June 6, 1950 H. E. ASHWORTH 2,510,305

ELECTROMAGNET WITH BALANCED ARMATURE

Filed Oct. 22, 1947 3 Sheets-Sheet 1

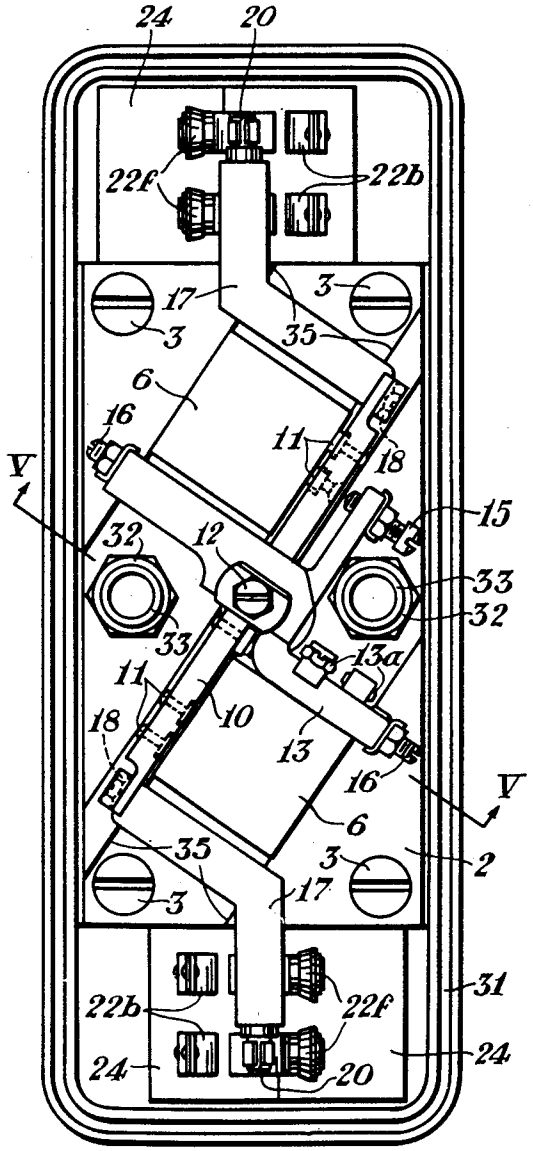


Fig. 1.

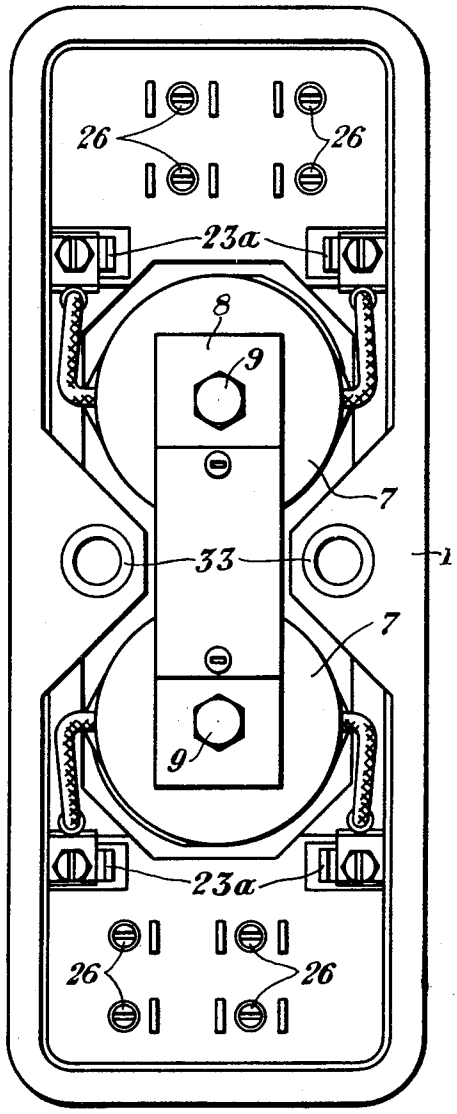


Fig. 3.

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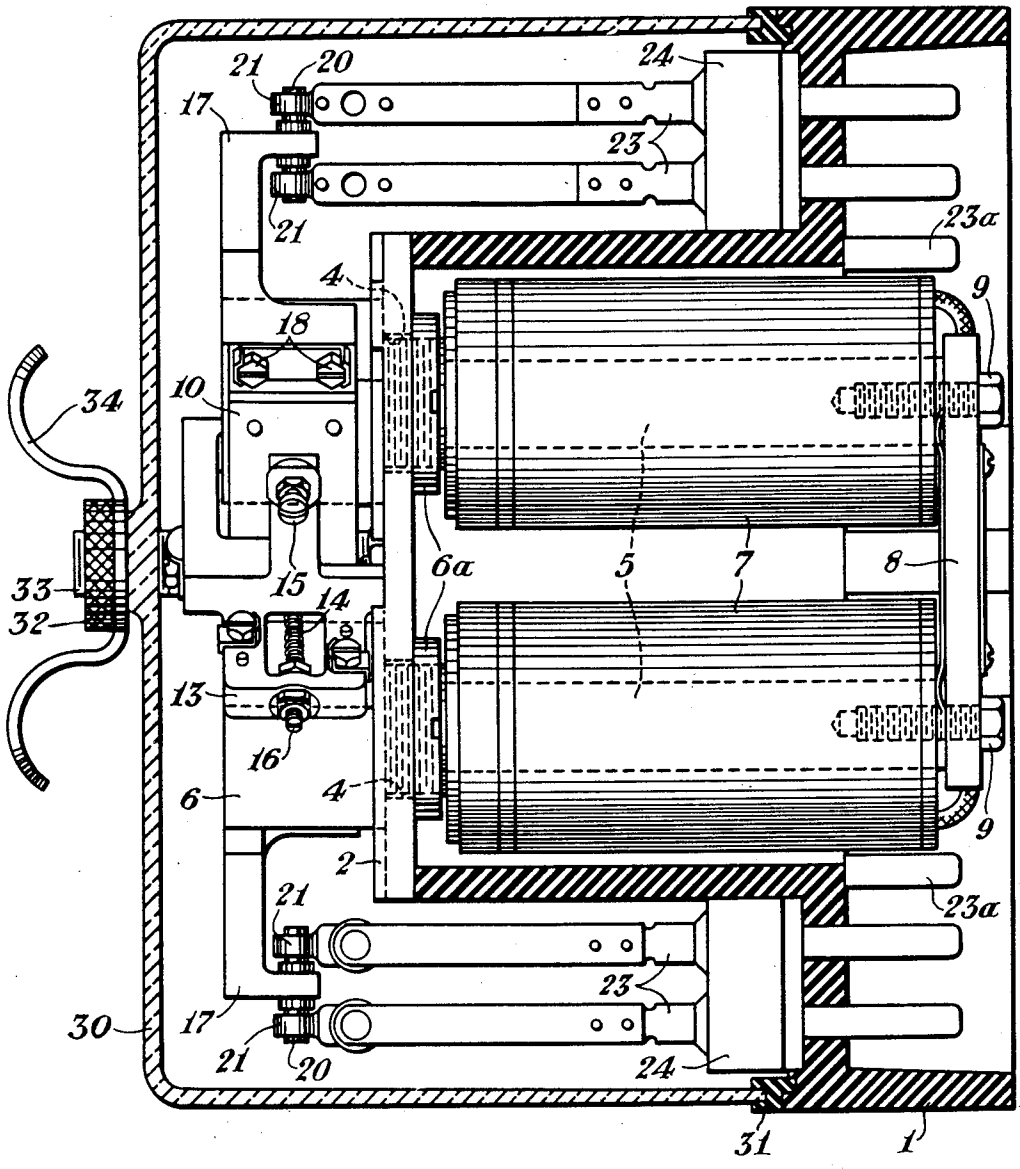


Fig. 2.

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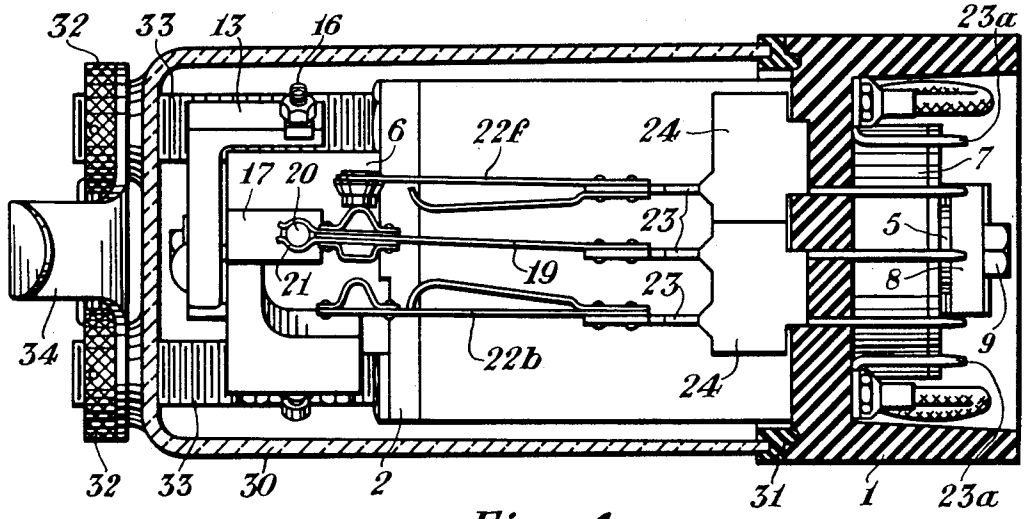


Fig. 4.

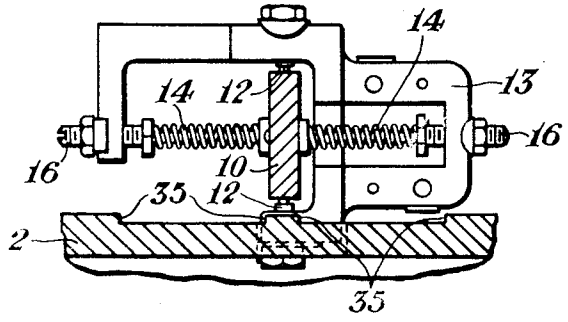


Fig. 5.

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Patented June 6, 1950

2,510,305

# UNITED STATES PATENT OFFICE

2,510,305

## ELECTROMAGNET WITH BALANCED ARMATURE

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Application October 22, 1947, Serial No. 781,298

3 Claims. (Cl. 175—336)

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My invention relates to electrical relays, and has particular relation to electrical relays having a centrally pivoted armature adapted to have the opposite faces of its two ends simultaneously attracted to the faces of the pole pieces provided for the relay energizing magnet. More particularly, my invention relates to an improved construction of a relay of this type.

Relays of the above described type have been proposed heretofore in order to assure proper operation of the relay armature when subjected to shock and vibration, and to avoid chattering of the relay contacts at the critical operating value of the relay current. These operating characteristics are of prime importance in connection with apparatus mounted upon railway locomotives, such as, for example, train control relays which are subjected in service to extremely severe jars, shock and vibration.

An object of my invention is to provide a novel and improved relay adapted for use in applications where the relay is subjected to severe shock, jars and vibrations.

Another object is to provide a novel and improved relay having an armature pivoted about its center to rotate in a vertical plane and arranged to have its opposite ends attracted simultaneously to the pole faces of the energizing magnet.

Another object is to provide a novel and improved construction of a relay having a centrally pivoted armature and incorporating means for establishing and maintaining a predetermined relationship between the pole faces of the magnet pole pieces.

Another object is to improve the construction of relays having a centrally pivoted armature.

The above mentioned and other important objects and characteristic features of my invention are attained in accordance with my invention by incorporating into a relay a supporting plate having means which locate and position the pole faces of the relay pole pieces so as to establish and maintain a predetermined relationship between such faces, and by providing in such a relay a novel arrangement of parts which cooperate to provide an improved and simplified manner of constructing the relay.

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

In the accompanying drawings, Fig. 1 is a front view of a novel and improved relay embodying my invention, with the cover 30 omitted. Fig. 2 is right side view, partially sectional, of the relay

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shown in Fig. 1. Fig. 3 is a rear view of the relay shown in Fig. 1. Fig. 4 is a top view, partially sectional, of the relay shown in Fig. 1. Fig. 5 is a sectional view taken on the line V—V of Fig. 1. In each of the several views, similar parts have been designated by corresponding reference characters.

Referring to the drawings, a relay embodying my invention is shown as comprising a frame 1 of suitable insulating material, such for example, as a phenol condensate product. A supporting plate 2 secured by screws 3 to frame 1 is provided with a pair of circular openings 4 through which project cylindrical cores 5 integrally formed at their outer ends with enlarged pole pieces 6 (see Fig. 1) preferably rectangularly shaped. The cores 5 are suitably threaded adjacent to the pole pieces 6 to receive core nuts 6a which when tightened down secure cores 5 to plate 2 and draw down pole pieces 6 into firm engagement with plate 2. Energizing windings 7 are mounted on cores 5 which are connected together at their opposite ends by a back strap 8 secured to the cores by bolts 9. The windings 7 are adapted to be supplied with current so as to constitute the cores and windings of an electromagnet. The openings 4 in supporting plate 2 are located spaced apart in such a manner that with the faces of pole pieces 6 arranged in predetermined relation to each other (as shown in Fig. 1), an armature 10 may be pivotally mounted intermediate its ends to lie between the pole pieces so that the opposite faces of the two ends of the armature will be simultaneously attracted to the pole pieces 6. This arrangement is best shown in Fig. 1 in which it will be seen that when one face of one end of armature 10 is attracted to one pole piece 6 the opposite face of the other end of armature 10 is likewise attracted to the other pole piece 6, the armature faces being actually spaced away from contact with the pole pieces 6 by non-magnetic core pins 11 carried by the armature and projecting slightly beyond the armature face.

The armature 10 is pivotally supported about its center on pivots 12 (see Fig. 5) carried in direct axial alignment in spaced aligned arms of a bracket 13 fastened by bolts 13a to one of the pole pieces 6 carried by plate 2. The bracket 13 also carries a pair of springs 14 which engage the opposite faces of armature 10 on opposite sides of its center, and a stop screw 15 which functions to limit the travel of armature 10 away from the pole pieces 6. The springs 14 are adjustable by means of bolts 16 and function to impose forces

on the armature tending to rotate it to a position away from the pole pieces so that when the windings 7 are deenergized the armature is biased to and will assume the position away from pole pieces 6, in which biased position the armature is in contact with stop screw 15. When windings 7 are energized by current of suitable magnitude, armature 10 will be attracted to the pole pieces 6 and will assume the position in which the armature is represented in the drawings.

The armature 10 is provided at its extreme ends with driving members 17 of insulating material secured at one end as by screws 18 to armature 10 and operatively connected at the other end with movable contact fingers 19 by means of a transverse contact operating pin 20 loosely mounted in member 17. The pins 20 are engaged by clips 21 secured to fingers 19 and function to drive the fingers 19 between two fixed contact fingers 22b and 22f, the fingers 19 engaging fingers 22b whenever armature 10 occupies its biased position away from the pole pieces 6, and finger 19 engaging finger 22f when armature 10 is attracted to pole pieces 6 by the energization of windings 7. The contact operating structure described is in general similar to that shown and claimed in Letters Patent of the United States No. 2,347,834, granted on May 2, 1944, to John W. Livingston.

As can be seen in the drawings, groups of fingers each including fingers 19, 22b and 22f arranged in alignment, are provided and preferably two of such groups of contacts (see Fig. 2) are provided for each driving member 17. Each group of three fingers includes a movable contact finger 19 located between a cooperating back contact finger 22b and a cooperating front contact finger 22f. The forward portion of each finger is flexible and is riveted to a rigid rear portion 23 moulded into an insulating block 24. Two of the insulating blocks 24 as shown support the two rows of three fingers each provided for each contact operating pin 20, and each block is removably clamped by means of screws 25 against the forward face of frame member 1 so that the contacts may be readily removed and replaced with other contacts when desired. The rigid portion of each contact finger 23 is made sufficiently long to extend through an aligned opening in the frame member 1 into a rectangular recess formed in the rear side of frame member 1, and these rigid portions of the contact fingers 23 constitute a plug for making contacts with a suitable female connector in the manner described in detail in Letters Patent No. 2,198,704, granted on April 30, 1940, to Branko Lazich. As shown in Fig. 4, an extra set of fingers 23a may be provided in frame 1 so as to be entirely independent of the fingers 23 carried by contact blocks 24. The fingers 23a are preferably provided to constitute terminals for establishing connection between coils 7 and the terminals of the mating female connectors.

The armature and contact assembly previously described is suitably enclosed preferably by a transparent cover 30 composed of glass or plastic, which fits in a rubber gasket 31 and is held attached to frame 1 by means of nuts 32 which are threaded onto hollow externally threaded tubes 33 (see Fig. 4) moulded into frame 1. As shown in Fig. 2, a pull member 34 is confined between cover 30 and nuts 32 and is formed with wings adapted to be grasped so as to make the relay readily capable of being plugged in or detached from its cooperating female connector. It should be noted that the hollow tubes 33 may constitute



guides through which rods (not shown) provided on the female connector may project outwardly beyond the cover. It is contemplated that these rods will be threaded at their outer ends to receive nuts which when tightened down attach the relay to the mating female connector.

It will be noted from an inspection of the drawings that the pivots 12 are located in alignment in such a manner that armature 10 will rotate about a horizontal axis in a vertical plane. Also, it will be noted that the faces of the pole pieces 6 are disposed at an angle with respect to both the horizontal and vertical axis of the relay so that with the corresponding faces of the two pole pieces 6 in parallel relationship, the armature 10 will also operate at an angle with the horizontal and vertical axis of the relay. The parts of the relay armature are so proportioned that when the armature is in its mid-stroke position, that is, when the armature is half-way between its fully attracted position when the core pins 11 engage the faces of the pole pieces 6, and its fully released position in which armature 10 engages stop screw 15, the transverse pins 20 carried at the opposite ends of armature 10 are then directly in alignment with the pivots 12 and these members will all lie in the vertical axis of the relay. At this position of the parts, the plane including the pivots 12 and contact operating pins 20 is perpendicular to the line of motion of the movable contact fingers 19 with the result that the arc traversed by each contact operating pin 20 is tangent to line of operation of the movable contact finger 10 at the mid-stroke position of armature 10.

The amount of motion given to the contact operating pin 20 by movement of driving member 17, attached to armature 10, is relatively limited as is readily apparent from an inspection of the drawing, and as a result the motion of driving member 17 is substantially in the same plane as that defined by the motion of the center of the contact spring operating pins 20.

The parts of the contact assembly and armature are so arranged that substantially a balanced armature type relay is provided. That is to say, all of the contact operating arms, contact loads, biasing spring forces, etc., imposed upon the armature 10 are balanced about the center pivots 12 so that a symmetrical arrangement is provided which tends to make the armature immune to vibration and shock. In other words, if the armature 10 is in its released position, shock or vibration acting upon the armature will not cause the armature to rotate about the pivot 12 due to its stable condition of equilibrium. The same condition is true when the armature is energized, and it will be noted that when the armature is picked up it is held attracted by a force couple operating on the armature on opposite sides of the armature pivot mounting.

In providing a relay of the type hereinbefore described, it is essential that the faces of the pole pieces 6 be held in a predetermined relationship with each other in order to provide for proper cooperation with the opposite ends of the pivotally mounted armature 10. For ease in manufacturing and assembly, the cores 5 preferably are formed of cylindrical material which is upset at one end to provide a rectangularly formed pole piece 6. The openings 4 in the supporting plate 2 are circular in shape to permit insertion of the cores, so that these openings provide no means for establishing the predetermined relationship between the faces of the pole pieces 6. This re-

lationship is established however in accordance with my invention by providing sidewalls **35** in the supporting member **2**. These sidewalls **35** are formed by milling or slotting depressions in the supporting member **2**, with the sides of the depressions running parallel to each other to form a central rib (see Fig. 5) whose sides engage the faces of the pole pieces **6**. In assembling the parts, therefore, the cylindrical cores **5** are inserted through the holes **4** and the faces of the pole pieces **6** are then brought into alignment with the side walls **35** so that the pole pieces **6** can be forced down firmly into engagement with the side walls **35**. The cores are fastened to supporting plate **2** by core nuts **6***a*, which insure that the pole pieces **6** are held in contact with the sidewalls forming the central rib to maintain the established relationship of the faces of the pole pieces **6** with respect to each other, and to readily permit assembly of the parts of the relay.

An additional feature of my invention is the provision of an armature assembly comprising the armature **10**, its supporting pivots **12**, biasing springs **14** and armature stop **15** all mounted on the armature bracket **13**. The pivots **12**, armature **10**, springs **14** and stop **15** are first assembled on bracket **13** as a unit, and that unit is then secured to one of the pole pieces which has been prepared with drilled openings to receive the bolts **13***a* which attach the bracket **13** to the pole piece. Preferably, the bracket **13** is further secured to its pole piece **6** by dowel pins (not shown) driven through the bracket member into the pole piece. This pole piece **6** is of course accurately positioned with respect to the other pole piece by the rib of supporting plate **2**, so that the armature assembly when mounted on the one pole piece accurately positions the armature **10** relative to both of its cooperating pole pieces, with the armature pivots, biasing springs and stop arranged in proper relation to the armature. This arrangement therefore affords a convenient and simplified manner of assembly of the components in the relay structure.

Although I have herein shown and described only one form of an electrical relay 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 scope of my invention.

Having thus described my invention, what I claim is:

1. In a relay, in combination, a supporting plate provided with a rib and with a pair of openings disposed respectively on opposite sides of said rib, a pair of cores one extending through each of said openings and each provided with an enlarged pole piece engaging said rib, means securing said cores to said supporting plate in such manner that said pole pieces are maintained in predetermined relative positions by engagement with said rib, and a removable armature assembly secured as a unit to one of said pole pieces, said armature assembly comprising a bracket member separate from said supporting plate, a pair of pivot pins mounted in alignment in said bracket member, an armature pivotally mounted on said pivot pins intermediate its ends for movement toward and away from both said pole pieces, and spring means secured to said bracket member and engaging said armature to bias said armature away from said pole pieces.

2. In a relay, in combination, a supporting plate provided with a rib and with a pair of openings disposed respectively on opposite sides of said rib, a pair of cores one extending through each of said openings and each provided with an enlarged pole piece engaging said rib, means securing said cores to said supporting plate in such manner that said pole pieces are maintained in predetermined relative positions by engagement with said rib, and a removable armature assembly secured as a unit to one of said pole pieces, said armature assembly comprising a bracket member separate from said supporting plate, a pair of pivot pins mounted in alignment in said bracket member, an armature pivotally mounted on said pivot pins intermediate its ends for movement toward and away from both said pole pieces, spring means secured to said bracket member and engaging said armature to bias said armature away from said pole pieces, and a stop secured to said bracket member and cooperating with said armature to limit its movement due to said biasing springs.

3. In a relay, in combination, a supporting plate provided with a rib and with a pair of openings disposed respectively on opposite sides of said rib, a pair of cores one extending through each of said openings and each provided with an enlarged pole piece engaging said rib, core nuts securing said cores to said supporting plate in such manner that said pole pieces are maintained in predetermined relative positions by engagement with said rib, a removable armature assembly comprising a bracket member separate from said supporting plate, a pair of pivot pins mounted in alignment in said bracket member, an armature pivotally mounted intermediate its ends on said pivot pins, and spring means secured to said bracket member and engaging opposite sides of said armature on opposite sides of its pivotal axis; and means securing said armature assembly as a unit to one of said pole pieces for positioning said armature in cooperating relation to bth said pole pieces with said aligned pivots located between said pole pieces.

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