

PATENT SPECIFICATION

DRAWINGS ATTACHED

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COMPLETE SPECIFICATION

Electromagnetic Relay

We, TEXAS INSTRUMENTS INCORPORATED, a Corporation organised according to the laws of the State of Delaware, United States of America, of 13500 North Central Expressway, Dallas 21, Texas, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electromagnetic relays and has for an object to provide an improved construction of electromagnetic relay.

According to the invention, and electromagnetic relay comprises stationary contact means; a bridging contact plunger type sub-assembly comprising a magnetic armature; a shank integral with said armature; a bridging contact element slidably mounted on said shank and engageable with said stationary contact means, said shank including a shoulder portion; a variable rate spring disposed about said shank and interposed between said shoulder portion and said bridging contact element, and a non-magnetic weight member movable with and also relative to said armature.

According to a further feature of the invention, the electromagnetic relay includes a housing having a pair of spaced stationary electrical contacts disposed therein and provided with a hollow cavity in which the said armature is disposed and guided for reciprocating axial movement, the said non magnetic weight member resting on said armature for movement therewith in the said hollow cavity.

In the accompanying drawings, in which one of the various possible embodiments of the invention is illustrated:

Figure 1 is a top plan view of an electromagnetic relay embodying the present invention;

Figure 2 is a front elevational view thereof;

Figure 3 is a view taken on line 3—3 of Figure 2, with the cover removed for clarity of illustration; and drawn to an enlarged scale;

Figure 4 is a top plan view of a cover member for the relay shown in Figure 1;

Figure 5 is a front elevational view of the cover member shown in Figure 4;

Figure 6 is a bottom plan view of the cover member of Fig. 5;

Figure 7 is a sectional view taken on line 7—7 of Figure 2, and drawn to an enlarged scale, showing certain parts in dashed lines in exploded position;

Figure 8 is a sectional view taken on line 8—8 of Figure 2, and drawn to an enlarged scale, showing certain parts in dashed lines in exploded relation;

Figure 9 is a sectional view taken on line 9—9 of Figure 1; and drawn to an enlarged scale;

Figure 10 is a view similar to Figure 9, showing the bridging element and plunger subassembly in contacts-closed position; and

Figure 11 is an exploded perspective view of the electromagnetic relay shown in Figure 1.

Referring now to Figure 1, an electromagnetic relay embodying the present invention is illustrated as being generally indicated by the reference number 20 and includes a casing member 22 and a cover member generally referred to by numeral 24, and best shown in Figures 4—6. Casing member 22 includes beveled lands or projections 25 and 26, and cover member 24 includes a boss or projection 27. Projections 25, 26 and 27 are adapted to interfit and mate with a spring-type bracket (not shown), which when in operative position about the respective projections, will secure and maintain the cover member and casing, and the parts contained thereby, in fixed, operative position.

Relay 20 includes a pair of stationary contacts 30 and 32 carried respectively by ter-

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minals 34 and 36, each of the latter being formed of a suitably electrically conductive material. Relay 20 also includes a third electrically conductive terminal 38, formed of a suitably electrically conductive material. Each of terminals 34, 36 and 38 are slidably received within, and respectively interfit with open-ended guide-way apertures 40, 42, and 44 provided in casing member 22, (as best shown in Figures 3 and 11). Each of apertures 40, 42 and 44 respectively include a pair of upstanding walls 45, 46; 48, 50; 49, 51 which interfit with respectively adjacent side portions of terminals 34, 36 and 38. Upstanding walls 45, 46; 48, 50 and 49, 51, each respectively include sidewall projections 52, 54; 56, 58 and 57, 59 which extend inwardly of casing 22 and respectively guide terminals 34, 36 and 38 for slidable insertion thereof into casing 22. Each of sidewall projections 52, 54; 56, 58 and 57, 59 also include inwardly projecting and opposed boss or shoulder portions 60, 62; 64, 68 and 65. Terminals 34, 36 and 38 are respectively supported on bosses 60, 62; 64, 68 and 65 and are maintained in spaced relation with respect to interior surface 69 of casing 22, as best seen in Figures 7 and 9. As best seen in Figures 3 and 11, each of apertured guideways, 40, 42 and 44 include pairs of recessed corner portions 70, which mate and interfit with pairs of projections 72 respectively provided on each of terminals 34, 36 and 38 to limit the extent of inward insertion thereof into casing 22.

Each of terminals 34, 36 and 38 are also respectively provided with an aperture 73, 74 and 76, within which projections 78, 80 and 82 are respectively disposed. Projections 78, 80 and 82 are fixedly carried by cover member 24 and extend through the respective apertures 73, 74 and 76 to facilitate alignment of the respective terminals and casing member maintain these parts in fixed, assembled relation, and prevent longitudinal movement of the respective terminals within their respective apertured guideways. Sidewalls 45, 46; 48, 50 and 49, 51 and their respective sidewall and shoulder projections, co-operate with the respective adjacent side portions of terminals 34, 36 and 38 to prevent rotation of these terminals about the axis of their respective interfitting projections 78, 80 and 82. Casing member 22 provides a recess in the form of a socket 84, as best seen in Figure 8, which interfits with projection 92 carried by cover member 24, and co-operates therewith to align and maintain cover member 24 and casing 22 in fixed assembled relation.

Referring now to Figures 4-6, cover member 24 includes two upstanding projections 90 and 92 which respectively carry pro-

jections 78 and 80. Projections 90 and 92 are respectively slidably received between pairs of upstanding opposed walls 94, 96 and 98, 100, provided by casing 22, as best seen in Figures 3 and 9. Cover member 24 further includes a plurality of transversely extending spaced shoulder portions 102, 104, 106, 108 and 110, which interfit with and rest on complementary shaped recess portions provided in casing 22, so as to facilitate alignment of and maintain the cover member 24 and casing 22 in relatively fixed, assembled relation. It is to be noted that cover member 24, because of the various projections, i.e. 78, 80, 82, 90 and 92, and the plurality of spaced shoulder portions advantageously preclude inadvertent misorientation of the cover member and casing.

Casing 22 is provided with a cylindrical bore for cavity 112, which is adapted to receive an armature and a non-magnetic weight of a plunger subassembly designated generally by numeral 120 for reciprocal sliding movement therein. The plunger subassembly includes a two-part plunger, one part comprising a magnetic armature and the other part comprising a non-magnetic weight, as will be described in greater detail below.

As best seen in Figures 9-11, the plunger subassembly 120 comprises a cylindrical armature 122 formed of a suitable magnetic material. Formed integrally with armature 122 is a shank 124 of considerably reduced diameter. Shank 124 is provided with a beveled reduced diameter portion 126 at its free end, and includes a recessed annularly extending shoulder portion 128. An apertured movable bridging contact member 130 is slidably mounted on shank portion 124. Bridging contact member 130 includes a main body portion 132 and a pair of spaced contact arms 134 and 136. Fixedly mounted and electrically connected to the contact arms 134 and 136 is a pair of electrical contacts 142 and 140 respectively which mate with respective stationary contacts 32 and 30. Bridging member 130 is preferably formed of a high electrical conductivity material such as beryllium copper alloy.

Contact arms 134 and 136 lie in a plane off-set from the plane of the main body portion 132 of the element, as best seen in Figures 9, 10 and 11. Upstanding portions 146 and 148, which interconnect the contact arms 136 and 134 respectively with the main body portion, are made flexible. The flexible nature of connecting portions 146 and 148 and the inherently resilient nature of the bridging element, advantageously increases the tendency for contact wiping to clean the respective pairs of contacts 30, 140 and 32, 142 upon contact closing.

Further, the offset contact arms isolate each of the pairs of contacts 30, 140 and 32, 142 into separate "compartments" formed for ex-

ample, respectively by walls 94, 96 and 98, 100 of casing 22 on each of opposite sides of the plunger receiving well or hollow portion 112. Isolating the relative pairs of contacts is advantageous for preventing the formation of a low resistance current path which might be formed by particles thrown off from the contacts, or by deterioration of other parts due to arcing in a manner well known. Contact arms 134, and 136, being of reduced width (see Figure 8) advantageously avoid physical contact with the side walls of the interior portion of casing 22, thus decreasing the effect on the side walls of arcing which tends to break down the wall material and providing more space for contact particles to build up on the side walls before physical contact is made between the contact arms and the built-up material on the side walls thereby minimising the formation of a low resistance short circuiting path and minimising the possibility of undesirable changes in calibration due to undesirable friction caused by rubbing contact between the contact arms and the side walls. Bridging contact member 130 has an aperture 150, as best seen in Figure 9, within each shank portion 124 is loosely disposed.

Circumferentially disposed about shank portion 124 is a spring 154 located intermediate the bridging member 130 and the annularly extending shoulder portion 128 adjacent the free end of shank 124. Spring 154 urges bridging member 130 upwardly, as best seen in Figure 9, into engagement with the lower surface 156 (see figure 10) of armature 122 and in a contact-closing direction. One end 158 of spring 154 engages the underside of bridging member 130 and the opposite end 160 of reduced diameter engages shoulder portion 128 of shank 124, as best seen in Figures 9 to 11. Spring 154 is of the type which has a variable spring rate, i.e. the force required for unit deflection of the spring increases with increased deflection or compression of the spring. The variable rate spring advantageously limits contact bounce so as to permit operation of the relay over a wide range of current values. By comparison, when a spring at a given uniform spring rate is employed, the relay may, for example, operate satisfactorily at a low operating current value. However, at a higher current value, unsatisfactory performance might be encountered because of such undesirable effects as high contact bounce, chatter, etc. which would be experienced at this higher operating current value. These undesirable effects are advantageously obviated, or at least minimised, by the plunger subassembly of the present invention. Further the construction of the plunger subassembly thus far described, advantageously facilitates rapid sub-assembly. All that is necessary to provide the plunger subassembly 120 is to slidably

place the bridging contact member about stem portion 124 and to slidably insert spring 154, which quickly snaps into place with portion 160 abutting shoulder portion 128.

The plunger subassembly of the present invention further includes a separate weight or slug 162, as best seen in Figures 9—11, for a purpose to be described below. Slug or weight 162 may be formed of a diameter corresponding to that of armature 122 and may be formed of a non-magnetic material such as, for example, silicon bronze, brass, or stainless steel.

Referring now to Figures 9 and 10, slug 162 and armature 122 are slidably received in the cylindrical cavity 112 provided by casing 22 as shown. Casing 22 further includes an external cylindrical portion 168 and a flange 170, which provides a spool for an energizing coil 172. Disposed about cylindrical portion 168 is a plurality of mutually insulated turns of electrically conductive wire forming the coil 172. As best seen in Figure 2, one end of coil 172 is electrically connected to terminal 34 and the other end is electrically connected to terminal 38. Cylindrical spool portion 168 serves a dual function of providing a spool for the energizing coil 172 and also providing a housing and guide for armature 122 and slug or weight 162, and obviates the necessity for other intricate and complex guiding members for the one-piece armature and stem. Such features as nylon bushings and stem guides which are ordinarily or conventionally required for proper guidance of the reciprocating armature are advantageously eliminated by the arrangement of the present invention.

When coil 172 is electrically energized, magnetic armature 122 will be moved upwardly in the direction of the arrow, as shown in Figure 10, to close the contacts 140, 30 and 142, 32. The non-magnetic slug 162 will also be moved upwardly in the direction of the arrow, as shown in Figure 10. Non-magnetic slug 162 adds weight to the plunger subassembly so as indirectly to increase contact pressure respectively between contacts 30, 140 and 32, 142. The increase in weight afforded by the non-magnetic slug 162 necessitates a greater number of ampere turns to lift the armature and the additional weight, and the contact pressure is consequently increased. Added weight 162 is further advantageous in facilitating drop-out and opening of the contacts and provides a greater force for breaking welds which may have formed between the respective pairs of contacts.

As the bridging element 130 moves upwardly sufficiently so that contacts 140, 30 and 142, 32 mate, movement of the armature 122 and the bridging element 130 will be momentarily arrested. However, weight or slug 162 because of its momentum, will continue to move upwardly and momentarily

leaves armature 122 thus temporarily relieving the armature 122 from the burden of supporting this weight. Armature 122 will then again move upwardly under a temporarily increased net upward force on the armature. This temporary increased upward force on the armature (i.e. before the weight or slug 162 returns downwardly to be again supported by the armature 122) advantageously increases contact pressure or contact sealing pressure at the time of contact making, and thereby minimizes contact resistance, heat generation, and the tendency of contact welding.

Further, the fact that the weight or slug 162 temporarily separates from the armature 122 by its continued movement upon contact making advantageously tends to stabilize the plunger subassembly to reduce vibration and also to minimize contact bounce. Non-magnetic slug or weight 162, after leaving armature 122, will continue to move upwardly and strike the surface 180 at the upper extremity of cavity 112 (see Figure 10). Thereafter, it will move downwardly into supporting engagement with armature 122. Thus, slug 162 dissipates at least part of the kinetic energy or momentum developed by the plunger subassembly in moving from a contacts-open to a contacts-closed position, at least a part of which is absorbed by the casing when the slug 162 strikes surface 180. This partial energy dissipation advantageously obviates or at least minimizes contact chatter and bounce and also vibration to which the plunger subassembly is subjected.

Cover member 24, as best seen in Figures 4, 8, 9, 10 and 11, includes a cylindrical hollow cavity 190 which receives the lower stem portion 124 and spring 154 of plunger subassembly 120 for reciprocal sliding movement therein. Adjacent the outer portion of cylindrical cavity 190 are a pair of spaced projecting abutments 192 and 194 which are adapted to engage the underside of the main body portion 132 of bridging element 130 to support the latter in the contacts-open position, as best seen in Figure 9. Cover member 24 further includes a pair of spaced deep recesses or pockets 196 and 198 for the purpose of receiving matter such as contact particles or casing material which is broken down during arcing. Casing member 22 is further provided with a plurality of projecting ribs 200 having recessed portions therebetween which are adapted to collect such contact particles and are thus effective to prevent the undesirable formation of a low-resistance current path which might be formed by such particles. Cylindrical cavity 112 is likewise provided with a plurality of axially extending circumferentially spaced rib projections 202. Rib projections 202, in addition to advantageously obviating the formation of a low resistance path, also provide

line contact for engagement with slug 162 and armature 122 thereby minimizing surface-to-surface contact. Projections 202 thus prevent or at least minimize binding or resistance to slidable reciprocating movement of the armature 122 and slug 162 within the cavity.

The electromagnetic relay 20 thus far described permits mass production of a variety of subassemblies which may be quickly and easily assembled together in final adjusted position.

Referring now to Figure 11, wherein the relay is illustrated in an exploded perspective view, it can be seen that to assemble the relay in operative conditions, it is only necessary to do the following:

(1) Slidably insert each of terminals 34, 36 and 38 in their respective aperture guideways.

(2) Drop or place slug 162 into cavity 112.

(3) Place or drop armature 122 of the plunger subassembly 120 (which is assembled in the manner described above, by slidably inserting bridging contact 130 about stem 124 and slidably disposing spring 154 about stem 124 with the end 160 of spring 154 snapping in place about shoulder 128 on stem 124).

(4) Once the terminals, slug 162 and plunger subassembly 120 are all in place in casing 22, it is now merely necessary to insert cover member 24 into operative position, as shown in Figure 9, whereby projections 78, 80 and 82 will interfit with their respective apertures in terminals 34, 36 and 38 to secure them firmly in place.

(5) It is then only necessary to apply a mounting bracket, as hereinbefore described to firmly secure the assembled apparatus and maintain the same in final assembled relation.

WHAT WE CLAIM IS:—

1. An electromagnetic relay comprising stationary contact means; a bridging contact plunger type subassembly comprising a magnetic armature; a shank integral with said armature; a bridging contact element slidably mounted on said shank, and engageable with said stationary contact means, said shank including a shoulder portion; a variable rate spring disposed about said shank and interposed between said shoulder portion and said bridging contact element, and a non magnetic weight member movable with and also relative to said armature.

2. An electromagnetic relay according to claim 1 and comprising a housing having a pair of spaced stationary electrical contacts disposed therein and provided with a hollow cavity in which the said armature is disposed and guided for reciprocating axial movement, the said non magnetic weight member resting on said armature for movement therewith in the said hollow cavity.

3. An electromagnetic relay according to

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- leaves armature 122 thus temporarily relieving the armature 122 from the burden of supporting this weight. Armature 122 will then again move upwardly under a temporarily increased net upward force on the armature. This temporary increased upward force on the armature (i.e. before the weight or slug 162 returns downwardly to be again supported by the armature 122) advantageously increases contact pressure or contact sealing pressure at the time of contact making, and thereby minimizes contact resistance, heat generation, and the tendency of contact welding.
- Further, the fact that the weight or slug 162 temporarily separates from the armature 122 by its continued movement upon contact making advantageously tends to stabilize the plunger subassembly to reduce vibration and also to minimize contact bounce. Non-magnetic slug or weight 162, after leaving armature 122, will continue to move upwardly and strike the surface 180 at the upper extremity of cavity 112 (see Figure 10). Thereafter, it will move downwardly into supporting engagement with armature 122. Thus, slug 162 dissipates at least part of the kinetic energy or momentum developed by the plunger subassembly in moving from a contacts-open to a contacts-closed position, at least a part of which is absorbed by the casing when the slug 162 strikes surface 180. This partial energy dissipation advantageously obviates or at least minimizes contact chatter and bounce and also vibration to which the plunger subassembly is subjected.
- Cover member 24, as best seen in Figures 4, 8, 9, 10 and 11, includes a cylindrical hollow cavity 190 which receives the lower stem portion 124 and spring 154 of plunger subassembly 120 for reciprocal sliding movement therein. Adjacent the outer portion of cylindrical cavity 190 are a pair of spaced projecting abutments 192 and 194 which are adapted to engage the underside of the main body portion 132 of bridging element 130 to support the latter in the contacts-open position, as best seen in Figure 9. Cover member 24 further includes a pair of spaced deep recesses or pockets 196 and 198 for the purpose of receiving matter such as contact particles or casing material which is broken down during arcing. Casing member 22 is further provided with a plurality of projecting ribs 200 having recessed portions therebetween which are adapted to collect such contact particles and are thus effective to prevent the undesirable formation of a low-resistance current path which might be formed by such particles. Cylindrical cavity 112 is likewise provided with a plurality of axially extending circumferentially spaced rib projections 202. Rib projections 202, in addition to advantageously obviating the formation of a low resistance path, also provide line contact for engagement with slug 162 and armature 122 thereby minimizing surface-to-surface contact. Projections 202 thus prevent or at least minimize binding or resistance to slidable reciprocating movement of the armature 122 and slug 162 within the cavity.
- The electromagnetic relay 20 thus far described permits mass production of a variety of subassemblies which may be quickly and easily assembled together in final adjusted position.
- Referring now to Figure 11, wherein the relay is illustrated in an exploded perspective view, it can be seen that to assemble the relay in operative conditions, it is only necessary to do the following:
- (1) Slidably insert each of terminals 34, 36 and 38 in their respective aperture guideways.
 - (2) Drop or place slug 162 into cavity 112.
 - (3) Place or drop armature 122 of the plunger subassembly 120 (which is assembled in the manner described above, by slidably inserting bridging contact 130 about stem 124 and slidably disposing spring 154 about stem 124 with the end 160 of spring 154 snapping in place about shoulder 128 on stem 124).
 - (4) Once the terminals, slug 162 and plunger subassembly 120 are all in place in casing 22, it is now merely necessary to insert cover member 24 into operative position, as shown in Figure 9, whereby projections 78, 80 and 82 will interfit with their respective apertures in terminals 34, 36 and 38 to secure them firmly in place.
 - (5) It is then only necessary to apply a mounting bracket, as hereinbefore described to firmly secure the assembled apparatus and maintain the same in final assembled relation.
- WHAT WE CLAIM IS:—
1. An electromagnetic relay comprising stationary contact means; a bridging contact plunger type subassembly comprising a magnetic armature; a shank integral with said armature; a bridging contact element slidably mounted on said shank, and engageable with said stationary contact means, said shank including a shoulder portion; a variable rate spring disposed about said shank and interposed between said shoulder portion and said bridging contact element, and a non magnetic weight member movable with and also relative to said armature.
 2. An electromagnetic relay according to claim 1 and comprising a housing having a pair of spaced stationary electrical contacts disposed therein and provided with a hollow cavity in which the said armature is disposed and guided for reciprocating axial movement, the said non magnetic weight member resting on said armature for movement therewith in the said hollow cavity.
 3. An electromagnetic relay according to



- 5 claim 2 wherein the said non magnetic weight member has a cross sectional configuration corresponding to that of the said hollow cavity and is movable with said armature in each of two opposite directions within said hollow cavity.
- 10 4. An electromagnetic relay according to claim 3 wherein after the armature and the weight member have moved together a pre-determined amount in one of said directions, the weight member is movable relative to the armature a further amount in said one direction.
- 15 5. An electromagnetic relay according to claim 6 wherein the end of said hollow cavity closest to said weight member provides a stop to limit said further movement of the weight member in said one direction.
- 20 6. An electromagnetic relay according to any of claims 2 to 5 wherein the said hollow cavity is provided with axially extending circumferentially spaced rib projections.
- 25 7. An electromagnetic relay according to any of claims 2 to 6 wherein the said bridging contact element comprises a main body portion which is slidably disposed about said shank and includes a pair of spaced contact arms each disposed in a plane offset from the plane of said main body portion.
- 30 8. An electromagnetic relay according to claim 7 wherein said arms are offset from said main body portion in a direction towards said stationary contacts.
9. An electromagnetic relay according to any of claims 2 to 8 wherein the said housing comprises first and second casing members, and wherein one of the said casing members houses the said stationary contacts, and is also formed to provide the said cavity, the other of said casing members providing a cover member for said one casing member, there being provided an energising coil for said armature and disposed exteriorly of said hollow cavity.
- 40 10. An electromagnetic relay according to claim 9 wherein the said one casing member is provided with a pair of spaced open-ended guide-way apertures, in each of which there is received a terminal having an aperture adjacent one free end thereof, and carrying a respective one of said stationary contacts adjacent said aperture, the said cover member including a pair of projections each of which is received within the aperture of a respective one of said terminals to align and maintain the terminals in fixed assembled relation.
- 55 11. An electromagnetic relay substantially as hereinbefore described with reference to the accompanying drawings.
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