No. 644,517. Patented Feb. 27, 1900.

J. H. HOLMES & F. BROADBENT.

RESISTANCE SWITCH FOR ELECTRIC CIRCUITS.

(Application filed Dec. 18, 1899.)

(No Model.) 9 Sheets—Sheet 1.

Fig. 1.

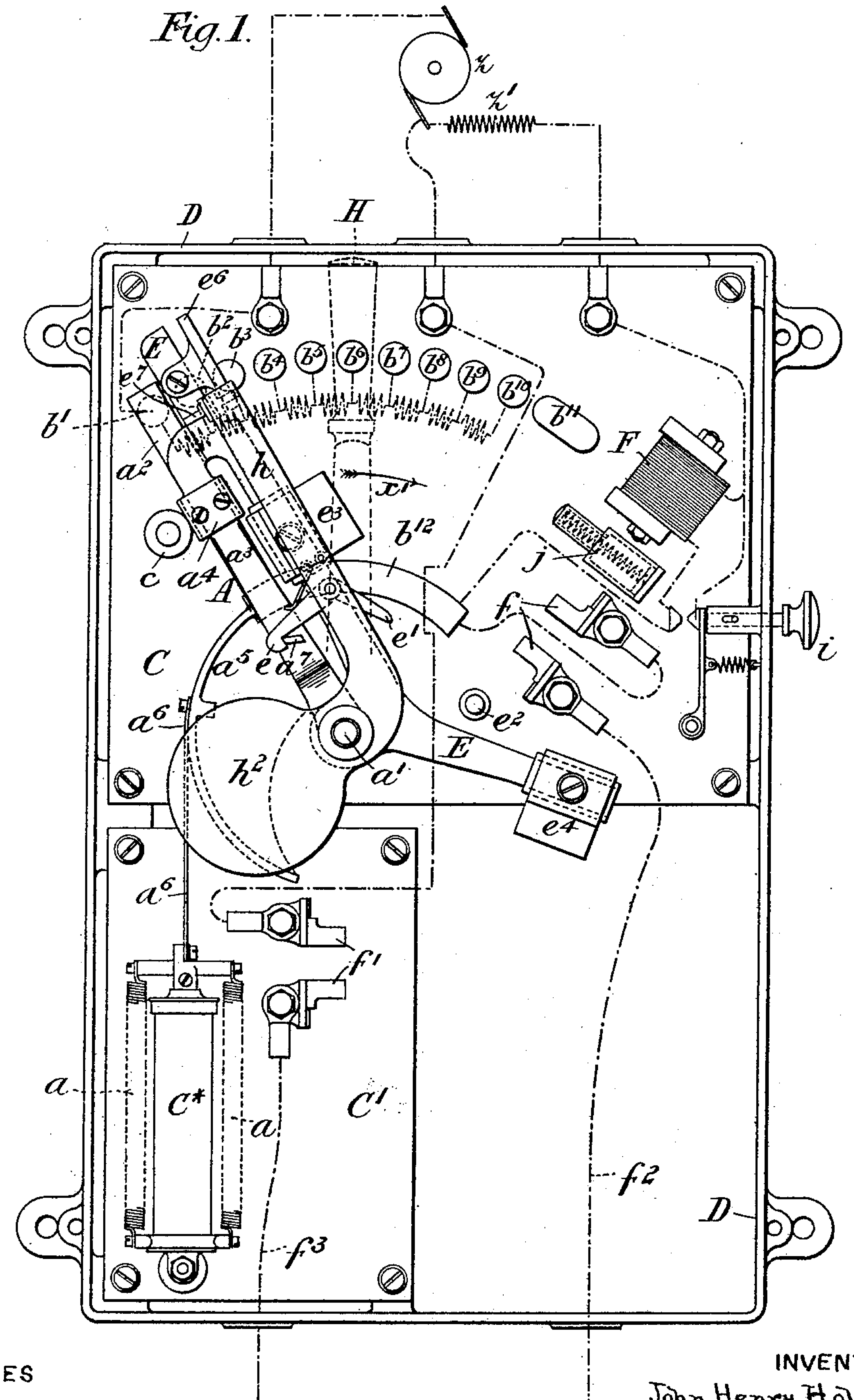

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Fig. 2.

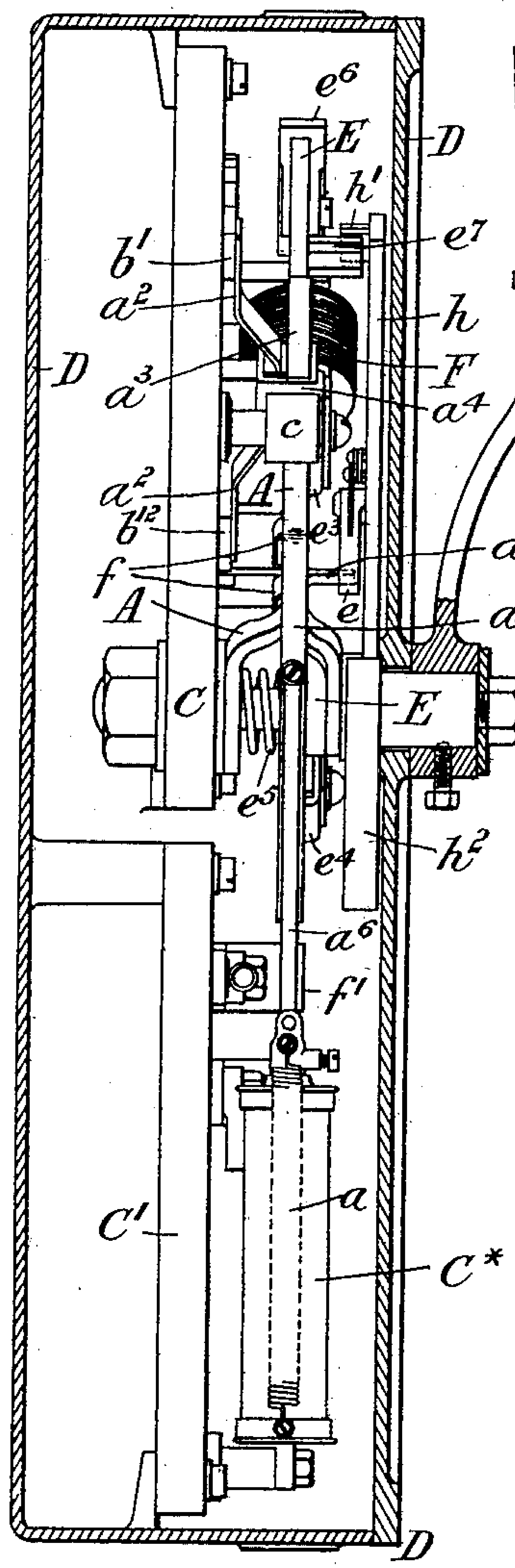

Fig. 3.

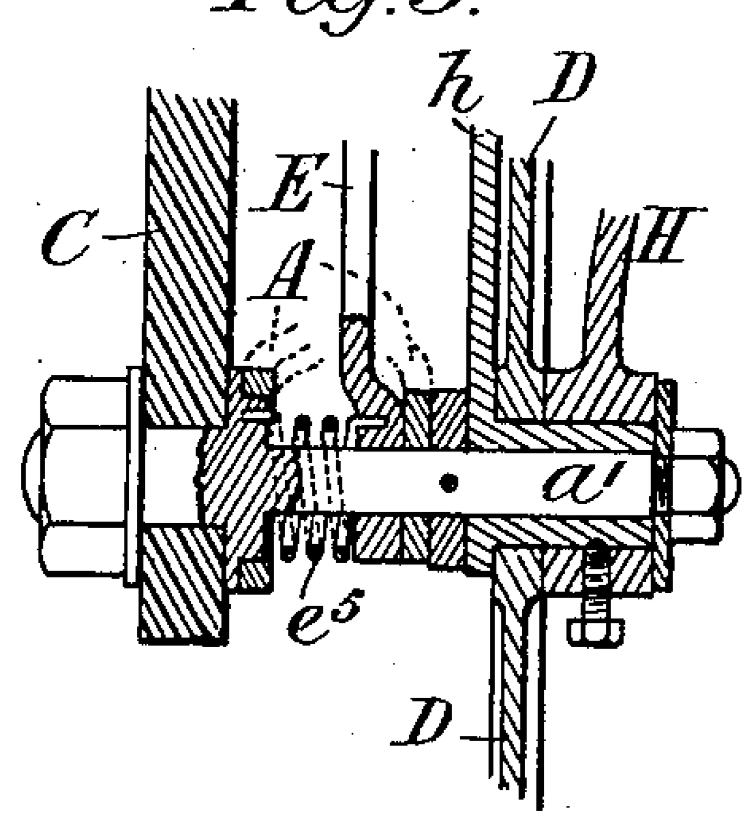

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Fig. 4.

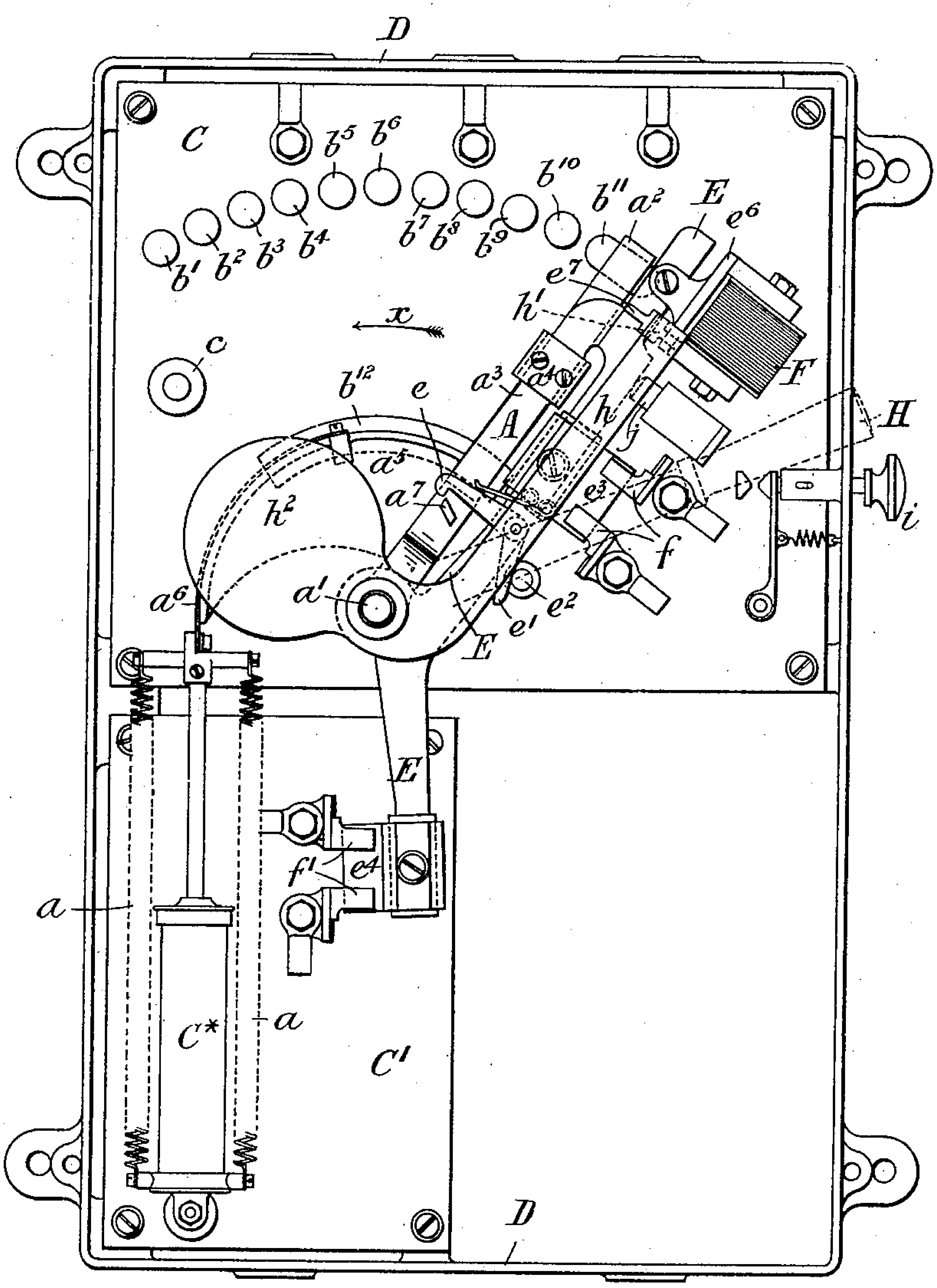

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Fig. 5.

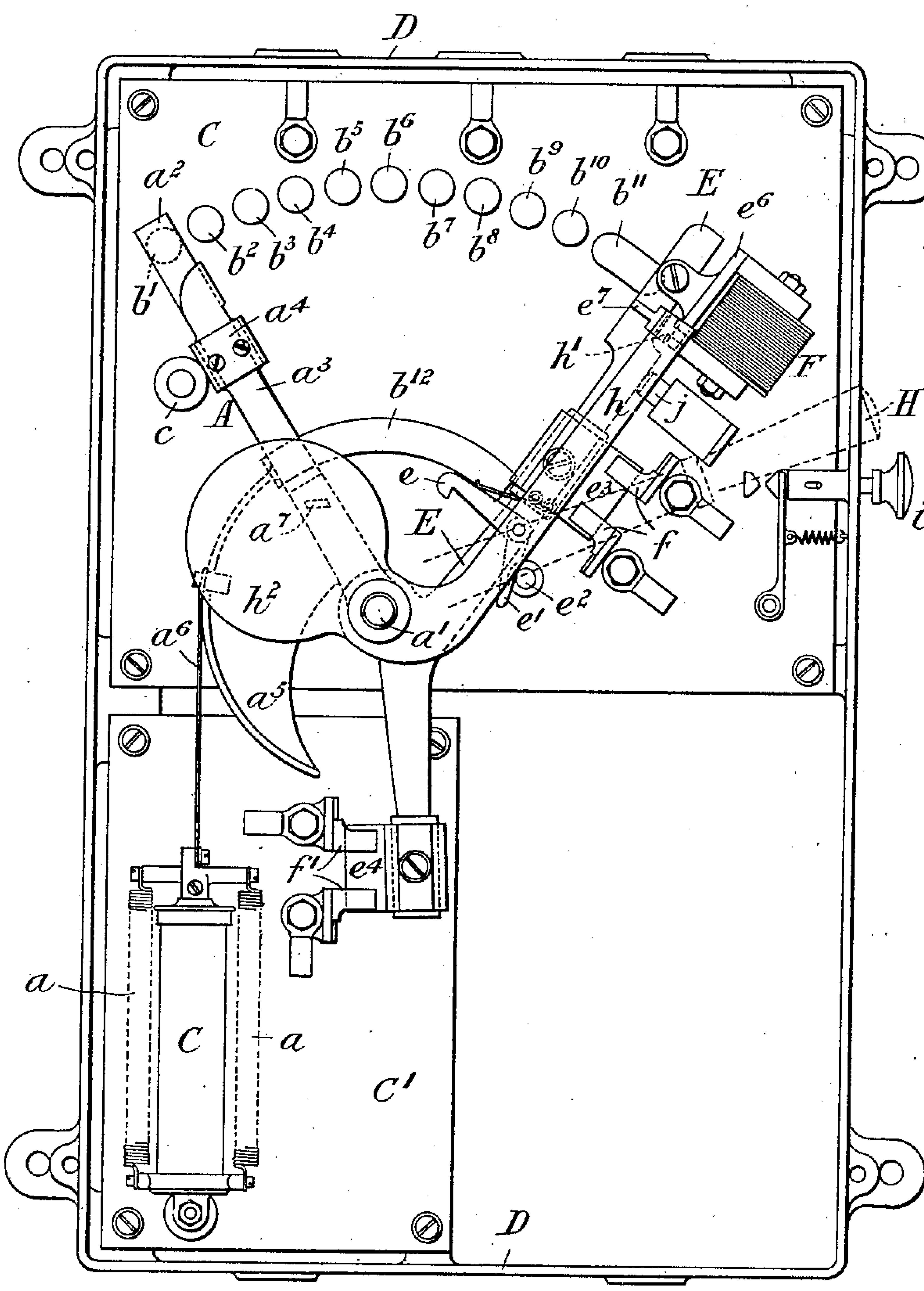

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Fig. 6.

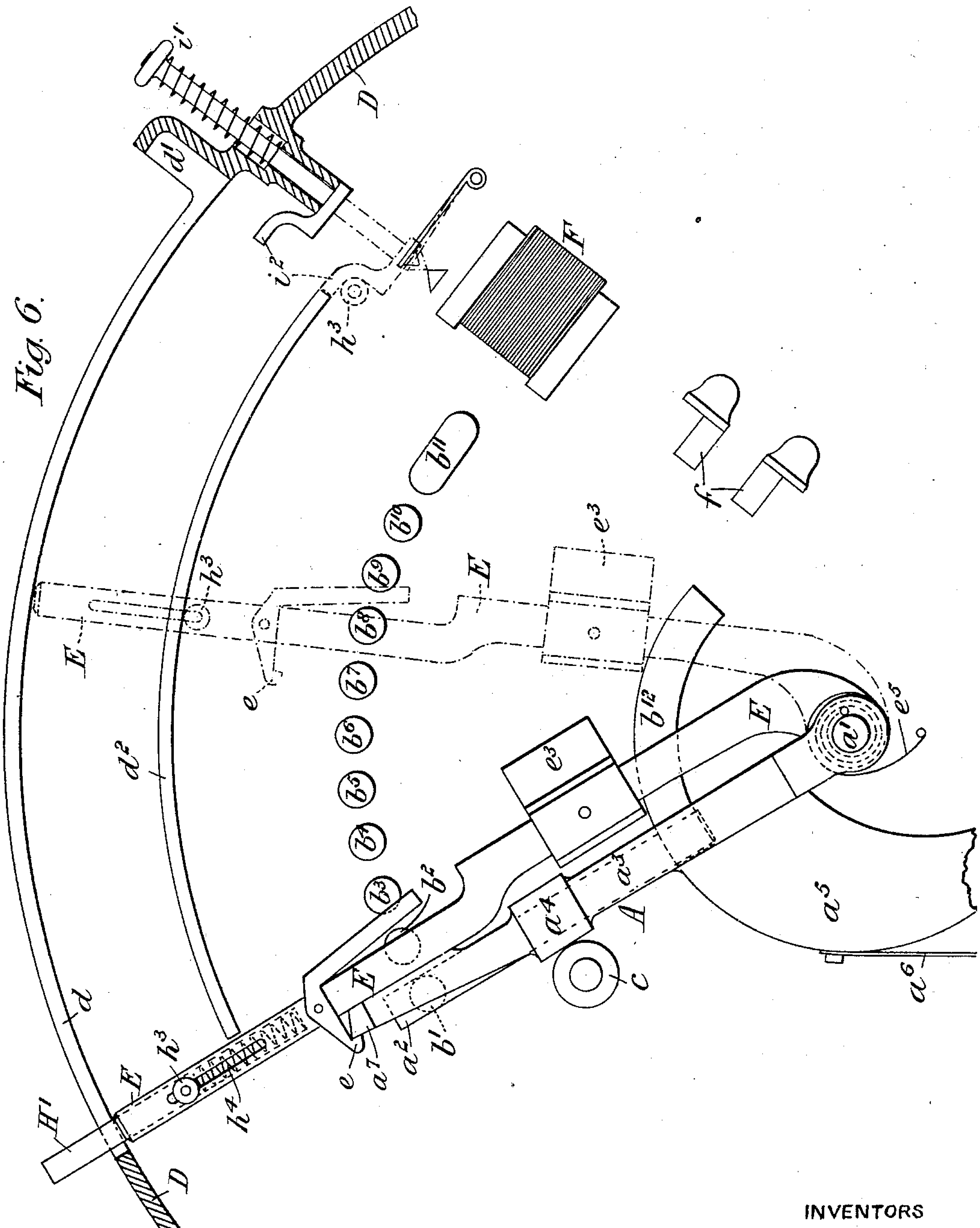

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Fig. 7.

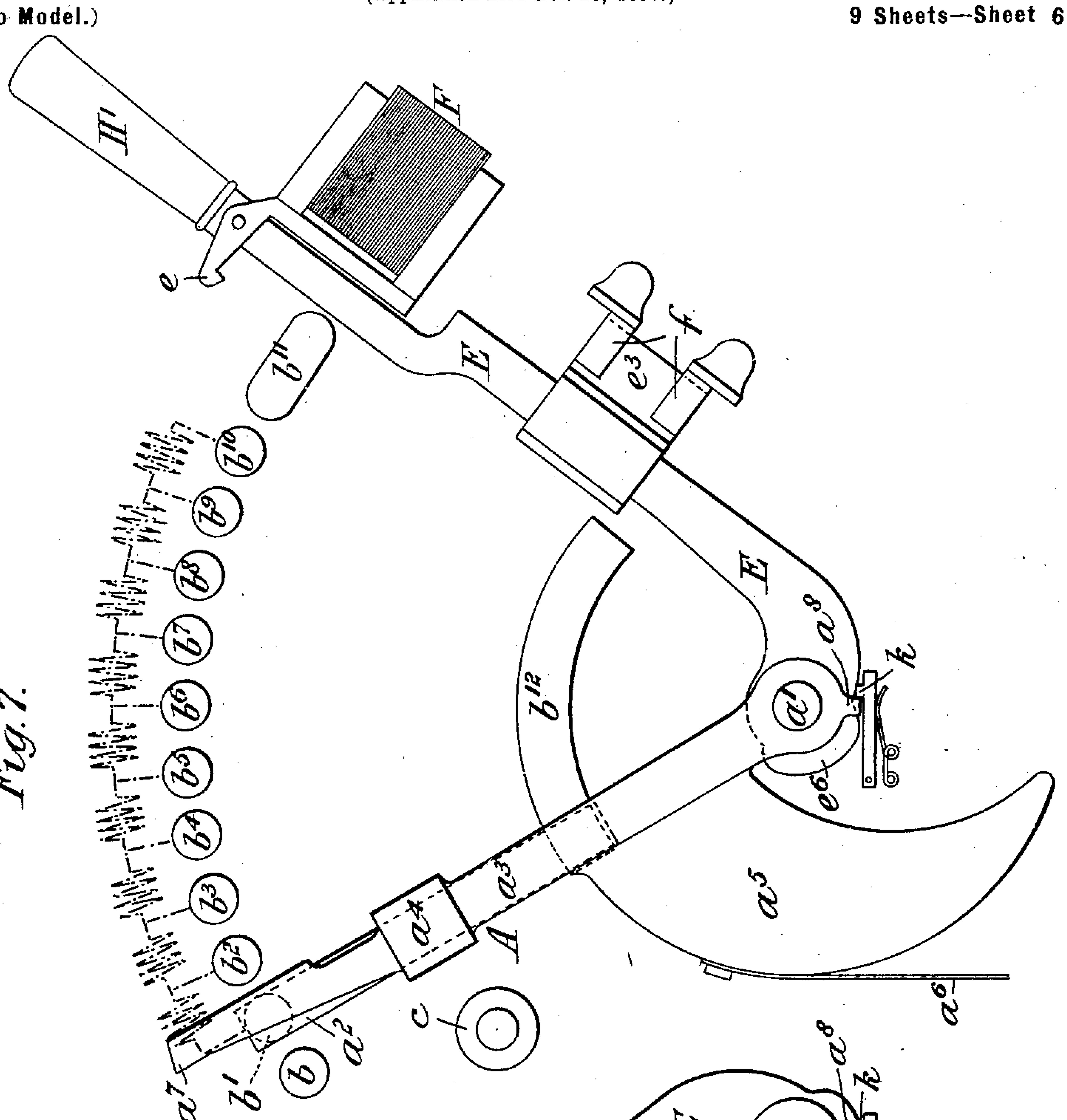

Fig. 8.

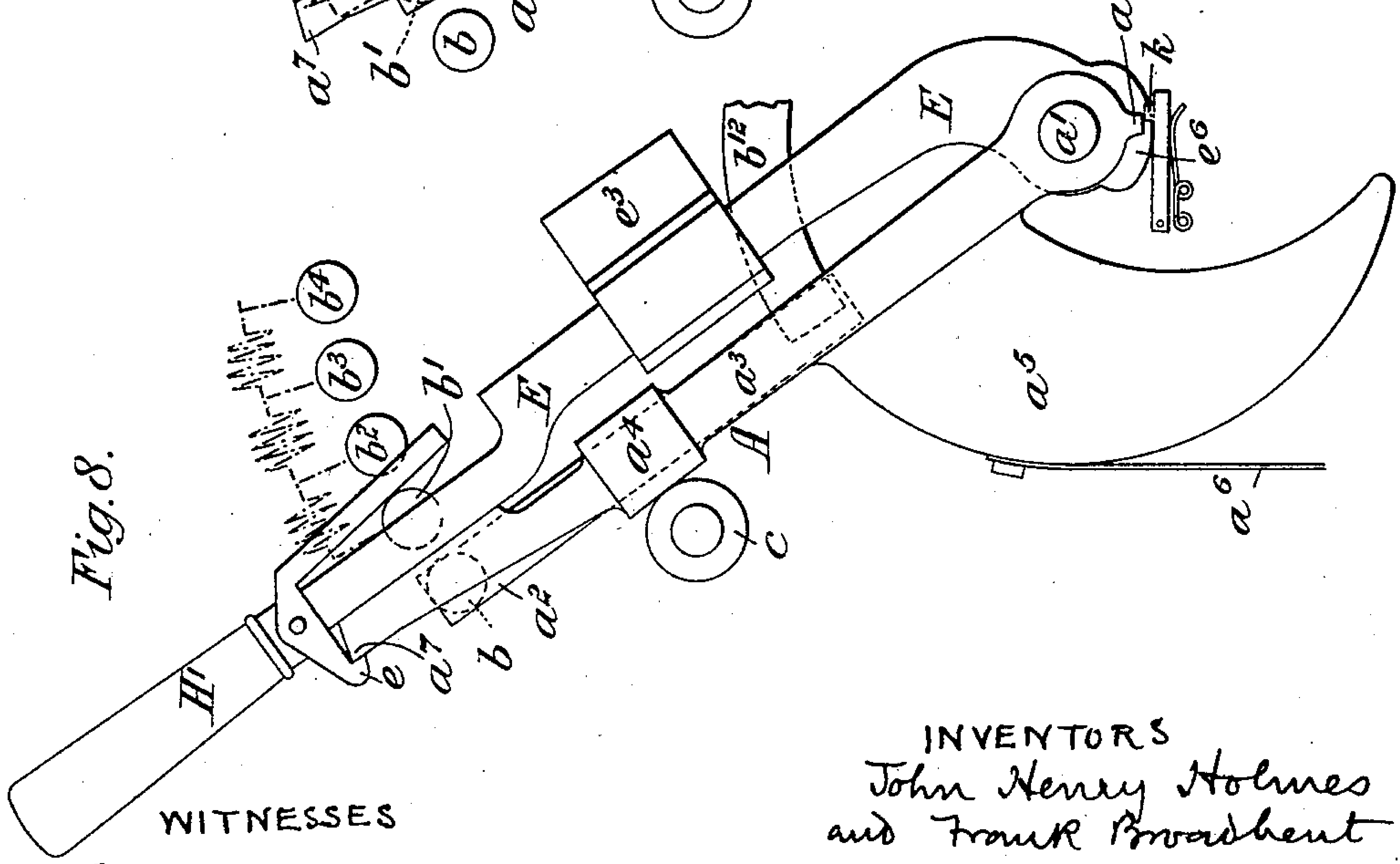

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Fig. 9.

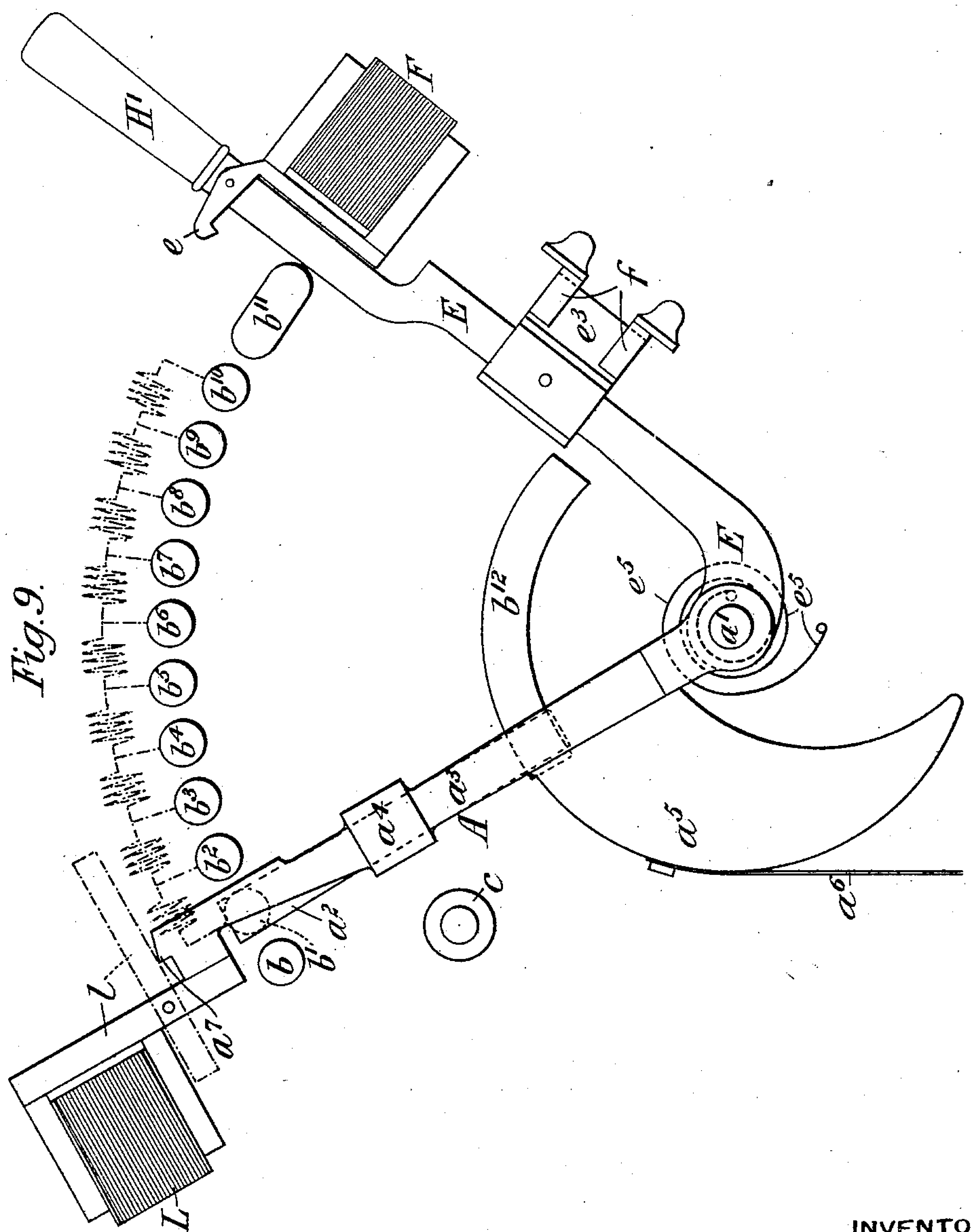

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Fig. 10.

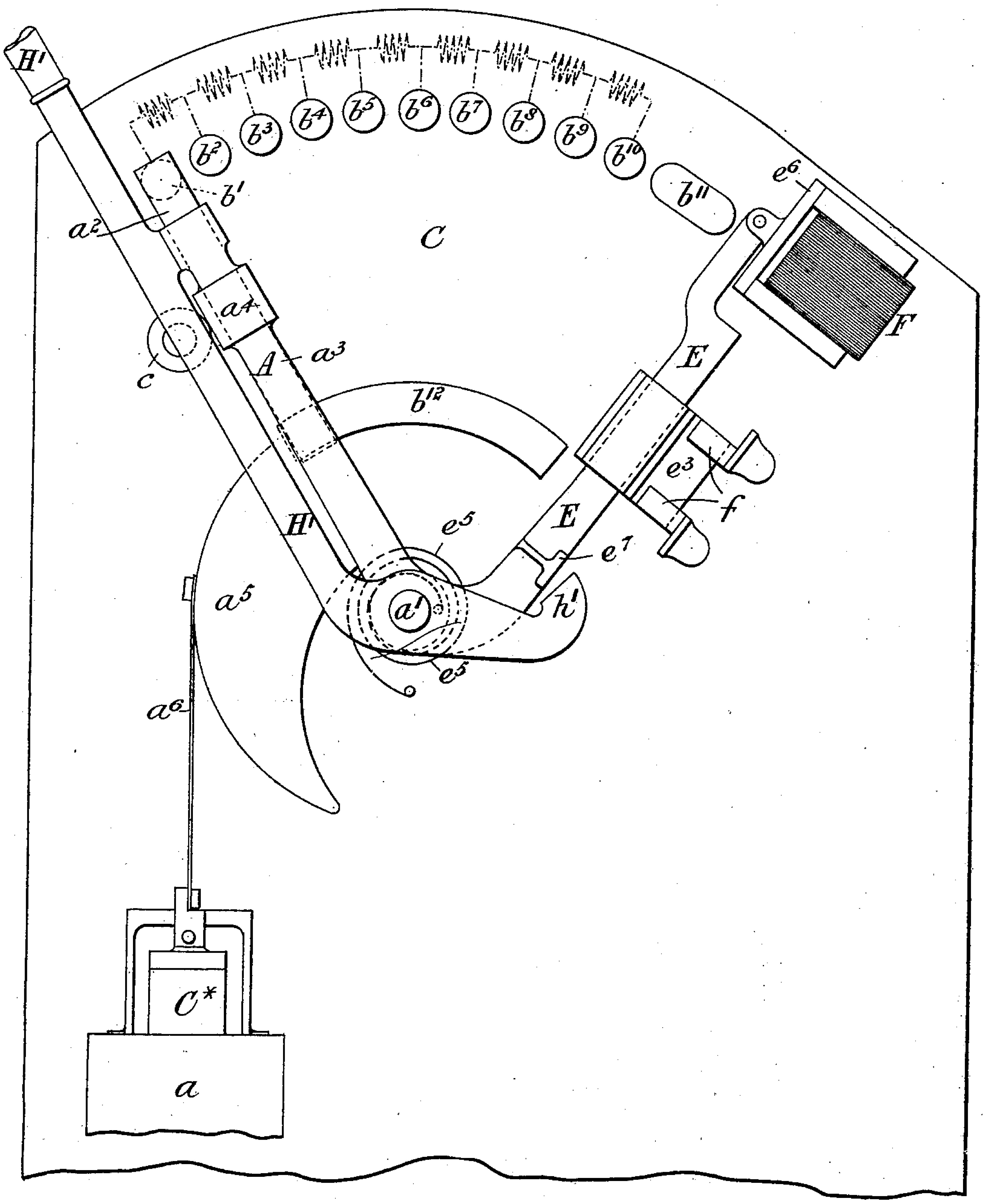

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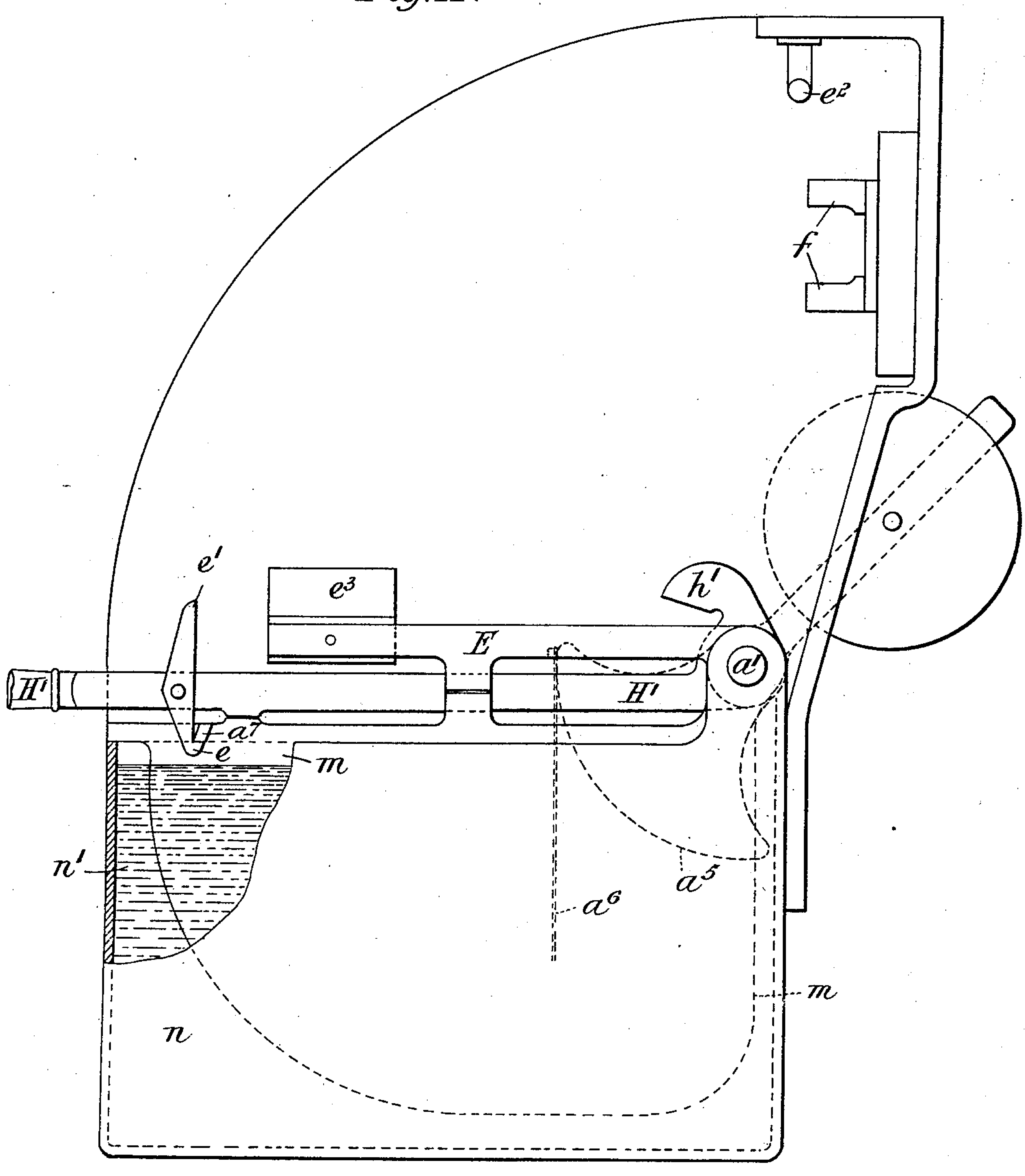
Fig. 11.



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UNITED STATES PATENT OFFICE.

JOHN HENRY HOLMES AND FRANK BROADBENT, OF NEWCASTLE-UPON-TYNE, ENGLAND.

RESISTANCE-SWITCH FOR ELECTRIC CIRCUITS.

SPECIFICATION forming part of Letters Patent No. 644,517, dated February 27, 1900.

Application filed December 18, 1899. Serial No. 740,744. (No model.)

To all whom it may concern:

Be it known that we, JOHN HENRY HOLMES and FRANK BROADBENT, electrical engineers, subjects of the Queen of Great Britain and Ireland, and residents of Portland Road Works, in the city and county of Newcastle-upon-Tyne, England, have invented certain new and useful Improvements in and Connected with Resistance-Switches for Electric Circuits, (for which we have applied for a patent in Great Britain, No. 4,801, dated March 4, 1899,) which invention is fully set forth in the following specification.

It is usual to provide in the circuit of an electric motor a resistance which as the speed of the motor increases can be gradually cut out by the operator to prevent an abnormal flow of current upon closing the said motor-circuit. In the case also of other electricity-consuming devices requiring a large current it is undesirable to suddenly switch them into circuit on account of the disturbance in the electrical pressure in the supply-conductors, and to prevent this a resistance may be inserted in series with the device to limit the current to a small amount when the circuit is first closed, which said resistance can then be gradually cut out until the current has reached the normal.

The object of our invention is to provide an improved apparatus whereby the motor or other circuit can be closed through a resistance, which said resistance is then gradually cut out of circuit in an automatic manner quite independently of the operator.

We will describe our invention by reference to the accompanying drawings, in which—

Figure 1 is a front elevation of one form of our improved resistance-switch arranged in an electric-motor circuit, which latter is shown diagrammatically. Fig. 2 is a view of the said resistance-switch, showing the casing in vertical section and the switch mechanism in side elevation. Fig. 3 is a vertical section of a detached portion of the switch. Figs. 4 and 5 are front elevations of the same switch with the parts in different positions; and Figs. 6 to 11, inclusive, are elevations of portions of other forms of our improved switch.

Like letters of reference indicate corresponding parts throughout all the figures of the drawings.

In constructing a resistance-switch such as shown in Figs. 1, 2, 3, 4, and 5 we provide a movable member or rheostat contact-arm A, adapted by a spring or springs a (or a weight a, as in Fig. 10, or other equivalent means) to be woaked over a series of contacts or contact-studs b', b^2, b^3, b^4, b^5, b^6, b^7, b^8, b^9, and b^{10} in the arc of a circle in the direction indicated by the arrow x in Fig. 4—that is to say, the direction for cutting out resistance from the completed circuit, the rate of this movement being controlled by a dash-pot C* or other regulating device, such as an escapement or fly, the said contact-arm A being moved by the operator in the direction indicated by the arrow x', Fig. 1, to insert resistance in the uncompleted circuit.

The rheostat contact-arm A is pivoted on a stud a', which is, as are also the contact-studs b' to b^{10}, rigidly secured to the support C, which is formed, preferably, of slate.

The rheostat contact-arm A is constructed in two main parts—viz., the conducting part or contact proper, a^2, which is formed of resilient metal and bears directly both on the above-named contact-studs b' to b^{10} and on a segmental contact-bar b^{12}, and the non-conducting part a^3, which is pivoted on the stud a' and to which is secured the conducting part a^2, suitable non-conducting material placed inside the metal strap a^4 being employed for electrically insulating the part a^2 from the part a^3. Connected to the arm A is a segment A^5, to whose periphery is attached one end of a flexible band a^6, the other end of which is attached to the before-mentioned springs or weight a and dash-pot C, these latter conveniently being combined, as shown in the drawings, to form a single fitting which may be secured to the support C' or to the casing D or other suitable part of the apparatus.

In combination with the rheostat-arm A we provide an arm or member E, which may be called the "switch-contact" arm, and which, like the arm A, is pivoted on the stud a', this arm E being so constructed that at one extremity of its range of movement it is caused by a hook e and projection a^7 to engage either directly, as in the arrangements shown in Figs. 6, 7, 8, and 9, or indirectly, as in Figs. 1 and 2, with the rheostat-arm A in such manner that when the said switch-contact arm is moved by the operator in the direction indicated by the arrow x' in Fig. 1 the rheostat-arm A is drawn by or moved with it more and more, resistance being inserted in the then incomplete circuit the farther the arm proceeds. On nearing the end of its rightward travel the rheostat contact-arm A leaves the last of the resistance contact-studs b^{10} and the switch-contact arm E, through the insulated contacts e^3 e^4 thereon, electrically connects the respective pairs of switch-terminals $f f'$. At this juncture the rheostat-arm A is released from the switch-contact arm E, for which purpose in the arrangement shown in Figs. 1 to 5 we provide an arm h, pivoted on the stud a' and carrying the spring or equivalently-controlled hook e, adapted to engage with the catch or projection a^7 on the rheostat-arm A, the said hook having an arm e' projecting therefrom to enable it to be released from the projection a^7, as shown in Figs. 4 and 5, by the said arm coming in contact with a fixed stud or projection e^2. The arm h is provided with a projection h', adapted to engage a projection e^7 on the switch-contact arm E, when the circuit is to be broken mechanically, which may be effected by the operator moving in the direction of the arrow x in Fig. 4 the handle H, secured on the boss of the arm h. When the rheostat-arm A is released from the switch-contact arm E, as last described, the said rheostat-arm under the influence of the springs or weight a is caused to move (at a regulated speed, as previously mentioned) toward the left, the circuit through the motor or other current-consuming device z being completed at the instant that the rheostat-arm A makes contact with the resistance contact-stud b^{10}, the maximum resistance being then included in the circuit. The resistance thereafter is gradually cut out automatically during the travel of the rheostat-arm A toward the left until the said arm A reaches the contact-stud b', when all the resistance is removed, the rheostat-arm A being arrested by a stop c when it reaches this position. When the switch-contact arm E is moved in the direction indicated by the arrow x in Fig. 4, it opens the switch and breaks the circuit, and the motion being continued to the end of the stroke, as it ought to be, the hook e being carried to its normal position under the influence of the weight h^2 on the arm h again engages with the projection a^7 of the rheostat contact-arm A, the apparatus being then, as shown in Fig. 1, in position for a repetition of the above-described operations.

Although we have described the backward movement of the switch-contact arm E to break the circuit as being directly performed by the operator, we prefer that it should take place through the agency of an independent force, such as that of a spring e^5, Figs. 2 and 3, or a weight, with the object of preventing it remaining in any intermediate position between the extremities of its travel or of the switch being improperly actuated. To accomplish this, we prefer to employ a retaining-electromagnet F, which, when energized, holds the switch-contact arm E, conveniently by an armature e^6, carried on the said arm, in such a position as will keep the circuit closed in opposition to the force of the spring or weight e^5, which, as aforesaid, tends to move the arm in the backward direction to its normal position. This retaining-electromagnet may be energized in any suitable manner, such as, as shown in Fig. 1, by inserting its exciting-coil in series with the shunt-winding z' of the magnets of the motor z or in the main circuit of the electricity-consuming device, or it may be wound of such a resistance that it may be connected as a shunt directly across the mains f^2 f^3. When thus arranged, the circuit may be opened either by mechanical operation through the hand-lever H, as previously described, or by the deënergization of the electromagnet F. This latter will occur automatically in the event of failure of the electric supply, or it may be effected at at any time by means of a push-button or switch i, so arranged as when operated either to short-circuit the exciting-coil of the electromagnet F when the said coil, as shown in Fig. 1, is included in the shunt-circuit of the electricity-consuming device z, or to divert the current from the said electromagnet when the exciting-coil thereof is in series with the electricity-consuming device, or to open the branch circuit when the exciting-coil of the magnet F is connected directly as a shunt across the supply-mains.

b^{11} is an insulated stud or projection on which the end of the part a^2 of the rheostat-arm rests when it has been moved past the resistance-stud b^{10} and before the circuit through the electricity-consuming device is completed, and j' is a spring device for imparting the initial impulse to the switch-contact arm E when the circuit is broken through the electromagnet F.

The apparatus shown in Figs. 1 to 5 is arranged as a double-pole switch and those shown in Figs. 6 to 11 are arranged as single-pole switches; but it will be obvious that, if desired, the apparatus shown in Figs. 1 to 5 may be arranged as a single-pole switch and those shown in Figs. 6 to 11 may be arranged as double-pole switches.

To prevent the attendant from opening and closing the switch when all resistance is cut out, and thus prevent an excessive current being passed through the motor or other electricity-consuming device z, we provide automatic mechanism which may be arranged as next described with reference to Fig. 6. In this arrangement we inclose the whole of the working parts in a casing D, (only the upper portion of which is represented in the drawings,) leaving only the handle H′, which in this example is formed as an extension of the switch-contact arm E, projecting through a slot d in the top of the casing D. When the handle H′ is moved to its farthest extremity to close the circuit, it enters a hood or cover d', or may be otherwise protected in such a way as to prevent the attendant taking hold of it in order to withdraw the contact-plate e^3 from the switch-contact jaws f. To release the arm E, the attendant must press a button or the like i', which may be arranged either as shown in Fig. 6 or as a movable part of the handle H′, so as to effect the deënergization of the electromagnet F, as previously described with reference to the push-button i in Figs. 1, 2, 3, and 4.

In order to prevent the attendant after releasing the arm E from arresting it on its return stroke, the handle H′ is constructed so as to slide upon or in the switch-contact arm E and is arranged to be actuated by the button i', when the latter is operated as above mentioned for deënergizing the electromagnet F, the stem of the said button i' being for this purpose provided with an arm i^2, adapted to bear on a roller h^3, carried on the stem of the sliding handle H′, so as to press the handle inward until it disappears within the casing D, the said handle being retained in its depressed position by a guide d^2 during its return stroke to the "off" position at a part corresponding to which the said guide terminates, allowing the handle H′, under the influence of a spring h^4, to again protrude through the slot, so as to be ready for a repetition of the switching operation.

In another arrangement for preventing the switch from being improperly actuated, as shown in Figs. 7 and 8, we provide a spring or equivalently-controlled stop k, which by engaging with a projection a^8 on the rheostat contact-arm A retains the latter on the resistance contact-stud b' during the time that the contact-plate e^3 of the switch-contact arm E is in the switch-contacts f, as shown in Fig. 7. On the switch-contact arm E being released either by the deënergization of the electromagnet F or by the attendant pulling over the handle H′ in opposition to the influence of the said electromagnet and the contact-plate e^3 thereby withdrawn from the switch-contacts f, the said switch-contact arm E, by means of a cam e^6, presses the stop k out of engagement with the projection a^8, and thereby allows the rheostat contact-arm A, under the influence of the actuating weight or springs a, to move clear of all the resistance-studs, as shown in Fig. 8, in which position it is arrested by the stop c, and the end of the part a^2 of the said rheostat-arm is supported on an insulated or non-conducting stud b. In this position it is absolutely necessary for the attendant to move the switch-contact arm E back to the extreme off position in order to admit of the hook e engaging with the rheostat contact-arm.

Instead of effecting the release of the rheostat contact-arm A by mechanical means, as last described, we may obtain the same result electrically—as, for example, by the apparatus shown in Fig. 9, wherein an electromagnet L is arranged at the left-hand side and connected in series with the electromagnet F, so that these two electromagnets are energized simultaneously. In Fig. 9 the switch is represented in its "on" position, wherein the switch-contact arm E is retained in position by the electromagnet F, and the rheostat contact-arm A is retained in contact with the resistance-stud b' by the pivoted armature l of the electromagnet L, which armature at that juncture is held in the position in which it is shown in full lines by the energization of the said electromagnet L. When the attendant breaks the circuit by moving the handle H′ toward the left, both of the electromagnets F and L are demagnetized and the pivoted armature l moves into the position in which it is shown in dotted lines, and thereby allows the rheostat contact-arm A to move clear of all the resistance-studs onto the insulated or non-conducting stud b.

In Fig. 10 we show a modification of the switch which admits of it being used for regulating the current in a motor or other circuit. In this arrangement the starting-handle H′ is adapted to operate at the back of the rheostat contact-arm A, and when this handle is moved toward the on position it pushes both the rheostat contact-arm A and the switch-contact arm E forward until the circuit is closed and the switch-contact arm E is retained by the electromagnet F, as explained in reference to the previously-described examples. When the attendant releases the handle H′, the rheostat contact-arm A, under the influence of its controlling-weight, springs, and dash-pot, is moved slowly back and pushes the handle before it. A stop (not shown in the drawings) may be provided for arresting the starting-handle H′, and therefore the rheostat contact-arm A, at any desired position, and consequently control the amount of resistance inserted in the circuit and the speed of the motor or the working of the other electricity-consuming apparatus, as the case may be.

Instead of using wire resistances, as diagrammatically represented in Figs. 1, 7, 8, 9, and 10, we may use any other suitable resistances. For example, as shown in Fig. 11, a liquid resistance may be used, in which arrangement the rheostat-lever A is formed in one with or as a dipper m, adapted to enter a trough n containing liquid n', the resistance being varied according to the extent to which the dipper is immersed in the liquid. When the operator lifts the starting-handle H′, the hook e engages with the projection a^7 on the dipper m, so that the latter is also raised and subsequently withdrawn from the liquid n', and at the same time the switch-contact lever E is moved over to electrically connect the pair of switch-contacts f. The dipper m is then released from the handle H' by the arm-hook e' striking against the stud or projection e^2, and the dipper then enters and descends deeper and deeper into the liquid n', so as to first complete the circuit with the maximum amount of resistance inserted therein and afterward gradually reduce the resistance until it is removed entirely from the circuit. To break the circuit, the handle H' is moved to the left, as in the before-described examples, when the projection h' pushes the switch-contact arm E along with it, so as to withdraw the contact-plate e^3 from the switch-contacts f, after which the hook e again engages with the projection a^7 on the dipper m, so as to make the switch ready for a repetition of the switching operation. If desired, the liquid resistance apparatus may be provided with a "holding-on" electromagnet F in the same manner as has been previously described in connection with the other examples.

It will be obvious that instead of arranging the resistance-contact devices of our improved switches to operate in curved paths we may, if desired, arrange them so as to operate in a straight line or otherwise.

By suitably duplicating the necessary parts the before-described arrangements can be applied to reversing-switches used for running motors in both directions.

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

1. In resistance-switches for electric circuits, a movable member adapted to work over a series of resistance-contacts, and means for returning the said member in a direction to cut out resistance in combination with another movable member, means for engaging these two movable members to operate together when moved in a direction to insert resistance, and a contact through which the second movable member can electrically connect the switch-terminals and means for then releasing the first-named member and means for controlling the backward movement of the said first-named member so that it slowly cuts out resistance, substantially as described.

2. In resistance-switches for electric circuits, a movable member adapted to work over a series of resistance-contacts, and means for returning the said member in a direction to cut out resistance in combination with another movable member, means for engaging these two movable members to operate together when moved in a direction to insert resistance and a contact through which the second movable member can electrically connect the switch-terminals, and a device tending to move the second movable member from the position in which it closes the circuit and an electromagnetic device to keep the circuit closed against the action of the said device, substantially as described.

3. In resistance-switches for electric circuits, a movable member adapted to work over a series of resistance-contacts, and means for returning the said member in a direction to cut out resistance in combination with another movable member, means for engaging these two movable members to operate together when moved in a direction to insert resistance, and a contact through which the second movable member can electrically connect the switch-terminals and means for then releasing the first-named member, a handle by which the switch is operated, and means whereby the handle is protected from improper actuation, substantially as described.

4. In resistance-switches for electric circuits, a movable member adapted to work over a series of resistance-contacts, and means for returning the said member in a direction to cut out resistance in combination with another movable member, means for engaging these two movable members to operate together when moved in a direction to insert resistance, and a contact through which the second movable member can electrically connect the switch-terminals and means for then releasing the first-named member, and means substantially as described whereby the operator cannot operate the first-named movable member which puts on and cuts out the resistance until he brings the second-named member back to the extreme "off" position, substantially as described.

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

JOHN HENRY HOLMES.
FRANK BROADBENT.

Witnesses:
CHARLES EDGAR GROUNSELL,
ROBERT WILLIAM RIDLEY.