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2,178,289

ELECTRICAL RELAY

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2 Sheets-Sheet 1

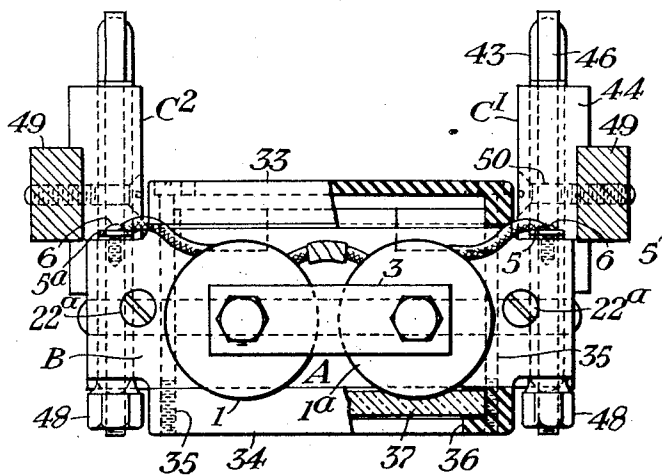


Fig. 3.

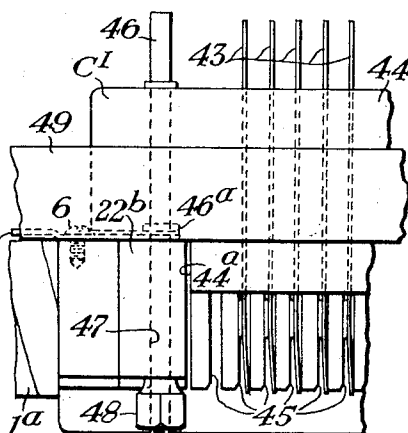


Fig. 4.

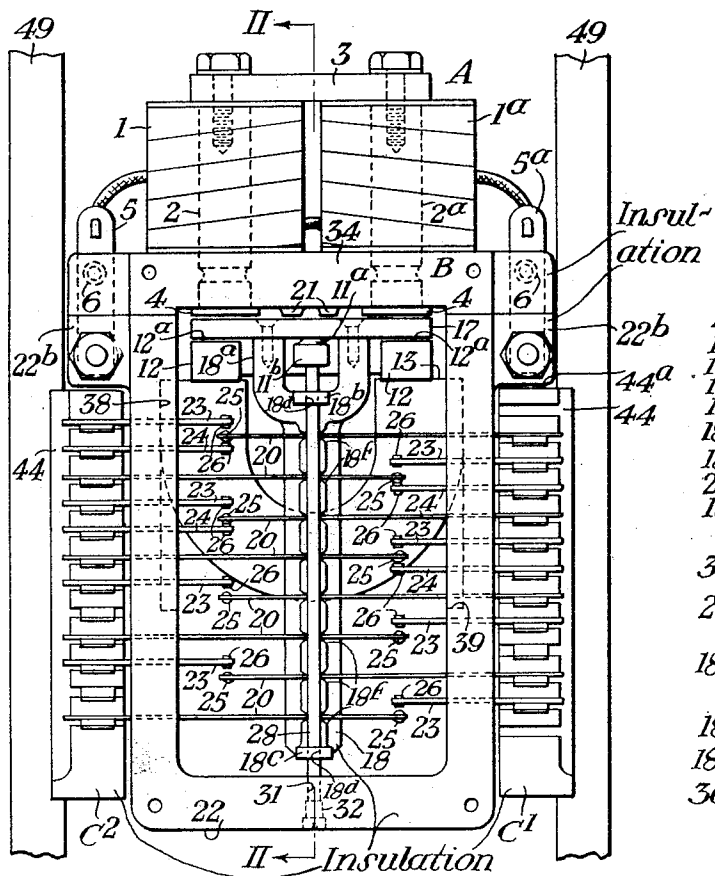


Fig. 1.

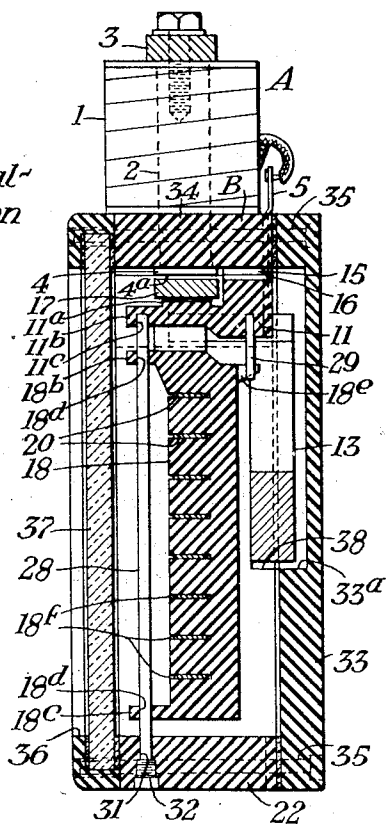


Fig. 2.

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UNITED STATES PATENT OFFICE

2,178,289

ELECTRICAL RELAY

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Application May 7, 1937, Serial No. 141,311

21 Claims. (Cl. 200—93)

My invention relates to electrical relays, and particularly to electrical relays suitable for use in centralized traffic controlling systems for railroads, such, for example, as that disclosed in an application for Letters Patent of the United States, Serial No. 31,592, filed by myself and others on July 16, 1935, for Remote control systems.

One object of my invention is to provide an improved relay of the type described of simple, rugged, and compact construction, which will operate without appreciable wear or change in operating characteristics over a long period of time and for a very large number of operations.

Another object of my invention is to provide a high speed relay of the type described which can be readily calibrated, and which will operate with sufficient predictable accuracy to permit it to function in timed sequence with a plurality of other similar relays operating on close marginal limits without special adjustment.

A further object of my invention is to provide a relay of the type described in which all of the operating parts and contacts are fully enclosed, but at the same time can be readily seen for purposes of inspection.

A further object of my invention is to provide a relay of the type described in which the contact assembly comprises a moulded unit which can be replaced, when the contacts become unfit for use, by a similar unit without altering the calibration of the relay.

A still further object of my invention is to provide a relay which lends itself to ready replacement with another relay when it becomes necessary to remove the relay from service for inspection or repair.

Other objects and characteristic features of my invention will appear as the description proceeds.

I shall describe one form of relay embodying my invention and one mounting means therefor, and shall then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a front elevational view showing one form of relay embodying my invention, the front plate of the relay being removed to better illustrate the construction of the operating parts of the relay.

Fig. 2 is a vertical sectional view of the relay shown in Fig. 1 taken substantially on the line II—II of Fig. 1. Fig. 3 is a top plan view of the relay shown in Fig. 1. Fig. 4 is a fragmentary right-hand side view of the relay shown in Fig. 3.

Fig. 5 is a back view, with the rear cover plate

removed, of the relay shown in Fig. 1. Fig. 6 is a top plan view of the bracket 16 and associated parts forming part of the relay illustrated in the preceding views. Fig. 7 is a bottom view of the top plate B of the relay as viewed in Fig. 5. Fig. 8 is a diagrammatic view showing by means of curves the operating characteristics of the relay illustrated in the preceding views.

Similar reference characters refer to similar parts in each of the views.

Referring to the drawings, the relay in the form here shown comprises an electromagnet A mounted on a top plate B of suitable insulating material, such for example, as a phenol condensation product. The electromagnet A is of the usual and well-known type, and comprises a pair of coils 1 and 1^a mounted on spaced parallel cores 2 and 2^a, the upper ends of which are connected together by a backstrap 3, and the lower ends of which extend downwardly through the top plate B and are provided on the underside of the top plate with enlarged pole pieces 4. The coils 1 and 1^a are connected in series between two coil connectors 5 and 5^a which are secured to the rear side of the top plate B adjacent its opposite ends by means of screws 6, and which extend downwardly past the lower side of the top plate for some distance and are provided adjacent their lower ends with holes 7 for a purpose which will appear hereinafter. The screws 6 extend through clearance holes in the coil connectors 5, and are screwed into threaded inserts moulded into the top plate B. The cores 2 and 2^a may be secured to the top plate B in any convenient manner, but as here shown, they are moulded into the top plate.

Secured to the underside of the top plate B adjacent the rear side thereof by means of screws 10 is an insulating supporting bracket 11 having moulded in, or otherwise secured to, its underside a pair of auxiliary pole pieces 12 (see Fig. 6). The pole pieces 12 extend forwardly toward the front of the relay, and are provided at their forward ends with ground upper surfaces 12^a which comprise pole faces, and which are disposed in spaced parallel relation with respect to the lower or pole faces 4^a of the pole pieces 4. The lower sides of the pole pieces 12 are also ground, and engage at their rear ends the ground upper ends of a U-shaped permanent magnet 13 which extends downwardly from these pole pieces. It will be seen, therefore, that the auxiliary pole pieces 12 are constantly magnetized. The screws 10 which fasten the bracket 11 to the top plate B extend through clearance holes in

the bracket, and are screwed at their upper ends into threaded inserts moulded into the top plate. In order to insure the proper vertically spaced relation between the two pairs of pole pieces, the underside of the top plate B is provided with a pair of laterally spaced depending bosses 15, the lower surfaces of which are accurately positioned with respect to the pole faces 4^a of the pole pieces 4, and the bracket 11 is provided with a pair of upstanding bosses 16 (see Figs. 2 and 5) which mate with the bosses 15, and the upper surfaces of which are accurately positioned with respect to the pole faces 12^a of the pole pieces 12. The positioning of the engaging surfaces of the bosses with respect to the associated pole pieces can usually be obtained with sufficient accuracy by the moulding of the parts, but these surfaces may, if desired, be ground after the moulding operation is completed.

Disposed between the two pairs of pole pieces 4 and 12 is a magnetizable armature 17. This armature is moulded onto or otherwise secured to the upper end of a contact operating member 18 of suitable insulating material, and is adapted to be moved vertically, in response to energization of the electromagnet A, from a lower position in which its lower surface engages a backstop 11^a formed on a forwardly projecting tongue 11^b comprising part of the bracket 11, to an upper position in which its upper surface engages a pair of spaced depending front stops 21 formed on the underside of the top plate. The contact operating member 18 is provided at its upper end with a yoke 18^a which straddles the tongue 11^b with sufficient clearance to permit the necessary vertical movement of the armature, and in its forward surface with a plurality of vertically spaced parallel slots 18^c which receive a plurality of vertically spaced superposed contact fingers 20 intermediate the ends of the fingers. The contact fingers 20 are moulded into the opposite legs of a U-shaped contact support 22 of suitable insulating material which is secured by means of screws 22^a to the underside of the top plate B, and the fingers are so disposed that alternate fingers are located in different legs and extend in opposite directions. Each of the flexible contact fingers 20 cooperates at its free end with an associated fixed front contact member 23 which is moulded into the leg of the contact support 22 opposite to the leg in which the finger is moulded, while the four upper contact fingers also each cooperate with an associated fixed back contact member 24 which is likewise moulded in the leg of the contact support 22 opposite to the leg in which the associated finger is moulded. To decrease contact resistance, the contact fingers are each provided with contact buttons 25 of low resistance conducting material such as silver, which contact buttons cooperate with contact buttons 26, also of low resistance conducting material such as silver, provided on the associated fixed contact members. The contact fingers and fixed contact members each extend through the associated legs of the contact support, and are provided with notched or pierced outer ends to facilitate making electrical connections with the fingers and fixed contact members. The screws 22^a which fasten the support 22 to the top plate B extend downwardly through clearance holes in the top plate, and are screwed into threaded inserts provided in the upper ends of the legs of the U-shaped contact support.

In order to permit free straight line vertical movement of the armature and contact operating

member, and at the same time insure that the parts will remain in the proper operative relation, the contact operating member 18 is provided on its forward side with vertically spaced lugs 18^b and 18^c having aligned openings 18^d which slidably receive a vertical guide rod 28, and on its rear side with a slotted lug 18^e which slidably receives a depending guide pin 29 moulded into the bracket 11. The guide rod 28 is mounted at its upper end in an opening 11^c provided in the underside of the tongue 11^b of the bracket 11, and at its lower end in an opening 31 which is provided in the lower end of the U-shaped support 18. The guide rod 28, after being inserted into the openings 11^c and 31, is held in place in these openings by means of a screw plug 32 which is screwed into the lower end of the opening 31. To reduce friction and wear to a minimum, the guide rod 28 and the pin 29 will preferably be provided with smooth polished surfaces.

The relay also comprises a back cover plate 33 and a front cover plate 34. These cover plates are clamped against the rear and front sides, respectively, of the top plate B and the U-shaped contact support 18 by means of four screws 35, and form with the top plate and the support 22 a case which encloses all of the operating parts of the relay. The two upper screws 35 pass through clearance holes provided in the back cover plate and in the top plate B, and are screwed into threaded inserts moulded into the front cover plate, while the two lower screws 35 pass through clearance holes provided in the back cover plate and in the contact support 22 and are screwed into threaded inserts moulded into the front plate. In order to permit ready inspection of the operating parts of the relay without the necessity for removing the cover plates, the front cover plate is formed with a window 36 which is closed by a window glass 37. The back cover plate 33 is provided in its forward face with a recess 33^a the opposite sides of which align with recesses 38 and 39 formed in the legs of the support 22, and this recess cooperates with the recesses 38 and 39 to insure that the permanent magnet 13 will remain in proper operative relation with respect to the auxiliary pole pieces 12 when the back cover plate is in place on the relay.

The operation of the relay as a whole is as follows: The parts are so proportioned that, when the armature 17 is approximately midway between the front and back stops, the flexible contact fingers 20 will be substantially unflexed, and the contact buttons 25 on these fingers will be approximately midway between the contact buttons 26 provided on the cooperating front contact members 23 and back contact members 24. The parts are further so proportioned that, when the electromagnet A is deenergized, the flux from the permanent magnet traversing the auxiliary pole pieces 12 and the armature 17, together with the weight of the armature and the contact operating member 18, will exert a sufficient biasing force of the armature to pull it downwardly to the position in which it engages the backstop 11^a, and that before the armature has been fully moved to the position in which it engages the backstop 11^a, the contact buttons 25 on each of the flexible contact fingers which cooperates with a fixed back contact member will move into engagement with the contact button 26 on the associated fixed back contact member. It will be seen, therefore, that the movement of the armature to its lowermost position will cause the centers of

those fingers which cooperate with back contact members to become bowed downwardly at the points where they are engaged by the operating member 18, thereby producing a limited amount of wiping action between the engaging contact buttons on the flexible contact fingers and the back contact members as the armature moves to its lowermost position, and hence insuring that, when the armature occupies its lowermost position, the contact buttons on the fingers will engage the contact buttons on the associated fixed back contact members with sufficient pressure to provide an effective low resistance contact. The downward movement of the armature will cause each of the flexible contact fingers which does not cooperate with a fixed back contact member to continue to move downwardly at its free end until the armature reaches its lower extreme position. It will be seen therefore from the foregoing that, when the permanent magnet 13 is in place and the parts are properly adjusted, if the electromagnet A is deenergized, the front contacts 20-23 of the relay will be open and the back contacts 28-24 will be closed.

When the electromagnet A becomes energized, flux will be forced through the electromagnet cores 2 and 2a, the pole pieces 4, and the armature 17, and the parts are so proportioned that this flux will cause the armature 17 to move upwardly in opposition to the bias of the permanent magnet and the weight of the armature and the contact operating member 18 to its upper extreme position in which it engages the frontstops 21. This upward movement will cause the contact buttons 25 on the flexible contact fingers to move out of engagement with the contact buttons 26 on the back contact members and into engagement with the contact buttons 26 on the front contact members, thereby opening the back contacts 28-24 and closing the front contacts 20-23. The parts are further so proportioned that the contact buttons 25 on the flexible contact fingers will move into engagement with the contact buttons 26 on the front contact members before the armature 17 reaches its upper extreme position, and it will be seen, therefore, that the movement of the armature to its upper extreme position will cause the flexible contact fingers 25 to become bowed upwardly intermediate their ends, and will thus cause a limited amount of wiping action between the contact buttons 25 and the front contact buttons 26 as the armature completes its upward movement, as well as insuring a good contact pressure to provide an effective low resistance contact.

It should be noted that with the relay constructed in the manner just described, the flexible contact fingers and associated fixed front and back contact members can be moulded into the contact support 22 with sufficient accuracy so that very little, if any, bending of these parts is required to obtain the proper contact adjustments, and that, as a result, there is substantially no tendency for the contact fingers and contact members to warp due to these contact members and contact fingers having been given sets in the process of manufacture. Furthermore, there are no "built-up" contact spring assemblies which might warp or shrink in service, nor are there any insulating bushings of any kind to break down and cause timing variations or circuit failures. The front and back contact members are relatively short and rigid so that there is little chance for these parts to warp, and if they should warp, the change in the positions of the

contact buttons secured thereto will be so small that the contact adjustment of the relay will not be materially affected thereby. The flexible contact members are held in fixed positions intermediate their ends by the operating member 18 in such manner that these fingers are prevented from warping between their free ends and the contact operating member, and the portion of the free ends of these fingers which projects beyond the contact operating member is relatively short so that, if this portion of the finger should become warped, the change in the position of the associated contact buttons would also be so small that it would produce practically no effect on the contact adjustment of the relay. In addition, the adjustment of any one contact is not dependent upon the adjustment of any other contact, so that, if one of the contacts should get out of adjustment, it will not affect the adjustment of any of the other contacts. Due to the fact that all of the forces involved in actuating the contacts are in a plane, there are no bearing surfaces which carry any heavy loads except the front and back stops for the armature, and the areas and materials of these stops are so chosen as to minimize wear. The guide lugs 18^b, 18^c, and 18^e of the contact operating member 18 do not transmit any forces except any small forces which might exist due to unbalances in the magnetic circuits or defective mechanical adjustments. The forces transmitted by the slots 18^f of the contact operating member 18 are small because each bearing surface of these slots transmits only the force which is necessary to actuate the associated contact finger in one direction, and the contact fingers have no initial sets to compress the back contacts. Also, there are no parts which can become loosened due to vibration and affect relay operation, nor are there any metal to metal surfaces between the armature and its supporting means which might become fused due to discharges of lightning, and thus impair or completely prevent the operation of the relay.

In a relay of the type described, it is essential to eliminate contact bounce in so far as it is possible to do so because, when a pair of contacts bounce, that is, vibrate with respect to each other when they are making contact, the circuit which they are controlling is interrupted many times in rapid succession, which causes delay in the operation of the circuit being controlled. The elimination of contact bounce also minimizes the burning of the contacts due to sparking. It has been determined by tests that the contacts of a relay constructed in accordance with my invention bounce very much less than the contacts of relays heretofore employed for a similar purpose. One reason for this is that the back contact members, due to their relatively short lengths, are too rigid to vibrate, and any vibration of the contact buttons with respect to each other must come from the flexible contact fingers, which fingers are supported intermediate their ends in such a way as to break up their lengths into two sections which tends to dampen vibration. Also, the forces involved in picking up and releasing the relay are nearly balanced so that the forces tending to move the armature are not much greater than the forces tending to retard motion, so that the contacts do not come together with so sharp a blow. This fact can be better understood by reference to the curves shown in Fig. 8. Referring to Fig. 8, the curve *a* represents the force that the armature must

exert to compress the contacts as well as the force which the flexible contact fingers exert on the armature as they are compressed. The portion of the curve below the stroke axis represents the back contact compression, and the part above the stroke axis represents the front contact compression. Curve *e* represents the force which the permanent magnet exerts on the armature in order to move the armature to its lowermost position. Curve *c* represents the combination force exerted by the springs and permanent magnet and is the force which the electro-magnet *A* must exert on the armature 17 to pick up the relay. Curve *d* represents the force which the electromagnet *A* actually exerts on the armature 17 when the coils 1 and 1^a are supplied with a current which is just equal to the pick-up current for the relay. The difference between the curves *d* and *c* is the force tending to move the armature provided the current in the coils 1 and 1^a remains constant. The fact that, during the normal operation of the relay, the coils 1 and 1^a are supplied with the full operating current causes the current to increase until the normal operating current is reached, but this current is retarded during the motion of the armature due to the counterelectromotive force set up by the motion of the armature. It has been determined by oscillograms that the current flowing in the coils 1 and 1^a is approximately equal to the pick-up current during the motion of the armature, so that the difference between curves *d* and *c* approximately represents the accelerating force of the armature during the motion of the armature. It will be seen, therefore, that it is possible to control the accelerating force by controlling the shape of the curve *d*. This is done in the present case by controlling the cross-sectional area of the core structure of the electromagnet and the area of the pole pieces. In this way the bounce is minimized when the relay picks up.

It should be particularly pointed out that, while the relay as shown is provided with eight front contacts and four back contacts, my invention is not limited to this particular contact combination, and any other contact combination may be provided which is necessary for any particular operating condition.

As has been pointed out hereinbefore, a relay embodying my invention is intended for use in centralized traffic controlling systems for railroads wherein large numbers of relays are employed, and it is necessary, in order to avoid traffic delays, to be able to quickly remove any relay from service and replace it with another relay. To permit this to be done with relays embodying my invention, I provide a pair of relay connectors C¹ and C², one for making connection with the outer ends of the flexible contact fingers and fixed contact members of the relay on each side of the relay. These connectors are similar, except for the fact that one is a right-hand connector and the other a left-hand connector, and it is believed, therefore, that a description of one connector will suffice for both. Referring to the connector C¹ shown in Figs. 1, 3, and 4, this connector comprises a plurality of conducting strips 43 moulded into a block 44 of insulating material in vertically spaced parallel relation. The strips 43 extend through the block 44 from the front end thereof to the back end, and have their front ends disposed in parallel slots 45 which are spaced apart the same distance as the outer ends of the contact fingers and fixed contact members of the relay, and which are of such height

vertically that the fixed contact members and contact fingers can be slipped into these slots above the ends of the conducting strips 43 with a sliding fit. To facilitate slipping the contact fingers and fixed contact members into place above the strips, the portions of the conducting strips which are disposed in the slots 45 are curved upwardly and then downwardly in such manner that the forward ends of the strips bear against the bottom of the slots with some tension. With this arrangement when the fingers and fixed contact members are slipped into place in the slots 45 the bowed portions of the conducting strips become flattened somewhat, thus insuring a good contact between the fingers and the associated strips. The upper end of the connector C¹ is provided at its forward side with a notch 44^a which when the connector is in proper operative relation with respect to the relay, receives the projecting end of the top plate and a laterally projecting portion 22^b which is formed on the contact support 22 below the top plate. Moulded into the upper part of the connector at the rear side of this notch is a round post 46 which projects forwardly through the previously described hole 7 in the coil connector 5 and an aligned hole 47 formed in the laterally projecting portion 22^b, and is provided at its forward end with the threaded portion for the reception of a nut 48 by means of which the relay and connector may be secured in proper operative relation. The post 46 is also provided at the forward side of the connector with a shoulder 46^a which cooperates with the rear face of the coil connector 5 in such manner that, when the nut 48 is tightened, the shoulder 46^a will be forced into contact with the connector 5 with considerable pressure, thus insuring good electrical contact between the post 46 and the coil connector 5. The rear end of the post 46 extends beyond the rear face of the block for some distance to enable a circuit wire to be soldered thereto. The outer surface of the connector is provided with a vertical groove for the reception of a mounting bracket 49, to which the connector is adapted to be secured by means of suitable screws 50.

In use, the two relay connectors C¹ and C² are secured to two of the mounting brackets 49 directly opposite each other, these mounting brackets being spaced apart the proper distance to permit a relay to be slipped into operative engagement with the connectors. The circuit wires are then permanently secured to the rearwardly projecting portions of the strips 43 and the post 46. The relay is then slipped into operative relation with respect to the connectors and is locked in place by means of the nuts 48. When it becomes necessary to replace a relay, the nuts 48 are removed and the relay is slid outwardly out of operative engagement with the connectors and a new relay is slid into place, after which the nuts 48 are again tightened. It will be seen, therefore, that with the relay constructed in accordance with my invention, and cooperating with connectors embodying my invention, in the manner shown in Figs. 1 and 3 the relay may be quickly removed and replaced with a similar relay, thus insuring minimum traffic delays. It will also be seen that the connectors serve not only as a means for providing electrical connection with, but also as a convenient means for supporting, a relay in a manner which permits a large number of relays to be conveniently mounted in a relatively small space.

Although I have herein shown and described 75

only one form of relay and one form of connectors embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and
5 scope of my invention.

Having thus described my invention, what I claim is:

1. An electrical relay comprising an insulating
10 top plate, an electromagnet mounted on said top plate and including a pair of pole pieces which are disposed on the underside of said top plate, a pair of constantly magnetized pole pieces secured to the underside of said top plate and disposed
15 in spaced parallel relation with respect to the pole pieces of said electromagnet, an armature slidably supported for straight line movement between said two pairs of pole pieces, an insulating member secured to said top plate and having
20 moulded therein movable contact fingers and fixed contact fingers which cooperate with said movable contact fingers, and means for operatively connecting said movable contact fingers with said armature.

2. An electrical relay comprising an insulating
25 top plate, an electromagnet mounted on said top plate and including a pair of pole pieces which are disposed on the underside of said top plate, a pair of constantly magnetized pole pieces secured to the underside of said top plate and disposed
30 in spaced parallel relation with respect to the pole pieces of said electromagnet, an armature slidably supported for straight line movement between said two pairs of pole pieces, an
35 insulating member secured to said top plate and having moulded therein in superposed relation cooperating movable contact fingers and fixed contact members, and means for actuating said movable contact fingers connected with said
40 fingers and with said armature.

3. An electrical relay comprising an armature, a contact operating member secured to said armature and comprising means for slidably supporting said armature for straight line movement
45 between two extreme positions, means including a permanent magnet for normally biasing said armature to one extreme position, electromagnetic means effective when energized for moving said armature to its other extreme position, a plurality of flexible contact fingers rigidly
50 supported at one end and operatively connected intermediate their ends with said contact operating member, and fixed contact members cooperating with said fingers at their free ends.

4. An electrical relay comprising an insulating
55 top plate, a pair of parallel cores mounted in said top plate and provided on the underside of said top plate with a first pair of pole pieces, a backstrap connecting said cores at their upper
60 ends, windings mounted on said cores, a second pair of pole pieces secured to the underside of said top plate in parallel spaced relation with respect to the pole pieces of said first pair, a permanent magnet for magnetizing the pole pieces
65 of said second pair, an armature slidably supported for straight line movement between said two pairs of pole pieces, a contact supporting member secured to said top plate, cooperating movable contact fingers and fixed contact members
70 moulded in said contact supporting member, and means secured to said armature and engaging said movable contact fingers intermediate their ends for actuating said movable contact fingers into and out of engagement with said
75 fixed contact members to open and close contacts

in response to the movement of said armature between said two pairs of pole pieces.

5. In an electrical relay, the combination with an armature, of a contact operating member secured to said armature and comprising means for slidably supporting said armature for straight
5 line movement between two extreme positions, said contact operating member being provided with a plurality of spaced slots, a plurality of flexible contact fingers rigidly supported at one
10 end and fitting in said slots intermediate their ends in such manner that said fingers are unstressed when said armature is approximately midway between its two extreme positions, and fixed contact members cooperating with said
15 fixed contact fingers at their free ends to form contacts which are operated by the movement of said armature between its two extreme positions.

6. In an electrical relay, the combination with
20 an armature, of a contact operating member secured to said armature and comprising means for slidably supporting said armature for straight line movement between two extreme positions, said contact operating member being provided
25 with a plurality of spaced slots, a plurality of flexible contact fingers rigidly supported at one end and fitting in said slots intermediate their ends in such manner that said fingers are unflexed when said armature is approximately mid-
30 way between its two extreme positions, and front and back contact members cooperating with said flexible contact fingers at their free ends in such manner that when said armature is moved to its
35 one extreme position said flexible contact finger will engage said front contact members but that when said armature is moved to its other extreme position said flexible contact finger will engage said back contact members.

7. An electrical relay comprising an insulating
40 top plate, an electromagnet mounted on said top plate and including a pair of pole pieces which are disposed on the underside of said top plate, a pair of constantly magnetized pole pieces secured to the underside of said top plate and disposed
45 in spaced parallel relation with respect to the pole pieces of said electromagnet, a U-shaped contact support secured to the underside of said top plate and having moulded in the legs thereof in superposed relation movable contact fingers
50 and cooperating fixed contact members, a contact operating member slidably supported for vertical movement and provided with slots which receive said fingers, an armature secured to said contact operating member and disposed between
55 said two pairs of pole pieces, a back plate clamped against the rear side of said top plate and said contact support, and a front plate clamped against the front side of said top plate and said contact support and provided with a window closed by a
60 window glass through which the operating parts of said relay may be viewed.

8. An electrical relay comprising an insulating
top plate, an electromagnet mounted on said top plate and provided on the underside of said top
65 plate with a pair of pole pieces, a pair of constantly magnetized pole pieces secured to the underside of said top plate and provided with pole faces disposed in spaced parallel relation with respect to the pole faces of the pole pieces of said
70 electromagnet, an armature slidably supported for straight line movement between said two pairs of pole pieces, a contact operating member secured to said armature and comprising part of the means for slidably supporting said armature, 75

said contact operating means being provided with a plurality of spaced slots, an insulating contact supporting member secured to the underside of said top plate and having moulded therein a plurality of flexible contact fingers which are rigidly supported at their ends in said member and which fit in said slots intermediate their ends in such manner that said fingers are unflexed when said armature is approximately midway between said two pairs of pole pieces, and fixed contact members moulded in said insulating contact supporting member and cooperating with the free ends of said flexible contact fingers.

9. An electrical relay comprising an insulating top plate, a pair of parallel cores mounted in said top plate and provided on the underside of said top plate with a first pair of pole pieces, a backstrap connecting said cores at their upper ends, windings mounted on said cores, a second pair of pole pieces secured to the underside of said top plate and disposed with their pole faces in parallel spaced relation with respect to the pole faces of said first pair, means for magnetizing said second pair of pole pieces, an armature slidably supported for straight line movement between said two pairs of pole pieces, a U-shaped insulating contact supporting member secured to the underside of said top plate and having moulded therein flexible contact fingers and fixed contact members the outer ends of which project through the legs of said supporting member to facilitate making electrical contact therewith and the inner ends of which cooperate with each other to form contacts, means secured to said armature and connected with said flexible contact fingers intermediate their ends for actuating said flexible contact fingers, a back plate secured to one side of said top plate and one side of said contact supporting member, and a front plate including a transparent member secured to the other side of said top plate and the other side of said contact supporting member, whereby the contacts and all of the movable parts of said relay are enclosed within the case formed by said top plate, said U-shaped contact supporting member and said front and back plates but are open to inspection through said transparent member.

10. An electrical relay comprising an insulating top plate, a pair of parallel cores mounted in said top plate and provided on the underside of said top plate with a first pair of pole pieces, a backstrap connecting said cores at their upper ends, windings mounted on said cores, a second pair of pole pieces secured to the underside of said top plate and disposed with their pole faces in parallel spaced relation with respect to the pole faces of said first pair, means for magnetizing said second pair of pole pieces, an armature slidably supported for straight line movement between said two pairs of pole pieces, a contact operating member secured to said armature and forming part of the means for slidably supporting said armature, said contact operating member being provided with a plurality of vertically spaced slots, a plurality of flexible contact fingers rigidly supported at one end and fitting in said slots intermediate their ends in such manner that said fingers are unflexed when said armature is approximately midway between said two pairs of pole pieces, and front and back contact members cooperating with said flexible contact fingers at their free ends in such manner that when said armature is moved toward the pole pieces of said first pair said flexible contact fingers will engage said front contact members but that when

said armature is moved toward the pole pieces of said second pair said flexible contact fingers will engage said back contact member.

11. An electrical relay comprising a top plate, an electromagnet mounted on said top plate and provided on the underside of said top plate with a first pair of pole pieces, a second pair of pole pieces secured to the underside of said top plate and disposed with their pole faces in spaced parallel relation with respect to the pole faces of said first pair, a U-shaped member of moulded insulating material having opposed recesses formed in the rear side thereof, a permanent magnet fitting in said recesses and having its ends connected with the pole pieces of said second pair, a back plate clamped against the rear side of said top plate and said U-shaped member and having in its inner face a recess which partly receives said permanent magnet and which assists in holding said permanent magnet in place, a combined contact operating and armature supporting member slidably supported between the legs of said U-shaped member and provided at its upper end with an armature which cooperates with said two pairs of pole pieces to move said contact operating member to one extreme position or another according as said electromagnet is energized or deenergized, flexible contact fingers moulded in the legs of said U-shaped member in superposed relation in such manner that alternate fingers are disposed in different legs and are operatively connected intermediate their ends with said contact operating member, fixed contact members moulded in the legs of said U-shaped member and cooperating with said flexible contact fingers, said fixed contact member and movable contact fingers being provided with portions which project through the associated legs of said U-shaped member to provide means for making electrical connections with said contact fingers and said contact members, and a front plate clamped against the front side of said top plate and said U-shaped member and including a transparent member through which said armature and the contacts of said relay may be viewed.

12. An electrical relay comprising a top plate, an electromagnet mounted on said top plate and provided on the underside of said top plate with a first pair of pole pieces, a second pair of pole pieces secured to the underside of said top plate and disposed with their pole faces in spaced parallel relation with respect to the pole faces of said first pair, a U-shaped member of moulded insulating material having opposed recesses formed in the rear side thereof, a permanent magnet fitting in said recesses and having its ends connected with the pole pieces of said second pair, a back plate clamped against the rear side of said top plate and said U-shaped member and having in its inner face a recess which partly receives said permanent magnet and which assists in holding said permanent magnet in place, a combined contact operating and armature supporting member slidably supported between the legs of said U-shaped member and provided at its upper end with an armature which cooperates with said two pairs of pole pieces to move said contact operating member to one extreme position or another according as said electromagnet is energized or deenergized, co-operating fixed contact members and flexible contact fingers moulded in the opposite legs of said U-shaped member, said flexible contact fingers being operatively connected intermediate their ends with said contact operating member, 75

and a front plate clamped against the front side of said top plate and said U-shaped member and including a window glass through which the operating parts of said relay may be viewed.

13. An electrical relay comprising a moulded top plate of insulating material, an electromagnet having its cores moulded into said top plate and provided on the underside of said top plate with a pair of pole pieces, a bracket of moulded insulating material secured to the underside of said top plate, a pair of auxiliary pole pieces moulded into said bracket and provided with pole faces which are adapted to be disposed in spaced parallel relation with respect to the pole faces of the pole pieces of said electromagnet, said top plate being provided on its underside with integral depending bosses having faces which are accurately positioned with respect to the pole faces of the electromagnet pole pieces and said bracket having integral upstanding bosses which engage the bosses on said top plate and the faces of which are accurately positioned with respect to the pole faces of said permanent magnet cores, whereby when the cooperating faces of said bosses are engaging each other an accurate spacing is provided between said two pairs of pole pieces, means for magnetizing said auxiliary pole pieces, an armature mounted for straight line movement between said two pairs of pole pieces, front stops moulded on the underside of said top plate for limiting the movement of said armature toward the pole piece of said electromagnet, and a backstop provided on said bracket to limit the movement of said armature toward said auxiliary pole pieces.

14. An electrical relay comprising a moulded top plate of insulating material, an electromagnet having its cores moulded into said top plate and provided on the underside of said top plate with a pair of pole pieces, a bracket of moulded insulating material secured to the underside of said top plate, a pair of auxiliary pole pieces moulded into said bracket and provided with pole faces which are adapted to be disposed in spaced parallel relation with respect to the pole faces of the pole pieces of said electromagnet, said top plate being provided on its underside with integral depending bosses having faces which are accurately positioned with respect to the pole faces of the electromagnet pole pieces and said bracket having integral upstanding bosses which engage the bosses on said top plate and the faces of which are accurately positioned with respect to the pole faces of said permanent magnet cores, whereby when the cooperating faces of said bosses are engaging each other an accurate spacing is provided between said two pairs of pole pieces, means for magnetizing said auxiliary pole pieces, and an armature mounted for straight line movement between said two pairs of pole pieces.

15. An electrical relay comprising a moulded top plate of insulating material, an electromagnet having its cores moulded into said top plate and provided on the underside of said top plate with a pair of pole pieces, a bracket of moulded insulating material secured to the underside of said top plate, a pair of auxiliary pole pieces moulded into said bracket and provided with pole faces which are adapted to be disposed in spaced parallel relation with respect to the pole faces of the pole pieces of said electromagnet, said top plate being provided on its underside with integral depending bosses having faces which are accurately positioned with respect to the pole

faces of the electromagnet pole pieces and said bracket having integral upstanding bosses which engage the bosses on said top plate and the faces of which are accurately positioned with respect to the pole faces of said permanent magnet cores, whereby when the cooperating faces of said bosses are engaging each other an accurate spacing is provided between said two pairs of pole pieces, means for magnetizing said auxiliary pole pieces, an armature mounted for straight line movement between said two pairs of pole pieces, and contacts controlled by said armature.

16. An electrical relay comprising an insulating top plate, an electromagnet mounted on said top plate and provided on the underside of said top plate with a pair of pole pieces, an insulating bracket secured to the underside of said top plate and provided with a depending guide pin and with a tongue, a pair of auxiliary pole pieces secured to said bracket on opposite sides of said tongue and provided with pole faces disposed in spaced parallel relation with respect to the pole faces of the pole pieces of said electromagnet, means for magnetizing said auxiliary pole pieces, a U-shaped member secured to the underside of said top plate, a guide rod extending parallel to said guide pin and mounted at its upper end in said tongue and at its lower end in said U-shaped member, a contact operating member provided with a yoke which straddles said tongue with clearance between said auxiliary pole pieces and with a pair of spaced lugs having aligned openings which slidably receive said guide rod and with a slotted lug which slidably receives said guide pin, and an armature secured intermediate its ends to the yoke of said contact operating member and having its ends disposed between said two pairs of pole pieces.

17. An electrical relay comprising a U-shaped contact support having a plurality of superposed flexible contact fingers moulded in its opposite legs in parallel spaced relation in such manner that alternate fingers extend in opposite directions, fixed contact members moulded in the legs of said support and cooperating with said fingers at their free ends, a guide rod extending at right angles to said fingers in spaced relation thereto intermediate the legs of said support, a guide pin extending parallel to said rod on the opposite side of said fingers from said rod, a contact operating member of insulating material provided with spaced slots which receive said contact fingers intermediate their ends and with a pair of spaced lugs having aligned apertures which slidably receive said guide rod and with a slotted lug which slidably receives said guide pin, whereby said operating member is guided to move in directions to open and close the contacts formed by said fingers and said fixed contact members, and electromagnetic means for actuating said operating member between its contact operating positions.

18. An electrical relay comprising a U-shaped contact support having a plurality of superposed flexible contact fingers moulded in its opposite legs in parallel spaced relation in such manner that alternate fingers extend in opposite directions, fixed contact members moulded in the legs of said support and cooperating with said fingers at their free ends, a guide rod extending at right angles to said fingers in spaced relation thereto intermediate the legs of said support, a guide pin extending parallel to said rod on the opposite side of said fingers from said rod, a contact operating member of insulating material provided

with spaced slots which receive said contact fingers intermediate their ends and with a pair of spaced lugs having aligned apertures which slidably receive said guide rod and with a slotted lug which slidably receives said guide pin, whereby said operating member is guided to move in directions to open and close the contacts formed by said fingers and said fixed contact members, means including an armature secured to said operating member and a permanent magnet cooperating with said armature for biasing said operating member to one contact operating position, and means including said armature and an electromagnet cooperating with said armature for moving said operating member in opposition to the bias of said permanent magnet to another contact operating position.

19. An electrical relay comprising a U-shaped contact support having a plurality of superposed flexible contact fingers moulded in its opposite legs in parallel spaced relation in such manner that alternate fingers extend in opposite directions, fixed contact members moulded in the legs of said support and cooperating with said fingers at their free ends, a guide rod extending at right angles to said fingers in spaced relation thereto intermediate the legs of said support, a guide pin extending parallel to said rod on the opposite side of said fingers from said rod, a contact operating member of insulating material provided with spaced slots which receive said contact fingers intermediate their ends and with a pair of spaced lugs having aligned apertures which slidably receive said guide rod and with a slotted lug which slidably receives said guide pin, whereby said operating member is guided to move in directions to open and close the con-

tacts formed by said fingers and said fixed contact members, an armature secured to said contact operating member, and means including an electromagnet and a permanent magnet mounted on a top plate secured to the upper end of said U-shaped bracket and cooperating with said armature for moving said contact operating member between two contact operating positions.

20. An electrical relay comprising a U-shaped contact support having a plurality of superposed flexible contact fingers moulded in its opposite legs in parallel spaced relation in such manner that alternate fingers extend in opposite directions, fixed contact members moulded in the legs of said support and cooperating with said fingers at their free ends, a contact operating member provided with slots which receive said flexible contact fingers intermediate their ends, means including a guide rod and a guide pin cooperating with lugs on said operating member for limiting the movement of said operating member to longitudinal sliding movement, and electromagnetic means for actuating said contact operating member.

21. Switching means comprising a U-shaped insulating contact support having a plurality of flexible contact fingers moulded in its opposite legs in parallel spaced relation in such manner that alternate fingers extend in opposite directions, fixed contact members moulded in the legs of said support and cooperating with said fingers at their free ends, and operating means for said flexible fingers comprising an insulating member slidably supported for straight line movement and provided with slots which receive said flexible fingers intermediate their ends.

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