

[54] **ELECTROMAGNETIC RELAY HAVING A PRINTED CIRCUIT BOARD CONNECTION BETWEEN THE CONTACTS AND RADIO TYPE PLUG-IN CONNECTOR**

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[58] Field of Search 335/178, 2, 199; 200/284, 200/292; 339/193 P, 193 VS; 174/50.52

[56] References Cited

UNITED STATES PATENTS

3,082,350 3/1963 Gulbrandsen 174/50.52

3,406,361 10/1968 Mauviel 335/178

Primary Examiner—Harold Broome

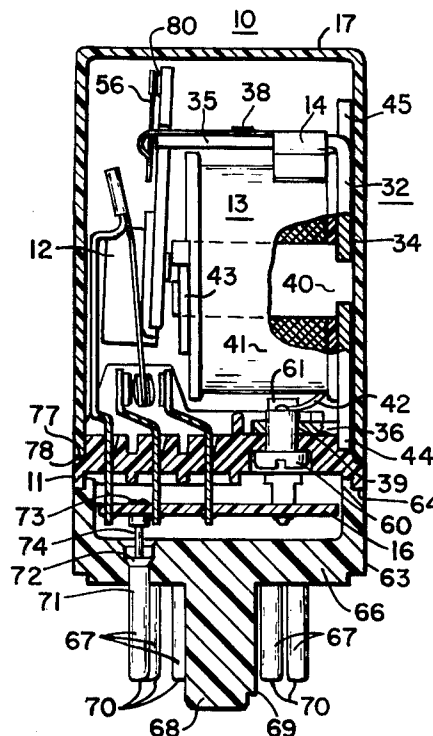
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[57]

ABSTRACT

An improved electromagnetic relay structure wherein a printed circuit board provides the electrical connection between the contact and coil terminals of the relay and the pins of a radio type plug-in connector. The printed circuit board is positioned in a cavity in the plug-in connector and includes openings which receive the contact terminals, openings which position pins that are received in the tubular pins of the connector and a printed circuit on the board which interconnects the terminals with the pins. The relay also includes a simplified clip which retains and provides a spring bias for the armature.

10 Claims, 4 Drawing Figures



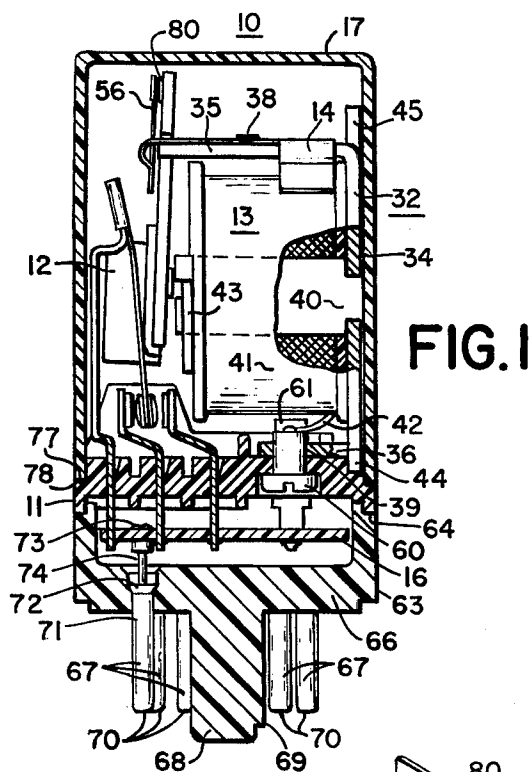


FIG. 1

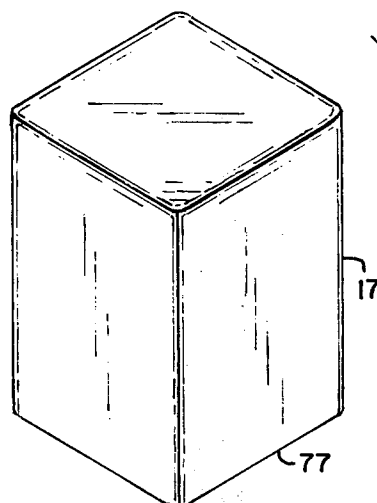


FIG. 3

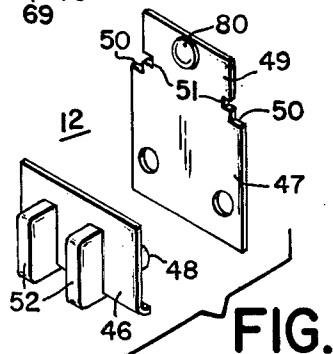


FIG. 4

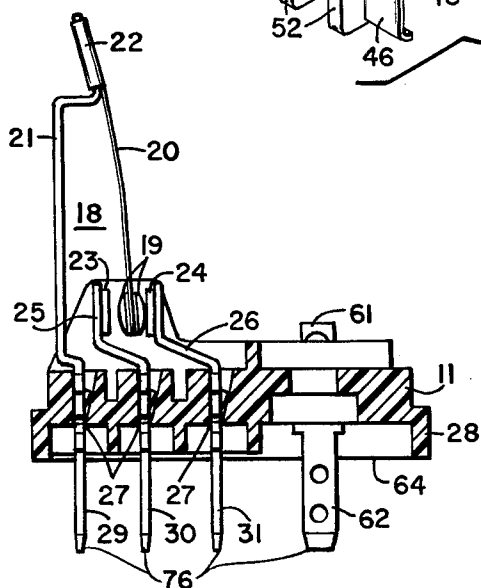
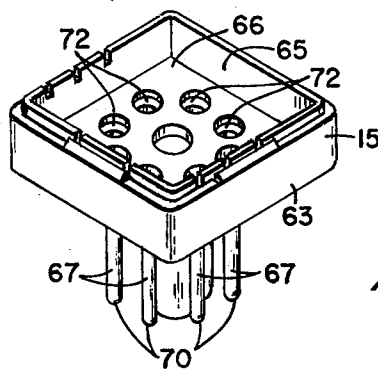
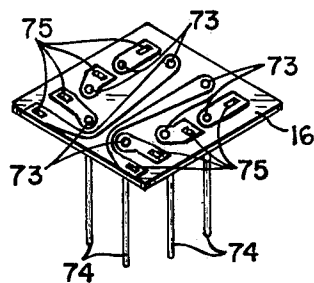
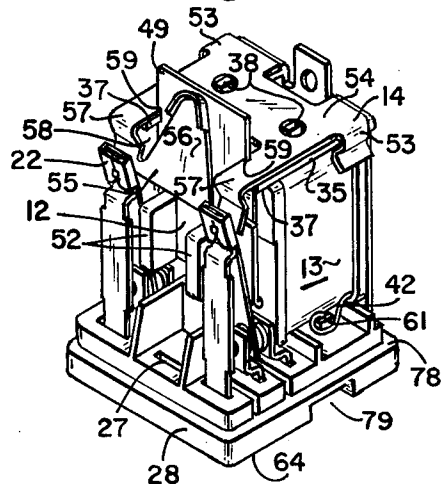


FIG. 2



ELECTROMAGNETIC RELAY HAVING A PRINTED CIRCUIT BOARD CONNECTION BETWEEN THE CONTACTS AND RADIO TYPE PLUG-IN CONNECTOR

This invention relates to electromagnetically operated relays and more particularly to miniature type electromagnetic relays.

Relays of the type with which the present invention is concerned are well known, as illustrated by the relay disclosed in the U.S. Pat. No. 3,406,361 which was granted to Paul J. LeMauviel on Oct. 15, 1968 and assigned to the assignee of the present invention. While the relay disclosed in the LeMauviel patent has enjoyed considerable commercial success, it included features which were costly to manufacture and a single spring clip which maintained the relay as an assembled unit. In addition to the spring clip, later production relays also included an epoxy bond between the magnet frame and base. In the relay according to the present invention, a single self-threading screw tapped into the magnet frame eliminates the possibility of a faulty epoxy bond between the magnet frame and base and the requirement that the spring clip act as a securing means. The spring clip as used in the relay as will be hereinafter described is formed of less material and is easier to manufacture than the clip used in the LeMauviel relay.

Further in the LeMauviel relay, the movable contact blades are spot welded to a rigid support. In the relay according to the present invention, the movable contact blades are connected to their associated supports by a slip-on connection which eliminates the possibility of faulty welds between the connected parts as well as facilitates reclamation of the parts when rework of the parts is required.

And finally, the LeMauviel relay included a conventional commercially available radio type plug-in connector which included a molded insulating part as well as a metal part. The metal part received securing screws for a cover for the relay and the molded part positioned the tubular pins for the connector. In the LeMauviel relay, the only connection between the base of the relay and the plug-in connector is provided by thin wires which are connected between the terminals on the rear surface of the base and the tubular pins. The thin wire connections made the assembly of the relay difficult, considerably increased the cost of the relay and provided a fragile connection between the connector and the base of the relay.

It is an object of the present invention to provide an improved lower cost miniature electromagnetic relay in which the connection between the coil and contact terminals of the relay and the tubular pins of a radio type plug-in connector is provided by a printed circuit board. The board has pins positioned thereon which are telescopically received in the tubular pins and has openings located to receive the contact terminals. The contact terminals and pins are electrically connected to a printed circuit that is formed on the board.

Another object is to provide an improved lower cost miniature electromagnet relay in which the connection between the coil and contact terminals of the relay and the tubular pins of a radio-type plug-in connector is provided by a printed circuit board and pins which are positioned by the board to be telescopically received in the tubular pins and the connection between the movable contact blades of the relay and the support for the blades is provided by a slip-on type connection which

eliminates the possibility of faulty welds between the blades and support as well as facilitating the assembly and reworking of the relay during manufacture.

Further objects and features of the invention will be readily apparent to those skilled in the art from the following specification and from the appended drawings illustrating certain preferred embodiments, in which:

FIG. 1 is a side elevation of a relay incorporating the features of the present invention showing certain of the components of the relay in cross section.

FIG. 2 is a side cross-sectional view showing a contact and a base sub-assembly unit separated from the remainder of the relay in FIG. 1.

FIG. 3 is an exploded perspective view of the components forming the relay in FIG. 1, and

FIG. 4 is an exploded perspective view of the armature and contact actuator as used in the relay shown in FIG. 1.

Referring to the drawings, a miniature relay 10 incorporating the features in accordance with the present invention comprises a contact and base unit 11, an armature and actuator sub-assembly 12, a magnet and coil sub-assembly 13, a spring clip 14, a radio-type plug-in connector 15, a printed circuit board 16 and a cover 17.

The contact and base unit 11, shown best in FIG. 2, includes contact means comprising, for the two pole relay shown, two electrically conductive contact assemblies 18. Each contact assembly 18 comprises a double-faced movable contact 19 carried at the free end of a resilient blade 20 having its other end secured to an elongated contact support 21 by a slip-on or fast-on type connection 22. The fast-on type connection 22 between the blade 20 and support 21 provides a reliable electrical connection and aids in the assembly of the relay 10 during manufacture as well as facilitates reclamation of the contact blade 20 should rework of the relay be required during manufacture.

The movable contact 19 for each pole is double-faced as previously mentioned, and has a contact surface disposed on each side of its associated blade 20 for selective engagement with an associated pair of opposed stationary contacts 23 and 24 between which each movable contact 19 is positioned for operation. The contacts 23 and 24 of each pole are carried by stationary contact supports 25 and 26 respectively, and the supports 21, 25 and 26 extend through and are retained by ultrasonic welds in respective openings 27 formed in a molded insulating base member 28. Although the relay shown and described herein has two poles, it could, if desired, be constructed as a triple pole device by including the necessary movable and stationary contact components in the unused openings 27 which are centrally located in the base 28, as illustrated in FIG. 3.

The supports 21, 25 and 26 for each pole have terminal portions 29, 30 and 31 respectively which project downwardly beyond a bottom side 64 of the base 28. Because each pole of the relay 10 has three terminal portions, the two-pole relay shown has for its switching circuit a total of six terminal portions spaced in two rows of three each. Obviously, if the relay 10 is constructed as a three pole relay, a total of nine terminal portions spaced in three rows of three each will extend from the bottom face of the base 28.

The magnet and coil sub-assembly 13 and the armature and actuator sub-assembly 12 are preferably made

as separate assemblies which are secured together in operative relationship by the spring clip 14. This arrangement of separate assemblies simplifies and expedites manufacture and facilitates ready separation of the components for adjustment or repair. Of particular advantage is that the movable and stationary contacts are exposed to permit convenient adjustment thereof prior to final assembly.

The magnet and coil sub-assembly 13 comprises a magnet frame 32 having a substantially flat rear portion 34 with bentover top and bottom portions 35 and 36, respectively. The top portion 35 is provided with a pair of forwardly directed flank portions 37 which, together with an intermediate forward edge on the top portion 35, define a shallow recess for receiving the armature and actuator sub-assembly 12 in juxtaposition with the frame 32. The top portion 35 also has a pair of upwardly directed projections 38 and the bottom portion 36 has an opening 39.

A laminated core 40 comprising a plurality of ferrous magnetizable laminations is secured in an opening in the rear portion 34 by staking or otherwise deforming the laminations after they have been positioned with respect to the rear portion 34. An operating winding or coil 41 having a plurality of turns of insulated electrically conductive wire wound on an insulating bobbin is provided with a pair of terminal leads 42, only one of which is shown. The coil 41 is fixedly retained in the sub-assembly 13 by a highly conductive shading coil 43, a portion of which is received in a notch in the forward face of the core 40 and thereafter staked or otherwise deformed to securely wedge the shading coil 43 in place in the notch in the forward face of the core 40. The purpose of the shading coil 43 is well known to those skilled in the art and need not be further explained. The rear portion 34 also has a pair of downwardly directed leg members 44 integral with the frame 32 and disposed one on each side of the portion 36. An upwardly directed ear 45 also extends contiguously from the rear portion 34 as an integral section thereof.

The armature and actuator sub-assembly 12 comprises an insulating non-conductive contact actuator 46, preferably molded of a thermoplastic compound, fixedly secured to a generally rectangular shaped essentially flat electromagnetic iron armature 47 by ultrasonically staking a pair of projections 48 extending from the actuator 46 through aligned complementary openings in the armature 47. A narrowed upper portion 49 of the armature 47 defining, and disposed intermediate of, a pair of shoulders 50 has a pair of transversely aligned slots 51 spaced upwardly from the shoulders 50 a distance substantially equal to the thickness of the top portion 35 and opening into the marginal edges of the portion 49. The actuator 46, when the armature and actuator sub-assembly 12 is installed in operative relation with the magnet and coil sub-assembly 13 and with the contact and base unit 11, is positioned for operative engagement with the contact blades 20 so as to move the contacts 19 between their associated stationary contacts 23 and 24. A pair of spaced barriers 52 molded integrally with, and extending forwardly of, the actuator 46, provides increased electrical clearance intermediate the areas of contact between the actuator 46 and the blades 20 where dust accumulation may occur.

The spring steel clip 14 maintains the armature and actuator assembly 12 securely in operative engagement

with the magnet and coil assembly 13. In addition, the clip 14 also serves to bias the armature and actuator sub-assembly 12 forwardly from the core 40. As is best illustrated in FIG. 3, the frame clip 14 comprises two bent-over fingers 53 disposed generally parallel to each other and extending downwardly from a central portion 54. The central portion 54 has a pair of holes or apertures therein which are shaped and located to receive the projections 38 of the top portion 35. The projections 38 and fingers 53 comprise means for constraining the clip 14 in alignment with the frame 32.

Each of the fingers 53 is shaped to grip a side edge of the top portion 35. A forward overhanging portion 55 of the clip 14 has an upwardly directed armature biasing tab member 56 and includes a pair of bent-over knee portions 57 joining the overhanging portion 55 to the forward marginal area of the central portion 54. The portion 55, including the tab member 56 and the knee portions 57, comprises biasing means for urging the armature and actuator sub-assembly 12 forwardly away from the core 40.

The overhanging portion 55 defines an opening 58 between a forward edge of the central portion 54 and the tab member 56. The opening 58 is bounded adjacent the knee portions 57 by respective transversely aligned recesses 59 which have a width slightly greater than the thickness of the armature 47.

The magnet and coil assembly 13 is secured on the upper surface base 28 by a self-tapping screw 60 that extends through a suitable counterbored opening in the base 28 into the previously mentioned opening 39 in the bottom portion 36. The upper surface of the base 28 is provided with a suitable recess which receives the bottom portion 36 and the base 28 is also provided with a pair of spaced recesses which receive the pair of leg members 44 to prevent movement of the magnet and coil assembly 13 after the assembly 13 is secured to the base 28 by the screw 60.

With the assembly 13 thus secured to the base 28, the coil terminal leads 42 are electrically connected to the top ends of a pair of terminals 61, one of which is shown in FIGS. 1 and 2. The terminals 61 extend through and are secured in the base 28 in a fashion similar to the terminals 29, 30 and 31 and provide terminal portions 62 which extend downwardly from the bottom side 64 of the base 28 in spaced relation to each other and the rows in which the terminals 29, 30 and 31 are located.

With the assembly 13 thus secured to the base 28, the upper narrowed portion 49 of the armature 47 is positioned in the opening 58 of the clip 14 so that the slots 51 in the portion 49 of the armature 47 are disposed adjacent the knee portions 57 at the recesses 59. Thus positioned, the armature and actuator sub-assembly 12 and the clip 14 can be fitted into assembled relationship with the magnet and coil sub-assembly 13, the clip 14 being received over the sub-assembly 13 with the fingers 53 gripping edge portions of the top portion 35 while the projections 38 of the top portion 35 are received in the apertures of the clip 14. The rear edge of the opening 58 is disposed closer to the projections 38 than the front edge of the recess between the flank portions 37 which causes the upper portion 49 of the armature 47 to be pivoted on the front edge of the top portion 35 in firmly abutting relationship with the tab member 56, as best illustrated in FIG. 1. When the armature portion 49 is positioned in the manner previ-

ously described, the slots 51 in the portion 49 receive respective inner marginal areas of the knee portions 57. The inner marginal areas of the portions 57 thus constrain the armature and actuator sub-assembly 12 against downward movement out of position with respect to the assembled frame clip 14 and the magnet and coil sub-assembly 13. At the same time, the shoulders 50 of the armature 47 cooperate with the underside of the flank portions 37 of the top portion 35 to constrain the armature and actuator sub-assembly from upward movement. Accordingly, in the assembly thus far described, the clip 14 not only constrains the armature and actuator sub-assembly 12 in pivotal engagement with the frame 32 but also biases it in a direction out of engagement with the core 40.

Because the armature and actuator sub-assembly 12 is biased away from the core 40 by the tab member 56, the actuator 46 normally urges the movable contact 19 of each pole into engagement with its associated stationary contact 23 when the coil 41 is de-energized, as shown in FIG. 1. Accordingly, it is evident that in order to maintain the contacts 19 and 23 closed, the biasing force of the tab member 56 must be sufficiently strong to overcome the combined force of the blades 20 which tend to urge the contacts 19 toward their associated stationary contacts 24. When the coil 41 is energized, the electromagnetic force of attraction between the armature 47 and the core 40 is sufficient to overcome the biasing force acting through the tab member 56 and, consequently, the armature 47 is drawn into engagement with the core 40 thereby permitting the movable contacts 19 to close against the stationary contacts 24. Hence, the stationary contact 23 and the movable contact 19 constitute, for each pole, a normally closed pair of contacts while the stationary contact 24 and the movable contact 19 constitute, for each pole, a normally open pair of contacts.

The radio-type plug-in connector 15 includes an insulating molded part 63 having an upper side positioned adjacent a bottom side 64 of the base 28. Preferably, the part 63 is secured to the base 28 by ultrasonically welding the parts together to provide a closed cavity 65 which extends from the bottom side 64 of the base 28 to a bottom wall 66 of the part 63. Extending downwardly from the bottom wall 66 are a plurality of tubular pins 67 at least equal in number to the total number of terminal portions 29, 30, 31 and 61 extending from the bottom side 64 of the base 28. The tubular pins 67 are equidistantly spaced from a common center and the walls of a cylindrical indexing plug 68 which extends downwardly from the bottom wall 66. The indexing plug 68 has a rib 69 formed along its outer wall which indexes the position of the tubular pins 67 when the connector 15 is inserted in a conventional suitable tube socket. Each of the tubular pins 67 has an open bottom end 70 and a portion 71 secured in and extending through the bottom wall 66 to present an open top end 72 which is exposed in the cavity 65.

The printed circuit board 16 is positioned in the cavity 65 and has a plurality of openings extending therethrough at least equal in number to twice the sum of the terminal portions 29, 30, 31 and 61. One half of the openings are arranged in a circular pattern and are located on centers so each tubular pin 67 will be aligned with an opening in the board 16. Each of the openings in the circular pattern has an end 73 of a relatively stiff wire-like pin 74 secured therein with the pins 74 ex-

tending downwardly from the bottom side of the board 16 and telescopically received in the interior of the tubular pins 67 and extending to the open bottom ends 70 so a solder connection between the pins 74 and the tubular pins 67 may be accomplished by well known techniques. The remaining half of the openings in the board 16, designated by the numeral 75, are arranged in a pattern so each opening 75 is aligned to receive a bottom end 76 of a terminal portion 29, 30, 31 and 61. The printed circuit board has a printed circuit pattern formed thereon which is arranged so each terminal portion 29, 30, 31 and 61 is electrically connected to an individual pin 74 when the ends 73 and the ends 76 are soldered to the pattern on the board 16, prior to the assembly of the part 63 and the base 28 and the formation of the solder connection between the pins 74 and the tubular pins 67.

The cover 17 is preferably formed of a molded transparent material which is slightly flexible and has a rear edge 77 positioned on a peripheral ledge 78 on the base 28. The cover 17 is secured on the ledge 78 by a pair of projections, not shown, which are received in a pair of recesses 79 extending in the opposite side walls along the bottom side 64 of the base 28. If desired, the relay 10 may be constructed and furnished with a suitable cover that includes a manual operating means, not shown, in a manner disclosed in the LeMauviel patent so the relay may be manually operated for test and other purposes.

While not shown herein, the portion of the armature 47 that engages the front end of the core 40 is covered by a thin brass shim which is welded to the armature. The shim provides a permanent air gap to prevent sticking of the armature and core because of the residual magnetism which may occur when the relay 10 is de-energized. If desired, the relay 10 may be furnished with a plug 80 which is carried by the armature 47 and engaged by the tab 56 to reduce the friction between the armature 47 and the tab 56.

While certain preferred embodiments of the invention have been specifically disclosed, it is understood that the invention is not limited thereto, as many variations will be readily apparent to those skilled in the art and the invention is to be given its broadest possible interpretation within the terms of the following claims.

What is claimed is:

1. An electromagnetic relay comprising: an insulating base, a plurality of contacts supported by the base with each of the contacts including a contact portion located forwardly of a front side of the base, a terminal portion extending rearwardly from a rear side of the base and a portion extending through the base interconnecting the contact portion and terminal portion, a radio type plug-in pin connector including an insulating part having a front side positioned adjacent the rear side of the base, an internal cavity extending from the rear side of the base to a rear wall of the part and a plurality of tubular pins with each pin including a portion extending rearwardly from the rear wall and open end exposed to the cavity, and a printed circuit board assembly positioned in the cavity, said assembly including a printed circuit board having openings extending therethrough equal in number to the sum of the pins and terminal portions with half of said openings receiving a terminal end of the terminal portions, a pin in each of the remaining openings in the board with each of the pins having an end portion secured in its associ-

ated opening and a portion extending rearwardly from a rear side of the board telescopically received in and electrically connected to one of the tubular pins, and a printed circuit pattern on the board electrically interconnecting the terminal portions with the secured ends of the pins.

2. The relay as recited in claim 1 wherein the plug-in connector includes a cylindrical indexing plug extending rearwardly from the rear wall of the part and the tubular pins are radially spaced around the plug.

3. The relay as recited in claim 1 wherein the insulating base has a ledge extending around the peripheral edge of its front side and a cover for the relay has a rear edge positioned on the ledge.

4. An electromagnet relay comprising: a base, a magnet frame secured to the base, a magnet core secured to the frame, a coil surrounding the core, said coil having a pair of input terminals, an armature pivotally engaging the frame for movement toward and away from the core about a pivotal axis dispersed intermediate the ends of the armature, contact means supported by the base, said contact means including at least one stationary contact having a stationary contact portion located forwardly of a front side of the base, a terminal portion extending rearwardly from a rear side of the base and a portion extending through the base connecting the stationary contact portion and the terminal portion, said contact means further including at least one movable contact assembly, said assembly including a support having a terminal portion extending rearwardly from a rear side of the base, a portion extending forwardly through the base from the terminal portion to a free end that is spaced forwardly of the stationary contact portion, a flexible blade having an end mounted on the free end of the support and extending rearwardly to a free end, and a movable contact portion mounted on the free end of the blade for engagement with the stationary contact portion, a pair of terminals positioned by the base to have a terminal portion extending rearwardly of the rear side of the base and a portion extending forwardly of the front side of the base electrically connected to the coil terminals, a contact actuator carried by the armature and movable therewith, a one-piece spring clip secured to the frame and including means for maintaining the pivotal engagement of the armature on the frame, and a biasing means acting upon the armature at the side of the pivotal axis furthest from the core and urging the armature away from the core and the contact actuator into engagement with a portion of the blade intermediate its ends, a radio type plug-in pin connector including an

insulating part having a front side positioned adjacent the rear side of the base, an internal cavity extending from the rear side of the base to a rear wall of the part and tubular pins at least equal in number to the number of terminal portions extending rearwardly from the rear wall of the base with each pin including a portion extending rearwardly from the rear wall and having an open end exposed to the cavity, and a printed circuit board assembly positioned in the cavity, said assembly including a printed circuit board having openings therethrough at least equal to twice the number of terminal portions extending from the rear wall of the base with half of said openings receiving the terminal portions extending from the rear wall of the base, a pin in each of the remaining openings in the board with each pin having an end portion secured in its associated opening and a portion extending rearwardly from a rear side of the board telescopically received in and electrically connected to one of the tubular pins, and a printed circuit pattern on the board electrically interconnecting the terminal portions in the openings in the board with the secured ends of the pins.

5. The relay as recited in claim 4 whereon the end of the blade is connected to the end of the support by a slip-on connection.

6. The relay as recited in claim 4 wherein the base has a ledge extending around the peripheral edge of its front side and a cover for the relay has a rear edge positioned on the ledge.

7. The relay as recited in claim 4 wherein the contact means includes at least one pair of spaced stationary contacts and one movable contact assembly having contact portions arranged to alternately engage the stationary contact portions on the pair of stationary contacts.

8. The relay as recited in claim 1 wherein the plurality of contacts includes at least one pair of spaced stationary contacts and one movable contact having a contact portion movable in the space between the pair of stationary contacts.

9. The relay as recited in claim 8 wherein the movable contact is carried by a flexible blade and the flexible blade is connected to a support providing the terminal portion of the movable contact by a slip-on connection.

10. The relay as recited in claim 1 wherein the openings in the board receiving the terminal portions are located in a pair of parallel rows and the openings in which the ends of the pins are secured are located equidistantly from a common center.

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