

No. 848,793.

PATENTED APR. 2, 1907.

H. G. WEBSTER.
RELAY STRUCTURE.

APPLICATION FILED FEB. 4, 1907.

2 SHEETS—SHEET 1.

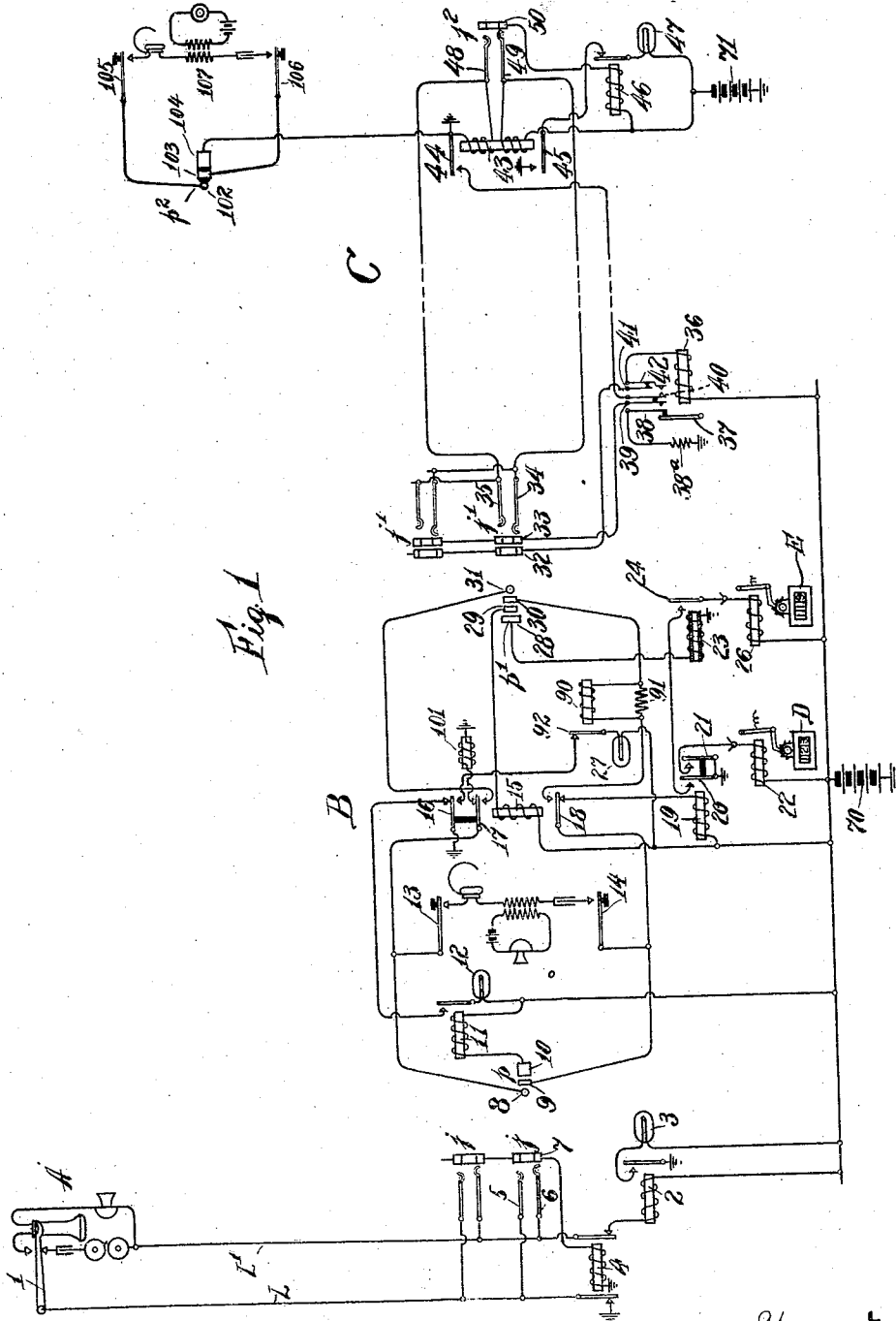


Fig. 1

Witnesses
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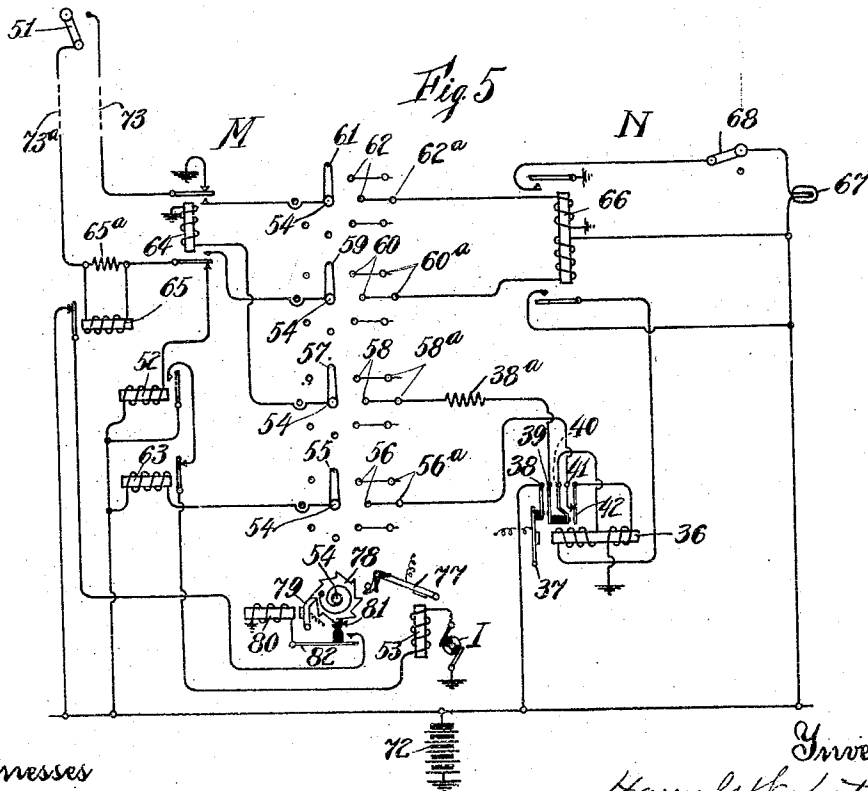
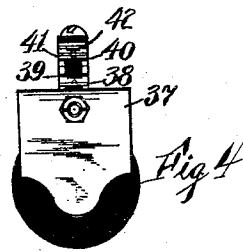
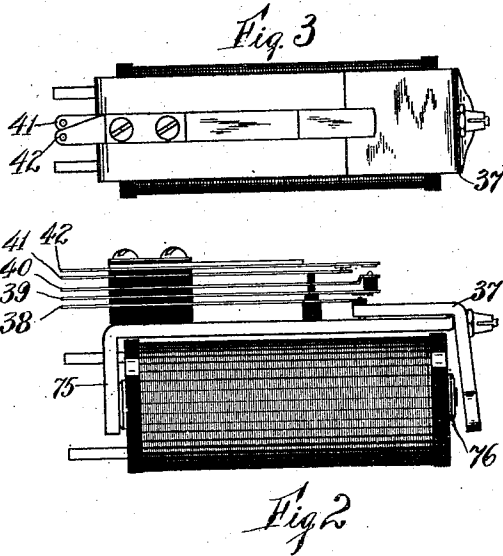
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2 SHEETS—SHEET 2.



Witnesses
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HARRY G. WEBSTER, OF CHICAGO, ILLINOIS, ASSIGNOR TO MILO G. KELLOGG, OF CHICAGO, ILLINOIS.

RELAY STRUCTURE.

No. 848,793.

Specification of Letters Patent.

Patented April 2, 1907.

Application filed February 4, 1907. Serial No. 355,720.

To all whom it may concern:

Be it known that I, HARRY G. WEBSTER, a citizen of the United States, and a resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Relay Structures, of which the following is a specification.

My invention relates to structures wherein relay-magnets are employed to operate and control electrical circuits, the object of my invention being in a general way to secure an improved structure of the described character.

A particular feature included in my invention which I consider to be novel, as aside from the structure generally considered, consists in the provision of a relay-magnet with associated operating means, such that when the magnet is initially energized a peculiar condition of magnetization exists which persists for a short period of time only—namely, until further operations set into train of action by the initial operation of the relay itself are completed—when a further different condition of magnetization of the relay-magnet is produced, which persists until such time as the use of the structure is terminated. The before-mentioned peculiar condition of magnetization produced in the magnet and operating, as indicated, to consequentially cause its own termination by the substitution of a different magnetization may be called an “unstable” or “inconstant” condition of magnetization.

Other features of my invention will more particularly appear and be pointed out in the following more specific description and in the claims.

In Figure 1 a circuit arrangement embodying a preferred specific embodiment of my invention as applied to a trunking structure for telephone purposes is shown. Fig. 2 is a side view of a relay-magnet adapted for employment in connection with Fig. 1. Figs. 3 and 4 are respectively top and end views of said magnet. In Fig. 5 a circuit arrangement, embodying my invention as applied to a signaling structure employing motor-driven switches is shown.

Referring first to Fig. 1, I show at A a telephone-substation comprising the usual transmitter, receiver, condenser, and call-bell, a telephone-line L L' connecting the same with the exchange where the usual line-

relay 2 and cut-off relay 4 are provided, the former displaying the line-signal 3 when operated in response to currents controlled at the substation, while the latter effaces the signal when operated in response to the insertion of answering-plug *p* into the spring-jack *j*. The cord-circuit B includes the test-lamp 12, displayed on the operation of the relay 11, which on inserting the plug is operated in series with the cut-off relay 4 by the battery 70. The test-relay 15 is connected from the active pole of battery 70 to a contact 29 of the plug *p'*. It is sensitive to the idle or busy conditions of trunk-circuits C as the operator inserts the plug *p'* into jacks *j'* of successive trunk-circuits C to find an idle trunk and will be operated to efface the test-signal 12 only when the jack of an idle trunk-circuit has been plugged into. Connected with contact 9 of answering-plug *p* via normal contact 18 is a counter-relay 19, adapted for operation by current over the subscriber's line on connection made therewith. Its operation closes contact 21 to energize the counter-magnet 22, whose armature-driven pawl advances in the well-known manner the ratchet of counter D to register for the operator an answered call. The contacts 30 and 31 of the plug *p'* are normally on open circuit at armatures 18 and 17 of the test-relay 15, being connected through to contacts 9 and 8 of the answering-plug when relay 15 is operated.

The calling counter-relay 23 is connected from ground to the contact 28 of testing-plug *p'*, said contact being brought to register with contact 32 of jack *j'* on insertion of the plug into the jack, whereby the relays 23 and 36 are serially connected with the battery 70 and the two relays operated, provided the jack employed is one of an idle trunk. The relay 23 when operated as described by its armature 24 closes the circuit of counter-magnet 26, whose armature-driven pawl turns the ratchet of counter E to register for the operator the completion of a connection to an idle trunk.

The relay 36 when initially operated as described may receive materially less current than it will receive later when its locking-circuit is completed, because at this latter time the winding of relay 23 will be excluded from circuit, as will later appear. Under the initial energizing-current, then, the relay 36

may only partially attract its armature 37 to close the contact 38 39, thus completing a circuit for relay 15 from battery 70 via said relay 15, contact 29 33, said contact 39 38, and the coil 38^a to ground. In addition, the said partial attraction will also close contact 40 42. The additional resistance presented to the further attraction of armature 37 by the tension of spring 42 may be sufficient to hold the armature in this intermediate position until relay 15 has operated to close circuit through relay 43, which latter relay upon its operation completes a lower resistance locking-circuit for the said relay 36 via contact 40 42, thereby causing a greater energization of the said relay to complete the attraction of its armature, whereby contact 41 42 is held open and relay 23 thus deenergized. The circuit over which relay 43 is energized, due to the said operation of relay 15, is as follows: from battery 71 through the lower winding of said relay 43, the lower conductor of the trunk-circuit C, plug and jack contact 34 30, relay and resistance 90 91, alternate contact 18, plug-and-jack contact 9 6, line-limbs L' L via the calling-substation A, plug-and-jack contact 5 8, alternate contact 17 of relay 15, plug-and-jack contact 31 35, the upper conductor of trunk C, and through the upper winding of said relay 43 to ground. The operation of relay 43 completes the following circuit: from battery 70 via the winding of relay 36, contact 42 40, closed contact 44 to ground, whereby the said relay 36 is completely energized, as above described, and whereby relay 23 is deenergized, as above stated. It is not necessary that the energization of relay 36, due to the flow of current over its initial energizing-path, including relay 23, be insufficient to prevent the opening of contact 41 42. On the contrary, the said energization of relay 36 in series with relay 23 may be sufficient to cause its armature to open contact 41 42, thereby momentarily opening its own circuit and causing the partial release of its armature to again close contact 41 42, which alternate partial release and reattraction will continue until relay 43 has been operated, as above described, to close the locking-circuit for relay 36 via contact 44 of said relay 43 to ground. In other words, the armature of relay 36 may vibrate, and thus alternately open and close contact 41 42; but said armature will hold contact 38 39 closed. The current through relay 23 is similarly intermittently and rapidly interrupted. These interruptions are, however, insufficient in duration to cause the release and reattraction of the armature of the counter-magnet 26. It may be, however, frequently desirable to prevent the vibration of the armature of relay 23 or of the armature of a similarly-located magnet, in which case, as shown in Fig. 1, a copper sleeve or hollow cylinder may be drawn over the core of said

relay, whereby, as is well understood, after its armature has once been attracted by the initial flow of current through relay 36 it will remain continuously attracted during the immediately-following succession of rapid interruptions. The construction of relay 36 is such as to permit its armature under the influence of a sufficient energizing-current to vibrate within a restricted range in its intermediate position, due to the alternate opening and closing of contact 41 42, while maintaining contact 38 39 closed, thereby permitting the energization of relay 15, thus placed in closed circuit with battery 70, as above described.

The adaptation of my invention illustrated in Fig. 1 is of particular utility in furnishing improved facilities for allowing the subscribers in a telephone system to obtain prompt connections for reporting troubles or complaints to the proper receiving-stations or for placing their orders for long-distance or toll connections to the proper recording operators and for securing an automatic record of the number of such received and completed connections. The remaining features of the structure will be best understood from the following description of operation: Let it be assumed that subscriber A has removed his receiver and that the lever 1 has engaged its alternate contact, operating relay 2 to display signal 3, and that the operator, responsive to the signal, has inserted plug *p* into a jack *j*, thus closing contacts 10 7, 9 6, and 8 5. The closing of contact 10 7 operated relay 4 to open the circuit of signal-relay 2, whose armature falls back, putting out lamp 3. The closing of contact 10 7 also operated relay 11, whose attracted armature completes circuit through test-lamp 12. The closing of contacts 9 6 and 8 5 operated relay 19 over the following circuit: from battery 70 through said relay 19, normal contact 18, said contact 9 6, line-limbs L' and L, including the substation apparatus A, said contact 8 5, normal contact 17, and retardation-coil 101 to ground. The counter-magnet 22 is thus operated once as and for the purpose already described, and contact 20 is closed to allow at a later stage the operation of counter-magnet 26. The operator now throws over levers 13 and 14, cutting in her telephone, and learns that the subscriber calling desires a connection over a trunk C. The operator having before her multiple jacks *j'* of a number of trunks C inserts the plug *p'* of the cord she used in answering into a multiple jack of one of them. If this trunk be busy, a plug *p'* of another cord similar to B will have been connected to another multiple jack *j'* of the trunk, and the test-relay 15 of the cord of Fig. 1 will then be placed in shunt of the relay 15 of the already-connected cord, and the first relay 15 will not receive enough current to cause it to attract

its armature, although enough current will continue flowing in the relay 15 of the previously-connected cord to cause its already-attracted armatures to continue in their attracted positions, the relays 15 of the cords and the resistance 38^a of the trunk being properly proportioned to this end. As an illustration, the voltage of battery 70 may be approximately thirty volts, the resistance of coils 38^a approximately seven hundred and fifty ohms, and the resistance of relays 15 approximately one hundred ohms. As relay 15 of the testing-cord remains inert, the lamp 12 continues lit, and the operator observing this is advised that the tested trunk C is busy. She therefore withdraws plug *p'* and inserts it into a multiple jack of another trunk. Assuming this to be idle, current will flow from battery 70 through relay 36, contact 42 41, contact 32 28, relay 23 to ground, armature 37 then assuming its intermediate or vibrating position as before described, and current then flows from battery 70 through relay 15, contact 29 33, contact 38 39 to ground through resistance 38^a. There being no other relay 15 at this time in shunt with relay 15 of the testing-cord, the relay of that cord is operated and attracts its armatures, of which 16 opens the circuit of test-lamp 12, whose going out notifies the operator that an idle trunk has been found. Armatures 17 and 18 engage their alternate contacts, causing a flow of current as follows: from battery 71, lower winding of relay 43, contact 34 30, relay and resistance 90 91, alternate contact 18, contact 9 6, hook-lever 1, contact 5 8, alternate contact 17, contact 31 35, upper winding of relay 43 to ground. This energizes relay 43, which attracts its armatures, 45 causing the display of signal 47 at the distant end of the trunk, while armature 44 engages its contact to complete a circuit from ground through contact 40 42, relay 36, to battery. It is on the establishment of this locking-circuit that what I call the "unstable" or "inconstant" condition of magnetization of the relay 36—that existing while its armature is in its intermediate position or is vibrating (the term being used broadly to include both conditions)—is terminated by the armature being fully attracted and so held. The full attraction of the armature opens contact 41 42, and relay 23 and magnet 26 are deenergized. The operator at the distant end of the trunk will now respond to the display of the signal 47, thus illuminated by current from battery 71 flowing through said signal 47, the normal resting contact of relay 46 and the operated contact 45 of relay 43, to ground. The trunk C is provided with a spring-jack terminal *p*², adapted to receive the plug *p*², comprising contact members 102, 103, and 104, registering, respectively, with the jack contact members 48, 49, and 50. Upon the insertion of

the plug battery 71 is closed through relay 46, contact 50 104, to ground, thus operating said relay to extinguish the signal 47. The operator depresses levers 105 106, thus connecting her telephone set 107 in circuit with the calling subscriber, and receives his order or complaint, as the case may be. Since the circuit of relay 43 includes the line of substation A when the subscriber there replaces his receiver the relay 43 becomes deenergized, and its armatures are retracted, the retraction of armature 44 opening the locking-circuit of relay 36. The armature of relay 36 thus again assumes its intermediate position, closing contact 41 42 to again establish the circuit of relay 36 through relay 23. In case the resulting energization of 36 is insufficient to again break contact 41 42 the armature will remain without vibration in its intermediate position and relay 23 will be again energized. As, however, the circuit of the counter-magnet 26 is at this time broken at contact 20 of relay 19, (now inert,) no operation of the counter E will result. Should, however, the energization of relay 36 through relay 23 be sufficient to again open contact 41 42, its armature will continue to vibrate as previously described. In either case the circuit of relay 15 is maintained closed at contact 38 39, whereby the operator's disconnect-lamp 27 will be illuminated over the following circuit: battery 70, said signal 27, contact 92 of relay 90, and alternate contact 16 of relay 15. Relay 90 being included in a strand of the cord-circuit is preferably provided with a non-inductive shunt resistance 91, whereby little impedance will be presented to the conversational currents. The operator withdraws plugs *p* and *p'*, and all apparatus is restored to normal.

The relay 36 (shown in a preferred mechanical form in Figs. 2, 3, and 4) may comprise the core 76, about which is placed the customary winding or windings. An angular pole-piece 75 is provided, extending along the top of the relay, the angular armature 37 being hinged or supported upon the end of the pole-piece in the customary manner. In the said Figs. 2, 3, and 4 the reference characters correspond to those of Fig. 1, and the spring arrangement will be understood from inspection of the mechanical drawings in connection with the before-given description of the relay, as shown in Fig. 1. It will be observed that the construction and arrangement of springs are such that contact 38 39 will be closed upon the first movement of the armature 37 and that contact 41 42 can only be broken subsequent to the closure of 38 39 and by a further movement of the armature, whereby the said armature may be maintained in an intermediate position under the influence of the unstable magnetization, while contact 38 39 remains closed.

Fig. 5 shows an embodiment of my inven-

tion including motor-driven switch-contacts adapted to automatically select an idle circuit out of a plurality of similar circuits and display its signal-lamp 67. At M, I have illustrated the circuits of a switch including the starting-relay 52, controlling the operating-magnet 53, the stopping-relay 63, also controlling said magnet 53, the cut-off relay 64, and the release-relay 65, controlling the release-magnet 80, which latter is adapted when operated to cause the restoration of the switch wipers or contacts 55, 57, 59, and 61. These motor-driven switch-contacts 55, 57, 59, and 61 are fastened to a common shaft 54, to which also the ratchet 78 is fastened, so that successive current impulses to be sent by interrupter I through magnet 53 may by causing successive thrusts of the pawl attached to the end of armature 77 rotate the ratchet 78 step by step, carrying with it shaft 54 and its wipers or contacts 55, 57, 59, and 61. The ratchet 78 has a suitable spring attached to it, against whose tension it is rotated, the retaining and release pawl 79 engaging the ratchet-teeth to hold the ratchet after each step. When release-magnet 80 is energized, pawl 79, fastened to its armature, is withdrawn from the ratchet, and the spring restores the ratchet, shaft, and contacts to normal, stop 81 engaging the stud upon ratchet 78 and arresting the movement when normal is reached. The said stud upon ratchet 78, also in its normal position, engages a stud carried by the off-normal spring 82 to open its contact; but on the first movement of said ratchet the studs are disengaged, thus allowing said spring 82 to close its contact and maintain it closed until the ratchet is again restored to normal. Wipers 55, 57, 59, and 61 are adapted to engage and make contact with, respectively, the circularly-arranged contact-points 56, 58, 60, and 62. Contact-points 56^a, 58^a, 60^a, and 62^a represent similarly-arranged contacts of another switch similar to the one, M, shown in full. N represents the signaling apparatus associated with one set of contacts 56 56^a, 58 58^a, 60 60^a, and 62 62^a, it being understood that each of the similarly-designated sets of contact-points may be connected to a similar signal-receiving group of apparatus N, whereby any switch M (and consequently any calling-circuit 73^a 73, associated therewith) may select any signaling-circuit N, unless at that time said signaling-circuit be already in use or be already selected by some other switch M.

In operating the structure of Fig. 5 the manually-controlled switch 51 is shifted to connect conductors 73^a and 73, when current flows from battery 72, through starting-relay 52, relay 65, and resistance 65^a in parallel, over 73^a 73, and upper armature of relay 64, to ground, operating said relays 52 and 65, the attracted armature of 65 opening a contact in the circuit of release-magnet 80,

while the attracted armature of 52 completes circuit from battery 72, via armatures of relays 52 and 63, operating-magnet 53, constantly-rotating interrupter I, to ground. The current impulses thus passing through magnet 53 are effective to cause thrusts of the pawl of armature 77, moving contacts 55, 57, 59, and 61 step by step over their respective associated multiple contacts. Stopping-relay 63 is connected in circuit with testing-contact 55, which wipes over the private contacts 56, those associated with busy signaling-circuits N being open at contacts 41, because the relays 36 of such busy signaling-circuits are then operated as hereafter explained. Thus relay 63 will remain inert while the wiping-contacts are passing over multiple contacts of busy signaling-circuits; but as soon as they reach multiple contacts of an idle signaling-circuit (whose relay 36 will be unoperated) circuit will be completed from battery 72, through relay 63, contact 55 56, contact 41 42, right winding of relay 36 to ground. The two relays 63 and 36 will then be operated, and relay 36 in attracting armature 37 will produce an unstable condition of magnetization in itself similar to that described in connection with Fig. 1. The armature of relay 63, which has now disengaged its contact, opening the circuit of magnet 53 and stopping the switch, may now be vibrating; but its motion in such case will be insufficient to operatively engage its contact, which engagement would cause a stepping along of the switch. While the unstable condition of relay 36 persists, cut-off relay 64 is becoming operated by current flowing from battery 72 through closed contact 38 39, resistance 38^a, contact 58 57, relay 64 to ground, and as soon as that relay is energized current will flow from battery 72, lower winding of relay 66, contact 60 59, lower attracted armature of 64, conductors 73^a 73, upper attracted armature of 64, contact 61 62, upper winding of relay 66 to ground. Relay 66 is thus operated, its lower armature closing a locking-circuit from battery 72, said lower attracted armature of relay 66, left winding of relay 36, contact 40 42, right winding of said relay 36 to ground, fully operating the relay and terminating its unstable condition of magnetization. When this occurs, contact 41 42 is held continuously open, which deenergizes relay 63, the retraction of whose armature would cause further operation of magnet 53 were it not that relay 52 is at this time deenergized because of the attraction of the lower armature of relay 64. The upper attracted armature of relay 66 caused the display of the selected signal-lamp 67, which the attendant after properly noting or recording it may extinguish by the manually-operated switch 68. The resistance 38^a and those of the relays 64 of the various switches are so proportioned that if a

wiper-contact 57 of a second switch M engages a multiple 58^a of the contact 58 enough current will not flow through its relay 64, now in shunt of relay 64 of the Fig. 5 switch, to attract its armatures, although the relay 64 of the Fig. 5 switch will continue to hold its armatures attracted. For instance, with a battery of about thirty volts relay 64 may be of approximately one hundred ohms resistance and coil 38^a may have approximately seven hundred and fifty ohms resistance. When now switch 51 is shifted back to normal, circuit is opened through relay 65 and its armature is retracted to cause a flow of current from battery 72 through said armature, off-normal spring 82, release-magnet 80 to ground. Said magnet is thus energized to withdraw retaining-detent 79, and the switch M is restored to normal, as previously described, magnet 80 being deenergized, when the restoration is completed by the before-described shifting to normal of spring 82, all apparatus being thus restored.

Various modifications of my invention may be made without departing from its scope—as, for instance, the conductors leading to springs 40 and 42 might be permanently connected, the spring 40 being then employed for its mechanical function only—and it is accordingly not my intention to limit myself to the precise structures shown and described; but

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

1. An electrical relay structure including a relay having two energizing-paths, an armature therefor partially actuated on completion of the first energizing-path and held temporarily in an intermediate position until the second energizing-path is completed, a normally open switch-contact of said relay held closed by said armature in both its intermediate and fully-attracted positions, a second relay responsive to the closing of said contact adapted to subsequently complete the second energizing-path to fully attract said armature, and a normally closed switch-contact of said relay held continuously open by said armature in its fully-attracted position only.

2. An electrical relay structure including a relay, an armature therefor, a normally open switch-contact for said relay, a normally closed switch-contact adapted to be opened on attraction of said armature, an electrical circuit including said last-mentioned contact for initially energizing said relay to cause said armature to vibrate said last-mentioned contact while said first contact is maintained closed, and means controlled by said normally open contact when closed adapted to subsequently hold said armature continuously attracted.

3. An electrical relay structure including a relay, a normally open switch-contact con-

trolled by said relay, a second normally open switch-contact controlled by said relay, a normally closed switch-contact controlled by said relay, means including said last-mentioned contact for initially causing a continuing peculiar operation of said relay holding said first normally open contact closed while preventing a continuous holding of said normally closed contact open, and means operated by the closing of said first contact adapted to eventually establish a locking-current flow for said relay including said second normally open switch-contact, the establishing of said locking-flow effecting a different energizing of said relay to cause it to hold said normally closed contact open.

4. An electrical relay structure including a relay having two windings, an armature therefor, means including an external resistance and a source of current for causing a preliminary energization of one winding of said relay, a switch-contact of said relay adapted to limit said preliminary energization, and means automatically set in train of action by said preliminary energization to subsequently establish a path for current fully energizing said relay, said path including both windings of said relay and excluding said external resistance.

5. An electrical relay structure including a relay having two windings, an armature therefor, means including an external resistance and a source of current for causing a preliminary energization of one winding of said relay, a switch-contact of said relay adapted to limit said preliminary energization, and means automatically set in train of action by said preliminary energization to subsequently establish a path for current to energize said relay to hold its armature fully attracted.

6. In an electrical relay structure, the combination of a relay, an armature for said relay having an initial and subsequent motion, an electromagnet, means controlled by the initial motion to establish the circuit of said electromagnet, and means controlled by the energization of said electromagnet to cause the subsequent motion of said armature.

7. In an electrical relay structure, the combination of a relay, an armature for said relay having an initial and subsequent motion, an energizing-circuit for said relay to produce said initial motion, an electromagnet, means controlled by said initial motion to energize said electromagnet, means controlled by the said subsequent motion to interrupt said energizing-circuit, and means responsive to the energization of the electromagnet to cause the final motion of said armature.

8. In an electrical relay structure, the combination of a relay, an armature for said relay having an initial and subsequent motion, an energizing-circuit for said relay to produce said initial motion, an electromagnet, means

controlled by the initial motion to energize
said electromagnet, means controlled by the
subsequent motion to interrupt said energiz-
ing-circuit, and means controlled by said
5 electromagnet to complete a locking-circuit
and cause the said subsequent motion of said
armature.

In witness whereof I hereunto subscribe
my name this 2d day of February, 1907.

HARRY G. WEBSTER.

Witnesses:

L. D. KELLOGG,
F. W. DUNBAR.