No. 621,417. **Patented Mar. 21, 1899.**

E. HUNGERBÜHLER.

ELECTRIC ARC LAMP.

(Application filed Dec. 18, 1897.)

2 Sheets—Sheet 1.

(No Model.)

Fig:1.

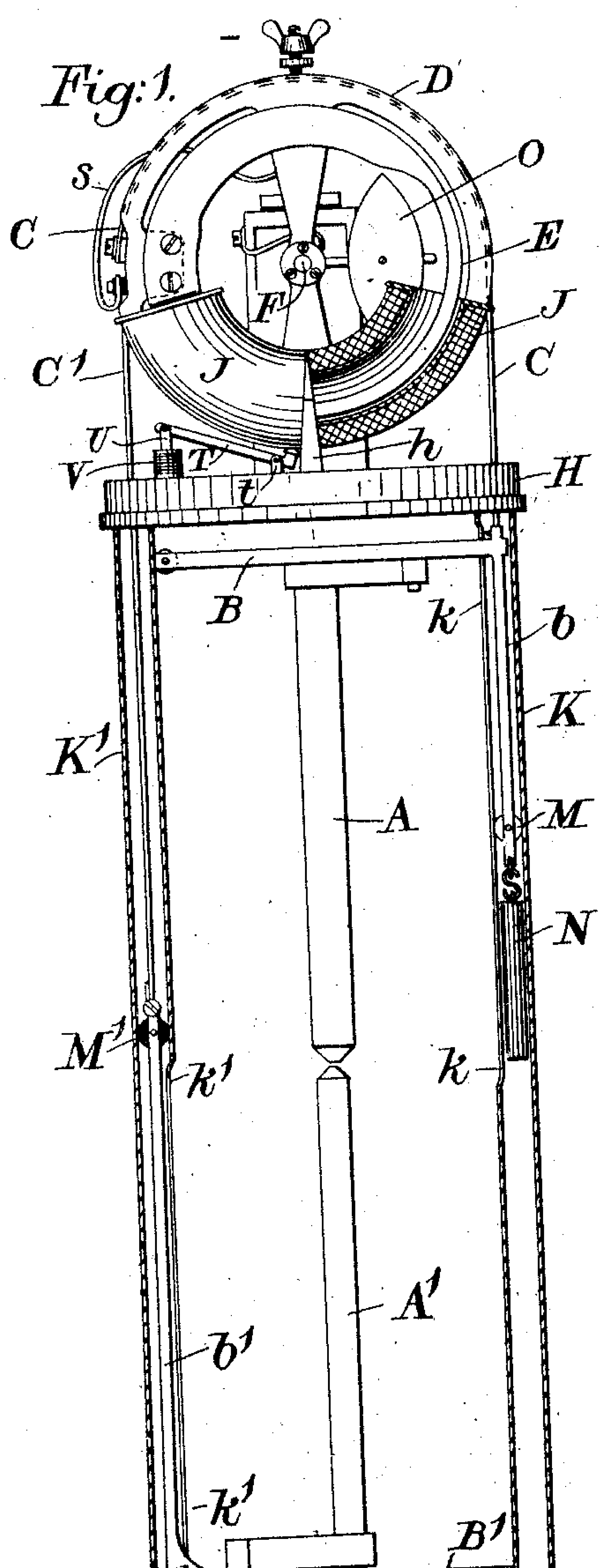


Fig:2.

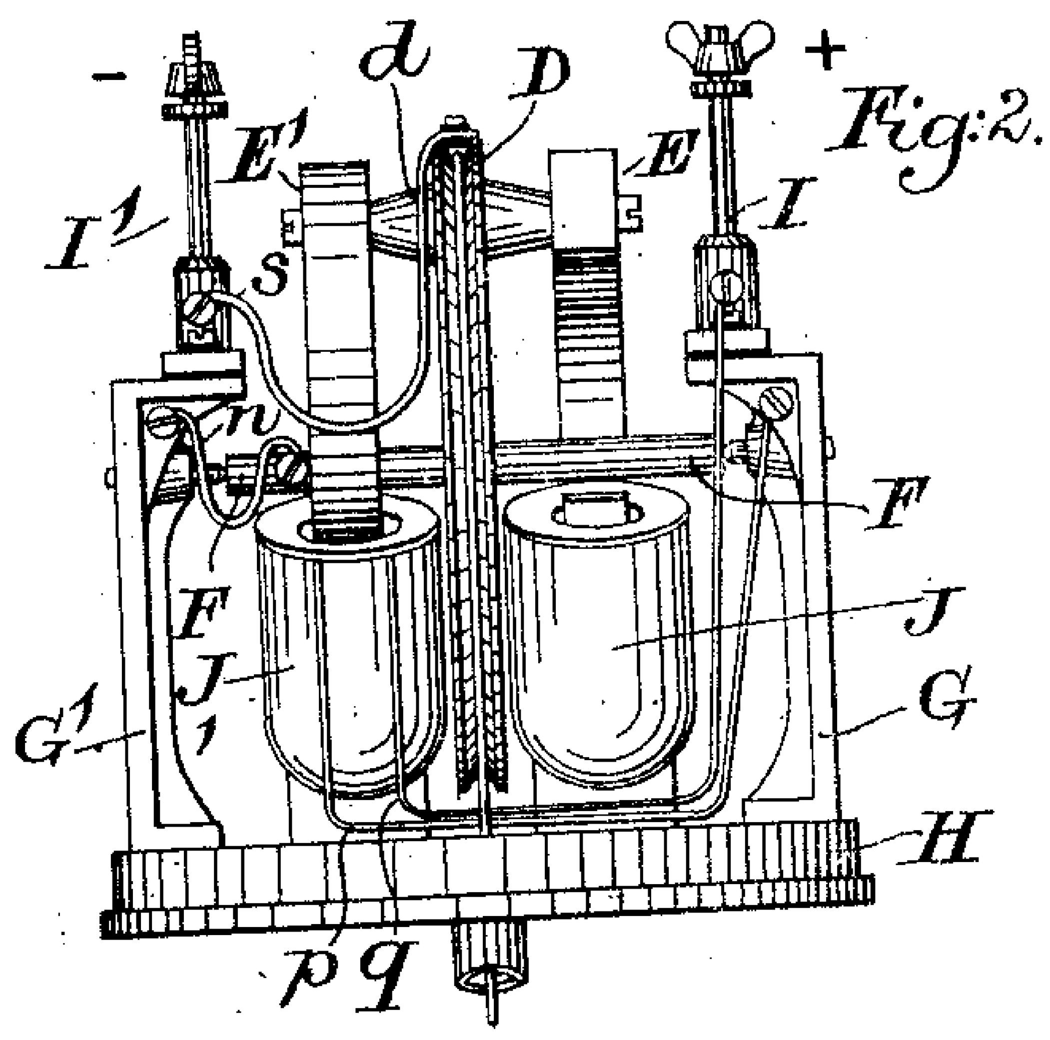


Fig:4.

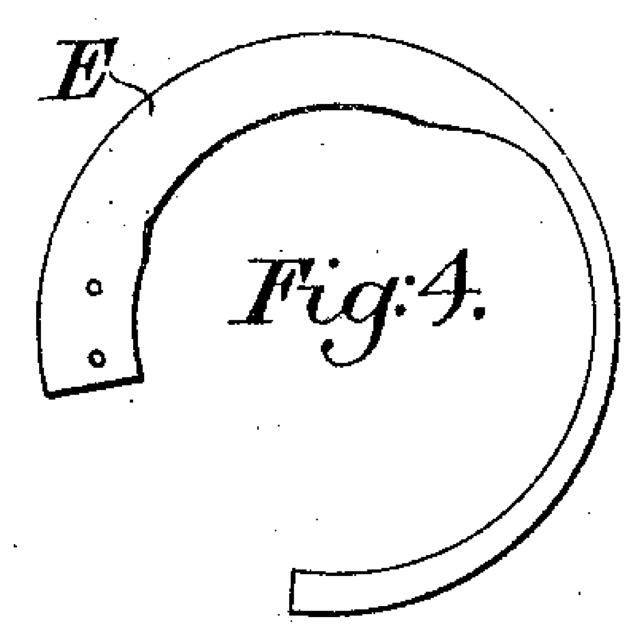


Fig:4a.

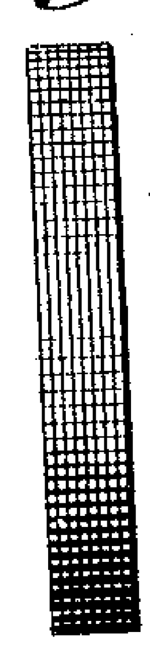
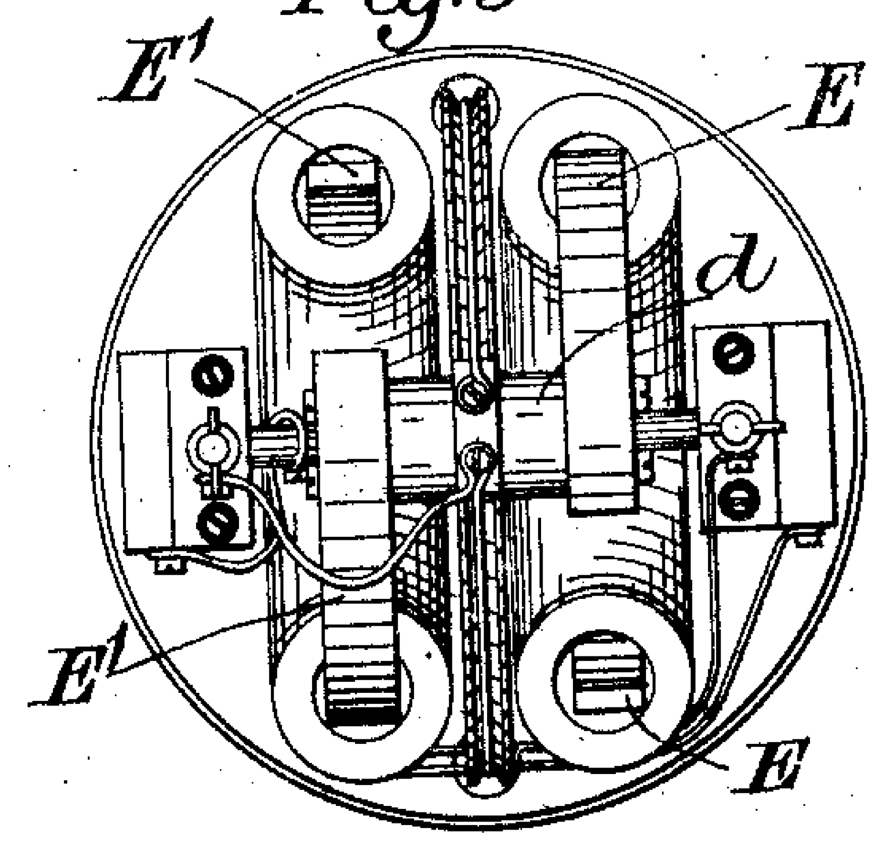


Fig:3



Witnesses:
E. Britt
E. Kaberry.

Inventor:
E. Hungerbühler
by Fairfax & Wetter
Attorneys

No. 621,417. Patented Mar. 21, 1899.

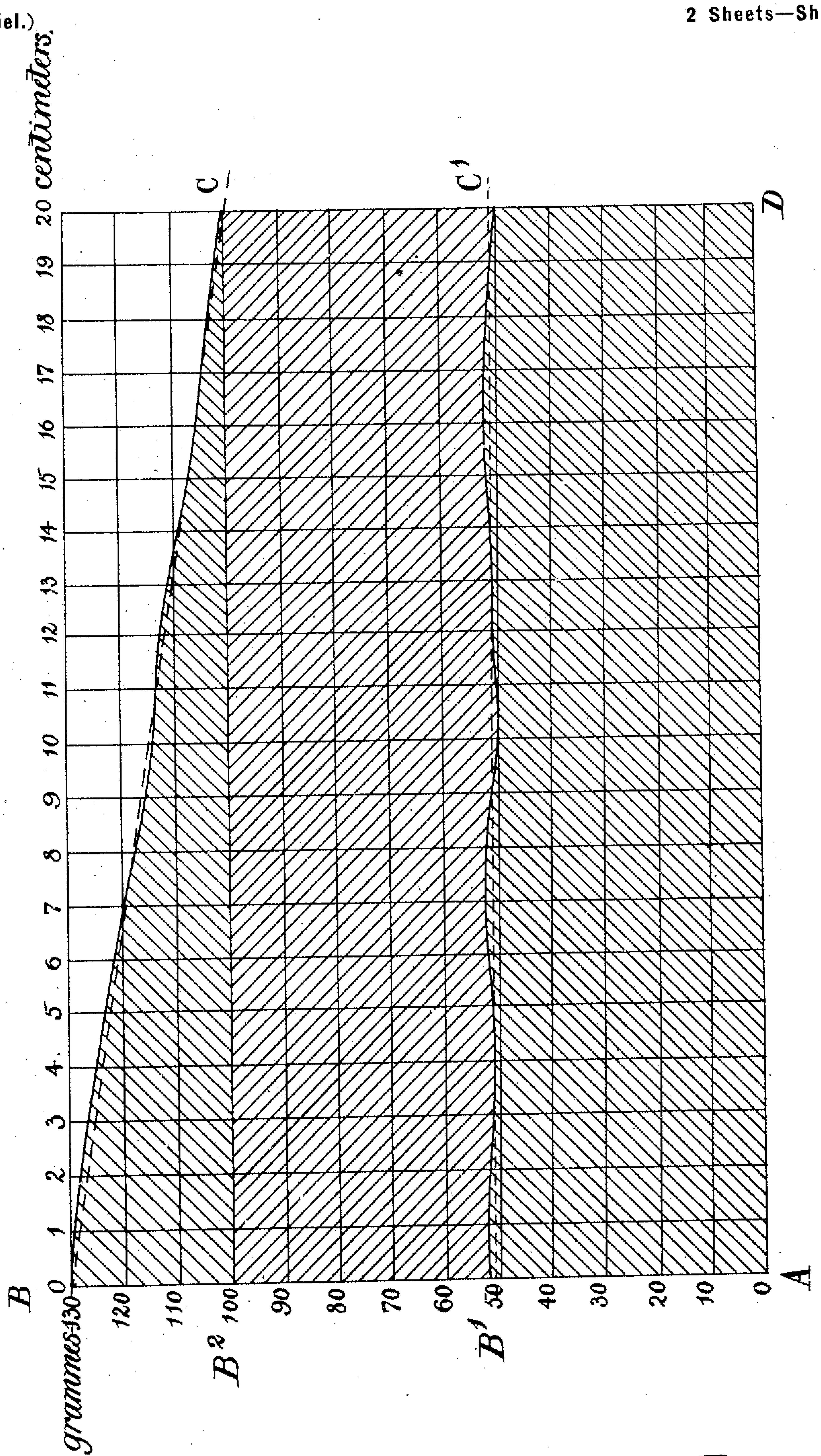
E. HUNGERBÜHLER.

ELECTRIC ARC LAMP.

(Application filed Dec. 18, 1897.)

(No Model.) 2 Sheets—Sheet 2.

Fig: 5



Witnesses:
E. Brett.
J. Kaberry.

Inventor:
E. Hungerbühler
by Fairfax & Wetter
Attys.

THE NORRIS PETERS CO., PHOTO-LITHO., WASHINGTON, D. C.

UNITED STATES PATENT OFFICE.

EMIL HUNGERBÜHLER, OF LONDON, ENGLAND.

ELECTRIC-ARC LAMP.

SPECIFICATION forming part of Letters Patent No. 621,417, dated March 21, 1899.

Application filed December 18, 1897. Serial No. 662,488. (No model.)

To all whom it may concern:

Be it known that I, EMIL HUNGERBÜHLER, a citizen of the Swiss Republic, residing at Bedford Place, London, England, have invented certain new and useful Improvements in Electric-Arc Lamps, of which the following is a full, clear, and exact specification.

This invention relates to that class of electric-arc lamps in which the feed of the carbons is automatically regulated by means of a solenoid or pair of solenoids having a specially-shaped core. The well-known Pilsen lamp, which belongs to this class, has a cylindrical regulating-coil and a conical core adapted to move in a straight line. Another lamp of this class has an annular core passing through a regulating-coil with a circularly-curved axis, the length of which is about one-sixth of the circumference of the core, and the sectional area of the latter, as in the case of the Pilsen lamp, increases uniformly from one end to the other. My improved arc-lamp has also a circularly-curved solenoid adapted to turn on its axis of curvature and thereby to regulate the position of the carbons; and my improvements have for their objects to reduce the space occupied by the regulating mechanism, to produce a better regulation, and to prevent violent oscillations at the time of striking the arc.

The core is laminated and not of uniform thickness, being, for instance, thick at the ends and thinnest at or near the middle of its length, so as to compensate for the changes of magnetic effect due to the position of the core and, if used with continuous current, for the gradual loss of weight of the positive carbon.

The movable core, together with its supporting-frame, may be adapted to serve as a rope-pulley, from which the two carbon rods are suspended by a pair of metallic cords.

Instead of using the movable core as part of the rope-pulley a separate pulley may, however, be mounted on the axle parallel to the movable core, and the movable core, together with the pulley and the parts attached to the same, may be balanced by a weighted lever mounted on the axle of the core.

The winding of the solenoids may be in series or in shunt or differential, as is the case with other arc-lamps.

A pair of regulating-coils and movable cores may be placed side by side, the cores being mounted on the same axle and acting in opposition to each other, one of the coils being placed in series with the lamp-circuit, while the other forms a shunt.

In the accompanying drawings, Figure 1 is a sectional elevation of an arc-lamp embodying my invention. Fig. 2 is a side view of the regulating apparatus. Fig. 3 is a plan of the same. Figs. 4 and 4^a are elevations of the core, taken at right angles to each other. Fig. 5 is a diagram of forces.

A is the positive and A′ the negative carbon. They are mounted on horizontal cross-bars B B′, suspended from a pulley D by means of wire ropes C C′, the ends of the ropes being attached to the pulley by screws, as shown in Fig. 1. The solenoid-cores E E′ are connected with each other and with the rope-pulley by a yoke *d*, as shown in Fig. 2. Between the position of the cores in Fig. 1 and that in Fig. 2 there is a difference of about ninety degrees, the yoke *d* being in Fig. 2 at the top, while in Fig. 1 it is approximately level with the axis of the cores. The pulley D, carrying the circularly-curved cores E E′, is mounted on a horizontal shaft F, which is held between the points of a pair of screws fixed in the standards G G′. The latter are mounted on the circular frame or base-plate H and support at the top the terminals I I′, insulated from the stands G G′. The circularly-curved solenoids J J′ are mounted in the center on the base-plate H by means of a vertical lug *h*.

The carbon-holders or cross-bars B B′ are guided at the ends by a pair of vertical tubes K K′, fixed at the top to the base-plate H and connected at the bottom by an oval or circular plate L. Each tube has on the inside a longitudinal slot *k* or *k′* for guiding the respective cross-bar B or B′. As shown by Fig. 1, the negative carbon A′ is insulated from the lower cross-bar B′ and suspended from the rope *k′* by means of a rod *b′*, guided in the tube K′ by an insulating-roller M′. The positive-carbon holder is fixed to the upper cross-bar B, suspended from the rope C and provided with a vertical guide-rod *b*, which carries a guide-roller M and a balance-weight N.

A balance-weight O is mounted on a lever extending radially from the shaft F. It serves to balance the weight of the cores E E', so that the turning moment of the weight O with regard to the axle F is equal to zero.

The solenoid J' is series wound, its coil being inserted between the positive terminal I and the stand G, as indicated by Fig. 2, and the solenoid-coil J is shunt-wound, its coil being inserted between the positive and negative terminals I and I'. In Fig. 1 one half of the shunt-coil J is shown in section and the other half in side view.

The current flows from the positive terminal I through the wire *q* to the series solenoid J', thence through the wire *p* into the standard G, thence through the base-plate H, standard G', and wire *n* into the axle F, thence through the pulley D, wire rope C, upper cross-bar B, upper carbon A, lower carbon A', lower cross-bar B', guide-rod *b'*, wire rope C', and wire *s* to the negative terminal I'.

As shown by Fig. 1, the axis of the solenoid occupies at least one-third of a circle, or one-third of the ring of which the core forms a part. The diameter of the said ring is therefore much smaller than in the lamp mentioned at the beginning of this specification, and the dimensions of the entire regulating mechanism are thereby much reduced. With this ratio between the length of the coil and that of the core the thickness of the core should no longer increase uniformly from one end to the other, but should be ascertained by experiment. Fig. 4 shows an example of such a core, which is thinner at one end than at the other and thinner in the middle than at either end.

To prevent violent oscillation and a rush of current at the time of striking the arc, a dash-pot is sometimes used; but I prefer to employ an electromechanical brake adapted to act on the circumference of the role-pulley or of a separate brake-pulley connected with the same and operated by the lamp-circuit. For this purpose the lamp-circuit may be led through a solenoid the core of which is attached to the long arm of a lever carrying on its short arm a brake-block. The latter is placed in proximity to the lower part of the rope-pulley or to the circumference of a brake-pulley and pressed against the latter if the exciting-current of the solenoid is strong enough to overcome the pull of a helical spring acting on the brake-block in opposition to the solenoid and tending to keep the brake-block out of contact with the pulley. The solenoid is so adjusted that it will apply the brake-block only at the time of striking the arc, not afterward. Such a brake is indicated in Fig. 1, where T shows the double-armed brake-lever, which has its fulcrum in a bracket *t*, mounted on the base-plate H. V shows the solenoid through which passes the current on its way to or from the carbons, and U is the solenoid-core, attached to the lever T.

If two solenoids are used, as in the example represented by the drawings, the core of the series solenoid and that of the shunt-solenoid are equal, but placed in opposite directions, Figs. 2 and 3, so that one core occupies its extreme right-hand position, while the other occupies its extreme left-hand position.

If the lamp is designed for alternating currents or for horizontal carbons, the core or cores should have such a shape that the pull of the solenoid or solenoids will remain constant for the whole range of the feed motion.

If the lamp is designed for continuous currents and vertical carbons, as represented by Fig. 1, the pull of the solenoid or solenoids on the core or cores should vary, so as to compensate for the gradual reduction of the surplus weight of the positive over that of the negative carbon, which surplus has generally a maximum of about thirty grams, and the shape of the core or cores should be adjusted so as to satisfy this requirement. The necessary adjustment may be ascertained by experiments or by calculation.

In the diagram Fig. 5 the abscissæ represent the feed motion of the carbons from zero to twenty centimeters and the ordinates the tangential pull of the solenoids on their respective cores at consecutive stages of the feed motion.

At the beginning of the feed motion—that is, when the carbons have their full length—the pull of the series coil is equal to one hundred and thirty grams and is represented by the ordinate A B, while the pull of the shunt-coil is equal to fifty-one grams and is represented by the ordinate A B'. At the end of the feed motion the pull of the series solenoid is represented by the line D C and that of the shunt by the line D C'. The straight line B C represents the theoretical variation of the pull of the series coil during the whole course of the feed motion, and the curve B C represents the actual variation ascertained by experiments. The curve B' C' differs but little from a straight line parallel to the base-line, because the pull of the shunt-coil remains approximately constant. As the two solenoids pull in opposite directions the result is shown by the difference between corresponding ordinates—that is, the tangential pull on the circumference of the pulley at the beginning and at the end is shown by the lines B B' and C C'. At the beginning this difference is balanced partly by the balance-weight N, which corresponds to the line B^2 B, (thirty grams.) At the end there is only the balance-weight N, which corresponds to the ordinate C' C to keep the magnetic pull in equilibrium.

What I claim is—

1. In automatic feed or regulating mechanism for electric-arc lamps, the combination of a curved solenoid controlled by the lamp-circuit, with a circularly-curved core adapted to turn on the axis of its curvature, a pulley and balance-weight connected with the said core, and a pair of flexible cords attached to

the said pulley at their upper ends, one cord being electrically connected with the pulley and the axle, while the other is insulated from the pulley and connected with one of the lamp-terminals, substantially as described.

2. In automatic feed or regulating mechanism for electric-arc lamps, the combination of a pair of circularly-curved solenoids, one of which is excited by a series coil and the other by a shunt-coil, with a pair of circularly-curved cores mounted on an axle which coincides with their respective centers of curvature, a pulley mounted on the said axle between the cores, and a pair of ropes passing over the said pulley and serving to suspend the carbons as well as to conduct current to the same, substantially as described.

3. In electric-arc lamps, the combination of a rope-pulley D, to which are attached a pair of ropes supporting the carbons, with a brake adapted to press against the circumference of the said rope-pulley, and a solenoid inserted into the lamp-circuit, so as to apply the brake, said solenoid being so adjusted that it will apply the brake only at the time of striking the arc, in order to prevent violent oscillations, substantially as described.

4. In electric-arc lamps an automatic feed or regulating mechanism, comprising in its construction a circularly-curved core of varying sectional area, and a curved solenoid occupying at least one-third of the circumference of the circle of the core, the said core being thinner at one end than at the other, and thinner in the middle than at either end, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

EMIL HUNGERBUHLER.

Witnesses:

J. WETTER,

CHAS. ROCHE.