No. 844,800. PATENTED FEB. 19, 1907.

E. M. HEWLETT & C. E. EVELETH.

SYSTEM FOR CONTROLLING ELECTRIC SWITCHES.

APPLICATION FILED MAY 12, 1903.

2 SHEETS—SHEET 1.

Fig.1.

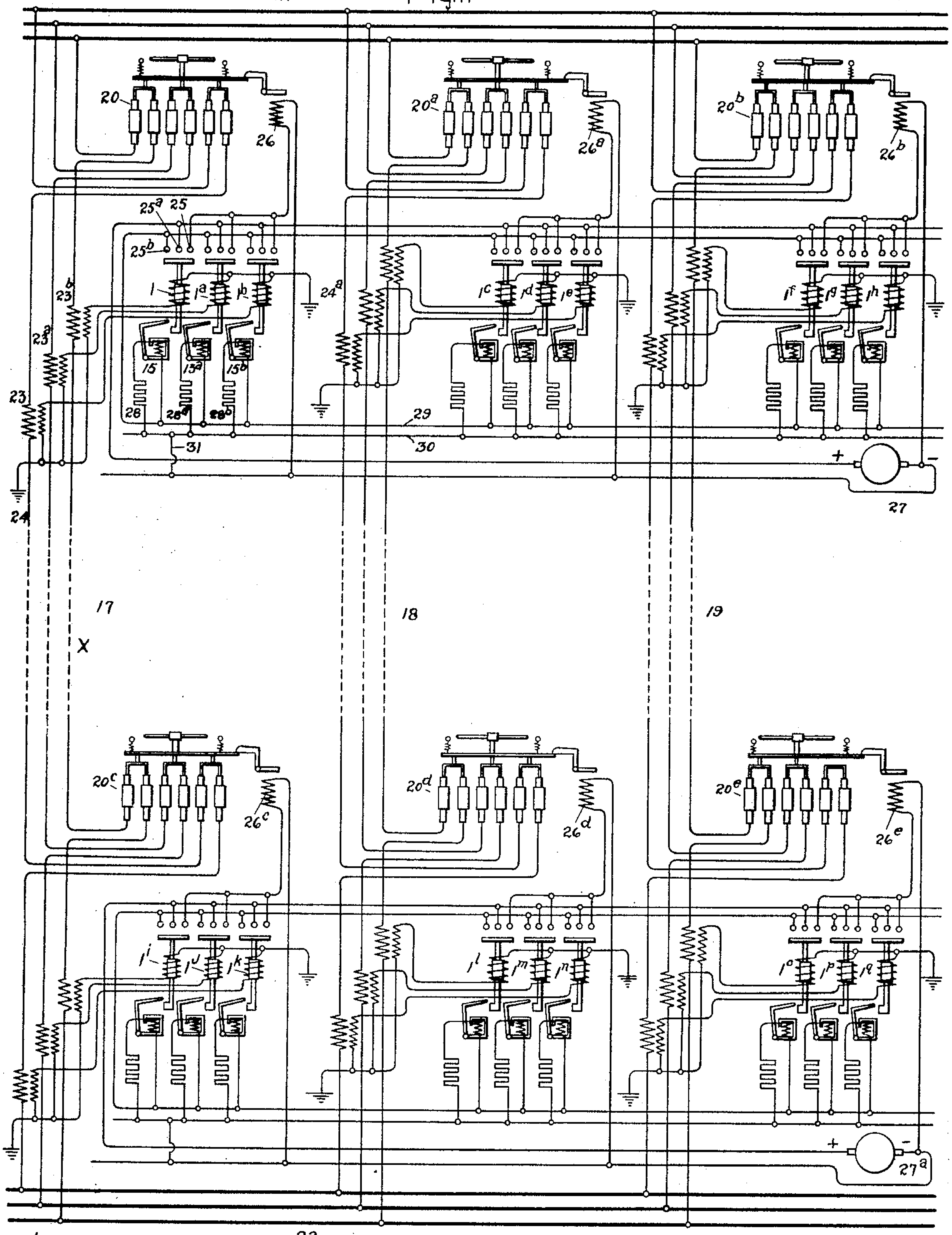

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Fig. 2.

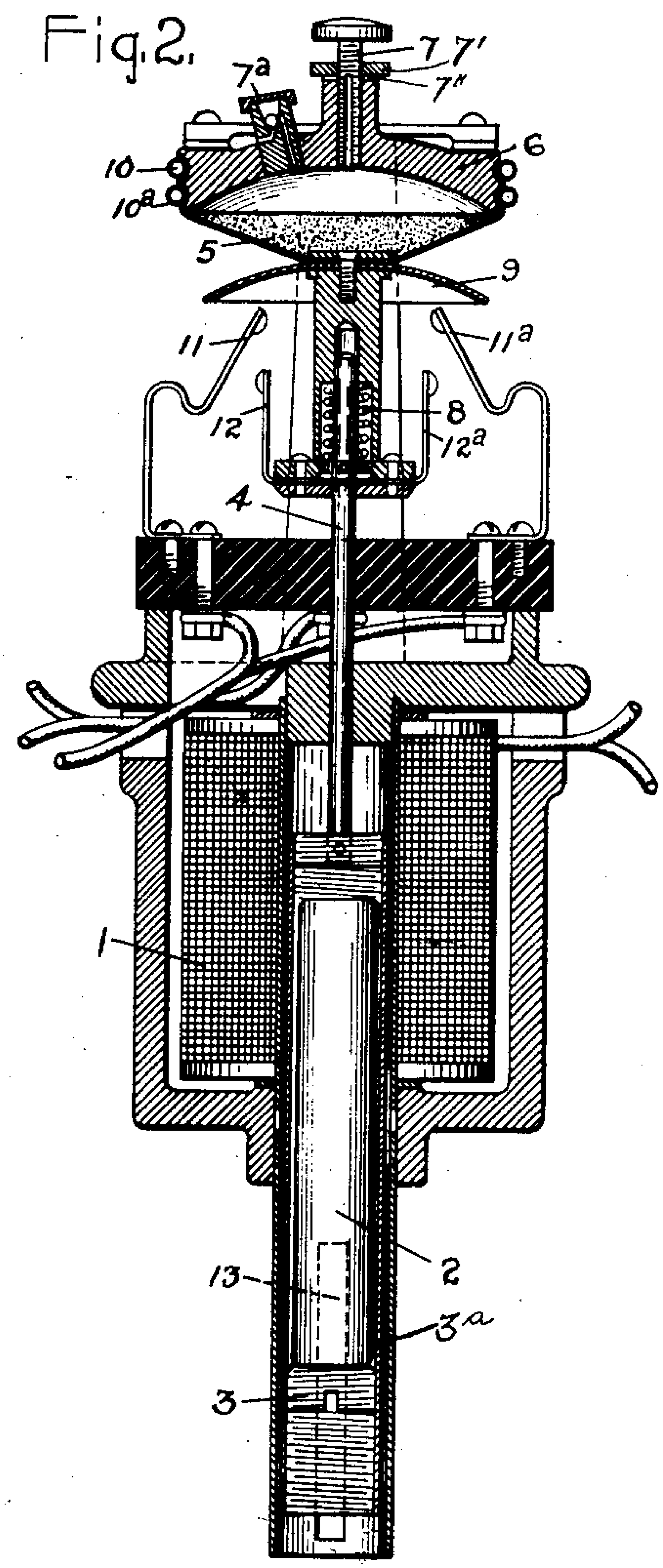


Fig. 3.

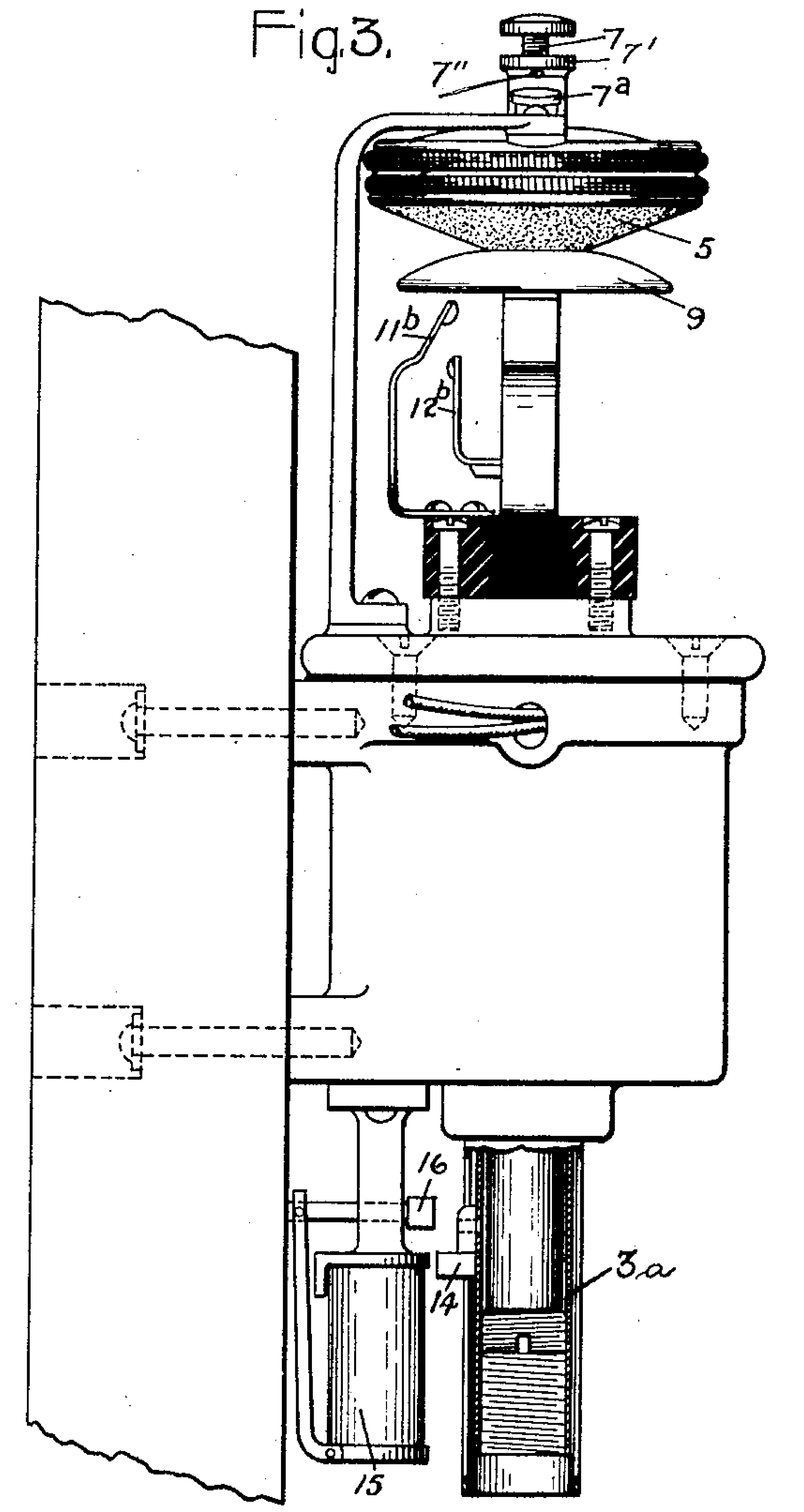
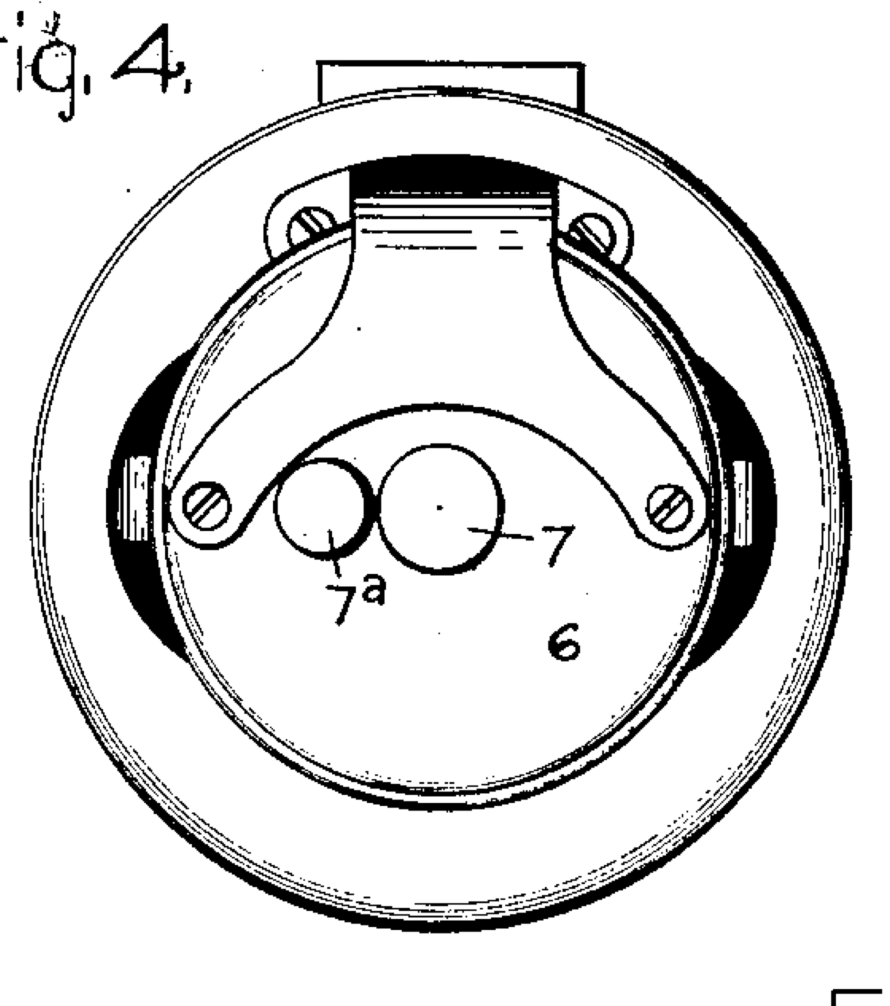


Fig. 4.



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UNITED STATES PATENT OFFICE.

EDWARD M. HEWLETT AND CHARLES E. EVELETH, OF SCHENECTADY, NEW YORK, ASSIGNORS TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

SYSTEM FOR CONTROLLING ELECTRIC SWITCHES.

No. 844,800. Specification of Letters Patent. Patented Feb. 19, 1907.

Application filed May 12, 1903. Serial No. 156,802.

To all whom it may concern:

Be it known that we, EDWARD M. HEWLETT and CHARLES E. EVELETH, citizens of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Systems for Controlling Electric Switches, of which the following is a specification.

In modern systems of electric supply it is common to provide a plurality of feeders between two or more points, as between a main generating station and a substation, and to install at each station an automatic switch for opening the circuit in case of extraordinary conditions which might endanger the safety of the apparatus. If a short circuit occurs on one such feeder, the heavy load on the others causes all the switches to be tripped, thus shutting down the entire system.

It is the object of this invention to provide means by which only the switch in the particular circuit or feeder which is defective can be actuated or tripped, the others being disabled at least until the defective circuit is opened. There are various ways of accomplishing this result, which will occur to a skilled engineer after being made acquainted with our invention; but the manner we prefer is to control the several feeder-switches by means of relays of the time-limit type, each relay being adapted when actuated to close a circuit which locks all the others against operation.

The invention is particularly applicable to alternating-current systems, each relay or group of relays corresponding to the several feeders being in operative relation to a trip or operating-circuit which controls its switch or circuit-breaker, the relays themselves being fed by energy supplied by current-transformers in the feeder-circuits.

Our invention therefore comprises a supply system provided with automatic control-switches, means for operating the same on predetermined energy variations, and means for disabling all the other switches when any one is in process of opening by reason of a defective circuit.

More specifically, it comprises a system of this character containing controlling-relays for the switches and means for locking all of the relays except the one which responds to the maximum load.

Other features of novelty will be hereinafter described, and pointed out in the claims.

In the drawings, Figure 1 is a diagrammatic illustration of a system embodying our improvements, and Figs. 2, 3, and 4 are details of a type of time-limit relay suitable for carrying out our improvements.

Referring first to the relay, 1 represents a solenoid, and 2 a core normally resting against an adjustable stop 3, located within a tubular carrier 3ª for the core. The core 2 and its carrier 3ª constitute a plunger which is housed by a brass tube and the solenoid inclosed in an iron casing to afford a good magnetic circuit. To the upper part of the carrier 3ª is secured a rod 4, operating a flexible diaphragm 5, of leather, mounted air-tight on a shallow pot 6. An adjusting-screw 7 is mounted in the upper part of the pot, having an axial slot milled in one side through a part of its length. By suitable adjustment of this screw the leakage from the pot may be finely graduated, so as to vary the time of movement of the plunger 2. The air escapes to atmosphere from the slot in the screw 7 through the paths formed by the loose fit of the screw-threads. If desired, the lock-nut 7′ on the screw may also be transversely grooved, as at 7″, to increase the rate of escape. A ball-valve 7ª, seating against a vent under upward movement of the diaphragm, but permitting a free downward movement, is provided. Between the plunger and the diaphragm 5 is a helical spring 8 to absorb vibration and prevent trembling contact. Between the leather diaphragm and the plunger is a convex plate 9, which acts as a piston to compress the air within the chamber formed between the diaphragm and the cup whenever the plunger is moved upward. The diaphragm is clamped to the pot by ring-springs 10 10ª, sprung over the leather and into grooves formed in the periphery of the pot On an insulating-plate are mounted contact-springs 11 11ª 11ᵇ, coöperating with corresponding contacts 12 12ª 12ᵇ, mounted on the piston. The brass tube which houses the plunger is slotted at 13, through which slot projects a lug 14, secured to the plunger. A lock-magnet 15 is provided on its armature with a stop 16, adapted to be interposed in the path of the lug 14.

The relay herein described forms no part of the present invention, as it is the sole invention of Edward M. Hewlett, our improvements relating, so far as the instrument is concerned, simply to the provision of the locking device which is referred to. Relays of this type are connected in circuit, as shown in Fig. 1, in which 1 1^a 1^b 1^c 1^d 1^e 1^f 1^g 1^h represent three groups of relays corresponding to three triphase feeders of an alternating-current-supply system. These feeders are represented at 17 18 19, connecting, say, a main generating-station with a substation. On the incoming side of each end of the feeder—that is to say, between the bus-bars and the line—is interposed a switch or circuit-breaker, as 20 20^a, &c.

The system here illustrated is especially designed for transmission of power over a considerable distance, in which it is necessary, for purposes of economy, to employ high potentials. We have therefore shown oil-switches, the drawings representing symbolically switches of the type described in the application of Hewlett and Button, Serial No. 88,757, filed on or about January 7, 1902, in which a plurality of oil-pots, two to each phase, are provided in which the circuit is opened under oil, all phases being opened simultaneously.

21 represents a group of main-station bus-bars, and 22 a group of substation bus-bars. 23 23^a 23^b represent series transformers, each feeder being provided with a similar group. We prefer to use one for each phase, the secondary supplying the operating-solenoids of the relays 1 1^a 1^b, &c. The several secondaries of each feeder are connected in parallel relation to a common return, being shown as grounded at 24 24^a. When any relay is operated, its movable element is gradually lifted according to the time-limit determined by its dash-pot adjustment until it cross-connects the several contacts. There are three fixed contacts, two of which, as 25 25^a, control the trip-coil 26 or operating device of the oil-switch, and the third, 25^b, cuts into circuit with a local generator 27 all of the lock-coils or magnets 15 15^a, &c., of the several feeders, thereby shifting the detent in the path of the plunger of each of the relays and disabling it from operation. 28 28^a, &c., represent resistances to adjust the current for the several relays, a low-potential direct-current generator being shown as supplying the energy. This, however, is a matter of indifference, as any low-potential source of current may be employed for this purpose.

Let us assume now that a short circuit occurs at a point on one of the feeders, as at the point marked X on feeder 17. This will immediately effect an overload on all of the relays of the system. Some one of the group of relays at each station corresponding to the feeder 17, however, will carry a greater proportion of energy than any of the others, since the feeders 18 and 19 divide up with 17 the entire energy flowing in the system. Consequently some one relay of the feeder 17 will be drawn up with a harder pull than any of the others of the system, the difference in the time of its traverse depending on the number of feeders employed or on the adjustment of the dash-pot. The dash-pot is so adjusted that the relay carrying the maximum overload will close its tripping or other operating-circuit for the switch before the others have been drawn beyond locking range. The result of this is that as soon as the relay carrying the maximum overload engages the contacts 25 25^a 25^b, &c., it trips its switch, thereby opening the feeder on which the short circuit occurred and simultaneously cuts in all locking-magnets of the system except, of course, its own, since its lug has been shifted above the locking position. Thus let us assume that a short circuit occurs between the two phases indicated by the X-mark on feeder 17. The transformers 23 23^a 23^b at both the main and substation will be overloaded to a much greater degree than any of the other transformers, and the relays 1 1^a 1^b 1^i 1^j 1^k will respond, being lifted to a point where the contacts 25 25^a 25^b, &c., are closed before the other relays have moved out of locking position. When so closed, a circuit through the switch-operating or trip coils 26 26^c at each station is closed over the circuit from the pole marked plus of, say, generator 27 to contact 25^a, and thence through the bridging-contact of the relay to contact 25, trip-coil 26 or 26^c, back to the minus-pole of the generator. The oil-switches at each end of the feeder 17 are thereby immediately tripped and the defective circuit cut out. Meantime the other switches have been disabled from operation or locked by means of a locking-circuit leading from the positive side of, say, generator 27 to fixed relay-contact 25^a, across the bridging-contact of the movable element of the relay to fixed contact 25^b, thence by wire 29 to all of the relay-locking coils in multiple and back by a common lead 30 and wire 31 to the negative pole of the generator 27. The locking-armatures of the relays are drawn forward; but as the movable elements of relays 1 1^a have been shifted out of locking range the armatures cannot detain them. The others, however, are in position to permit interposition of the stops 16, (see Fig. 3,) which arrest them, and thereby disable their switches from being tripped. The detent 16 of the armature and the lug which it arrests on the movable element of the relays are so arranged that a proper amount of lost motion is permitted, so that the relays not carrying maximum overload will be within locking range when the proper relay completes its movement. Thus it will be seen that any trouble arising in one part of a system or on one feeder of a system will not necessitate the shutting down of the entire plant or any interruption of the service except on the defective line.

The term "trip-coil" is herein used in its broad sense as a controlling release or operating device for the switch.

It will be observed that after a feeder is cut out its relays are deënergized and, dropping back to the initial position, open the locking-circuit, thereby opening the locks and putting all other relays in condition to act in case of further trouble in the feeders they control. The relays can return quickly by reason of the ball-valve 7^a, which permits free influx of air to the pot. The relays herein employed are of a type in which the time-limit varies somewhat, according to the degree of overload. We term such a device an "inverse time-limit" device, since the time of operation varies inversely as the load. While we have shown our invention herein as particularly applied to a system of feeders supplied by bus-bars fed from a generator or group of generators, it will be understood that the same system of protection may be used for protecting leads from different generating units connecting with a common distribution-circuit.

What we claim as new, and desire to secure by Letters Patent of the United States, is—

1. A system of electric transmission comprising a plurality of distributing-conductors connected in parallel, means for cutting out any defective conductor, and means for disabling the cut-out devices of all of the remaining conductors.

2. The combination of a plurality of interconnected circuits, automatic switches for the same, and means for selectively operating the switch in any short-circuited branch and obstructing the switches in the other branches to prevent their operation.

3. In an electric-supply system, a plurality of conductors, a source or sources of energy feeding the same, automatic switches for the conductors, and means actuated upon the occurrence of a dangerous overload on any of the conductors for locking the switches of all the other conductors.

4. In an electric-supply system, a plurality of feeders, a common source of energy for the same, an automatic circuit-breaker for each feeder, tripping dev ces responsive to overload, and means actuated upon the occurrence of a dangerous overload on any of the feeders for disabling the tripping devices of all the other feeders.

5. In an electric-supply system, a plurality of feeders, a common source of energy for the same, an automatic circuit-breaker for each feeder, tripping devices responsive to predetermined overload, and means operative upon the occurrence of a dangerous overload on any of the feeders for disabling the tripping devices of all the other feeders.

6. In an electric-supply system, a plurality of feeders, a common source of energy for the same, an automatic circuit-breaker for each feeder, a trip-circuit therefor, a time-limit relay controlling each trip-circuit, and means operative upon the occurrence of excessive current variation in any feeder for locking the relays of all the other feeders.

7. In an electric-supply system, a plurality of feeders, a common source of energy for the same, an automatic circuit-breaker for each feeder, a trip-circuit therefor, an inverse time-limit relay controlling each trip-circuit, and electromagnetic devices operative upon the occurrence of excessive current variation in any feeder for locking the relays of all the other feeders.

8. In an alternating-current electric-supply system, a plurality of multiphase feeders, a common source of energy for the same, an automatic circuit-breaker for each feeder, trip devices for each phase of each feeder, and means actuated by abnormal current in any phase of any feeder for locking the trip devices of all the other feeders.

9. In an electric-supply system, a plurality of feeders, a source of energy for the same, an automatic circuit-breaker for each feeder, a trip device for each circuit-breaker, and a locking-circuit closed by the trip device which first reaches tripping position for restraining all the other trip devices.

10. In a relay controlling a trip-circuit, the combination with an actuating-magnet, of a movable element actuated thereby to close the trip-circuit, a circuit for energizing said magnet, a normally open lock for said movable element, a locking-magnet for closing said lock to restrain the movement of said movable element, and an independent circuit for controlling said locking-magnet.

11. The combination of a plurality of interconnected circuits, automatic switches for the same, means for selectively operating the switch in any defective branch, and means for preventing the operation of the switches in the remaining branches.

In witness whereof we have hereunto set our hands this 11th day of May, 1903.

EDWARD M. HEWLETT.
CHARLES E. EVELETH.

Witnesses:
BENJAMIN B. HULL,
HELEN ORFORD.