

Dec. 30, 1941.

J. F. MERKEL

2,268,261

RELAY

Filed Aug. 18, 1938

3 Sheets-Sheet 1

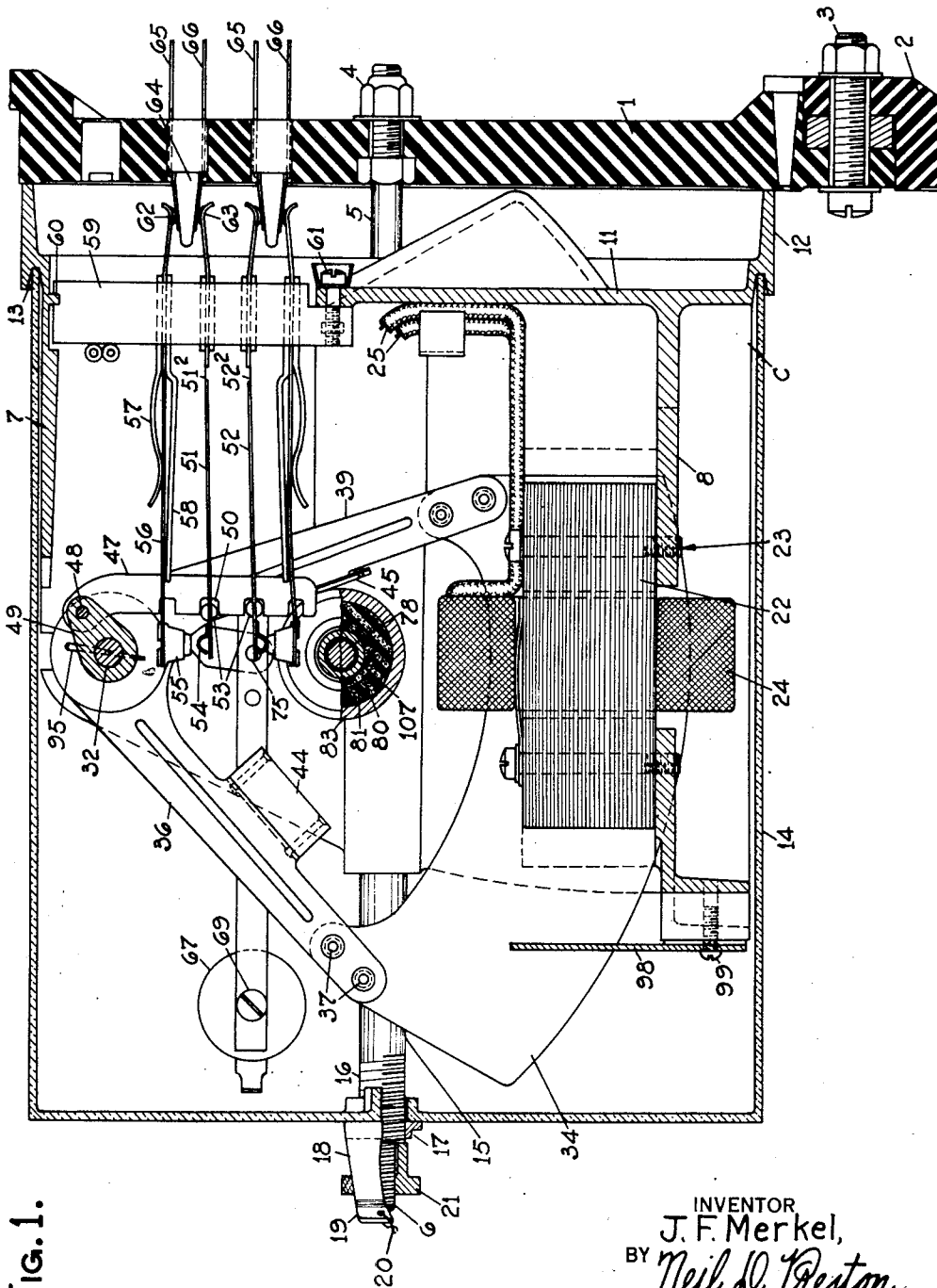


FIG. 1.

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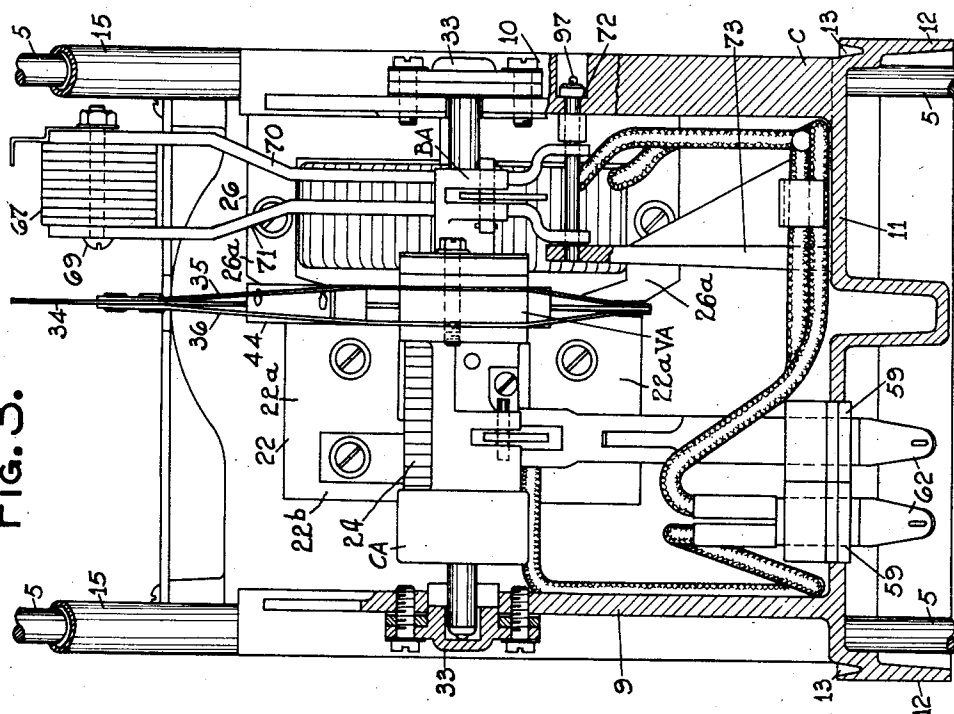
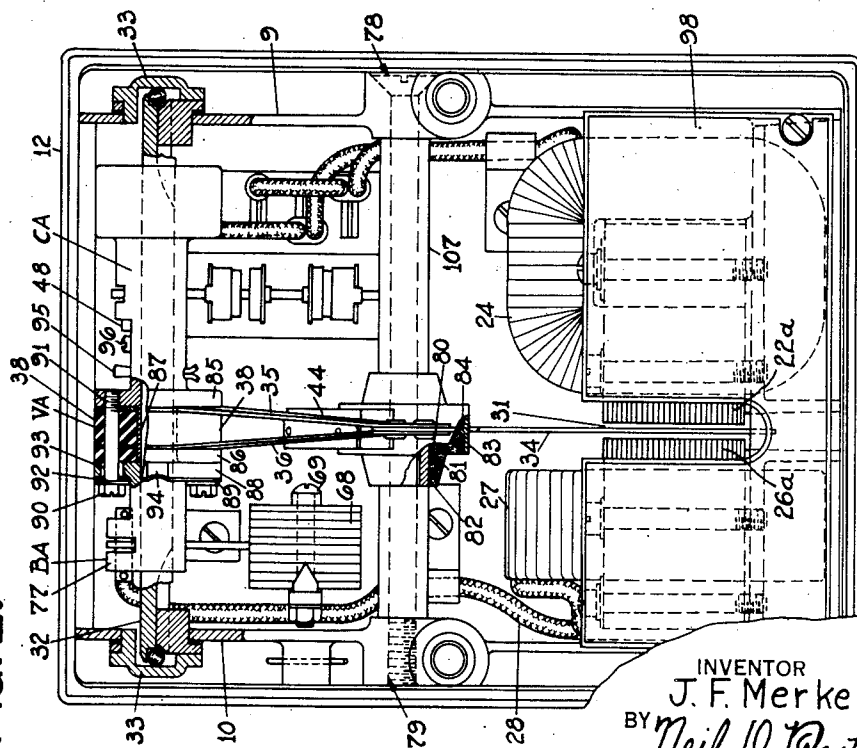


Fig. 2.



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FIG. 8.

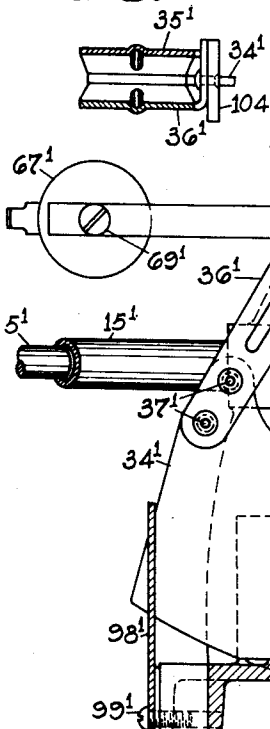


FIG. 4.

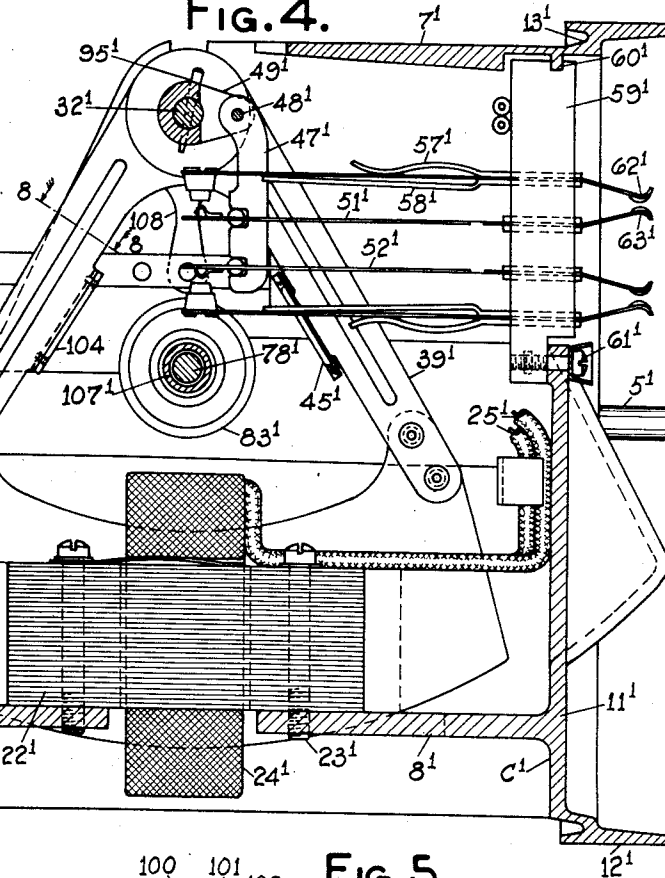


FIG. 7.

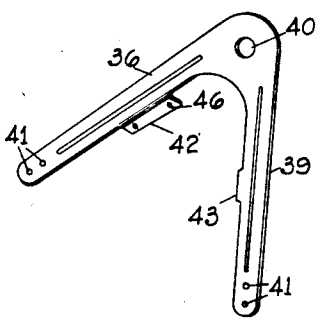


FIG. 5.

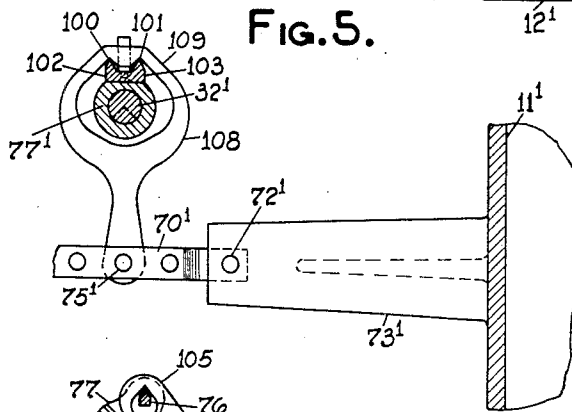
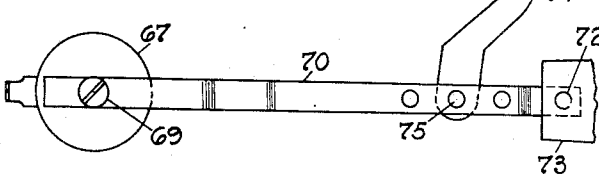


FIG. 6.



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2,268,261

RELAY

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Application August 18, 1938, Serial No. 225,545

13 Claims. (Cl. 200-91)

This invention relates in general to electrically operated relays, and has more particular reference to a relay of the vane type.

In relays of the type here concerned, difficulties have been experienced in preventing warping and distortion of the vane. Difficulties have also been encountered in providing a wholly satisfactory damping or stop means for the moving parts, for bringing them to a stop at the end of a movement without undue vibration and rebound.

In relays of this type, it has been found that excessive wear appears at various of the pivot points, so as to require frequent replacement of parts.

With the above and other considerations in mind, it is proposed, in accordance with the present invention, to provide a vane relay of a construction which largely obviates many of the disadvantages and drawbacks encountered in relays heretofore produced.

One of the objects of the present invention is to provide a vane relay having a vane which is largely free from warping and distortion and thus does not get out of its proper position with respect to its operating magnetic structure.

A further feature of the present invention is the provision of an improved stop or damping means which readily absorbs the energy of the moving parts which are promptly stopped and largely prevents rebound, and the replacement of the damping means.

A further feature of the present invention is the provision of knife-edge bearings of various characters for preventing excessive wear and thus the necessity for frequent replacement of bearings.

A further feature of this invention is the provision of a novel adjusting means between a biasing member and the vane member, whereby to permit accurate adjustment during assembly.

A further feature of the present invention is the provision of a holding means for the relay, whereby the means for holding the relay to its fixed support, and the means for holding the relay casing in position to cover the relay mechanism within the casing, are unusually conveniently located and compact in their arrangements.

Further objects, purposes and characteristic features of this invention will appear as the description progresses, reference being made to the accompanying drawings showing, solely by way of example, and in no manner whatsoever

in a limiting sense, two forms which the invention can assume. In the drawings:

Fig. 1 is a sectional side elevation of one form of relay in accordance with this invention.

Fig. 2 is a front elevation, with parts shown in section, and parts broken away, of the form of invention of Fig. 1.

Fig. 3 is a top plan view, with parts shown in section, of the invention of Fig. 1.

Fig. 4 is a sectional side elevation of a slightly modified form of relay, in accordance with this invention.

Fig. 5 is a fragmentary sectional view of a detail of the relay of Fig. 4.

Fig. 6 is a fragmentary sectional view of a detail of the relay of Fig. 1.

Fig. 7 is a detailed view of an element common to the two forms of relays.

Fig. 8 is a sectional view, on line 8-8 of Fig. 4, viewed in the direction of the arrows.

Referring now to the drawings, and first to Fig. 1, there is here shown a relay support rack having sections 1 and 2, interconnected by bolts 3. Fastened to section 1 of the rack, by bolting it thereto as at 4, is a support rod 5, extending forwardly of the relay rack and terminating in a threaded outer end 6. There are two of these rods 5, for supporting each relay, as shown in Fig. 3, for example.

The relay mechanism and operated parts are largely contained in a casting C, of aluminum or other suitable material, and of a general box-like shape, with an open front end. This casting has a top portion 7, a bottom portion 8, with side portions 9 and 10, and a rear portion 11. The casting, at the rear, also has a bearing portion 12, which rests against the rack member 1, when the relay is fixed in position. In the mechanism casting is an annular groove 13, for receiving the open end of relay casing 14, which can be made of glass, or other suitable, and preferably transparent, material, such as any one of the numerous transparent low temperature plastics which are readily available.

Connected to the mechanism casting are two tubes 15, which receive the holding rods 5, and in turn receive the casing 14, the ends of tubes 15 being threaded, as at 16, to receive nuts 17, for clamping the casing onto the mechanism casting. These nuts 17 have plates 18 connected thereto, which extend forwardly and then inwardly toward each other as at 19, with the portions 19 drilled to receive a wire 20, extending between the two members 19, with the

two ends of wire 20 interconnected by a seal or the like (not shown). In this fashion, in order that the casing 14 can be removed from the mechanism casting, it is necessary first to break the seal, in order to remove the nuts 17, and permit the separation of the casing from the mechanism casting.

Projecting through the tubes 15 and the nuts 17 are the holding rods 5, on the threaded outer end 6 of each of which is a holding nut 21, for clamping the relay, including the casing, onto the rods 5.

With the arrangement as just described, it is obvious that the relay can be bodily removed from the relay rack member 1, by merely removing the nuts 21, and without breaking any seal. If, however, it is desired to remove the casing from the mechanism casting, the seal must be broken in order to permit removal of the holding nuts 17.

The magnetic structure employed in this relay is of the type shown and described in the patent to W. K. Howe, No. 1,882,846, granted October 18, 1932, and accordingly, need not be described in any great detail in the present specification. In brief, the magnetic structure involves a V-shaped or two legged member 22, having a back strap 22b and the two legs 22a, 22a, of laminated magnetic steel, connected to the casting by screws 23, and carrying an energizing winding 24, connected to an external source of energy by two wires 25. Facing the ends of the two legs 22a of core 22, is a three legged laminated core structure 26, having the two outside legs 26a, 26a and carrying a coil 27 on the middle leg, and energized from an external source by wires 28. The facing ends of the legs of the core structures can be seen best in Fig. 2, at 22a and 26a, and these cores are spaced to leave a slot 31 therebetween, for receiving the vane, in the usual manner.

The vane of this relay, together with other parts to be described below, in detail, is carried by spindle 32, supported by the sides 9 and 10 of the mechanism casting, in knife-edge and thrust bearings 33, of the type shown and described in the patent to J. L. Osborne, No. 1,785,702, granted December 16, 1930.

The vane, as can best be seen in Figs. 1 and 2, is constituted by a thin arcuate plate 34, of a non-magnetic material such as aluminum, copper, or the like. This plate, in its dimension toward spindle 32, is relatively narrow, so as to just properly cooperate with the magnetic structure by which it is operated.

For supporting the vane on spindle 32, there are employed two arms, forming a bifurcated arm structure, at each end of the vane, designated, at the left side of Fig. 1, as 35 and 36; the lower ends of the arms 35 and 36 being riveted, at 37, to an end of the vane, with these arms being spaced at their upper ends, where they are received on spindle 32, and spaced by a spacer 38, whereby to make a very strong rigid arm support for the vane, and one which is much less liable to warping and distortion than would be the case if the vane were extended in the usual fashion up to the spindle 32, as a continuous flat thin plate. The two arms at the other end of vane 34, are designated as 39, for convenience in future reference thereto.

While the arms at the two ends of the vane have been referred to as two separate arms in each case, it can be seen from Fig. 7 that these four arms are constituted by two stamped out,

or otherwise formed, members, each having a general V-shape, and being perforated at 40 to receive the spindle 32. Each of these V-shaped members, two of which constitute the two sets of arms for supporting a vane, are perforated at 41 at the outer end of each arm, to receive the rivets 37, above referred to, for fastening the V-shaped member to the vane. On one of the arms, such as 36, for example, is a support plate 42, pressed at right angles to the plane of the arm, with the other arm, as 39, having a projecting lug 43, whereby when two of the V-shaped members are placed together, and back to back, as in their assembled position as seen in Fig. 1, for example, a support is furnished in the case of each pair of arms, for each end of the vane, for supporting a stop member such as 44 and 45 respectively at the left and right of Fig. 1, for a purpose to be more completely described below. These stop members 44 and 45 are fastened to the plates 42 by rivets or the like, passing through holes 46 in plate 42.

Carried by spindle 32, is the vane 34, as described just above, which vane is supported by an arrangement of parts which can be conveniently designated as a vane assembly VA. Also carried by this spindle 32, is a contact operating assembly CA, and a biasing weight assembly BA.

The contact operating means can be best seen from Fig. 1, and is constituted by a contact operator 47, connected by a pin 48, to a crank arm 49, on the contact operating assembly CA, and its lower end is connected, by means of notches 50, to movable contact fingers 51 and 52 which carry rollers 53 receivable in the notches. At the outer ends of the contact fingers 51 and 52, are low resistance metal contact points 54, made preferably of silver, and these cooperate with fixed contacts 55 of copper impregnated carbon, or the like, carried by contact fingers 56, having usual pressure and stop plates 57 and 58 respectively. The contact fingers are carried in a block of molded insulating material 59, supported in the mechanism casting at 60 and 61. The contact fingers have projections, such as 62 and 63, to form a socket to receive a plug 64, for electrically connecting each contact finger with a separate wire, as 65 and 66, extending to the rear of the relay rack section 1.

At a point near the contact carrying block 59, the contact fingers 51 and 52 are milled out, as at 51² and 52², to a thinner dimension, whereby to substantially produce a pivot at this point. In this manner the contact fingers 51 and 52 at their outer ends are relatively rigid, and hence build up a contact pressure with the fixed contacts without any material amount of flexing at their outer ends. With this construction it is possible to build up proper contact pressure without the expenditure of an undue amount of energy.

It is obvious that with the arrangement of parts just described, in connection with the operation of the contacts, upon spindle 32 being rocked, the operator 47 will be raised or lowered, and the contacts will be correspondingly operated, in the usual manner.

The vane of this relay is biased to a normal deenergized position, as shown in Fig. 1, with the lower pair of contacts closed, and the upper pair of contacts open. This is accomplished by means of a biasing weight 67, constituted by a plurality of washers, or the like, 68, so that the weight can be readily varied in amount. The washers are held together by a screw 69, con-

necting the washers to extending arms 70 and 71, which are pivoted on a pin 72, carried by one side of the mechanism casting, and by an inwardly extending boss 73 on the casting. As best seen in Fig. 6, a connecting arm 74 is pivoted, at 75, between the arms 70 and 71, and at its upper end 105, the arm terminates in a loop received over a knife-edge bearing 76, carried by the biasing means assembly.

With the arrangement of parts just described in connection with the biasing means, it can be readily seen that the biasing weight 67 tends to rock the arms 70 and 71 on the fixed pivot 72, and by means of the crank 77 which carries the knife edge bearing 76, tends to rock the spindle 32 in a clockwise direction as viewed in Fig. 6. Thus, the vane upon being moved to its operated position, and away from its biased position, must raise the biasing weight, and upon deenergization, the biasing weight moves the vane back again to its normal biased position, all as will appear more clearly in the description to follow.

In order to limit the movement of the vane in either its operated movement, or its biased movement, a stop or damping means is employed which can conveniently be termed a bumper. This bumper, as best seen in Figs. 1 and 2, is constituted by a tube 107, of steel or other suitable material, extending between the two sides of the mechanism casting and held in place by an elongated screw 78 which passes through the side 9 of the casting and is threaded into the side 10 of the casting at 79, with the tube loosely received on the screw. By tightening up on the screw the sides of the casting can easily be sprung to rigidly grip the tube in place, and if necessary shims or washers can be employed so that the tube is rigidly held in position.

This tube 107 passes across the casting at right angles to the plane of the vane, and is positioned between the two vane legs 36 and 39, and in line with the path of movement of the two stops 44 and 45, which are fastened to the supporting legs for the vane.

Constituting the bumper proper is a thin cylinder 80, of sulphur containing rubber, which is molded directly onto the steel tube 107, and over this is a cylinder of non-sulphur containing rubber 81, which is molded directly onto the rubber 80 and extends at the ends 82, beyond the rubber 80, so as to completely cover the sulphur containing rubber. Carried by the rubber member 81 is a band, 83, of metal, such as steel or the like, which is molded into the rubber, and held securely in place by an inwardly projecting ring 84. This bumper ring 83 is positioned directly in line with the path of movement of each of the stops 44 and 45, whereby, as can be clearly seen from Fig. 1, the contacting of these stops with the rubber bumper defines the limiting positions of the vane member.

As shown in Fig. 1, the relay is deenergized and the biasing weight 67 has moved the vane to a position where the stop 45 is contacting with the bumper ring 83. Upon energization of the relay, the vane will swing to the right, as viewed in Fig. 1, to bring stop 44 into contact with ring 83. By employing a mass of rubber of relatively large volume, the energy contained in the moving parts can be readily and quickly absorbed by the mass of rubber and thus prevent any great amount of rebound or sharp shock. By employing the steel bumper ring 83, the energy is transferred around the ring and throughout the entire mass of rubber in a manner which

would not occur were the stop 44, for example, to strike directly on the rubber. Also, the steel ring prevents undue wear on the rubber and greatly prolongs the operative life of the bumper.

With regard to the construction of the rubber bumper, it is to be noted that with the silver contact members employed in this relay, any sulphur containing rubber which were exposed to atmosphere, would have a very harmful and corrosive effect on the contact members, and quickly reduce their conducting capacity very greatly. To prevent this, the exposed rubber is non-sulphur containing, as set forth above. Non-sulphur containing rubber, however, does not bond with metal, such as steel, and accordingly, by first employing a thin cylinder of sulphur containing rubber which readily bonds with the steel, the non-sulphur containing rubber, constituting the bulk of the bumper, can be readily molded onto the rod by way of the sulphur containing rubber, with the steel ring held in place largely by the inwardly projecting ring 84, since the steel ring does not readily bond with the non-sulphur containing rubber 81. In this manner, the sulphur containing rubber is completely enclosed in the other rubber, and hence can produce no harmful effect on the silver contacts, and at the same time, the entire bumper becomes a molded mass of rubber, cheaply and efficiently and securely molded in place so as to constitute a long lived and efficient bumper member.

It has been found in practice that the positioning of the biasing member with respect to the vane member is very critical, and in assembling the relay it is necessary to adjust these two members relatively to each other in a very accurate manner. Thus it is very desirable to have adjusting means between the biasing member assembly and the vane assembly. This adjusting means is afforded in the following manner.

It can be seen from Fig. 2, that the contact operating assembly, at its inner end, has a disc-like head 85, against which bears one of the V-shaped arm members of Fig. 7, such for example, as the member 35 in Fig. 2. Next to this arm 35 is the spacer 38, and against the spacer is the other arm, such as 36. Against this arm 36 is a spacer 86, and, it should be noted, the two arms 35 and 36 and the two spacers 38 and 86 are threaded, not directly on the spindle 32, but on a tubular extension 87 which is integral with the head 85. In this assembly, the tubular member 87 extends slightly beyond the spacer 86 and is headed over or upset, as shown, to tightly interconnect the vane assembly and the contact assembly.

Against spacer 86, bears the head member 88, which is integral with the biasing means assembly BA, and between the crank 77, and this head 88, is a washer 89, which has a large enough opening in it to allow it to be passed over the crank 77. Screws 90 are employed to connect the biasing means assembly to the vane assembly, and these screws 90 screw into tapped openings 91 in the head 85 and pass through openings which snugly fit the screw in the vane arms and the spacers 38 and 86 and through a snug opening 92 in the washer 89. In the head 88, however, is an enlarged opening 93 which is considerably larger than the body of the screw, and hence permits rotation of the biasing means assembly around the shaft with respect to the other two assemblies due to this loose fit of the opening 93 on the screw 90. In this manner the biasing means assembly can be adjusted angu-

larly on the spindle 32 with respect to the other assemblies and then the screw can be tightened up to hold the parts in adjusted position.

As an added means for holding these parts in adjusted position, it will be noted that the washer 89, having a snug fit on the screw 15, in effect, anchored to the screw, and thus by depressing, or forcing, a portion of the washer into an edge groove 94, in head 88, the parts can be additionally locked in position. This can be readily appreciated when it is noted that the screws 98 are fixed in position with respect to the vane assembly, and the contact operating assembly, and that the washer 89 is fixed in position with respect to the screws, so that by deforming the washer, the washer can be fixed in position with respect to the head 88 integral with the biasing means assembly. Thus the three assemblies are rigidly fixed in position with regard to angular movement around the shaft and should it be necessary to remove the biasing means assembly for any reason, as for inspection or repair, due to the deformed washer 89, the parts can be readily reassembled in the exact position which they previously had assumed.

The various assemblies carried on spindle 32 are held in fixed position on the spindle by means of a cotter pin, or the like, 95, and the pivot pin 48, for the contact operator, is driven, or otherwise positioned, in the crank 49, and is held from accidental withdrawal therefrom, by a screw 96, carried by the contact assembly CA. In a similar manner the pivot pin 72, for the biasing means, is held against accidental withdrawal by means of a pin 97, positioned in the mechanism casting.

If desired, a name plate such as 98, carrying various data, can be fastened, as at 99, to the front of the bottom 8 of the mechanism casting, so as to be readily visible from the front of the relay through the transparent casing.

The above described relay is a vane type relay of the two-position type, whereby, upon energization it will move to an energized position, and upon deenergization, the biasing means will move it to its normal deenergized position.

In Fig. 4, is a slightly different form of relay, that is, a three-position vane type relay, which has an energized position on each side of its biased deenergized position. Since many of the parts of this three-position relay are identical with the two-position relay, just described, the description of this three-position relay will be largely confined to those features which are distinctive to the three-position characteristics.

Referring now to Fig. 4, the magnetic structure here involved is identical with that described in connection with the two-position relay, as is also the mechanism casting, the contact fingers and their operating means, and the vane and its supporting legs; and accordingly, these parts have been given the same reference characters, but each with a distinctive exponent, as have been used in connection with the two-position relay.

Referring to Fig. 4, it can be seen that with the contacts shown with the relay in its deenergized position, both sets of contacts are open. Upon energization in one direction, one set of contacts will close, and upon energization in the other direction, the other set will close. Of course, to produce the opposite energizations, it is merely necessary to reverse the polarity of one of the two operating coils with respect to the other, to thereby cause a shifting field in the op-

posite direction, all as is well understood to those skilled in this particular art.

Referring to Fig. 5, there is here shown a knife-edge bearing employed in connection with the three-position relay. As before, the biasing weight is carried by the arm 70¹, which is pivoted, as before, at 72¹, and carries an arm 108, pivoted at its lower end, at 75¹, and carries at its upper end, a loop 109, having two spaced bearings 100 and 101, for receiving, respectively, the two spaced knife-edges 102 and 103, the knife-edges being carried by a crank 77¹, as before, and being a part of the biasing means assembly, as before.

In order to permit of proper operation in the case of the three-position relay, the stop 44 of the two-position relay has been replaced by a shorter stop 104, similar to the stop 45¹ employed on the other side of the rubber bumper 83¹.

With the structure as described above, it can be readily seen that, when deenergized, the biasing weight will move downwardly to cause loop 109 to bear symmetrically on the two knife-edges 102 and 103, and to position the vane in a central position, with an equal distance between the rubber bumper 83¹ and the opposite leg stops 104 and 45¹. Upon energization in one direction or the other, spindle 32¹ will rock the spaced double knife-edges carried by crank 77¹, so as to lift the biasing weight and cause one of the knife-edges to leave its bearing. For example, if spindle 32¹, as viewed in Fig. 5, is rocked clockwise, the knife-edge 103 will leave its bearing 101 while the knife-edge 102 will operate to lift the connecting arm 108, and with it the biasing weight. The spindle 32¹, of course, in rocking, will operate through its connecting crank 49¹ and pin 48¹ to move the contact operator 47¹, and in this case in a downward direction, to close the lower pair of contacts.

As described above, there has been produced a vane type relay of the two-position, and the three-position type, wherein a biasing means is carried on a knife-edge bearing, to thus avoid undue wear on this bearing, which, of necessity, must receive relatively heavy pressures.

Furthermore, the single biasing means serves to bias the three-position relay from either of its extreme operated positions, to the identically same neutral position, due to the particular arrangement of spaced double knife-edges.

Also, a rigid mounting means has been provided for the vane whereby to avoid warping and distortion of the vane within the relatively narrow slot through which it must function to be economical in operation, and thus avoids binding and undesirable stresses.

Again, a compact arrangement of parts has been provided whereby to remove the casing from the mechanism and casting, a seal must be broken, but to remove the relay from its supporting rack, no seal need be broken, and this arrangement of parts is constituted primarily by supporting rods passing through tubular members on the mechanism casting with both the rods and the tubular members passing through the relay casing.

Still again, a compact and dependable adjusting means has been provided between the biasing means assembly, and the assemblies for the contact operation and the vane operation, whereby to permit accurate adjustment of these parts in assembly, with rigid maintenance of the parts in proper position, and the ability of duplicating

the adjusting position if, after assembly, it should prove desirable to separate these parts.

The above rather specific description of two forms which this invention can assume, has been given solely by way of example, and is not intended, in any way whatsoever in a limiting sense. Furthermore, it is to be understood that all such variations and modifications, as come within the scope of the appended claims, are intended to be covered and protected by the present application.

Having described my invention, I now claim:

1. In a vane relay, in combination, a support, an electro-magnetic operating means in the support, a vane operatively positioned with respect to the operating means and constituted by an elongated plate of thin metal, a spindle pivotally supported in the support and positioned above, and at substantially right angles to the plane of, the vane, and spaced from the upper edge of the vane, and a relatively rigid arm at each end of the vane, each connected at one end to the vane, and at its other end connected to the spindle so as to connect the vane to the spindle, each said arm comprising two rigid arm members spaced apart from each other at the upper ends, where received on the spindle, to form a truss-like, bifurcated, connecting means.

2. A relay bumper member for preventing rebound and absorbing kinetic energy of an armature, comprising, an armature movable in a given path, a support rod positioned with one portion in said path, a cylinder of live rubber moulded onto the rod at said portion, and a rigid metal band connected to, and encircling, the rubber cylinder and constituting the striking member of the bumper.

3. A relay bumper member for preventing rebound and absorbing kinetic energy of a movable part, comprising, a support rod, a cylinder of live rubber moulded onto the rod, and a rigid metal band connected to, and encircling, the rubber cylinder and constituting the striking member of the bumper, said cylinder of rubber comprising an inner relatively thin cylinder of sulphur containing rubber moulded directly onto the rod, and a relatively thick cylinder of sulphur free rubber moulded onto, and completely covering, the thin cylinder, said metal band having an inwardly extending annular flange on its inner face embedded in the said thick cylinder.

4. In a vane relay, in combination, a support member, an electro-magnetic operating means in the member, a vane operatively positioned with respect to the operating means and constituted by an elongated plate of thin metal, a spindle pivotally supported in the member and positioned above, and at right angles to the plane of, the vane, and spaced from the upper edge of the vane, a rigid arm at each end of the vane each connected at one end to the vane and at its other end to the spindle, so as to connect the vane to the spindle, a stop on the inner side of each of said arms, a rod carried by the member and extending parallel with the spindle and between the two arms, and a bumper fixed to the rod and positioned in the path of movement of both of the stops as the vane moves in one direction or the other.

5. In a vane relay, in combination, a support, an electro-magnetic operating means in the support, a vane operatively positioned with respect to the operating means and constituted by an elongated plate of thin metal, a spindle pivotally supported in the support and positioned above,

and at right angles to the plane of, the vane, and spaced from the upper edge of the vane, a rigid arm at each end of the vane and each connected at one end to the vane and at its other end to the spindle to connect the vane to the spindle, each said arm comprising two rigid arm members spaced apart at their upper ends where received on the spindle to form a truss-like, bifurcated, connecting means, a stop on the inner side of each of said arms, a rod carried by the support and extending parallel with the spindle and between the two arms, and a bumper fixed to the rod and positioned in the path of movement of both of the stops as the vane moves in one direction or the other.

6. In a vane relay, in combination, a support, an electro-magnetic operating means in the support, a vane operatively positioned with respect to the operating means and constituted by an elongated plate of thin metal, a spindle pivotally supported in the support and positioned above, and at right angles to the plane of, the vane, and spaced from the upper edge of the vane, a rigid arm at each end of the vane and each connected at one end to the vane, and at its other end to the spindle to connect the vane to the spindle, each said arm comprising two rigid arm members spaced apart at their upper ends where received on the spindle to form a truss-like, bifurcated, connecting means, a stop on the inner side of each of said arms, a rod carried by the support and extending parallel with the spindle and between the two arms, and a bumper fixed to the rod and positioned in the path of movement of both of the stops as the vane moves in one direction or the other, said bumper comprising a mass of live rubber carried by the rod and a single rigid metal band encircling the rubber and positioned to be struck by both of said stops.

7. In a vane relay, in combination, a support, an electro-magnetic operating means in the support, a vane operatively positioned with respect to the operating means and constituted by an elongated plate of thin metal, a spindle pivotally supported in the support and positioned above, and at right angles to the plane of, the vane, and spaced from the upper edge of the vane, a rigid arm at each end of the vane and each connected at one end to the vane and at its other end to the spindle to fasten the vane to the spindle, each said arm comprising two rigid arm members spaced apart at their upper ends, where received on the spindle, to form a truss-like, bifurcated, connecting means, each of the rigid arm members at one end of the vane being integral, respectively, with an arm member at the other end of the vane, and together constituted by a V-shaped element received on the spindle at the point of the V.

8. In a vane relay, in combination, a support casting, an electro-magnetic operating means in the casting, a vane operatively positioned with respect to the operating means and constituted by an elongated plate of thin metal, a spindle pivotally supported in the casting and positioned above, and at right angles to the plane of, the vane, and spaced from the upper edge of the vane, a rigid arm at each end of the vane and each connected at one end to the vane, and at its other end to the spindle, to fasten the vane to the spindle, each said arm comprising two rigid arm members spaced apart at their upper ends, where received on the spindle, to form a truss-like, bifurcated, connecting means, each of the rigid arm members at one end of the vane

being integral, respectively, with an arm member at the other end of the vane, and together constituting a V-shaped stamped out, element received on the spindle at the point of the V, one leg of each of the V's carrying an integral seat plate bent at right angles to the plane of the V, and the other leg carrying an integral bearing boss extending inwardly from the inner edge of the leg, the seat plate and bearing boss of one V element cooperating, respectively with the bearing boss and seat plate of the other V element, to form a stop support.

9. In a two position vane relay, in combination, a pivoted spindle, a vane on the spindle, electro-magnetic means for operating the vane, a biasing arm, means pivoting one end of the arm to a fixed support, a biasing weight on the other end of the arm, a crank on the spindle, a knife-edge carried by the crank, a hanger pivoted to the arm intermediate the ends thereof, and a socket in the other end of the hanger receiving the knife edge.

10. In a three position vane relay, in combination, a pivoted spindle, a vane on the spindle, electro-magnetic means for operating the vane, a biasing arm, means pivoting one end of the arm to a fixed support, a biasing weight on the other end of the arm, a crank on the spindle, two spaced separate knife edges carried by the crank, a hanger pivoted to the biasing arm intermediate the ends thereof, and two sockets on the other end of the hanger spaced in like manner to the spacing of the knife edges, and respectively receiving the said knife edges.

11. In a three position vane relay, in combination, a pivoted spindle, a vane on the spindle, electro-magnetic means for operating the vane, a biasing arm, means pivoting one end of the arm to a fixed support, a biasing weight on the other end of the arm, a crank on the spindle, two separate spaced knife edges carried by the crank, a hanger pivoted to the biasing arm intermediate the ends thereof, and two sockets on the other end of the hanger spaced in like manner to the spacing of the knife edges and respectively supported on the said knife edges,

said two knife edges, when the magnetic means is deenergized, being positioned in the same horizontal plane, whereby energized movement of the vane in either direction from its neutral position causes one or the other knife edge to leave its socket and causes the biasing weight to be lifted.

12. In a vane relay, in combination, a pivoted spindle, a vane carried by the spindle, electro-magnetic means for operating the vane, a crank on the spindle, a biasing weight connected to the crank, a perforated and peripherally slotted head fixed to, and spaced from, the crank, a perforated head fixed to the vane, a perforated washer on the spindle and between the crank and crank head, a bolt for clamping the vane head to the crank head, the perforations in the washer and the vane head registering for snugly receiving the bolt, the perforation in the crank head being considerably larger than the bolt and receiving the bolt, an upset portion on the washer being received in the peripheral slot in the crank head when the said two heads are in proper assembled position to each other and clamped together by said bolt.

13. In a vane relay, in combination, a pivoted spindle, a vane carried by the spindle, electro-magnetic means for operating the vane, a crank on the spindle, a biasing weight connected to the crank, a head, fixed to, and spaced from, the crank, a head fixed to the vane, a washer on the spindle and between the crank and crank head, a bolt for clamping the vane head to the crank head, registering opening in the washer and the vane head for snugly receiving the bolt, an opening in the crank head considerably larger than the bolt and receiving the bolt, a peripheral slot in the crank head, an upset portion on the washer received in the slot when the said two heads are in proper assembled position to each other and clamped together by said bolt, a contact finger assembly on the spindle, a contact finger, means operatively connecting the finger to the finger assembly, and means rigidly connecting the finger assembly to the vane head.

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