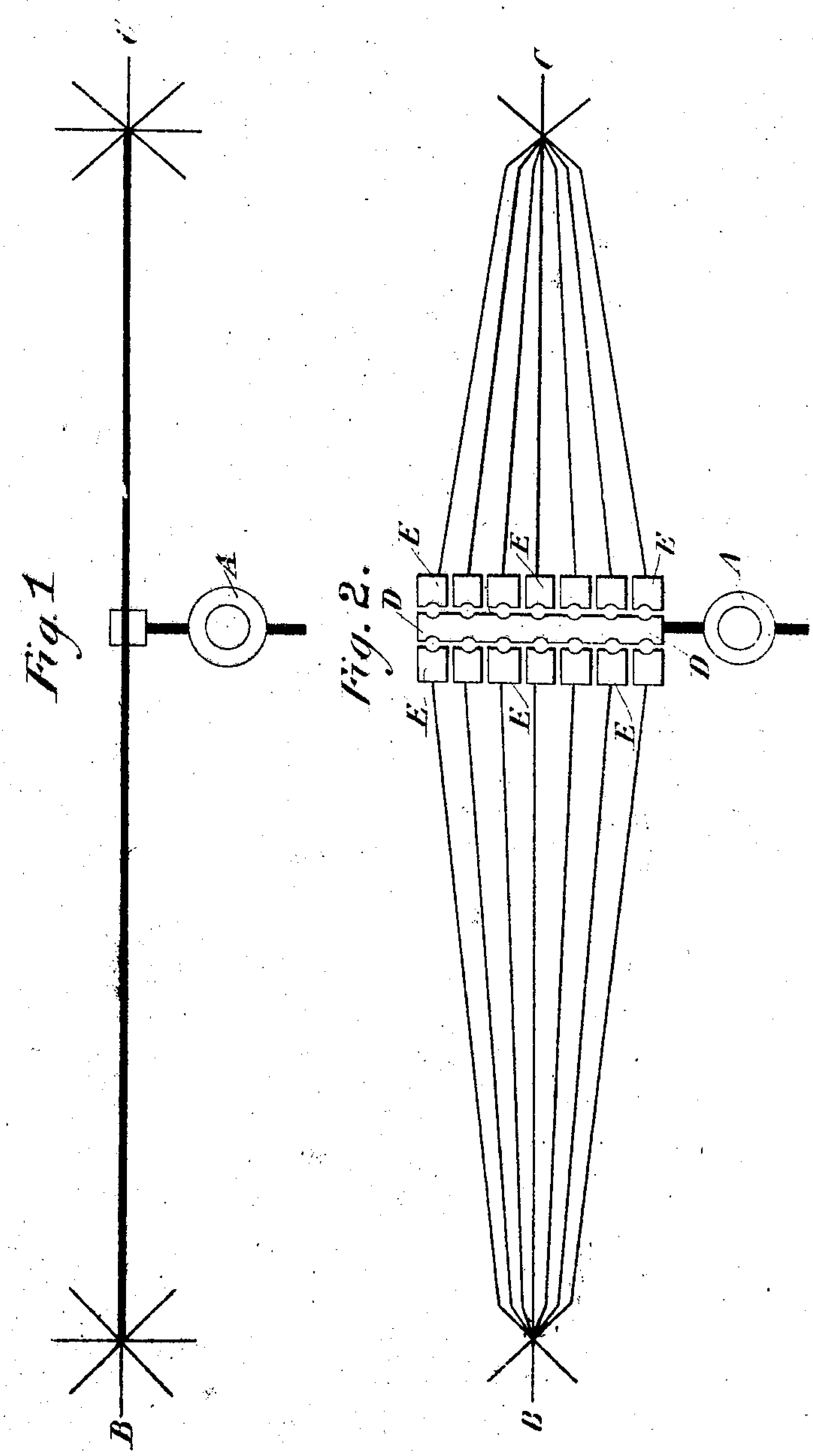
(No Model.) 6 Sheets—Sheet 1

J. E. H. GORDON.

ELECTRIC LIGHTING SYSTEM.

No. 358,346. Patented Feb. 22, 1887.



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Baltus De Long

Inventor:
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(No Model.)

6 Sheets—Sheet 2.

J. E. H. GORDON.

ELECTRIC LIGHTING SYSTEM.

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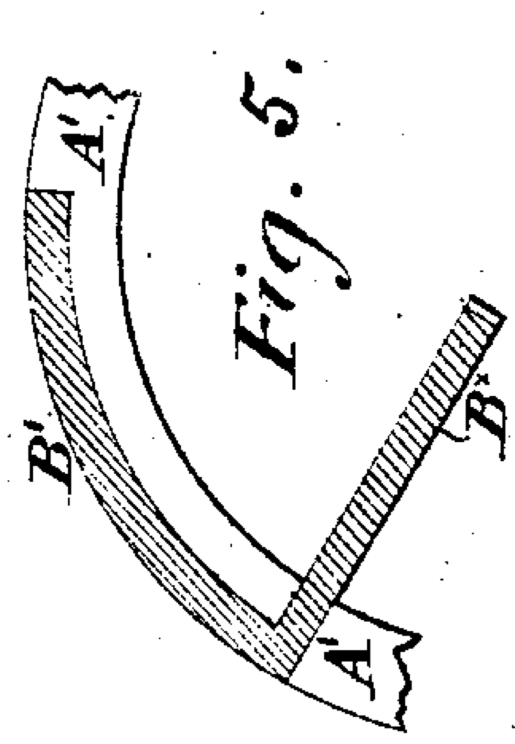

Fig. 5.

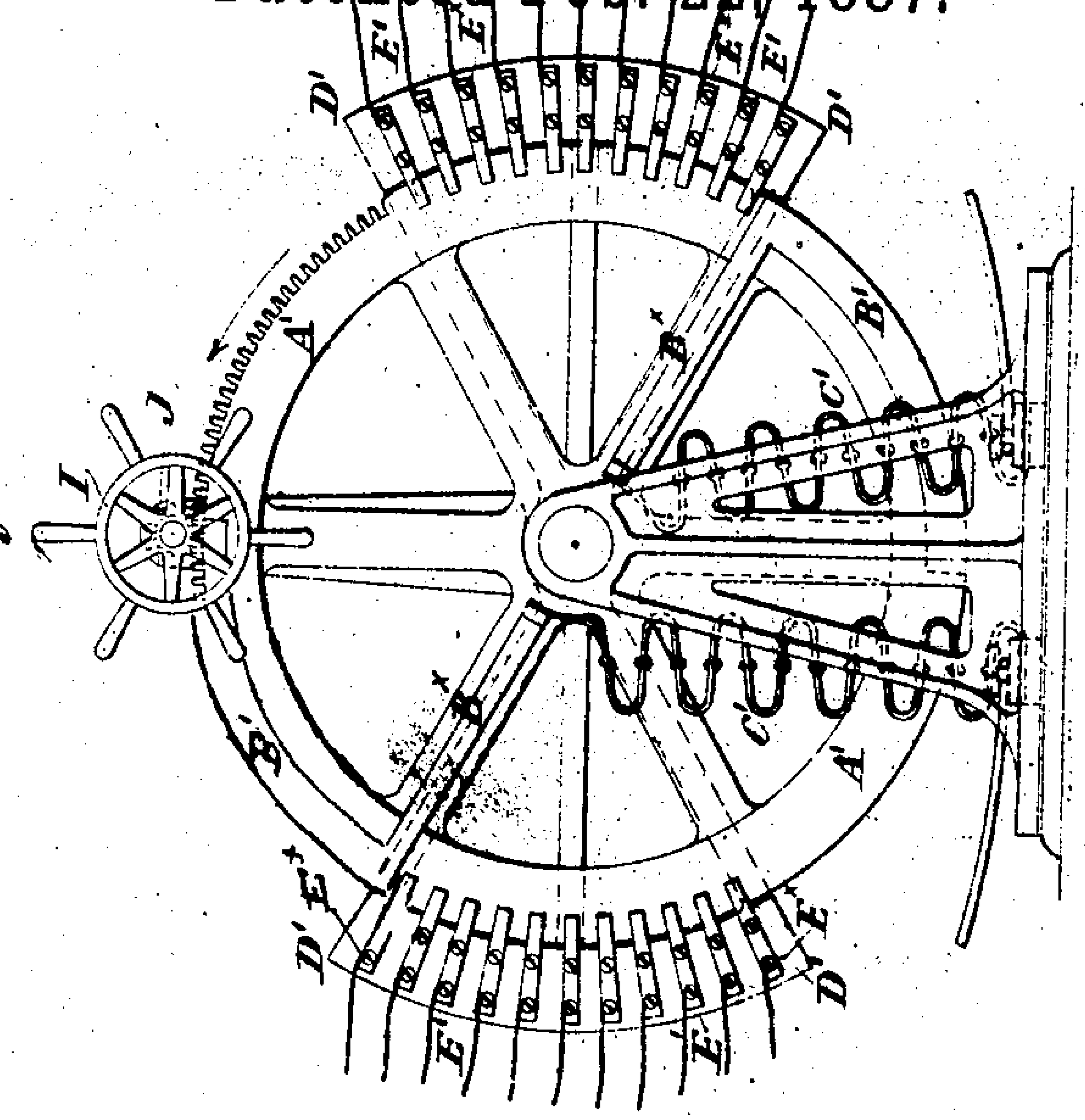

Fig. 6.

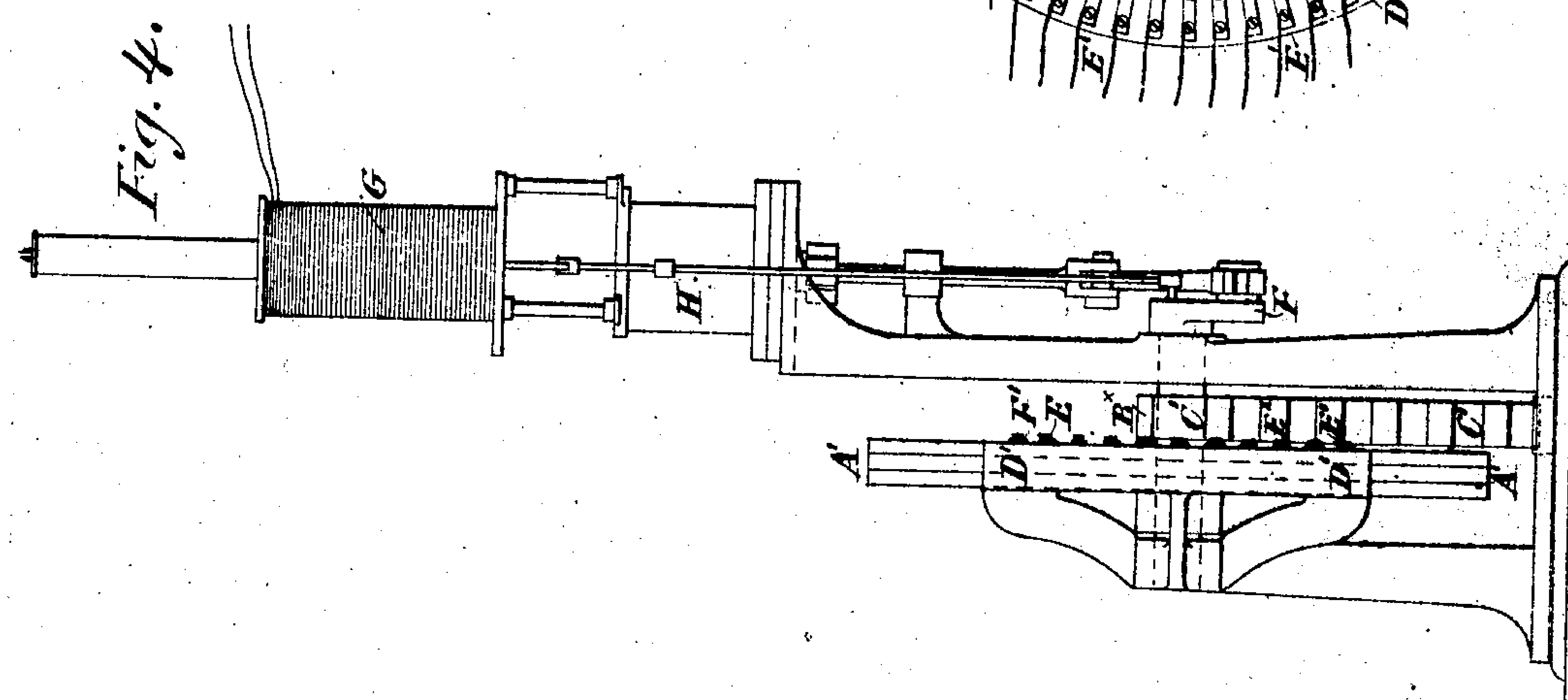

Fig. 4.

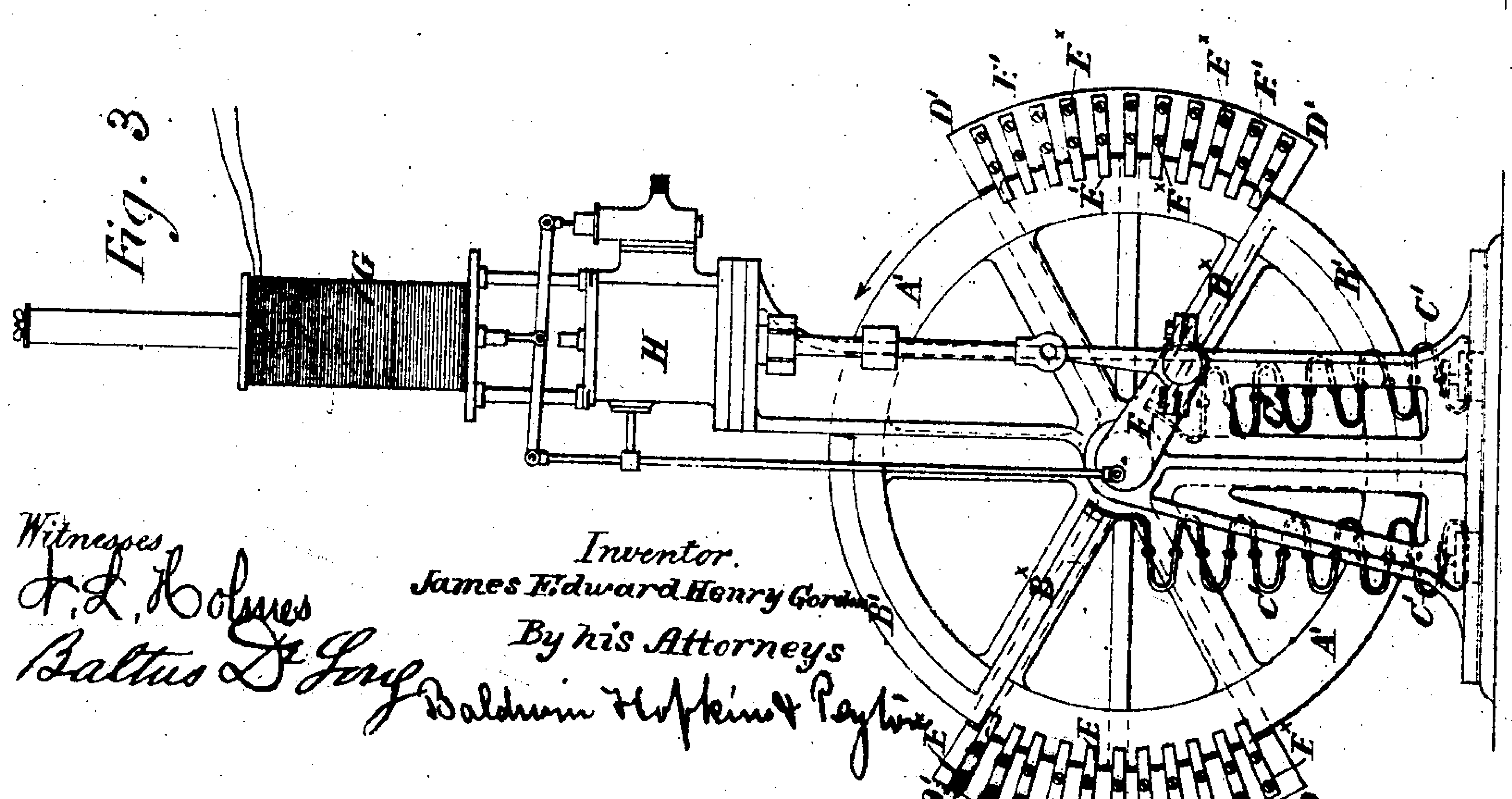

Fig. 3

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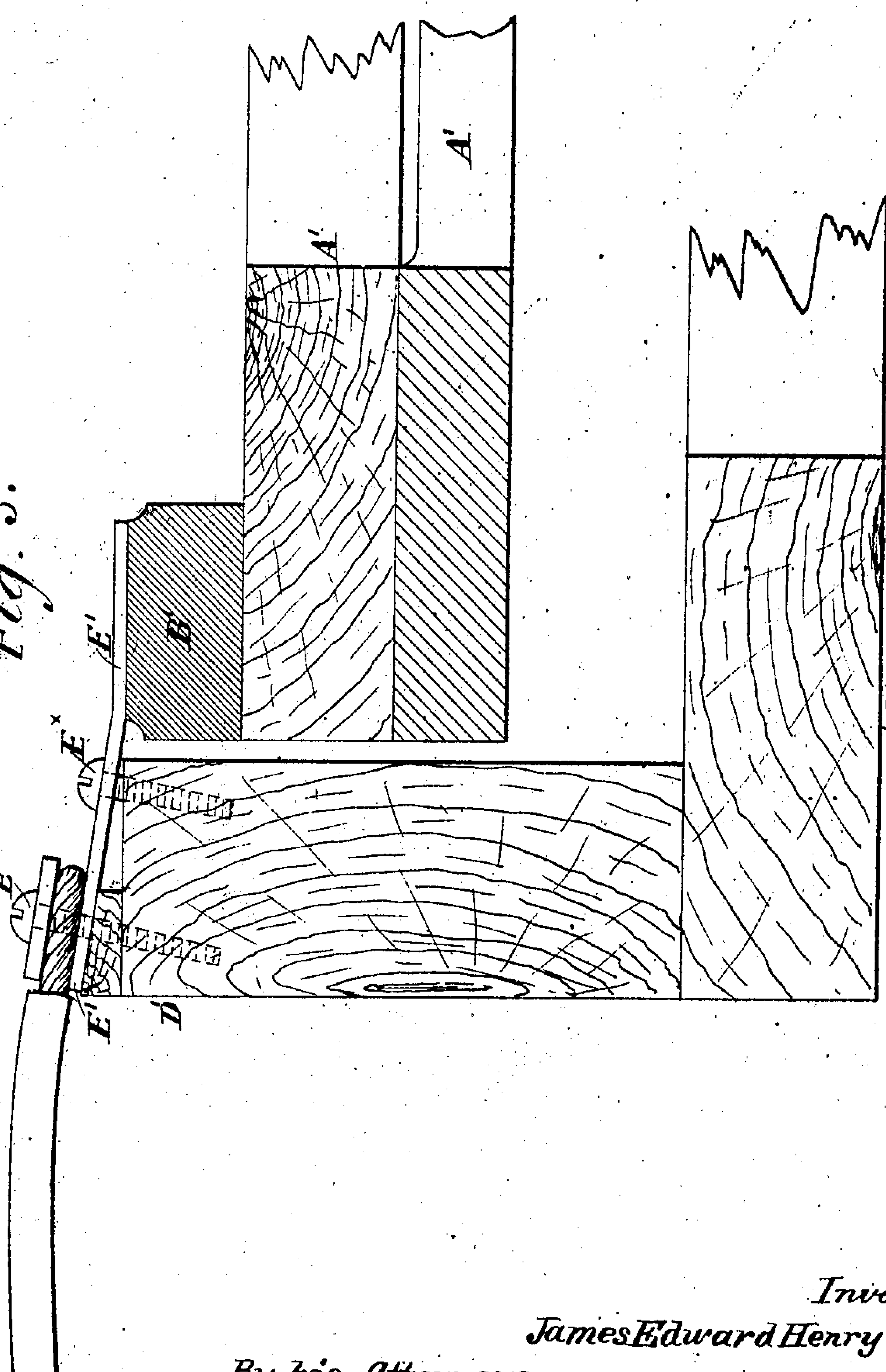
J. E. H. GORDON.

ELECTRIC LIGHTING SYSTEM.

No. 358,346. Patented Feb. 22, 1887.

Fig. 3.×



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ELECTRIC LIGHTING SYSTEM.

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Fig. 10.

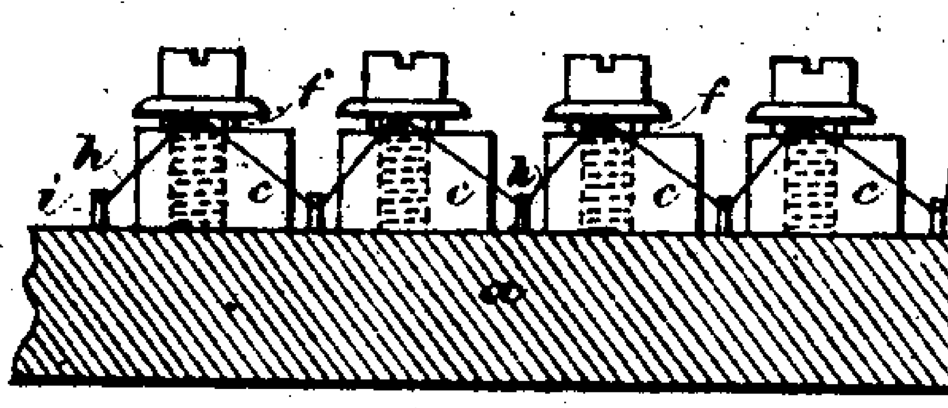


Fig. 8.

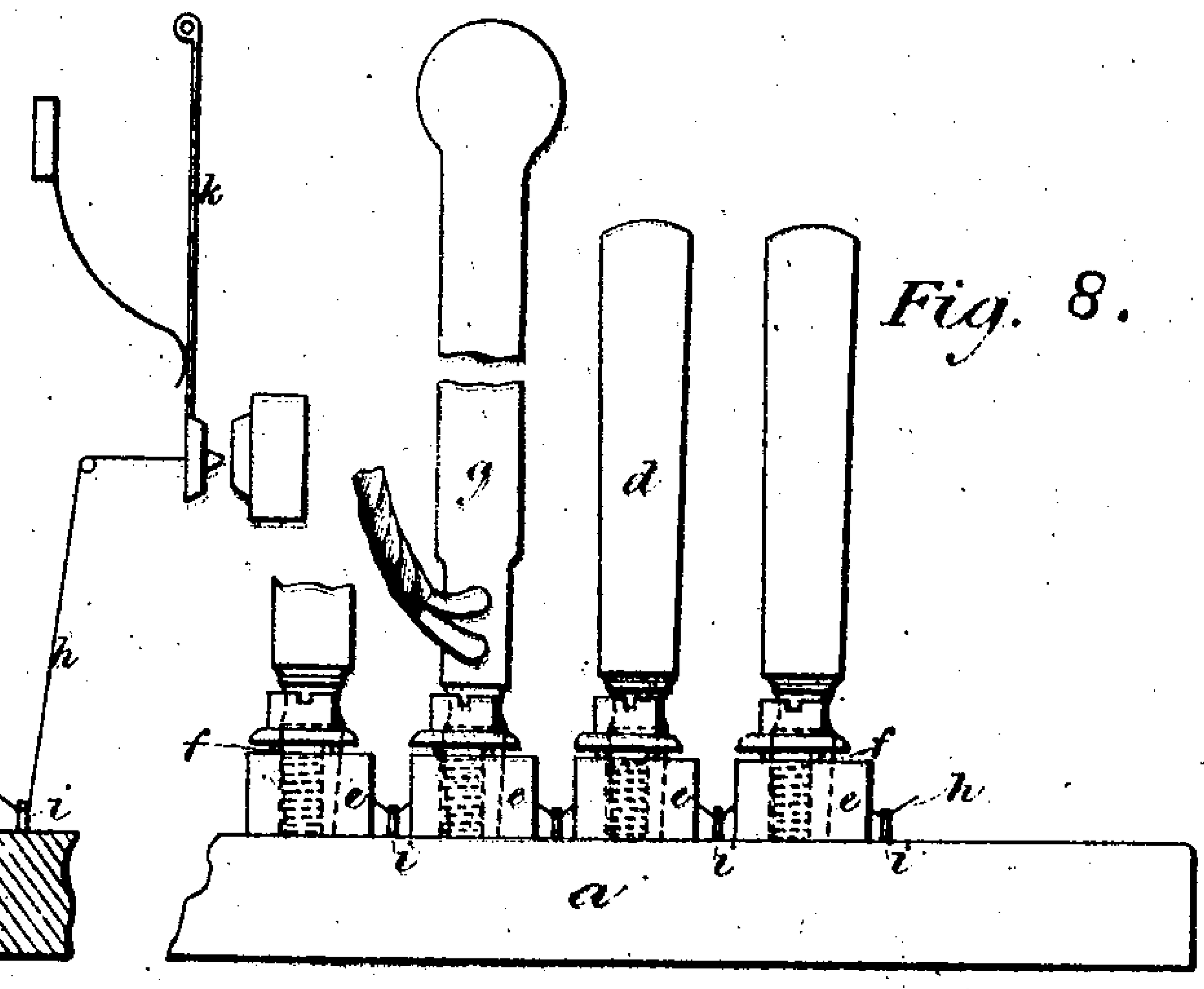


Fig. 9.

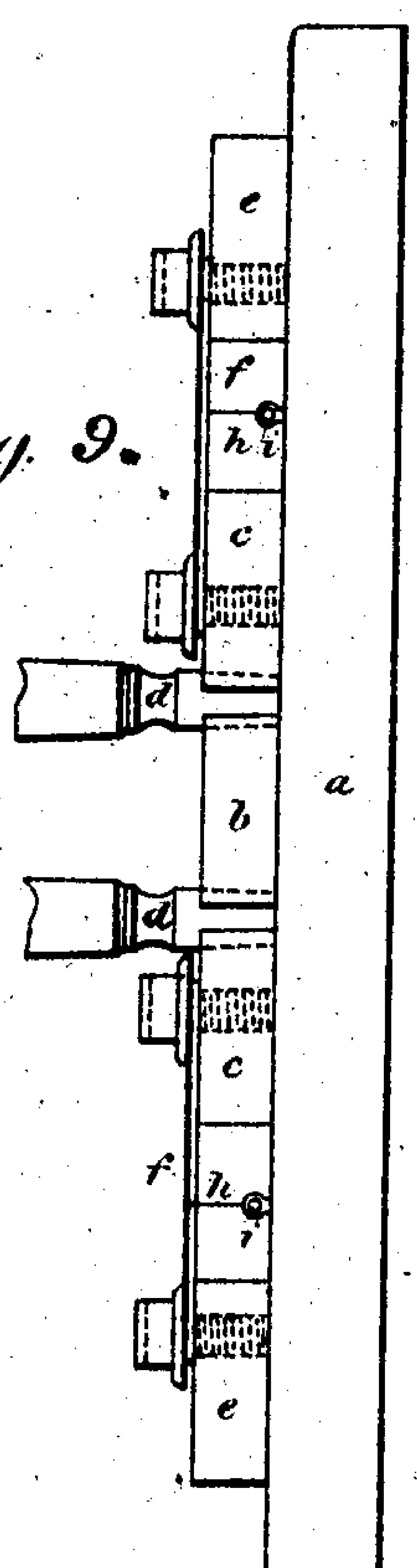
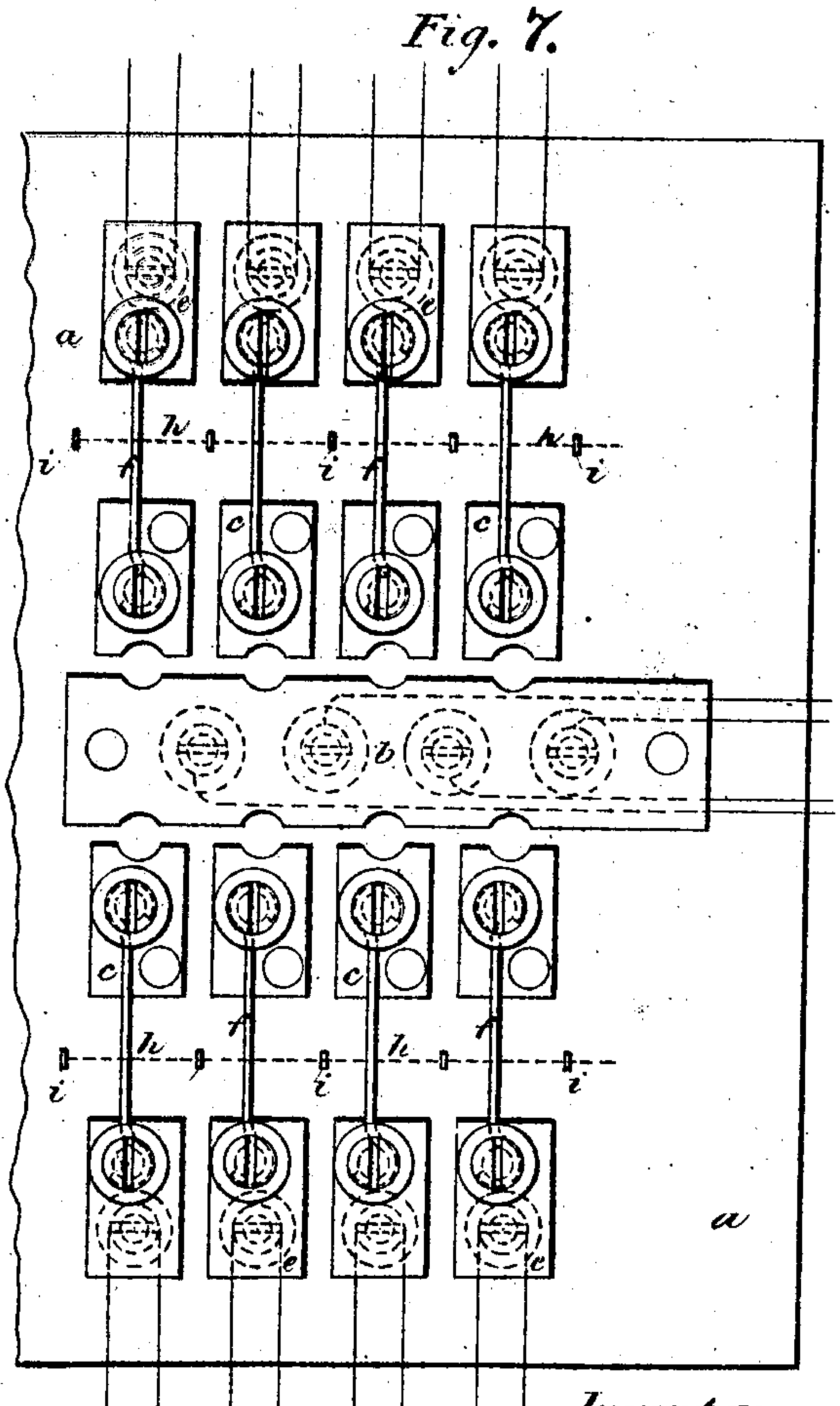


Fig. 7.



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J. E. H. GORDON.

ELECTRIC LIGHTING SYSTEM.

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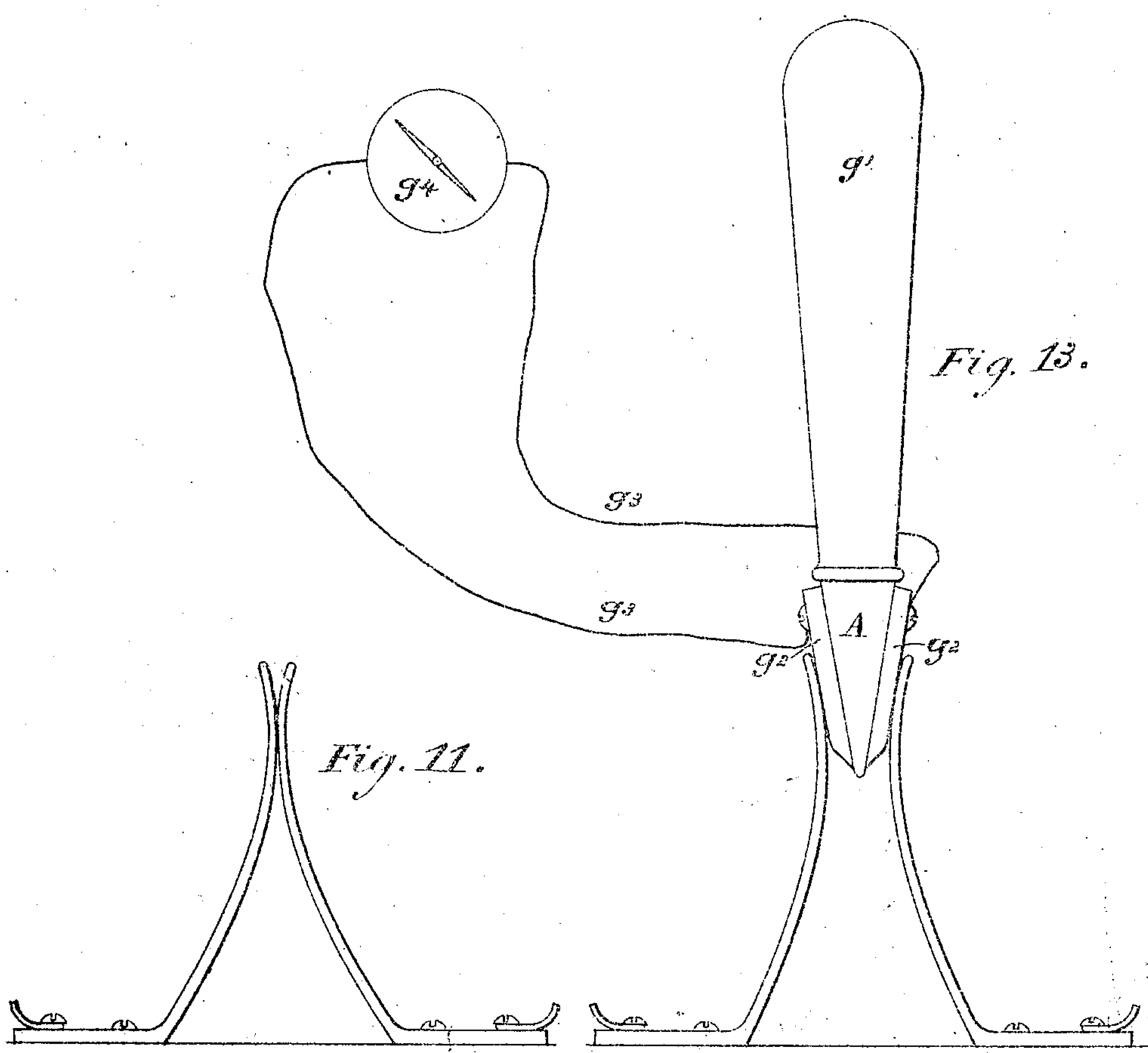

Fig. 13.

Fig. 11.

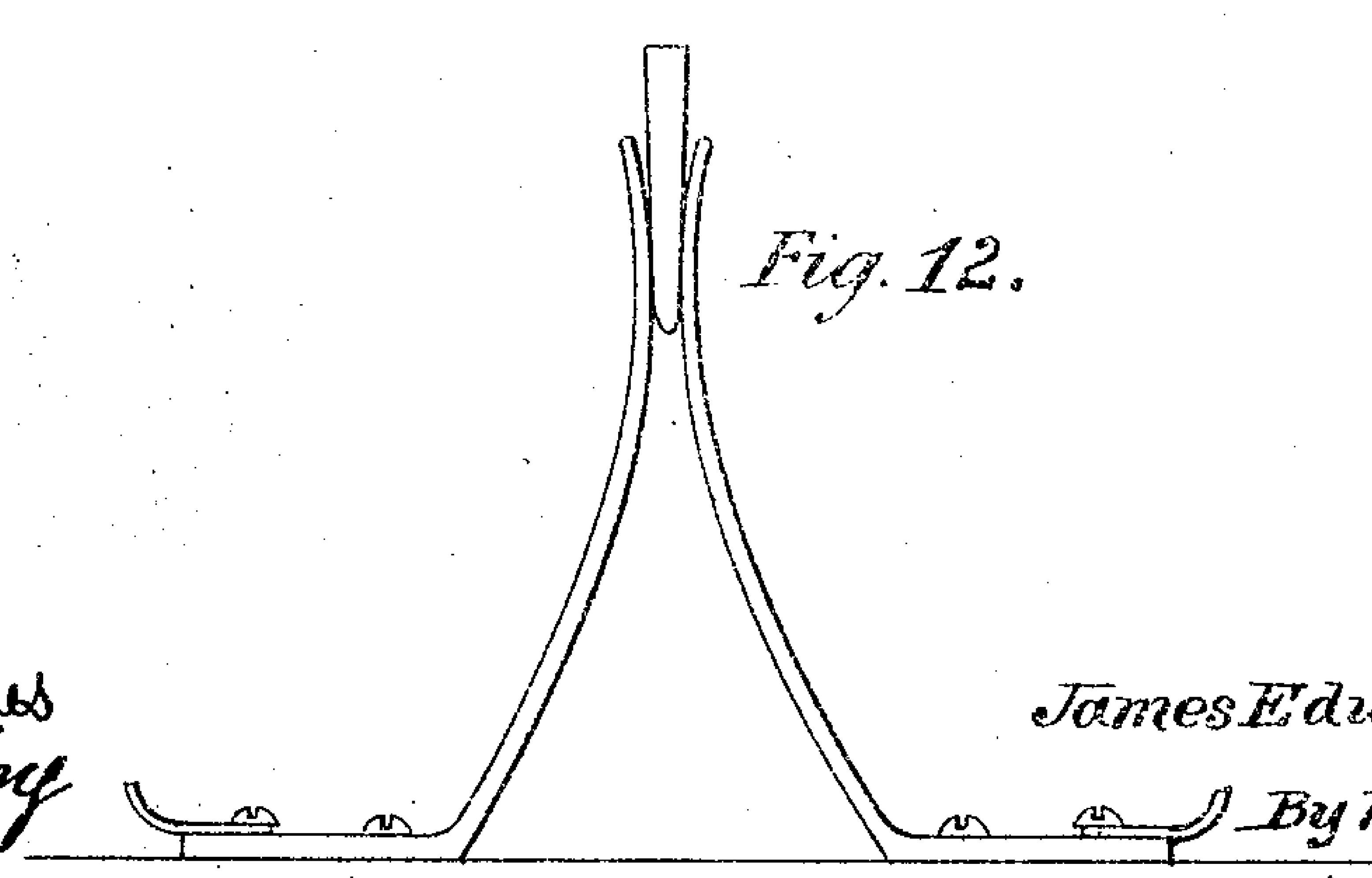

Fig. 12.

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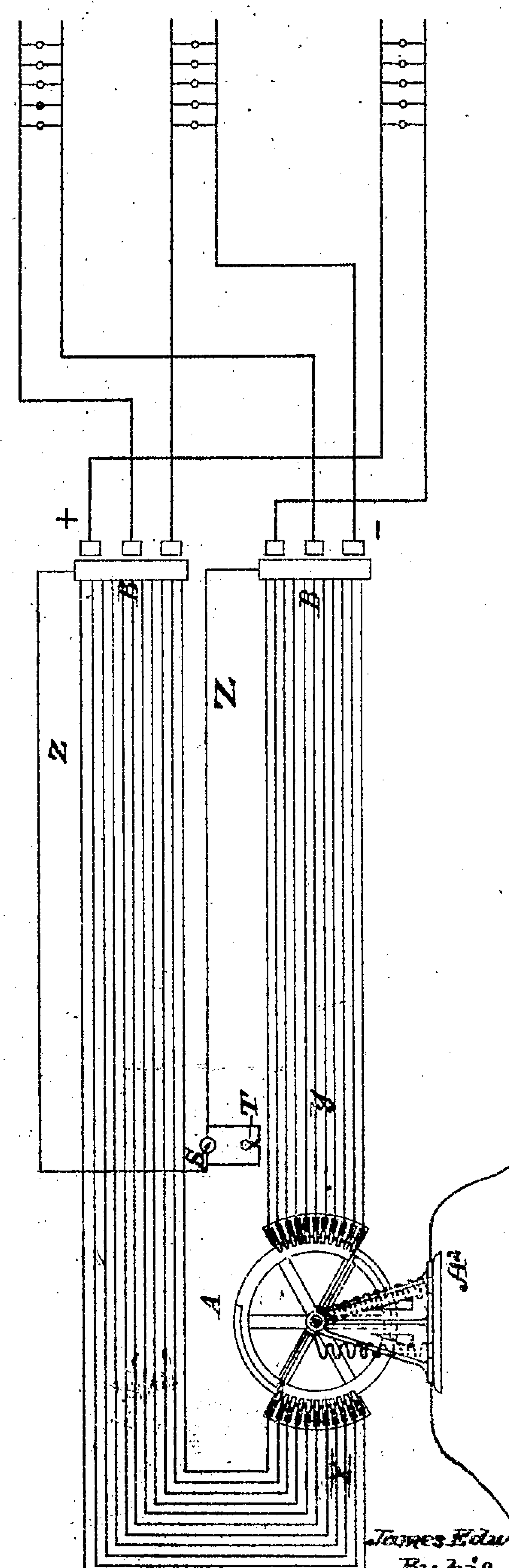
ELECTRIC LIGHTING SYSTEM.

No. 358,346.

Patented Feb. 22, 1887.

Fig. 14.



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UNITED STATES PATENT OFFICE.

JAMES E. H. GORDON, OF 28 COLLINGHAM PLACE, KENSINGTON, COUNTY OF MIDDLESEX, ENGLAND, ASSIGNOR TO THE GORDON ELECTRIC LIGHT COMPANY OF AMERICA, (LIMITED,) OF PHILADELPHIA, PENNSYLVANIA.

ELECTRIC LIGHTING SYSTEM.

SPECIFICATION forming part of Letters Patent No. 358,346, dated February 22, 1887.

Application filed August 21, 1886. Serial No. 211,529. (No model.) Patented in England February 25, 1885, Nos. 2,575 and 2,596; in France February 28, 1885, No. 167,334, and in Germany March 5, 1885, No. 34,469.

To all whom it may concern:

Be it known that I, JAMES EDWARD HENRY GORDON, a subject of the Queen of Great Britain, residing at 28 Collingham Place, Kensington, in the county of Middlesex, England, electrical engineer, have invented certain new and useful Improvements in Electric Lighting Systems, (for which I have received Letters Patent in Great Britain, No. 2,575, dated February 25, 1885, and No. 2,596, dated February 25, 1885; in France, No. 167,334, dated February 28, 1885, and in Germany, No. 34,469, dated March 5, 1885,) of which the following is a specification.

This invention has for its object improvements relating to the electric mains employed in district lighting.

In district lighting it is important that the electro-motive force at each lamp should be always constant. It is obvious that the electro-motive force at points distant from the dynamo must always be less than at the dynamo itself. The amount of difference depends upon the relative horse-powers expended in the lamps at the distant points and in the mains, respectively. If the number of lamps at a distant point were always constant, then the electro-motive force at that distant point would be a definite number of volts less than the constant electro-motive force at the dynamo; but it occurs that in practice the number of lamps alight at any distant point are constantly varying, and it is the case that as the number of lamps (in parallel circuit) at a distant point is decreased the electro-motive force at that distant point approaches more and more closely the electro-motive force of the dynamo. If there were only one distant point being fed from the dynamo, this change would cause no difficulty, as the electro-motive force at the dynamo could be varied so as to keep the electro-motive force at the distant point always constant. When, however, two or more distant points are being fed from the same dynamo, then it may happen that the full number of lamps are being used at one distant point and only a few at the other distant point. If in this case the electro-motive force of the dynamo is adjusted to give the required electro-motive force at the first point, then the electro-motive force at the second point will be too high, and will cause breakage of lamps; or if, on the other hand, the electro-motive force at the dynamo be adjusted so as to make the electro-motive force at the second point right, then the electro-motive force at the first point will be too low and the lamps there will burn dimly. This difficulty has hitherto been partially met by making the conductors, which we may call the "feeders," which lead from the dynamo to the distant points of very great thickness. The objection to this method is, first, the great expense of the copper required, and, secondly, the fact that even with thick conductors it is only partially successful. (It will be understood that we are assuming the lamps in different outlying districts to be supplied by mains or feeders which lead from the dynamo to a point within each of the outlying districts, respectively. These points are the "distant points" or "feeding centers" of which we have been speaking. From each of these comparatively short thick conductors radiate to the lamps or groups of lamps in its district. This method of arrangement is a matter of common knowledge.)

My improvements consist in certain new organizations, hereinafter specifically claimed, involving in part the use of a main consisting not of one large cable, but of a number of small strands placed side by side, as appears more fully from the following description.

Figure 1 of the drawings hereunto annexed is a diagram view of a feeding-main, such as has heretofore been used for conveying currents from a dynamo to distant points. Fig. 2 is a diagram view of a main divided into a number of separate insulated conductors. Fig. 3 is a side elevation of contact apparatus for coupling any one or more of the conductors of the divided main with the dynamo; Fig. $3^{\times}$, a cross-section through the wheel of said apparatus, and Fig. 4 an end view. Fig. 5 shows separately a portion of the rim of the wheel of this machine and a copper segment carried by it. Fig. 6 shows a side elevation of a modification of this machine. Fig. 7 is a face view, Fig. 8 an end elevation, Fig. 9 an edge view, and Fig. 10 a cross-section, of part of apparatus for coupling the feeding-main with the distributing-main. Figs. 11 and 12 show an alternative way of making the contacts. Fig. 13 shows an instrument to be used for measuring the current passing when this form of contact is employed. Fig. 14 is a diagram view of the whole apparatus.

In the diagram view, Fig. 1, which shows the old way of conveying current to a distant point, A is a dynamo, or connected system of dynamos, from which one thick conductor is conveyed to each distant point. In the diagram it is shown to be conveyed to two distant points, B and C.

In the diagram view, Fig. 2, which represents the mains as being divided into numerous parts, A is a dynamo, or connected system of dynamos, coupled to a metallic block, D. E E are smaller metallic blocks ranged alongside of it, so that any one or more of the blocks E may be electrically connected with the block D by the insertion of a metallic plug between them. B and C are the distant points to which the two divided mains are led.

When one or more conductors of each feeding-main are disconnected, the resistance of the feeding-main is of course increased and the difference of electro-motive force between its ends is thereby increased, and therefore if the electro-motive force of the dynamo is kept constant the disconnecting of some of the cables which go to form the compound main will reduce the electro-motive force at the distant point.

In practice, as the lamps fed from the distant point are turned out, and so the total lamp-resistance at the distant point is increased, some of the component cables of the feeding-main will be disconnected one by one until the electro-motive force at the distant point is reduced to the same value which it had when all the lamps were on, it being understood that the electro-motive force at the dynamo is, as a rule, kept constant. In order to ascertain when cables require disconnecting, a pair of light wires are brought back from the distant point to the dynamo-room, or to a convenient regulating-room near it, and attached to a voltmeter of any suitable construction placed there, and to an incandescent lamp.

In practice it will be found convenient to have the number of cables in the positive and in the negative compound mains, respectively, each equal to the difference in the number of volts between the potential at the dynamo and at the distant point when all the lamps are on. This will enable the electro-motive force at the distant point to be varied in steps of about half a volt each. This particular proportion is, however, not essential, but is mentioned to indicate one convenient proportion. By the use of this method a very great constancy of electro-motive force may be obtained, and it is not necessary that the total section of the main should be great, because it is only necessary to have it of such a size that it shall neither heat unduly nor waste any undue quantity of horse-power. It is no longer necessary, as heretofore, to have it large enough to keep the difference of electro-motive force at its two ends very small, as is the case when a single cable is used.

With arrangements made in accordance with this system, there is no objection to having even a considerable difference of potential between the dynamo and the distant point, because by the use of the invention that difference is kept always constant. It is also unnecessary to have the same electro-motive force at various distant points fed from the same dynamo, it being remembered that if different electro-motive forces are used for different points then different incandescent lamps have to be used at those points respectively.

My improved arrangement for throwing the strands in and out of the circuit is shown at Figs. 3, 4, and 5, or Fig. 6.

The drawings represent the apparatus adapted to be used in cases where both the positive and negative mains are subdivided, which is the arrangement I prefer. A′ is a wheel. B′ B′ are copper arcs or segments let into the side of the rim of the wheel. $B^{\times}$ are conductors from these arcs to flexible conductors C′, one of which is coupled to the positive pole and the other to the negative pole of the dynamo, or connected system of dynamos. D′ D′ are fixed wooden segments concentric with the wheel and in close proximity to opposite sides of its circumference. E′ E′ are contact plates or brushes carried by the segments and made to bear against the circumference of the wheel. There are as many brushes on each segment D′ as there are parts in the positive or negative portions of the divided main.

The drawings show the wheel in position when no current is passing to any portion of the divided mains. If the wheel be turned in the direction of the arrow, the metallic segment on one side of the wheel, and which is in connection with the positive pole of the dynamo, is brought into contact with one contact plate or brush, E′, while the metallic segment on the opposite side of the wheel, which is in connection with the negative pole of the dynamo, is brought into contact with another contact plate or brush, and in this way an electric circuit is completed through one part or division of the divided main. A further movement of the wheel completes the electric circuit through two parts of the divided main, and so on. The flexible conductors C′ allow of the wheel being turned a quarter of a revolution or more without impeding it.

In Figs. 3, 4, and 5 the wheel is shown to be turned by a crank-arm, F, on its axis, acted upon by an electrical governor. The electrical governor shown is one known as the

"Willans governor." It consists of a solenoid and core, G, actuating the valves of a hydraulic cylinder, H. The piston-rod passing from this cylinder is coupled by a connecting-rod with the crank-arm F. Willans' electric governor being well known, no further description of it is here necessary. It has hitherto been used for actuating the valve-gear of steam-engines driving dynamos. I use it for actuating the contact apparatus used in connection with the divided main.

When the electro-motive force at the distant center is too high, the wheel A′ is turned by the governor in a direction to reduce the number of brushes in contact with the segments, the governor being worked by return-wires from the distant point or feeding-center. The brushes are kept pressed against the wheel by screws E×, as shown in Fig. 3×, which is a cross-section taken through one part of the circumference of the wheel and through one of the fixed segments D′.

In Fig. 6 the wheel is shown as being arranged to be turned by hand, by means of a hand-wheel, I, on the axis of which is a toothed pinion, J, gearing with teeth projecting from the circumference of the wheel. In this case the regulation is effected by an attendant, who watches a voltmeter or lamp and shifts the wheel according as the current increases or decreases.

The apparatus used at each feeding-center consists of a wooden frame on which are fixed "plug-boards." Figs. 7, 8, 9, and 10 show one typical form, but not the only useful form, of one of these plug-boards. Each plug-board consists of a mahogany or other insulating base, *a*, with an oblong block, *b*, of brass or other metal, to which a feeding-main, divided, as hereinbefore described, into numerous parts, is connected. Near this block are fixed a number of smaller metal blocks, *c*, corresponding to the number of distributing-mains leading from that center and fed from that feeding-main. These are connected to the central block, *b*, by means of plugs *d*, which can be removed at will. Outside each block *c* is another metal block, *e*, to which the distributing-main is attached. The blocks *c c c e*, &c., are respectively connected by fusible safety-wires *f*, of the usual construction. In addition to the plug-holes between the block *b* and the small blocks *c c*, &c., there are plug-holes in the central block, *b*, and in the small blocks *c* and *e*. Separate plug-boards are used for the positive and negative feeding-mains and for any separate circuits which may be supplied to the center. For instance, if two circuits come to the center, two positive and two negative plug-boards will be required—four in all. These plug-boards are used for localizing faults and for measuring the current in each distributing-main. In case of a fault, such as an earth-connection, appearing on a circuit, the plugs *d d* must be removed and replaced one by one until, on removing one plug, the earth-connection ceases. We then know that the fault is in the distributing-main governed by that plug, or in one of its branches.

To measure current, two plugs, such as shown at *g*, are connected respectively by wires to the terminals of any suitable galvanometer, ammeter, or dynamometer. The plugs *g* are inserted respectively into the holes in the central block, *b*, and into the small block *e* or *c*. On the connecting-plug *d* being removed the whole current passes through the galvanometer without being in any way interrupted.

In case of a fault which heats or melts one of the fusible cut-offs, the fact is automatically telegraphed to the engine-room or elsewhere by the following method: A fine cord, *h*, of gutta-percha, is threaded in and out over each fusible wire, and sometimes also under rings or hooks *i* on the board, in the manner shown in section in Fig. 10. As long as the thread is tight it keeps a contact-key, *k*, open; but on its becoming soft and stretching through the heating of any of the fusible cut-offs contact is made and a signal telegraphed. By using a thread of gutta-percha in this way the melting of the fusible wires is often avoided.

A convenient form of signal is the lighting up of a red lamp. There would be in the engine-room as many of these lamps as there are feeding-centers in the district. The lighting up, for instance, of red lamp No. 3 would mean "accident in district fed from No. 3 center." A man would then go to that center and look to see which fusible wire had melted, and this would show him in which set of rooms, &c—*i. e.*, on which distributing-main—the accident had occurred. A bell and ordinary indicator might be used, if desired, in place of using red signal-lamps.

In place of using movable metallic plugs to make or break the contacts between the metallic blocks, the contacts between the blocks might be made by springs which normally press against one another and complete the contact, but which can be separated by the insertion of a plug of insulating material between them when the contact is to be broken. This contact arrangement is shown at Figs. 11 and 12. When contacts of this kind are used, the measurement of current may be effected by the use of an insulating-plug—such as shown at Fig. 13—which carries at each side of its tapering end a metallic plate with an insulated wire passing from each plate to a galvanometer. g' is the plug of insulating material; g^2 the metallic plates secured to its opposite sides; g^3 g^3 the insulated wires leading from these metallic plates to a galvanometer, g^4. The current may be interrupted by inserting an insulating-plate, as in Fig. 12.

The diagram, Fig. 14, shows the whole arrangement. A is a point in or near the engine-room in which the dynamo or coupled system of dynamos is situated; B, a distant point or feeding-center. At A is situated a regulating apparatus, A^2, such as shown at Figs. 3, 4, 5, and 6. From it pass the positive and negative feeding-mains X and Y, each subdivided into numerous subdivisions. These mains are carried to plug-board apparatus at the point B, from which the distributing-mains are led away to wherever desired. Z are wires led back from the two plug-boards at B to the point A, where they are coupled to a galvanometer, S, and incandescent lamp T, so that the attendants at A can at once see the strength of current at B.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is—

1. The combination of a wheel carrying two insulated metallic arcs at different points on its circumference, one to be coupled to the positive and the other to the negative pole of a dynamo or system of dynamos, and two fixed arcs, each carrying a number of insulated brushes or contact-pieces with which the metallic arcs on the wheel can be brought into contact, and also positive and negative divided mains led from the two sets of brushes to a distant point.

2. The combination of an oblong block, *b*, to which all the positive wires of a divided feeding-main are coupled with smaller blocks *c*, ranged along one or both of its sides, means for electrically connecting or disconnecting any of the blocks *c* with the block *b*, and with other small blocks *e*, ranged alongside of the blocks *c*, and fusible wire-connections between the blocks *c* and *e*, and with distributing-mains, attached one to each block *e*, and also with means for electrically connecting the block *b* with any of the blocks *c* and *e* through a galvanometer, ammeter, or dynamometer, for testing purposes.

3. The combination, with the oblong block *b*, small blocks *c* and *e*, and fusible connections *f*, of a thread of gutta percha or like material which will soften with heat, made to bear against all the fusible connections, and of a contact-key, *k*, held open by the gutta percha thread, but which makes an electrical contact should the thread stretch or break.

4. The combination, with the fusible connections of an electric system, of a thread of material which is stretched against the fusible connections and yields upon being heated, and an alarm device which is thrown into operation by the yielding of the thread.

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