Dec. 28, 1948. J. F. MERKEL 2,457,703

PLUG BOARD ARRANGEMENTS

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FIG. 2.

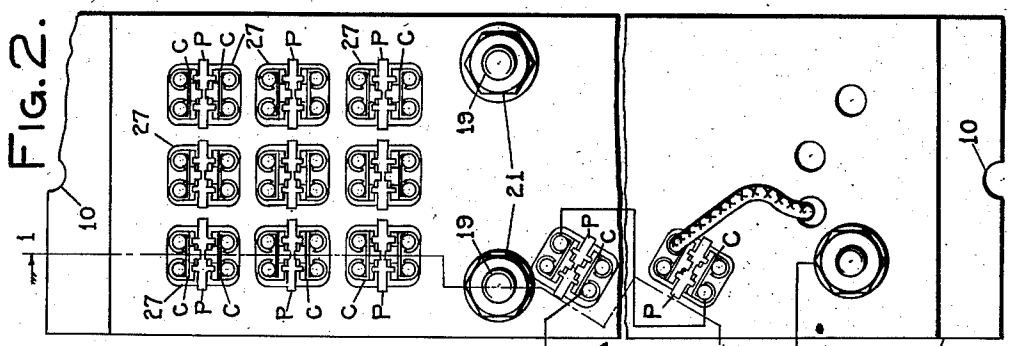


FIG. 1.

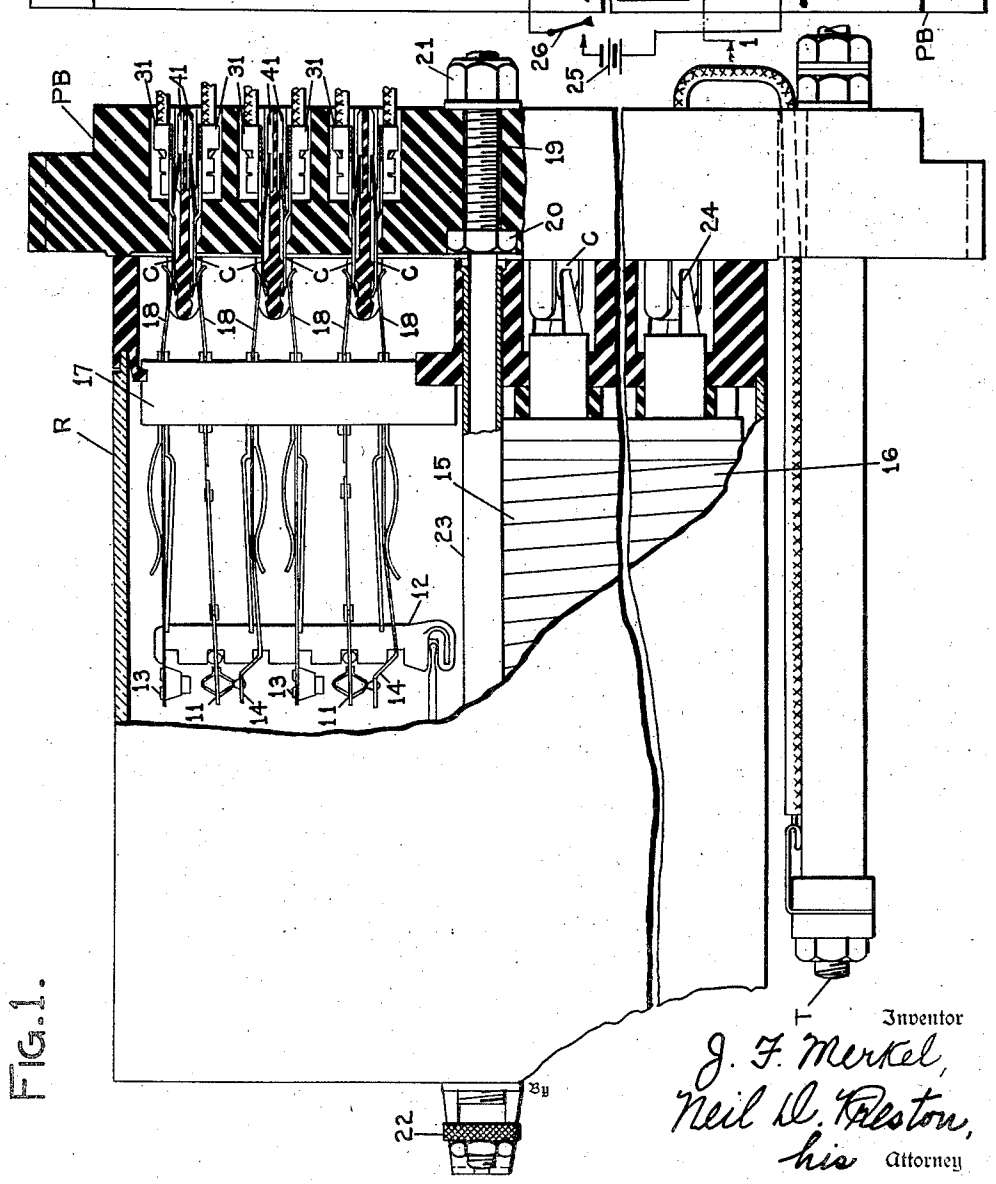


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FIG. 5.

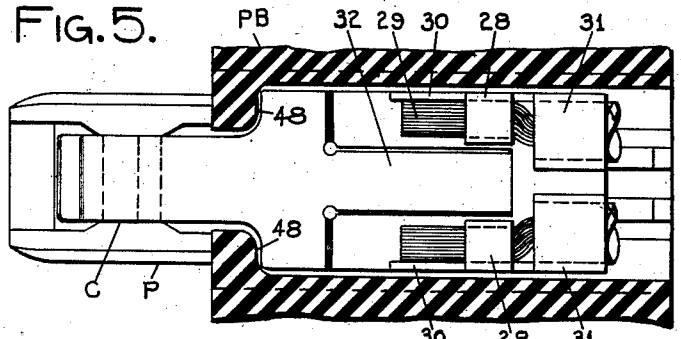



FIG. 4.

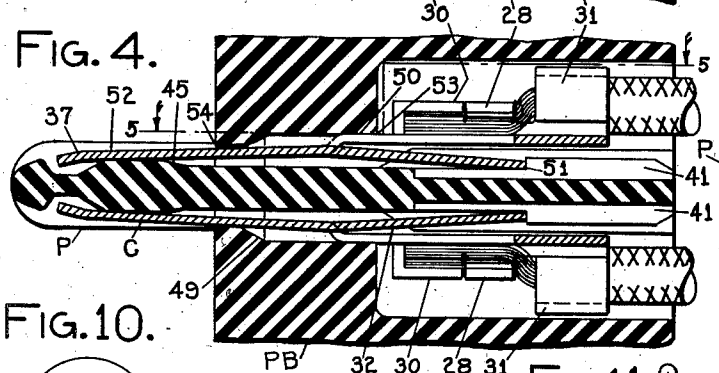



FIG. 3.

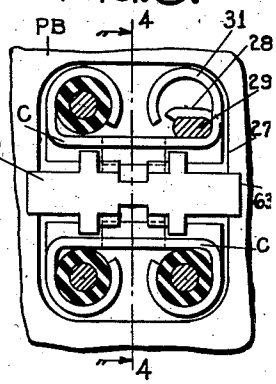



FIG. 10.

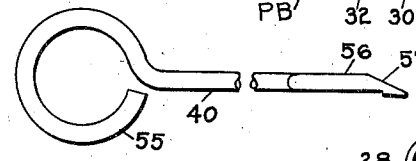



FIG. 11.

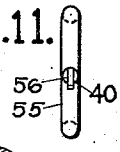



FIG. 7.

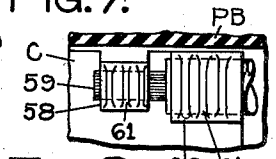



FIG. 6.

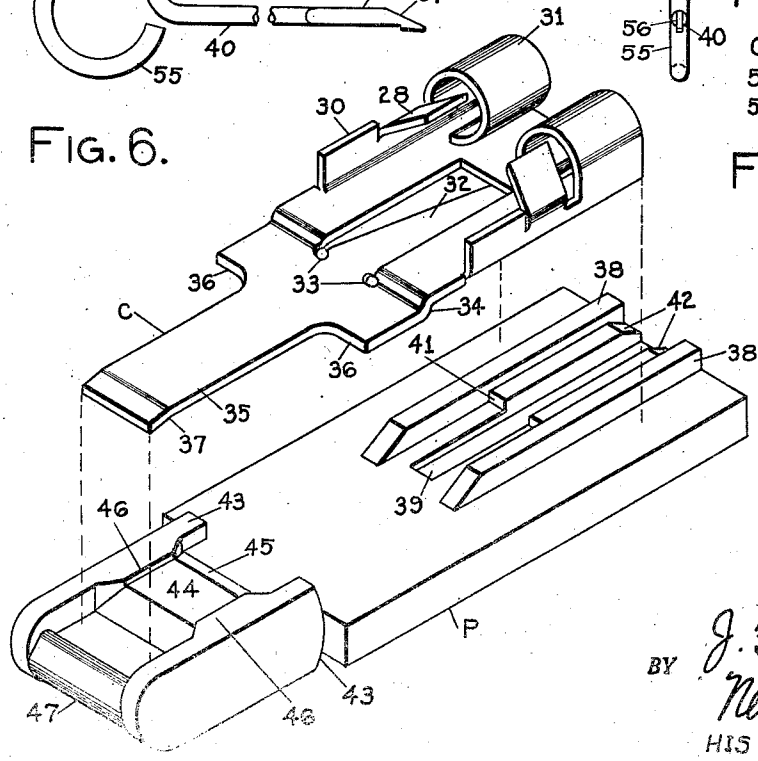



FIG. 8.

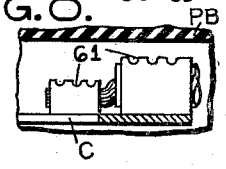
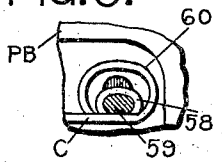



FIG. 9.

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Patented Dec. 28, 1948

2,457,703

# UNITED STATES PATENT OFFICE

2,457,703

## PLUGBOARD ARRANGEMENT

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Application November 23, 1946, Serial No. 712,000

4 Claims. (Cl. 173—328)

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This invention relates to plug couplers for electrical devices and it more particularly pertains to use in such organizations of contacts that are quickly attachable to and detachable from a plug board.

In plug coupler arrangements such as is shown in my prior Patent No. 2,258,122, dated October 7, 1941, an electro-responsive device is coupled to a plug coupler board comprising a large number of contacts spaced close together and permanently secured within the plug board, thus requiring that wiring connections to such contacts be made on the back of the plug board where considerable skill is required to solder or otherwise secure the wires to their respective contacts without damaging or short circuiting wires on adjacent contacts. If a contact on such a board is found to be defective, or is damaged in wiring, it becomes necessary to replace the entire board.

An object of the present invention is to provide quickly attachable and detachable contact strips disposed above and below each of a plurality of insulating plugs that are secured within openings of a plug board, or the like, so as to allow the connection of wires to the contacts as by soldering or the use of solderless connector sleeves, before the assembly of such contacts to the plug board, and so as to facilitate the replacement of defective contacts and the addition of wires upon modification of the organization in which the plug board is employed.

Another object of the present invention is to provide the detachable contacts of rugged construction, without sacrifice of their desired resiliency, to insure the positive locking of the contacts within the plug board against a considerable force that may at times be inadvertently applied to wires connected to such contacts tending to withdraw such contacts from the plug board.

Another object of the present invention is to allow the removal of contacts from the back of the plug board as would be desirable, for example, in making wiring changes, but to allow the removal of such contacts only by an authorized person to whom is issued a special tool required to release the engagement with a plug or plug board of a detent of each contact, such tool having a structure sufficiently distinctive from most common hand tools to make it extremely difficult for an unauthorized person to remove a contact.

Other objects, purposes and characteristic features of the present invention will be in part obvious from the accompanying drawings, and in part pointed out as the description of the invention progresses.

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In describing the invention in detail reference is made to the accompanying drawings in which like and corresponding parts are designated in the several figures by like reference characters, and in which:

Fig. 1 is an elevational view shown partially in cross-section of a relay coupled to a plug coupler, the parts shown in cross-section being viewed in the direction of the arrows along the line 1—1 of Fig. 2;

Fig. 2 is a back view of the plug coupler showing particularly the manner in which the various plugs and contacts are disposed in the plug board at positions adapted to cooperate with the location of contacts of the relay associated therewith;

Fig. 3 is an enlarged back view of a typical pair of contacts of the plug coupler;

Fig. 4 is an elevational sectional view of the pair of contacts of Fig. 3 as taken along the line 4—4 and viewed in the direction of the arrows;

Fig. 5 is a sectional plan view of a typical plug and contact organization taken along the section line 5—5 of Fig. 4 and viewed in the direction of the arrows;

Fig. 6 is a perspective view of a typical contact and plug organization with the plug and contact shown in expanded relationship;

Fig. 7 is a plan view of a portion of a typical contact showing how solderless connector sleeves may be employed for the connection of wires to the detachable contacts;

Fig. 8 is an elevational view of the solderless connector shown in Fig. 7;

Fig. 9 is an end view of the solderless connector shown in Fig. 8;

Fig. 10 is a plan view of a suitable tool for allowing the removal of the detachable contacts; and,

Fig. 11 is an end view of the tool shown in Fig. 10.

With reference to Fig. 1, a relay R is shown as being secured to the plug board PB in a manner whereby the electrical connections of the relay are plug coupled to plug and contact arrangements secured in the plug board PB. The plug board PB is formed of insulating material and it is suitably secured to a plug board rack (not shown) when associated with other plug boards by suitable means, such as bolts (not shown) extending through the semi-circular openings 10 (see Fig. 2) of the plug board PB.

The relay R which is plug coupled to the plug board PB is to be considered as typical of other electro-responsive devices which may be plug coupled to a similar plug board. The relay R is

of the general character disclosed in my prior Patent No. 2,258,122, dated October 7, 1941, to which reference is to be made for a more complete disclosure as to the relay structure. However, for an understanding of the present invention, it is believed sufficient to assume the movable contacts 11, connected by the pusher 12, to be actuated by the electro-magnetic attraction of an armature to selectively close front contacts 13 and back contacts 14 in accordance with the respective energization or deenergization of the relay windings 15 and 16. The respective contacts 11, 13 and 14 are secured within the contact block 17 of insulating material, and electrical connections to such contacts are provided by the coupling of contact tips 18 of such contacts, arranged in pairs and in vertical and horizontal rows, with the respective contacts C in the form of contact strips which are detachably secured within the plug board PB.

The plug board PB has laterally spaced rods 19 suitably secured thereto as by the nuts 20 and 21 at the respective front and back sides of the plug board. These rods serve as a means for alignment of the contact tips of the relay R when it is being coupled to the plug board PB, and the relay R is securely held in its coupled position by suitable thumb nuts 22 threaded on to the ends of the rods 19 and bearing on the ends of the sleeves 23 which are a part of the relay R.

Near the bottom of the plug board PB is secured a test terminal T having a structure similar to that disclosed in my above mentioned patent except that the elongation of the terminal at the front of the plug board is preferably provided as shown to render the terminal more readily accessible from the front of the plug board.

The plug board PB as provided in this embodiment of the present invention is arranged to accommodate nine pairs of contacts C, three rows of three pairs in each row, as illustrated in Fig. 2 for coupling with contact tips 18 of the relay R. In addition to these contacts, the respective contact arrangements are provided in the lower portion of the plug board for connection to the respective contact tips 24 associated with the respective ends of the windings of the relay R. Although these contact arrangements are shown disposed at an angle, it is to be understood that this position is particularly selected to facilitate in providing maximum clearance of the contacts from other parts in the structure of the relay R in this embodiment of the present invention, and that the contact arrangements may be otherwise disposed in accordance with the requirements of practice. It is to these contact arrangements that wiring connections are made for the control of the energization of the windings of the relay. Thus it is schematically illustrated, for example, that the windings are connected in series and energized by the battery 25 upon the closure of the control switch 26.

To consider the structure in detail of a typical plug and contact ogranzation, reference is made to Fig. 3 in which it is shown that the contacts C and the plug P are inserted within substantially rectangular openings 27 in the plug board PB, the plug P being suitably secured, as by cement, in the slots 63 of the plug board PB. One contact C is disposed above the plug P, and another contact C is disposed below the plug P in each opening 27.

Each of the contacts C is substantially rectangular in shape, and is formed preferably of a strip of resilient material having low electrical contact resistance such, for example, as Phosphor bronze. It is adapted by suitable ears and sleeves to have secured thereto two wires, one along each side of the contact. Thus the ears 28 at opposite sides of the contact C are adapted by being formed inwardly at an angle to be readily clinched down upon a wire to securely hold it tightly against the base of the contact as shown for the clamping of the wire 29 in Fig. 3. Adjacent the ears 28 are shorter ears 30 formed upwardly for the purpose of providing shoulders against which the bare wires may be bonded as by sweating or welding as more clearly illustrated in Fig. 5.

For providing additional support at the ends of wires connected to the contact C to reduce to a minimum the possibility of the breaking of strands at the point of their connection to the contact by the flexing of the wires, the sleeves 31 are provided at the opposite right-hand corners of the contact C of a diameter to receive insulated wires and thus limit the flexing of the wire at the point of its connection to the contact C. With reference to Fig. 3 it will be noted that the sleeve 31 is preferably formed so as to allow the clinching of the sleeve on to the insulated wire with a suitable tool if desired.

The contact C has a spring detent 32 formed downwardly and extending longitudinally near the center of the contact C. It is preferably formed as a part of the contact C as by the piercing of the contact C by a U-shaped longitudinal cut extending to the right of the small holes 33 which are provided for accurately locating the starting point of the pierced section.

The contact C has a transverse offset 34 near the center of the contact to provide that the right-hand part of the contact C is raised slightly above its left-hand portion. This is to provide a desired bearing point for the contact against the upper side of an opening in the plug board for purposes to be hereinafter more specifically considered.

The left-hand portion 35 of the contact C is reduced in width to provide shoulders 36 on the opposite sides of the contact for limiting the degree of insertion of the contact C from the back of the plug board PB, the reduced portion 35 of the contact being of sufficient width to provide adequate eletcrical connection with the cooperating tip 18 or 24 of the relay R, and being of sufficient width to be substantially biased by its resiliency to be maintained tightly against the supporting plug P. The left-hand end of the contact C is formed slightly downwardly at the point 37 to prevent the cooperating contact tip 18 or 24 of the relay R from striking the end of the contact C upon the coupling of the relay R to the plug board PB.

The plug P is formed of insulating material and has a substantially rectangular shape. The width of the plug P is slightly greater than that of the contact C to provide for the fitting of the plug into the slots 63 in the opposite sides of the opening 27 in the plug board PB. The longitudinal ribs 38 are so spaced on the opposite sides of the center of the plug P as to center the contact C longitudinally over the plug P by properly locating the detent 32.

A slot 39 along the longitudinal center of the plug P is provided to allow the insertion of a suitable tool such as the tool 40 shown in Fig. 10, to remove the detent 32 from its engagement with

the abutments 41 which are formed on opposite sides of the slot 39 for locking the detent 32 of the contact C. The right-hand end of each abutment is tapered at the point 42 to facilitate the insertion of the contact C into the plug board PB.

At the left-hand end of the plug P, the abutments 43 limit the insertion of the plug P into the plug board PB from the front of the plug board. A boss 44 is formed on the upper surface of the plug P in the portion which extends beyond the front of the plug board to provide a bearing surface for the contact C, such boss 44 having a sloping side 45 to facilitate the insertion of a contact C in the plug board PB. The shoulders 46 at the opposite sides of the boss 44 are oppositely spaced to properly center the left-hand end of the contact C longitudinally with the left-hand end of the plug P. The rounded front edge 47 of the plug P is formed to provide a striking edge for a contact tip 18 or 24 of the relay R upon the coupling of that relay to the plug board PB.

Inasmuch as the plug P is adapted for supporting contacts both above and below that plug, it is to be understood that its under surface corresponds to the upper surface which has been specifically illustrated and described.

The opening 27 formed in the plug board PB for each plug and contact organization is larger near the back than at the front of the plug board for the purpose of providing a housing for the respective wiring connections and to provide abutments 48 (see Fig. 5) to limit the extent of the insertion of the respective contacts C from the back of the plug board PB. This arrangement reduces the possibility of wires being short-circuited as by the dropping of small metal parts across the wires. In the plug board disclosed in my above mentioned prior patent it was necessary to insulate the wiring connections against such short circuiting by the use of sleeving of insulating material. The sloping surfaces 49 (see Fig. 4) within each opening in the plug board PB reduce the opening 27 to its smallest size at the front of the board, the gradual reduction of the opening facilitating the insertion of the contacts C in their respective slots.

The assembly of the plug P to the plug board PB is accomplished by the insertion of the plug P in the oppositely spaced slots 63 (see Fig. 3) along opposite sides of the opening 27, such plug being inserted until the abutments 43 strike the front of the plug board, and being permanently secured in these slots as by the use of cement.

After attachment of the wires to a contact C in a suitable manner as by the soldering of such wires to the shoulders 30 of that contact, the contact may be inserted in a slot formed above the plug P, such contact being inserted from the back of the plug board PB until the abutments 48 limit its insertion. At this point, the detent 32 of the contact drops behind the abutments 41 of the plug and securely locks the contact against backward movement. In a similar manner a contact C can be inserted in a slot formed opposite the lower surface of the plug P, such contact being inverted so that the full insertion of the contact into its slot allows the detent 32 to spring upwardly past the abutments 41 as shown in Fig. 4.

The contact C when inserted in the plug board PB applies pressure by its resiliency at three bearing points in a manner to urge the detent 32 against the surface of the plug P behind the



abutments 41 and in a manner to urge the left-hand end 35 of the contact C tightly against the boss 44 of the plug. This is more clearly illustrated in Fig. 4 which shows the contact C in its fully inserted position with an upper bearing point 50 against the upper side of the opening 27 in the plug board PB, a lower bearing point 51 against the surface of the plug P at the right-hand end of the detent 32, and another lower bearing point 52 against the boss 44 near the left-hand end of the contact C.

This means of support for the contact C has several advantages. One of which is that the contact C is urged against the plug P near the end of the contact by the resiliency of the material of the contact, thus insuring that the end of the contact is always protected by the end 47 of the plug P against its striking a contact tip 18 or 24 of the relay R upon the coupling of that relay to the plug board PB. Another advantage is that by such an organization, any force applied at the right-hand end of a contact C to raise or lower that end can in no way effect a reduction in the pressure urging the spring detent 32 in engagement with the abutments 41 of the plug P. In fact the point 53 acts as a fulcrum if an attempt is made to raise the right-hand end of the contact C, away from the plug P, to apply increased pressure to the spring detent 32 and also to the left-hand end of the contact C at the point 52. Likewise the application of pressure at the right-hand end of the contact C in the opposite direction is obviously effective to increase the pressure of the spring detent 32. It is therefore provided that a force applied to the right-hand end of the contact C as by the pulling of the wires connected thereto either in the same direction or in the opposite direction to the force urging the detent 32 against the plug P to insure against the contact C becoming disengaged from its locked position and becoming withdrawn from its normal position.

If for any reason the left-hand end of the contact were to be raised upwardly as, for example, by being caught in cleaning the plug board with the relay R removed, the point 54 of the plug board PB would act as a fulcrum to increase the pressure of the spring detent 32 and thus insure against the contact C becoming disengaged from its locked position.

Inasmuch as it is at times desirable to remove the contacts C as, for example, when wiring changes are being made, it is provided that each of the contacts C is quickly detachable from its associated plug P by the insertion of a suitable tool such as the tool 40 shown in Fig. 10 between the detent 32 of the contact C and the associated plug P in the slot 39 of that plug. As has been heretofore pointed out, it is desirable that only authorized persons be allowed to detach contacts from the plugs, and therefore the plug and contact organizations are provided with structure requiring a special tool for the release of the detents of such contacts such tool being of a structure different from that of the more common hand tools. With reference to Fig. 10, a contact removing tool 40 is illustrated as being formed with a ring 55 for a handle and having its right-hand end 56 flattened to a width to be readily inserted within the relatively narrow slot 39 of a plug P. The height of the right-hand end of the contact removing tool 40 is preferably slightly greater than the depth of the slot 39 of the plug P, plus the height of the abutments 41 which restrict the withdrawal of the contact C.

The right-hand end of the contact removing tool **40** has a tapered cam surface **57** for raising the detent **32** of the contact C upon insertion of the tool **40** in the slot **39** of the plug P beneath that detent from the back of the plug board. When the tool **40** is fully inserted under the detent **32**, the contact C can be readily removed by pulling lightly on the wires associated with that contact, thus causing the escapement of the detent **32** from its normally locked position behind the abutments **41**. It will be noted by the difference in the height of the abutments **41** and the ribs **38** of the plug P, that the disengagement of the detent **32** can be effected without requiring such detent to be restored entirely within the portion of the contact C from which it has been cut.

As a modification of this embodiment of the present invention, it is illustrated in Figs. 7, 8 and 9 that solderless connecting sleeves can as well be either adapted to the contact C or formed as a part thereof if it is required in practice that solderless connections be used rather than the soldered wiring connections as has been specifically described. With reference to Fig. 7, at the right hand end of a typical contact C, a sleeve **58** is formed of a diameter for receiving the bare end of a wire **59**, and a sleeve **60** is formed of a diameter for receiving the insulated end of the wire. The wire is clamped securely within these sleeves by a suitable crimping tool preferably forming transverse pressure points **61** as illustrated in Figs. 7 and 8. It is to be understood that the inside surfaces of the sleeves may be ribbed to more securely lock the wire within the sleeve if desired in accordance with the requirements of practice in the use of solderless connectors. Fig. 9 illustrates how the round sleeves of the solderless connector are flattened by the crimping operation.

By allowing the wires to be attached to the contacts C prior to the insertion of the contacts C into the plug board PB, it is provided that such wires can be secured to the contacts C at a more convenient stage in the wiring of the electrical apparatus in that the contacts C can be attached when held spaced from adjacent wires and in the most convenient position for an operator to solder, thus reducing the possibility of damaging other wires or other contacts in the soldering operation. It is also by allowing the attachment of the wires to the contacts C before their insertion into the plug board PB that it is practical to use the solderless connectors. Wires can be attached by such solderless connectors to the greatest advantage where they can be taken to a machine having dies formed particularly for crimping the sleeves with the desired amount of pressure. Although hand tools are provided for crimping sleeves of solderless connectors, it is impractical to use a tool of this character in securing wires to contacts that are permanently secured in a plug board because of the relatively close spacing of adjoining contacts.

Having thus described a particular plug coupler organization having contacts quickly attachable and detachable to a plug board as one specific embodiment of the present invention, it is desired to be understood that this form is selected to facilitate the disclosure of the invention rather than to limit the number of forms which the invention may assume, and it is to be further understood that various adaptations, alterations and modifications may be applied to the



specific form shown to meet the requirements of practice without in any manner departing from the spirit or scope of the present invention except as limited by the appending claims.

What I claim is:

1. In a plug coupler of the character described for detachably supporting an electro-responsive device providing plug coupled electrical connections for a plurality of pairs of spring contact tips on said device, the combination with a plug board of insulating material having openings opposite said pairs of contact tips and a plug of insulating material secured in each of said openings, said plug having a portion protruding from the front of the plug board separating said contact tips of each pair, said plug having a transverse abutment and two laterally spaced longitudinal abutments in both its upper and lower surfaces within the opening in the plug board, and said plug cooperating with said plug board to form a slot extending through said plug board substantially opposite each of said contact tips above and below said plug, of a contact strip formed for the attachment of a plurality of wires at one end and receivable in said slot from the back of the plug board with wires attached thereto to a limited extent permitting the other end of the contact strip to be supported by the protruding portion of said plug so as to make electrical connection with one of said contact tips when said device is plug coupled to the plug board, said contact strip having a longitudinally extending detent formed therein of a breadth to be held in longitudinal alignment in said slot between said laterally spaced abutments of said plug, said detent being compressible upon insertion of the contact strip in said slot from the back of the plug board and being effective to lock said contact strip against removal from the back of the plug board by engagement with said transverse abutment of said plug when said contact strip is fully inserted.

2. In a plug coupler for detachably supporting an electro-responsive device providing plug coupled electrical connections for a plurality of pairs of spring contact tips on said device, a plug board of insulating material having openings formed therein opposite the respective pairs of contact tips of said device, a plug of insulating material receivable in each of said openings from the front of the plug board only to a limited extent, said plug having a tapered end protruding from the front of the plug board when in its inserted position for spacing said contact tips of each pair, said plug having formed therein transverse abutments in its upper and lower surfaces, and said plug when inserted cooperating with said plug board to form slots extending through said plug board above and below said plug, and a contact strip formed for the attachment of a wire at one end and receivable in each of said slots from the back of the plug board subsequent to the attachment of a wire thereto to a limited extent wherein the other end is supported by said protruding portion of said plug and makes electrical connection with one of said contact tips, said contact strip having a longitudinally extending spring detent formed from its mid-portion compressible upon insertion of the contact strip in either of said slots and effective when said contact strip is inserted in said plug board to its fullest extent to lock behind one of said abutments of said plug and thereby lock said contact strip against removal from the back of the plug

board and lock said plug against removal from the front of the plug board.

3. In a plug coupler for detachably supporting an electro-responsive device having a plurality of pairs of contact tips, a plug board having an opening therein opposite each of said pairs of contact tips, a pair of contact strips receivable in said opening, each of said contact strips having a longitudinally extending spring detent formed from the mid-section thereof, and each of said contact strips having one end formed for the attachment of wires and having the other end formed of reduced width for insertion through said opening from the back of the plug board to make electrical connection with one of said contact tips, and a plug receivable in each of said openings from the front of the plug board to a limited extent between said contact strips, said plug having upper and lower transverse abutments cooperating with said detents of the contact strips respectively above and below said plug to lock such contact strips in their fully inserted positions against removal from the back of the plug board and to lock said plug in its fully inserted position against removal from the front of the plug board, said plug having upper and lower longitudinal slots extending through and below said abutments whereby a tool can be inserted to release the locking of the detents of the respective contact strips and permit the removal of said contact strips without detachment of their associated wires from the back of the plug board, irrespective of whether or not there is a device coupled to the front of the plug board at that time.

4. In a plug coupler providing quickly detachable connections to a plurality of pairs of contact tips of an electro-responsive device, a plug board having openings opposite the respective pairs of contact tips of said device, a plug of insulating material secured in each of said openings, said plug having a protruding portion extending from the front of the plug board sufficiently to separate the contact tips of a pair on said device, said plug having upper and lower transverse



abutments formed therein within the associated opening in said plug board, and said plug cooperating with said plug board to form a slot extending through said plug board above and below said plug, and a contact strip of resilient material receivable in said slot from the back of the plug board with a wire attached thereto to an extent permitting the support of one end of the contact strip by said protruding portion of said plug and permitting an electrical connection of said contact strip with one of said contact tips, said contact strip having a longitudinal detent formed therefrom effective upon insertion of said strip in said slot from the back of the plug board to lock behind one of said abutments against backward movement of said strip, said contact strip being formed with a transverse off-set at an intermediate point between the point of support by said protruding portion of said plug and the point of engagement of said detent behind said abutment whereby said contact strip is maintained in three point suspension within said slot, and said contact strip having a terminal portion formed therein extending from said off-set for the attachment of a wire.

JOSEPH F. MERKEL.


## REFERENCES CITED

The following references are of record in the file of this patent:

### UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 2,060,761 | Landers | Nov. 10, 1936 |
| 2,111,118 | Lake | Mar. 15, 1938 |
| 2,143,645 | Carson | Jan. 19, 1939 |
| 2,158,004 | Douglas | May 9, 1939 |
| 2,222,252 | Cochran et al. | Nov. 19, 1940 |
| 2,258,122 | Merkel | Oct. 7, 1941 |
| 2,279,915 | Cram | Apr. 14, 1942 |
| 2,318,648 | Penfold | May 11, 1943 |

### FOREIGN PATENTS

| Number | Country | Date |
|---|---|---|
| 537,968 | Great Britain | July 15, 1941 |