Oct. 11, 1949. G. M. STAPLETON 2,484,358

RELAY

Filed Dec. 22, 1945 2 Sheets-Sheet 1

Fig. 2.

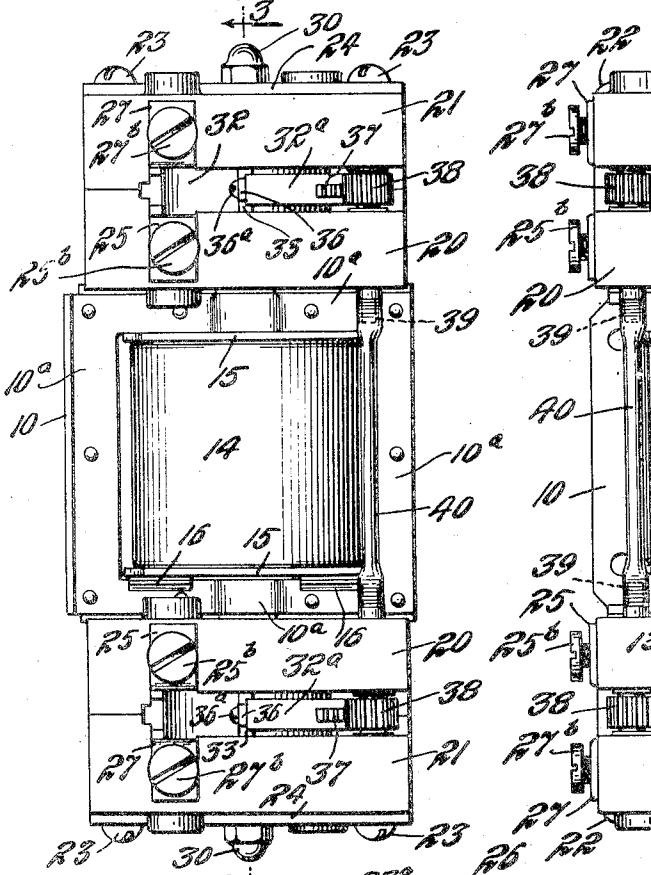
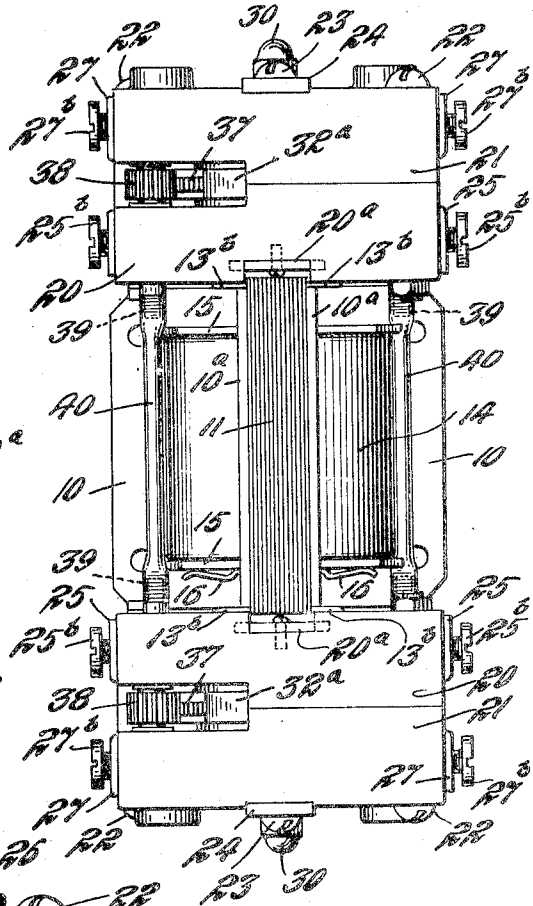


Fig. 1.



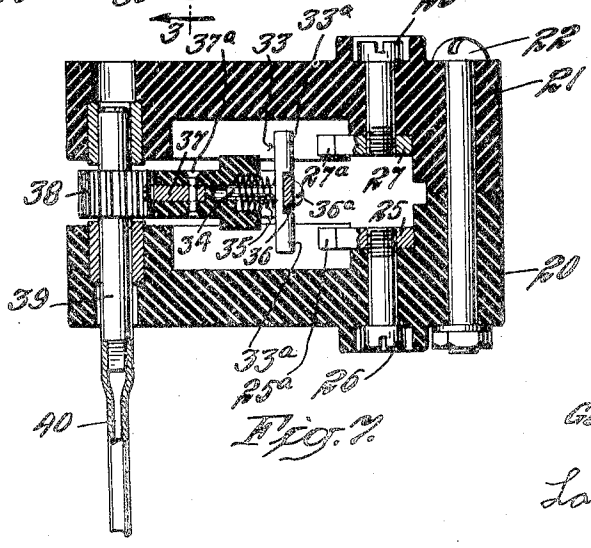


Fig. 3.

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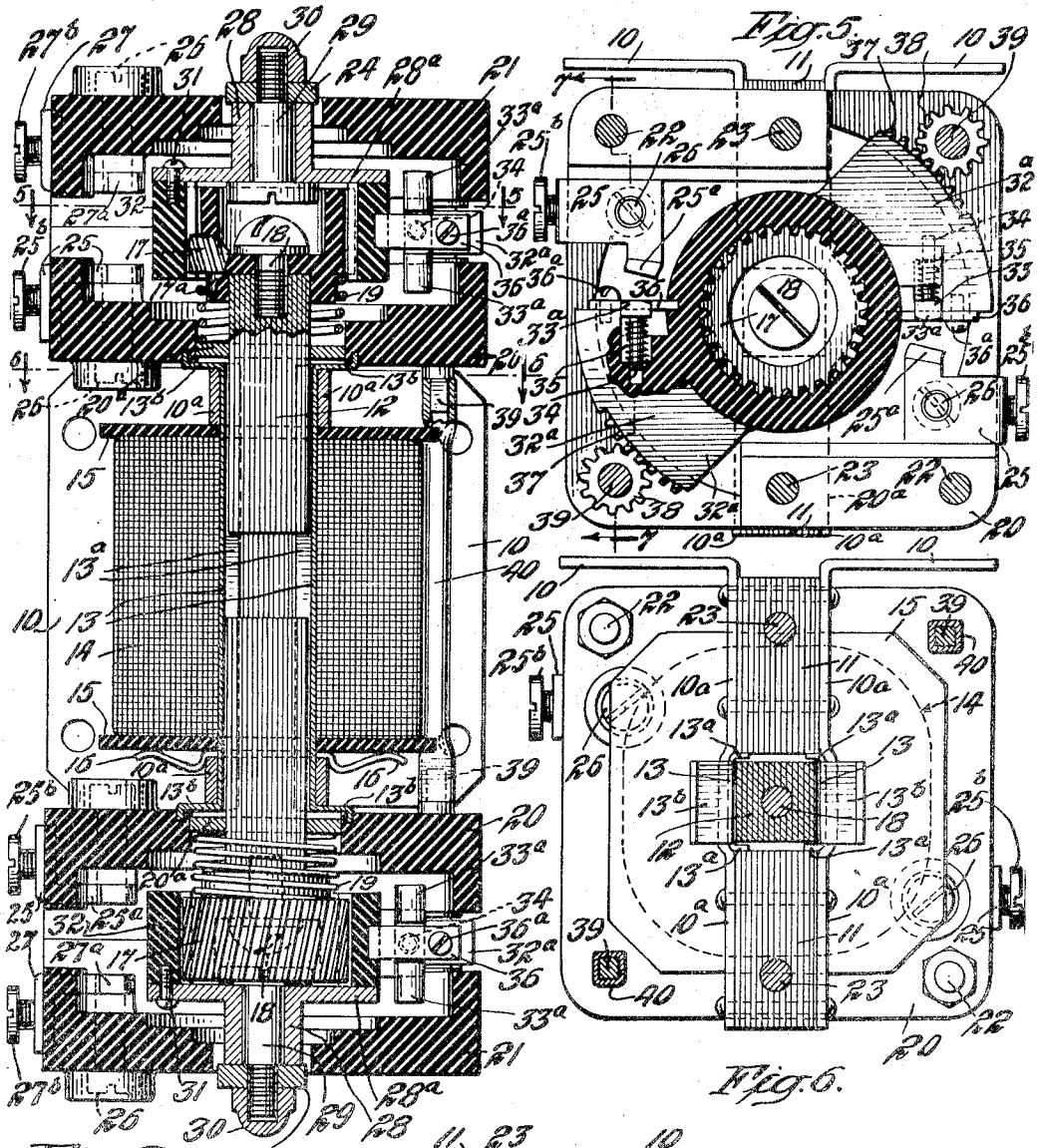


Fig. 3.



Fig. 5.



Fig. 6.

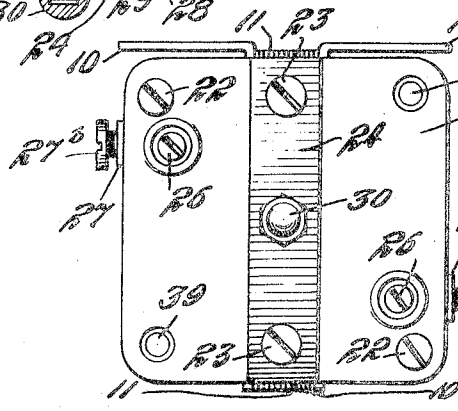


Fig. 4.

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# UNITED STATES PATENT OFFICE

2,484,358

## RELAY

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Application December 22, 1945, Serial No. 637,055

6 Claims. (Cl. 200—103)

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This invention relates to electric controlling apparatus and particularly to relays for avoiding the effects of mechanical shocks or jars and for avoiding any movement of the parts when the relay is in its attracted position and when in the unattracted position. Thus disturbance of the relay from its proper position is avoided and this desirable result is accomplished regardless of the direction, frequency or magnitude of the mechanical shocks.

The main object of the invention is to avoid disturbance of the relay from its proper position when subjected to mechanical shocks or jars of any character. Another object is to provide a structure which may be readily assembled and disassembled and in which a number of the parts are duplicates or substantial duplicates for simplicity in manufacture and in requiring only a small number of dies for the making of the parts. A further object is to make provision for the control of a number of different circuits, or for circuits with a plurality of make and break contacts connected in series with each other. Another object is to protectively house the make and break contacts for reducing the arcing and for avoiding tampering by the user. Other objects and advantages will be understood from the following description and accompanying drawings which illustrate a preferred embodiment.

Fig. 1 is a front elevation; Fig. 2 is a side view; Fig. 3 is a vertical section on the line 3—3 of Fig. 2; Fig. 4 is a top plan view; Fig. 5 is a horizontal section on the line 5—5 of Fig. 3; Fig. 6 is a horizontal section on the line 6—6 of Fig. 3; and Fig. 7 is a vertical section of a portion of the relay on the line 7—7 of Fig. 5.

The proof against shocks is based upon the principle of interlocking the movable parts of the relay in such a manner that under any impact the tendency of any parts to move is counteracted by an opposing tendency of other corresponding parts which maintains the parts at rest. Also, members are used which are non-reversible in movement which aids in preventing improper movement when the forces acting on the parts are unbalanced. On the other hand, in controlling the actuation of the relay to its attracted or to its unattracted position the movement of all the parts cooperates to assist each other.

Referring to Figs. 1, 2 and 3, the relay is adapted to be supported on a panel by a pair of sheet steel plates 10, each of which is bent at right-angles to provide forwardly extending portions 10a of hollow rectangular shape. These portions serve to clamp between them the fixed laminae 11 of the magnet frame as well shown

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in Fig. 6. The laminae have the same form as the clamping portions of the frame except at the upper and lower central parts where space is provided to receive the upper and lower laminated plungers 12 of rectangular cross-section. The central passage for the plungers is lined throughout its length by a pair of oppositely disposed thin metal strips 13 for guiding the plungers. The opposite edges 13a of each strip along its length are turned inwardly to form channels for guiding the plungers, as shown in Fig. 6; and the ends 13b of each strip are turned outwardly and again turned at right-angles for holding them in place, as shown in Figs. 3 and 6. The solenoid coil or winding 14 surrounds the plunger and is within the magnet frame. It is interposed between a pair of insulating disks 15 and is firmly held in position by a pair of locking leaf springs 16 positioned between the lower disk 15 and the lower portions of the magnet frame.

In the drawings the parts are shown in their unattracted positions. Fig. 3 shows the inner ends of the two plungers spaced from each other. The plungers are drawn toward each other upon excitation of the magnet winding. The outer end of each plunger carries a helical gear formed on the exterior surface of a cylindrical block 17 which may be made of moulded material. The block is hollow at its outer end and is secured to the end of its plunger by a central screw 18. The block has an inner extension 17a which fits over the rectangular end of its plunger. A spring 19 interposed between each gear block and a fixed support, biases each plunger outwardly.

A fixed contact housing is provided at the upper and lower portions of the relay, each housing being similar to the other. Each housing is formed of an inner head 20 and an outer head 21 formed of moulded insulating material. The heads 20 and 21 are secured to each other by a pair of through screw bolts 22 at diagonally opposite corners; and the united heads are fixed to the magnet frame by a pair of screw bolts 23 which pass through an external metal cross strip 24 and through the heads into the laminae of the magnet frame by a threaded engagement. The inner head 20 has a central opening for the passage of the plunger and is hollowed out on its outer surface for reception of the spring 19 and the gear block 17 in its inward movement. The inner face of the head 20 is recessed crosswise to form a slot in which is secured a metal cross piece 20a as shown in Fig. 1. This cross piece is enlarged at the middle portion as shown in Fig. 3 and has a central rectangular opening which fits around the plunger 12. It serves as a

guide for the plunger and prevents the plunger from any appreciable turning movement. The inner end of the spring 19 seats against this cross plate 20a. In recessed portions of the head 20 near the diagonally opposite corner portions, as shown in Fig. 5, are mounted terminals 25 of copper or brass strips having circumferentially extending inner ends carrying fixed contacts 25a. The terminals are bent inwardly over the outside edge of the head for reception of screws 25b for forming connection to the outside controlled circuit or circuits. The terminals are fixed in position by screw bolts 26 which pass through the head from the inner face and have a threaded engagement with the terminals respectively. The outer heads 21 are similar to the inner heads and have similarly formed terminals 27 with terminal screws 27b. They are mounted opposite the terminals 25 and similarly held in place by screw bolts 26 as shown in Fig. 7. Thus there are two pairs of terminals in each upper and lower portion of the relay and each pair has two oppositely positioned contacts spaced from each other adapted to be bridged by movable contacts respectively.

Each outer head 21 has a central opening for the reception of a metal tube 28 having an outwardly extending flange 28a at its inner end, as shown in Fig. 3. The outer end of this tube has a bearing surface on the inner face of the cross piece 24. The tube is journaled on a bearing bolt 29 having a screw head at its inner end for holding the tube in place. The outer end of the shank of the bolt 29 firmly engages the inner face of the strip 24 and affords sufficient clearance for the free rotation of the tube 28 on the bolt. The reduced end of the bolt has a threaded engagement with the strip 24 and is locked by an acorn nut 30 on the outside of the strip.

The outer portion of the flange or disk 28a of the tube 28 has secured thereto by the screws 31 a cylinder 32 having internal helical gear teeth which mesh with the corresponding gear teeth of the block 17. This internal cylindrical gear may be formed of moulded material. It is apparent that when the plungers are drawn within the magnet coil, the gears 32 at each end portion of the relay will be rotated on their bearing bolts through a predetermined angle in view of the fact that the plungers cannot turn. Also, the inclination of the helical gears at the two ends of the relay is such that when the plungers move inwardly toward each other, the gears 32 are rotated in the same direction and, of course, when the plungers move outwardly from each other, the two gears 32 rotate together in the reverse direction.

Each gear element 32 has formed therewith portions 32a extending outwardly on opposite sides, as shown in Fig. 5. They serve to carry the movable contacts and also carry a part of the interlocking mechanism. As to the movable contact assembly, one is mounted diametrically opposite the other on the side faces of the extensions 32a opposite each pair of fixed contacts. As shown in Fig. 3 and more particularly in Fig. 7, a conducting contact bridge piece 33 carries the contacts 33a at its upper and lower portions which contacts face the fixed contacts 25a and 27a. A pin 34 extends rearwardly into a hole in the extension 32a. A spring 35 encircles the pin and is seated in a recess in the extension 32a and is seated at its front end against the bridge 33 for biasing the bridge towards the fixed contacts. The bridge is prevented from turning by being seated within a small vertical slot formed in the extension 32a. The pin 34 is fixed at one end to a metal cross piece 36 positioned in front of the contact bridge for retaining it in place, this cross piece, as shown in Fig. 3, being fixed at one end in a notch in the extension 32a and fastened by a screw 36a at its other end. When the gears 32 are turned, it forces the contact bridges and their contacts against their respective fixed contacts for making a direct connection between each pair of fixed contacts. In this movement the biasing springs 35 are compressed and balanced pressure is imposed on the contacts by their self-adjustment.



The interlocking of the movable parts for avoiding displacement under mechanical shocks will now be described. In the periphery of each extension 32a is inserted a metal gear segment 37 with its teeth projecting somewhat beyond the extension. This segment is moulded in place and held by rivets 37a as shown in Fig. 7. Each gear segment meshes with a pinion 38. Each pinion is fixed to a small shaft or pin 39 which is journaled at opposite sides of the pinion in bearing sleeves held friction tight in the heads 20 and 21 respectively. The inner end of each shaft 39 is squared. The diagonally opposite shafts 39 of the upper housing heads are opposite the similarly disposed shafts 39 of the lower housing heads; and the upper shafts are coupled respectively with the lower shafts by the interlocking links or tubes 40. Each of these two tubes, or interlocking elements, are squared internally at their ends and fit over the squared ends of the shafts 39.

Upon excitation of the magnet winding the two plungers move inwardly from the position shown in Fig. 3 which, as already explained, turn the upper and lower movable contact assemblies in the same direction as each other in planes perpendicular to the axis of the winding. In this movement the interlocking coupling by the segmental gears 37, pinions 38 and connecting elements 40 permits this action because the parts cooperate in corresponding directions of movement. Upon deenergization of the magnet winding the biasing springs 19 return the parts to the positions shown in the drawings. Now assume that the relay is subjected to a mechanical shock that would tend to move one or both of the plungers from the position shown and close momentarily certain of the contacts when they are supposed to stay open. Such improper action is prevented by the previously described interlocking of the parts. If the force applied to the relay, or a vertical component of a force, were in a downward direction, the lower plunger would tend to move upwardly and tend to turn the lower movable contact assembly in a direction to close its contacts. However, the interlocking of the lower contact assembly with the upper contact assembly would prevent such movement because the upper contact assembly remains stationary; and the shock on the upper plunger tends to move it upwardly which exerts a restraining force on the upper contact assembly opposing any movement thereof. That is, the shock on the plungers tending to move them in the same direction would result in a tendency to move the upper and lower movable contact assemblies in opposite directions to each other and thereby lock the parts against any appreciable movement. If the applied shock or vertical component of a shock, were in an upward direction the reverse application of forces on the parts takes place resulting in the preven-

tion of the closing of the relay. Similarly if the relay be in the closed position, any force tending to move the plungers up or down to disturb any of the contacts from their closed position, would result in the attempted movement of one plunger being opposed by that of the other because the movement of the plungers in the same direction causes the force of one plunger to be opposed by the force of the other through the interlocking connection. Also, any force in a sidewise direction, or horizontal component of a force, would not disturb the parts from their open or closed positions because all movable parts are symmetrical with reference to the vertical axis and balanced. Also, any unbalanced force or jar tending to turn either of the contact assemblies would have no effect because, owing to the inclination of the helical gears, their movement is non-reversible. Thus regardless of the character or direction of the force or forces to which the relay may be subjected, there is no appreciable movement of the parts or disturbance of the relay from its open or closed position.

Although the relay has been described as being moved to close circuit connections when the magnet winding is energized, it is obvious that when desired the contacts could be closed under the deenergized condition of the relay and opened when the relay is energized. Also, instead of opening and closing contacts, the relay when desired could control merely the mechanical actuation of parts, or have a combined control of mechanical and electrical actions.

It will be understood that this invention may be embodied in various forms of structure and relationship of parts for adaptation to particular requirements without departing from the scope thereof.

I claim:

1. A relay comprising a solenoid winding and two opposite non-rotatable plungers actuated toward each other upon excitation of said winding, a helical gear secured to the outer end of each of said plungers respectively, a second helical gear in mesh with each of said first named gears respectively and rotatable in planes perpendicular to the axis of said winding, controlling means actuated by each of said second helical gears, additional gearing actuated by each of said second helical gears respectively, and interlocking connecting means between said additional gearing for locking said plungers against movement under mechanical shocks.

2. Controlling apparatus comprising an electromagnet having a solenoid winding and two non-rotatable magnetic plungers actuated in opposite directions to each other upon excitation of said winding, controlling means rotatable about the axis of said winding in planes perpendicular to the axis of said winding and respectively located opposite the ends of said winding and respectively actuated by the movement of said plungers, and means connected between said rotatable controlling means for locking said plungers against movement under mechanical shocks tending to move said plungers in the same direction as each other.

3. Controlling apparatus comprising an electromagnet having a solenoid winding and two non-rotatable magnetic plungers actuated in opposite directions to each other upon excitation of said winding, controlling means rotatable about the axis of said winding in planes perpendicular to the axis of said winding and respectively located opposite the ends of said winding and respectively actuated in the same direction as each other by the said movement of said plungers, and means connected between said rotatable controlling means for locking said rotatable means against movement in the reverse direction to each other under mechanical shocks tending to move said plungers in the same direction as each other.



4. Controlling apparatus comprising an electromagnet having a solenoid winding and two non-rotatable magnetic plungers actuated in opposite directions to each other upon excitation of said winding, controlling means rotatable about the axis of said winding in planes perpendicular to the axis of said winding and respectively located opposite the ends of said winding and respectively actuated by the movement of said plungers, and gearing connected between said rotatable controlling means for locking said plungers against movement under mechanical shocks tending to move said plungers in the same direction as each other.

5. Controlling apparatus comprising an electromagnet having a solenoid winding and two non-rotatable magnetic plungers actuated in opposite directions to each other upon excitation of said winding, controlling means rotatable about the axis of said winding in planes perpendicular to the axis of said winding and respectively located opposite the ends of said winding and respectively actuated by the movement of said plungers, a gear actuated by each of said rotatable means respectively, and means connected between said gears for locking said rotatable means against movement under mechanical shocks tending to move said plungers in the same direction as each other.

6. Controlling apparatus comprising an electromagnet having a solenoid winding and two non-rotatable magnetic plungers actuated in opposite directions to each other upon excitation of said winding, a housing located opposite each end of said winding respectively, fixed contacts supported within each of said housings respectively, rotatable controlling means within each of said housings respectively and rotatable about the axis of said winding in planes perpendicular to the axis of said winding and respectively actuated by the movement of said plungers, contacts carried by said rotatable means respectively for engaging and disengaging said fixed contacts upon movement of said rotatable means as controlled by the movement of said plungers, and means connected between said rotatable means for locking said plungers against movement under mechanical shocks tending to move said plungers in the same direction as each other.

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