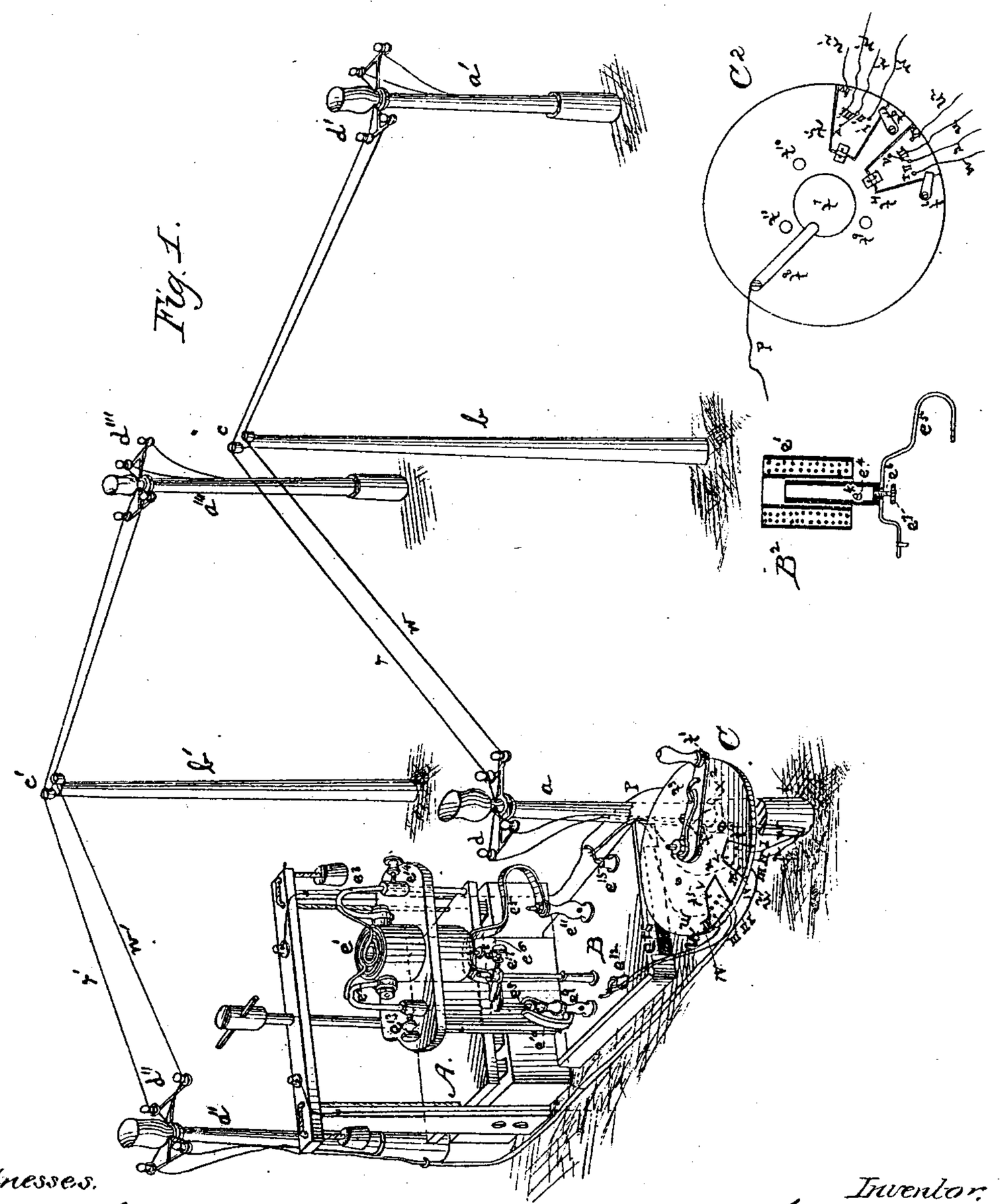
2 Sheets--Sheet 1.

J. VANSANT.

Electrical Gas-Lighting Apparatus.

No. 139,692. Patented June 10, 1873.

Fig. 1.



Witnesses.

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AM. PHOTO-LITHOGRAPHIC CO. N.Y. (OSBORNE'S PROCESS.)

2 Sheets--Sheet 2.

J. VANSANT.

Electrical Gas-Lighting Apparatus.

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Fig. 3.

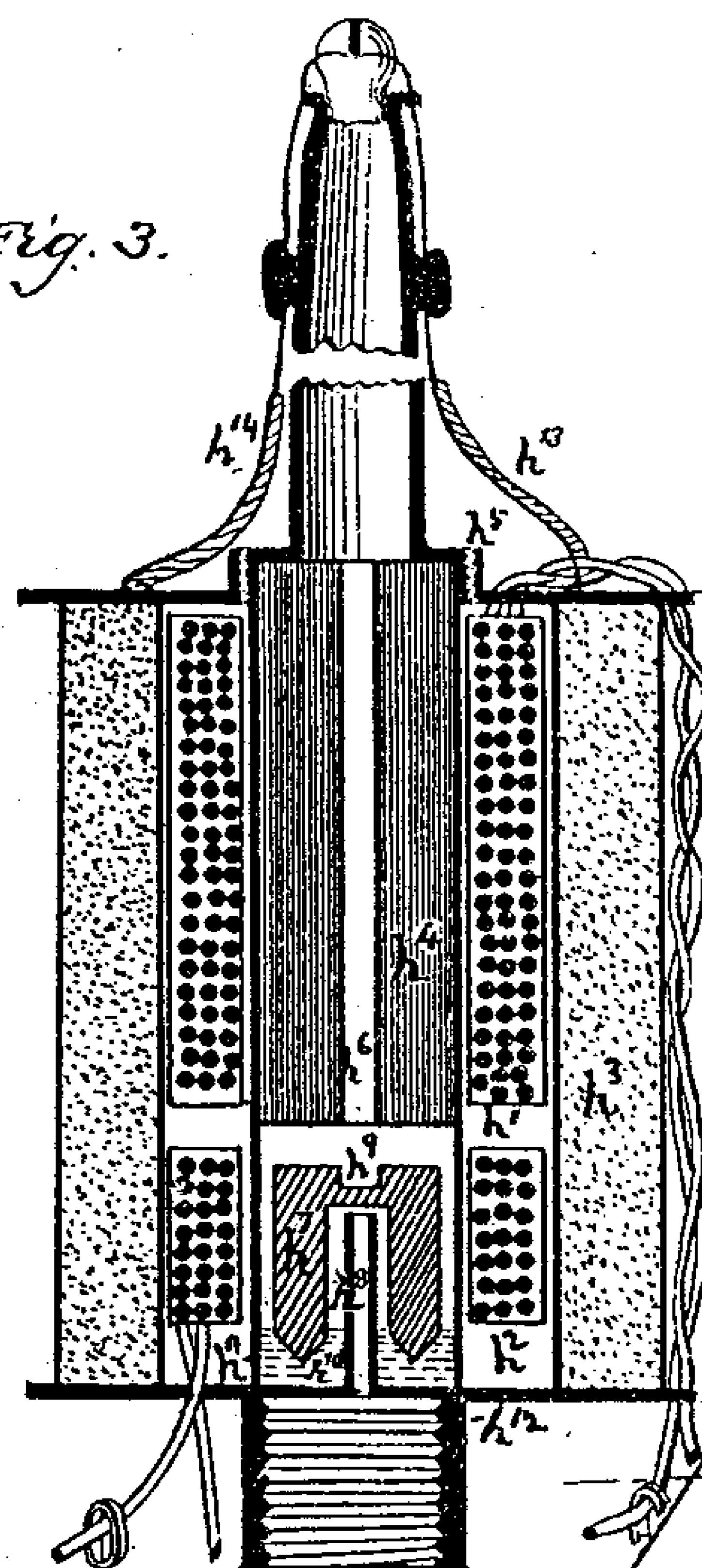


Fig. 4.

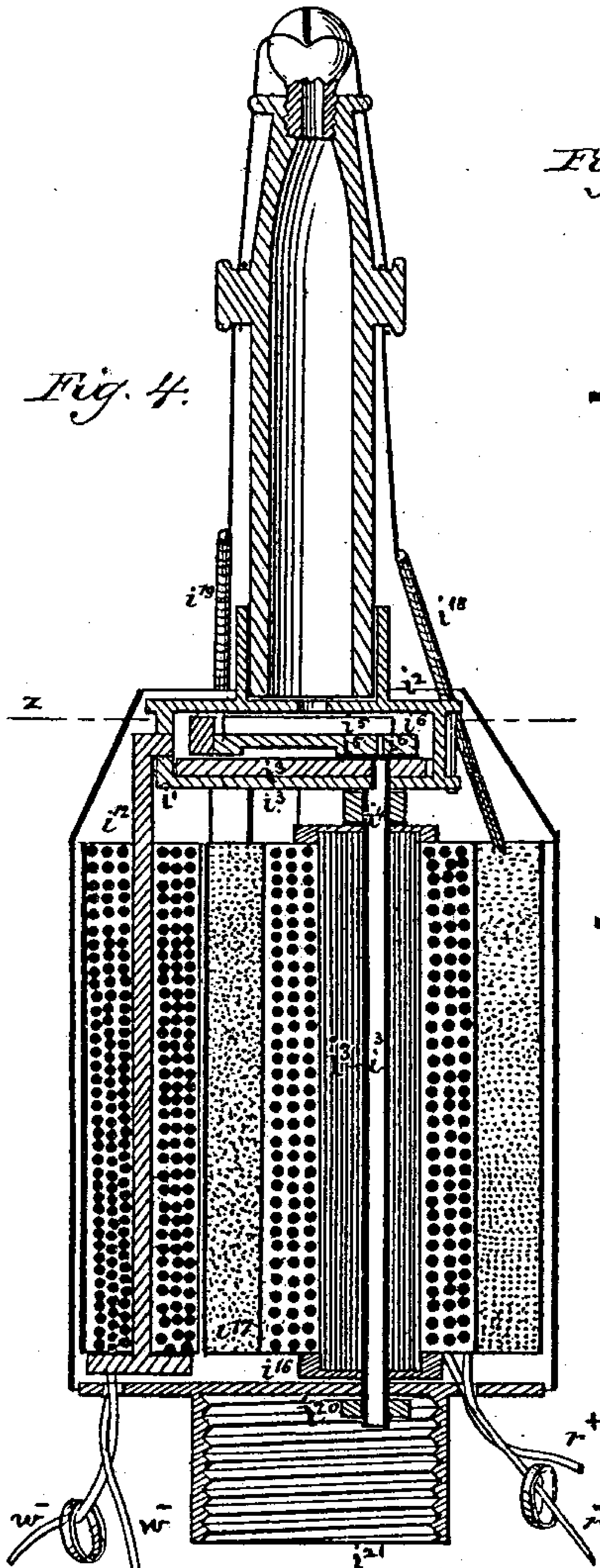
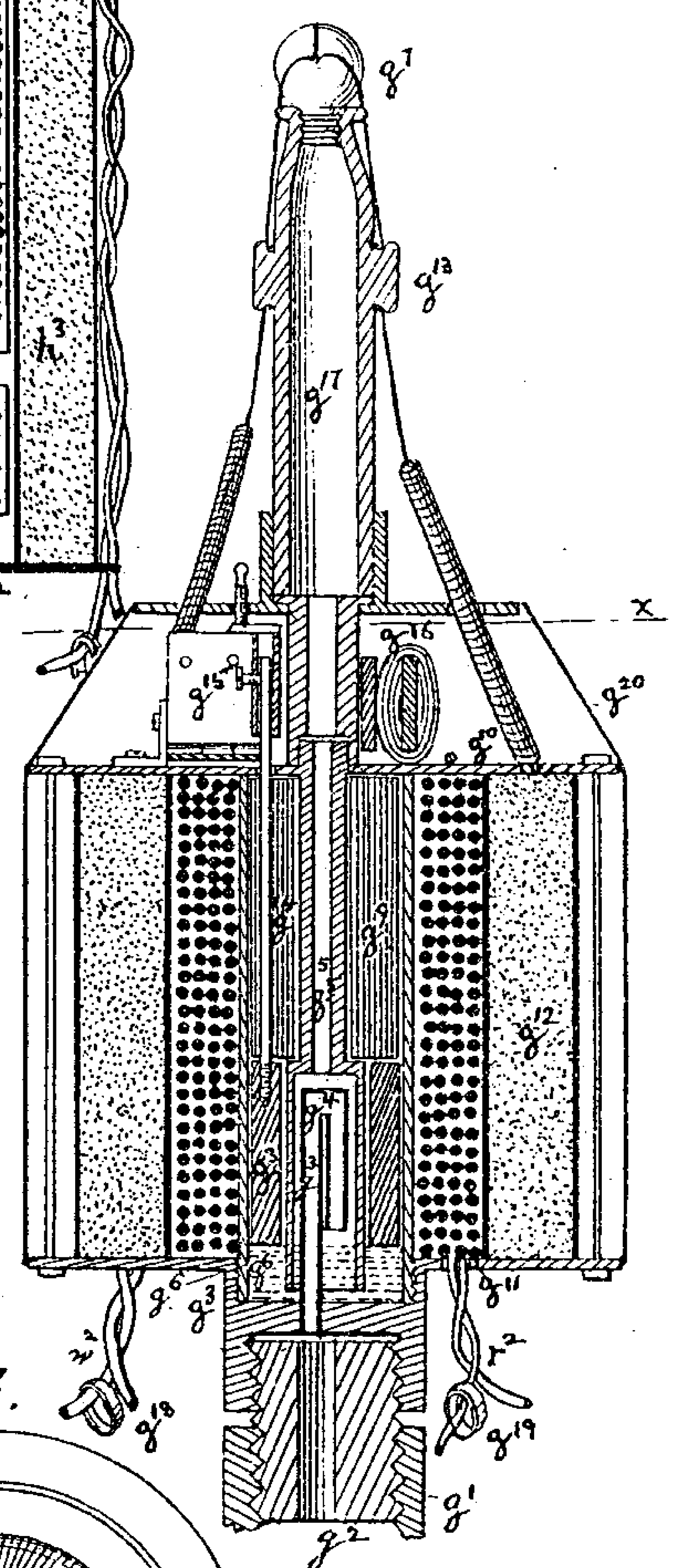


Fig. 2.



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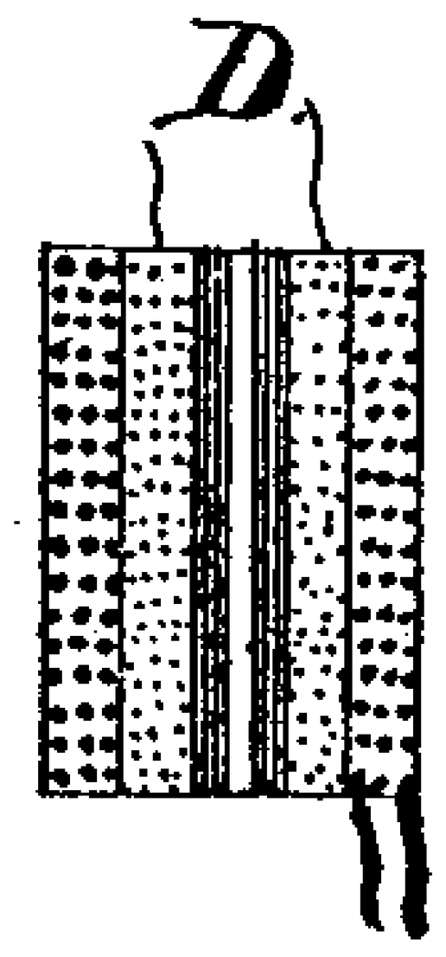
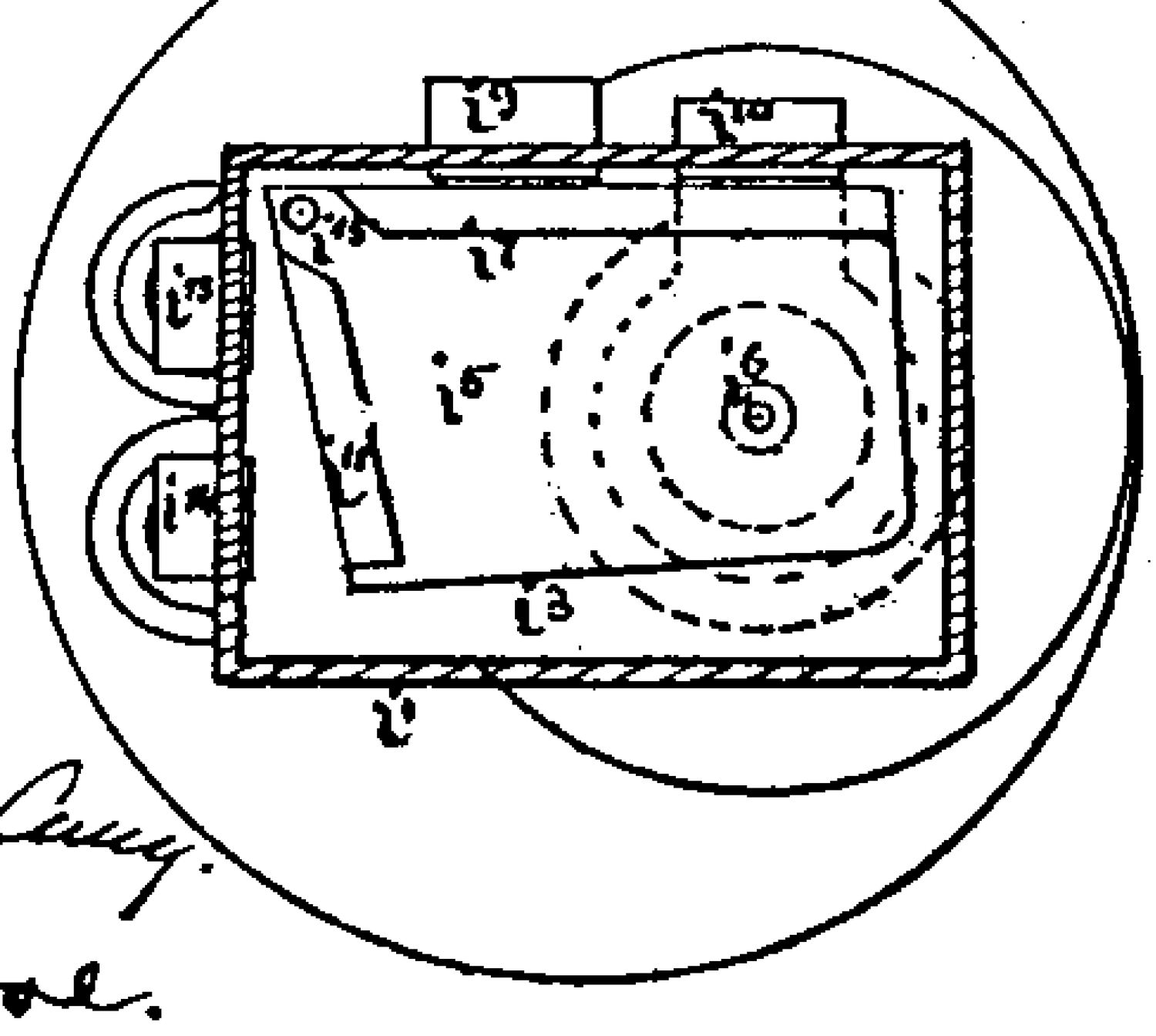
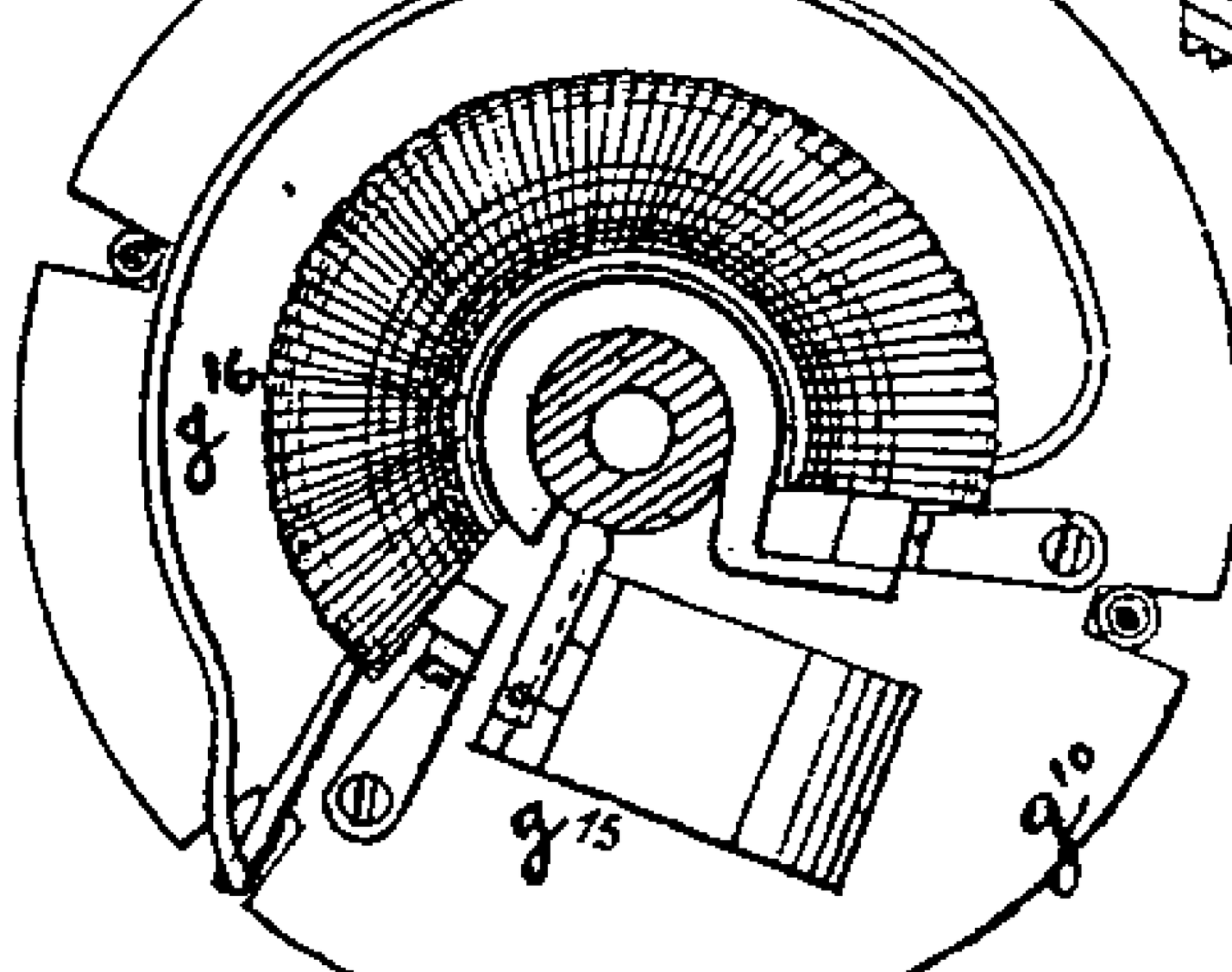


F



E.



Witnesses.

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UNITED STATES PATENT OFFICE.

JOHN VANSANT, OF SAN FRANCISCO, CALIFORNIA.

IMPROVEMENT IN ELECTRICAL GAS-LIGHTING APPARATUS.

Specification forming part of Letters Patent No. **139,692**, dated June 10, 1873; application filed February 3, 1873.

To all whom it may concern:

Be it known that I, JOHN VANSANT, of San Francisco, in the county of San Francisco and State of California, have invented certain new and useful Improvements in Apparatus for Lighting and Extinguishing Gas by Electricity; and I hereby declare that the following, taken in connection with the drawings which accompany and form part of this specification, is a description of my invention sufficient to enable those who are skilled to make and use the same.

United States Letters Patent Nos. 113,370, and 120,469, and 124,773 have been granted to me for improvements in lighting and extinguishing street and other gas lamps by electric agency, and Letters Patent No. 127,000 for improved apparatus for lighting gas by electrical sparks.

My present invention relates to apparatus embodying to a certain extent the principles and construction shown in said patents; to an improved arrangement of the circuit-line for street-lamps; to a novel circuit-breaker, and the switch for connecting it with the rest of the apparatus; and to new devices for controlling the gas at each lamp.

In my present invention I employ either of the following methods for admitting gas to a burner or shutting it off therefrom: In a chamber containing mercury or other suitable liquid, the inlet-gas tube enters from the main pipe, and is curved so that its mouth presents downward, and is a little above the surface of the liquid when the latter is at its natural level. Surrounding the inlet-tube is a straight tube, the lower end of which is immersed in the liquid, and from the upper end an opening exists directly to the burner. The chamber, outside of the last-named tube and above the liquid, contains a movable weight, which is or may be the lower one of two electro-magnets, (the upper being fixed,) that may be simultaneously excited by the passage of an electric current through a wire coil surrounding both. This lower electro-magnet is in connection, by means of a rod, with a catch above the chamber, which catch, itself the armature of a third electro-magnet, may support the rod and said lower magnet, or let them drop, according as the third electro-magnet is passive or active. When the lower magnet is released it falls into the liquid and displaces a quantity of it, varying with its specific gravity, and the displaced liquid rises around and within the mouth of the inlet-gas tube, and stops the flow of gas to the burner. Should the current be now sent through the above-mentioned wire coil the two electro-magnets within it mutually attract one another, and the lower is suddenly elevated out of the liquid, and is caught and held there by the armature-catch before mentioned, while the liquid at the same time resumes its level and opens a passage for the gas to the burner. If a current be now passed through the third electro-magnet alone the armature-catch is withdrawn, and the displacing-weight, falling into the liquid, closes the mouth of the inlet-tube and excludes the gas.

One feature of this part of my invention is the direct employment of the force of electro-magnetism, without intermediate mechanism, to raise the displacing-weight out of the liquid; and another feature is the instantaneous admission of the gas, by this means, to the burner; and still another feature is withdrawing the supporting armature-catch by the direct action of an independent electro-magnet, thus effecting, by the fall of the weight and simultaneous rise of the liquid, the instantaneous arrest of the escaping gas.

Instead of employing an electro-magnet as the liquid-displacing weight, a piece of iron, unmagnetized by the direct influence of the wire coil, may be used; or a permanent steel magnet may be employed as the weight, and its fall caused by a reversal in direction of the current sent through the wire coil of the associated electro-magnet, rendering, in this latter case, the armature-catch above spoken of, or any other catch, unnecessary, and requiring, to produce a movement of the weight in either direction, only the use of a single line of wire. But the objection to associating permanent magnets with electro-magnets is, the demagnetizing of the former by the latter. This objection can, however, be overcome in the present case, and a catch dispensed with, permanent magnetism being substituted for it, as the retaining agent of the weight, by employing two separate and distinct wire coils,

one surrounding the permanent magnet, and the other the electro-magnet. When electric currents are passed through both coils simultaneously in the same direction, attraction will ensue between the permanent and electro-magnetic cores, and one or the other will be moved, according as it may be made the fixed core or the movable weight, and, having come in contact with its fellow, will be retained in position by the permanent magnetism after the electric currents have ceased to flow. If, now, two currents be again made to traverse the two coils simultaneously, but the current passing through the coil around the electro-magnet have its former direction reversed, while the direction of the other current in the coil around the permanent magnet be the same as the first, then repulsion will take place without demagnetization, and the two magnetic cores will be separated, and to such a distance that the permanent magnetism of one will be insufficient to draw the two together again (and thus readmit the gas) after the currents are discontinued. This combination requires for its operation two line-wires connecting the lamps when the reversal of the current is effected at a distant station. In place of using a liquid as the means of opening and closing communication between a gas pipe and burner, I also employ for that purpose a slide-valve composed of two solid pieces of metal, glass, or other suitable material, one, at least, of which is perforated, and both are interposed as a diaphragm between the source of supply of the gas and the burner. A surface of each piece is ground to fit accurately one to the other, and they slip or slide upon one another, and close or open the aperture above referred to, by bringing a continuous surface or a hole to correspond with it, or by withdrawing the edge of the sliding piece beyond the aperture; and these movements are accomplished by one electric or magnetic impulse imparted to the valve, so as to admit or exclude the gas instantaneously. As I make these ground surfaces perfectly flat, (though curved surfaces may be used,) of non-corrodible substances, use no lubricating material between them, and press them together only by the weight of the slide itself, (though a spring may be used,) there is but little adhesion, and no dust or deposit from the gas can get between them, since they are always in air-tight apposition. This slide-valve, with its seat, is inclosed in a tight valve-case a little larger in every way than it is, and in the top of this case is an opening direct to the gas-burner, while out of the bottom passes the gas-tube to the source of supply. On two sides of this valve-case are situated the poles, or a pole, of two independent electro-magnets. One of these poles or pairs of poles is an extension of the electro-magnet of the induction-coil, to be hereafter described, and which furnishes the spark to ignite the gas. The sliding valve is or may be square or oblong, and pivoted loosely at one corner to its seat, and has on each of its sides, opposite to the electro-magnetic poles, a piece of iron attached as an armature to the non-magnetic material of which the valve is mainly composed. This iron is for the purpose of being attracted and moving the slide toward the active magnet, while the non-magnetic material prevents the conduction of the magnetism to the pair of unexcited poles on the opposite side, and the consequent adhesion that would then ensue. If the slide be made entirely of iron, it must always be kept some distance from the poles of both electro-magnets by the interposition of a non-magnetic substance; otherwise it may adhere to the poles of the passive magnet, or actually move away from the active one; but this defeats one purpose I have in view, viz., to use the residual magnetism to prevent slipping of the valve by gravity if the lamp should be much inclined from the perpendicular, and which I accomplish by using the compound slide. A slide of magnetized steel may also be employed, and, in this instance, but one electro-magnet, with a pole on each side of the case, and one main circuit-wire will be required, the current being reversed at the station, and the forces of repulsion and attraction being alternately evoked on different sides to move the valve in opposite directions. A compound slide of which an electro-magnet forms a part may also be used within the valve-case, which then should be somewhat more elongated. The two poles of the electro-magnetic core of the induction-coil which is used for lighting may be brought to act on one end or both ends of this electro-magnetic slide, and motion will thus be imparted to it to admit or exclude the gas, accordingly as the two independent currents are sent simultaneously in the same direction, or in opposite directions, around the core and the slide.

The chief features of this part of my invention are, the peculiar construction of the several slide-valves; the opening and closing of the valves by the direct action thereon of electro-magnetism, without intermediate moving mechanism, (though I do not limit myself to this particular method of applying electro-magnetism to move these slide-valves;) the instantaneous admission and exclusion of gas to and from a burner by an electro-magnetical machine having but one moving part —*i. e.*, the valve; the use of an electric helix around a permanent magnet to prevent its demagnetization when combined with an electro-magnet whose poles may be reversed; the employment of both poles of the iron core of an induction-coil for attracting one armature.

The method I use for lighting the gas as it escapes from the burner is by passing an electric spark across the combustible mixture of air and gas, as it is found just at the base of the slit in a common lava or other tip. The igniting sparks for each lamp of a series are generated by an independent induction-coil at every lamp, and within or without each

induction-coil is one of a connected series of inducing-helices, which also serves to excite the magnet that gives motion to the gas-admitting devices.

The manner in which the inducing-wire, the induction-coils, the circuit-breaker, and condenser are combined to produce the igniting sparks is or may be substantially that described in my Patent No. 127,000, before referred to; but the arrangement of the inducing and induction helices, in relation to the mechanism for admitting and shutting off the gas, is peculiar to this invention, as is, also, the relative position that said helices may have to each other. The advantage of placing the inducing-helix exterior to the induction-coil arises from the greater proximity of the induction-coil to the magnetic core, and, also, from the diminution by this arrangement of the inductive influence that would otherwise be expended in the inducing-helix, and which increases the injurious spark at the break-piece.

Another part of my invention is the insulation of the electro gas-lamp (as I will, for convenience, style the entire machine placed in a street-lantern for lighting and extinguishing the gas therein by electric agency) from the gas-pipe to which it is attached, and consequently from the ground. This important feature confines almost every possible accident which may occur to one or more of a connected series of electro gas-lamps to the particular lamp or lamps affected. This insulation is accomplished by inserting between the base of an electro gas-lamp and the gas-pipe a piece of dry wood, or other suitable electrically non-conducting substance, in such a way that no metallic contact exists between the pipe and lamp, while at the same time their union is secured, and the gas can pass into the lamp by a perforation through the insulating material. The insulation of the electro gas-lamps renders inoperative the device shown in two of my aforesaid patents for using each lamp-post as a testing-point in case of accidents to the main line connecting together many street-lamps, especially if the line be subterranean; but, in my present apparatus, I attain the same end by even simpler means, namely, joining an uncovered piece of metal, as a ring of brass, to the exit-wire of each electro-magnetic coil just below the base of the lamp. When, for certain faults, the line is to be tested, it is only necessary that the inspector should apply one end of a curved metallic rod or wire against the aforesaid ring, and the other end against the gas-pipe below its insulated junction with the lamp, and a ground connection is at once established.

In my Patent No. 124,773 is shown a method of constructing a subterranean line for connecting together several series of street-lamps with a central station; but, in my present invention, the use of an aerial or overhead line of wire is often desirable for the purpose just mentioned. This aerial line may be made of ordinary uncovered telegraph-wire, or the wire may be wrapped and tarred, or more or less insulated in any other way if it be deemed necessary to prevent metallic contact with the foliage of trees, &c. I support and secure the wires at each lamp-post, or other support for a street-lamp, by means of insulators of glass, porcelain, vulcanite, or other suitable material, attached to projecting arms extending out from the lamp-post or support; and between the lamp-posts, if necessary, I attach the wires to similar insulators placed on a pole sufficiently high to keep the line from injury, or the line between the posts may be attached to insulators on the adjacent buildings.

The feature of this part of my invention is attaching insulators to lamp-posts, or other supports for street-lamps, for the purpose of sustaining wires connecting together electrical machinery at different lamp-posts, and also for taking off the strain due to the weight and tension of the wires from the said electrical machinery.

As the apparatus I am describing is designed mainly to light and extinguish the street-lamps of cities, I propose to send out the electric wires for this purpose from one or more convenient stations, the number depending upon the size of the city. The lamps can then be joined together in sections or series of, say, fifty, more or less, and those of each series or section lighted or extinguished simultaneously and instantaneously, while the different series or sections are lighted and put out in rapid succession.

To effect this certain machinery is required at the station, viz., a voltaic battery or some other source of dynamic electricity, an electrotome or current-breaker, and a switch or circuit-changer. The battery may be made of any convenient form or material. I use carbon and zinc plates immersed in solution of bichromate of potash and sulphuric acid, without porous cells, and have the plates so suspended and balanced above the acid solution that a large number may be quickly lowered at the same time into it, or raised from it. A magneto-electric machine, or a thermo-electric battery, or an electro-magnetic machine, may be used, if desired, to produce the current that operates the series of electro gas-lamps.

The electrotome I have invented and used as part of the lighting apparatus consists of a helix having within it, freely movable, a core of iron or magnetized steel, in regard to which the helix is adjustable longitudinally. The core rests vertically on a metallic spring, one end of which is or may be connected with the helix-wire, while the other end touches a metallic surface that may be put in communication with one pole of a voltaic battery. Through an opening in the spring projects a pin, which is firmly attached to the core, and freely movable in the opening till arrested by a head too large to pass through. When an electric current is sent through the

helix and spring, by bringing the opposite battery-pole into contact with the free end of the helix-wire the core will be suddenly drawn further into the helix, until the head of the attached pin strikes a blow upon the spring, the end of which is thereby separated from the metal surface it touches, and the current is broken. The electricity ceasing to flow in the helix, the core drops by gravity, but the spring returns to its normal position by elasticity, and closes the circuit for an instant before the momentum of the falling core can be overcome by the now flowing current, and for another instant while the core is rising again to strike the blow that breaks the circuit. These intervals of time suffice for the current to charge well the magnets of a connected series of electro gas-lamps, when they are included in a circuit with the electrotome, and to produce at the lamps the maximum secondary effects that the primary current can afford. The magnetic influence of the helix on the included core can be perfectly graduated by elevating or depressing the helix, so that a fewer or greater number of the spiral turns of wire shall surround the core; this adapts one electrotome to currents of various powers. The hammer-like blow which the spring receives when the core is drawn within the helix causes a very abrupt breaking of the current, and a consequent increased intensity of the induction obtainable therefrom. The induction effects in a connected series of electro gas-lamps may be further heightened by associating a condenser with the electrotome connecting one of the two series of metallic sheets in the condenser on either side of the rupture-point in the electrotome, and as near to it as convenient. These induction effects may be still further increased by placing the poles of a strong magnet close on either side of the rupture-point of the electrotome, so that the extra spark shall be suddenly broken by the influence of the magnet. Other kinds of electrotomes moved automatically by the current may be used in combination with the apparatus described in this specification; and, also, mechanical electrotomes having wheel-work driven by the stress of a spring, or manual or other force, beside that of the current itself, may be employed in such combination. One of the latter kind, consisting of a metal disk, with insulated spaces around its periphery, turned rapidly by any of the means above mentioned, and having a metallic spring pressed lightly against its dentated edge, if introduced into a circuit of gas lamps, instead of my automatic percussive electrotome before described, and connected with the switch so that the current passing from the disk to the spring shall be often interrupted in every revolution of the disk, will bring about the induction necessary to light the lamps. The chief features of this part of my invention are, the plan of moving an electro or permanent magnet within a fixed coil, for the purpose of rupturing the circuit of an induction apparatus; the plan of breaking the circuit automatically by a blow produced by the action of the current; the particular mode of continuing contact between two solid metal surfaces transmitting a current for a sufficient time to enable any electro-magnets that may be included in the electric circuit to be fully charged before the circuit is suddenly broken by the action of the electricity itself; the plan of regulating the quantity of electricity affecting the movable magnet of the electrotome by changing the relative position of the helix and magnet, the current passing through the circuit being at the same time unchanged, thus adapting one electrotome to currents or batteries of various powers; the method of using a mechanical electrotome with the connected series of primary inducing-coils as disposed in my apparatus.

The switch or mechanism for shifting the currents that I use in my apparatus consists of a non-conducting disk or table, over the surface of which passes a rotating radial arm, having firmly connected with its central end, below the disk, a metal plate, on which presses a spring, that keeps the plate in constant communication with one pole of the voltaic battery while the arm is turning. From the plate, along the top of the arm for about half its length, extends a metal spring, which carries on its end a metallic pin, that passes through the arm and projects a little below its under surface, in order to make and break contact, as required, with one or more series of metallic pins or plates arranged around the upper surface of the disk, and connected by wires with one or more corresponding series of street or electro gas-lamps, and with one electrotome. The rotating arm also has on its upper side another shorter spring, which is insulated from all the metallic connections of the switch, except when a pin on each end of the spring, and passing through the arm, shall be brought into contact with two of the pins or plates of the disk.

Each series of the contact pins or plates of the disk is arranged near together on a section cut from the disk, but fitted in its place, and hinged so as to be dropped, when required, out of the way of the rotating arm, and thus leave out of connection with the battery the particular series of electro gas-lamps joined to the pins or plates on that swinging disk-section. The series of contact-pins on every disk-section numbers five, three of these being on the line of a circle drawn concentric with the circumference of the disk, and the other two placed on a radial line passing through the last of the three pins. The first of the three pins is connected with a wire joining together the electro-magnets that are instrumental in extinguishing the gas at each of a series of lamps; the second pin is connected with a wire joining together the electro-magnets that are employed to let on the gas to the burners of the same series of lamps; and

the last of the three pins is connected with a wire proceeding to the electrotome. The outer pin of the two on the radial line is attached to the return-wire from the electrotome, and the inner pin is connected by a short wire to the second pin of the three above mentioned.

When the radial arm swings around the disk from left to right the battery-current is conveyed thereby, successively, to each contact-pin on a disk-section, and also to each series of contact-pins, producing in every series of connected electro gas-lamps, in regular order, the admission and lighting of the gas. When the arm swings in the opposite direction every series of lamps, in succession, is extinguished by the valve-motion arresting the flow of gas, this result occurring upon the completion of the circuit through the last contact-pin (formerly the first) now reached on each disk-section.

The rotary movement of the radial arm of the switch may be produced by hand, or by the pressure of a spring or weight acting thereon through a system of cog-wheels, so combined that motion in a constant direction given to two wheels fixed on a horizontal axle shall impart rotation to the left or right to a single wheel placed between them on a vertical axis, accordingly as one or other of the two wheels separately gears into the single one.

One feature of this part of my invention is the arrangement of the contact-pins of the switch with the electrotome and main circuit-wire, so that the same wire at one time conducts a continued current that opens the valves, and at another time an interrupted current to produce the induction that lights the admitted gas; and a second feature is the combination of the short insulated spring on the switch-arm with the disk-pins, electrotome, and main circuit-line, in such a manner that one electrotome answers to interrupt the current for successive series of lamps; and a third feature is placing the disk-pins in such order, in relation to the respective line-wires of each connected series of lamps, that the rotation of the arm in one direction admits the gas and lights it, and in the opposite direction, over the same pins, shuts off the gas, and thereby, of course, extinguishes it.

I prefer to use the ground to complete the circuit through my apparatus in case of lighting street-lamps, though a complete metallic circuit may be employed. I also make use of a very feeble battery, (of insufficient power to operate the lamp-valves,) in combination with a galvanometer and the connected series of electro gas-lamps, to test the continuity and perfection of the circuit from the station. This is done by substituting the poles of the small battery for those of the large one, and interposing the galvanometer in the general circuit. The amount of the deflection of the needle will indicate, to a considerable extent, the condition of the line.

The drawings represent an apparatus and parts of an apparatus embodying my invention. Figure 1 shows a view in perspective of the apparatus applied to two series of street-lamps: A is the battery; B is the electrotome; C is the switch; B^2 is a vertical section of the coil, core, and spring of the electrotome; C^2 is a view of the under side of the switch. Figs. 2, 3, and 4 are vertical central sectional views of three different kinds of electro gas-lamps that may be used as part of this apparatus: D is to exhibit the manner that the induction-coil of either lamp may be placed within the inducing-helix; E is a horizontal section of Fig. 2 at the line *x*, showing the armature-catch and third magnet; F is a horizontal section of Fig. 4 at the line *z*, showing a plan of the slide-valve.

a a' denote the lamp-posts for any number of gas-lamps, placed, for instance, in the streets of a city. They are joined together by the circuit-wires *r w*, extending from a central station; these wires also connecting into a series the electrical machinery at each lamp-post intended for lighting and extinguishing the gas. Another series of lamps is represented at *a'' a'''*, the line or circuit wires of which are independent of those of the first series, except in that they are attached to the same switch. Any required number of such series may form a system, connected with the same switch, and operated through it. *b b'* are poles, bearing insulators *c c'* at their tops, and placed between the lamp-posts to elevate the line. *d d' d'' d'''* denote the insulators attached to each lamp-post to support and insulate the line, and to relieve the wires immediately belonging to the electro gas-lamp of all strain. This is accomplished by bending the line-wire around an insulator and securing it by a clamp, or in any other way, so that the weight and tension of the line shall fall upon the insulator. The end of the line-wire is then passed up, within the lantern, to the electro gas-lamp, and soldered to the appropriate wire projecting therefrom, which is thus not liable to be broken. A proper way to attach the insulators to the lamp-posts is by means of metallic rods, which support the insulators at their ends, and are bent, as shown in the drawing, and fixed to the posts; but I do not confine myself to this or any particular method for their attachment. The last lamp of each series is or may be put into direct communication with the ground by having its exit-wires buried, and the electric circuit is then completed through the earth back to the station. *r* denotes the valve-opening and lighting wire, and *w* the valve-closing wire, of the first series of electro gas-lamps, and r^1 the opening and w^1 the closing wires of the second series.

A denotes the voltaic battery, fitted with stationary cells, and the plates attached to a vertically-sliding frame, which is balanced by weights, and can be lowered or raised as needed. Two binding-screws on top of the cross-bar are the poles for the attachment of

wires, one of which is in communication with the earth, and the other with the switch-arm.

B points out the electrotome or current-breaker. e^1 denotes a coil of insulated wire surrounding a brass tube, and inclosed within another brass tube, which latter has attached to its upper end, but insulated from it, the two brass rods e^2 e^3, that curve downward and pass through binding-screws, which hold the coil at any desired height above the wooden frame. An end of the coil-wire is soldered to one of these rods, and the other end to the opposite rod. e^4 is a core, consisting of a tube or rod of iron or steel, a little shorter than the interior brass tube, within which it easily slides, and is supported in position by the curved brass spring e^5. e^6 is a pin projecting downward from the core, and passing very loosely through a slot in the horizontal portion of the spring e^5; but it is prevented from being withdrawn entirely from the slot, when the core rises by the action of an electric current, by a head or nut, e^7, that, in such case, strikes a blow on the under surface of the spring, separating the platina-pointed end of the latter, e^8, from the platina-capped adjustable screw-post e^9. e^{10} is a strong magnet, either electro or permanent, with its poles near the rupture-points, to aid in dispelling the extra spark when the circuit is broken. The rupture-points can also be surrounded by a cup containing alcohol or pure water, if it be deemed desirable to break the circuit beneath a fluid. The other end of the spring e^5 is firmly secured to a metal post, e^{11}. Metallic wires (partly beneath the base of the instrument) extend from a binding-screw, e^{12}, to the upper binding-screw e^{13}, and from the opposite binding-screw e^{14} to the post e^{11}, and from post e^9 to binding-screw e^{15}. Posts e^9 and e^{11} are also connected beneath the base-board with a condenser, of tin-foil and varnished paper, e^{16}. The course of an electric current is or may be from e^{15} to e^9; thence through the platina junction and spring to e^{11}; thence to e^{14}, and through the brass rods and coil to e^{13}, and thence to e^{12}. If it be wished at any time to increase the sensitiveness of the electrotome an additional short electro-magnet may be inserted in the top of the coil, and held in a fixed position by any convenient means. e^{17} is an adjustable check or stop to regulate the height to which the spring e^5 shall ascend. C denotes the switch or mechanism for transferring the battery-current from one continuous line-wire to another of the same series of lamps, and also for connecting the electrotome with one of said line-wires and the battery; and, further, for transferring the current from one series of lamps to other series, and also for connecting the same electrotome and battery with one of the continuous line-wires of each successive series of lamps. C^2 shows a bottom view of the same mechanism. t^1 is an arm of dry wood, that swings around just above a disk of dry, varnished wood, of any convenient size. This arm has on its upper surface the flat brass spring t^2, whose central end is fastened to the metallic axis of the arm, and its outer end attached to a metal pin that pierces the arm and protrudes below it far enough to make good connection with the several series of contact pins or plates I II III I′ II′ III′, placed around the upper surface of the disk. t^3 indicates another shorter spring, fastened at its middle on the arm, but insulated from the spring t^2. Each end of t^3 has attached to it a pin, penetrating through the arm, as described above, for making connection with the disk contact pins or plates IV V IV′ V′ when the arm is revolved. t^4 t^5 denote the segments containing the series of contact-pins cut from the disk, and hinged thereto, so as to be lowered out of the way of the arm when needful. They are secured in position, when up, by the bolts t^6 $t^{6\prime}$, shown in C^2. t^7 is a solid brass wheel attached to the axis of arm t^1, and turning with it. t^8 is a brass spring, with one end screwed to the wooden disk, and the other end pressing on the wheel t^7 to make connection between said wheel and the battery-wire p, soldered to the spring. The valve-closing or catch-withdrawing line-wire w is seen attached below to contact disk-pin I; the valve-opening and lighting line-wire r to disk-pin II. u shows the connecting-wire from disk-pin III to binding-screw e^{15} of electrotome, and u^2 the return-wire from binding-screw e^{12} of electrotome to disk-pin IV. A short connecting-wire is also shown in C^2 on the under side of the disk, between contact-pins V and II. The adjacent segment t^5 shows similar connections, viz., wire w^1 to pin I′; wire r^1 to pin II′; wire u^1 from pin III′ to binding-screw e^{15}; and wire $u^{2\prime}$ from binding-screw e^{12} to pin IV′. t^9 t^{10} t^{11} denote the supporting-legs for the disk.

Fig. 2 shows a vertical section of an electro gas-lamp, such as may be placed in the lantern at each lamp-post. g^1 denotes the top of a gas-pipe proceeding from the source of gas-supply. g^2 is a perforated plug of dry, varnished wood, screwed into the gas-pipe below, and into the base-plate g^3 of the lamp above, but in such a manner that the pipe and plate cannot touch one another, and the lamp is insulated from the ground. g^4 is a crooked inlet-tube or passage-way, with its interior opening looking downward, for the gas to enter from g^1 into a small chamber at the lower end of the tube g^5, which leads to the burner. The bottom edge of this small chamber does not quite touch the floor of a larger circular chamber, g^6, that contains it, but dips into a quantity of mercury on the said floor. This mercury, at its natural level, is a little below the interior opening of the inlet-tube g^4, so that gas can freely pass from the pipe g^1 to the burner g^7; but when a hollow cylindrical electro-magnet, g^8, that surrounds the small chamber, is dropped into the mercury, the latter is displaced and elevated, and closes the mouth of the tube g^4, shutting off the gas from

the burner. When the electro-magnet g^8 is raised the mercury resumes its former level, and the passage-way is thus again open for the admission of gas to the burner. g^9 denotes an electro-magnet composed of iron wires, and firmly fixed to the top plate g^{10}. g^{11} is an inducing-coil of coarse wire, properly insulated, that surrounds the two electro-magnets g^8 g^9, and it may be considered as a coiled portion of the circuit-wire of a connected series of lamps. g^{12} is an induction-coil of very fine insulated wire, surrounding the primary coil g^{11}; or this position of the inducing and induction coils may be reversed, as shown at D. The two ends of the wire of the induction-coil are strengthened and insulated by gutta-percha when passing toward the burner, and are properly supported at g^{13}, and tipped with platina where they approach each other to give the igniting spark. g^{14} is a rod of metal fastened below to the magnet-weight g^8, and passing through a hole in the electro-magnet g^9 and plate g^{10}, and having on its upper end a projection that may be caught by the pivoted armature g^{15}, when g^8 is attracted and raised. g^{16} is an electro-magnet with two curved legs, only one of which is wound with wire. Its two poles are near the pivoted and weighted armature g^{15}, and its function is, when charged, to draw back the armature, release the rod g^{14}, and drop the weight g^8 to extinguish the gas. The function of the armature g^{15} is to uphold g^8, both when the main current is entirely broken, and also when it is rapidly interrupted by the electrotome to produce the induction current and sparks. I do not limit myself to the above-described shape or position of the electro-magnet g^{16}, or its armature g^{15}, as they may have various shapes and positions; and g^{15} may be drawn back by a spring instead of a weight. The insulating-support g^{17} for the radiating coils of the spark-wires is or may be like that described in Patents Nos. 120,469 and 124,773; and the arrangement of the points of said wires at the burner is the same as described in the last-named patent. g^{18} g^{19} are the uncovered metallic rings for testing the line, and they are soldered onto the exit-wires w^2 and r^2, respectively. g^{20} is the cover.

Fig. 3 is a vertical sectional view of an electro gas-lamp with two independent coarse-wire inducing-coils, h^1 h^2, which are shown inside of the fine-wire induction-coil h^3; but the relative position of the coarse and fine coils may be reversed, as shown at D, so as to bring the fine-wire coil next to the magnetic core. h^4 is a bundle of soft-iron wires, fastened at the upper end to the plate h^5, and having an opening, h^6, through the center up to the burner. h^7 is a cap of magnetized steel fitting loosely over the straight inlet-gas tube h^8, and having a groove, h^9, across the solid metal at its top. The lower end of the cap is immersed to a sufficient depth in mercury h^{10} to prevent the passage of gas from the inlet-tube to the burner when the cap is down in the position shown in the figure. h^{11} is a tube of vulcanite or other suitable material, firmly fastened to the base-plate h^{12}, and secured with a gas-tight junction to the plate h^5, thus serving as the bond of union for the two plates, as a chamber for the mercury, and as a conduit for the gas. The ends h^{13} h^{14} of the induction-coil h^3 are insulated and pass to the burner in the manner stated when describing Fig. 2. When two currents pass in the same direction at the same time through the coils h^1 h^2 the magnetism of the iron wires and of the steel cap combine to elevate the latter out of the mercury and attach it to the lower end of the wires, where it remains, when the current ceases to flow by virtue of its permanent magnetism. The gas then has a free passage from the tube h^8, beneath the lower margin of the cap h^7, through the tube h^{11} and the groove h^9, the opening h^6, and thence onto the burner. When the same two currents are then rendered intermittent by the use of an electrotome the induction-coil h^3 gives a spark at the burner that ignites the gas. When, on the other hand, the direction of the current through the coil h^1 is reversed by means of a pole-changer, while the direction of that through the coil h^2 remains unchanged, the magnetism evoked in the iron h^4 repels that maintained in the steel h^7, and the latter, being alone movable, is driven down into the mercury and shuts off the gas. When the currents now cease the magnetized cap remains down by virtue of its gravity.

Fig. 4 is a vertical section of another electro gas-lamp lighted upon the same principles as those above described under Figs. 2 and 3; but in this the valve is quite different. i^1 denotes the valve-case, which may be made of brass, rectangular in form, and have a perforated lid, i^2, screwed tightly upon it, supporting the burner. i^3 is or may be a flat piece of brass, ground perfectly smooth on its upper surface, plated with nickel, and perforated near one end with a small hole for the passage of gas from the inlet-tube i^4, which is soldered to its lower surface, and also to the bottom of the case i^1. i^5 is the slide for admitting or excluding the gas, ground to fit air-tight to the surface of i^3, on which it rests. It is preferably made of brass plated with nickel, and has a shape corresponding to that of the case i^1, but a little shorter and narrower, so as to admit of a small amount of sliding motion in two directions, in order to bring the aperture i^6, with which it is pierced, over or away from the hole in i^3. i^7 indicates a piece of soft iron firmly attached to the brass slide to serve as an armature for the poles of the electro-magnet i^8, as shown at F, (i^8 i^{10};) and i^{11} denotes a similar piece of iron fixed on another side of the slide before the poles of the U-shaped electro-magnet i^{12}, as seen in F, (i^{13} i^{14}.) These poles penetrate through the sides of the valve-case, and are soldered in place. The slide i^5 is pivoted, or turns loosely about a pin passing through one of its corners at i^{15}. The bundle of iron wires i^8 has its ends con-

tinued by iron, first, outward horizontally, and then upward, to form the poles i^9 i^{10}. i^{16} is a helix of coarse wire, and i^{17} is an induction-coil of fine wire, i^{18} i^{19} being its spark-giving ends. $r+$ and $r-$ denote the entrance and exit ends for the line-wire for admitting and lighting the gas, and $w+$ $w-$ show similar ends for the extinguishing wire, its continuation forming the coil of the electro-magnet i^{12}. i^{20} is a nut securing and making gas-tight the end of the tube i^4 where it passes through the base-plate. i^{21} shows the part to be screwed on the gas-pipe from the source of supply. When the poles i^9 i^{10} are active the slide is moved toward them, and, the holes in i^3 and i^5 being continuous, the gas has free passage to the burner; but when the poles i^{13} i^{14} are active (i^9 and i^{10} being now passive) the armature i^{11} is attracted against them, and, the brass slide having moved also, the gas is shut off by the hole in i^3 being covered by a solid part of i^5. The residual magnetism of these poles is sufficient to hold the slide gently, and prevent any motion thereof from gravity should the lamp be considerably inclined from a perpendicular.

Having described my invention, I claim—

1. An electro-magnetic displacing-weight, g^8, combined with a catch for sustaining the raised weight, and an electro-magnet, g^{16}, for releasing it when desired, substantially as specified.

2. In combination with the helix surrounding an electro-magnet that opens by its immediate attraction a mercury-valve or a slide-valve, substantially as shown, for admitting gas to a burner, a secondary induction-coil, arranged substantially as specified, for lighting the escaping gas.

3. The slide-valve i^5, with its armatures, combined with the poles i^9 i^{10}, constructed and operated substantially as specified.

4. The combination of an electric helix around a permanent steel magnet to prevent its demagnetization with an electro-magnet to produce motion by repulsion.

5. The combination of a gas-valve with an electro-magnet and a helix surrounding a permanent magnet, in such a manner that an electric current sent in a constant direction through the helix around the permanent magnet, and another current sent simultaneously through the coil of the electro-magnet, shall produce motion that will open or close the valve, according to the direction of the latter current.

6. In combination with an electric machine placed near a gas-burner to admit or exclude the gas, the use of an electrical insulator to prevent metallic connection between said machine and the gas-supply pipe, or any other non-insulated support.

7. In combination with an insulated electro gas-lamp, the use of an independent metallic connector to bring the said lamp into electric communication with the ground when required, substantially as specified.

8. In combination with one or more induction-coils, an electrotome having a permanent or electro-magnetic core, movable automatically within a fixed or adjustable electric coil, substantially as specified.

9. The headed pin e^6, attached to the axial bar e^4 and moving in the slot of the connecting-spring e^5, for rupturing the circuit, in the manner specified.

10. The combination of a source of dynamic electricity with an electrotome, an electrical switch, C, and two or more series of connected electric machines at street-lamps, for lighting or extinguishing the gas.

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Witnesses:
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