clearness, this molding insulator is shown only in cross section, as pointed out above, it extends all around the interior of the apparatus and somewhat chokes off the effluent opening of the collector. In the drawings this choking off is relatively greater than it is in practice, because of the fact that the showing must be a finite size and is out of proportion to the rest of the apparatus. This choking off of the effluent opening has an advantage, however, in tending to keep the main stream of dust laden gases inwardly away from the partition walls 3 and 4 upon which it is not desired to build up a charge of collected dust. In fact, if desired, the portions of these partition walls 3 and 4 between the collector screens may be formed of strips of insulating material with a negative electrode lying along the mid interior face of each strip. The strips of insulating material referred to may be laminated of ordinary clear soft pine for collectors in which relatively low temperatures for the dust laden gas maintain. For higher temperatures, it is preferred that the strips of insulation be any suitable sheet insulating material such as sheet mica or mica board. The grill work or grid may be employed structurally to cooperate with this molding insulator by outwardly pressing against it. It is of course to be understood that these features of insulation apply more particularly to a collector when employed with high potential than with low potentials. It is to be understood that the collector may be operated entirely as a high potential collector without the utilization of the special electron emitting material for the electrodes E.

A bottom grill work J is also preferably employed, supported from the top grill work by the four corner electrodes two of which are indicated as E_1 and by two pairs of diagonal electrodes indicated by E_2 extending down in the plane of the electrodes E_1 at the front and back of the apparatus, as shown in Fig. 1. All the other electrodes pass through perforations in the bottom grill J and are provided with small weights 102 at their lower ends, so that each pendant electrode may independently adjust itself like a plumb line. In mounting the collector, it is usually sufficient so to position the collector, that any periodic vibration of the foundation will be in a direction to be overcome by the diagonal guy electrodes E_2 . However, if desired, the pendant electrodes E may be guyed at right angles to the effect of the guys E_2 but carrying down to a central

position a pair of diagonal cords 103 of insulating material or thin pine sticks anchored to a centrally positioned eye 104 on the bottom of the hood 6, the upper ends of these guys corresponding with the points of attachment for the lower ends of the guys E_2 . Again, if desired, the bottom grill J may be mounted upon the walls of the collector through the medium of a second insulator like the molding insulator I.

It is preferred that the high tension negative potential be taken into the apparatus through a plurality preferably four in number, of bushing type leadins 105, each comprising alternating concentric cylinders of insulating material and conducting material about a conductor 106. The inner ends 107 of these leadins may be connected by a chain or wire 108 to the grill work H, both mechanically to support the grill work and to connect it with the negative lead of the source of the potential. It is also preferred that a metal fabric screen K be supported from the inner ends 107 of the lead-ins 107, and disposed substantially equi-distant from all the walls of the hood 8 internally thereof. The mesh of this screen K is preferably that of the electric ceiling, that is, $\frac{1}{4}$ that of the grill work H. In this way, together with the special type of bushing insulators substantial all localized electrostatic stress and strain are eliminated from the interior of the apparatus.

It is, of course, to be understood that this collector operates with equal facility upon a stream of dust laden gas, either being blown through the collector and consequently within the collector at a pressure greater than that of the atmosphere, or upon a stream of dust laden gas, being exhausted through the collector and consequently at a pressure within the collector below that of the atmosphere. It is, of course, also to be understood that the moving collector screens may be driven at any desired rate of speed from a snail's pace to a speed great enough to prevent any substantial building up of collected powder. It is also to be understood that, although a preferred embodiment of a completed structure has been illustrated and described, most of the individual features going to make up the whole are useful by themselves alone in a collector of more ordinary construction. It is also to be understood that the relative positions and dispositions of the parts are subject to change within scope of the invention. For example, it is unnecessary that the hoods 6, and 8 take in and discharge in the directions indicated. The functioning of the remainder of the collector is independent of this feature. It is also to be understood that the electric ceiling is useful in a stationary plate collector. It is also to be understood that the special mounting of the electrode grid is useful in any electric collector; and,

furthermore, that the movable collector screens of this invention are applicable to any plate type of electric collector. The invention is not limited to moving screens made up of convolutions of wire, nor to any of the details of construction illustrated.

What I claim and desire to secure by United States Letters Patent is:

1. An electrical collector comprising means forming a main chamber through which dust laden gas is adapted to pass in an upward direction and laterally positioned pocket chambers partially open to said main chamber but partitioned therefrom; outer walls for said pocket chambers completing an air-tight closure for said main chamber; pendant charging electrodes in said main chamber adapted to be charged electrically with a potential difference from the walls of said chamber; movable collector screens occupying substantially vertical planes and movable laterally through the outer walls of said chambers and conductively connected with the walls of all said chambers.
2. The structure defined in claim 1 and further characterized by the fact that the top of the passage through said main chamber is covered by an open mesh screen electrically connected with said pendant electrodes and insulated from the walls of said chambers and constituting an electrical repulsion screen exerting a repulsion force opposite to the direction of flow through said collector.
3. In an electric collector a chamber having conducting walls, a relatively high potential conducting screen within said chamber, means for supporting said high potential screen from the walls of said chamber comprising mechanically connected alternating strips of conducting material and insulating material as a sort of moulding about said chamber.
4. In an electrical collector comprising an outer grounded shell and interior high potential conductors; means for preventing local electrostatic stresses comprising an open mesh screen of conducting material, the fabric of which is arranged in parallelism with but separated and insulated from the outer shell and located on the interior thereof, and is electrically connected with the high potential conductors therein, the spacing of all high potential parts including said screen from all grounded parts being maintained substantially uniform as to distance.
5. In an electric collector, an outer grounded shell; a high tension lead passing through said shell at substantially right angles thereto; alternate coaxial tubular layers of conducting material and insulation between said shell and said lead; and a distributor screen connected with the inner end of said lead and in substantial parallelism with the inner wall of said shell.
6. In an electric collector, a collection chamber; parallel driving drums journaled to rotate outside of said chamber, one set on one side of said chamber and the other set on the other side of said chamber and constituting pairs of drums; a pair of cross-over idlers for each pair of drums; an endless wire making a number of convolutions about said drums through said chamber to form vertical collection plates of substantial surface extent and once over said idlers; means for driving said drums to cause the passage of said convolutions through said chamber into and out of the same and a wall having sealed slots through which said wire passes.
7. In the collection of particles from a moving stream of gas the process of arresting the flow of particles comprising directing the direction of flow so that gravity opposes the motion of said particles and in addition charging said particles and interposing in the path of flow an electro-static repulsion field operative in the same direction as gravity.
8. In an electrical collection apparatus in combination, charging electrodes and movable collecting electrodes; and means providing a collecting zone for said collecting electrodes and a discharge zone for said collecting electrodes and a separate driving zone for said collecting electrodes, comprising partitions through which said movable collection electrodes pass.
9. In an electrical collection apparatus charging electrodes and movable collection electrodes; means providing a heated collection zone; and means providing a cold collection zone separate from said collecting zone, but at the same barometric pressure as that of the collecting zone including a partition through which said movable collection electrodes pass.
10. A collector comprising a pair of spaced collector screens constrained to occupy substantially parallel vertical planes; means for moving said screens in an horizontal direction; means providing a free space for the fall of collected powder along the vertical sides of said screens and localized apart from the main dust collecting portions of said screens.
11. In an electrical collector a collection chamber of rectangular cross-section; electrically charged electrodes within said chamber; movable collecting electrodes running cross-wise of said chamber; an electrostatic repulsion screen being so positioned that there is a free unobstructed path therebetween for the repulsion of dust directly upon said collecting electrodes.
12. In an electric collection apparatus, means providing a passage through which dust laden gas has an upward flow; an electric repulsion screen located across the effluent end of said passage; means for negatively charging said screen; means provid-

ing a collection zone beneath said repulsion screen; and means for negatively charging particles to be collected before they reach said repulsion screen.

6 13. In electric collection of dust particles from a stream of dust laden gas, the process of preventing the discharge of remaining dust particles after the major dust collection has been effected, comprising directing
10 the effluent gas upwardly; negatively charging the dust particles therein; and opposing in a downwardly directed direction an electrostatic negative field against said remaining dust particles.

15 In witness whereof, I have signed my name to this specification this 11th day of December, 1926.

LEONARD DAY.

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