Dec. 29, 1959 B. J. GREENBLOTT ET AL 2,919,326

ELECTRICAL RELAY AND CONTACT ASSEMBLY

Filed May 17, 1956 3 Sheets-Sheet 1

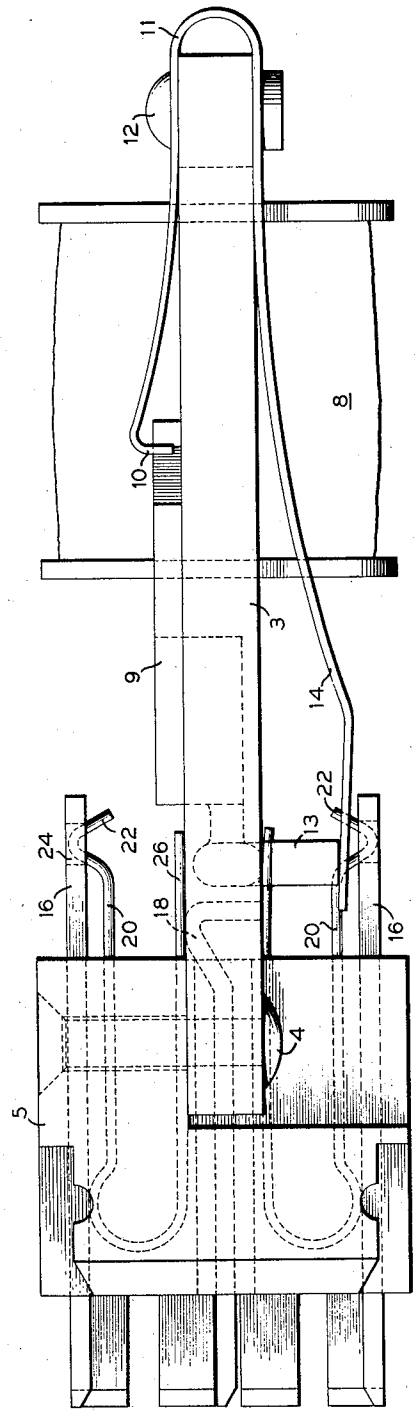


FIG_1.

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ELECTRICAL RELAY AND CONTACT ASSEMBLY

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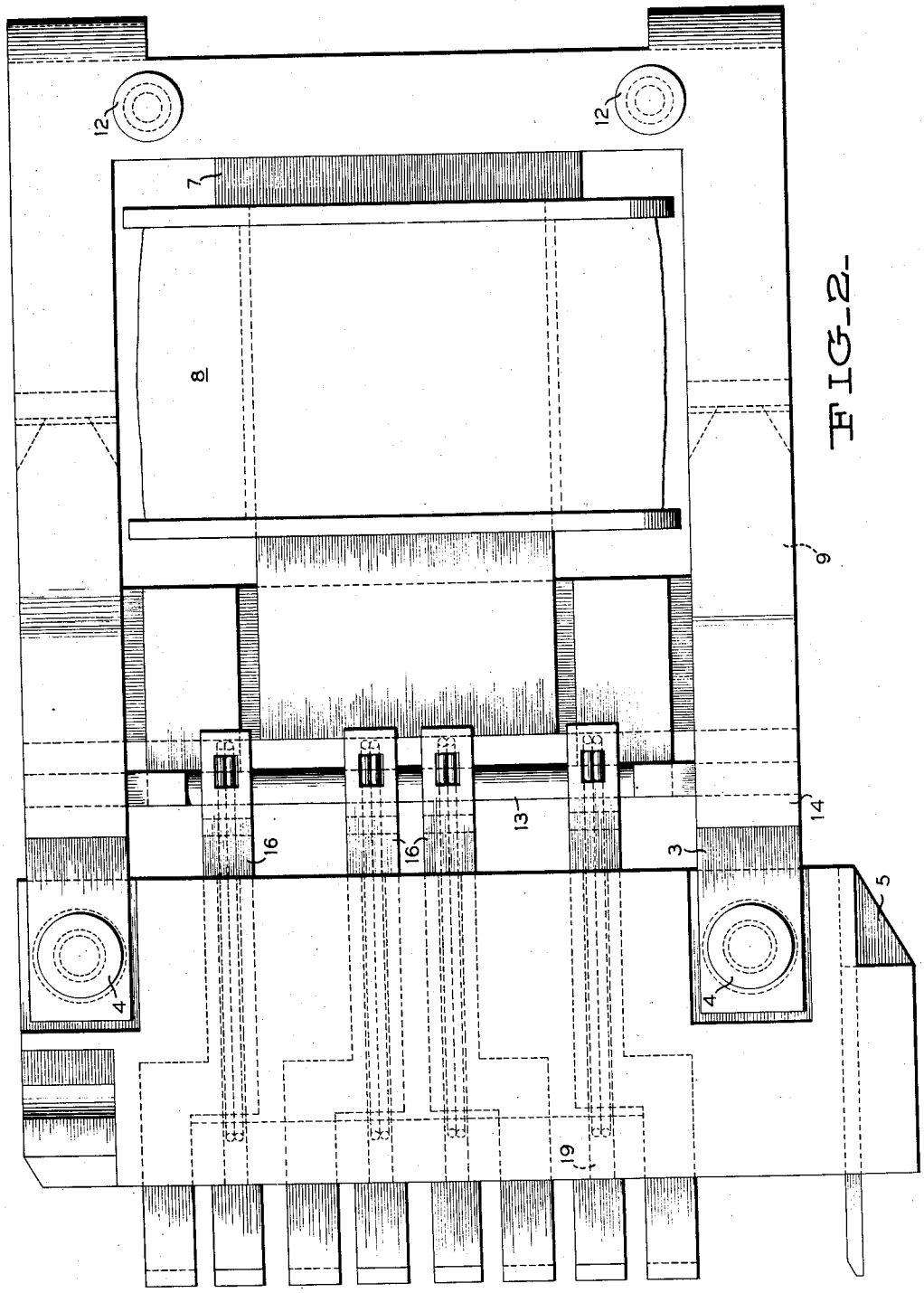


FIG_2_

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ELECTRICAL RELAY AND CONTACT ASSEMBLY

Filed May 17, 1956 3 Sheets-Sheet 3

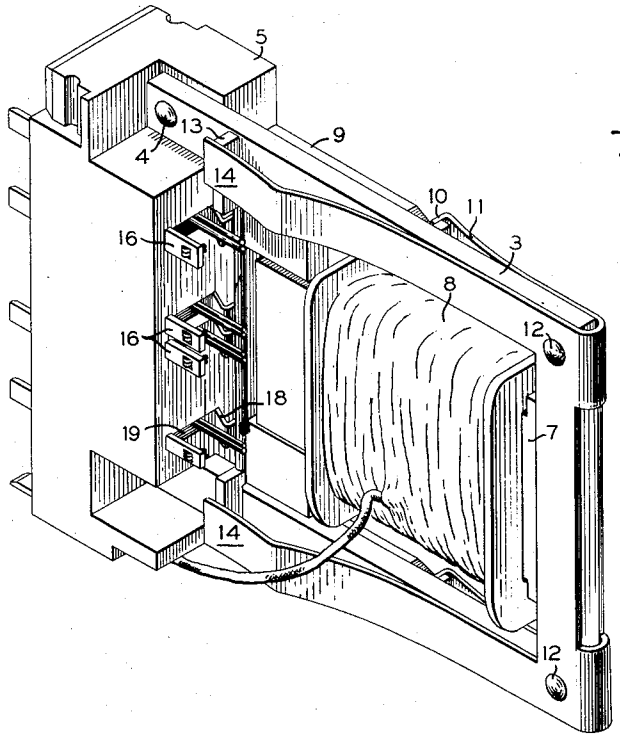


FIG_3_

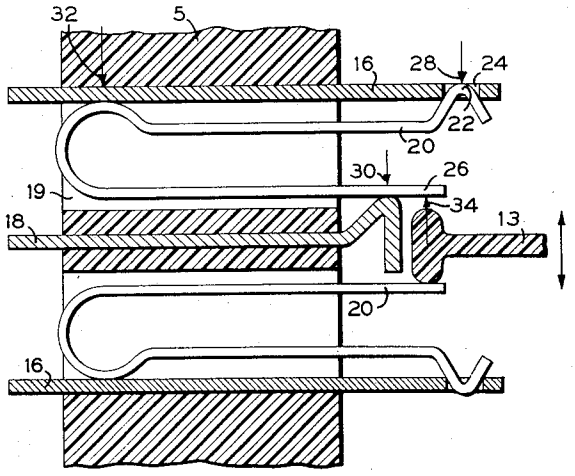


FIG_4_

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2,919,326

ELECTRICAL RELAY AND CONTACT ASSEMBLY

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Application May 17, 1956, Serial No. 585,508

15 Claims. (Cl. 200—104)

This invention relates to an electrical relay and contact assembly, and particularly to an improved electrical contact assembly for use in relays or other electromechanical devices where high operating speeds are required and contact "bounce" must be eliminated as much as possible.

The bounce or vibration of electrical contacts as they close is deleterious to the life of the contacts and may adversely affect the operation of the circuit which they govern. As higher operating speeds are attained, the problem of bounce elimination becomes more acute, in view of the increased velocity of the contacts.

It is accordingly an object of this invention to provide an improved electrical relay, and an electrical contact assembly therefor in which the contact bounce which occurs on the closing of the contacts is substantially or wholly eliminated.

Another object of the invention is to provide an improved electrical contact assembly in which the frequency of vibration of the contact springs is substantially lowered, although the total length of the springs is sufficiently long to permit contact spring material of substantial cross sectional area to be employed.

A further object of this invention is to provide an improved electrical relay and a contact assembly especially suited for automatic production and assembly.

Still another object of this invention is to provide an electrical contact assembly having an operating spring member which is constrained by the inherent spring forces in the member from motion at at least two points falling substantially on nodes of flexural vibration of the spring member.

A further object of the invention is to provide an improved electrical contact assembly having a reentrant or looped operating spring member, in which one leg of the loop is constrained from motion by the inherent spring force in the member, and in which at least one other point of restraint is provided at a point at or near the bight of the looped contact member, so that the spring member is constrained at substantially two nodal points of the flexural vibration wave length of thes pring member.

Yet another object of the present invention is to provide an improved electrical contact assembly in which a looped operating spring member is confined in a suitable enclosure to provide a degree of frictional damping for reducing unwanted vibration in the member.

The foregoing objects are attained in this invention by the provision of a contact assembly in which a resilient spring member, or movable contact member is arranged with a free end which is moved into or out of engagement with a fixed contact member. The opposite end of the spring member is constrained from motion preferably by the inherent resilience of the spring member, and additionally, a constraining force is applied at an intermediate point along the length of the spring member, at or near a point on the spring member which is a nodal point for flexural vibrations in the spring

member. Since the spring member is thus effectively restrained at one of its ends and at or near a nodal point along its length, the flexural vibration is highly damped. Thus the free end of the spring has little or no vibrating movement as a result of its impact with the cooperating stationary contact member when the contacts close.

In order to employ a spring member having a cross sectional area of sufficient size to provide adequate mechanical strength, and yet to reduce the overall dimensions of the contact assembly, the spring members are made in a re-entrant or looped configuration, approximating a U-shape. In this manner the frequency of flexural vibration is kept relatively low without increasing the length of the contact assembly or reducing the cross-sectional area of the spring members.

The operating spring members are enclosed in a slot in a block or base of insulating material, so that their motion is confined substantially to a single plane, and so that the friction between the springs and the walls of the enclosing slot provides a degree of damping for any vibration which may occur.

The improved relay of this invention comprises a contact assembly of the type described above, and an electromagnetic operating structure for operating the contacts. A common datum surface is provided from which all critical dimensions of the relay are taken, so that individual parts may be fabricated and assembled without cumulative tolerances building up to a point where automatic manufacturing operations would not be feasible. One surface of the relay yoke may be taken as the reference or datum surface, for example, and all critical dimensions measured therefrom. A mating surface is provided on the base or contact block, to which the magnet yoke is attached, and all fixed contact elements are accurately located with respect to this surface. The movable contact elements are adapted to be preformed or prestressed, so that they may be inserted in the contact assembly by machine operation and will have the required amount of spring tension when so assembled. In this manner, the contact assembly and the electromagnetic operator portion of the relay may be made separately, with the assurance that the final asembly will find all parts properly located so that little or no manual adjustment is required.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of examples, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is a diagrammatic plan view of an electrical relay constructed in accordance with a preferred embodiment of the invention.

Fig. 2 is a diagrammatic elevation view of the relay.

Fig. 3 is an isometric view of the relay, and

Fig. 4 is a schematic cross-sectional view of the contact assembly illustrating certain of the relations between the various parts.

Similar reference characters refer to similar parts in each of the several views.

Referring now to the drawings, there is shown the details of an electrical relay constructed in accordance with the invention and provided with the improved contact assembly which forms a part of the subject invention. The relay includes an electromagnetic operating mechanism, and a plurality of electrical contacts adapted to be operated by the operating mechanism, all in a unitary assembly.

Considering first the electromagnetic operating mechanism, a stationary yoke structure 3 of magnetic material, having an E-shaped configuration, is provided, the outer

legs being attached by rivets 4 or other suitable fastening means to a base block 5, which is molded or otherwise formed from suitable insulating material, such as the so-called "plastic" materials. The center leg 7 of the stationary yoke member 3 has mounted thereon an energizing winding 8, which may be wound on any suitable type of bobbin and slipped onto the center leg 7 during assembly of the relay.

A U-shaped armature 9 of magnetic material is provided, with the legs of the U notched at the ends as shown so that the armature is retained in place by forked portions 10 of a suitable spring member 11, which is fastened to the yoke 3 by any suitable means, such as the rivets 12. The spring member serves to position the armature on the yoke and to define the pivot point for the legs of the armature.

A contact operating member 13, of suitable insulating material, is attached to armature 9 in any suitable way, as by molding thereto, or employing other fastening means. Projections or shoulders of member 13 engage legs 14 of the spring member 11, as most clearly seen in Figs. 1 and 3, and the parts are proportioned and arranged so that a force is exerted on the contact operating member 13, and hence the armature 9, tending to pivot the bight of the U-shaped armature away from the stationary yoke. The projections or shoulders of operating member 13 are arranged to engage the surface of yoke 3 when the armature 9 is released, to thereby act as a stop which limits the travel of operating member 13.

When the operating winding 8 is energized, the flux created in the yoke 3 attracts the armature 9 so that it swings at its pivot points against the yoke 3, to occupy the position shown in the drawings. The motion thus produced is utilized to operate the contacts as described hereinafter.

It is to be pointed out that the contact assembly subsequently described is not dependent upon the use of any particular contact operating means and the electromagnetic operator structure may take any number of forms well known in the art.

Considering now the details of the improved contact assembly, the drawings illustrate a contact assembly which provides four contact positions, each position being the equivalent of a transfer position having a normally open contact, a normally closed contact, and a common contact. Each position includes at least a first and a second fixed contact element such as those designated by reference characters 16 and 18. Where the equivalent of a transfer position is provided, an additional fixed contact element 16 is provided, so that two of the elements 16 lie on either side of a common fixed element 18. As shown, the fixed contact elements 16 and 18 may be stamped or otherwise formed, after which they are molded in place in the insulating base 5. The ends of the elements 16 and 18 which project from the left-hand side of the relay, as seen in the drawings, may be formed to act as pins or plugs, receivable by suitable sockets in a suitable mounting or holding block for the relay, not shown. Obviously, the number of contact positions may be varied as desired.

Rectangular slots or openings 19 are provided in the base block 5, one for each of the contact assemblies, to accommodate the movable contact springs or members 20. The slots confine the motion of the movable contact springs and additionally provide frictional damping as a result of the movable springs rubbing on the sides of the slots, that is to say, the width of the slot is sufficient to permit the movable springs to flex during operation, with a small clearance, but in view of the length of the springs and the fact that the springs are free to cant slightly within the slot, portions of the springs will rub on the walls of the slot during the flexing so that some amount of frictional damping is provided.

Each of the movable spring members 20 is in the form of a looped or U-shaped length of suitable spring material. To increase the reliability of the contacts, the spring members are provided in pairs, with one pair being used for each normally open or normally closed contact. The spring members 20 are preformed before assembly to provide the proper degree of spring force when engaging the fixed contact elements, and are then inserted in the slots 19. One end of each contact spring member is provided with a hook-shaped bend 22, which engages a slot 24 in the fixed contact element 16, thus anchoring the spring 20 in place, and additionally providing an electrical connection to one end of spring 20.

As can be seen from the drawings, the other or free end 26 of spring 20 is moved into or out of engagement with the fixed common contact element 18, as a result of the operation of contact operating member 13, which in turn is operated by armature 9 in response to energization of the electromagnetic operating mechanism.

The contact assembly thus provided is of the type known as "permissive make," in which each of the movable contact springs is prestressed so that when unimpeded, it will engage its free end with the common stationary contact member with the required amount of contact pressure to insure a low contact resistance. The contacts are operated out of engagement by forcing the movable contact away from the stationary contact as a result of operation of the contact operating member, either by the electromagnet when the relay is energized in the case of a normally closed contact, or by the armature return spring when the electromagnet is de-energized in the case of a normally open contact. Such an arangement is advantageous over the more usual flexure type of contact, since the work required for contact actuation is one-half that required by flexure contacts. Moreover, by arranging the parts so that the contact actuating member moves clear and remains clear of the movable contact spring when it engages the fixed contact element, the effects of armature rebound are eliminated insofar as contact pressure and contact bounce are concerned.

The spring rate of the movable contact member is dictated by a number of requirements, particularly reasonable manufacturing tolerances, for a given type of spring material. The cross-sectional area and the effective length determine the spring rate, for a given type of material, but since the cross-sectional area cannot be reduced below that required for maximum allowable safe stress limits, it follows that, for a given cross-sectional area, a predetermined length of spring is required, if the spring rate is to be within suitable limits. The use of a U-shaped or reentrant spring member thus permits a total spring length twice that which is available with a straight spring, in the same available space.

A further advantage is gained in the use of the looped or re-entrant movable contact spring, in that vibrational damping is obtained which further obviates contact bounce. As may be seen from Fig. 4, the movable contact member 20 has its one end 22 fixed from motion in the plane of operation, since the spring force retains the hooked end 22 of the spring in the slot 24 of the fixed contact element 16 under all states and operating conditions. It can be shown that, for a curved bar having a given total length, the frequencies of vibration are not only lower than those for a straight bar of the same length, but also that the nodes of the vibrations are forced toward the middle of the bar. The configuration of the parts is such that spring forces of the movable contact member at the hooked end 22 and at the free end are exerted at the points designated by the referenced arrows 28 and 30, respectively. The unbalanced force thus created forces the looped portion of the movable contact member into engagement with the contact slot wall at the point designated by referenced arrow 32. It is further apparent that the operating force, which is applied at the point designated by the referenced arrow 34, enters the system at a point between the forces exerted by the spring at points 30 and 28, so that, under all

static and operating conditions, the spring member is forced against the wall of the contact slot at point **32**.

The restraint of the movable spring member **20** at the one end **22**, and at the point **32** near the middle of its total length causes an internal damping of the spring member which acts to minimize vibrations occurring upon impact of the free or operating end **26** of the spring with the common fixed constant member **18**.

Thus the provision of a prestressed looped spring member constrained at one end and at a point near the center provides a contact structure which not only requires a minimum amount of space, but also leads to elimination of contact bounce.

Having thus described the particular features of the electromagnetic operator and the contact assembly, a number of features of the entire relay assembly will now be described.

From the standpoint of mass production, it is desirable to limit the number of manual assembly operations and adjustments to a minimum, particularly the manual adjustment of the individual movable contact springs. In the present invention, the parts are proportioned and arranged so that nearly all fabrication and assembly operations may be carried out by suitably designed machines. The fixed contact elements **16** and **18** are molded into the base block **5**, which may be made of a material having a high degree of dimensional stability, so that the various dimensions may be held within close tolerances without undue machining of the various surfaces after molding. Such machining as is necessary may be done in a one-pass operation after the base is molded.

By selecting a suitable datum surface, and dimensioning all parts therefrom, cumulative tolerance errors are eliminated. For example, the datum surface may be chosen to be the surface of the magnet yoke **3** against which the armature **9** seats. All parts are dimensioned from this surface, and since this surface is accurately located with respect to the contact assembly, as a result of the base **5** being attached to the yoke **3** with this surface as an interface, it follows that all dimensions may be readily maintained within reasonable tolerances when the contact assembly is fastened to the yoke.

The movable contact springs may be cut and preformed from suitable lengths of material, and thereafter inserted in their slots, all by machine operation.

The yoke and armature may be made from any suitable magnetic material, such as sintered magnetic material, and the assembly thereto of the spring **11**, which may be preformed, can be carried out by a machine operation. The contact operating member **13** can be affixed to the armature **9** by any suitable means, such as riveting or molding, also by machine operation.

In the final assembly, the legs of yoke **3** are riveted or otherwise fastened to the block or base **5**, with the contact operating member inserted between the opposed movable contact fingers. Thereafter, the leads for the operating coil **8** are soldered or otherwise connected to suitable pins in the block **5** which act as coil terminals for the relay, as shown in Fig. 3.

It can be seen from the foregoing that this invention provides a novel type of electrical relay structure, embodying a number of features lending the relay to mass production with very little manual assembly or adjustment procedures. Additionally, a unique type of electrical contact assembly is provided, economical in space and manufacturing cost, and providing bounce-free operation. As previously pointed out, the contact structure may be employed in devices other than relays, such as cam or manually operated switches.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a preferred embodiment, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art, without departing from the spirit of the invention. It is the intention, therefore, to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a switching device, the combination comprising a first and a second fixed contact element, a looped resilient contact spring member having a first and a second straight portion connected by a bight portion with all of said portions lying in a common plane including said first and said second fixed contact elements, said spring member being prestressed to cause said straight portions to engage said fixed contact elements, contact operating means effective at times to engage one of said straight portions of said spring member and disengage it from the associated fixed contact element, the other straight portion continuously engaging its associated fixed contact element and means confining the motion of said spring member in said plane.

2. In a switching device, the combination comprising a block of insulating material, a first and a second fixed contact element located on opposite sides of an opening in said block, a looped resilient contact spring member having a first and a second straight portion connected by a bight portion with all of said portions lying in a common plane, said contact spring member being disposed in said opening and prestressed to cause said straight portions to engage said fixed contact elements, and contact operating means effective at times to engage one of said straight portions of said spring member and disengage it from the associated fixed contact element, the other straight portion continuously engaging its associated fixed contact element.

3. In a switching device, the combination comprising a first and a second fixed contact element, a looped resilient contact spring member having a first and a second straight portion connected by a bight portion, each of said portions lying in the same plane and disposed between said fixed contact elements, the end of said first straight portion of said spring member remote from said bight portion engaging said first fixed contact element, and the end of said second straight portion of said spring member remote from said bight portion engaging said second fixed contact element, means for confining the motion of said spring member in said plane, and contact operating means for at times engaging one of said straight portions and moving said straight portion out of engagement with the associated fixed contact element, the other of said straight portions continuously engaging its associated fixed contact element.

4. In a switching device, the combination comprising a first and a second fixed contact element, a looped resilient contact spring member having a first and a second straight portion connected by a bight portion, each of said portions lying in the same plane and disposed between said fixed contact elements, the end of said first straight portion of said spring member remote from said bight portion engaging said first fixed contact element, and the end of said second straight portion remote from said bight portion engaging said second fixed contact element, means for confining the motion of said spring member in said plane, means for restraining the motion of said spring member at said bight portion, and contact operating means for at times engaging one of said straight portions and moving said straight portion out of engagement with the associated fixed contact element, the other straight portion continuously engaging its associated fixed contact element.

5. In a switching device, the combination comprising a first and a second fixed contact element, a looped resilient contact spring having a first and a second straight portion connected by a bight portion, each of said portions lying in the same plane and disposed between said fixed contact elements, said first straight portion being anchored to said first fixed contact element, said second straight portion engaging said second fixed contact element, operating means for moving said second straight portion out of en-

gagement with said second fixed contact element against the resilience of said member, and confining means for confining the motion of said contact spring to said plane, said confining means frictionally engaging at least a portion of said contact spring.

6. An electrical contact assembly comprising, in combination, a base block of insulating material having a rectangular slot therein, a first and a second fixed contact element disposed at opposite ends of said slot, a looped resilient spring member disposed in said slot, said spring member having first and second straight portions connected by a bight portion and prestressed to cause the extremities of said first and second straight portions remote from said bight portion to engage said first and second fixed contact elements, and a contact operating member effective at times to disengage one of said straight portions of said spring member from the associated fixed contact element, the other of said straight portions remaining continuously engaged with its associated fixed contact element.

7. An electrical contact assembly comprising, in combination, a base block of insulating material having a rectngular slot therein, a first and a second fixed contact element disposed at opposite ends of the slot, a looped resilient spring member disposed in said slot, said spring member having first and second straight portions conneted by a bight portion and prestressed to cause the extremities of said first and second straight portions remote from said bight portion to engage said first and second fixed contact elements and to cause a portion of said first straight section adjacent said bight portion to engage the adjacent end wall of said slot, and a contact operating member effective at times to disengage said second straight portion of said spring member from its associated fixed contact element, the extremity of said first straight portion remaining continuously engaged with said first fixed contact element.

8. An electrical contact assembly comprising, in combination, a base block of insulating material having a rectangular slot therein, a first and a second fixed contact element disposed at the opening of said slot and at opposite ends thereof, a looped resilient contact spring member disposed in said slot, said spring member having a first and a second straight portion connected by a bight portion, and prestressed so that said first and second straight portions engage said first and second fixed contact elements, the lines of action of the spring forces on said first and second fixed contact elements being staggered so that a force is exerted on said bight portion to cause it to engage the end of said slot associated with said first straight portion and said first fixed contact element, and contact operating means for at times exerting a force on the free end of said second straight portion to thereby disengage it from said second fixed conact element, the line of action of the force exerted by said contact operating means on the free end of said second straight portion falling between the lines of action of said spring forces, whereby a continuous force is exerted on said bight portion to engage it with the end of said slot adjacent said first fixed contact element.

9. An electrical contact assembly comprising, in combination, a base block of insulating material having a rectangular slot therein, a first and a second fixed contact element disposed at opposite ends of said slot, said first fixed contact element having an opening formed therein adjacent said slot, said second fixed contact element having a contact surface adjacent said slot, a pair of prestressed looped resilient spring contact members disposed in said slot, each of said spring contact members having a first and a second straight portion connected by a bight portion, said first straight portion having its free end shaped to engage the opening in said first fixed contact element, and said second straight portion having its free end adapted to engage the contact surface of said second fixed contact element, the spring force exerted by said

spring member having a first line of action through said first fixed contact element and a second line of action through said second fixed contact element, said first and second lines of action being staggered so that the resultant force causes the bight portion of said spring members to engage the end wall of said slot adjacent said first fixed contact element, and contact operating means effective at times to exert a contact operating force on said second straight portion of said spring members to disengage them from said contact surface, the line of action of said contact operating force falling between said first and second lines of action of said spring force, whereby a continuous force is exerted on each of said bight portions to engage them with the end wall of said slot adjacent said first fixed contact element.

10. A relay comprising a yoke of magnetic material having a first and a second outer leg and a center leg, one surface of each of said legs lying in a common datum plane, an armature pivoted on said first and second outer legs of said yoke for an angular motion in a direction substantially transverse to said common plane, biasing spring means for biasing said armature away from said yoke, an operating winding mounted on said center leg of the yoke and effective when energized to create flux in the yoke and thereby attract the armature to the yoke, a contact operating member operatively connected to said armature, a base block provided with a contact assembly including a plurality of fixed contact elements molded therein and including a plurality of slots between opposite ones of said fixed contact elements, a plurality of movable contact spring members, one for each set of opposed fixed contact elements, disposed in said slots, and each of said movable contact spring members having one end thereof disposed for operation by said contact operating member into and out of engagement with one of said fixed contact elements and the other end engaged with the opposite one of said fixed contact elements, a datum surface on said base block for referencing all dimensions of said contact assembly, and means for fastening said base block to said yoke with said common datum plane of said yoke and said datum surface coplanar.

11. A relay comprising a yoke of magnetic material having a first and a second outer leg and a center leg, one surface of each of said legs lying in a common datum plane, an armature pivoted on said first and second outer legs of said yoke for an angular motion in a direction substantially transverse to said common plane, biasing spring means for biasing said armature away from said yoke, an operating winding mounted on said center leg of said yoke and effective when energized to create flux in the yoke and thereby attract the armature to the yoke, a contact operating member operatively connected to said armature, a base block of insulating material provided with a contact assembly including a plurality of slots extending therethrough, a plurality of fixed contact elements molded in said base block on opposite sides of said slots, a plurality of looped resilient contact spring members, one pair of said spring members disposed in each of said slots, each of said members having first and second straight portions connected by a bight portion, the free end of first straight portion of each spring member being anchored to an associated fixed contact element and the free end of said second straight portion of each spring member engaging an associated fixed contact element, the free end of said second straight portion of each spring member being adapted for engagement by said contact operating member, a common datum surface on said base block for referencing all dimensions of said contact assembly, and means for fastening said base block to said yoke with said common datum plane of said yoke and said datum surface of the base block coplanar.

12. An electrical relay structure adapted for automatic production comprising a contact assembly and an electromagnetic operator assembly; said contact assembly including a base block of insulating material having a

reference surface thereon, and a plurality of slots therein, a plurality of pairs of fixed contact elements molded in said block, one pair of fixed contact elements being provided for each of said slots and disposed with one of the pairs of contact elements located at one end of said slot and the other of the pair of contact elements located at the other end of said slot, a plurality of pairs of prestressed looped resilient contact spring members, each having first and second straight portions connected by a bight portion, one pair of said spring members being disposed in each of said slots so that said first and second straight portions engage the fixed contact elements associated therewith; said electromagnetic operator assembly comprising an E-shaped yoke of magnetic material having a reference surface including one side of the outer legs of the yoke, an operating coil mounted on the center leg of said yoke, an armature pivoted on the outer legs of said yoke, a contact operating member operatively connected to said armature, and a biasing spring operatively connected to said operating member, and means for fastening said contact assembly to said electromagnetic operator assembly, with said reference surface of said contact assembly coplanar with said reference surface of said yoke.

13. In a switching device, the combination comprising a pair of fixed contact elements, a U-shaped resilient contact spring member having one leg in continuous engagement with one of said fixed contacts and flexed to urge the other leg into engagement with the other of said fixed contact elements, means normally holding said other leg away from engagement from its related fixed contact element and operable at times to permit said other leg to move into engagement with its related fixed contact element, and antibounce means comprising means engaging said spring member in the vicinity of a nodal point of flexural vibration along the length of said spring member to dampen the vibration of the contact spring member.

14. In a switching device, the combination comprising first and second fixed contact elements, a U-shaped resilient contact spring member having a first and a second leg connected by a bight portion, said contact spring member being prestressed and disposed with said first and said second legs engaging said first and said second fixed contact elements, means engaging said bight portion, and operating means effective at times for disengaging one of said legs of said spring member from the associated fixed contact element, the other of said legs remaining continuously engaged with its associated fixed contact element.

15. A relay comprising a yoke of magnetic material having a first and a second outer leg and a center leg, one surface of each of said legs lying in a common datum plane, an armature pivoted on said first and second outer legs of said yoke for an angular motion in a direction substantially transverse to said common plane, biasing spring means for biasing said armature away from said yoke, an operating winding mounted on said center leg of the yoke and effective when energized to create flux in the yoke and thereby attract the armature to the yoke, a contact operating member operatively connected to said armature, a base block provided with a contact assembly including a plurality of fixed contact elements molded therein and including a plurality of slots between opposite ones of said fixed contact elements, a plurality of movable contact spring members, one for each set of opposed fixed contact elements, disposed in said slots, and each of said movable contact spring members having one end thereof disposed for operation by said contact operating member into and out of engagement with one of said fixed contact elements and the other end engaged with the opposite one of said fixed contact elements, a datum surface on said base block for referencing all dimensions of said contact assembly, and means for fastening said base block to said yoke with said common datum plane of said yoke and said datum surface coplanar, said contact assembly being disposed in said base block to be positioned between said first and second outer legs of said yoke.

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