

June 29, 1954

H. M. KNAPP ET AL
ELECTROMAGNETIC RELAY

2,682,585

Filed May 24, 1952

FIG. 1

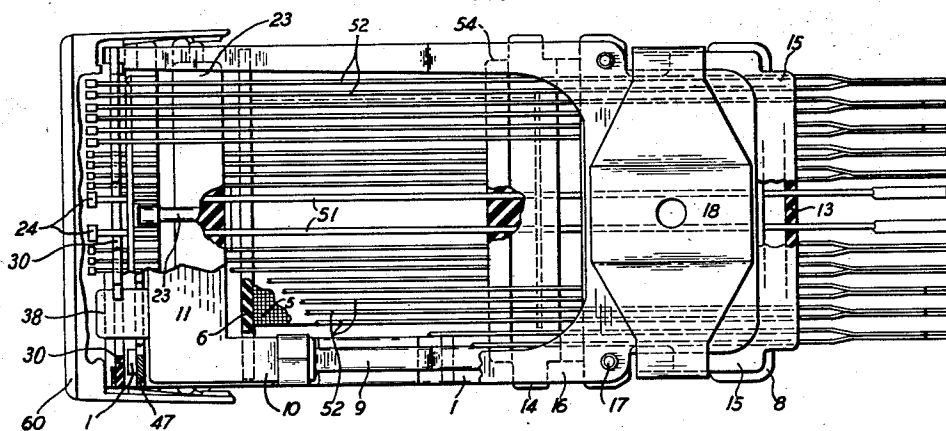


FIG. 2

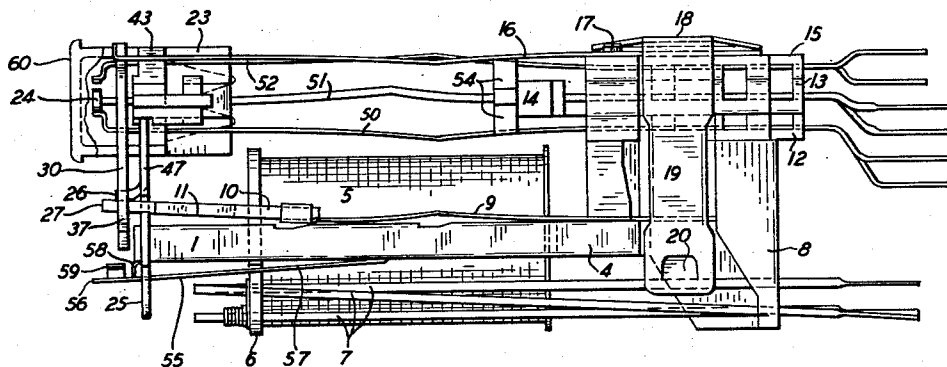
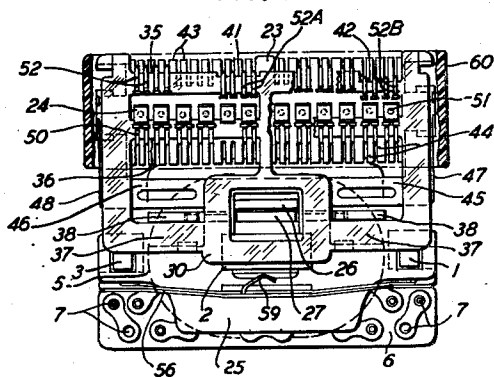


FIG. 3



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2,682,585

ELECTROMAGNETIC RELAY

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Application May 24, 1952, Serial No. 289,843

5 Claims. (Cl. 200-104)

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This invention relates to switching devices, and more particularly to electromagnetic relays.

An object of this invention is to improve the efficiency, the compactness and the economy of manufacture and maintenance of electromagnetic relays.

A further object of this invention is to increase the capability of a relay to meet a plurality of diverse circuit requirements.

A feature of this invention is a unitary means for accurately positioning the legs of a relay core, for defining the position of rest of a relay armature and for adjustably supporting certain of the contact making elements of a relay.

Another feature of this invention is a structural arrangement whereby the types of contact combinations in a relay are determined by the configuration of a single readily replaceable element.

Another feature of this invention is a means for assisting the restoral of a relay armature to its normal position without impeding the contact-controlling operation of the armature.

The manner in which the above-noted objects are attained and the nature of the listed features may be comprehended from the following detailed description of a preferred embodiment of the invention when read with reference to the accompanying drawings in which:

Fig. 1 is a plan view of a preferred embodiment of the invention partially cut away to show certain details of the construction more clearly;

Fig. 2 is an elevational view of the relay shown in Fig. 1; and

Figure 3 is a front-end view of the relay shown in Fig. 1.

The relay herein disclosed is also disclosed and described, and certain features thereof claimed, in the patent application of H. M. Knapp, filed on even date herewith, S. N. 289,842.

The relay disclosed in the accompanying drawings comprises an E-shaped core having three leg portions 1, 2 and 3 and a bridging portion 4 which serves to interconnect the leg portions 1, 2 and 3. Removably placed upon the center one of these leg portions 2 is an electromagnetic coil 5 having a front spoolhead 6. The terminals of the coil 5 are connected to wires 7 which are mounted in the front spoolhead 6 and extend rearwardly of the relay through apertures in a molded element of insulating material 8 and appear at the rear of the relay as terminals to which external circuits may be connected. A plurality of these terminal wires 7 are provided so that coils

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having multiple windings may be employed if desired.

The molded block 8 is substantially L-shaped in cross-section (the L being inverted in the showing of Fig. 2) whereby a flat surface is provided against which the upper side of the bridging member 4 of the core may rest. However, interposing the upper surface of the bridging member 4 and this surface of the molded block 8 is a flat-U-shaped spring member 9. By virtue of this construction, the bight of the U-shaped spring member 9 is clamped between the lower surface of the offset portion of the molded block 8 and the upper surface of the bridging element 4 of the core.

The two leg portions of the spring member 9 extend forwardly in spaced proximity to the outer core legs 1 and 3. The extreme forward ends of the legs of the spring member 9 are provided with extending flange portions which may be wrapped or clinched around the tip ends of the legs 10 of the armature 11 whereby the spring member 9 serves as a means for hinging the armature and for biasing that armature to its unoperated position. The clinched ends of the legs of the spring member 9 may further be attached to the legs 10 of the armature 11 by welding, if desired.

The armature 11 is essentially U shaped in appearance, the bight of the U extending across the relay so as to be capable of bridging the three legs 1, 2 and 3 of the core. The leg portions 10 of the armature 11 extend rearwardly of the relay and the tip ends of the legs 10 rest against the legs of the spring member 9, which in turn rest against the outer core legs 1 and 3. Therefore, the armature 11 is pivotally mounted, the fulcrum being approximately at the extreme ends of the legs 10 of the armature 11. The legs 10 of the armature 11 may be of any suitable length depending upon the operational requirements of the relay. Thus, in the embodiment of the invention disclosed in Figs. 1, 2 and 3, the armature legs have been made substantially as short as possible and still provide a sufficient air-gap between the bight of the relay 11 and the central core leg 2.

It will be seen that the electromagnetic circuits of the relay include a first circuit comprising the center core leg 2, the core bridging member 4, the outer core leg 1, leg 10 and the bight of the armature 11, and an air-gap between the armature and the core. A similar path exists including core leg 3 and the other leg 10 of the armature 11. Therefore, upon energization of the coil 5, a force will be exerted tending to pivot the armature 11 to

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a position in which it bridges the three core legs 1, 2 and 3, i. e., the forwardmost edge of the armature 11 will tend to move downwardly to engage the core, in the showing of Fig. 2.

Three layers of contact-holding elements are provided, and in the preferred embodiment of the invention these contact-holding members are in the form of thin wires. The lowermost layer 50 and the uppermost layer 52 of wires are movable, under the control of the armature, relative to the centermost layer of wires 51. As may best be seen in Fig. 2 of the drawings, the lowermost set of these wires 50 is molded or otherwise mounted in an insulating member 12 which engages the upper edge of the molded block 8. The centermost layer of wires 51, which are preferably of heavier construction than the lower and upper layers of wires, are mounted in an intermediate block of insulating material 13 which rests on block 12. To provide the requisite rigidity, it is advantageous to provide a forward extension 14 for the block 13. The centermost layer of wires 51 are preferably mounted in the block 13 and in its forward extension 14 during the operation in which blocks 13 and 14 are molded. Similarly, the upper layer of springs 52 are molded or otherwise affixed in an upper molded block of insulating material 15 which abuts the upper surface of block 13. Abutting the upper edge of molded block 15 is an essentially U-shaped balancing spring member 16, the function of which will hereinafter be described.

In order accurately to position and retain the bridging portion 4 of the core, the molded blocks 8, 12, 13 and 15 and the balancing spring 16 in fixed position relative to one another, it is advantageous to provide corresponding projections and indentations in the several elements. For example, the balancing spring member 16 is apertured to engage projections 17 on the upper block 15. This group of elements is firmly rendered integral by means of a clamp which has a top portion 18 and two leg portions 19. The top portion 18 firmly engages the upper surface of the balancing spring member 16 and the leg portions 19 are provided with inwardly extending projections 20 which engage the edges of the undersurface of the bridging portion 4 of the core. The upper surface 18 of the clamp may be suitably deformed to provide a spring action.

The centermost layer of spring members 51 are affixed, preferably during the molding operation, in a front molded block member 23, and pass through that front molded block 23. Springs 51 are provided at their forwardmost ends with contact elements 24. As may best be seen in Fig. 3 of the drawings these contact members 24 are preferably square or rectangular blocks of metal with relatively thin layers of precious or semi-precious contact metal at their upper and/or lower edges.

In order that the centermost layer of fixed springs 51, which are integral with the front molded block 23, may be securely immobilized, a core plate 25 is provided. This core plate 25 performs a plurality of functions. It is affixed to the front ends of core legs 1, 2 and 3 by apertures in the plate 25 securely engaging these legs. This serves not only to retain the core plate in position, but also greatly improves the economy of manufacture of the relay. The three apertures in the core plate 25 which engage the core legs 1, 2 and 3, may be accurately located at relatively small cost. When the core plate is assembled to the core, the core plate then serves

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accurately to position the three legs 1, 2 and 3 of the core with relation one to the other. Therefore, there is no necessity for machining the core legs to close tolerances and no necessity for maintaining the upper surfaces of the core legs 1, 2 and 3 accurately in a plane. The core plate serves to force those upper surfaces to be coplanar when the relay is assembled.

A portion 26 of the core plate 25 is bent forwardly so as to rest in proximity to a central forward extension 27 of the armature 11. This projection 26 serves as a back stop for the armature, i. e., it defines the unoperated position of the armature. By virtue of this construction the back stop is centrally located on the armature and is positioned in line with the member 30 upon which the armature's force is exerted. It has been found that if the line of the armature's output force passes through the back stop member, armature rebound is substantially obviated.

The core plate 25 is also provided with two projecting arms comprising horizontal portions 45 and 46 and vertically extending portions 47 and 48. The front molded block 23 rests against the uppermost edges of the upstanding arm portions 47 and 48, being firmly held against those portions primarily by the downward force exerted by the pretensioned single fixed springs 51 and also by the downward force exerted by the pretensioned twin springs 52. The horizontal portions 45 and 46 are apertured so that a tool may be inserted to bend the horizontal portions 45 or 46 up or down to adjust the position of the front molded block 23 and thus to adjust the position of the fixed contact elements 24 relative to the movable springs 50 and 52.

The upper and lower spring members 52 and 50, respectively, extend forwardly in approximate parallelism with one another and with the fixed springs 51, are provided with downwardly and upwardly extending offset portions, respectively, at their forwardmost ends, and terminate in precious or semi-precious metal contact elements. As may best be seen in Fig. 3 of the drawings, two upper springs 52 and two lower springs 50 are provided for each contact element 24 of each fixed spring 51 so that upon any contact closure two independent contacts engage a single fixed contact. This construction reduces the possibility of malfunctioning of the relay due to dust or other impediments.

The upper springs 52 and the lower springs 50 are controlled by a moving card 30 of insulating material. The member 30 is generally rectangular in external configuration and is suitably apertured to perform its necessary functions. The upper layer of springs 52 rest against the uppermost edge 35 of the card 30; the lowermost layer of springs 50 are engageable by an edge 36 of the moving card 30. The card 30 is moved downwardly upon the operation of the relay by virtue of an engagement of a portion 37 of the card 30 with forwardly extending projections 38 of the armature 11.

The uppermost layer of springs 52 are bent so as to be pretensioned in a downward direction. The upper springs 52 therefore continuously exert a force downwardly on the moving card 30 so that upon the downward movement of card 30 as a result of the operation of armature 11, the upper layer of springs 52 are permitted to move downwardly to engage the fixed contact elements 24. Similarly, the lower layer of springs 50 are bent so as to be pretensioned upwardly into engagement with the fixed contact elements 24.

Therefore, upon a downward movement of the moving card 30, the lower springs 50 are forcibly separated from the fixed contact elements 24. Upon the release of the relay and the return of the armature 11 and the moving card 30 to their normal positions, as shown, the upper layer of springs 52 will be forced back to their normal positions, as shown, and the lower layer of springs 50 will be permitted to return to engagement with the fixed contact elements 24.

The movement of the springs 52 and 50 both upon the operation and the release of the relay is controlled not only by the moving card 30 but also by the front molded block 23. Thus, a plurality of tooth-like projections 43 are provided on the upper surface of the front molded block and the upper movable springs 52 are accurately laterally positioned and guided thereby during their movement. Similarly, a plurality of projections 44 are provided on the lower surface of the molded block 23 to guide the lower springs 50 during their movement. By virtue of this arrangement, accurate lateral engagement of the moving springs with the fixed contact elements is assured.

In certain uses of the relay the moving springs may be subjected to high-frequency vibratory chatter upon the operation or release of the relay. To avoid this condition, a shock absorbing material 54 may be affixed to the portion 14 of the molded block 13 so as to press against the moving springs 50 and 52 to damp vibrations of those springs.

It will be noted that in the embodiment of the invention shown in Figs. 1 to 3, which represent a relay of conventional size, there are twelve groups of contact elements, each of which groups may comprise a fixed contact element, an upper twin contact element and a lower twin contact element. By virtue of the previously described operation, it will be perceived that the upper twin contact elements, mounted on the twin wires 52, are normally separated from the fixed contact elements 24 but that upon operation of the relay these upper contact elements will be brought into contact with the fixed contact elements 24, i. e., the fixed contact elements 24 and the upper contacting elements form so-called "make" combinations. If the edge 35 of the moving card 30 be straight and parallel with the fixed elements 24, all of the upper moving springs 52 will simultaneously engage all of the fixed elements 24. However, in some uses of the relay it may be found to be desirable for selected ones of the uppermost springs 52 to engage the fixed contact elements 24 at earlier or later times than others of those upper springs 52 engage others of those fixed contact elements 24. If a slight depression such as 41 (Fig. 3) is made in the upper edge 35 of card 30, the springs 52A which engage that slight depression will obviously make contact with their associated fixed elements 24 at an earlier point in the course of the downward movement of armature 11 than will others of the moving springs 52. These contacts may be labeled "early make" contacts. Further, if an even deeper depression 42 be made in the edge 35 of the moving card 30, the springs 52B engaging that deeper depression will make contact not only prior to the time at which the normal springs 52 make contact with their associated fixed elements 24, but also prior to the time at which the "early make" contacts 52A engage their fixed elements 24. This latter group of springs 52B may be labeled "preliminary make" contacts.

It will also be perceived that by virtue of the

above-described operation of the relay, the lower movable spring elements 50 are normally in contact with their associated fixed contacts 24 and that upon the operation of the relay and the consequent downward movement of armature 11 and moving card 30, this lower layer of springs 50 will "break" contact with their associated fixed elements 24. By providing similar discontinuities (not shown) in the surface 36 of the moving card 30, "early break" contacts and "preliminary break" contacts may also be provided. Conversely in both the case of "make" and "break" contacts, if the surface 35 or 36 of the card 30 be provided with areas which project upwardly or downwardly from the surfaces 35 or 36, respectively, "late make" contacts and "late break" contacts may also be provided. However, three stages of make-contact and three stages of break-contact operation are sufficient for substantially all circuit requirements.

Assuming that each upper set of twin springs 52 may be of the "normal," "early" or "preliminary" type, and that each lower set of twin contact springs 50 may also be either "normal," "early" or "preliminary," it is possible to provide for any one of fifteen different possible contact arrangements for each set of contacts. Thus, by omitting the set of lower springs 50 there may be provided a "normal make" contact set, an "early make" contact set or a "preliminary make" contact set. Similarly, by omitting the upper pair of twin springs 52, a "normal," an "early," or a "preliminary" break contact set may be provided. By using both the upper set of twin springs 52 and the lower set of twin springs 50 in conjunction with the fixed contact element 24, and by selecting whether each of the upper sets and lower sets be "normal," "early," or "preliminary," the following combinations of contact operation may, in an obvious manner, be obtained: A "break-make" combination in which both the upper and lower sets are either "normal," "early" or "preliminary"; an "early make-break," or a "preliminary make-early break" or a "preliminary make-break" combination, all normally called "continuities," in which the upper set of twin wire contacts engages the fixed contact element 24 either somewhat before or substantially before the time that the lower set of contacts separates from the fixed contact elements 24; and an "early break-make," or a "preliminary break-early make" or a "preliminary break-make" combination, all normally called "transfers," in which the lower set of twin wire contacts 50 separates from the fixed contact 24 either somewhat before or substantially before the upper set of twin wire contacts 52 engages the fixed contact element 24. Similarly, there may be "early make-early break" or "preliminary make-preliminary break" combinations.

These diverse combinations may be obtained primarily by the "coding" of the moving card 30, i. e., by the configuration of the surfaces 35 and 36 of that card. If only make contact combinations or only break contact combinations are required, obviously either the surfaces 35 and 36 of the card 30 must be so conformed that the springs never make contact or never break contact, or else, more economically, one or more sets of springs 52 or 50 may be omitted or the contact elements may be removed therefrom.

It will be seen that the possible combinations may be extended concatenately by the strapping the terminals of adjacent groups of contacts in the well-known fashion, whereby a

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plurality of complex combinations such as "make-before-break-before-make" may be obtained if circuit conditions require.

Referring again to Figs. 1 and 2 of the drawings, it will be noted that the armature 11 is subjected to a plurality of forces. The spring 9 exerts a force tending to maintain the armature in its unoperated position, as shown in the drawings. The electromagnetic flux tends to move the armature downwardly to bridge the core legs 1, 2 and 3. The moving card 30 exerts a downward force on the armature due to the fact that the moving springs 52 are pretensioned downwardly and consequently exert a force on moving card 30 in a downward direction. Balancing spring 16, which is connected to moving card 30, serves to exert an upward force on card 30 and, therefore, an upward force on armature 11. The upward force exerted by spring 16 is selected substantially to counterbalance the force exerted by the moving springs 52 and consequently the force exerted by balancing spring 16 must be varied in accordance with the degree of pretensioning of the springs 52 and the number of springs 52 which are provided.

In special uses of the relay, it may be desirable to have an additional force exerted on the armature tending to restore that armature to normal. If such force be required however, it is normally disadvantageous to have that force continually exerted inasmuch as such force would also oppose the movement of the armature during its operation. Buffer spring 55 is operative to exert a force to assist restoration of the armature to normal but does not impede the downward movement of the armature until after all contact operations have been completed. Buffer spring 55 is essentially U-shaped, having a crosspiece 56 and two legs 57. A projection 58 (Fig. 2) extends upwardly from the crosspiece 56 and engages the lower edge of the middle core leg 2. The extreme ends of the legs 57 of spring 55 press against the lower surfaces of the outer core legs 1 and 3, and at a point on the buffer spring 55 intermediate the projection 58 and the extreme ends of the spring legs 57, the spring legs 57 engage projections on the spoolhead 6. The projections on the spoolhead 6 are so located that the legs 57 of the buffer spring 55 are slightly deformed when the buffer spring is in position on the relay, and the resulting tension of the spring legs 57 serves to retain the buffer spring 55 in position. An additional upstanding portion 59 is provided on crosspiece 56. This portion 59 is so located that the lower edge of the moving card 30 will contact it when the relay is operated. Consequently, just prior to the completion of the operation of armature 11, the moving card 30 will engage the buffer spring 55 and bend it downwardly. When the coil 5 is deenergized the buffer spring 55 will be effective to exert an additional upward force to assist the return of the armature 11 to normal.

While the use of twin contact elements mating with single contact elements substantially obviates the possibility of malfunctioning of the relay in the presence of dust or other impurities, a contact cover 60 may be provided further to insure proper operation and also to prevent damage through mishandling. This cover is arranged to engage the front molded block 23 on all four sides to create a substantially dust-tight enclosure for the contacts. It will be noted that since the contact cover 60 engages the upper extremes of the projections 43 and the lower extremes of the projections 44 on the front molded block 23,

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the contact cover also serves to insure that the springs 52 and 50 will be trapped in their proper positions and yet that, upon removal of the contacts, the springs 52 and 50 may be readily displaced so that the moving card 30 may be removed and a card of different surface configuration inserted for coding purposes.

It is to be understood that the above-described arrangements are but illustrative of the principles of the invention. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An electromagnetic relay comprising a core, an energizing coil on said core, a plurality of insulating members, means for clamping said members in stacked relationship on said core, an armature, means for hinging said armature to said core, a molded block, means connected to said block and said core for fixing the position of said block relative to said core, a plurality of fixed contact springs molded in one of said insulating members and in said block, a first plurality of movable contact springs molded in another one of said insulating members and extending in spaced proximity to and on one side of said fixed contact springs, a second plurality of movable contact springs molded in another one of said insulating members and extended in spaced proximity to and on the other side of said fixed contact springs, and a movable operating card engaging said armature and having a first surface engageable with said first plurality of movable contact springs and a second surface engageable with said second plurality of movable contact springs.

2. An electromagnetic relay comprising an E-shaped core having three coplanar legs and a bridging member, an energizing coil mounted on the center one of said legs, a spoolhead for said coil, a plurality of insulating members, means for clamping said insulating members and the bridging member of said core in stacked relationship, an armature, means for hinging said armature to said core, a molded block, a core plate engaging said core and fixing the location of the ends of the legs of said core, a pair of extensions on said core plate engaging said molded block for fixing said block with respect to said core, a plurality of fixed contact springs molded in one of said insulating members and in said block, a first plurality of movable contact springs molded in another one of said insulating members and extending in spaced proximity to and on one side of said fixed contact springs, a second plurality of movable contact springs molded in another one of said insulating members and extending in spaced proximity to and on the other side of said fixed contact springs, and a movable operating card engaging said armature and having a first surface engageable with said first plurality of movable contact springs and a second surface engageable with said second plurality of movable contact springs.

3. An electromagnetic relay comprising a core, an energizing coil on said core, a plurality of insulating members, means for clamping said members in stacked relationship on said core, an armature, means for hinging said armature to said core, a molded block, means connected to said block and said core for fixing the position of said block relative to said core, a plurality of fixed contact springs molded in one of said insulating members and in said block, a first plurality of

movable contact springs molded in another one of said insulating members and extending in spaced proximity to and on one side of said fixed contact springs, a second plurality of movable contact springs molded in another one of said insulating members and extended in spaced proximity to and on the other side of said fixed contact springs, a movable operating card engaging said armature and having a first surface engageable with said first plurality of movable contact springs and a second surface engageable with said second plurality of movable contact springs, and a buffer spring engaging said core and engageable with said movable operating card.

4. An electromagnetic relay comprising an E-shaped core having three coplanar legs and a bridging member, an energizing coil mounted on the center one of said legs, a spoolhead for said coil, a plurality of insulating members, means for clamping said insulating members and the bridging member of said core in stacked relationship, an armature, means for hinging said armature to said core, a molded block, a core plate engaging said core and fixing the location of the ends of the legs of said core, a pair of extensions on said core plate engaging said molded block for fixing said block with respect to said core, a plurality of fixed contact springs molded in one of said insulating members and in said block, a first plurality of movable contact springs molded in another one of said insulating members and extending in spaced proximity to and on one side of said fixed contact springs, a second plurality of movable contact springs molded in another one of said insulating members and extending in spaced proximity to and on the other side of said fixed contact springs, a movable operating card engaging said armature and having a first surface engageable with said first plurality of movable contact springs and a second surface engageable with said second plurality of movable contact springs, and a U-shaped buffer spring comprising two leg portions engaging said core and said spoolhead, a cross member engaging said core

and a projection on said cross member engageable with said movable operating card.

5. An electromagnetic relay comprising an E-shaped core having three legs and a bridging member, an energizing coil mounted on the center one of said legs, a plurality of insulating members, a clamp for holding said insulating members and the bridging member of said core in stacked relationship, a U-shaped armature bridgeable across the three legs of said core, a U-shaped hinging spring connected to said armature and clamped between said core and said insulating members, a front and an intermediate molded block, a core plate engaging the three legs of said core, a back-stop projection on said core plate engageable with said armature, a pair of L-shaped extensions on said core plate engaging said front molded block, a first plurality of wire springs molded in one of said insulating members and in said front and intermediate molded blocks, a fixed contact element mounted on each of said first plurality of wire springs adjacent said front molded block, a second and a third plurality of twin-wire springs molded in individual ones of said insulating members and extending in spaced proximity to said first plurality of wire springs and on opposite sides thereof, a plurality of projections on said front molded block forming slots engaging the individual ones of said second and said third pluralities of springs, a movable operating card engaging said armature and having a first surface engageable with said second plurality of wire springs and a second surface engageable with said third plurality of wire springs, and a balance spring held by said clamp and engaging said movable operating card.

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