No. 701,843. Patented June 10, 1902.

N. A. CHRISTENSEN.

AUTOMATIC CONTROLLER FOR ELECTRIC MOTORS.

(Application filed Oct. 21, 1901.)

(No Model.) 4 Sheets—Sheet 1.

Fig. 1.

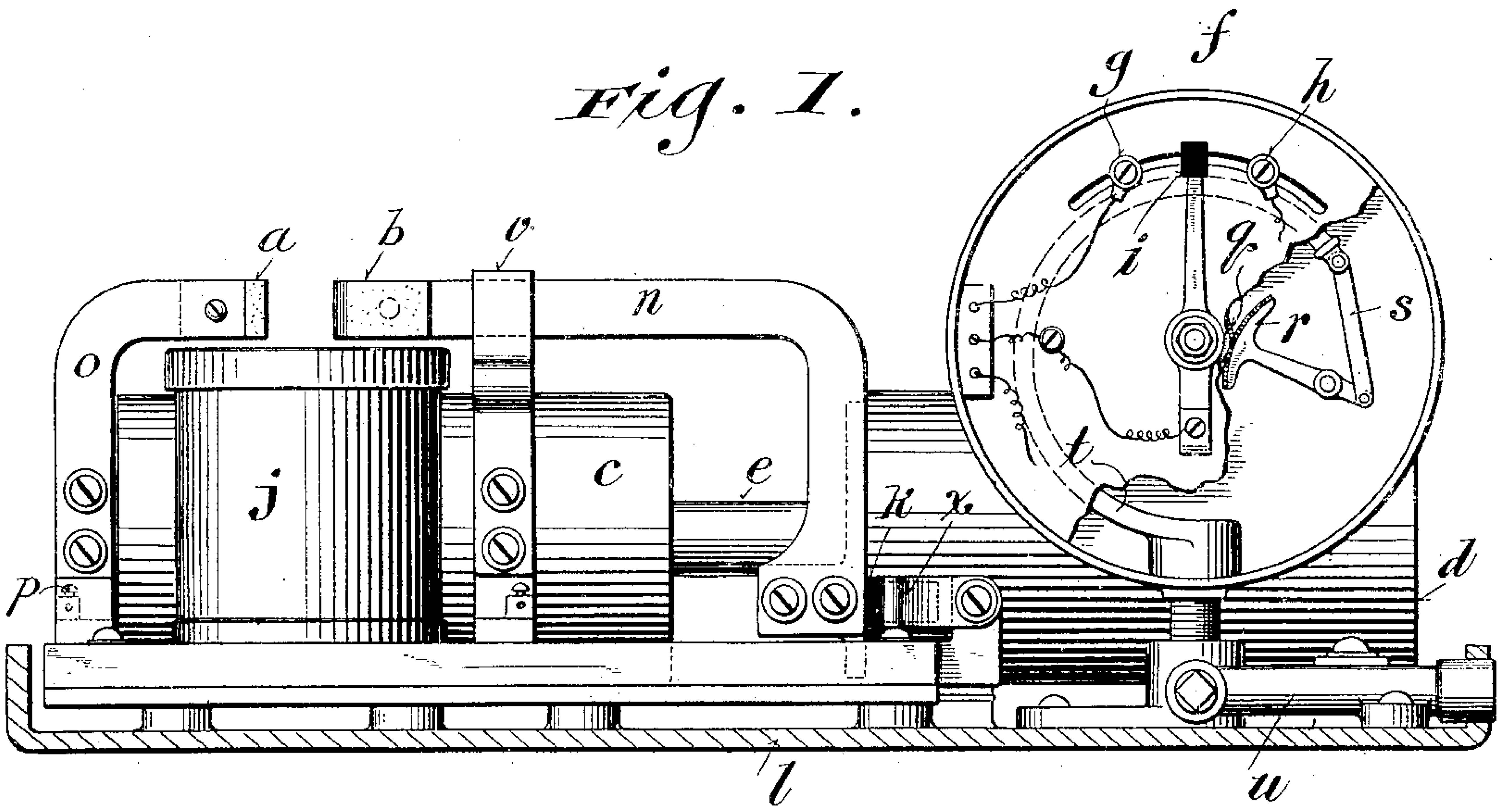

Fig. 2.

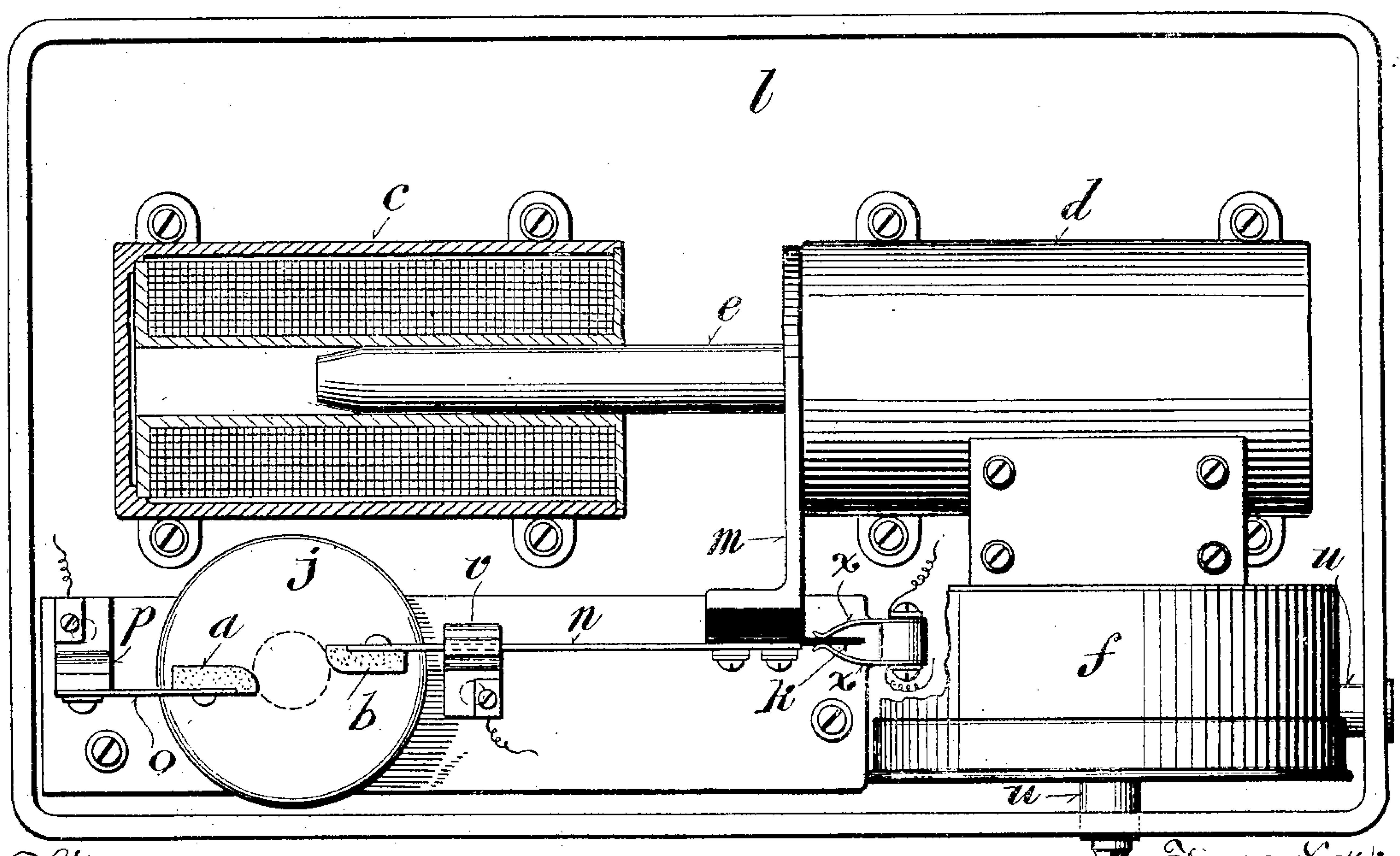

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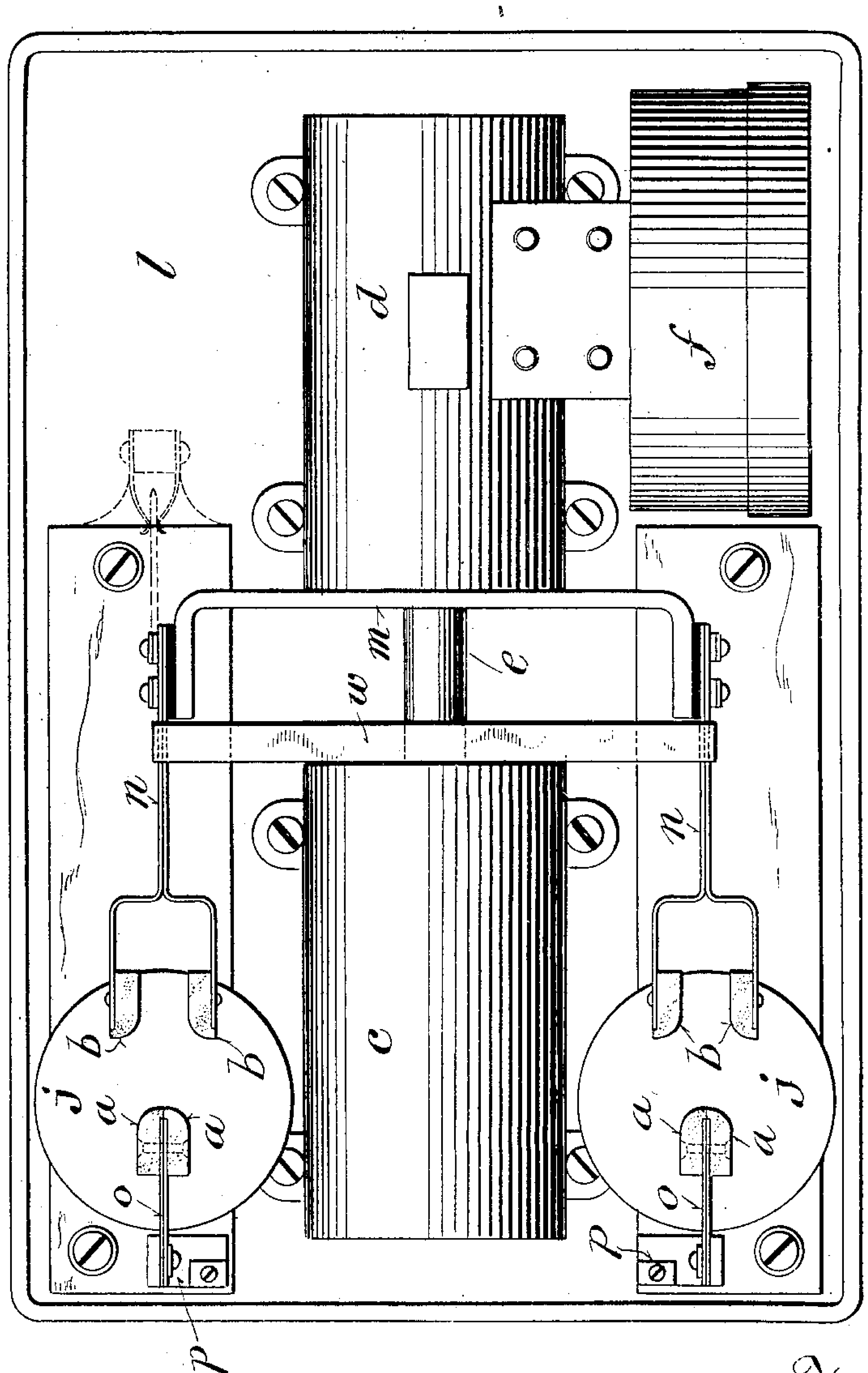
Fig. 3.



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(No Model.) 4 Sheets—Sheet 3.

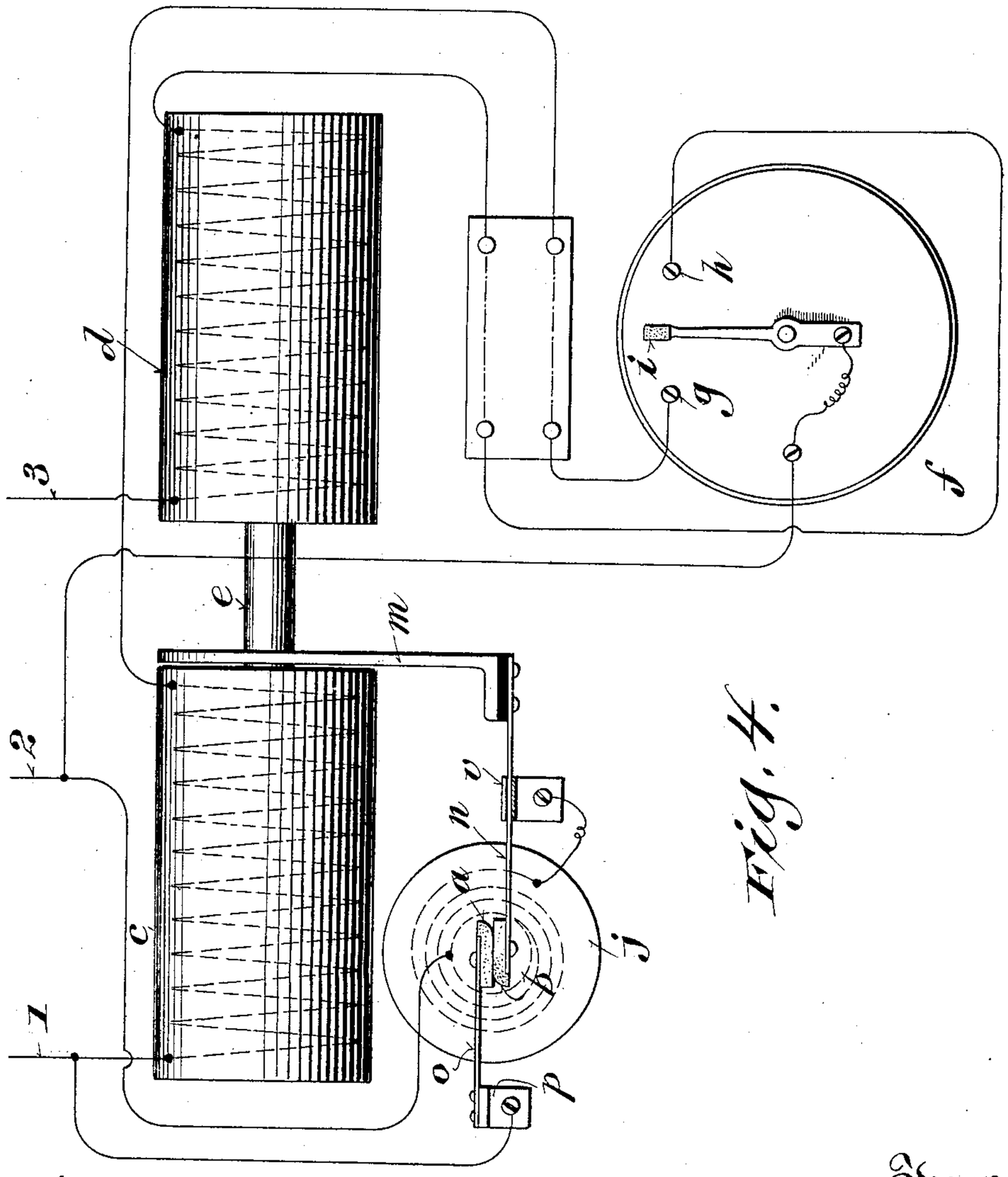

Fig. 4.

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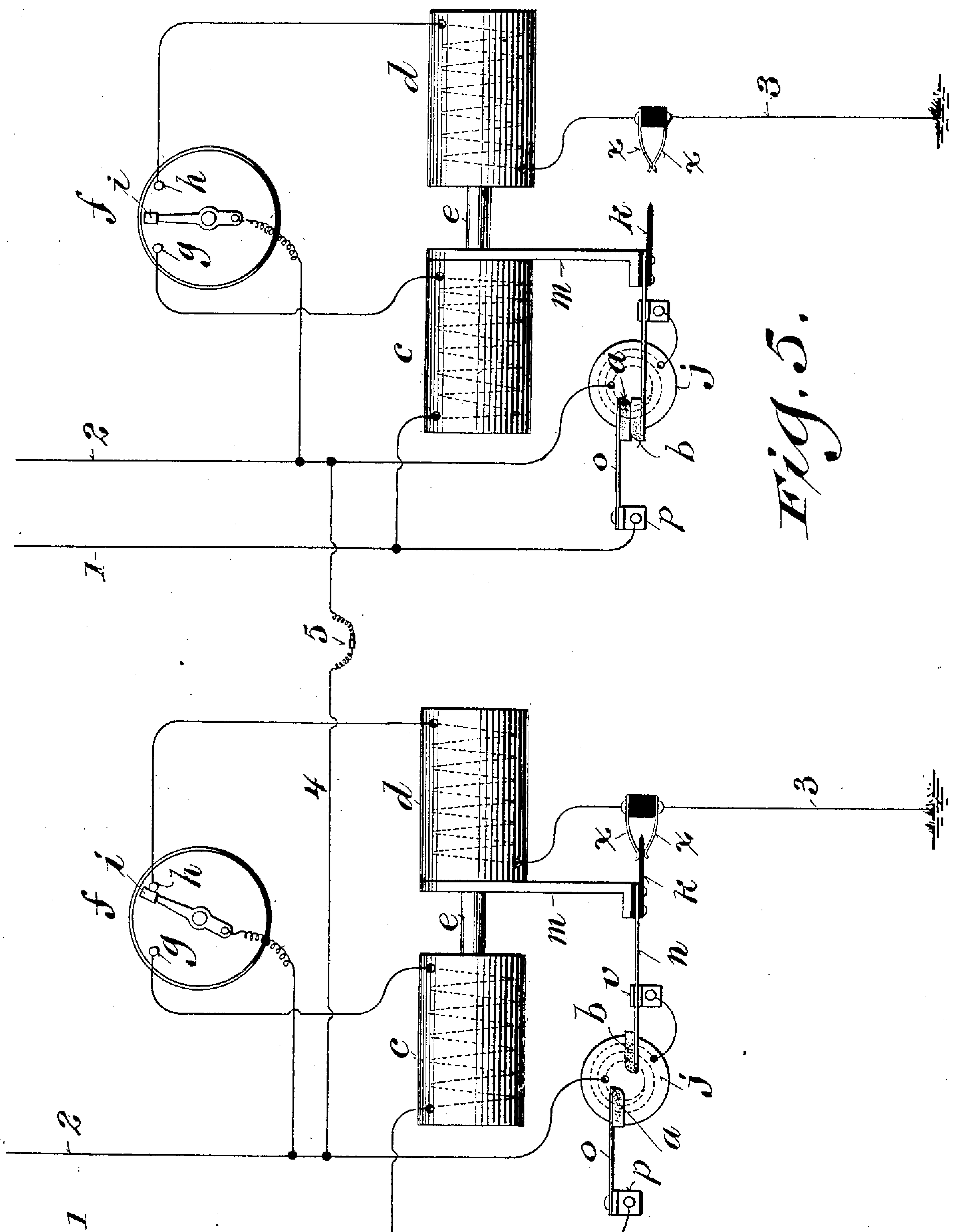

Fig. 5.

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UNITED STATES PATENT OFFICE.

NIELS A. CHRISTENSEN, OF MILWAUKEE, WISCONSIN.

AUTOMATIC CONTROLLER FOR ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 701,843, dated June 10, 1902.

Application filed October 21, 1901. Serial No. 79,322. (No model.)

To all whom it may concern:

Be it known that I, NIELS A. CHRISTENSEN, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Automatic Controllers for Electric Motors, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

The main objects of this invention are to maintain fluid-pressure within certain limits for the operation of brakes on railway-cars and for other uses and to simplify and improve the construction and operation of apparatus of this class.

It consists in certain novel features of construction and in the arrangement and combinations of parts, substantially as hereinafter set forth, and defined in the claims.

In the accompanying drawings like characters designate the same parts in the several figures.

Figure 1 is a side elevation of an automatic controller embodying the invention, certain parts being broken away and shown in section. Fig. 2 is a view of the controller, partly in plan and partly in section. Fig. 3 is a plan view of a modified construction designed for stronger currents. Fig. 4 is a diagram illustrating the electrical connections of the controller for air-brake service on a single car, and Fig. 5 is a diagram illustrating the electrical connections of controllers like that shown in Figs. 1 and 2 for multiple-unit service.

Referring to Figs. 1 and 2, the controller proper comprises a main switch having relatively stationary and movable contact-pieces *a* and *b*, switch closing and opening magnets *c* and *d*, having a common core or plunger *e* movable axially therein and carrying the movable contact-piece *b*, a primary switch or circuit-controller *f*, having minimum and maximum pressure contact-pieces *g* and *h*, and a third contact-piece *i* for controlling the circuits of the magnets *c* and *d*, a blow-out magnet *j*, arranged to extinguish arcs produced by the separation of the contact-pieces *a* and *b*, and when the controller is employed for multiple-unit service a circuit-breaker *k* for opening the circuit of the magnet *d* when the main switch is opened. All the foregoing parts being assembled are mounted upon the same base *l* and are inclosed and protected by a removable cover or case, which is not shown. The magnets *c*, and *d* are arranged in line with each other, and their coils, which are wound on spools of brass or non-magnetic metal, are preferably incased in iron cylinders or shells, as shown at the left in Fig. 2. The plunger *e* is provided between the two magnets *c* and *d* with an armature-plate *m*, to which an insulated metallic spring-arm *n* is attached at one end parallel with said plunger. To the other end of this arm is attached the contact-piece *b* of the main switch. The contact-piece *a* is attached in the path of the contact-piece *b* to a spring-arm *o*, which is attached at its other end parallel with the arm *n* to an insulated post or bracket *p*. For the primary switch *f* a device similar to a manometer or pressure-gage is employed. The movable contact-piece *i* is carried by the gage-hand between the minimum and maximum pressure contact-pieces *g* and *h*, which are separately adjustable toward and from each other in a curved slot in the face of the gage concentric with the pivot-stem of the hand for the purpose of varying the limits of pressure as may be desired. The gage-hand is connected, as shown in Fig. 1, by a pinion *q*, a segment gear and lever *r*, and a link *s* with the free end of a curved spring-tube *t*, which is rigidly attached to and communicates at its opposite end with a fluid-pressure-supply connection *u*.

For air-brake service the tube *t* of the primary switch *f* is connected with the main reservoir supplied with compressed air by a compressor-motor, the operation of which is governed by the main switch of the controller. For a current of moderate strength a single break-switch having two contact-pieces, as shown in Figs. 1 and 2, is preferably employed, and with such a switch the electrical connection with the movable contact-piece *b* is made by means of a spring-clip *v*, consisting of two metallic strips which engage the spring-arm *n* on opposite sides. For heavier or stronger currents the controller may be provided, as shown in Fig. 3, with a multiple break-switch having a plurality of contact-pieces, and two or more blow-out magnets, one

for each pair or set of opposing contact-pieces, may be employed. In this case the spring contact-clip *v* is dispensed with, and the spring-arms *n*, which carry the movable contact-pieces *b* on opposite sides of the magnet *c*, are electrically connected by a metallic strip *w*. When the main switch is closed, the current flows through the coil of one blow-out magnet *j*, thence through the associated contact-pieces *a* and *b* on one side of the controller, and thence through the connecting-strip *w*, the contact-pieces *a* and *b*, and the coil of the associated blow-out magnet *j* on the other side of the controller, so that when the contact-pieces are separated in opening the switch the circuit will be simultaneously broken at four points, and the arc thus divided and reduced in strength will be more readily extinguished by the blow-out magnets *j*. For multiple-unit service the controller is provided with an auxiliary circuit-breaker consisting of an insulating-strip *k*, carried by the plunger *e* parallel therewith and adapted when the contact-pieces *a* and *b* are separated to pass between and separate two contact-springs *x x*, which are located in and normally close the circuit through the switch-opening magnet *d*. This circuit-breaker may be applied to either form of controller, as shown by full lines in Figs. 1 and 2 and as indicated by dotted lines in Fig. 3.

When it is designed to be used by itself on single cars, the controller is connected and operates as follows: As shown in Fig. 4, the trolley or one of the main conductors 1 is connected with one terminal of the magnet *c* and with the stationary contact-piece *a* of the main switch. The movable contact-piece *b* of said switch is connected through the spring-clip *v* and the winding of the blow-out magnet *j* by a conductor 2 with the motor. The other terminal of magnet *c* is connected with the minimum-pressure contact-piece *g* of the primary switch. The maximum-pressure contact-piece *h* of said switch is connected with one terminal of the magnet *d*, the other terminal of which is connected with a ground or return conductor 3, and the movable contact-piece *i* of the primary switch is connected with the conductor 2. Assuming that the air-pressure is at zero or below the minimum limit for which the controller is adjusted, the movable contact-piece *i* of the primary switch will rest against the minimum-pressure contact-piece *g*. If now current is supplied to the trolley or main conductor 1, it will flow through the coil of magnet *c*, the contact-pieces *g* and *i* of the primary switch, and thence by the connection 2 to the ground or return conductor. The magnet *c* will thus be energized, and if the main switch is open the plunger *e* will be shifted to the left, carrying the contact-piece *b* into engagement with the contact-piece *a*, thereby closing the circuit from the trolley or supply-conductor 1 through said contact-pieces, the spring-clip *v*, the coil of magnet *j*, and the conductor 2 to the motor. The compressor-motor will thereupon start and operate to replenish the air-supply till the motor-circuit is broken, as hereinafter explained. As the pressure rises the gage-hand, carrying the contact-piece *i*, will be turned gradually to the right, breaking the circuit through the magnet *c*, and when it engages the maximum-pressure contact-piece *h* closing the circuit from the trolley or supply-conductor 1 through the main-switch contact-pieces *a* and *b*, clip *v*, magnet *j*, contact-pieces *i* and *h*, and thence through magnet *d* to the ground or return conductor 3. Magnet *d* will thus be energized and shift the plunger *e* to the right, separating the contact-pieces *a* and *b* of the main switch and opening the motor-circuit, as well as the circuit just closed through the magnet *d*. As the pressure falls the gage-hand will gradually move back to the left, and when it touches the minimum-pressure contact-piece *g* the circuit will be closed through magnet *c*, the main switch will be closed, and the motor started, as above explained. These operations will be repeated according to the variations in the air-pressure produced by the compressor-motor as long as current is supplied to the controller by the conductor 1.

When a number of controllers provided with auxiliary circuit-breakers *k* are used together in a multiple-unit system, they are connected as shown in Fig. 5. The electrical connections of each controller in a multiple-unit system are substantially the same as explained in connection with Fig. 4 for an individual controller which is to be operated independently of other controllers, except that the contact-springs *x x* or separable contact-pieces, which normally engage with each other, are provided in the circuit of the switch-opening magnet *d* of each controller, strips *k* of insulating material are provided on the plungers *e* for separating said springs or contact-pieces when the main-switch contact-pieces *a* and *b* are separated, and the motor-circuits are connected between the main switches and motors by a balancing-wire or equalizing-conductor 4 running through the train and provided with detachable couplings 5 between the cars. When so connected, a number of governors will operate as follows: Assuming that the air-pressure is at zero and that current is supplied to the conductors 1, the contact-pieces *i* on the gage-hands will rest against the minimum-pressure contact-pieces *g*, the magnets *c* will be energized, and the main switches will be closed. The compressor-motors will thus be supplied with current and operated till their circuits are opened, as hereinafter explained. As the pressure rises the gage-hands will be gradually turned to the right. In case both or all primary switches *f* in the system are adjusted so that the movable contact-pieces *i* will engage simultaneously with the maximum-pressure contact-pieces *h* circuits will be closed through all the magnets *d*, and the main switches will be opened si-

multaneously; but in practice it is difficult or impossible to so adjust the primary switches that their movable contact-pieces *i* will engage simultaneously with either the minimum- pressure or the maximum-pressure contact-pieces *g* and *h*. It follows, therefore, that if each of the several compressor-motors in a train was governed independently by the associated controller they would be started and stopped independently of each other at different times. As such independent operation of the compressor-motors in a connected train of cars is objectionable, the equalizing-conductor 4, by which they are made to operate simultaneously, is provided. Supposing now for illustration that the movable contact-piece *i* of the controller at the left first touches the associated maximum contact-piece *h*, the magnet *d* will thereupon be energized and the contact-pieces *a* and *b* of the main switch at the left will be separated, as shown. By the shifting of the plunger *e* to the right in opening the main switch the insulating-strip *k* will be thrust between the contact-springs *x x*, thereby separating them and breaking the circuit through said magnet *d*. If the circuit of magnet *d* was not thus broken, a heavy or strong current would continue to flow through it from the motor-circuit at the right by way of the equalizing-wire 4 and the contact-pieces *i* and *h* of the primary switch *f* at the left. This would in a short time overheat and injure or destroy the windings of said magnet. After the main switch at the left is opened and until the main switch at the right is opened by the engagement of the associated contact-piece *i* with the maximum contact-piece *h* the compressor-motor at the left will be supplied with current through the equalizer 4 from the motor-circuit at the right. When the movable contact-piece *i* of the primary switch *f* at the right touches the associated maximum-pressure contact-piece *h*, the magnet *d* of the controller at the right will be energized and the associated main switch will be opened, thereby cutting off the supply of current to and stopping both motors. As the pressure falls both the gage-hands will turn gradually back to the left, and the first contact-piece *i* to touch the associated contact-piece *g* will close the circuit through the magnet *c*, connected therewith, thereby energizing said magnet and closing the associated main switch, through which current will be supplied both to the motor on the same car and to the motor on the adjoining car by way of the equalizing-wire 4. The movable contact-piece *i* of the other primary switch, which is adjusted to close the circuit through the associated switch-closing magnet *c* at a lower minimum limit, will not reach the minimum-pressure contact-piece *g* before both compressor-motors are started, as above explained, whereupon both gage-hands will be turned again to the right by the augmented air-pressure.

In a multiple-unit system comprising two or more controllers and compressors connected as described by an equalizing-wire the primary switch, which is adjusted to close the circuit through the associated switch-closing magnet *c* at the highest minimum limit of pressure, will take control of the entire system, and all the motors will be stopped and started simultaneously thereby, and in case the governor having control of the system at any given time is disabled or cut out that controller which is adjusted to close the circuit through the associated switch-closing magnet at the next highest minimum limit of pressure will take control of the system.

The trolley or supply and the ground or return connections of the controller may obviously be reversed and various changes in the details of construction and arrangement of parts of the apparatus may be made without materially affecting the operation of the governor and without departing from the principle and intended scope of the invention.

I claim—

1. In an automatic controller the combination of two magnets having a common core or plunger movable axially therein, a spring-arm mounted upon said plunger and provided with a contact-piece, and an opposing contact-piece arranged in the path of the movable contact-piece, substantially as described.

2. In an automatic controller the combination of two magnets having a common core or plunger movable axially therein, a contact-piece mounted upon and movable with said plunger, and an opposing contact-piece yieldingly mounted upon a fixed support in the path of said movable contact-piece, substantially as described.

3. In an automatic controller the combination of two magnets arranged in line with each other and having a common core or plunger movable axially therein, a spring-arm mounted upon said plunger and provided with a contact-piece, and a spring-arm mounted on a fixed support and provided with a contact-piece in the path of the contact-piece carried by said plunger, substantially as described.

4. In an automatic controller the combination of two solenoid-magnets having a common core or plunger movable axially therein, an insulated arm mounted upon said plunger and provided with a contact-piece, a stationary electric conducting guide or clip with which said arm has a sliding contact, and a contact-piece arranged in the path of the contact-piece on said arm, substantially as described.

5. In an automatic controller the combination of two solenoid-magnets arranged in line with each other and having a common plunger movable axially therein, an insulated spring-arm mounted on said plunger approximately parallel therewith and provided with a contact-piece, another insulated contact-piece arranged in the path of the contact-piece on said spring-arm, and a switch controlling the circuits of said magnets and hav-

ing a fluid-actuating connection, substantially as described.

6. In an automatic controller the combination of two solenoid-magnets arranged in line with each other and having a common plunger movable axially therein, an insulated spring-arm mounted on said plunger and provided with a contact-piece, a stationary guide or clip with which said arm has a sliding contact, and with which one terminal of an electric circuit is connected, an insulated spring-arm mounted on a stationary support and provided in the path of the first contact-piece with another contact-piece with which the other terminal of said circuit is connected, and a switch controlling the circuits of said magnets and having a fluid-actuating connection, substantially as described.

7. In an automatic controller the combination of two solenoid-magnets having a common plunger movable axially therein, a main switch having a contact-piece mounted on and movable with said plunger, and another contact-piece arranged in the path of said movable contact-piece, a primary switch controlling the circuits of said magnets, and a circuit-breaker mounted on said plunger and adapted to open the circuit through the switch-opening magnet when the main-switch contact-pieces are separated, substantially as described.

8. In an automatic controller the combination of two solenoid-magnets arranged in line with each other and having a common plunger movable axially therein, a main switch having contact-pieces one of which is mounted upon said plunger and movable therewith into and out of engagement with the other, a primary switch having minimum and maximum pressure contact-pieces and a fluid-pressure-actuated contact-piece for controlling the circuits of said magnets, normally-engaged springs in the circuit of the switch-opening magnet, and a circuit-breaker carried by said plunger and adapted to separate said springs when the main switch is opened, substantially as described.

9. In an automatic controller the combination of two magnets arranged in line with each other and having a common core or plunger movable axially therein, a switch having a contact-piece mounted on said plunger and another contact-piece in the path of said movable contact-piece, and a blow-out magnet arranged in circuit with said contact-pieces and having one of its poles in proximity with the stationary contact-piece, substantially as described.

In witness whereof I hereto affix my signature in presence of two witnesses.

NIELS A. CHRISTENSEN.

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