Feb. 17, 1970 B. R. McFADDEN 3,496,516

ELECTRICAL CONNECTOR

Original Filed Dec. 19, 1963

FIG. 1

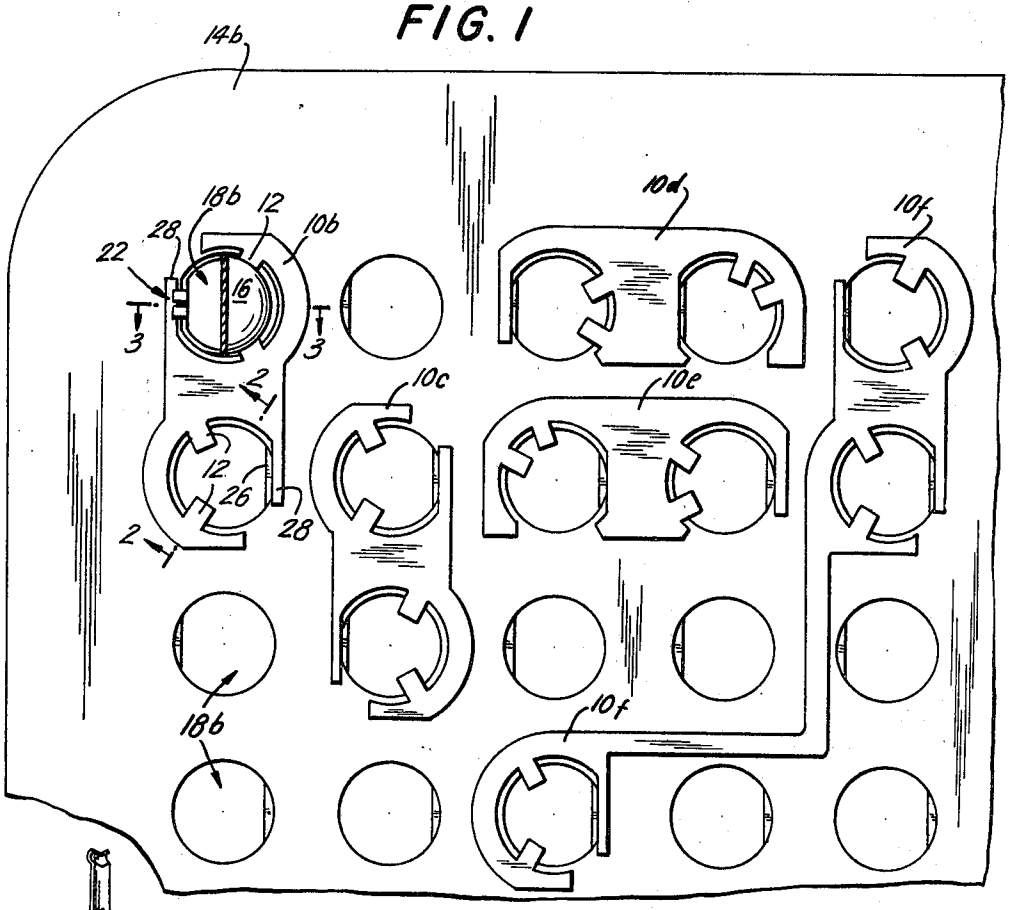
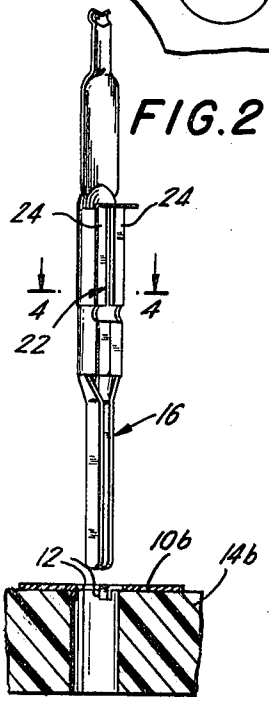


FIG. 2



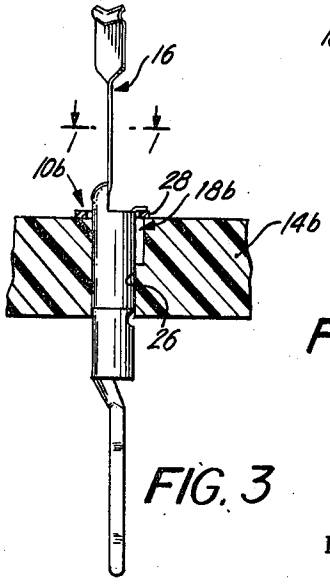


FIG. 3

FIG. 1a

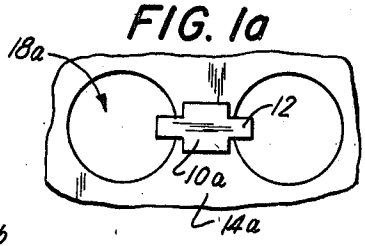
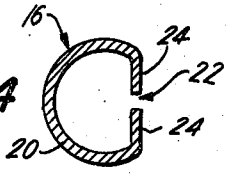


FIG. 4



INVENTOR.
BRUCE R. McFADDEN
BY
Curtis, Morris & Safford
ATTORNEYS

United States Patent Office 3,496,516 Patented Feb. 17, 1970

3,496,516

ELECTRICAL CONNECTOR

Bruce Richard McFadden, Harrisburg, Pa., assignor to AMP Incorporated, Harrisburg, Pa.

Continuation of application Ser. No. 331,785, Dec. 19, 1963. This application Jan. 9, 1967, Ser. No. 608,228
Int. Cl. H01r 25/00, 29/00
U.S. Cl. 339—18 3 Claims

ABSTRACT OF THE DISCLOSURE

A termination for printed circuits utilizing firm insulation boards. The termination being a tab formed from the conductive-metal, printed-circuit lamina itself, which extends over a plughole in the insulation board. Also, the connection between such a "tab" termination and a resilient metal contact inserted into the plughole, thereby forming an excellent electrical wipe-contact with residual contact pressure therebetween.

This application is a continuation of application Ser. No. 331,785, filed Dec. 19, 1963 and now abandoned.

The present invention relates to electrical connecting means. More particularly, it pertains to printed circuit type jumper devices and the like, especially with respect to their use on plugboards (such as are found in patchcord systems utilized in connection with electrical accounting or computing machines or the like).

It has become common practice to use patchcord systems as master switching controls in data processing or computing machines, each of which conventionally include a pair of contact, or plug, boards that carry the rows and columns of electrical contacts to be interconnected in a variable predetermined arrangement according to the manner in which the control components of the machine are to be operated. The contact-carrying boards, one of which is usually fixed relative to the machine while the other is moved into and out of cooperating relationship therewith, are positioned in and relatively manipulated by a suitable mechanism as shown, for example, in Patent No. 2,927,295.

The rows and columns of contact elements on the fixed board typically constitute the terminals of electrical conductors leading from the sensing elements and the instrumentalities to be controlled in the machine, and on the movable board provide rearrangeable interconnecting plugs or jacks through which the particular circuit connections on the first board may be made. In an average system, several hundred contact elements are located on each board in a minimum area with a minimum space between rows and columns. Not only is the movable board readily rearrangeable, but when the rearrangement would be extensive, it is preferably replaced by another movable board already pre-programmed in the new arrangement.

It will be readily realized that the larger and more complex machines which extensively utilize patchcord systems will often have a number of jumper connections which do not vary when the overall programming is changed for the various different applications of the machine. When these jumper connections begin to number in the thousands then having a patchcord jumper, each with two electrical plug contacts, for each pre-programmed movable patchboard becomes significantly expensive, especially when there is no need to change the jumper connection at all. What is preferably required is an inexpensive jumper that could be inexpensively applied on the fixed board (thereby eliminating the need of a multiple number of jumpers for one connection), a permanent jumper, and one which would not necessitate

the redesign of any of the elements of the existing patchcord systems to accommodate its use.

Various prior art devices have been proposed to meet these needs but without providing truly satisfactory solutions. Bus bars proved to be bulky, tended to make poor contact unless soldered or screwed into place, and often required redesigning the existing patchcord systems. Wire-wrap and soldered wire jumpers were difficult and costly to apply, especially in such confined spaces, and often gave rise to shorting due to slack wire. Even a coiled conductive spring has been proposed as a jumper, which appears to be a bulky, probably expensive item, that would tend to make a poor contact.

It is therefore an object of this invention to overcome the objections raised with respect to the prior art by providing a simple, effective jumper device which is permanent and inexpensive to make and apply, and does not require redesign of any existing equipment for its use.

Another object is to provide a versatile jumper device that can be readily applied and used in the confined spaces common to the plugboards employed in patchcord and other systems to jumper two or more plug contacts whether in adjacent holes or not.

Still another object is to provide such a jumper which can be easily mass produced and yet to adapt readily to different design requirements for different plugboard jumper situations.

Yet another object is to provide an assembly where such a jumper maintains gas-tight, mechanically strong connections having a substantially constant low resistance in spite of varying environmental conditions, and further without having a significant current leakage.

An advantage of this invention is the creation of a jumper with integral terminating means made solely by printed circuit techniques without any special termination adapters screwed, soldered, or otherwise affixed to the jumper.

Another advantage lies in the creation of such a permanent terminating means which is dependable and electrically superior.

Still another advantage is the creation of a printed circuit procedure whereby the baseboard is preformed and the printed circuit applied thereafter instead of forming the printed circuit and then drilling out or otherwise modifying the baseboard. This reversed procedure has the advantage of not subjecting the thin circuitry to the shocks of processing the baseboard and further permits the formation of tabs or other similar circuit overhangs previously though impossible.

Other objects, advantages, and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there are shown and described preferred embodiments of the invention; it is to be understood, however, that these embodiments are not intended to be exhaustive nor limiting of the invention, but are given for purposes of illustration in order that others skilled in the art may more fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the conditions of a particular use.

In the drawings:

FIGURE 1 is a plan view of a portion of a plugboard illusrating several preferred embodiments of our printed circuit jumper invention with several of the dimensions of this and the following figures exaggerated for emphasis as will become evident from the subsequent discussion, and with the lower portion of an electrical contact (plug) shown, in horizontal section, inserted in the upper left hand plug hole (see line 1—1 in FIGURE 3).

FIGURE 1A is a simplified embodiment of our invention;

FIGURE 2 is an exploded elevational view taken line 2—2 in FIGURE 1 of the plug and, in cross section of a portion of the plug board and of the jumper device;

FIGURE 3 is an elevational view similar to FIGURE 2, except with the plug inserted, taken along line 3—3 in FIGURE 1; and

FIGURE 4 is a horizontal section of the plug taken along line 4—4 in FIGURE 3.

In the drawings, the lamina jumper device **10**, having tab terminating means **12**, is illustrated as applied to a preformed baseboard **14**, here shown as a plugboard. The electrical contact, or plug, **16** upon insertion into one of the plugholes **18** (which is jumpered by one of the devices **10**) engages the tab contact **12**, forms it over against the wall of the hole **18** (see FIGURE 2), and establishes a good electrical wipe-contact with the jumper **10** through the tab **12**.

In its simplest form, this invention comprises a thin metal electrical jumper **10***a* fixed to a baseboard **14***a* and extending between two plugholes **18***a* having at least one tab portion **12** extending over each of said holes **18***a*; so that, when a snugly fitting plug **16** is inserted into plughole **18***a* at either end of the jumper **10***a*, an effective jumper circuit is thereby completed. See FIGURE 1A.

This novel jumper **10** takes advantage of the simplicity and cost savings inherent in normal printed circuit procedures, and additionally makes the innovation of applying a printed circuit over a preformed baseboard in such a manner that portions of the printed circuit extend unsupported out over cut-away portions of the baseboard (for example, over plugholes **18** in the plugboard **14**) and use such an extension as a terminating means **12**. Not only was it novel in the art of printed circuitry to form the baseboard prior to the application of the printed circuit, but even more surprising to a person skilled in the art would have been the thought that the delicate tab extensions **12** of such printed circuit jumpers would withstand the insertion of a plug **16** without tearing loose, but even more strinking, as has actually proven to be the case, is the ability to withstand repeated insertions; thereby ensuring non-failure in service and also allowing for repair of the permanent installation if it should become necessary for the plug to be removed for any reason.

The preferred embodiments illustrated in FIGURE 1 may advantageously be prepared by applying a thin copper lamina to the preformed plugboard **14***b* by any of a number of well known adhesives, for example epoxy resin. A protective coating of tin solder, or other similarly effective substance, may be then placed over the copper to prevent corrosion of the copper and also to enhance the electrical contact properties of the device. A pattern of etch-resist material is placed over the exposed areas of the copper lamina by a standard screening or photographic method and then etched to form the desired jumper devices **10**, complete with overhanging tabs **12**.

By referring to the more sophisticated preferred embodiments, for example **10***b* shown in FIGURES 1, 2, and 3, one can more readily appreciate the various patentable features of this invention. In order to maintain an effective electrical connection between the plug **16** and the formed over tabs **12** (as shown in FIGURE 2) under various environmental extremes, it is highly desirable that there is maintained a residual contact pressure between the plug **16** and the tabs **12**. This residual contact pressure is attained in this preferred embodiment by employing a plug **16** which has a body portion **20** formed substantially in a circular cylinder with a longitudinal slot **22**. This plug **16** has a lead-in taper so that upon insertion into holes **18***b* the tabs **12** are formed over and the plug **16** is compressed to partially close the slot **22** and thereby build up an outward radially directed pressure against the walls of hole **18***b* and therefore against the tabs **12** wedged therebetween. The plug **16**, as illustrated in FIGURES 2 to 4, is already disclosed in an application of my co-worker, John G. Hatfield, Ser. No. 298,002, filed July 25, 1963, which was copending with the parent application of this case and which is now Patent No. 3,288,915, issued Nov. 29, 1966, and is presently being commercially used in the patchcord assemblies disclosed in Patents Nos. 2,882,508 and 2,927,295. This serves to illustrate how the present invention can be used with existing patchcord systems and not require any modification of the various elements thereof.

One aspect of the plug **16** illustrated as having a substantially circularly cylindrical body portion **20** with a longitudinal slot **22**, is that when such a plug is inserted into its plughole **18** it exerts not only a longitudinal pull on tabs **12** but also a circumferential shear if the tabs should be oriented close to the slot **22**. Clearly this circumferential shear diminishes the further the tab is placed away from this slot **22**. Therefore, jumper **10***b* takes advantage of another design feature of the plug **16**, illustrated in FIGURES 2 to 4. Namely, the body portion **20** is flattened into an orienting surface **24** on either side adjacent to the slot **22** in order to provide an orientation of the plug as it is inserted into holes **18***b*, which in turn have a corresponding flattened shelf **26** in the lower half of each of the holes **18***b*, thereby giving the hole outline at that point a D-shape. By taking advantage of this orienting means, **24** and **26**, it is possible always to have tabs **12** placed sufficiently far away from the slot **22** to avoid most of the detrimental shear action encountered upon the insertion of the plug **16** into the hole **18***b*. It has been found advantageous to employ two tabs **12** as a safety feature in case one should prove to be faulty (as may happen in mass production). Advantageously, this pair of tabs **12** are spaced 120° from each other and from shelf **26** thereby minimizing the shear on the tabs. If the tabs **12** were located closely adjacent to each other, then the longitudinal pull therealong would be concentrated at one point on the jumper **10**, thereby requiring a larger jumper **10** at that point in order to withstand this pull, and there might not be sufficient clearance between the plugholes to allow for the wider jumper surface required to give increased adherence to the plugboard **18** at that point.

Another advantage in using printed circuit tabs **12** as the terminating means for the shunt **10** is that the thickness of these tabs **12** adds very little bulk in the hole **18**. This is one of the features mentioned before which avoids the necessity of redesigning any of the elements of the patchcord assembly system. Thus, where two tabs **12** are used, it is better to have them closer together than on opposite sides of the hole. By having these tabs placed at 120° from each other, their effective bulk with respect to a circular plug **16** is substantially reduced and yet the other advantages to be found with this orientation are also attained.

A recital of some of the dimensions of one installation of embodiment **10***b* will help to illustrate two important points, how strong these tabs **12** are in spite of their dimensional delicacy, and what a surprisingly small jumper surface need be adhered to the plugboard in order to support these tabs. Thus, in one embodiment the jumper is made from what is called in the trade "two ounce copper," which has a thickness of approximately 0.0028 of an inch. One standard plugboard **14***b* has plugholes **18***b* spaced a quarter of an inch apart with the holes themselves having approximately 0.15 inch diameters. Each tab **12** is approximately 0.04 by 0.03 inch, and though the jumper is close to a fifth of an inch wide across its center, yet that portion connecting the two tabs **12** at a plughole **18***b* is only 0.04 inch wide. Note that extension **28** of the jumper **10***b* actually overhangs the hole **18***b* and serves only as an outside visual orientation to locate the shelf **26** and is not intended to give any added structural support to the jumper **10***b*.

The patchcord system in which this particular jumper with the above dimensions was to be used had a normal working voltage of 50 volts or less. However, these jumpers are spaced by at least 0.04 inch from each other between adjacent holes and have been actually tested to have a minimum voltage breakdown of 1.20 kilowatts. Thousands of test readings showed this jumper device to have a plug to plug average resistance reading of less than a milliohm, and even under the most severe testing conditions this resistance was rarely doubled. Furthermore, it was found that one tab of this installation was completely sufficient both electrically and mechanically, and a second tab was needed only as an added safety feature to increase on a mass production basis an already surprisingly high reliability. Three or more tabs could have been used, but in the illustrated embodiment having the above dimensions additional tabs were found unnecessary and bulky and therefore impractical.

The other preferred embodiments of FIGURE 1 illustrate various modifications to jumper **10***b*. For example, jumper **10***b* is shaped to extend between two opposingly oriented plugholes **18***b*, and jumper **10***c* is a mirror image of **10***b* in order to jumper two *reversed* opposingly oriented plugholes **18** and still leave the minimum clearance from the first. Jumpers **10***d* and **10***e* show another suggested shape. Jumper **10***f* illustrates how two or more remotely located plugholes might be advantageously jumpered by the present invention.

I claim:

1. In an electrical assembly the combination comprising a firm insulation board having a substantially cylindrical hole therein; an electrical contact mounted in said hole and having a body portion formed of a conductive spring metal and having a longitudinal slot therein to permit compression thereof, a thin fragile lamina of conductive metal having a thickness typical for printed circuitry, said lamina being fixed to said insulation board and having tab portions extending down into said hole in good electrical wipe-contact with said body portion of said contact and wedged between said body portion and the walls of said hole, said body portion being naturally slightly larger than the space left within said hole by said tab portions and being shaped to exert a residual contact pressure against said tab portions, means for orienting said contact within said hole, said tab portions being disposed in said hole in positions substantially removed circumferentially from said longitudinal slot.

2. In a plugboard assembly the combination comprising a plugboard having a plurality of holes therein; electrical contacts mountable in said plugboard holes, each having a resilient cylindrical body portion with a longitudinal slot therein, thereby being adapted to exert a residual pressure against the walls of said plugboard hole; means for rotatively orienting the insertion of said contacts within said plugboard holes; a thin metallic jumper device fixed to said plugboard, extending between two adjacent plugboard holes and spaced from any conductive elements, other than electrical contacts mounted in the two adjacent holes, sufficiently to avoid voltage breakdown therebetween, and spaced from any contacts mounted in said two adjacent holes sufficiently to avoid mechanically dislodging said device from said plugboard except for two tabs which extend radially in over part of each of said two adjacent holes which tabs are oriented such that insertion of said contact into one of said holes will engage the tabs respective at substantially 120° from either side of said longitudinal slot thereby wedging said tabs in good electrical wipe-contact between said cylindrical portion of said contact and the walls of said plugholes.

3. A combination as described in claim **2** wherein said jumper device is generally about 0.003 of an inch thick, is spaced from any conductive elements other than electrical contacts mounted in the two adjacent holes by at least 0.040 inch and is spaced from the contacts mounted in said adjacent holes by about 0.005 to 0.010 inch.

References Cited

UNITED STATES PATENTS

1,939,130	12/1933	Mills	339—17
2,502,291	3/1950	Taylor	339—17
2,958,064	10/1960	Swengel	339—17
3,105,729	10/1963	Rosenthal et al.	339—18
3,142,783	7/1964	Warren	317—101
3,189,868	6/1965	Hatfield	369—252

MARVIN A. CHAMPION, Primary Examiner

P. A. CLIFFORD, Assistant Examiner

U.S. Cl. X.R.

339—17