July 21, 1964 D. H. MINK 3,141,939

PLURAL CONTACT RELAY WITH SOLENOID ACTUATOR

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Fig. 1.

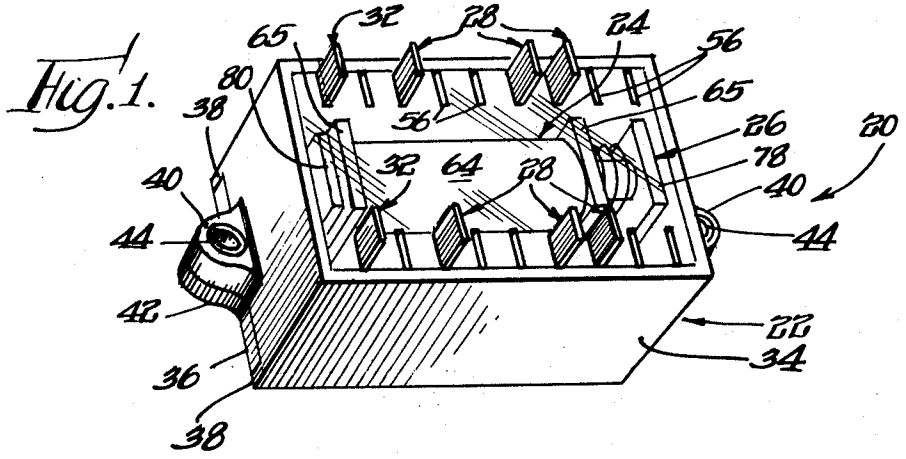
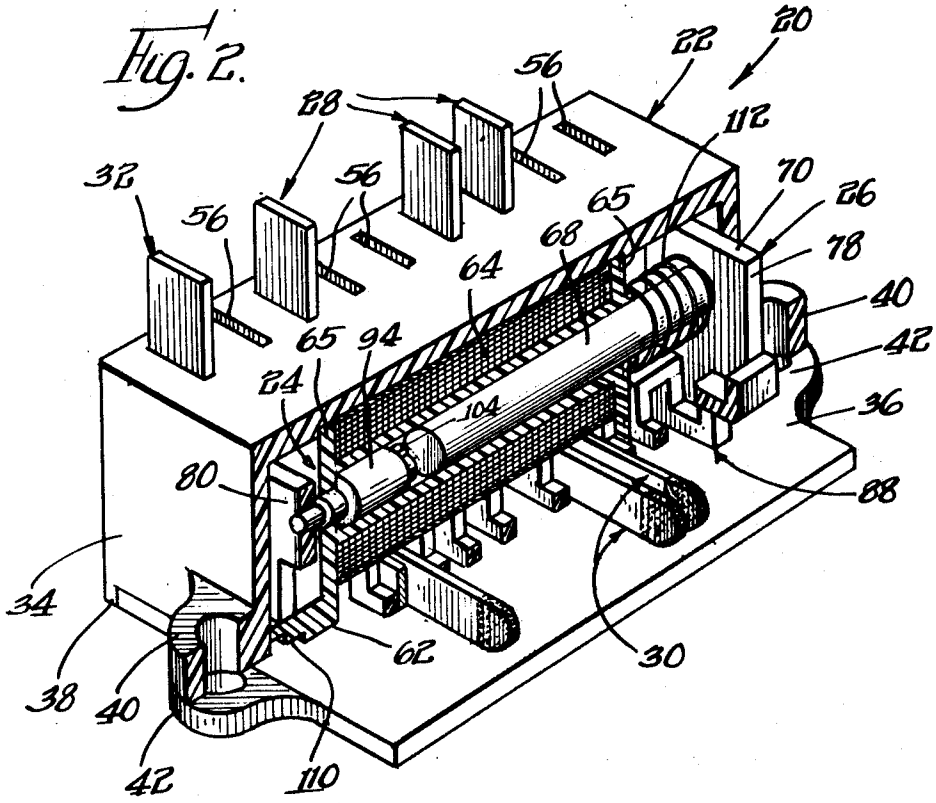


Fig. 2.



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Fig. 3.

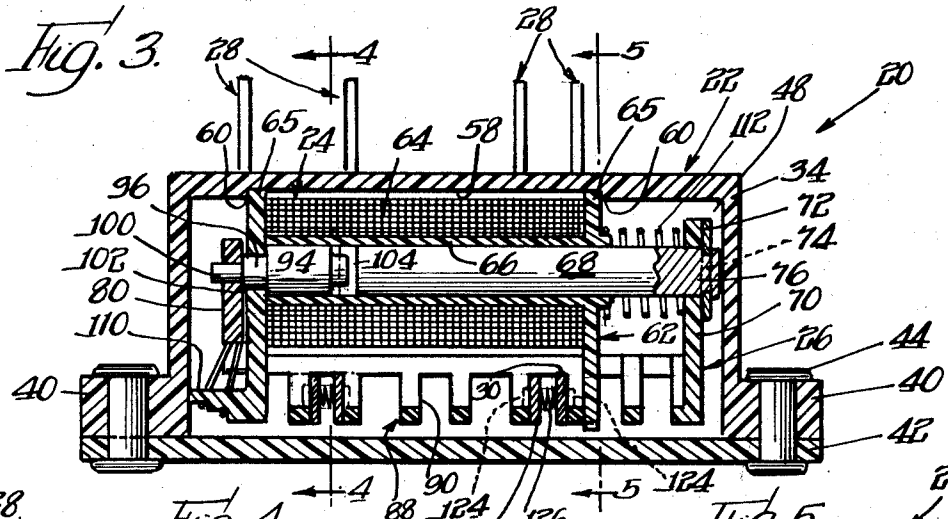


Fig. 4.

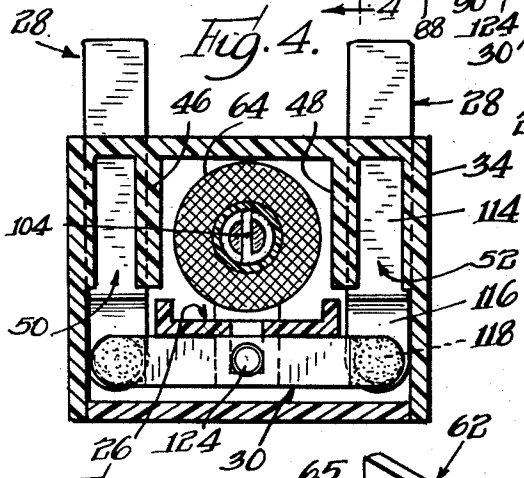


Fig. 5.

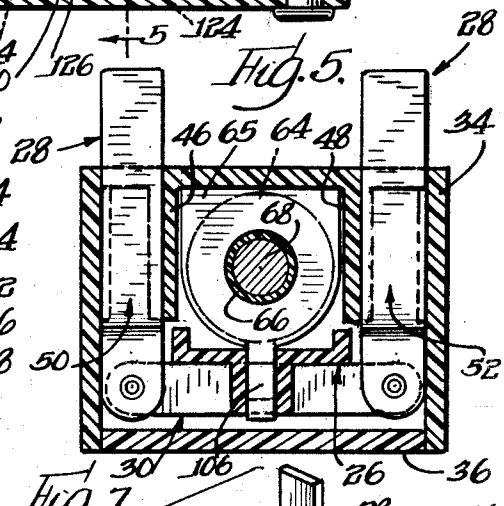


Fig. 6.

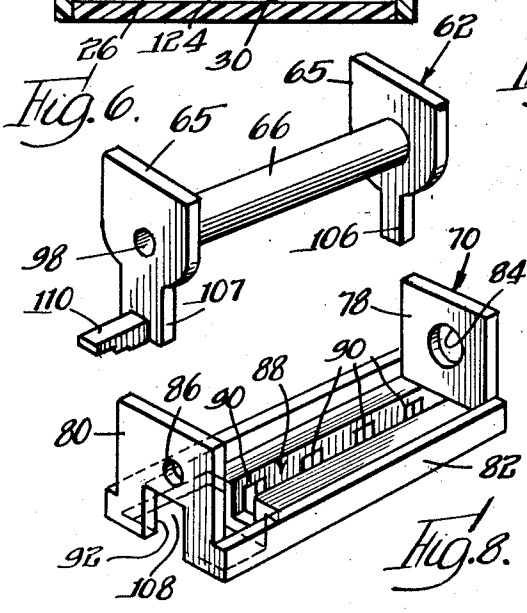


Fig. 7.

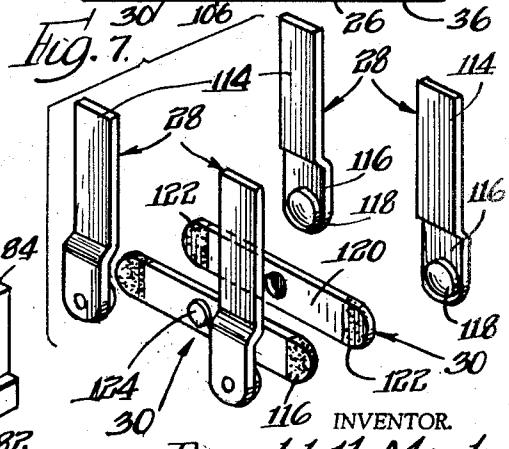


Fig. 8.

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Fig. 9.

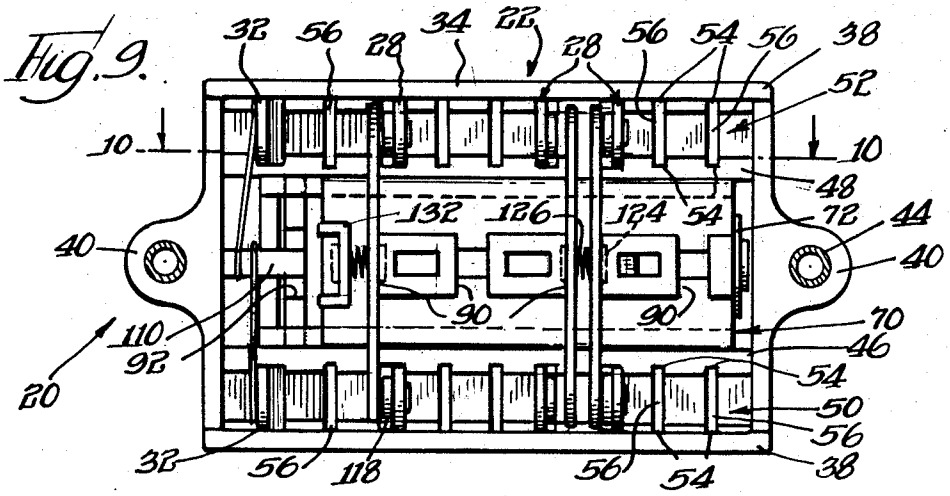


Fig. 10.

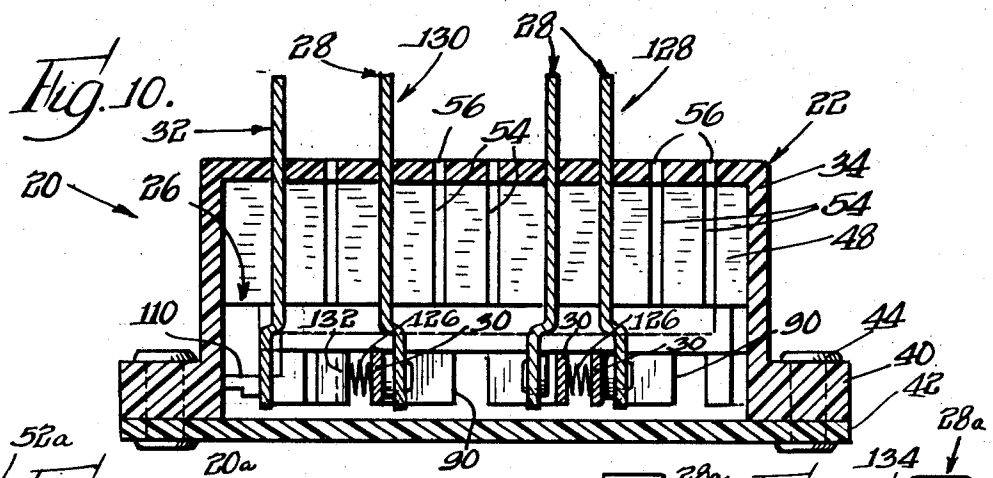


Fig. 11.

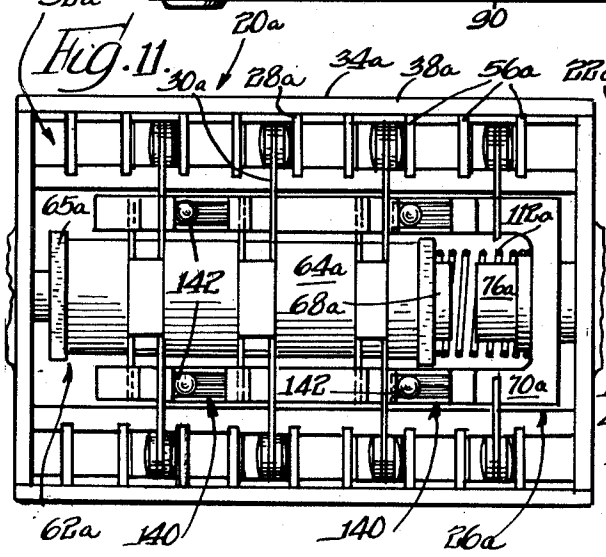
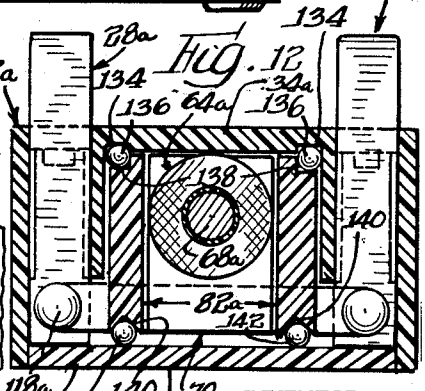


Fig. 12.



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United States Patent Office 3,141,939 Patented July 21, 1964

3,141,939 PLURAL CONTACT RELAY WITH SOLENOID ACTUATOR

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Filed Apr. 9, 1962, Ser. No. 186,111
12 Claims. (Cl. 200—104)

This invention relates generally to electromagnetic devices and more particularly to solenoid actuated relays.

In the past, it has been the common practice to actuate a relay using a solenoid; and conventionally, the attracted plunger or armature has been directed to shift a switch operator through a pivoted link. Because of the pivotal linkage involved, the prior art solenoid actuated relays have required the expenditure of rather considerable amounts of labor in their production, particularly in the matter of individually adjusting each unit for proper operation. Accordingly, these prior art relays have been relatively high cost items, the cost of which has advanced in proportion to the general increases in wage rates which have occurred during recent years. Moreover, these prior art relays have resisted automation of their production, largely due to the pivotal linkages which have been incorporated.

Therefore, a general object of the invention is to provide a new and improved electric relay of the solenoid actuated type.

Another object of the invention is to provide a solenoid actuated relay which is relatively inexpensive to manufacture.

Yet another object of the invention is to provide a solenoid actuated relay which eliminates the need for pivotal linkages.

Still another object of the invention is to provide a relay device which can be arranged to control a selected number of circuits by the mere incorporation of the appropriate number of contact pieces.

A further object of the invention is to provide a relay device which is adapted to the incorporation of either single-throw or double-throw switches.

A still further object of the invention is to provide a relay device which is relatively insensitive to dimensional variations in the parts.

And a still further object of the invention is to provide a relay device having a smooth action and a long life.

These and other objects and features of the invention will become more apparent upon a reading of the following descriptions.

A device in accordance with the invention includes a housing defining a channel and contact-mounting structures disposed on opposite sides of the channel; a solenoid arrangement fixed in the channel separated from the ends thereof to define operating spaces, the solenoid arrangement including a coil; an actuator arrangement mounted in the channel to be slidable relative to the solenoid arrangement, including a control element to magnetic material disposed coaxially with respect to the coil and having an end portion reciprocable in one of the operating spaces; means biasing the actuator arrangement against the attraction of the coil; fixed contacts in the contact-mounting structures, having portions exposed through the housing for connection to circuit means; movable contacts on the actuator arrangement confronting the fixed contacts to be selectively engageable upon movement of the actuator arrangement; and terminal means connecting the coil externally of the housing for energization thereof.

The invention, both to its structure and mode of operation, will be better understood by reference to the following disclosure and drawings forming a part thereof, wherein:

FIG. 1 is a perspective view of a relay device constructed in accordance with the principles of the present invention, the housing being shown fashioned from transparent material whereby to reveal interior details;

FIG. 2 is an enlarged perspective view of the relay device of FIG. 1, a portion being shown cut away to reveal further details of the construction;

FIG. 3 is an enlarged, side elevational view in cross-section of the relay device of FIG. 1;

FIG. 4 is a view taken through the section 4—4 of FIG. 3;

FIG. 5 is a view taken through the section 5—5 of FIG. 3;

FIG. 6 is an enlarged perspective view of the bracket used in mounting the coil of the solenoid in the housing of the relay device of FIG. 1;

FIG. 7 is an enlarged perspective view of the fixed and movable contacts used in the relay device of FIG. 1;

FIG. 8 is an enlarged perspective view of the actuator bracket used in carrying the movable contacts;

FIG. 9 is an enlarged, bottom plan view of the relay device of FIG. 1, the cover of the housing being removed to reveal internal details of the device;

FIG. 10 is a view taken through the section 10—10 of FIG. 9;

FIG. 11 is a bottom plan view of a modified embodiment of the invention, the cover of the housing being removed to reveal internal details of the device; and

FIG. 12 is an end elevational view in central cross-section of the modified relay device of FIG. 11.

Referring now in detail to the drawings, specifically to FIGS. 1 and 2, a relay device indicated generally by the numeral 20 will be seen to comprise a housing 22, a solenoid arrangement 24, an actuator arrangement 26, fixed contacts 28, movable contacts 30, and terminals 32 for the coil of the solenoid arrangement. In compliance with the invention, the solenoid arrangement 24 and the fixed contacts 28 are secured in the housing 22; and in addition, the actuator arrangement 26 carries the movable contacts 30 and is slidably arranged in the housing 22 for movement in response to energization of the coil of the solenoid arrangement.

The housing 22 is fabricated of an electrically insulating material, preferably a suitable resinous plastic material. Polystyrene, polycarbonate and phenolic plastic materials have proved useful in this regard. As to its structure, the housing 22 comprises a hollow rectangular body 34 having an open bottom which is closured by a cover 36. Opposed bottom edges of the body 34 are formed with ribs 38 between which the cover 36 is secured. Moreover, the body 34 and the cover 36 are provided with cooperating ears 40 and 42 respectively; and these ears are fashioned with alignable apertures for receiving rivets 44 or other suitable fasteners.

In accordance with the invention, the housing 22 includes a channel for receiving the solenoid arrangement 24 and the actuator arrangement 26; and with reference to FIGS. 4, 5 and 9, this channel will be seen to be defined generally by parallel partitions 46 and 48 which are integrally connected to the top of body 34 in depending relationship therewith. In further compliance with the invention, contact-mounting trays 50 and 52 are defined between partition 46, partition 48 and the corresponding sidewalls of body 34. Opposed pairs of grooves 54 are fashioned in the partitions and the cooperating sidewalls of body 34 to open into the trays 50 and 52, and each pair of these grooves is aligned with a slot 56 formed in the top of the body 34. Thus, the grooves 54 and the slots 56 cooperate to define stalls, each of which is adapted to receive the blade of a fixed contact 28 as is well shown in FIG. 10.

The housing 22 is also intended to establish and fix a particular position of the solenoid arrangement 24; and turning to FIG. 3, the floor of the channel between partitions 46 and 48, i.e. the top of the body 34, will be seen fashioned with a recess 58 which defines shoulder formations 60 at its opposite ends. These shoulder formations 60 are situated generally closer to one end of the channel than the other in order to insure proper location of the solenoid arrangement 24 as will be described more fully hereinafter.

Considering FIG. 2, the solenoid arrangement 24 is seen to comprise a bracket 62 and a coil 64; and turning to FIG. 6, the bracket 62 is seen to include end plates 65 interconnected by a tubular core 66, the bracket 62 being fabricated from an electrically insulating material and coil 64 being wound on the core 66. With reference to FIG. 3, the end plates 65 will be seen to have been suitably spaced apart by the tubular core 66 for cooperation with the shoulder formations 60. Specifically, the bracket 62 is situated in the housing 22 between the partitions 46 and 48 with the top edges of the end plates 65 disposed in recess 58 in abutting relationship with the corresponding shoulder formations 60. So disposed, the solenoid arrangement 24 is spaced from both ends of the channel which is defined by partitions 46 and 48.

As mentioned hereinabove, the actuator arrangement 26 is mounted to be slidable relative to the solenoid arrangement 24; and considering FIG. 2, the actuator arrangement 26 is seen to comprise a control element or plunger 68 formed of soft iron or the like, a carrier bracket 70 and, as will be seen in FIG. 3, means for coupling the plunger 68 to the carrier bracket 70 for movement in one direction. These latter means, in the illustrated embodiment, include a washer element 72 received in a groove 74 formed circumferentially in an end portion 76 of the plunger 68.

Considering FIGS. 3 and 8, the carrier bracket 70 includes arms 78 and 80 which are spaced apart by a bridge element 82. Arm 78 is provided with a relatively large bore 84 adapted slidably to pass the end portion 76 of plunger 68; arm 80 is fashioned with a relatively small bore 86 axially aligned with bore 84; and bridge element 82 is provided with a longitudinally extending rib formation 88 depending from the bridge element and including longitudinally spaced-apart transverse notches 90. Arm 80 is also provided with a notch 92 which is generally aligned with the rib formation 88. It has proved advantageous to fabricate carrier bracket 70 from a flame-resistant, resinous plastic.

In assembly of the solenoid arrangement 24 and the actuator arrangement 26, a pin 94 is inserted in one end of the tubular core 66 as is illustrated in FIG. 3. The pin 94 includes a reduced diameter section 96 which extends through a relatively small diameter bore 98 drilled or otherwise suitably formed in the corresponding end plate 65. The pin 94 includes a further reduced diameter end portion 100 which passes through the cooperatively shaped bore 86 in arm 80. In addition, the section 96 is advantageously staked at locations 102 in order to fix the pin 94 in the bracket 62.

The opposite end of pin 94 is fashioned with a slotted head; and when the relay device 20 is intended for A.C. applications, a D-shaped copper shading coil 104 is assembled to the slotted head of pin 94 in accordance with conventional practice.

Assembly of the solenoid arrangement 24 in the actuator arrangement 26 is further implemented by inserting the plunger 68 through bore 84 in bracket 70 and thence into the tubular core 66. Thus, the actuator arrangement 26 is journaled to the solenoid arrangement 24.

The actuator arrangement 26 is desirably mounted to the solenoid arrangement 24 in a non-rotatable manner. Therefore, the end plates 65 of bracket 62 are fashioned with tongues 106 and 107. Tongue 106 slidably operates in the groove formed in the upper side of rib formation 88, and tongue 107 traverses a space 108 defined between arm 80 and the rib formation. These arrangements are best shown in FIGS. 6 and 8.

Advantageously, an extension 110 is joined to the tongue 107; and this extension is passed through notch 92 in bracket 70 to act as a strain relief for the ends of the wire that is used in forming coil 64. This is shown in FIGS. 3 and 9. To further its utility for this purpose, extension 110 is provided with the steps which are shown in FIG. 6.

In order to establish a normal position of the actuator arrangement 26 relative to the solenoid arrangement 24, a compression spring 112 is disposed encircling the end portion 76 of plunger 68 between arm 78 and the confronting end plate 65 as is well shown in FIGS. 2 and 3. Thus, the plunger 68 is biased away from the attraction established by the coil 64 when energized.

Considering FIG. 7, the fixed contacts 28 are seen to comprise electrically conductive blades 114 having offset tip portions 116 to which appropriately shaped masses 118 of contact metal are welded, riveted, plated or otherwise suitably attached. Similarly, each of the movable contacts 30 is fashioned of a conductive blade 120 having opposite tip portions 122 carrying quantities of contact metal. The movable contacts 30 are also formed with central pins 124 bumped or extruded to extend from one surface.

The movable contacts 30 are adapted to be carried by the bracket 70 in the notches 90 formed in the rib formation 88 thereof; and considering FIG. 3, the movable contacts 30 will be seen having been arranged to possess a thickness less than one-half the corresponding thickness of the notches 90. So arranged, the contacts 30 can be assembled with the pins 124 extending into the groove developed on the under surface of rib formation 88 in order to establish a fixed lateral position. Thereupon, a compression spring 126 is assembled between the contacts 30 to maintain the contacts in proper position and to provide a resilient mounting thereof.

Because the actuator 26 is arranged to be slidable in its operation and because the contact trays 50 and 52 are provided with a substantial number of contact-receiving stalls, the relay device 20 can be selected to control any one of a substantial number of circuits by selecting the number and arrangements of the fixed and movable contacts upon assembly of device 20. For example, a double-throw switch may be provided by arranging fixed contacts 28 in adjacent pairs of the stalls and by arranging a pair of movable contacts 30 in the corresponding notch 90 of the carrier bracket 70. Such a double-throw switch is indicated in FIG. 10 by the numeral 128. Similarly, a single-throw switch may be provided by situating fixed contacts 28 in a pair of the stalls and by situating a movable contact 30 in coactable relationship in the corresponding notch 90. Such a single-throw switch is indicated in FIG. 10 by the numeral 130. It will be noted that a dummy 132 is inserted in the notch 90 to provide proper action of the spring 126 in the single-throw switch arrangement. As will be recognized, substantial variation can be obtained by further rearrangement of the fixed and movable contacts.

It is also important to realize that the resilient mounting of the movable contacts which is achieved by means of the springs 126 tends to compensate for loose tolerances in the parts involved and additionally gives a certain amount of freedom of movement of the parts upon assembly and during use.

After the relay device 20 is completely assembled, it may be readily connected in suitable circuits, the fixed contacts 28 being exposed through the housing 22 for attachment to appropriate conductors and the terminals 32 of the coil 64 being similarly exposed. When the circuit which includes the coil 64 is energized, the coil will develop a magnetic field tending to attract the plunger 68; and this attraction of the plunger 68 will tend to draw the

plunger toward the pin **94** and into deeper penetration in the tubular core **66**. This movement of the plunger will be opposed by the spring **112**, and when the magnetic attraction is sufficient to overcome the spring force, the plunger will move; and because of the abutment provided by washer **72**, the plunger **68** will cause the carrier bracket **70** to move correspondingly. Since the movable contacts **30** are mounted on the carrier bracket **70**, these contacts will move in a like manner to make or break contact between the opposed pairs of fixed contacts **28** according to the particular arrangement thereof which has been made. Deenergization of the coil **64** will allow the spring **112** to return the carrier bracket **70** to its initial position whereby to reestablish the original relationship between the fixed and movable contacts.

While a particular embodiment of the invention has thus far been shown and described, it should be understood that the invention is not limited thereto since many modifications may be made. For example, a modified embodiment of the invention is shown in FIGS. 11 and 12. Because the embodiment of FIGS. 11 and 12 is similar in many respects to the embodiment of FIGS. 1–10, like numerals have been used to designate like parts, the suffix letter "*a*" being used to distinguish those elements associated with the embodiment of FIGS. 11 and 12.

The embodiment of FIGS. 11 and 12 is particularly distinguished by the provision of anti-friction means acting between the housing and the actuator arrangement. Specifically, the top of body **34***a* of the housing is fashioned with spaced, longitudinally extending grooves **134**, and ball bearings **136** are disposed in the grooves **134**. The bridge elements **82***a* of the carrier bracket **70***a* are extended and are provided with grooves **138** confronting the grooves **134** so as to retain the ball bearings **136** in position. Similarly, the opposite ends of the bridge elements **82***a* are provided with V-grooves **140** which receive ball bearings **142**, cover **42***a* acting to hold the ball bearings **140** in the grooves **142**. This arrangement of grooves and ball bearings provides smooth action to the movements of the actuator arrangement and insures long life in the relay device.

The embodiment of FIGS. 11 and 12 is also distinguished by the separation of plunger **68***a* from the end portion **76***a*, the plunger **68***a* being fixed in position in the center of coil **64***a*. Since the end portion **76***a* is affixed to the carrier bracket **70***a* of the actuator arrangement, a clapper type of armature is thus provided. As will be recognized, energization of coil **64***a* magnetizes the plunger **68***a* and attracts the end portion **76***a* whereby to move the carrier bracket **70***a* against the bias of spring **112***a*.

The specific examples herein shown and described are to be considered as being primarily illustrative. Various changes will, no doubt, occur to those skilled in the art; and these changes are to be understood as forming a part of this invention insofar as they fall within the spirit and scope of the appended claims.

The invention is claimed as follows:

1. A relay device comprising:

(*a*) housing means defining a channel having spaced longitudinally extending walls and a connecting web and having contact-mounting means disposed laterally of said channel;

(*b*) solenoid means fixed in said channel separated from at least one end thereof to define operating space, said solenoid means fitting between said walls for lateral positioning and said web having stop means interfitting with said solenoid means for longitudinal positioning thereof, said solenoid means including a coil;

(*c*) actuator means mounted in said channel to be slidable relative to said solenoid means, including a control element of magnetic material disposed coaxially with respect to said coil and having an end portion reciprocable in said operating space;

(*d*) means biasing said actuator means against the attraction of said coil;

(*e*) fixed contact means in said contact-mounting means, at least some of said fixed contact means having portions exposed through said housing means for connection to circuit means;

(*f*) movable contact means on said actuator means confronting said fixed contact means to be selectively engageable therewith on movement of said actuator means; and

(*g*) terminal means connecting said coil externally of said housing means for energization thereof.

2. A relay device according to claim 1 wherein said housing means includes contact-mounting means on opposite outward sides of the walls of said channel, said contact-mounting means including external sidewalls of said housing parallel to said longitudinally extending walls and spaced therefrom, at least one of such adjacent sidewall and longitudinally extending wall having slots therein receiving fixed contact means in the other of said adjacent walls holding said fixed contact means in said slots.

3. A relay device according to claim 2 wherein there are more slots than fixed contact means, said fixed contact means being selectively received in said slots.

4. A relay device according to claim 2 wherein each adjacent sidewall and longitudinally extending wall is provided with confronting slots, said fixed contact means being in said confronting slots.

5. A relay device according to claim 1 wherein said actuator means is provided with slots selectively receiving said movable contact means, and further including retaining means holding said movable contact means in said actuator slots.

6. A relay device comprising:

(*a*) housing means defining a channel having ends and spaced formations intermediate said ends, said housing means further defining contact-mounting means disposed laterally of said channel;

(*b*) solenoid means fixed in said channel separated from at least one end thereof to define operating space, said solenoid means including bracket means located in position by said formations and further including a coil fixed to said bracket means;

(*c*) actuator means mounted in said channel to be slidable relative to said solenoid means, including a control element of magnetic material disposed coaxially with respect to said coil and having an end portion reciprocable in said operating space; said actuator means further including a carrier bracket and means coupling said end portion of the control element to said carrier bracket for movement in one direction;

(*d*) means biasing said actuator means in the opposite direction and against the attraction of said coil;

(*e*) fixed contact means in said contact-mounting means, having portions exposed through said housing means for connection to circuit means;

(*f*) movable contact means on said actuator means confronting said fixed contact means to be selectively engageable therewith upon movement of said actuator means; and

(*g*) terminal means connecting said coil externally of said housing means for energization thereof, wherein said solenoid means is separated from both ends of said channel; wherein said carrier bracket includes arms extending into each of the spaces between said solenoid means and the ends of said channel; and wherein said bracket means is fixed against movement laterally of said carrier bracket by said control element slidably entering an aperture in one of said arms and an aligned bore in said bracket means and by pin means entering an aperture in the other of said arms and an aligned bore in said bracket means.

7. A relay device according to claim 6 wherein said

housing means, said bracket means and said carrier bracket are formed of electrically insulating material.

8. A relay device according to claim 6 and further including means fixing said carrier bracket against movement laterally and angularly of said bracket means.

9. A relay device comprising:

(*a*) housing means defining a channel and contact-mounting means disposed on opposite sides of said channel;

(*b*) solenoid means fixed in said channel separated from at least one end thereof to define operating space, said solenoid means including a coil;

(*c*) actuator means mounted in said channel to be slidable relative to said solenoid means, including a control element of magnetic material disposed coaxially with respect to said coil and having an end portion reciprocable in said operating space, said actuator means further including a carrier bracket and means coupling said end portion of the control element to said carrier bracket for movement in one direction;

(*d*) means biasing said actuator means in the opposite direction and against the attraction of said coil;

(*e*) fixed contact means in said contact-mounting means, having portions exposed through said housing means for connection to circuit means;

(*f*) movable contact means on said actuator means confronting said fixed contact means to be selectively engageable therewith upon movement of said actuator means; and

(*g*) terminal means connecting said coil externally of said housing means for energization thereof, wherein a said contact-mounting means includes means defining a plurality of contact-receiving stalls spaced-apart from one another in the direction of the longitudinal axis of said channel, said stalls being adapted to receive a selected number of said fixed contact means in a selected arrangement; and wherein said carrier bracket includes a longitudinally extending formation having spaced-apart, transverse notches adapted to receive a selected number of said movable contact means in a cooperative arrangement.

10. A relay device according to claim 9 wherein said notches loosely receive said movable contact means; and wherein said relay device further comprises spring means biasing said movable contact means against the walls of the corresponding notches whereby to provide a resilient mounting for said movable contact means.

11. A relay device comprising:

(*a*) housing means defining a channel having ends and spaced formations intermediate said ends, said housing means further defining a plurality of contact-receiving stalls disposed in laterally aligned pairs on opposite side of said channel;

(*b*) solenoid means fixed in said channel separated from at least one end thereof to define operating space, said solenoid means including bracket means located in position by said formations and further including a coil fixed to said bracket means;

(*c*) actuator means mounted in said channel to be slidable relative to said solenoid means, including a control element of magnetic material disposed coaxially with respect to said coil and having an end portion reciprocable in said operating space, said actuator means further including a carrier bracket and means coupling said end portion of the control element to said carrier bracket for movement in one direction;

(*d*) means biasing said actuator means in the opposite direction and against the attraction of said coil;

(*e*) fixed contact means in said stalls, each of said contact means having a portion exposed through said housing means for connection to circuit means;

(*f*) movable contact means on said actuator means confronting said fixed contact means to be selectively engageable therewith upon movement of said actuator means; and

(*g*) terminal means connecting said coil externally of said housing means for energization thereof.

12. A relay device comprising: housing means defining a channel and contact-mounting means disposed on opposite sides of said channel; solenoid means fixed in said channel and having a pin extending from one end thereof, said solenoid means including a coil; actuator means mounted in said channel to be slidable relative to said solenoid means, including a control element of magnetic material disposed coaxially with respect to said coil and having an end portion extending oppositely of said pin, said actuator means further including a carrier bracket having two ends and slidably received in said channel, and means coupling one end of said bracket to said end portion of the control element and the other end of said bracket to said pin for movement of said bracket longitudinally of said channel; means biasing said actuator means against the attraction of said coil; fixed contact means carried from said contact-mounting means; movable contact means on said actuator means confronting said fixed contact means to be selectively engageable therewith upon movement of said actuator means; and terminal means connecting said coil externally of said housing means for energization thereof.

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