

Nov. 14, 1950

L. E. HAYSLETT
MULTICONTACT CONNECTOR

2,530,354

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2 Sheets-Sheet 1

Fig. 1.

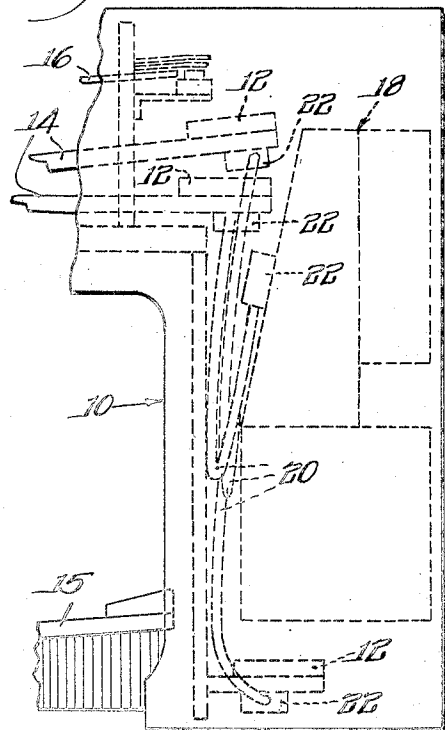


Fig. 4.

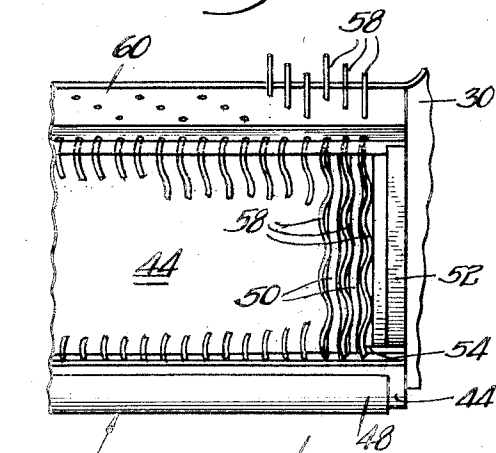


Fig. 4A.



Fig. 2.

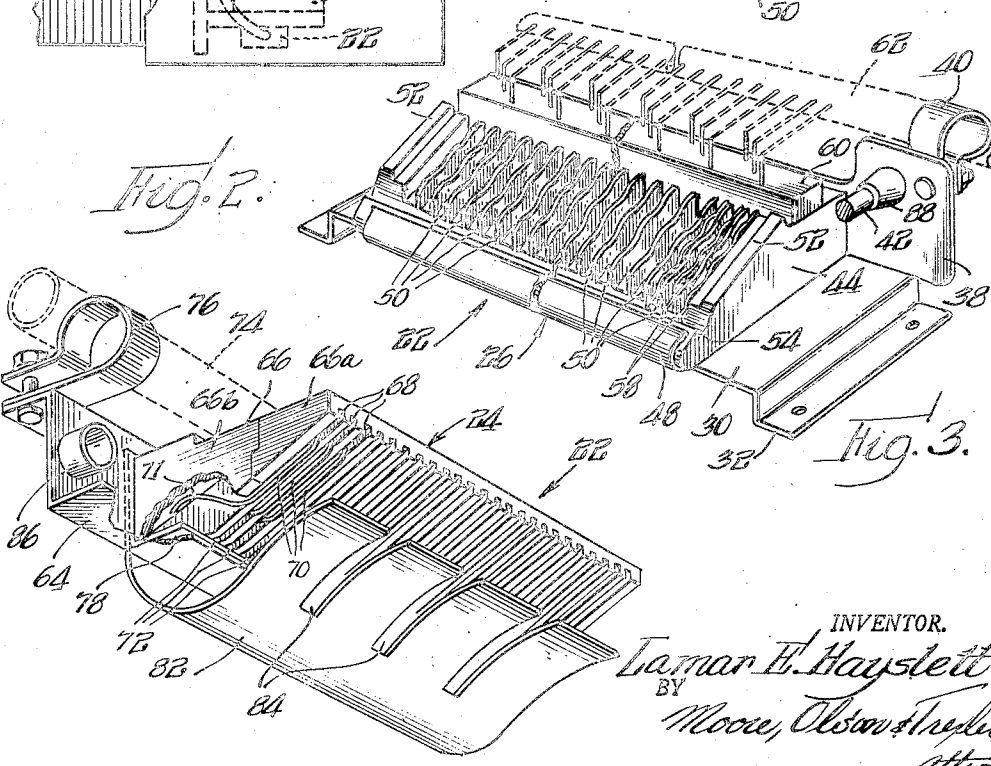


Fig. 3.

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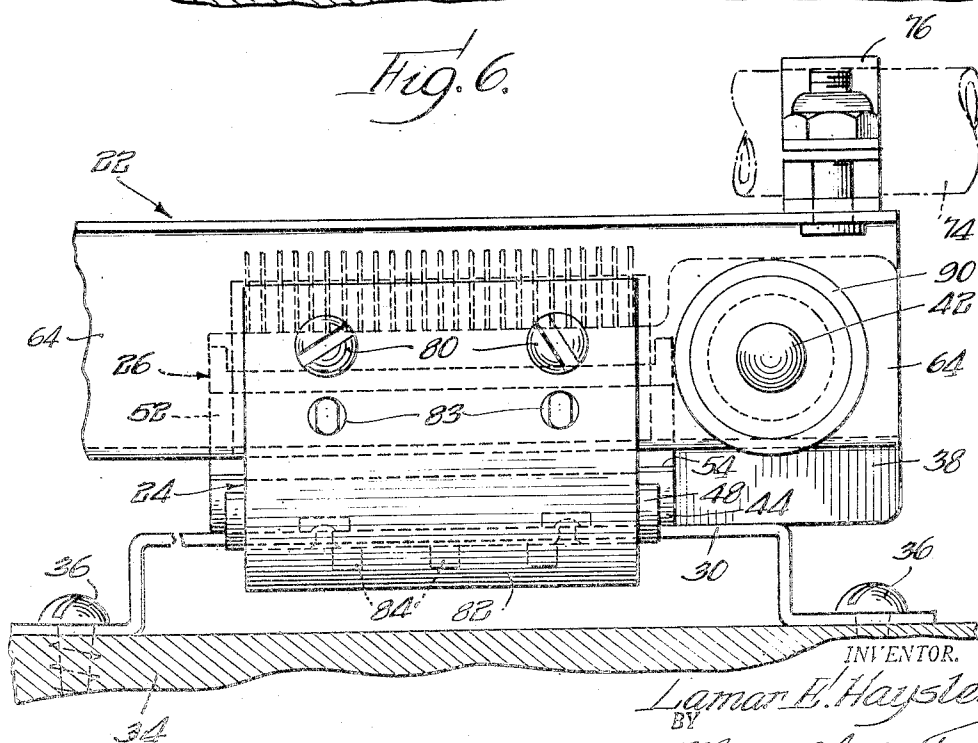
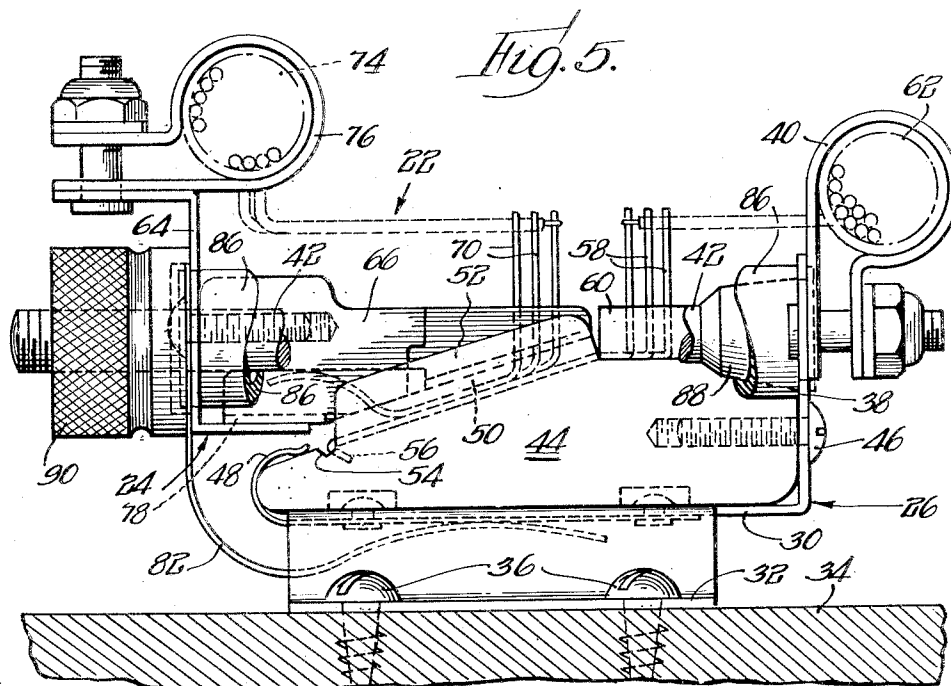
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2 Sheets-Sheet 2



UNITED STATES PATENT OFFICE

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MULTICONTACT CONNECTOR

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12 Claims. (Cl. 173—328)

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The present invention relates generally to connectors for electrical circuits and, in particular, to electrical connectors which are adapted to terminate multi-conductor cables.

One of the objects of the invention is to provide an improved form of multi-contact connector which affords an extended wiping action between contacts during assembly and disassembly of the connector so as to render the contacts self-cleaning.

Another object of the invention is to provide an improved form of electrical connector wherein the cooperating contacts are brought into engagement at a plurality of places, thus insuring good electrical contact and the establishment of low-resistance circuits when the connector is assembled. Specifically, I propose to accomplish the foregoing by forming the contacts as wires or like conductors arranged to cross each other several times throughout their extent.

A further object of the invention is to provide an improved electrical connector wherein wedge-shaped elements are employed to secure a mechanical advantage which enables the connector to be assembled easily, and thus permits the use of high contact pressures despite the large number of circuits which the connector is adapted to establish.

A still further object of the invention is to provide an improved electrical connector which is constructed in such manner as to provide long leakage paths and low capacity between contacts in separate circuits, whereby the connector is adapted for use in high-impedance electrical circuits.

Still another object of the invention is to provide an electrical connector having an improved means for locating the separable portions thereof in the desired relation with respect to each other and for maintaining such portions firmly engaged when the connector is assembled.

Various other objects, advantages and features of the invention will be apparent from the following specification when taken in connection with the accompanying drawings wherein a certain preferred embodiment is set forth for purposes of illustration.

In the drawings, wherein like reference numerals refer to like parts throughout:

Fig. 1 is a side elevational view of an electric organ selected to illustrate the principles of the invention;

Fig. 2 is a perspective view of a plug, or movable portion of the improved connector;

Fig. 3 is a perspective view of a jack, or fixed portion of the improved connector;

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Fig. 4 is an oblique view of the jack portion of the connector, illustrating the formation of the contact surfaces thereof;

Fig. 4A is a detail sectional view to show the physical relation of the contact elements when the connector is assembled;

Fig. 5 is an enlarged side elevational view of the connector in assembled relation; and

Fig. 6 is an enlarged front elevational view of the connector in assembled relation.

The present invention is adapted to be utilized, for example, in an electric organ wherein each key of the organ controls selectively a number of tone sources in accordance with the setting of the organ stop tablets, the tone sources being activated in response to the operation of an organ key through the medium of a multi-contact switch mechanism which generally is termed a coupler assembly. For example, there may be as many as six individual tone sources associated with each organ key, any one or more of which tone sources may be activated in response to the operation of the corresponding key depending upon the setting of the stop tablets. Individual, electrically operated pallets generally are provided for the tone sources, these pallets being energized through electrical circuits controlled by the coupler assembly, which in turn is controlled jointly by the stop tablets and the organ keys.

The organ 10 shown in Fig. 1 illustrates a typical form of construction of electric organ as just described. This organ includes a number of coupler assemblies 12 which are mechanically coupled to the keys and pedals of the organ, each of the assemblies corresponding to one of the manual keyboards 14 or to the pedal keyboard 15. The coupler assemblies 12 are provided with electromagnets (not shown) which are controlled by electrical circuits that extend through contacts controlled by the organ stop tablets 16. Inasmuch as the stop tablet switches and the coupler assemblies are intended to remain fixed in position, the electrical connections extending therebetween may be permanent in character. On the other hand, the electrical connections between the coupler assemblies 12 and the tone-producing apparatus 18 preferably are contained in flexible cables 20 to permit removal of the tone-producing apparatus from the organ cabinet without interrupting the circuit for operating the pallets included in such apparatus.

To facilitate disconnecting the conductors of the cables 20 from the tone-producing apparatus 18 or from the coupler assemblies 12 when this is required, as for instance when the apparatus

18 is to be removed entirely from the organ, the ends of the cables 20 are terminated in multi-contact connectors 22 which embody my present invention.

Referring to Figs. 2 through 6, each connector 22 includes a plug 24 (Fig. 2) which is adapted to be connected to the end of a flexible multi-conductor cable 20, and a jack 26 (Fig. 3) which is mounted on the apparatus to which the cable conductors are to be extended. It should be understood that the terms "plug" and "jack" are used principally for convenience in description and that the functions of these two parts may be interchanged by slight modifications in structure without departing from the invention.

The jack 26 comprises a sheet metal base plate 30 which is formed over at its ends and is then turned outwardly to afford mounting flanges 32. The jack 26 is adapted to be secured to a supporting surface 34 (Figs. 5 and 6) by screws 36 or other suitable fastening devices extended through openings in the flanges 32. The offset end portions of the base plate 30 space the central portion thereof above the supporting surface 34 a sufficient distance to enable a clamping spring, which forms a part of the plug 24, to extend thereunder, as will subsequently be described. A longitudinal edge portion of the base plate 30 is bent upwardly to form a wall 38 to which a cable clamping ring 40 and a guide rod 42 are secured.

The body portion of the jack 26 comprises a block 44, which preferably is molded of phenolic resin or other suitable insulating material. The block 44 is generally wedge-shaped in transverse section. This block is rigidly secured to the base plate 30 by screws 46, which pass through openings in the wall 38 and are threaded into tapped openings in the rear side of the block, and also by a spring member 48 which is riveted to the under side of the base plate 30 and extends around one edge thereof over the narrow edge of the block 44. Along the slanting surface of the block 44 there are formed transverse ribs or ridges 50 preferably having sideward undulations or sinuosities to define serpentine grooves in which the contact members of the jack 26 are disposed. At each end of the slanting surface of the block 44, flanges 52 somewhat higher than the ridges 50 are provided to serve as guides for locating the plug 24 relative to the jack 26 when the connector 22 is assembled.

A V-shaped groove 54 is formed lengthwise of the block 44 near the narrow edge thereof, and a row of blind openings 56 extends into the block 44 from the groove 54. Contact members 58 consisting of elongated conductors or wires are disposed in the grooves between the ridges 50 and are held in place at one end thereof by being formed over and inserted respectively into the openings 56. The contact members 58 are held in place at their other ends by a bar 60 of insulating material, which extends lengthwise of the block 44 along a flat portion thereof, and which is provided with staggered rows of openings through which the bent ends of contact members or wires 58 pass, the under surface of the bar 60 being grooved to accommodate the contact members 58. Preferably the bar 60 is formed of phenolic resin or of wood which has been impregnated with phenolic resin, and is bonded to the block 44 by the application of heat and pressure so as to permanently secure the contact members 58 in place.

As may best be seen in Figs. 4 and 4A, the por-

tions of the contact members 58 which are disposed in the grooves in block 44 are formed into a sinuous shape, these sinuous portions of members 58 being adapted to cooperate with the contact surfaces of the jack 26. The sinuosities in the wires 58 are more exaggerated than are those of the ribs 50, the curves of the wire 58 nesting snugly in corresponding concavities in the pair of ribs 50 flanking it. Preferably, each wire 58 is of such configuration that the crest of each curve therein is displaced a distance equal to thrice the thickness of the wire transversely from the crest of the adjacent opposite curve. The ends of the contact members 58 which extend from the block 60 serve as terminals to which the conductors of a cable 62 are connected electrically as by soldering. The staggering of the rows of openings in the block 60 provides a greater separation between adjacent terminals than would be obtained if they were all included in the same line, whereby the soldering of leads to the terminals is facilitated. The contact members 58 preferably are formed of phosphor-bronze wire which is silver plated to provide low contact resistance.

The plug 24 includes a frame member 64 to which there is secured a block 66, preferably molded of phenolic resin. The block 66 is shaped in the general form of a wedge which is complementary to the wedge-shaped block 44. The block 66 may be formed in two parts, 66a and 66b, which are bonded to each other by the application of heat and pressure after the contact members 70 have been secured in part 66a. Along the slanting surface of the block 66 several parallel, shallow grooves 68 are provided. These grooves are disposed in alignment with the grooves defined by the ridges 50 and flanges 52 in the block 44 when the plug 24 and jack 26 are assembled, the block 66 being positioned between the flanges 52. A series of staggered vertically extending openings, each communicating with one of the grooves 68, is provided in the block 66 along the narrow edge thereof. Through each of these openings there extends the terminal of a wire or other elongated contact member 70 which is formed parallel to the slanting surface of the block 66 and is spaced therefrom a distance slightly greater than the height of the ridges 50 in the jack 26. These contact members 70 terminate in S-shaped end portions 71 which are disposed within relatively deep transversely extending grooves 72 formed in the block 66 and communicating with the grooves 68 therein. The contact members 70 are rigidly secured only at their terminal ends, the S-shaped ends 71 being free to slide within the deep grooves 72. Phosphor-bronze or other resilient contact material is used in making the contact members 70.

The conductors of a cable 74 are connected to the terminal ends of the contact members 70 of plug 24 in the same manner as described for the jack 26. A clamping ring 76, which is riveted or staked to an upper flange portion of the frame member 64, is provided to rigidly clamp the cable to the frame member so as to prevent any strain from being placed on the individual cable conductors. A sheet 78 of insulating material, Fig. 2, is provided between the block 66 and a lowermost flange portion of the frame member 64 to prevent accidental contact between the frame member and the free ends of the contact members 70. The block 66 is secured to the frame member 64 by screws 80, Fig. 6, which pass through

openings in the frame member 64 into tapped openings in the block 66.

A wide leaf spring 82, Figs. 2, 5 and 6, secured to the frame member 64 by the screws 80 and half punches 83, extends over the slanting surface of the block 66. The spring 82 maintains the plug 24 and jack 26 in firm engagement, when they are assembled with the spring 82 extending beneath the base plate 30 of the jack, and also serves to protect the contact surfaces of the plug 24 when it is disassociated from the jack 26. The spring 82 is provided with a series of slots 84 to assist in maintaining a uniform contact pressure along the entire length thereof.

A guide tube 86 is provided with a neck portion which extends through an opening in the frame member 64 and is then formed over to securely rivet the tube to the member 64. Tube 86 is adapted to fit over the guide rod 42, the free end of tube 86 being tapered on the inside to receive a conical shoulder portion 88 of the guide rod 42. The length of tube 86 determines the spacing between the wall 38 and frame member 64 when the connector 22 is assembled. The connector 22 is assembled by positioning the plug 24 adjacent the jack 26 with the narrow edge of the block 44 interposed between the narrow edge of the block 66 and the slotted end of the spring 82, and with the tubular guide member 86 aligned with the guide rod 42. The plug 24 is then advanced until the free end of the guide tube 86 engages the tapered end of the guide rod 42 and abuts against the wall 38 of the jack 26. A knurled nut 90 is then threaded on the free end of the guide rod 42 to securely clamp the plug 24 to the jack 26 and prevent relative movement therebetween.

During the movement of the plug 24 the ribs formed on the slanting surface thereof intermediate the grooves 68 slide over the ribs 50 on the slanting surface of the jack 26. The plug and jack are pressed together with increasing pressure as they approach the final assembled position, due to the increased flexure of the clamping spring 82. The contact members 70 of the plug are somewhat deformed as they are pressed into firm engagement with the contact members 58 of the jack, thereby placing the S-shaped ends 71 of the contact members 70 under stress. The contact members 70, being resilient, are caused to wipe over the sinuous portions of the contact members 58 under considerable pressure to mechanically break down any unwanted insulation due to oxidation or other causes which may be present on any of the contact members so as to insure the establishment of a good electrical connection. The sinuous valleys or slots between the ribs 50 are sufficiently wide so that the straight wires 70 will lie therein without bending, as shown in Fig. 4A. Wedging of the wires 70 between the wires 58 and the ribs 50 is prevented by the convex wall portions of the ribs. Also, the straight wire 70 is kept substantially centered in the slot to insure making contact with the wire 58.

It will be noted that, when the plug and jack are fully engaged, the contact members 70, which are substantially straight along the contact surfaces thereof, will cross the sinuous portions of the contact members 58 at a plurality of spaced points. The spacing between the cross-over points, each of which constitutes a contact surface, is sufficient to render each of the contact surfaces of a pair of contact members independent of the other; that is, if one set of con-

tact surfaces of a pair of contact members fails to make contact, due to the presence of dust particles or the like, the straight contact member of the pair will flex sufficiently to make contact with the sinuous contact member of the pair at the other contact surfaces. Thus, a good electrical connection is insured despite the fact that a poor contact may occur occasionally at any one of the cross-over points of a pair of contact members. The mechanical advantage which is obtained as a result of the wedge-shaped construction of the plug and jack enables high contact pressures and a large number of contacts to be employed without requiring a great deal of force to be used in assembling the connector.

It should be noted that the base plate 30 may be extended to enable a number of wedge-shaped blocks such as 44 to be mounted therein and the frame member 64 may likewise be extended to enable a number of wedge-shaped blocks such as 66 to be attached thereto. With such an extended connector, it is desirable to provide guide rods such as 42 and guide tubes such as 86 at a plurality of points on the connector.

It should now be apparent that, by reason of the novel features of construction of the invention, a connector has been provided wherein improved contact reliability is obtained due to the extended wiping action which takes place between the contact surfaces during assembly and disassembly thereof, and also due to the novel formation of the contact members whereby the cooperating contacts of each pair touch at a plurality of spaced points. Good electrical connections are insured by employing high contact pressures without sacrificing ease of assembly, by reason of the mechanical advantage inherent in the wedge-shaped construction of the plug and jack which enables effortless assembly thereof despite the considerable force required to engage the contact members.

The ribs which are formed in the insulating blocks supporting the contact members result in extended leakage paths between adjacent contact members to minimize the occurrence of unwanted shunting effects, whereby the connector is adapted for use in high-impedance circuits such as are encountered in electric organs. These ribs also aid to accurately locate the pairs of contact members so as to result in a predetermined contact pressure when the connector is assembled.

It is obvious that various changes may be made in the specific embodiment set forth for purposes of illustration without departing from the spirit of the invention. The invention is accordingly not to be limited to the specific embodiment shown and described, but only as indicated in the following claims.

The invention is hereby claimed as follows:

1. An electrical connector comprising a first member of insulating material, a plurality of first contacts disposed on said first member adjacent a surface thereof, said first contacts being elongated and of sinuous form substantially in a plane parallel to the plane of said surface, a second member of insulating material, a plurality of second contacts disposed on said second member and respectively adapted to cooperate with said first contacts, said second contacts being elongated, and means for guiding said first and second members into association with each other along a path having a component extending longitudinally of said contacts when the connector is assembled in closed-circuit position to bring the

contacts into engagement respectively at a plurality of points along their length, the sum of the distances separating said first and second contacts respectively from the surfaces of said first and second members when the connector is in its open-circuit position being greater than the distance between said surfaces when the connector is in its closed-circuit position.

2. An electrical connector comprising a first member of insulating material having a row of sinuous ribs extending from one surface thereof, a row of contact members respectively disposed in the grooves defined by said ribs, a second member of insulating material, a row of resilient contact members extending from said second insulating member a distance slightly greater than the depth of said grooves, and guide means directing the insulating members together along a path oblique to said grooves, whereby said resilient contact members are pressed into electrical engagement with said first contact members with a predetermined contact pressure when said surfaces of said insulating members are brought together.

3. An electrical connector comprising a first member of insulating material having a row of ribs extending from one surface thereof, a first set of contacts extending lengthwise of the grooves defined by said ribs and in sinuous form transversely of said grooves, a second member of insulating material, a second set of contacts secured to said second insulating member and extending parallel to one surface thereof at a distance slightly greater than the depth of said grooves and engageable with the sinuously formed first set of contacts at spaced points, means for clamping said insulating members to each other with said surfaces in contact, and guide means constraining said insulating members to substantially rectilinear movement with the sets of contacts disposed substantially lengthwise of each other during assembly or disassembly of the connector whereby said contacts are wiped over substantially the entire extent of the contacting surfaces thereof during such assembly or disassembly of the connector.

4. An electrical connector comprising a first member of insulating material having a row of ribs on one surface thereof, a first set of contacts extending lengthwise of the grooves defined by said ribs, a second member of insulating material, a second set of contacts secured to said second member and extending parallel to one surface thereof at a distance slightly greater than the depth of said grooves, and guide means directing the insulating members together along a path oblique to said grooves, the contacts of one of said sets being sinuously formed transversely of said grooves so as to engage the corresponding contacts of the other set at a plurality of spaced points when said surfaces of said members are pressed together.

5. An electrical connector comprising a first member of insulating material having a row of ribs on one surface thereof, a first set of elongated contacts extending lengthwise of the grooves between said ribs, a second member of insulating material, a second set of elongated contacts secured to said second insulating member and extending parallel to one surface thereof at a distance slightly greater than the depth of said grooves, the contacts of one of said sets being sinuously formed so as to engage the corresponding contacts of the other set at a plurality of spaced points when said surfaces of said insulat-

ing members are pressed together, means for clamping said insulating members to each other with said surfaces thereof in contact, and guide means constraining said insulating members to substantially rectilinear movement with the sets of contacts disposed substantially lengthwise of each other and oblique to the line of movement of said insulating members whereby said contacts are wiped over substantially the entire extent of the contacting surfaces thereof during assembly and disassembly of the connector and into wedging contact when the connector is assembled in its closed-circuit position.

6. An electrical connector comprising a pair of members of insulating material which are disposed in abutting relation when the connector is assembled, a row of sinuously formed contact members secured at each end thereof to one of said insulating members and having their undulations lying in a plane parallel to the abutment surface thereof, a row of straight contact members secured at one end thereof to the other of said insulating members, said straight contact members being resilient and extending parallel to the abutment surface of said other insulating member in spaced relation thereto to form contact surfaces which are aligned with the contact surfaces of corresponding contact members in said first row, the free ends of the contact members in said second row being formed to bear against said other insulating member, whereby each pair of cooperating contact members is pressed into electrical engagement at a plurality of spaced points when the connector is assembled.

7. An electrical connector comprising a first member of insulating material having a row of ribs on one surface thereof, a first set of contacts respectively disposed in and extending lengthwise of the grooves between said ribs, a second member of insulating material, a second set of contacts secured to said second member and extending parallel to one surface thereof at a distance slightly greater than the depth of said grooves, the contacts of one of said sets being sinuously formed so as to engage the corresponding contacts of the other set at a plurality of spaced points when said surfaces of said members are pressed together, and a leaf spring secured to one of said members and adapted to shield the contacts thereof when the connector is disassembled and to clamp said members to each other with the contacts in electrical engagement when the connector is assembled, one of said insulating members being wedge-shaped to facilitate assembling the connector.

8. An electrical connector comprising a first member of insulating material, a row of first contact members mounted on said first insulating member, a first frame supporting said first insulating member, a second member of insulating material, a row of second contact members mounted on said second insulating member, said first and second contact members being of elongated form, a second frame supporting said second insulating member, said first and second frames being capable of relative movement, a guide rod mounted on said first frame, and a hollow guide tube mounted on said second frame, said guide rod and said guide tube being disposed on an axis oblique to the contact faces of said insulating members for causing said first and second contact members to be engaged with longitudinal and oblique wiping motion when the connector is assembled.

9. An electrical connector comprising a first

member of insulating material having a series of ribs arranged side by side on one surface thereof, said ribs being sinuous to define serpentine grooves therebetween, a first set of elongated contact members disposed in said grooves and having sinuosities corresponding to those of said ribs, a second member of insulating material, a second set of elongated contact members disposed side by side on said second insulating member and spaced outwardly from one surface thereof, said second contact members being less sinuous than said first contact members whereby each of said second contact members engages a corresponding one of said first contact members at a plurality of spaced points when said surfaces of said insulating members are brought together.

10. An electrical connector as set forth in claim 9, wherein the sinuosities of said first contact members are more exaggerated than the sinuosities of said ribs, and said second contact members are substantially straight.

11. An electrical connector comprising a first member of insulating material, a plurality of first contacts disposed on said member, a second member of insulating material, a plurality of second contacts disposed on said second member for cooperation with said first contacts, the contacts on one of said members being sinuous in the plane presenting the contacting surfaces thereof and the contacts on the other of said members being elongated and substantially parallel to the plane of the contacting surfaces of the said sinuously formed contacts whereby the elongated contacts will engage the sinuously formed contacts at a plurality of spaced points, and guide means associated with said insulating members effective to bring said first and second contacts into wiping engagement with each other during assembly of the connector.

12. An electrical connector comprising a first wedge-shaped member of insulating material

having a row of grooves on one face thereof, a plurality of elongated first contacts disposed in parallel on the face of said first member and of sinuous form transversely of the grooves therein, a second wedge-shaped member of insulating material complementary to said first member, a plurality of elongated second contacts disposed in parallel on the face of said second member and adapted to cooperate with said first contacts, said second contacts being spaced outwardly from the surface of said second member and engageable with the sinuously formed first contacts at spaced points when the connector is assembled, and means for guiding said first and second members into association with each other and with the lengthwise extent of said elongated contacts substantially parallel to each other and oblique to the line of movement of said first and second members whereby to concurrently apply pressure on said first and second contacts by wedging action of said members when the connector is assembled in its closed-circuit position.

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