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W. L. TANCRED

2,863,103

RELAY

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FIG. 1-

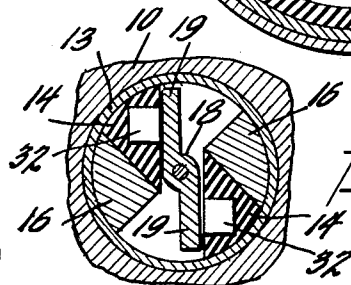
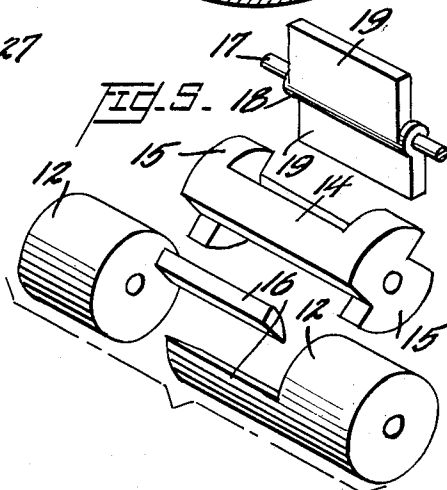
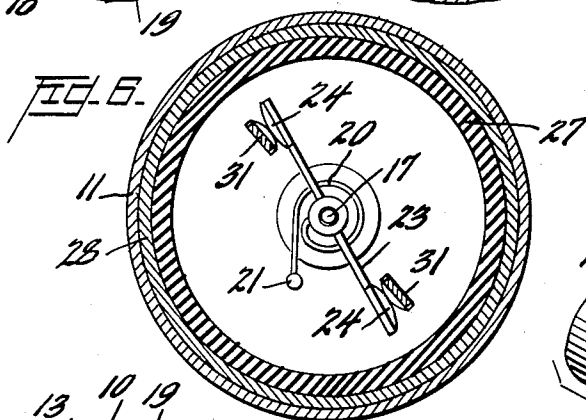
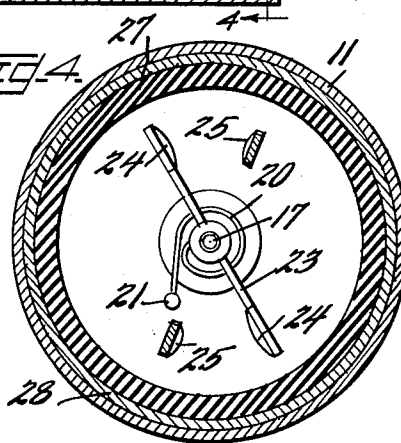
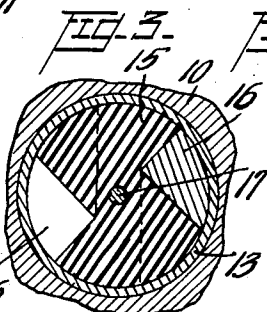
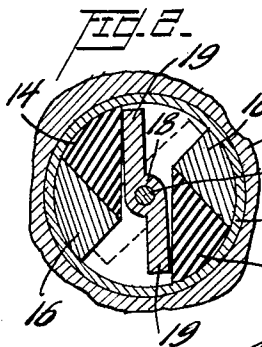
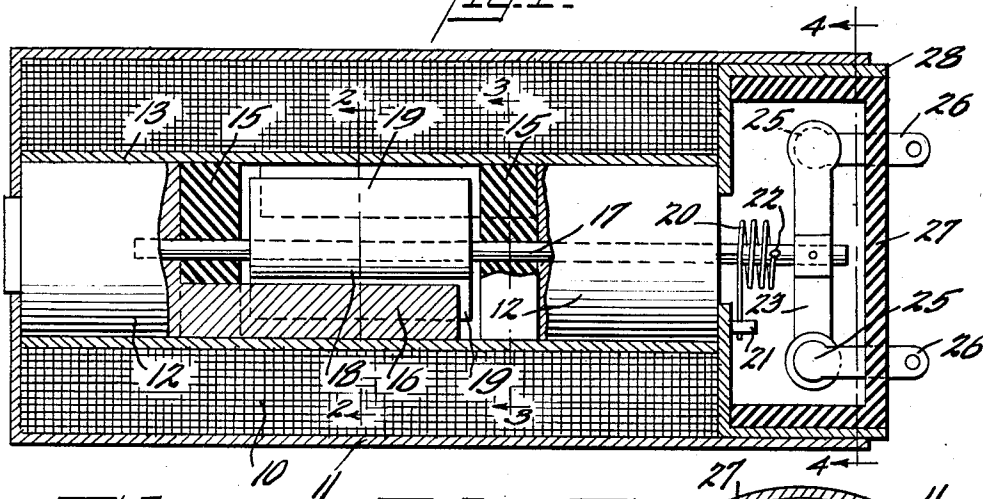


FIG. 7-

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1

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RELAY

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5 Claims. (Cl. 317-197)

This invention relates to an improved electromagnetic relay which has been previously disclosed in abandoned application Serial No. 259,065, filed November 30, 1951.

Electrical and electronic equipment employed in many modern applications are quite often subjected to severe shock which may be caused by gunfire, explosion, impact of projectiles, rapid changes in vehicle velocity, and the like. The forces created by these conditions necessarily result in considerable momentary acceleration of the framework of the equipment thereby subjecting the components to a corresponding acceleration. It can be readily appreciated that for proper equipment operation, the individual components must be designed so as not to effectuate false operation in response to the forces of acceleration. Additionally, the design of these reliably operating components should incorporate other desirable characteristics, such as miniaturization, efficient operation, and economy of manufacture.

A principal object of this invention is to provide an electromagnetic relay having effective safeguards against false contact operation caused by the forces of acceleration, and featuring a design which is highly sensitive and effective to actuate a relatively large number of contacts reliably in any relay position with a structure of miniature dimensions and which can be economically manufactured.

Another object is to provide an electromagnetic relay design possessing the foregoing characteristics and which may also be readily altered during the manufacturing operation to produce relays having varied degrees of contact actuating force.

As is well known in the art, the basic relay structure comprises a movable armature associated with an electromagnet, or a plunger acting in conjunction with a solenoid. The armature or plunger is arranged to actuate suitable contacts in response to the application of an energizing current. When such a relay structure is undergoing substantial acceleration, the armature or plunger, while being subjected to a relative motion restraining force such as that of a spring or the like, may, due to inertia, fail to accelerate as rapidly as the relay framework and to move correspondingly with the remaining portion of the relay. This relative movement tends to actuate the relay and may actually do so under severe conditions thereby producing false contact operation.

Relays have heretofore been proposed having structural arrangements devised to safeguard against false contact operation caused by the forces of acceleration. One such structure features a plurality of plunger or core members positioned within a solenoid such that contact operation is effected only by movement of the core members in reverse directions relative to one another. In the main, such relative reverse motion of the core members cannot be produced by the usual accelerating forces to which electrical and electronic equipments are subjected.

Other relay arrangements of the prior art have em-

2

ployed a balanced armature rotatably pivoted within a solenoid. Inasmuch as the forces of acceleration apply equal and opposing torques to each of the balanced armature sections oppositely disposed with respect to the pivot, the armature cannot be rotated to produce false contact operation. Prior art relays embodying this design have not, however, attained optimum results with respect to relay sensitivity, damping control over the contact operation, miniaturization, and economy and simplicity of structure.

Accordingly, a preferred embodiment of the relay structure of this invention features advantageous improvements in the basic relay structure employing a rotatably balanced armature in conjunction with an actuating solenoid. In particular, there is positioned at each end of the actuating solenoid, a magnetic core each having a body portion from which a relatively flat pole piece projects into the centermost portion of the solenoid. The faces of both pole pieces are closely spaced with respect to one another, and may overlap if contact damping is required. A balanced armature having a pair of relatively flat wing portions is pivotally positioned in the space gap between the pole pieces on a shaft supported at the terminal ends thereof by the core members. The armature is aligned with respect to its shaft support such that armature rotation occurs in a plane which is perpendicular to the longitudinal axis of the solenoid. This particular disposition of the rotating armature within the centermost portion of the solenoid and between the intervening space gap of the pole pieces provides for optimum sensitivity and contact actuating torque. These advantages occur because the intensity of the magnetic field is greatest at the center of the solenoid, and also because a minimum of magnetic reluctance is established by the relatively close magnetic coupling of the armature between the relatively large faces of the sandwiching pole pieces.

Another feature of the operation of the foregoing relay structure is that any desired damping of the armature movement can be readily obtained by lengthening or shortening the pole pieces relative to the center plane for the solenoid. That is, if the pole pieces are constructed so as to overlap whereby each pole piece contains surface portions on both sides of the center plane, armature rotation can be effectively dampened. Likewise, shortening the pole pieces so that they do not project past the center plane produces a greater rotatable speed, and a distinctively sharper action opposite to damping.

The relay of this invention may also be effectively miniaturized because substantially all of the contact driving structure is positioned within the solenoid; therefore, for any specified relay volume, an increased contact load may be actuated thereby. The contacts are actuated by a terminal portion of the armature support rod which projects out of the solenoid such that a rotating torque is made available to actuate the contact load. In a first preferred embodiment, a spring is coupled to the projecting portion of the rod so as to spring bias the armature and associated contacts to the required non-operating position. An alternative structural arrangement eliminates this biasing spring and employs a pair of permanent magnetic discs positioned within the solenoid and magnetically coupled to the armature so as to position the armature to the non-operate position. This latter biasing arrangement provides for further miniaturization. These discs are positioned within similar polarities and will not lose magnetic effectiveness since upon each energization the discs and poles will equalize in potential.

In order that all of the structural features for attaining the objects of this invention may be readily understood,

3

detailed reference is herein made to the accompanying drawings wherein:

Figure 1 is a central longitudinal sectional view of a preferred embodiment of the relay of this invention;

Figures 2, 3 and 4 are detail sectional views on the correspondingly numbered section lines of Figure 1;

Figure 5 is an exploded perspective view of certain of the parts;

Figure 6 is a view similar to Figure 4 but showing a modification of the contact load; and

Figure 7 is a view similar to Figure 2 but showing a modification incorporating permanent magnet biasing of the armature.

Referring to the drawing, the relay shown therein comprises a controlling solenoid 10 supported on an inner tube 13 of non-magnetic material. This structure is enclosed within a suitable cylindrical enclosure 11 which may also be of non-magnetic material. A pair of stationary cores 12 of magnetic material are secured within inner tube 13 in an axially spaced relationship. The cores are separated one from the other by non-magnetic spacer 14 having a pair of end partitions 15 which contact the inner faces of cores 12. Each of the cores is provided with an eccentrically arranged pole piece 16 which extends lengthwise within tube 13 so that the common faces of pole pieces 16 are generally parallel one to the other. These pole pieces may or may not extend past the center plane of the solenoid common with section line 2—2 for the reasons hereinafter set forth.

Shaft 17 extends through spacer 14 and rotatably supports magnetic armature 18 within the gap between pole pieces 16. Armature 18 comprises a pair of oppositely directed, balanced wings 19, which during relay operation contact the inner exposed faces of pole pieces 16 as is shown in the broken line position of Figure 2. In the relay non-operate or solid line position shown in Figure 2, the opposite faces of wing portions 19 contact the inner faces of spacer 14. The terminal ends of shaft 17 are loosely supported by core members 12.

Coil spring 20 is coupled to shaft 17 as shown in Figures 1 and 4 so as to bias armature 18 to the solid line or non-operate position of Figure 2. A first terminal portion of spring 20 is secured to fixed lug 21 and the other terminal portion of spring 20 is secured to shaft 17 at 22. When solenoid 10 is energized, armature 18 is rotated from the angular position to which it is normally biased by spring 20 to the broken line position of Figure 2. This change in angular position may be employed to actuate the contact load as is shown, for example, in Figures 1 and 4. The rotation of armature 18 causes shaft 17 to drive contact arm 23 until contacts 24 supported thereby engage with contacts 25 supported on terminals 26. These terminals extend through the end wall of insulating casing 27 which encloses the contact load whereby external connections can be made to the contacts. Cup-shaped mounting elements 28 couples casing 27 to relay enclosure 11.

A normally-closed contact load is shown in Figure 6. In this modified arrangement, contact arm 23 and contacts 24 supported thereby are normally held in engagement with contacts 31 by the biasing force applied by spring 20. The contacts are opened in response to the energization of actuating solenoid 10.

An alternative arrangement for biasing armature 18 to the proper non-operate position is shown in Figure 7. In this modified arrangement, magnetic biasing is employed in lieu of spring biasing. A pair of permanent magnet discs or buttons 32 are positioned in insulating spacer 14 in such a manner as to normally hold the armature 12 out of contact with the pole pieces 16. These magnets are ineffective, however, to so hold the armature when the solenoid 10 is energized.

Optimum relay sensitivity is attained by the foregoing structure when pole pieces 16 extend to the center plane of the solenoid common with section line 2—2 shown in

4

Figure 1. If pole pieces 16 are constructed so as to overlap whereby each pole piece contains surface portions on both sides of the center plane, armature rotation can be effectively dampened. Counterwise, shortening the pole pieces so that they do not project past the center plane intensifies the armature movement. Accordingly, during the relay fabrication process relays characterized by different degrees of armature damping or intensifying can be readily manufactured by altering the length of the pole pieces the required amount with respect to the center plane for the solenoid to be used.

In view of the fact that the relay armature is positioned within the centermost portion of the solenoid between the relatively close spacing of the extending pole pieces, optimum relay sensitivity is obtained with a structure which can be substantially miniaturized. It should be noted that the relay motion mechanism is positioned in the main within the solenoid and that only a terminal portion of the rotating shaft 17 projects from the solenoid, thereby providing for an extremely compact relay structure.

Further miniaturization is provided by employing the biasing arrangement shown in Figure 7 wherein spring 20, which is external to solenoid 10, is omitted and permanent magnets 32 positioned within the solenoid provide for the requisite biasing force. The foregoing structure represents optimum economy in the use of component space and therefore the design is adaptable for use in equipments having stringent volume requirements.

It is to be understood that the above described arrangements are illustrative of the application of the principle of this invention. Numerous arrangements may be devised by those skilled in the art without departing from the scope of the invention.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. An electromagnetic relay comprising an actuating solenoid having a substantially linear axis, a pair of axially spaced magnetic cores rigidly fixed within said solenoid, a relatively long and narrow pole piece projecting from the inner face of each of said core members to at least the centermost portion of said solenoid with the inner pole faces thereof lying generally in parallel planes and being displaced in these planes with no more than a portion of the faces of each pole piece overlapping with respect to one another, a non-magnetic spacer separating said cores one from the other and holding said pole pieces in the afore-mentioned position, a rotatable shaft aligned with the longitudinal axis of said solenoid and loosely supported by said core members and passing through said spacer and one of said core members, a balanced armature having equal depending wings rotatably positioned on said shaft in the space gap between said pole pieces, a bias spring coupled to the end of said shaft projecting through said core member and forcing said armature wings to contact said spacer, a contact arm rigidly coupled to the projecting end of said shaft and actuating a contact load when said solenoid is energized thereby driving said armature in opposition to the force of said spring bias until said armature wings contact the faces of said pole pieces.

2. An electromagnetic relay comprising an actuating solenoid having a substantially linear axis, a pair of axially spaced magnetic cores rigidly fixed within said solenoid, a relatively long and narrow pole piece projecting from the inner face of each of said core members to at least the centermost portion of said solenoid with the inner pole faces thereof lying generally in parallel planes and being displaced in these planes with no more than a portion of the faces of each pole piece overlapping with respect to one another, a non-magnetic spacer separating said cores one from the other and holding said pole pieces in the aforementioned position, a rotatable shaft aligned with the longitudinal axis of said solenoid and loosely supported by said core members and passing

5

through said spacer and one of said core members, a balanced armature having equal depending wings rotatably positioned on said shaft in the space gap between said pole pieces, a bias spring coupled to the end of said shaft projecting through said core member and forcing said armature wings to contact said spacer, and a contact load coupled to the projecting end of said shaft and being actuated in response to the energization of said solenoid whereby said armature is driven in opposition to the force of said spring bias until said armature wings contact the faces of said pole pieces.

3. An electromagnetic relay comprising an actuating solenoid having a substantially linear axis, a pair of axially spaced magnetic cores rigidly fixed within said solenoid, a finger-like pole piece projecting from the inner face of each of said core members to at least the center portion of said solenoid, a rotatable shaft aligned with the longitudinal axis of said solenoid and loosely supported by said core members and passing through one of said core members, a balanced armature having equal depending wings rotatably positioned on said shaft in the space gap between said pole pieces, means biasing said armature to the non-operate position wherein said armature wings are separated from said pole pieces, and a contact load rigidly coupled to the projecting end of said shaft and being actuated in response to the energization of said solenoid whereby said armature is driven in opposition to said bias until said armature wings contact the faces of said pole pieces.

4. An electromagnetic relay comprising an actuating solenoid having a substantially linear axis, a pair of axially

6

spaced magnetic cores rigidly fixed within said solenoid, a finger-like pole piece projecting from the inner face of each of said core members toward the center portion of said solenoid, a non-magnetic spacer positioned within said solenoid and separating said cores one from the other, a rotatable shaft aligned with the longitudinal axis of said solenoid and loosely supported by said core members and passing through said spacer and one of said core members, a balanced armature having equal depending wings rotatably positioned on said shaft in the space gap between said pole pieces, means biasing said armature to the non-operate position wherein said armature wings contact said spacer, a contact load rigidly coupled to the projecting end of said shaft and being actuated in response to the energization of said solenoid whereby said armature is driven in opposition to said bias until said armature wings contact the faces of said pole pieces, and said bias means including a pair of permanent magnets positioned in the faces of said spacer which are contacted by said armature in the relay non-operative position.

5. The electromagnetic relay of claim 4 wherein said finger-like pole pieces extend to at least the center plane for the solenoid whereby contact damping is effected.

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