No. 755,367. PATENTED MAR. 22, 1904.

E. E. FEWKES.

STATIC ELECTRIC MACHINE.

APPLICATION FILED JUNE 1, 1903.

NO MODEL. 4 SHEETS—SHEET 1.

Fig. 1.

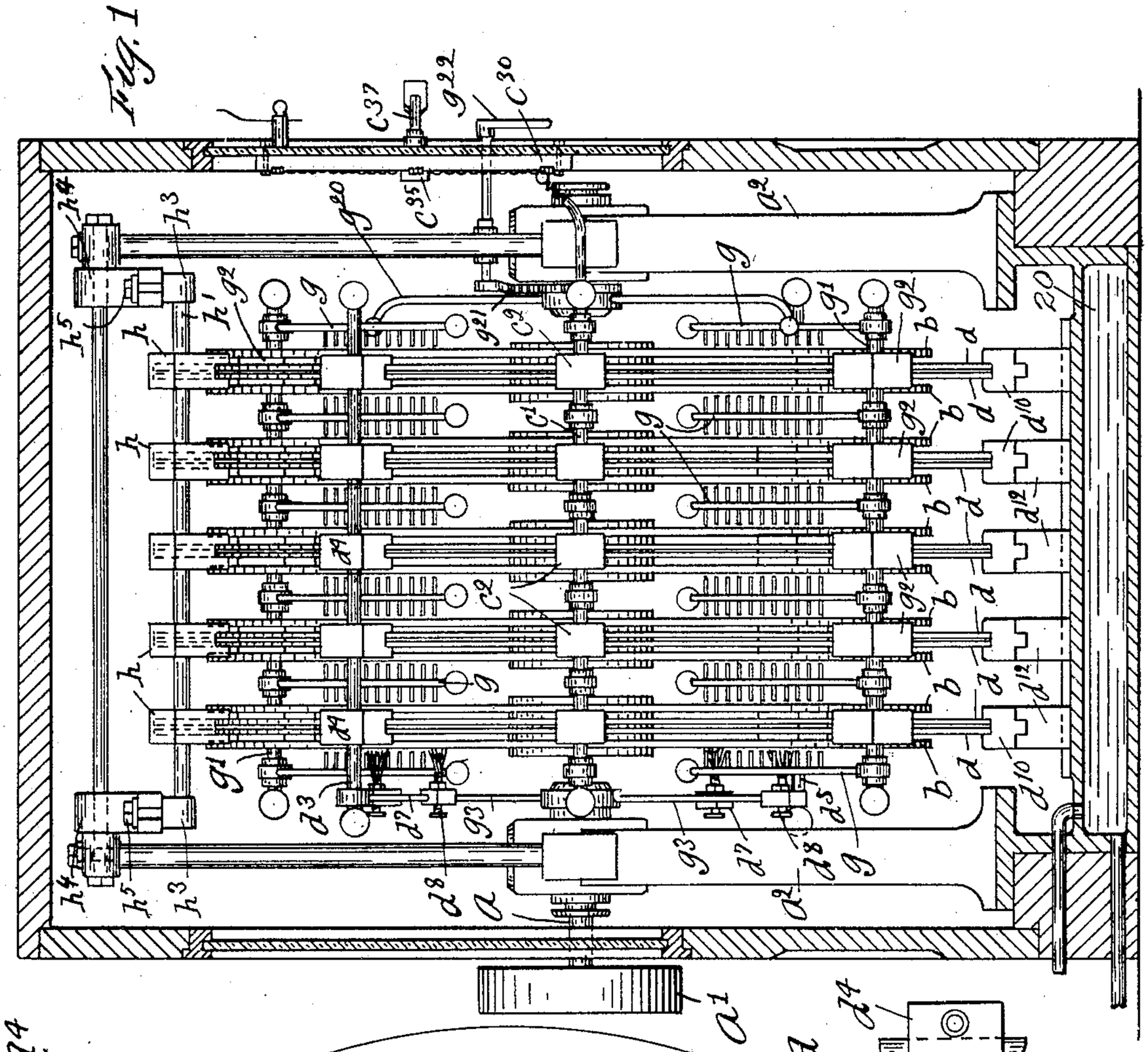


Fig. 10.

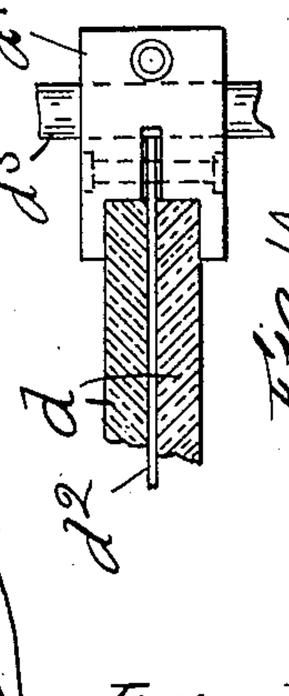
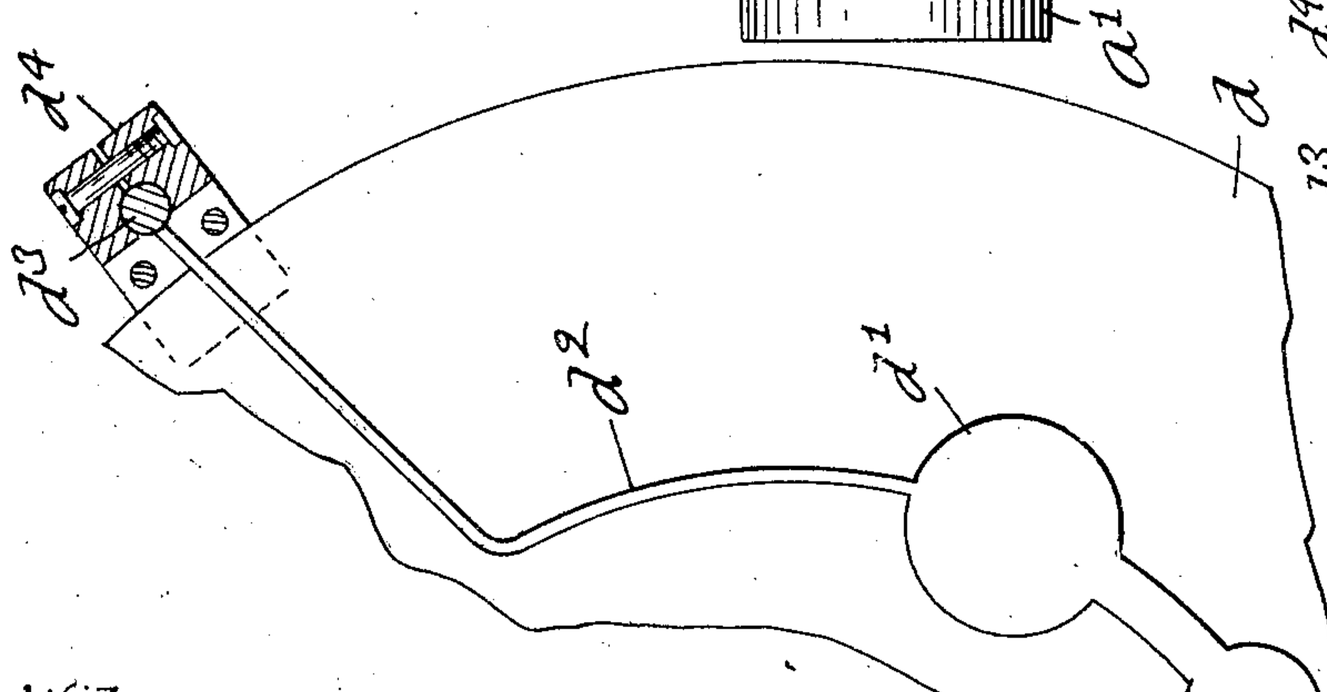


Fig. 4.



Witnesses:
H. B. Davis.
M. M. Pipes

Inventor:
Ernest E. Fewkes
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Attys

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NO MODEL. 4 SHEETS—SHEET 2.

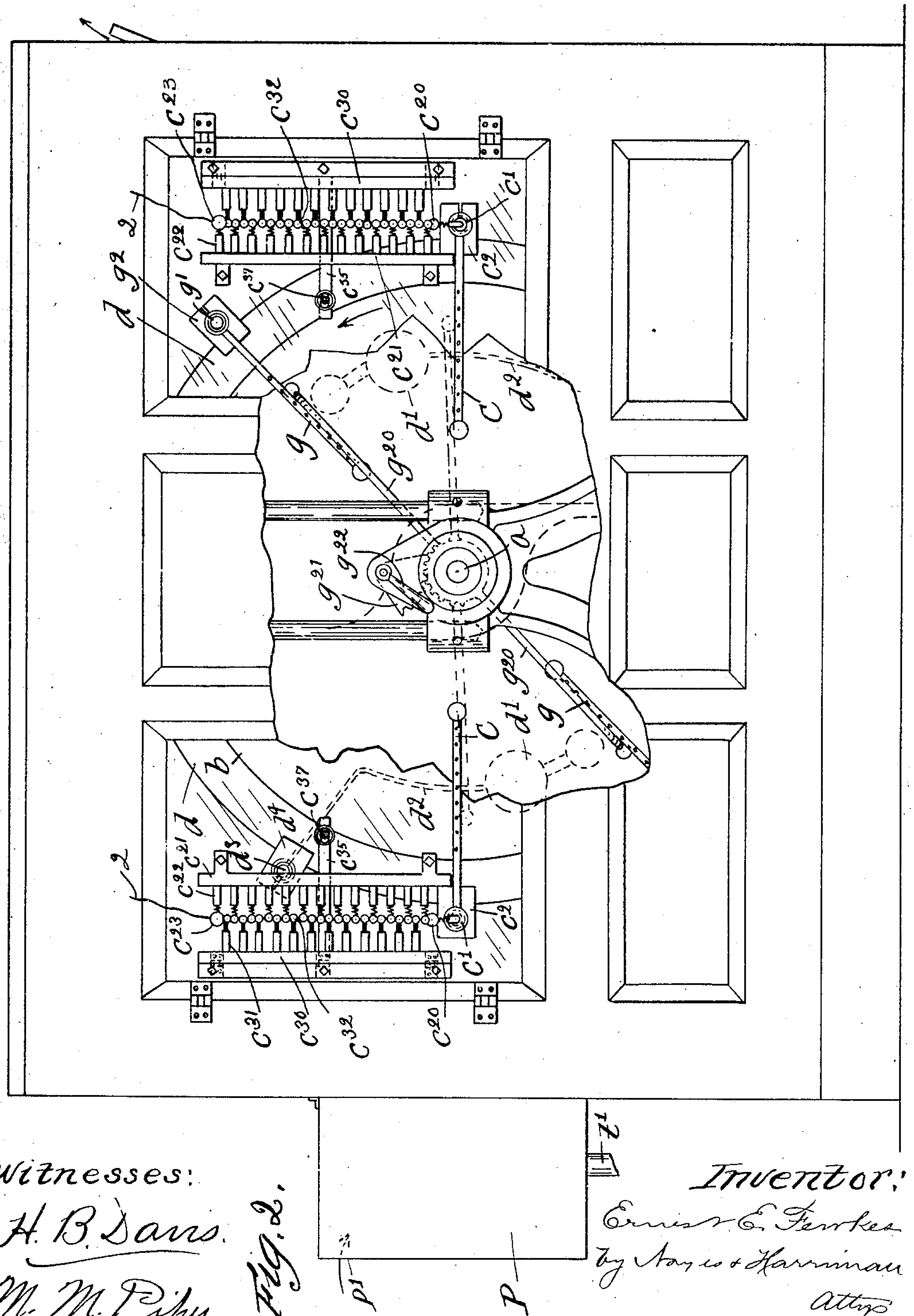

Fig. 2.

Witnesses:

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M. M. Piper

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No. 755,367. PATENTED MAR. 22, 1904.

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STATIC ELECTRIC MACHINE.

APPLICATION FILED JUNE 1, 1903.

NO MODEL. 4 SHEETS—SHEET 3.

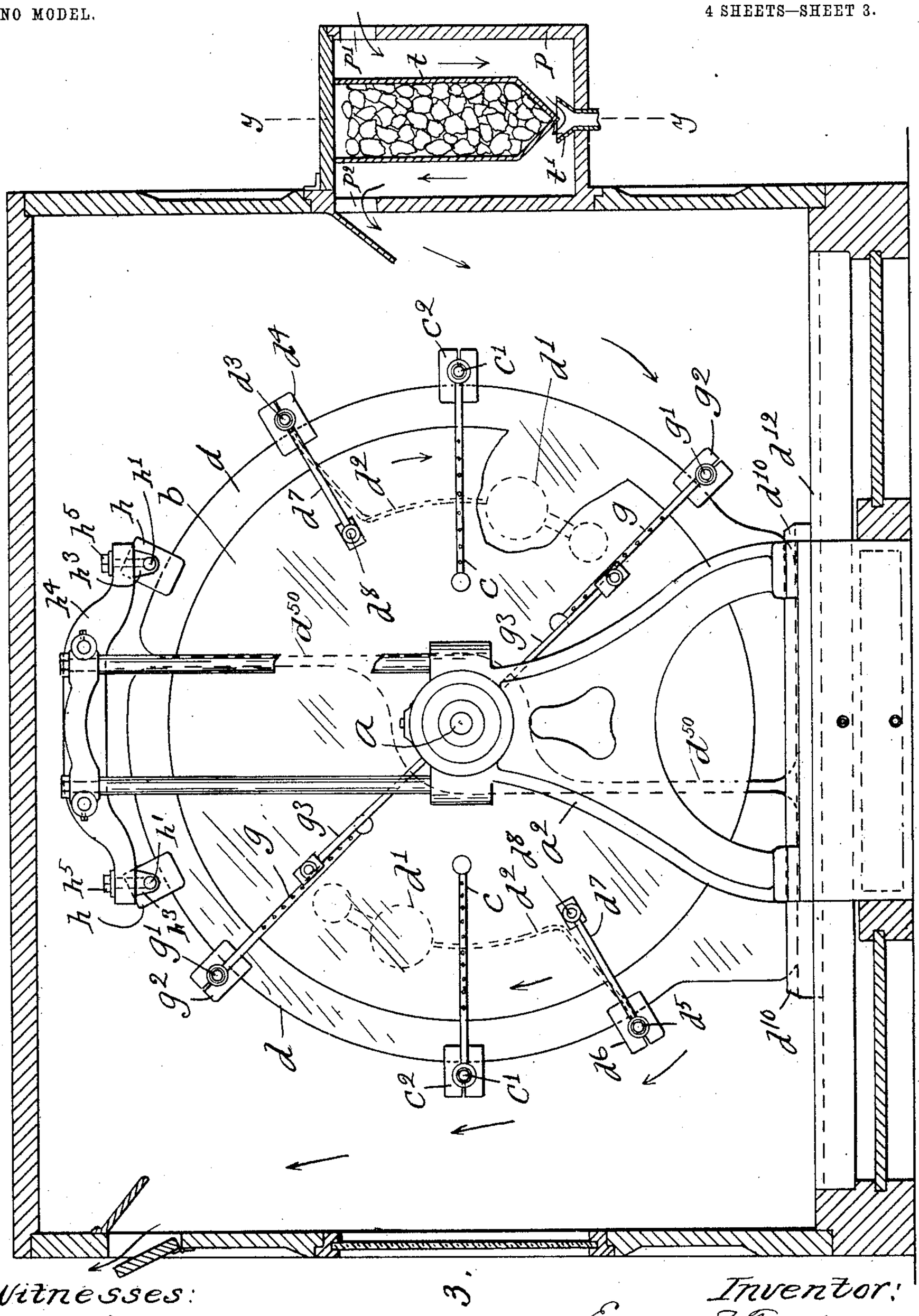

Fig. 3.

Witnesses:
H. B. Davis.
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No. 755,367. PATENTED MAR. 22, 1904.

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STATIC ELECTRIC MACHINE.

APPLICATION FILED JUNE 1, 1903.

NO MODEL. 4 SHEETS—SHEET 4.

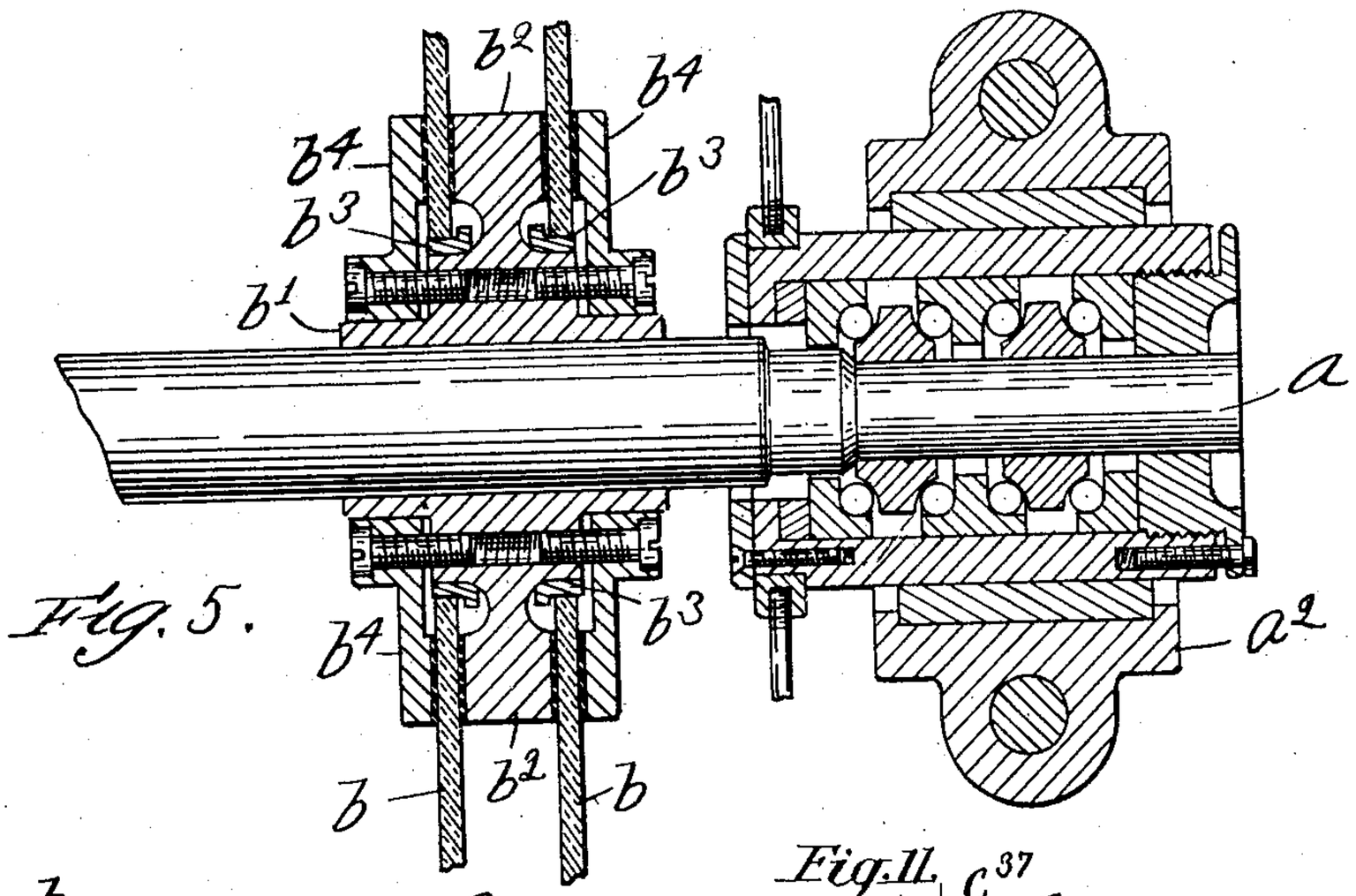

Fig. 5.

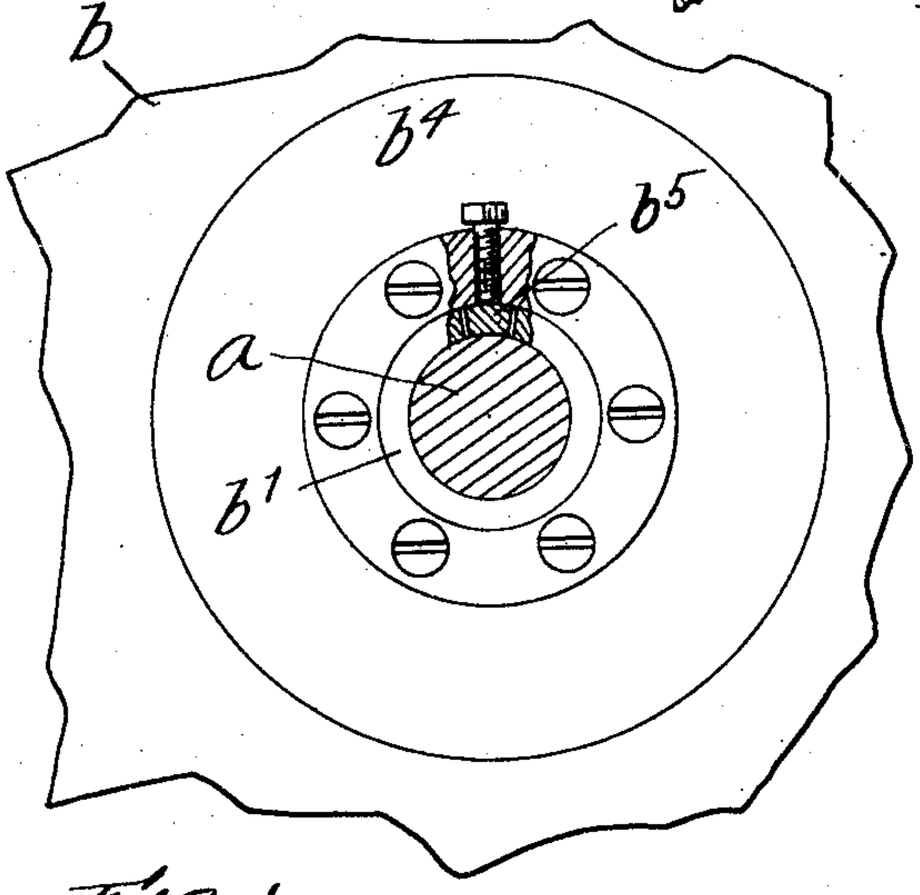

Fig. 6.

Fig. 11.

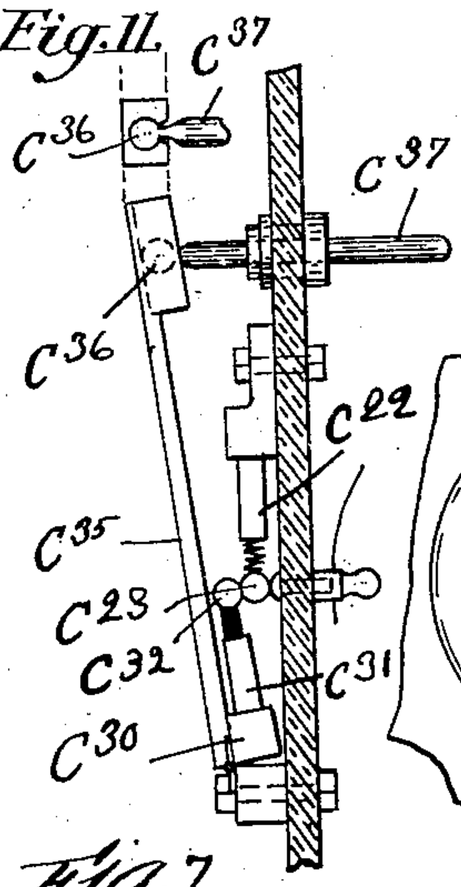

Fig. 7.

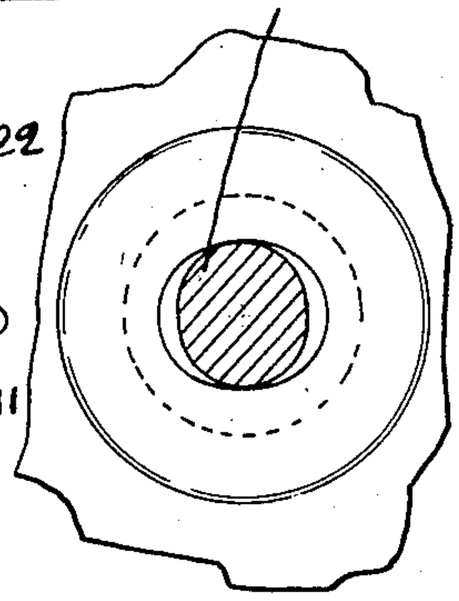

Fig. 8.

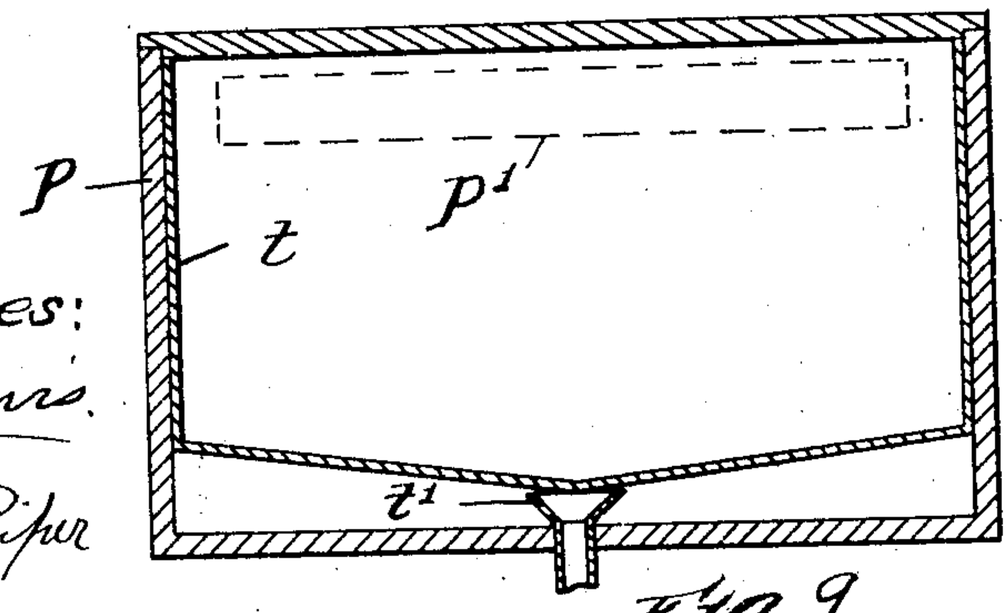

Fig. 9.

Witnesses:
H. B. Davis.
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No. 755,367. Patented March 22, 1904.

UNITED STATES PATENT OFFICE.

ERNEST E. FEWKES, OF NEWTON, MASSACHUSETTS, ASSIGNOR OF ONE-HALF TO FREDERICK W. COLE, OF NEWTON, MASSACHUSETTS.

STATIC ELECTRIC MACHINE.

SPECIFICATION forming part of Letters Patent No. 755,367, dated March 22, 1904.

Application filed June 1, 1903. Serial No. 159,559. (No model.)

To all whom it may concern:

Be it known that I, ERNEST E. FEWKES, of Newton, county of Middlesex, State of Massachusetts, have invented an Improvement in Static Electric Machines, of which the following description, in connection with the accompanying drawings, is a specification, like characters on the drawings representing like parts.

This invention relates to static electric machines especially adapted for supplying electricity to the well-known Crookes tubes for the production of Roentgen or X rays; and the invention is shown as applied to that type of static electric machines comprising a plurality of circular glass plates which revolve in the field of influence of charged inductors.

The invention has for its object to improve and simplify the construction of the machine in many particulars, to the end that the generating-plates may be used solely for generating purposes, thereby producing a stronger current, the charging device being independent of the generating-plates and properly connected with the inductors, which are borne by the inductor-plates; also, that the revolving plates may be correctly balanced; also, that the shaft may be disconnected and withdrawn easily and quickly by an endwise movement without disturbing the adjustment of the revolving plates; also, that the inductor-plates may be more easily removed from the machine by being divided on a line passing through the inactive or neutral parts thereof; also, that the inductors may be disposed on that area of the inductor-plates located entirely between the region of influence of the collecting-combs and the region of influence of the corresponding equalizing-combs; also, that the equalizing-combs at the ends of the machine may be provided with a separable part or member which is supported by the frame, whereby the divided parts of the inductor-plates may be separately withdrawn; also, that the supports for the upper ends of the inductor-plates may be easily detached from their support; also, that the air surrounding the active parts of the machine, as well as said parts, may be kept at a point of high insulation by removing the moisture by physical means; also, that the machine may be provided with novel means of changing the resistance of the circuit.

Figure 1 shows in side elevation a static electric machine embodying this invention, the case being shown in section. Fig. 2 is a front elevation of the machine. Fig. 3 is a rear elevation of the machine. Fig. 4 is a detail showing the inductor and its connection with the bar to which the charging-brush is attached. Fig. 5 is a vertical section of the holder for the generating-plates mounted on the main shaft. Fig. 6 is a detail showing the means for securing the plate-holder to the shaft. Figs. 7 and 8 are details of the resistance device. Fig. 9 is a vertical section of the condenser to be referred to, taken on the dotted lines *y y*, Fig. 3. Fig. 10 is a sectional detail of the inductor and inductor-plates. Fig. 11 is another detail of the resistance device shown in Fig. 7.

a represents the main shaft, to which a driving-pulley *a'* is secured, and said shaft has its bearings in the upright stands a^2, which form a part of the main frame. A plurality of circular glass plates *b* are secured to said shaft *a*, being arranged at suitable distances apart and in pairs, as will be described. A plate-holder is provided for each pair of plates *b*, and the several plate-holders are mounted upon and separately secured to the shaft, and the glass plates are adjustable on said holder about their axes, to the end that they may be turned one with relation to the other, so as to be correctly balanced, it being understood that in practice the plates vary slightly in thickness notwithstanding great care is exercised in their manufacture, and consequently must be balanced on the shaft. By balancing the plates in pairs it will be seen that the whole number of plates may be easily and quickly balanced. The plate-holder is adapted to be secured to the shaft in such manner that the shaft may be removed by an endwise movement whenever desired. The plate-holder herein shown consists of a collar *b'*, adapted to be placed upon the shaft, having a circular shouldered extension or flange b^2 at a point intermediate its length, and on the shoulders suitable packing-

rings b^3 are placed, on which the circular glass plates rest, said rings serving as a yielding support or cushion for the plates, and said plates firmly bear against suitable packing-rings on the opposite sides of the flange, and flat-surfaced clamping-plates b^4 are placed on opposite sides of the collar, which bear against the glass plates b, said clamping-plates being firmly held in place by screws. By loosening the screws the plates b will be released sufficiently to be turned relative to each other. The collar b' has at each end a spring-tongue b^5, formed by longitudinally slitting the ends of the collar inward for short distances, and set-screws pass through the hubs of the clamping-plates, which bear upon these spring-tongues and impinge them securely against the shaft. The plate-holder is thus firmly secured to the shaft, and the means employed for securing it will not mar or in any way injure the shaft, and whenever said set-screws are loosened the spring-tongues will disengage the shaft sufficiently to enable the shaft to be withdrawn from the plate-holder by an endwise movement.

On one side of each revolving plate at diametrically opposite points two collecting-combs c are located, which project inwardly from terminal rods or bars c', which extend lengthwise the machine, at the side thereof and which are supported just outside of the outer edge of the revolving plates by suitable blocks c^2, which are supported upon or by the stationary or inductor plates to be described. For the endmost revolving plates of the group of plates the collecting-combs will have but a single row of tongues, which project toward the plates; but for the intermediate plates each collecting-comb will have a double row of tongues, which project in opposite ways toward the plates. These revolving plates serve as and constitute the generating-plates, and they revolve in the field of influence of charged inductors. The inductors are borne by stationary inductor-plates, which are located between each pair of revolving generating-plates, each comprising a pair of stationary divided glass plates d, placed close together, with small pieces of tin-foil or equivalent material d' located between them at diametrically opposite points. These pieces of tin-foil serve as the inductors, and so far as my invention is concerned they may be of any suitable shape. Each plate d is divided approximately diametrically, as shown by dotted lines d^{50}, Fig. 3. Each inductor d' has a conductor d^2 leading from it between the two plates d to the outer edge of said plates, and all the conductors on one side of the machine are connected to a bar d^3, which extends lengthwise the machine and is supported by the blocks d^4, and all of the conductors at the opposite side of the machine are connected to a similar bar d^5, supported by the blocks d^6. At one end of each bar d^3 and d^5 a rod d^7 is secured, which projects toward the axis of the main shaft and bears at its extremity or other convenient point a brush d^8, which engages the endmost revolving plate, said brush being called the "charging-brush." There are charging-brushes d^8 only in connection with the endmost revolving plate, and said plate is designed and intended to serve as the sole charging-plate for charging all of the inductors. Consequently the appropriating-brushes ordinarily employed in connection with the remaining revolving plates are herein omitted. In my machine the endmost plate serves as the charging-plate, and the other plates serve as the generating-plates. As the generating-plates do not have appropriating-brushes and do not act to charge the inductors, they become non-charging plates, and hence I herein refer to them as "non-charging" generating-plates as contrasted to the ordinary generating-plates, which have appropriating-brushes, and therefore serve as generating and charging plates. The charging-plate, which is herein shown as the endmost plate of the group, although not necessarily so, while employed especially for charging purposes incidentally also serves as a generating-plate to a certain extent; but such function is secondary to its primary function of serving as a charging-plate. I find in practice that while using a charging-plate for charging purposes and using the remaining revolving plates solely for generating purposes a much stronger current is obtained than where each plate charges its own inductor with a portion of its own electricity. The machine thus constructed is self-charging, and, so far as I am aware, I am the first to have the charge built up and thereafter continue to be held up to its highest efficiency by a charging device employed especially for charging purposes independent of the action of the generating-plates, thus allowing the full effect of the generating-plates to be felt at the terminals.

The inductor-plates d consist of pairs of divided plates placed one upon or against the other, with the inductors d' located between them at diametrically opposite points, and said plates are divided across the center and through the neutral zone instead of through the line of action, as has heretofore been the case. By dividing the plates in this manner the solid portions are left at the active areas for high insulation and for the purpose of deriving the benefit of high-inductive capacity of the glass at the most effective or vital point. Along the neutral zone the insulation and inductive capacity of the glass is not so necessary, and therefore the division is made along this zone. Another important result gained by thus dividing the inductor-plates, which in practice are nearly vertical, is the facility of removing the plates for the purpose of cleaning them and also for the purpose of clean-

ing the revolving plates. In practice it is necessary to frequently clean all of the plates in order to obtain the best efficiency, and the easier this can be done the better. To facilitate removing the divided parts of the inductor-plates, the parts thereof are set in shoes d^{10} d^{10}, disposed in alinement, which rest in a suitable horizontal guideway d^{12} in the base of the framework, said shoes being free to slide in said guideway, so as to be moved in opposite directions. Thus either part of the inductor-plates may be withdrawn at will.

g represents the equalizer-combs which are located at diametrically opposite points at the front of the several revolving plates, said combs being connected to bars g', which extend lengthwise the machine and which are supported by the blocks g^2. The equalizer-combs are located, with respect to the collecting-combs so that the inductors d' are disposed entirely between these adjacent combs, which in practice I find is productive of the best results. At the end of the machine the equalizer-combs g are connected together by a cross-bar which is supported by the frame, so as to provide for the withdrawal of the divided parts of the inductor-plates, the connection between the ends of the cross-bar and equalizer-combs being merely a contact sufficient for the passage of the current. At one end of the machine g^3 represents the cross-bar, which is mounted on the frame, and the ends of said cross-bar rest one against the upper side of one of the equalizer-combs and the other against the under side of the other equalizer-comb. At the opposite end of the machine g^{20} represents a cross-bar which connects the two equalizer-combs, and said bar is secured to a hub which is rotatably mounted on the frame, so that said cross-bar may be swung on its axis out of engagement with the pair of equalizer-combs and into engagement with the pair of collecting-combs c to thereby short-circuit the machine, and to make a good connection the extremities of said bar are supplied with flexible tips. To swing the short-circuiting bar g^{20} on its axis, the hub has teeth formed on it which are engaged by a sector g^{21}, pivoted to the frame, and a hand-lever g^{22} is attached to the pivot-shaft, which serves as a means for operating the sector to in turn swing the short-circuiting bar. The blocks d^6, which support the bar carrying the charging-brush, and the blocks c^2, which support the collecting-combs, and the blocks g^2, which support the equalizer-combs, are all secured to the outer edges of the inductor-plates, and as said inductor-plates are divided vertically it will be seen that when the parts thereof are withdrawn the several parts connected thereto will be withdrawn at the same time. The upper end portions of the divided inductor-plates are held in position by blocks h, secured to bars h', which hold the blocks in their respective positions, and said bars h' have at their ends small blocks h^3, adapted to bear against the under sides of the ends of the yokes h^4, being held in position against said yokes by screws h^5. By removing these screws the bar carrying the blocks is released, so that the divided parts of the inductor-plates may be removed. The yokes are supported at the upper ends of the main framework.

The collecting comb-bars c' each have leading from them a spring-acting terminal c^{20}, which is adapted to engage one member of a resistance device, and the circuit-wires 2 lead from the opposite ends of the said resistance devices. The resistance device is attached to the inside of a swinging door which is hinged to the casing, and when said door is closed the resistance device will be brought into engagement with the spring-acting terminal c^{20}. The resistance device consists, essentially, of a stationary ball-carrying plate c^{21} and a movable ball-carrying plate c^{30}. The stationary plate has a plurality of fingers c^{22} projecting laterally from it in a direction toward the other plate, each finger bearing at its extremity a spring supporting a ball c^{23}, and the movable member likewise has a plurality of fingers c^{31} projecting laterally from it in a direction toward the other plate, each finger bearing at its extremity a ball c^{32}. The fingers are made of wood. The spaces between the balls borne by each plate are sufficient to receive the balls of the other plate, so that the balls of the two plates will be alternately arranged when the movable plate is in one position, and at such time all the balls borne by said movable plate will engage all the balls borne by the stationary plate, and when the plates are in such relative positions the current is free to pass through the resistance device, and the resistance of the circuit is not increased; but whenever said movable plate is swung inward air-gaps are produced, which increase the resistance according to the size of the gaps produced. These gaps may be very slight or may be quite wide, as desired. The balls being disposed at the extremities of the wooden fingers, the electricity will not leak across the wood from ball to ball, but will be compelled to pass through the air-gaps. All the balls on one member—as, for instance, the stationary member—are connected with the fingers by springs, spiral springs being preferably employed, so that when the two members are brought together the several balls will readily find their proper places. The movable member c^{30} is hinged to the framework and has attached to it an arm c^{35}, the extremity of which is grooved to receive the spherical end c^{36} of a bar c^{37}, which projects through a hole in the casing or sleeve set therein, and by a longitudinal movement of said bar the arm c^{35} will be moved to in turn move the movable member c^{30} of the resistance device. For the purpose of securing the bar c^{37} in whatever position it may be set the said bar is made other

than round in cross-section, as shown in Fig. 8, and the hole through the case, through which said bar passes, is also made other than round, and by turning the bar on its axis it will be caused to impinge the sides of the other than round hole through the case and bind frictionally.

It is evident that the resistance device herein shown is also adapted to be used in any current of high potential, however produced, and I therefore do not limit its use to static machines, as similar currents for analogous purposes which require the same regulation are produced in many other ways, among which may be mentioned induction-coils, magneto-generators, dynamos, &c.

So far as I am aware I am the first to make the resistance device in such manner as to vary the resistance by producing air-gaps and varying the sizes of the air-gaps.

Insulation is one of the most important features in a static electric machine, and I depend principally upon glass and air to obtain it, and in order to obtain the best effect they must be dry or as free from moisture as possible. For the accomplishment of this result the working parts of the machine and the air surrounding them are kept warm to prevent condensation of moisture. To effect this result, the base of the machine is made hollow, as at 20, and said hollow base may be filled with water adapted to be heated by any suitable heating apparatus, or it may contain steam, to thereby produce a heating device. By means of this heating device the air contained in the case will be heated to thereby keep the working parts warm and the air in a better condition to absorb moisture. For the best results, however, the air which is taken into the machine should be as dry as possible before it is heated by the heating device above described, and to effect this result a moisture-condenser *t* is located in a suitable box-like structure or case *p* at one end of the machine-case, which, as herein shown, consists of a thin receptacle adapted to contain ice or other cooling medium, and the lower end of this receptacle is made V-shaped, so that the moisture which collects on the surface of the receptacle and which runs down the sides thereof may find its way to a common point of delivery. Beneath the V-shaped bottom of the receptacle a delivery-tube *t'* is provided for conducting away any water of condensation that may drip from the condenser. The air passes into the box-like structure *p* through the opening *p'* and then passes into the machine-case through the opening p^2, thereby passing around the condenser before it is delivered to the machine-case. The air coming in contact with the cool surface has its moisture condensed.

Having thus described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. In a static electric machine, one or more inductor-plates having inductors at diametrically opposite points, and one or more revolving non-charging generating-plates, and an independent charging device for the inductors, substantially as described.

2. In a static electric machine, one or more inductor-plates having inductors at diametrically opposite points, and one or more revolving, non-charging generating-plates, and an independent charging device for the inductors comprising a charging-plate secured to the shaft bearing said generating-plates, substantially as described.

3. In a static electric machine, one or more inductor-plates having inductors at diametrically opposite points, and one or more revolving, non-charging generating-plates, combined with a revolving charging-plate, two charging-brushes engaging it, located at diametrically opposite points, and means for connecting said brushes with all of the inductors at the corresponding side of the machine, substantially as described.

4. In a static electric machine, a plurality of inductor-plates each having inductors at diametrically opposite points, a plurality of revolving, non-charging generating-plates located adjacent to said inductor-plates, combined with a revolving charging-plate, charging-brushes located at diametrically opposite points, and conductors connecting said brushes with the several inductors at the corresponding side of the machine, substantially as described.

5. In a static electric machine, a plurality of inductor-plates, each having inductors at diametrically opposite points, a plurality of revolving non-charging generating-plates located adjacent to said inductor-plates, combined with a revolving charging-plate, charging-brushes located at diametrically opposite points, bars extending lengthwise of the machine to which said brushes are connected, and conductors leading from the several inductors to said bars, substantially as described.

6. In a static electric machine, one or more revolving non-charging generating-plates, and a revolving charging-plate, equalizing-combs for all the plates and electrical connections between the equalizing-combs of the charging-plate and the equalizing-combs of the generating-plates, substantially as described.

7. In a static electric machine, a pair of circular revolving plates, a plate-holder supporting them comprising a collar having a shoulder, a flange, and a pair of clamping-plates, and means for securing said plate-holder to the shaft, substantially as described.

8. In a static electric machine, a pair of circular revolving plates, a plate-holder supporting them comprising a collar having a shoulder, a flange, a pair of clamping-plates and screws passing through the clamping-plates into the flange substantially as described.

9. In a static electric machine, a pair of circular revolving plates, a plate-holder supporting them comprising a collar having one or more spring-tongues, and a pair of clamping-plates, and set-screws passing through the clamping-plates which press said spring-tongues into firm engagement with the shaft, substantially as described.

10. In a static electric machine, an inductor-plate divided on the line of its neutral zone, and sliding shoes supporting the separate parts of said plate, substantially as described.

11. In a static electric machine, an inductor-plate divided on the line of its neutral zone, a sliding shoe supporting each part of said plate, said shoes being disposed in alinement, and a horizontal guideway on which said shoes slide, substantially as described.

12. In a static electric machine, a divided inductor-plate, blocks supporting the upper ends thereof, and detachable means for connecting said blocks to the frame, substantially as described.

13. In a static electric machine, equalizing-combs located at diametrically opposite points at the end of the machine, and supported by the inductor-plates, and a cross-bar mounted on the frame which engages said equalizing-combs, substantially as described.

14. In a static electric machine, the combination of the generating-plates and inductor-plates, a pair of equalizing-combs located at diametrically opposite points, and a pair of collecting-combs also located at diametrically opposite points, and a swinging cross-bar which, when in one position, engages the equalizing-combs and when in another position, engages the collecting-combs, to thereby short-circuit the machine, substantially as described.

15. In a static electric machine, the combination of the generating-plates and inductor-plates, a pair of equalizing-combs, located at diametrically opposite points, and a pair of collecting-combs also located at diametrically opposite points, a cross-bar pivoted on the frame which, when in one position engages the equalizing-combs, and when in another position engages the collecting-combs to thereby short-circuit the machine, and means for swinging said cross-bar on its pivot, substantially as described.

16. In a static electric machine, the combination with the collecting-combs, and resistance devices connected to the terminals thereof comprising two members, one of which is movable relative to the other, said members having alternately-disposed insulated spherical ends, and means for moving said member and for holding it securely in whatever position it may be set, substantially as described.

17. In a static electric machine, the combination with the collecting-combs, and resistance devices connected to the terminals thereof comprising two members, one of which is movable relative to the other, each having alternately-disposed insulated spherical ends, an arm attached to said movable member, a longitudinally-movable bar loosely connected to said arm, and means for holding said bar in whatever position it may be set, substantially as described.

18. In a static electric machine, the combination with the collecting-combs, and resistance devices connected to the terminals, bars thereon comprising two members, one of which is movable relative to the other, each having alternately-disposed insulated spherical ends, an arm attached to said movable member, a longitudinally-movable other than round bar, rotatably connected to said arm, which passes through an other than round hole in the casing, substantially as described.

19. A resistance device adapted to be connected to the terminals of the collecting-combs of a static machine, comprising two members bearing insulating-fingers having spherical conducting ends and disposed alternately with relation to each other, one of said members being movable with relation to the other to produce air-gaps and to vary the sizes of said gaps, substantially as described.

20. A resistance device adapted to be connected to the terminals of the collecting-combs of a static machine, comprising two members bearing insulating-fingers having spherical conducting ends disposed alternately with relation to each other, the spherical ends being yieldingly connected to the fingers on one of the members and means for moving one of said members with relation to the other member to produce air-gaps, and to vary the sizes of said gaps, substantially as described.

21. A resistance device adapted to be connected to the terminals of the collecting-combs of a static machine, comprising two members bearing insulating-fingers having spherical conducting ends disposed alternately with relation to each other, one of said members being movable with relation to the other to produce air-gaps and to vary the sizes of said gaps, and means for moving said member and for securing it in whatever position it may be set, substantially as described.

22. A resistance device adapted to be connected to the terminals of the collecting-combs of a static machine, comprising two sets of balls alternately arranged with relation to each other, a support for each set of balls, means for moving one of said supports with relation to the other to produce air-gaps, and to vary the sizes of said gaps and means for securing said movable support in whatever position it may be set, substantially as described.

23. A resistance device adapted to be connected to the terminals of the collecting-combs of a static machine, comprising two sets of balls alternately arranged with relation to each other, a support having insulating-fin-

gers for each set of balls, means for moving one of said supports with relation to the other to produce air-gaps, and to vary the sizes of said gaps and means for securing said movable support in whatever position it may be set, substantially as described.

24. In a static electric machine, the combination with the collecting-combs having spring-acting terminal connections, resistance devices adapted to engage the same, swinging doors to which said resistance devices are attached which, when closed, place the resistance devices into engagement with the terminals of the collecting-combs, substantially as described.

25. A resistance device adapted to be connected to the terminals of the collecting-combs of a static machine, comprising two sets of balls, alternately arranged, a support for each set of balls, one of said supports being movable with relation to the other, a longitudinally-movable bar loosely connected to said movable support and means for holding said bar in whatever position it may be set, substantially as described.

26. A resistance device adapted to be connected to the terminals of the collecting-combs of a static machine, comprising two members, one of which is movable with relation to the other, and one of which consists of a support bearing a plurality of insulating-fingers having conducting ends, substantially as described.

27. A resistance device for electric currents of high potential, consisting of a series of insulating-fingers and a conductor supported at the extremity of each finger, each conductor being separated from the others by an airspace, substantially as described.

28. A resistance device for electric currents of high potential, consisting of a series of insulating-fingers and a conductor supported at the extremity of each finger, each conductor being separated from the others by an airspace, and means for varying the resistance of said device, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subsubscribing witnesses.

ERNEST E. FEWKES.

Witnesses:

B. J. NOYES,

MAUD M. PIPER.