

United States

Glaister

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[54] CONNECTORS

[75] Inventor: Frank J. Glaister, Ipswich, Mass.

[73] Assignee: Chomerics, Inc., Woburn, Mass.

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[52] U.S. Cl. 339/61 M; 339/DIG. 3

[51] Int. Cl. H01r 13/24

[58] Field of Search 339/59, DIG. 3, 61 M

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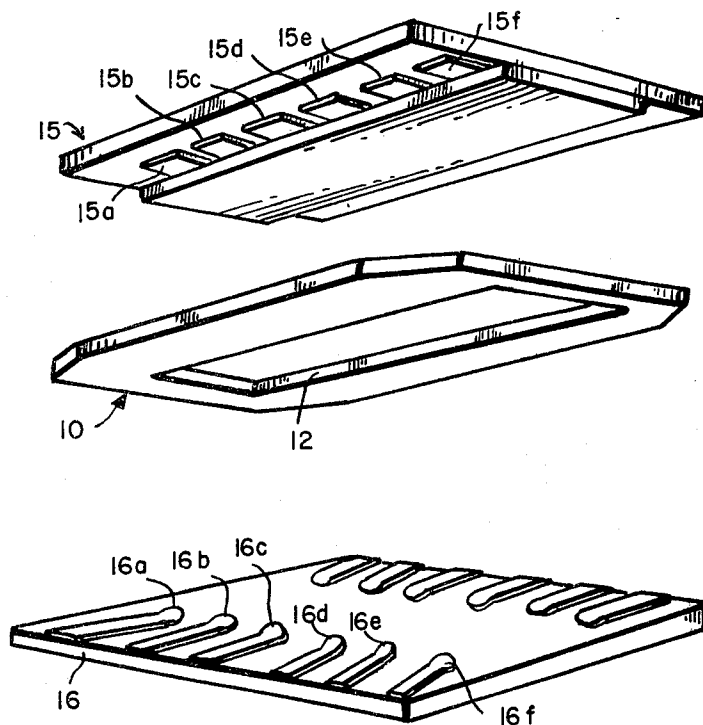
Nov., 1970, "Extender-Type Pluggable Electrical Interconnector", by D. W. Rice.

Primary Examiner—Roy Lake
 Assistant Examiner—E. F. Desmond
 Attorney, Agent, or Firm—Donald Brown; Dike,
 Bronstein, Roberts, Cushman & Pfund

[57] ABSTRACT

An electrical connector which normally has a high resistance when uncompressed but which when pressure is applied to compress a volume thereof exhibits a low resistance through the compressed volume.

9 Claims, 9 Drawing Figures



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 OR IN 339/61M

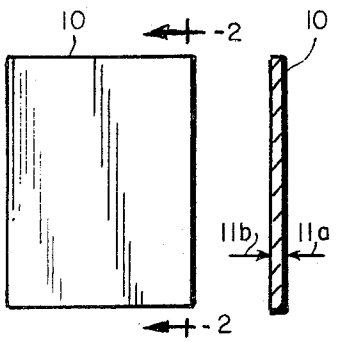


FIG. 1 FIG. 2

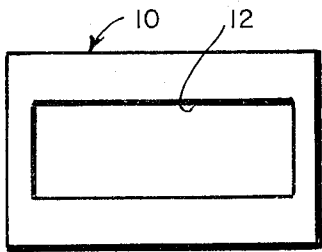


FIG. 3

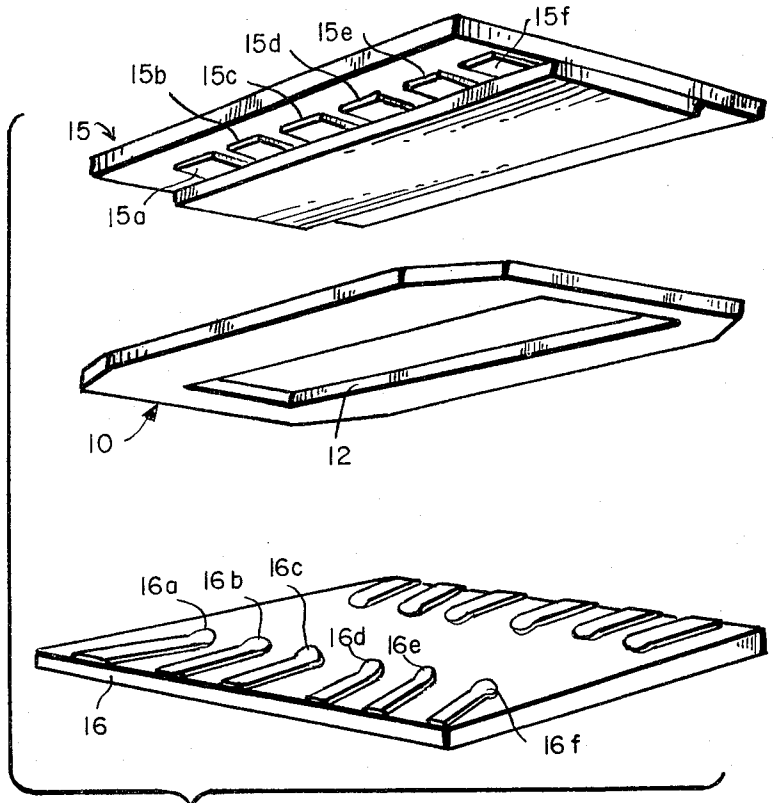


FIG. 4

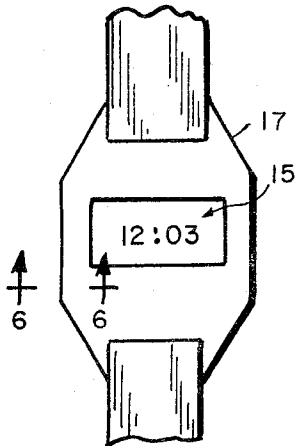


FIG. 5

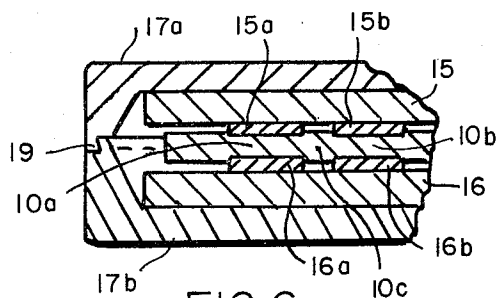


FIG. 6

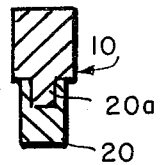


FIG. 8

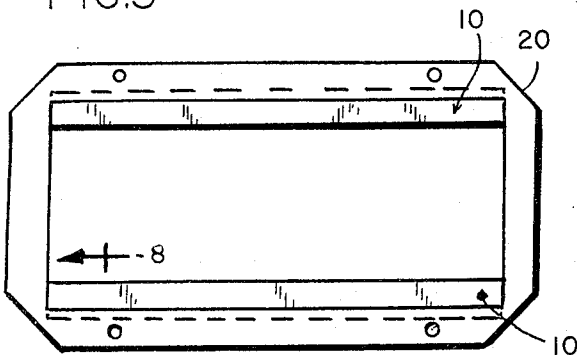


FIG. 7

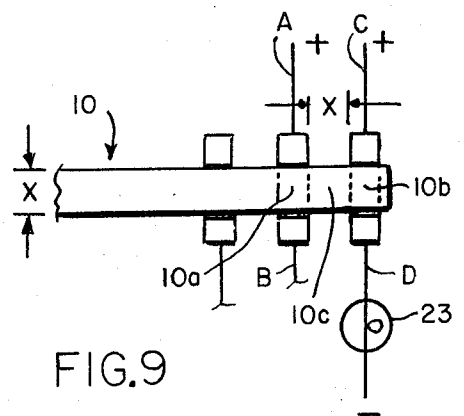


FIG. 9

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CONNECTORS

BACKGROUND OF THE DISCLOSURE

This invention is directed to connectors useful for coupling contacts of a first electrical device to the contacts of a second electrical device.

It is still conventional practice to couple contacts of one device to the contacts of a second device by soldering wires to the contacts. More recently other schemes have been proposed such as a plurality of electrically conductive plastic or rubber pads supported by an insulator e.g., along slots on the sides thereof or in holes formed therein. In this case the contacts of the devices to be connected are positioned on opposite ends of the pads and the assembly is then held together in a conventional manner.

While the aforementioned schemes are quite useful they are expensive due to the costs associated therewith. Obviously soldering is time consuming and thus labor costs are high. In the second scheme manufacturing costs are high because of the steps needed to construct the insulator support and to then fill the slots or holes thereof in a molding process.

Accordingly a new and improved connector was needed which would be comparatively inexpensive in terms of materials used as well as in the cost of manufacture.

The present invention provides a connector which is both simple and inexpensive to manufacture and extremely simple to use in order to couple contacts of one electrical device to contacts of a second electrical device.

The connector of the present invention can be termed an electrical insulator which becomes highly electrically conductive, i.e., has a low resistance between volumes under compression but remains highly electrically resistant, i.e., has a high resistance in the plane at right angles to the compressed volumes.

Thus the present invention can be used as a sheet connector and placed between aligned or superimposed contacts on either side of the sheet. Upon application of low pressure, that is the squeezing of the aligned contacts together to compress the volume of the sheet connector therebetween the resistance between aligned contacts drops sharply so that it is highly electrically conductive whereas the resistance between adjacent contacts positioned along the surface of the sheet connector or through the uncompressed volume of sheet connector remains high, i.e., the resistance is so high that it may be termed an insulator, and thus adjacent contacts on the same side of the sheet are electrically isolated.

BRIEF DESCRIPTION OF THE DISCLOSURE

The connector of the invention in its preferred form comprises a layer or sheet of material comprising a binder and electrically conductive particles. The material is normally non-conductive and could be termed an insulator. Upon application of pressure to points on opposite sides of said material, the resistance of the compressed volume between the points substantially decreases to such a degree so that the connector is useful for electrically coupling the points on opposite sides of said sheet to each other.

In addition, if pressure is also applied as above to the same material at points closely adjacent the first men-

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tioned point the resistance between the first mentioned and second mentioned points remain high such that the first and second mentioned points are in effect electrically isolated from each other.

In the preferred form of this invention the binder is of a low durometer, such as between 30 to 60 durometers, with a durometer of 40 to 50 being most preferred so that it may easily be compressed under pressure. In addition, the thickness of the layer or sheet of material is preferably between 5 mils to 100 mils with a thickness of 10 to 30 mils being preferred and a thickness of 15 to 25 mils being most preferred so that the resistance switching effect under pressure will readily manifest itself. If the material becomes too thick, too much pressure is required to produce the resistance switching effect, and if the material is too thin then it is difficult to work with.

The present invention discloses the use of nickel powder to produce the above resistance switching and isolation effect. In particular it has been found that the effect is reproducible by controlling the amount of nickel relative to the binder between certain limits.

In terms of parts by weight of nickel powder based on 100 parts by weight (pbw) of the binder, the preferred range for nickel powder is between 250 to 450 pbw, with 300 to 350 pbw being more preferred and about 320-330 pbw being most preferred.

In addition, the particle size in terms of its maximum dimension is preferably between 50 to 600 microns with 75 to 300 microns being more preferred and 125 to 175 microns being most preferred. In addition, the particle size is preferably less than the thickness of the layer or sheet of material so that the particles do not extend above or below the plane of the layer or sheet of material.

For example, with a sheet thickness of 20 mils it is preferred that the particles be of a size of at least less than about 10 mils (about 250 microns). The binder materials suitable for the practice of the invention include materials having elastomeric-like properties, e.g., elastomers such as silicone rubber, ethylene propylenediene monomer, ethylene propylene monomer, BUNA N (nitrile rubber), polyurethane rubber, styrene butadiene rubber, natural rubber and neoprene rubber, or plastics, e.g., polyethylene, polypropylene, etc., when modified with plasticizers.

In addition, the present invention does not preclude the use of fillers, plasticizers, catalysts, accelerators, pigments, smoothing agents commonly utilized in conductive plastics or elastomers such as silica (useful for its mechanical binding properties) so long as these materials do not severely affect the desirable properties of the connector.

It should be understood that the connector of this invention need not be in sheet form and can take many other physical shapes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a top view of a connector sheet or layer according to the invention;

FIG. 2 is a sectional view taken along line 2-2 in FIG. 1;

FIG. 3 is a top view of the connector layer or sheet having a portion cutout therein prior to placement into the structure shown in FIGS. 4-8;

FIG. 4 illustrates the sheet of FIG. 4 positioned between first and second electrical devices such as a liquid crystal display and circuit board;

FIG. 5 illustrates a watch containing the connector as well as the other members shown in FIG. 4;

FIG. 6 is a sectional view taken at line 6—6 in FIG. 5 illustrating pressure being applied to the connector sheet;

FIG. 7 is an alternate embodiment for supporting the connector sheet in a watch or other device;

FIG. 8 is a sectional view taken along line 8—8 in FIG. 7; and

FIG. 9 illustrates schematically the physical properties of the connector of this disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

FIGS. 1 and 2 illustrate a layer or sheet of the connector material 10 which can in the configuration shown be placed between aligned contacts of two electrical devices. When low pressure is applied usually greater than 20 psi to less than about 500 psi, the sheet will exhibit dramatically reduced resistance in the localized volume between aligned contacts on either side of the sheet.

(The sheet of connector material is between about 5 to 100 mils in thickness where the thickness X is shown in FIG. 9.)

The resistance of the material without pressure applied, i.e., between the bottom and top surfaces along the bottom or top surface is greater than 10^5 ohms, very often greater than 10^6 ohms, and often greater than 10^7 ohms.

With pressure applied such as by the pointed tips 11a and 11b (see FIG. 2) of the probe of a Simpson Model 260 ohmmeter at about 50 psi pressure, the resistance between probe tips 11a and 11b for the material at thickness of about 20 mils is less than 10 ohms and is usually less than 1 ohm. At greater thicknesses proportionally greater pressure is applied to reduce the resistance through the material to less than 10 ohms. The Simpson 260 series ohmmeter is made by Simpson Electrical Company, Chicago, Illinois.

In FIG. 3 there is shown a cutout 12 in the sheet connector so that the connector 10 may be positioned as shown in FIGS. 4-6 in a watch or other electrical system to couple contacts 15a-15f of a first electrical device 15 e.g., a liquid crystal display to the contacts 16a-16f of a second electrical device 16 such as a circuit board supporting other circuitry not shown e.g., on the underside thereof.

The circuitry may comprise circuit patterns, passive devices e.g., resistors, and active devices such as transistors to provide at contacts 16a-16f etc., the signals to drive the liquid crystal package via contacts 15a-15f, etc.

It should be quite obvious to those skilled in the art that the present invention is not limited to the interconnection of the contacts of any specific or particular electrical devices and accordingly the invention herein should be construed to cover the interconnection of any types of electrical devices in which the invention could obviously be utilized.

As may be seen in FIG. 6 the contacts 15a and 15b are shown aligned with contacts 16a and 16b. Pressure is applied to the connector sheet 10 by means of pressure snap means 19 of the watch casing halves 17a and 17b. The application of pressure compresses the vol-

ume of connector material between the aligned or superimposed contacts e.g., 15a and 16a and causes the sheet to substantially reduce its resistance e.g., through the volumes 10a and 10b. The remainder of the connector sheet remains substantially high in resistance and thus the resistance in the connector 10 volume between contacts e.g., 15a to 15b, 16a to 16b, 15b to 15a, or 15b to 16b remains high.

Therefore when current flows between contacts 15a and 15b it will primarily flow in the connector material volume 10a and not be dissipated by flowing through different pathways to the non-aligned contacts 16a or 16b.

In FIGS. 7 and 8 there is shown a plastic frame 20 e.g., of polypropylene for holding the connector sheets 10 (in the form of strips) by way of a slot 20a formed in the frame. The frame 20 may then be placed between the electrical devices of FIG. 4 to perform the same function as the connector sheet having the cutout 12.

FIG. 9 illustrates in schematic form the use of the connector of the invention. In this FIGURE the connector is in the form of a sheet having a thickness X e.g., 20 mils and the contacts A, B, C, D etc., to be interconnected are shown on opposite sides of the sheet.

As may be seen contacts A and B are aligned or superimposed at opposite sides of the sheet to compress a volume 10a therebetween and contacts C and D are also aligned at opposite sides of the sheet to compress another volume 10b of the sheet. The distance between contacts A and C, and B and D along the surfaces of the sheet are also set at a distance X e.g., 20 mils although obviously this may vary.

Upon application of pressure e.g., 20 to 500 psi, via one or both of the contacts A or B, or C or D, (which may for example be a raised square or land and have an area of one-eighth inch by one-eighth inch) in order to compress the volumes 10a and 10b the resistance between contacts A to D or A to C is 10^5 to 10^8 ohms greater than the resistance between contacts A to B.

Thus the volume 10c between the contacts remains high so as to effectively electrically isolate the contacts D or C from contacts A or B. Upon the application of pressure to compress the volume 10b between contacts C and D sufficient current can be made to flow between the + and - terminals of a source (e.g. a battery) to cause an indicator light shown at 23 to illuminate. Obviously in place of an indicator light other electrical devices may be supplied with energy in a like manner.

The following examples illustrate the connector of the invention. Unless otherwise indicated, all parts are parts by weight (pbw).

EXAMPLE 1

A connector sheet is prepared from:

Dow Corning	— 100 pbw
440 Silicone Gum Rubber	— 12 pbw
Cabosil MS 7 fumed silica	— 325 pbw supplied by
Nickel 00 224 powder	Ventron Corp.
	Beverly, Mass.
Varox peroxide catalyst	— 1 pbw

The dry materials, that is the Varox, silica and nickel powder are stirred together in a container to intermix them. Thereafter the rubber gum is banded together at room temperature on a rubber roll mill until a small

bank is produced between the mill rolls. At this time the dry intermixed materials are added to the silicone gum before it proceeds through the rolls to force the dry materials into the gum. The gum with the dry materials is periodically cut as it comes out of the rolls and is refed through the rolls until a homogenous mixture is obtained. Fifteen passes have been found to be sufficient. The rolls of the mill are spaced apart to provide a sheet of about 16 mil thickness. The sheet is then placed in a compression mold at 4,000 psi pressure for 20 minutes at 325° F to cure. The sheet is then post baked for 3 hours at 300°F to complete the cure.

The sheet thus obtained has a thickness of about 16 mils.

EXAMPLE II

The formulation of Example I was used as was the procedure of Example I except that the following pigments were added to provide color as well as to enhance the smoothness of the finished sheet and to make it more sensitive to the application of pressure:

Iron oxide supplied by Harwick Chemical as Stan-tone Color D8201 red oxide	— 10 pbw
Zinc oxide - XX4 supplied by New Jersey Zinc Co.	— 10 pbw
Cobalt pigment supplied by Harwick Chemical D4900 Blue	— 10 pbw

The sheet formed was also about 16 mils in thickness.

In tests with a Simpson 260 ohmmeter using the probes thereof as in FIG. 2 the resistance across the sheet in the absence of pressure was greater than about 10⁷ ohms and the resistance through the compressed volume between the probes at about 50 psi pressure was less than 2 ohms.

EXAMPLE III

The following ingredients are combined as per the procedure of Example I except that the mill rolls are heated to 135°F to provide a sheet:

Epcar 306 supplied by B. F. Goodrich	100 pbw
Agerite Resin D supplied by Vanderbilt	1 pbw
Zinc oxide	2 pbw
Sunpar 2280 supplied by Sun Oil Co.	2 pbw
Stearic Acid	1 pbw
Nickel 00224 powder - 100 mesh	325 pbw
Varox Caralyst	8 pbw

EXAMPLE IV

The ingredients and procedure of Example III is used except that 100 parts by weight of CHEMIGUM N-300 (a nitrile rubber) supplied by Goodyear was substituted for Epcar 306.

I claim:

1. In an electrical system comprising first and second electrical devices, each of said first and second electrical devices having a plurality of spaced apart contacts,

at least one of said plurality of contacts comprising raised land portions, a one piece sheet connector having elastomeric-like properties positioned between the devices and overlapping superimposed contacts of said first and second devices, means to compress the sheet connector between superimposed contacts of said first and second devices on opposite surfaces of said sheet connector, said sheet connector having a low resistance through the volume between superimposed contacts where compressed and a high resistance where not directly compressed between said superimposed contacts so that each pair of superimposed contacts are electrically isolated from every other pair of superimposed contacts, said sheet connector of a thickness X and has the property that when adjacent contacts on opposite sides of said sheet are positioned as close as the distance X apart and compression is applied by pressing superimposed contacts on opposite sides of the sheet together, the resistance through the sheet between superimposed contacts is low relative to the resistance between adjacent contacts, where X is 5 to 100 mils and said sheet connector comprises a homogeneous mixture of electrically conductive particles and a non-conductive binder material having elastomeric properties.

2. In a system according to claim 1 in which the system is an electrical watch.

3. In a system according to claim 2 in which the first device is a liquid crystal display.

4. In a system according to claim 1 in which the resistance through the volume where compressed between superimposed contacts is less than 10 ohms and wherein the resistance through the volume which is not directly compressed between superimposed contacts is greater than 10⁵ ohms.

5. In a system according to claim 1 wherein the resistance between adjacent contacts compressively engaging the sheet is greater than 10⁵ ohms and wherein the resistance between superimposed contacts is less than 10 ohms.

6. In a system according to claim 1 wherein the sheet is of a thickness of 10 to 30 mils.

7. In the system of claim 1 in which said sheet connector includes conductive particles which are nickel, said nickel particles being in the amount of 250 to 450 parts by weight based on 100 parts by weight of the binder material.

8. In the system of claim 7 in which the thickness X is 10 to 30 mils and the maximum dimension of the nickel particles is 50 to 600 microns provided that the particle size is less than the thickness of the sheet.

9. In the system of claim 8 in which the resistance through the volume where compressed between superimposed contacts is less than 10 ohms and wherein the resistance through the volume which is not directly compressed is greater than 10⁵ ohms.

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