(No Model.) 2 Sheets—Sheet 1.

A. & T. GRAY.

REGULATOR FOR ELECTRIC ARC LAMPS.

No. 302,221. Patented July 15, 1884.

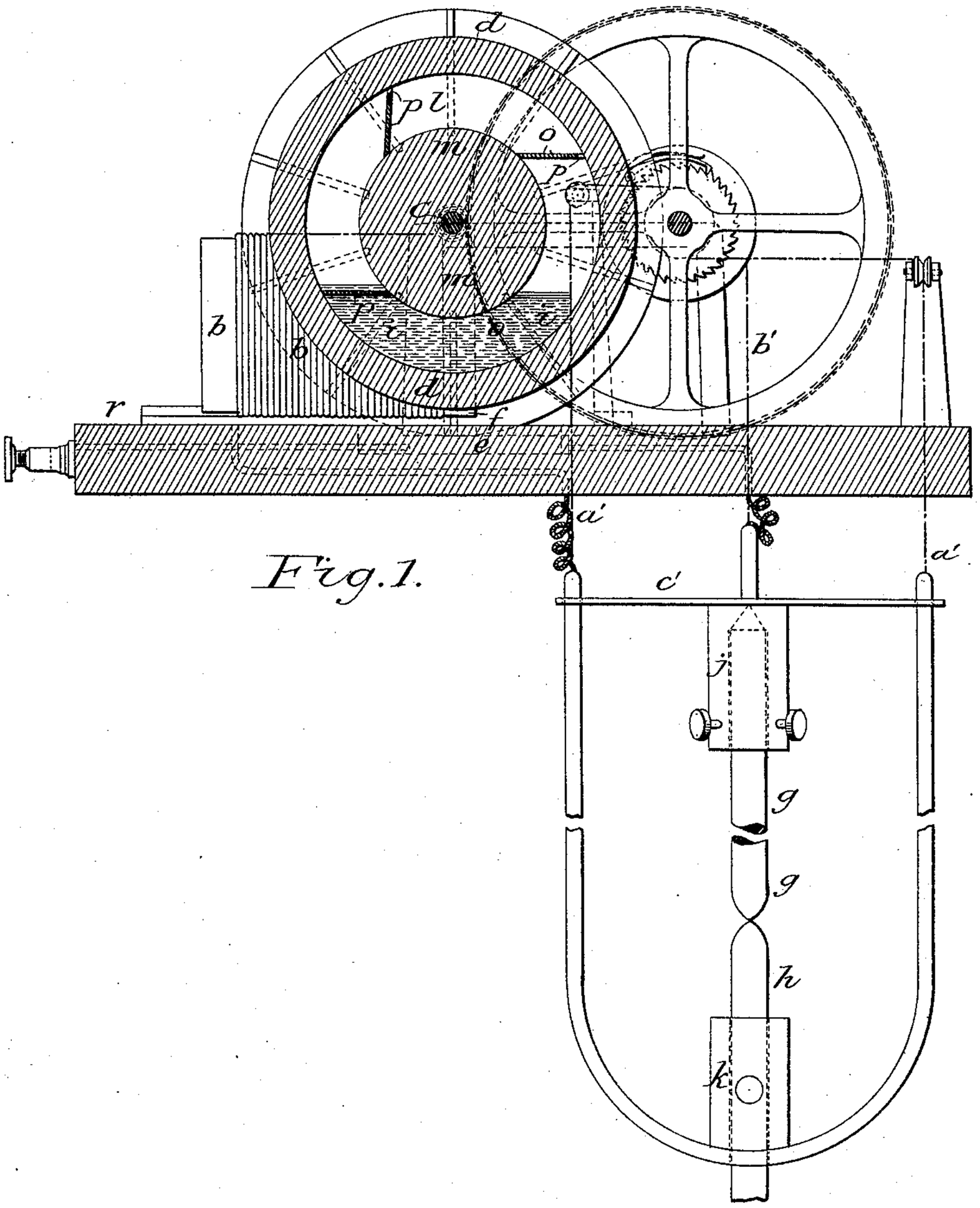

Fig. 1.

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(No Model.) 2 Sheets—Sheet 2.

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Fig. 2.

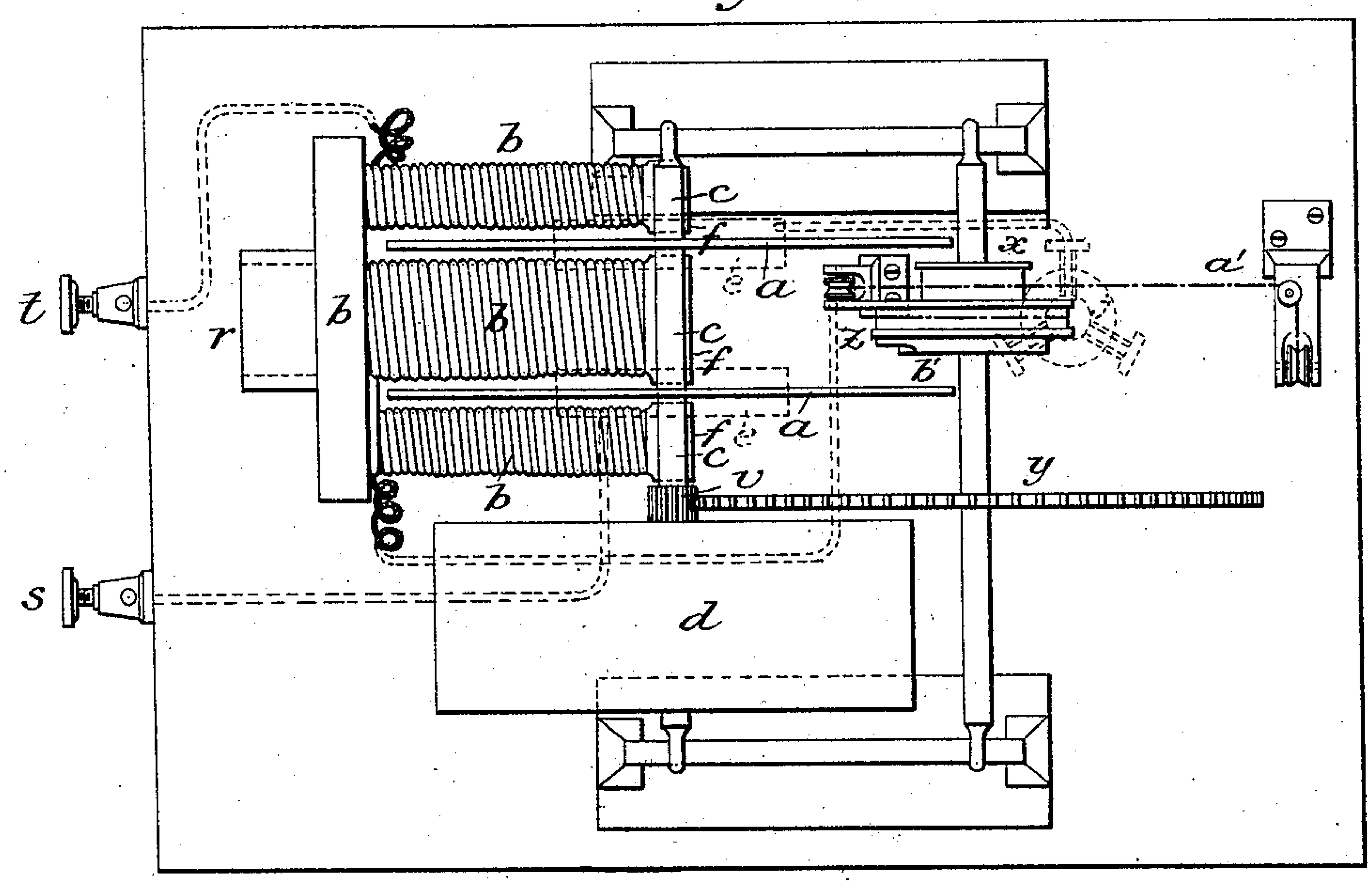
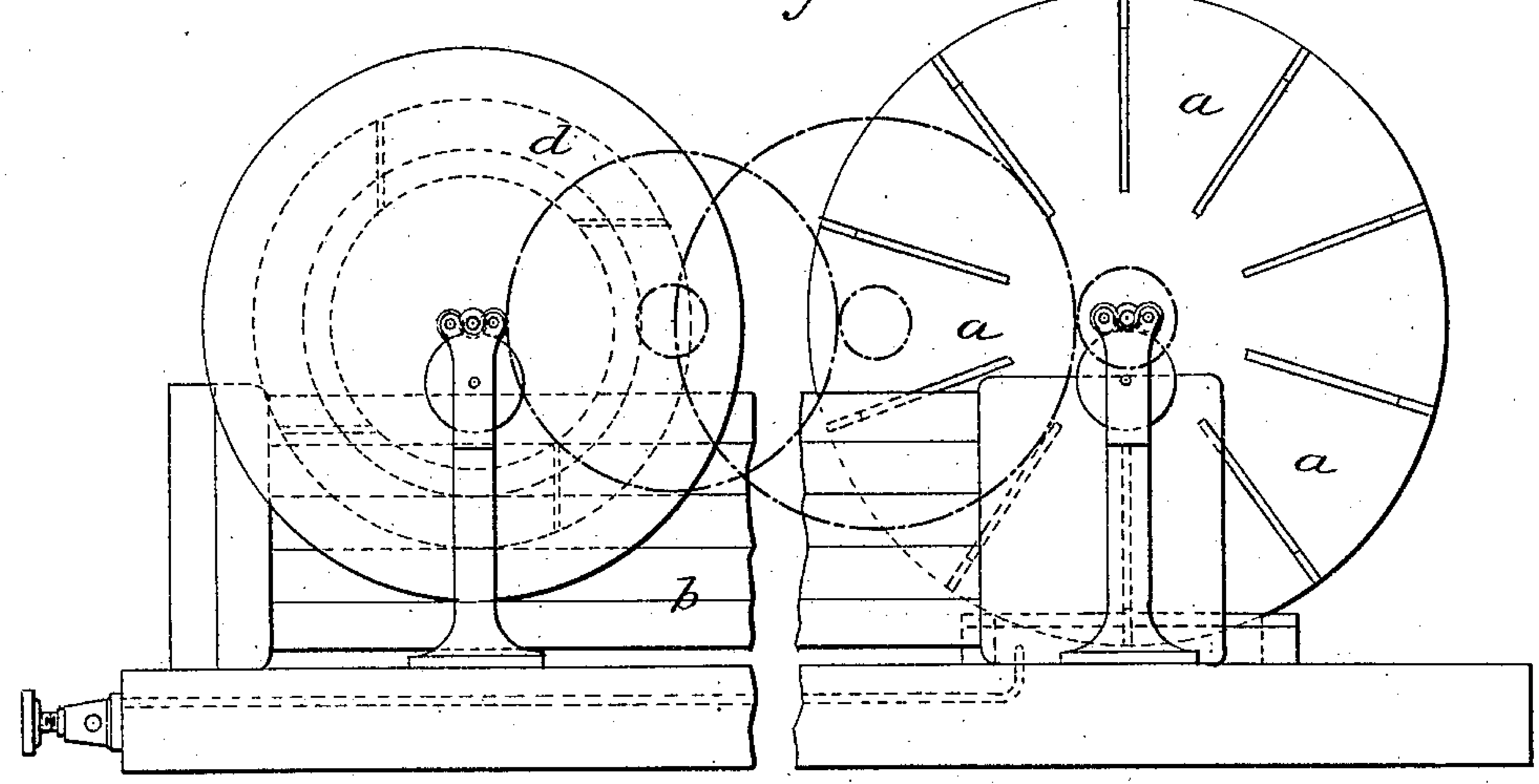


Fig. 3.



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UNITED STATES PATENT OFFICE.

ANDREW GRAY AND THOMAS GRAY, OF GLASGOW, COUNTY OF LANARK, SCOTLAND.

REGULATOR FOR ELECTRIC-ARC LAMPS.

SPECIFICATION forming part of Letters Patent No. 302,221, dated July 15, 1884.

Application filed August 13, 1883. (No model.) Patented in England July 20, 1882, No. 3,441.

To all whom it may concern:

Be it known that we, ANDREW GRAY, of Glasgow, in the county of Lanark, North Britain, assistant to the professor of natural philosophy in the University of Glasgow, and THOMAS GRAY, also of Glasgow, aforesaid, electrician, have invented Improvements in Apparatus for Regulating Electric Lamps, (for which we have received Letters Patent of the United Kingdom of Great Britain and Ireland, No. 3,441, dated July 20, 1882,) of which the following is a specification.

Our said invention relates to apparatus for regulating electric lamps.

To regulate the feed of the carbons in an electric lamp we use a retarding device consisting of a hollow drum formed by a single hollow cylinder, or having a hollow space between two coaxial cylinders of different diameters, or the hollow space within which is divided into two or more cellular spaces by partitions properly placed. These cellular spaces are partially filled with a suitable liquid and communicate with one another by small apertures in the partitions. When this drum is moved round in any direction by the action of a turning-couple, which may be supplied by the carbons and their holders in an electric lamp, the liquid applies an opposite couple resisting the motion. If the magnitude of the turning-couple be less than a certain value depending on the amount and density of the liquid contained in the cellular spaces, the wheel will be turned round by the couple until the liquid, by being accumulated in one side of the drum, opposes an equal and opposite couple. The motion thereafter becomes uniform, or nearly so, and depends on the rate of loss of head of the liquid by flow through the aperture. Combined with this, in the application to an electric lamp, we use an apparatus, as hereinafter described, for further controlling the motion of the carbons according to the amount of current flowing, so as to keep the carbons constantly, as nearly as may be, at the desired distance apart. One convenient form of this apparatus, which may be used either by itself or in combination with other apparatus for controlling the motion of the carbons, depends on an application of the principle of a similar instrument to that known as "Barlow's wheel," which is a metallic disk which can be rotated round an axis through its center by the action of a properly-placed magnet or magnets on a current of electricity passing between the center and circumference of the disk. We so modify this instrument by multiplying the number of disks, and so arranging the currents through them and the magnets, as to obtain the power necessary to separate the carbons when the circuit is first closed, and thereafter to control according to the strength of the current the rate of motion of the carbons. We place the apparatus employed either in the main circuit or in a derived circuit, as we find convenient. The form of Barlow's wheel which we use consists of one metallic disk or a series of metallic disks provided with fixed electro-kinetic devices for giving them rotation, and so connected up that the power of a single disk is duplicated by the multiplication of disks.

In the drawings, Figure 1 is an elevation, partly in section, of mechanism for controlling the motion of carbons in an arc-lamp constructed according to and constituting part of our present invention. Fig. 2 is a plan of the same. Fig. 3 shows the disk connected with the retarding-drum by a series of gear-wheels.

The lamp represented at Figs. 1 and 2, Sheets 1 and 2, is suitable for being used with strong currents of electricity, and is regulated by the electro-magnetic action between the currents flowing along a radius of each of a series of metallic disks, *a*, and a properly-situated permanent magnet, as in Fig. 3, or an electro-magnet, *b*, as shown in Fig. 2, and as hereinafter more fully described. The disks *a* are mounted on the same axis, *c*, as, or an axis geared with, that of the hollow drum *d*, (hereinafter more particularly described with reference to Fig. 3 of the accompanying drawings,) and the disks have their planes parallel. The current is sent into the disks *a* either by causing their lower edges to dip into cups of mercury *e* or by means of brushes properly arranged to make contact on the edges of the disks *a*, and are connected together metallically at their centers by their axis *c*. To prevent the current spreading in the disks *a*, they may be cut into segments in the manner shown at Figs. 1 and 3, the whole of these segments

remaining connected at the center. The electro-magnet *b* is made in three pieces, as shown more particularly at Fig. 2, connected together at one end so as to form a compound magnet consisting of three straight, flat electro-magnets with soft-iron cores, set with their planes parallel and with their cores fixed at one end to a common end plate of iron. The coils of these magnets are so joined in circuit that the polarity induced by the current in the two side magnets is of the opposite name to that of the central magnet. They are of the same length, and have pole-pieces *f* at their extremities, made so as to give two pairs of opposing faces parallel to the planes of the magnets *b* and sufficiently far apart to allow the disks *a* to be introduced freely between them. The magnets are made sufficiently broad to give pole-faces long enough to cover nearly all the available radial spaces in the disks *a*, in which the current is at any time flowing. The disks *a* are placed between the opposing faces of the magnets *b* in such a manner that the vertical radius joining the mercury-cup *e* and the center of the disk *a* is parallel to a plane which may bisect the pair of pole-faces along their lengths. The magnet *b* can be moved on slides *r*—that is to say, drawn to a greater distance from the radius of the disk in which the current is flowing until the plane through its poles is at such distance from the vertical radius of the disk *a* as to give the requisite force. We may suppose the current from the generator to pass by one of the cups of mercury *e* from one of the terminals of the generator to the disk *a;* then along a radial space in that disk to the center and to the other disk along the axis *c*, along the other disk *a* to the second cup of mercury, *e;* then to pass through the lamp-carbons *g* and *h*, and thence by the electro-magnet coils to the other terminal, *t*, of the generator, or otherwise, so that the whole or a convenient portion of the current may pass through the electro-magnet coils, disks, and carbons.

In order that the lamp may be used with other lamps in circuit, a high-resistance coil is wound round the outside of the electro-magnet coils, which is joined up so as to act as a shunt on the arc. This feature is so well known that we do not deem it necessary to show it. The electro-magnetic action between the magnetic field and the current in the disks *a* causes them to turn round until the turning-couple is balanced by the opposite couple, due to difference of levels of the liquid *i* in the two sides of the hollow drum *d*, and the resultant couple given by the carbons and their holders *j* and *k*. This drum is shown in Fig. 1, Sheet 1. The hollow space *l* in it is the annular space between two coaxial cylinders, *m* and *d*. This space is divided into compartments by partitions *o*, all inclined at the same angle to the radius, as shown, and each partition is pierced at its outer end with a small orifice, *p*. In consequence of this difference of levels, the liquid flows through the orifices *p* in the partition *o* of the drum *d*, and the disks *a* turn round slowly in obedience to the resultant of the electro-magnetic and gravitational action.

The disks actuate the carbons in the following manner: On the disk-shaft is a pinion, *v*, gearing into wheel *y* on a shaft carrying two drums, *x* and *z*, on which cords *a'* and *b'* are adapted to be wound, respectively. Cords *a'* are connected to the side rods of the lamp, to which the lower carbon, *h*, is attached, while *b'* is connected to upper carbon, *g*, which is attached to plate *c'*, sliding on rods *a'*. By this mechanism any motion of the disks is communicated to the carbons, rotation in one direction separating and in the other approaching them. The electro-magnetic action tends in the first place to separate the carbons *g* and *h* until this action is counterbalanced by the gravitation of the carbon-holders *j* and *k* and carbons *g* and *h*, while the drum *d* prevents any great sudden change in the length of the arc from taking place, thus insuring steadiness of the light. At the same time, if by any accident the current ceases to flow, the difference of the weight of the carbons *g* and *h* and their holders *j* and *k* is sufficient to turn the drum *d* so as to close the arc.

We claim—

1. The combination, with an electro-kinetic device, of a retarding device consisting of a hollow rotating cylinder divided into compartments by a series of perforated radial partitions, and containing a suitable retarding-fluid.

2. The combination, with the carbons of an electric-arc lamp, of electro-kinetic devices for separating and regulating them, and a retarding device consisting of a hollow rotating cylinder divided into compartments by a series of perforated radial partitions, and containing a suitable retarding-fluid.

3. The combination, with the carbons of an electric-arc lamp, of a pivoted conducting-disk, an adjacent magnet, and electrical connection with the axis and periphery of said disk, whereby the action of the magnet on a radial current in the disk forms an electro-kinetic device acting to separate and regulate the carbons.

4. The combination, with electric-arc-lamp carbons, of a number of pivoted conducting-disks, magnet-poles adjacent to each disk, and axial and peripheral electric connections for said disks, and connecting mechanism, whereby the combined action of said magnets on the radial currents passing in said disks acts to separate and regulate the said carbons.

5. The combination, with the carbons of an electric-arc lamp, of a number of pivoted conducting-disks, axial and peripheral electric connections for said disks, the actuating-current of the lamp passing through said disks in series, and magnets adjacent to the disks for giving rotation thereto, with connecting mechanism, whereby the combined action of

said magnets on the radial currents in the disks will act to separate and regulate the carbons.

6. The combination, with the carbons of an electric-arc lamp, of a pivoted conducting-disk having axial electric connection, speed-reducing gear between said disk and the movable carbons, a fixed peripheral electrical connection for said disk, and adjacent magnets exercising an attractive influence on the radial currents passing in the disk.

7. The combination, with the carbons of an electric-arc lamp, of an electric motor, substantially as described, having a constant rotative tendency acting to separate the carbons, and included in circuit with the carbons, and a retarding device consisting of a hollow pivoted cylinder divided into compartments by perforated radial partitions, and containing suitable retarding-liquid.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

ANDREW GRAY.
THOMAS GRAY.

Witnesses:
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JOHN MADDER TUDHOPE,
Both of 115 *St. Vincent Street, Glasgow.*