ABSTRACT: A multiple electrical connector for a printed-circuit board embodying a receptacle having an open-topped trough for receiving a printed-circuit board and contact elements spaced from one another along said receptacle trough, featured by contact elements formed in the flat as from a sheet of conductive material and each comprising a base and a pair of spring legs of different lengths extending up from the base, the contact element being positioned in the receptacle in a plane normal to the plane of the printed-circuit board. The spring legs provide a redundancy in that the legs function independently to provide an electrical connection to the contact areas of the board and have independent deflection and resonant frequencies.
MULTIPLE ELECTRICAL CONNECTOR

This invention relates to a microminiature multiple electrical connector for use with a printed circuit board. In multiple connectors of the type for use with a printed-circuit board, a large group of miniature contact elements are mounted in closely spaced relation in a receptacle having an open-topped trough for receiving a printed-circuit board containing a correspondingly large group of closely spaced conductive contact areas adapted for mating contact with said contact elements. The multiple connector and particularly the multiple contact elements therein must be so designed as to assure the effective electrical engagement of the contacts and the closing of all of the involved circuits. In multiple electrical connectors of prior makes, the contact elements supplied were generally either "tuning fork" or "ribbon-type" contacts, the ribbon contacts being generally either the single-leaf, multiple-leaf or "bel lows" type. All of these types of contact elements were designed to assure engagement between the contact elements and the conductive contact areas of the printed circuit board.

Other problems of concern in the manufacture and use of these multiple miniature connectors are providing a structure for the receptacle and the contact elements such that a printed-circuit board could be inserted and removed without causing damage or excessive wear to either the contact elements or to the conducting areas on the board. Within limits, the greater the pressure which a contact element exerts on the conducting areas on the board, the better is the electrical connection which results and, this is a usually very important factor, particularly when very low voltages are involved as in computer input and output signals. Too great a contact pressure, however, has the effect of making it more difficult to insert or remove a board from the connector, resulting also in increasing the wear on the contacts and particularly the very thin conducting areas on the board. The various types and forms of contact elements supplied in prior design are devised to solve these problems, the solution of which usually involves a compromise of satisfying the different factors or requirements involved.

In addition to these problems are others which so far as I am aware are not effectively dealt with in the design of these prior type of multiple connectors; and it is to these problems, in addition to those above referred to, that the structure of the present multiple-connector invention is addressed. Such additional problems involve the double assurance of effecting the desired contact engagements particularly in equipment which is subject to vibrations, intermittent or constant, or to sudden shocks when the equipment is used on vehicles in transit, particularly on aircraft, such vibrations or shock causing contact weakening and interruptions to take place in the connector with resulting circuit interruptions.

The prime object of the present invention is directed to the provision of a structure and a design of a miniature electrical connector having a contact element embodied in the form of a tuning fork type, in which in addition to solving the usual problems that are met with as above referred to, there is introduced a redundancy in the operation of the contact element which is not available, so far as known to me, in any of the existing tuning fork contact designs and not possible to achieve as a contact element in the microminiature class of connectors. In the structure of the present invention, a redundancy is introduced by providing a plurality of members or parts in the contact element functioning independently to effect electrical contact with the contact area on the board which members have as well deflection properties independently of each other, and also have different resonant frequencies to meet different vibration frequencies to which the connector may be subjected in use.

A further important object of the invention is the devising of a contact element for miniature connectors satisfying the various needs above referred to, which can be made and supplied at a reasonable cost and also one which can be mounted in or assembled to the connector receptacle easily and securely.

To the accomplishment of the foregoing objects and such other objects as may hereinafter appear, my invention relates to the multiple electrical connector as sought to be defined in the appended claims and described in the following specifications taken together with the accompanying drawings in which:

FIG. 1 is a perspective view, in exploded form, of the parts comprising the electrical connector of the invention, consisting of the receptacle and the contact elements associated therewith;

FIG. 2 is a vertical cross-sectional view, shown to an enlarged scale, of the assembled parts of the electrical connector;

FIG. 3 is a bottom plan view of the receptacle depicted in FIG. 1 and shown on a reduced scale;

FIG. 4 is a vertical elevational view shown to an enlarged scale of one of the contact elements of the connector;

FIG. 5 is a side elevational view of the contact element shown in FIG. 4;

FIG. 6 is a view of a part of the contact element taken in cross section in the plane of the line 6--6 of FIG. 4; and

FIG. 7 is a view of another part of the contact element taken in cross section in the plane of the line 7--7 of FIG. 4.

Referring now more in detail to the drawings and having reference first to FIGS. 1 and 2 thereof, the microminiature multiple electrical connector of the present invention comprises a receptacle generally designated as R structured to receive a substantial number of connector elements each generally designated as C, which latter are especially designed in accordance with the above-stated principles of the invention.

The receptacle R, made of a single molded piece of insulation material, is formed with a central longitudinal trough 10 for receiving a printed circuit board B, the said trough being defined by two oppositely facing walls 12 and 14, at least one and preferably both of which walls are formed with a plurality of pockets 16, 18, spaced longitudinally along the trough corresponding in number to the number of contact elements C received by the receptacle, each contact element being located and partially housed by a pocket 16. The receptacle R may also be formed with perforated terminal lug portions 18 (only one being shown in the drawings) for the reception of attaching elements.

The contact elements C are each structured in the form of a tuning fork or bifurcated member, the same being formed from a sheet of conductive material made to comprise a base 20 and a pair of spring legs 22 and 24 extending up from the base, the said spring legs, lying in the same plane, being of different lengths as clearly depicted in the drawings. The two spring legs 22, 24 have top laterally extending portions 26 and 28, respectively, adapted to engage the contact areas 30, 32 on the board B. Each contact element is also formed with one or more tails 32 (one being depicted in the drawings) defining an electrical terminal. As indicated, the contact elements are formed from sheet stock, thereby being produced in the flat as shown, the said sheet-formed contact elements being thereby structured to be each positioned in a pocket 16 of the receptacle in a plane normal to the plane of the printed circuit board as best indicated in FIGS. 1 and 2 of the drawings.

As noted, the spring legs 22 and 24 are of different lengths. With this construction of the contact elements and their location and arrangement in the receptacle, each of the spring legs 22, 24 functions independently to provide an electrical connection with the contact area 30 on the board, and thereby a redundancy is introduced by the second leg of the contact element in the operation of the connector. In addition, the base 20 of each contact element is formed with a slot 34 between the spring legs configured to determine different contact pressure or load characteristics that may be applied to said legs. Each contact element is thus specially constructed of members or parts (the two spring legs) in the element functioning independently of each other to effect electrical contact with the contact area on the board, the said members hav-
ing as well deflection properties independently of each other and also having different resonant frequencies to meet the different vibration frequencies to which the connector may be subjected in use.

The structure described also allows several choices load characteristics; namely, a load equal for both spring legs, a load on the long leg less than that on the short leg, and a load on the short leg less than the load on the long leg; these choices are determined by configuring the couple circuit at the lower end of the slot 34 between the spring legs.

As above described, the contact elements are formed from a sheet of conductive material; the material is preferably phosphor bronze, and preferably gold or silver plated. Such sheet material may comprise stock having a thickness of 0.025 inch as indicated in FIG. 6 of the drawings. The width of each spring leg 22, 24 is also of the order of 0.025 inch as indicated in FIG. 4. The width of the top of the leg 22 including the protuberance 26 may be 0.122 inch as indicated in FIG. 6, and the width of the top of the spring leg 24 including its lateral protuberance may be 0.067 inch as indicated in FIG. 7 of the drawings. The thickness of different boards B used may be of the order of 0.060 to 0.070 inch. These dimensions in addition to the 0.050 spacing between the centers of the pockets 16 serve to indicate the micro miniature character of the connector.

The base 20 of each contact element is formed with lateral protuberances 20 a and 20 b for engagement with walls 16 a and 16 b of the pocket 16 of the receptacle for securely mounting the contact elements at the base of the receptacle; and extra- nally marking the protuberances of each contact element to retain the contact elements in the receptacle through an interference fit. This mounting permits complete freedom of contact adjustment and movement of the two tines or spring legs 22 and 24 of the tuning fork like contact element. The contact-engaging tips of the top protuberances 26, 38 of the spring legs are preferably suitably coined at 38, 28 to render the same contact smooth. While the contact elements in the described connector are detailed as a double-sided, single-readout device, the same may be furnished for single-sided use and for double-readout use, the latter function being obtained by adding an additional tail to the contact element. The terminal tails as shown are squared for wire wrap use, but may be shaped for solder use.

As shown, the right and left side contact elements are reversely shaped as mirror images. The contact elements on each side are preferably arranged in staggered form as clearly appears in FIG. 2 and as is best indicated by the staggered arrangement of the tails 32, 32 in FIG. 3. This facilitates the wire working of the terminals. With the staggered arrangement, left side contact elements may also be used on the right side and vice versa.

The operation of the connector, the uses and functions which are satisfied by the contact elements, and the advantages thereof over prior art devices, will in the main be fully apparent from the above-detailed description. In operation and use, in addition to accomplishing the customary functions of assuring engagement between the contact elements and the conductive contact areas of a printed-circuit board, of permitting reliable insertion and ease of removal of the contact elements and of inhibiting or minimizing damage or excessive wear to either the contact elements and the conducting areas of the board, the structure of the connector of the present invention attains the following purposes, functions and advantages:

a. a tuning fork type of connector element is provided having tines or spring legs of different lengths, each leg functioning independently of the other to provide a redundancy in that each leg affords an independent electrical connection with the contact area of the board;

b. the spring legs may be configured to determine different (or equal) contact pressures or load characteristics;

c. the spring legs are designed to have different resonant frequencies to meet different vibration frequencies that may be met with in service;

d. the contact element may be designed to be base-supported in the connector receptacle to permit freedom of contact and adjustment engagement with the printed circuit board; and

e. the contact element may be formed simply form sheet stock, yielding a device, readily adaptable for use in a micro-miniature edge board connector at a low and reasonable manufacturing cost.

It will be apparent that changes may be made in the construction of the connector described without departing from the spirit of the invention defined in the following claims.

1. A multiple electrical connector for a printed-circuit board comprising a receptacle having an open-topped trough for receiving a printed-circuit board having conductive contact areas and contact elements spaced from one another along said receptacle trough, said contact elements each being formed from a sheet of conductive material and comprising a base and inner and outer spring legs extending up from the base, said sheet-formed contact element being positioned in said recepable in a plane normal to the plane of the printed circuit board, said base extending laterally outwardly beyond said outer spring leg and being relatively snugly received in said receptacle, a substantial lateral clearance being defined between said receptacle and said outer leg, one of the spring legs being longer than the other, and the two spring legs having laterally extending portions adapted to engage the contact areas on the board, each of said spring legs functioning independently to provide an electrical connection with the contact areas on the board of the printed circuit board having deflection properties one independently of the other.

2. The multiple electrical connector of claim 1, in which the two spring legs of the contact element have different resonant frequencies.

3. The multiple electrical connector of claim 1, in which the base of the contact element is formed with a slot between the spring legs configured to determine different contact pressure or load characteristics that may be applied to said legs.

4. The multiple electrical connector of claim 1, in which the base of the contact element is formed with lateral protuberances for engaging walls at the base of the receptacle for mounting and retaining the contact element in the housing.

5. In a multiple electrical connector for a printed-circuit board comprising a receptacle having an open-topped trough for receiving a printed-circuit board having conductive contact areas, a contact element adapted to be received by said receptacle for connection to the conductive areas of said board, said contact element being formed from a sheet of conductive material and comprising a base and inner and outer spring legs extending up from the base, said sheet-formed contact element being positionable in said receptacle in a plane normal to the plane of the printed circuit board received therein, said base extending laterally outwardly beyond said outer spring leg and being relatively snugly received in said receptacle, a substantial lateral clearance being defined between said receptacle and said outer leg, one of the spring legs being longer than the other and the two spring legs having laterally extending portions adapted to engage the contact areas on the board, each of said spring legs functioning independently to provide an electrical connection with the contact areas on the board, and the said spring legs having deflection properties one independently of the other.

6. The contact element of claim 5, in which the two spring legs have different resonant frequencies.

7. The contact element of claim 5, in which the base of the contact element is formed with a slot between the spring legs configured to determine different contact pressure or load characteristics that may be applied to said legs.

8. The contact element of claim 5, in which the base of the contact element is formed with lateral protuberances for engaging walls at the base of the receptacle for mounting and retaining the contact element in the housing.

9. The multiple electrical connector of claim 1, in which said base engages said receptacle with an interference fit.
10. The multiple electrical connector of claim 1, in which said base extends laterally inwardly beyond said inner spring leg.

11. The multiple electrical connector of claim 1, in which when said base is received in said receptacle said inner leg is located outwardly of said trough but the laterally extending portion of said inner leg extends into said trough.

12. The multiple electrical connector of claim 5, in which said base engages said receptacle with an interference fit.

13. The multiple electrical connector of claim 5, in which said base extends laterally inwardly beyond said inner spring leg.

14. The multiple electrical connector of claim 5, in which when said base is received in said receptacle said inner leg is located outwardly of said trough but the laterally extending portion of said inner leg extends into said trough.

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