

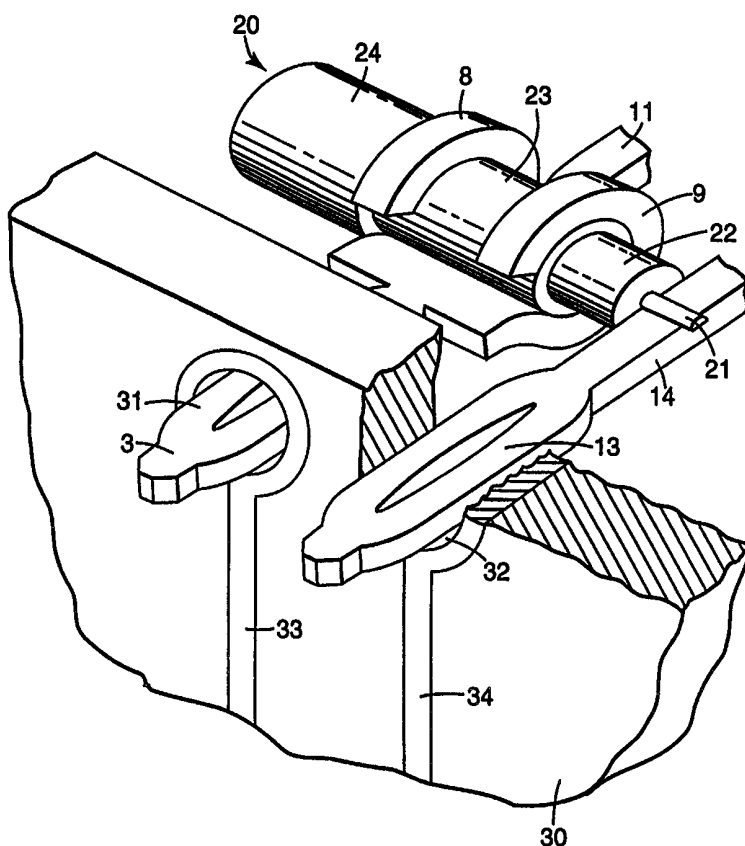


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(54) Title: A CABLE CONNECTOR ADAPTED TO BE SOLDERED OR WELDED**(57) Abstract**

An electrical connector with a first connecting member is described which includes a first conductive portion adapted to be connected to another electrical component and a second conductive portion integrally joined to the first conductive portion and adapted to be soldered or welded to a deformable external conductor of a cable, the second conductive portion comprising two substantially parallel edges between which the deformable external conductor of the cable is engageable for soldering, characterized in that at least one third elongated portion is formed integrally, by at least one free end, at one edge only of the second conductive portion, the integral formation and dimensioning being selected such that, upon application of the deformable conductor of the cable to the second conductive portion, the third portion is bendable about the deformable external conductor of the cable by a force acting on at least one free end of the third portion such that the deformable external conductor of the cable substantially is preserved in shape, and that the cable is retained between the second conductive portion and the third portion after connection by the action of the force.



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A Cable Connector Adapted To Be Soldered Or Welded

The invention relates to an electrical connector for connecting a cable provided with a deformable
5 external conductor to another electrical component. The external conductor may serve to shield the cable from electromagnetic noise and may consist, for example, of braided metal or a metal film. The cable preferably is a coaxial cable and the electrical
10 component in particular is a printed circuit board. There is increasing need for transmission of high frequency signals to corresponding processing electronics, such as when using mobile radio equipment. The frequency range in question, as a rule, requires
15 use of coaxial cables, and the electronic processing of the signals preferably is performed on modules having the respective components mounted on printed circuit boards. It is desirable, both for reasons of space and cost, to provide the simplest possible connection
20 between the coaxial cable and the circuit board, and the connection need not be detachable in view of the intended application. In many electronic devices the connection between coaxial cables and circuit boards is obtained by suitable plug-in systems which, however,
25 decidedly are quite expensive. With these plug-in systems, on the other hand, allowance is made for the fact that the impedance values both of the cable and the components on the circuit board are defined precisely and harmonized in a way so as not to cause

undesirable side effects, such as reflections of the waves to be transmitted.

A great variety of connecting systems are known none of which, however, solves all the problems mentioned. EP 0 462 879 discloses a system with which the shield of the coaxial cable and the signal conductor are connected separately to the circuit board. In this case the parts which are to be connected by soldering are suitable for use with only one cable cross section.

EP 0 446 488 describes a system with which the cable end, suitably prepared, is placed in a bendable metallic member which is adapted to receive cables of different diameters. To obtain the connection, however, a crimp or pinch connecting procedure must be performed with the aid of a corresponding tool. That leads to deformation, often inadmissible, of the cable shield and cable insulation whereby the impedance values are altered, it being especially critical that the impedance values change in a way which can hardly be controlled with this kind of crimp connection. Moreover, the conventional crimping of a connector part requires the contact surfaces of the connector which are to be crimped to be of symmetrical design.

WO 93/21669 relates to a system with which the conductor portions to be introduced into the circuit board first are interconnected. The prepared cable must be inserted by a suitable holding means into a

shrinkable hose suitably prepared. During a subsequent heat shrinking process, solder rings previously placed inside the hose are not only shrunk on but also fused on. Therefore, it is advantageous to hold the cable in
5 place by a suitable separate device during the soldering and shrinking operations.

EP 0 750 366 relates to a system with which the above mentioned problems of possible impedance variations are avoided by bringing the shield of the
10 coaxial cable between two metal parts which essentially correspond to the diameter of the shield. The connecting device permits the shield and the signal conductor to be connected simultaneously since the corresponding contact elements are interconnected by a
15 bridge which can be broken off once the connection with the circuit board has been completed. However, also in this case the cable must be held by a suitable device during the connecting operation. Furthermore, the parts are useful for only one predetermined cable
20 diameter.

US 3,743,748 relates to a connecting system which comprises but one metal element shaped such that a structure of semicircular cross section is predetermined at one end, and the shield of the cable
25 may be placed in that structure, while attaching the signal conductor to a corresponding tongue is rendered possible at an oppositely disposed part. In this case, too, the metal parts first are connected by a bridge

which is not broken off until the cable has been attached to the connector and the entire system to the circuit board. The system is useful for only one cable diameter. Moreover, the cable possibly is held in
5 position by the first metal part. Yet this should not be sufficient for the soldering of the shield and the welding of the signal conductor which preferably takes place.

JP 4-171997 describes a system with which the
10 signal conductor is bent and soldered directly to the circuit board, while the cable shield is soldered to contact surfaces of the connector proper. This connector incorporates a lug having one or more arms deformed previously such that the cable can be
15 introduced into them. Again the system is preformed such that it can be used for only a very small range of cable diameters.

It is the object of the invention to provide a connection between a cable having a deformable external
20 conductor and another electrical component, especially between a coaxial cable and printed circuit boards, which connection can be achieved easily and at low cost. Additionally, the connector according to the invention permits a compact structure and, at the same
25 time, makes sure that the impedance values of the individual components remain within acceptable limit values.

It is another object of the invention to find a

device for connecting which is universally useful, i.e. which can be used for different cable cross sections, especially of coaxial cables. Furthermore, it is desirable to apply soldering between the deformable
5 external conductor and in particular the electro-magnetic shield of the coaxial cable and the connection system, based on the impedance which is better controllable and the increased functional safety of the connection. That should be possible by
10 mechanized automatic means and this requires that the cable can be held during the soldering or welding process. Moreover, it is desirable in addition that the original soldering of the shield of the coaxial cable to the connection system not become dissolved
15 again during later additional soldering operations, such as the soldering of the system to the circuit board, without having to employ relatively high melting solder for the soldering of the shield.

The object of the invention is met, according to
20 the invention, by a first connecting member comprising a first electrically conductive portion adapted to be connected to another electrical component. A second electrically conductive portion is directly connected to the same, both mechanically and electrically, and is
25 designed such that it can be fixed by soldering or welding to the deformable external conductor of the cable. This second conductive portion comprises two essentially parallel edges between which the deformable

conductor of the cable can be placed in order to be fixed by soldering. At least one third elongated portion is formed integrally, by at least one free end, at one edge only of this second conductive portion and, upon application of the deformable external conductor of the cable to the second conductive portion, the third portion is bendable around the deformable external conductor of the cable by a force acting on at least one free end of the third portion such that the deformable external conductor of the cable substantially is preserved in shape and that the cable is retained between the second conductive portion and the third portion after completion of the action of the force.

Even though such a device is useful very particularly for a coaxial cable and its connection to a circuit board, the invention described hereby is applicable in general for all cables having a conductor which is deformable and with which it is desirable that the configuration of the deformable conductor remain unchanged, if at all possible, after the connection is made. This may be a coaxial cable, for instance, incorporating two signal conductors or a flexible wave guide which is to be connected or a multi-wire conductor whose cross sectional shape is to be kept constant.

What is decisive is the arrangement and configuration of the third portion specified of the

connector according to the invention. In contrast to known solutions, the arrangement of the third portion at one edge only of the second conductive portion is asymmetric. In this manner the cable can be placed
5 inside with particular ease. As the function is limited to holding the cable, the requirements as to bending of the third portion are less strict. The configuration is to be chosen such that bending is possible without substantially changing the cable and
10 the other parts of the device. Normally this is accomplished by using adequately thin metal parts and by matching length and width in such a way that bending can be achieved with relatively little force. For example, this force may be so slight that manual
15 bending will be possible. The kind of fixing or holding of the cable according to the invention is fundamentally distinct from crimp-connecting it in that the external conductor and the underlying cable insulation do not become deformed substantially with the
20 inventive kind.

Such a system not only offers the advantage of the cable remaining unaltered in geometry and of impedance values remaining within controllable limits, especially with coaxial cables. This system further has the
25 advantage of being useful for a great variety of cable diameters so that the result is a universal device for electrically connecting cables with at least one deformable external conductor.

Pre-bending of the free end of the third portion is preferred, specifically such that the degree of the bend enclosing the cable around the deformable external conductor of the cable is reduced, in order to achieve the bending in simple and defined manner either manually or by a corresponding mechanical device when the connection is produced automatically. In this manner, the portion in question is given a preferential direction which allows the bending to be accomplished easily and securely in the desired direction.

Furthermore, it appears to be advantageous to devise the third portion as an arm whose width is much less than the length which is given by the distance between the one edge of the second conductive portion and the free end. It is likewise feasible, and often very advantageous, to form not only one but two arms so that two third portions are obtained.

The resulting advantage is that the cable is retained in the desired fashion not only against longitudinal displacement but also twisting of the cable is prevented during the mounting procedure. This is particularly important when it comes to soldering the cable shield, i.e. the deformable external conductor of the cable to the second and third portions. As already specified above, this results in the advantage that also low melting solder may be employed because any shifting of the conductor during a later soldering operation on the circuit board, for

example, is prevented by the securing function of the second and third portions.

If at all possible, the second conductive portion should be so designed between its two edges that

5 substantially surface area contact will be produced when the deformable external conductor of the cable is applied so that soldering can be achieved across a certain area. This is achievable according to the invention by the fact that the second conductive

10 portion is shaped between its two edges like a cylinder element which corresponds at least approximately to that of the deformable external conductor of the cable. Care should be taken that the second conductive portion and the third portion are configured accordingly so

15 that, in spite of predetermined cylindrical shapes of these portions, cables having deformable external conductors of the widest possible range of diameters can be mounted and secured to the device by soldering. That is rendered possible by the cylinders having radii

20 which typically are greater than some of the deformable conductor of the cable.

A connector according to the invention proves to be especially advantageous for connection to a so-called sheet- or film-type cable. Such a cable does

25 not have the outer shield of the coaxial cable embodied by a copper wire fabric but instead by a film provided with a conductive layer, preferably aluminum. In practice, it has proved that such film-type cables are

extremely difficult to connect to other components. To facilitate that, some cables are provided with an additional shield conductor (drain wire) which then must be fixed to the connectors by soldering or
5 welding. These film-type conductors are not suitable for connection to all connectors. Crimping (a squeeze connection) is problematic because the film provided with a conductive layer is compressed in uncontrollable fashion and the shield wire (drain wire) is held in a
10 non-definable position within the cable so that a reliable connection does not result (cf. EP 0 446 448).

With other connectors, too, connecting them to a film-type cable is problematic. It is not possible, for example, with a connector according to EP 0 750 366
15 because, there, the coaxial cable must be brought between two metal parts which fully enclose the outer circumference of the cable. In this case it is problematic to produce a connection with the shield conductor (drain wire). The latter would have to be
20 bent out of the way in front of the connectors and fixed separately.

A connector according to the invention, on the other hand, is especially well suited for connection to a film-type cable. That is due to the fact that the
25 third portion is curved in such a way that it will always be possible to leave free part of the circumference and thus offer room for the shield wire (drain wire) which then may be secured to parts of the

connector by soldering or welding. This may be gathered from the figures enclosed in addition (fig. 6).

The embodiment of the invention with one or more arms at one side only of the second conductive portion permits much better insertion of the conductor in comparison with the prior art, e.g. US 31743,748 and JP 4-171997. Moreover, an electrical connector according to the invention clearly is easier to manufacture since there is no obstruction between the first conductive portion and the third portion as they are located at different sides of the second conductive portion. This is especially significant because attention must be paid during manufacture to the pitch. This is 2 or 2.54 mm.

The invention, first, relates to a method of making a connection between a first connecting member and the deformable conductor of the cable, typically the shield of a coaxial cable. In another embodiment, however, also a second conductor of the cable, for instance the signal conductor of the coaxial cable, is connected electrically. That is done by using a second connecting member which is joined to the first connecting member. Preferably, it is accomplished by providing a fourth electrically conductive portion similar to the first conductive portion so that it will be adapted for connection to the other electrical component, and in particular to the circuit board. A

fifth portion is bound to this fourth electrically conductive portion and the signal conductor of the cable may be connected to the former. Preferably the fourth or fifth conductive portion is connected to the first or second conductive portion of the first connecting member by a sixth portion which presents a bridge and can be severed, such as by cutting or breaking off, when the electrical connection has been established between the cable and the other electrical component such as the circuit board. The sixth portion may be mounted directly or through an integrally molded arm at the same edge of the second conductive portion where also the third portion is located. If the third portion is arranged to have two arms, the sixth portion serving as bridge preferably is secured between the two arms.

For the second embodiment described here, reference is made in particular to patent application EP 0 750 366 which specifies a great number of other possibilities, all of which have in common that, with this embodiment, the connection is made both with the deformable conductor and the second conductor of a cable, first and second connecting members always being present which are connected to a bridge.

The object also is met according to the invention by a method of making the connection, which method consists of the following steps:

The end of the coaxial cable is prepared in the

usual manner so that the signal conductor, the shield, and the cable sheath of the coaxial cable are exposed. When braided copper wire is used as the shield conductor, the soldering thereof preferably takes place
5 prior to removal of the outer insulation, as described in DE 41 16 165.

The end of the cable thus prepared is placed in the connector, more specifically pressed on the second portion between the two edges.

10 Then a force is exerted between the second and third portions so that the third portion, designed as an arm, becomes curved, the force being limited such that deformation of the cable is largely avoided.

Thereafter, the permanent connection of the shield
15 to the connector is effected. In the case of a braided copper wire this means soldering to the second and third portions, and in the case of a film-type cable it means soldering or welding of the shield wire (drain wire), preferably at the side of the second conductive
20 portion. The signal conductor is connected to the second connecting member, more specifically the fifth portion, by soldering or welding.

The connector thus attached to the cable is introduced into the openings provided for this purpose
25 in the circuit board, more specifically by the first and fourth portions which then are soldered to the circuit board.

The bridge essentially consisting of the sixth portion is removed by being cut or broken off to cause

electrical separation between the shield and the signal conductor.

If it is intended to provide the connector with a casing, the latter is placed on the connection either before (figs. 7 and 8) or after introduction into the circuit board.

The embodiments of the invention will now be described with reference to the following figures.

10 Brief Description Of The Figures

Fig. 1 shows a connector according to a first embodiment of the invention.

15 Fig. 2 shows a connection of the connector illustrated in fig. 1 to a coaxial cable.

Fig. 3 shows the connection of the coaxial cable to a circuit board by the connector according to the first embodiment of the invention.

Fig. 4 shows a connector according to a second embodiment of the invention.

25 Fig. 5 shows a connection of the connector illustrated in fig. 4 to a coaxial cable.

Fig. 6 shows a connection of the connector illustrated in fig. 1 to a coaxial cable including a film-type shield and a shield wire.

Fig. 7 shows the connection according to fig. 2 with a

two part casing.

Fig. 8 shows a cross section through the installed casing illustrated in fig. 7.

5

Description Of The Embodiments Of The Invention

Fig. 1 illustrates an electrical connector 1 of a first embodiment of the invention comprising a first connecting member 2 shown at the lower left. At the lower end there is a first conductive portion 3 adapted to be connected to an electrical component (not shown), preferably a printed circuit board. It is followed by a second conductive portion 4 which is connected directly to the first conductive portion 3 and curved such that it forms a cylinder-like surface 5 at the inside. This cylinder surface 5 is defined by two edges 6, 7 which are essentially parallel to each other and between which a cable may be placed for soldering. The first edge 6, remote from the first conductive portion 3, is integrally formed with three arms 8, 9, 11. The two outer arms 8, 9 each constitute a third portion 8, 9. As they are separate and independent of each other they present two third portions 8, 9. Preferably they are pre-shaped in such a way that their internal sides approximately form continuations of the cylinder surface 5 of the second portion 4. The central arm 11 establishes a link towards a bridge 10 to be explained below. A second connecting member 12 is shown to extend parallel to the first connecting member 2 and comprises a fourth electrically conductive portion 13 of similar configuration as the first conductive portion 3 so that it is likewise adapted to be connected to the electrical component, preferably the circuit board. It is followed by a straight

portion 14 joined directly to the fourth conductive portion 13. This fifth conductive portion 14 is adapted to be connected by soldering or welding to the signal conductor of the cable. As illustrated, the two
5 connecting members 2, 12 are linked by the bridge 10 which may be provided with circular apertures 15, 16. The bridge 10 enhances the stability of the two connecting members prior to their final attachment to the circuit board. The bridge need not be made of
10 conductive material. Yet it is advantageous to punch the entire electrical connector 1 out of a flat metal plate. Thus the entire connector 1 can be formed with the aid of a typical stamping-bending tool, the circular apertures 15, 16 in the bridge 10 possibly
15 being utilized for transportation of the article 1 during its manufacture. As this bridge 10 will be removed later on its design is not significant with respect to the actual function of the connector 1 on the circuit board.

20 Fig. 2 essentially shows the connection between the connector 1 and a coaxial cable 20. The coaxial cable 20 is prepared in the usual manner, i.e. the signal conductor 21, the insulation 22 between signal conductor 21 and shield 23, the shield 23, and finally
25 the cable sheath 24 are exposed successively and in stepwise fashion. The cable end thus prepared then is placed in the opening defined by the second and third portions 4; 8,9. Thereupon the arms 8, 9 of the third portion are curved, which may be accomplished manually
30 in the simplest manner but, preferably, is done by a simple device so that the arms 8, 9 will engage the surface of the shield 23 without substantially deforming either the shield or the underlying insulation 22. Following this, the end of the coaxial

cable 20 is retained sufficiently by the arms 8, 9 to provide the electrical connections with the cable 20 and the circuit board. Those are realized, as far as the shield 23 is concerned, by corresponding soldering to the surface 5, including the arms 8, 9, whereas the signal conductor 21 is soldered, preferably welded, to the fifth conductive portion 14.

As shown in fig. 3, the first and third conductive portions 3, 13 are introduced into corresponding holes 31, 32 in an electrical component 30, e.g. a printed circuit board, and retained therein by soldering and the like and connected to electrical paths 33, 34. Subsequently, the sixth portion, the bridge 10, is removed upon severing. The arms leading to the bridge 10 also may be formed previously with adequate impressions so that they may be broken off instead of being cut off.

Fig. 4 illustrates a second embodiment of a connector according to the invention. It shows an electrical connector 40 prior to the actual connection being made with another electrical component, e.g. a printed circuit board. Component parts of the second embodiment indicated by the same reference numerals as in the first embodiment relate to like components. A difference over the first embodiment is to be seen in that the third portion consists of a single arm 8. Moreover, the fourth conductive portion 14 is not straight but rather formed with a cranked section 42 intended for convenient reception of the signal

conductor of a coaxial cable. The respective connection made with a coaxial cable 20 may be gathered from fig. 5. The shield 23 in this case is retained only by the single arm 8. The connections between cable 5 20 and connector 40 once more are made in the manner described above, namely by soldering the shield 23 to the first connecting member 2 and welding the signal conductor 21 to the second connecting member 12 or to the cranked section 42. The crank is needed in this 10 instance in order to prevent the cable from being attached obliquely. Yet this is to be regarded as merely an example to demonstrate that both connecting members 2, 12 and the individual parts thereof must be matched geometrically so that the necessary connection between 15 the connector 40 and the cable 20 may readily be made.

Fig. 6 shows the connection of a connector 1 according to the first embodiment with a coaxial cable 50, including a film-type shield 43 and a shield wire 44. Due to the fact that the arms 8 and 9, when bent, 20 do not reach as far as the edge 7 of the second conductive portion 4 of the first connecting member 2, there is room for the shield wire 44 which may be attached by soldering or welding between the ends of the arms 8, 9 and the edge 7.

25 Figs. 7 and 8 illustrate the use of a connector according to the invention with a two-part casing 70, 71. A connection already established between the connector 1 and the cable 20 in accordance with fig. 2

is depicted in the middle, while there are two parts 70, 71 of a plastic casing enclosing the connection shown above and below. The first and second connecting members 2, 12 are introduced into the lower part 70 of the casing, as may be seen in fig. 8, so that these members which are to be inserted in the circuit board 30 are stably guided. Then the bridge 10 (the sixth portion) is broken or cut off, and the upper part 71 of the casing is mounted. In fig. 8, the completed connection is shown prior to its insertion on a circuit board 30, and on top of it the bridge 10 already separated.

The connectors according to the invention may be made from conventional connector materials, in particular contact surfaces may be made of beryllium copper CuBe, pack fong or German silver CuZn, brass ME 70 (70 % Cu, 30 % Zn), copper nickel alloys or similar materials.

We claim:

1. An electrical connector, comprising a first connecting member which includes a first conductive
5 portion adapted to be connected to another electrical component and a second conductive portion integrally joined to the first conductive portion and adapted to be soldered or welded to a deformable external conductor of a cable, the second conductive portion
10 comprising two substantially parallel edges between which the deformable external conductor of the cable is engageable for soldering, characterized in that
at least one third elongated portion is formed
15 integrally, by at least one free end, at one edge only of the second conductive portion, the integral formation and dimensioning being selected such that, upon application of the deformable conductor of the cable to the second conductive portion, the third portion
20 is bendable around the deformable external conductor of the cable by a force acting on at least one free end of the third portion such that the deformable external conductor of the cable substantially is preserved in
25 shape, and that the cable is retained between the second conductive portion and the third portion after connection by the action of the force.
- 30 2. The electrical connector as claimed in claim 1, characterized in that the at least one free end of the third portion is bent such that the degree of deformation around the deformable external conductor of the cable is reduced.

3. The electrical connector as claimed in any one of claims 1 to 2, characterized in that the third portion has the shape of an arm whose width is much
5 less than the length given by the distance between the one edge of the second conductive portion and the free end.

4. The electrical connector as claimed in claim 3,
10 characterized in that the third portion consists of two or more arms which are formed integrally with the one edge of the second conductive portion, independently of each other.

15 5. The electrical connector as claimed in any one of the preceding claims, characterized in that the second conductive portion is shaped in such a way, between its two edges, that substantially surface area contact is established when the deformable external conductor of
20 the cable is applied so that soldering across an area becomes possible.

6. The electrical connector as claimed in any one of the preceding claims, characterized in that the second
25 conductive portion and the third portion are designed such that cables of different diameters of a given diameter range are applicable.

7. The electrical connector as claimed in any one of
30 the preceding claims, characterized in that a second connecting member is provided which is joined to the first connecting member and adapted to be connected to a second conductor of the cable.

8. The electrical connector as claimed in claim 7,
characterized in that the second connecting member
includes a fourth conductive portion adapted to be
connected to the other electrical component and a fifth
5 portion adapted to be connected to the second conductor
of the cable and joined to the fourth portion.

9. The electrical connector as claimed in claim 8,
characterized in that a sixth portion is provided which
10 connects the fourth or fifth conductive portion to the
first of second conductive portion and is adapted to be
severed when the electrical connection between the
cable and the electrical component has been
established.

15

10. The electrical connector as claimed in claim 9,
characterized in that the sixth portion is bound by an
integrally molded arm to the same edge of the second
conductive portion as the third portion.

20

11. The electrical connector as claimed in any one of
the preceding claims, characterized in that the cable
is a coaxial cable, the deformable external conductor
is the shield of the coaxial cable, and the second
25 conductor of the cable is the signal conductor of the
coaxial cable.

12. The electrical connector as claimed in any one of
the preceding claims, characterized in that the other
30 electrical component is a printed circuit board.

1/8

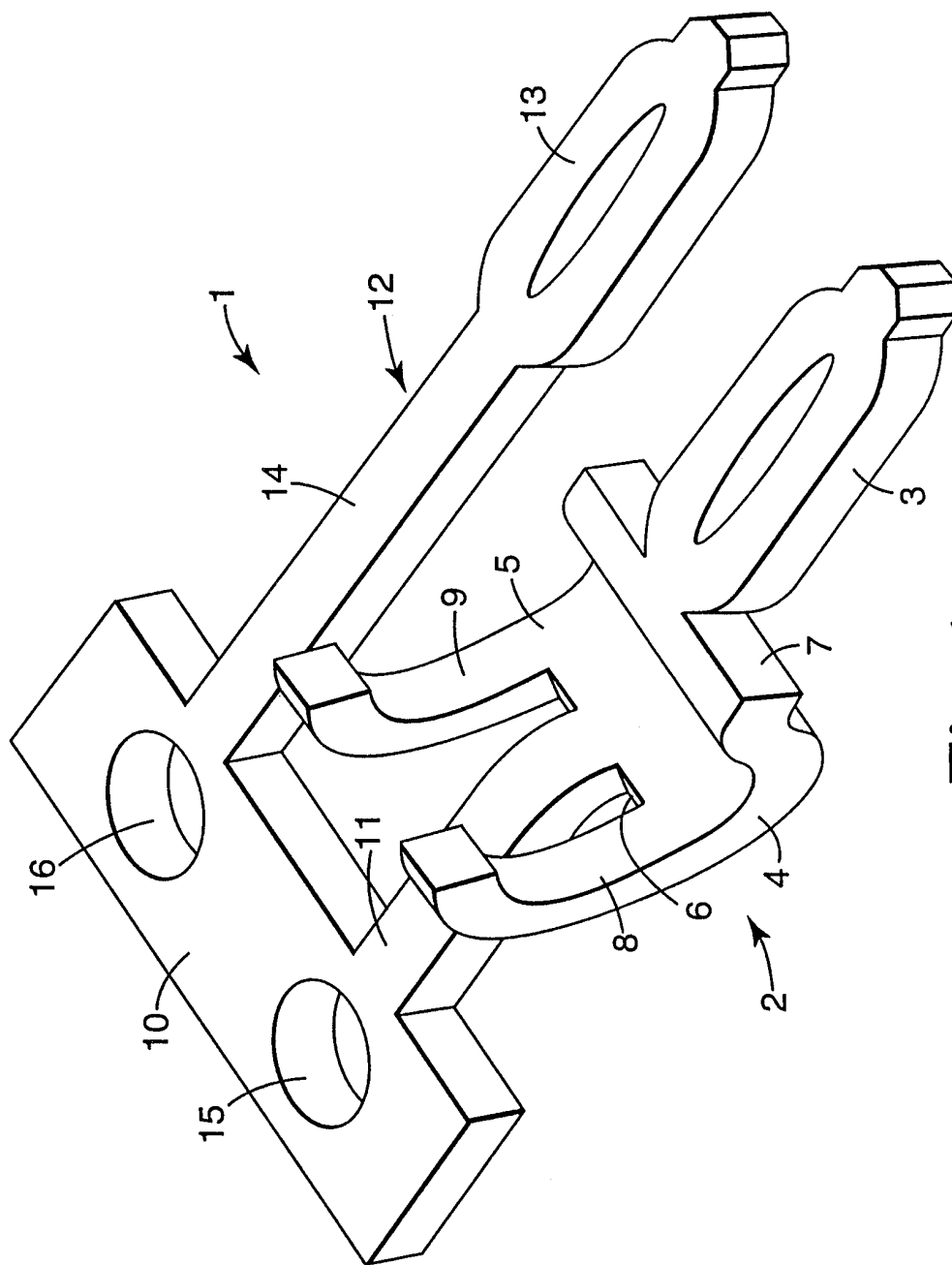


Fig. 1

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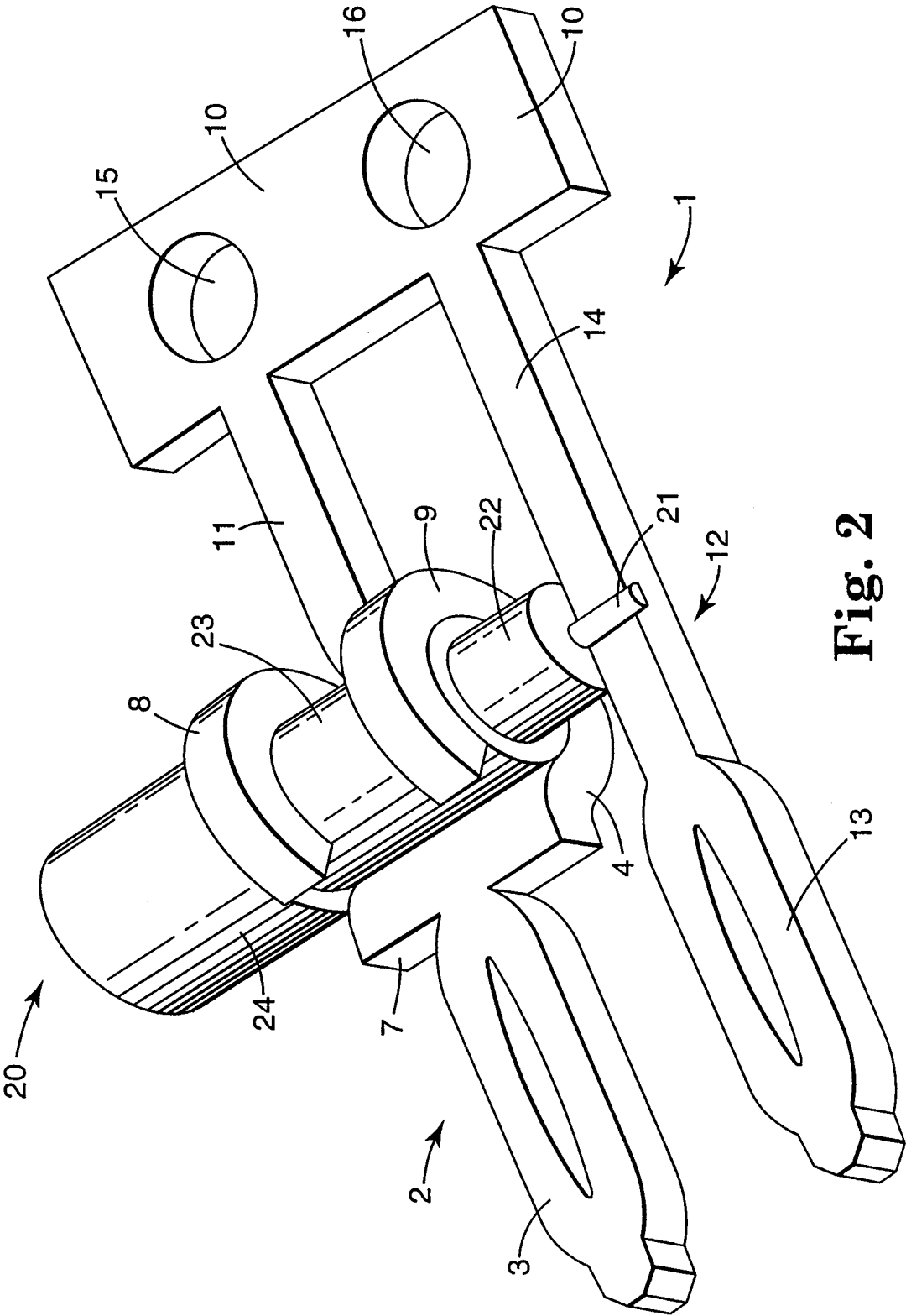
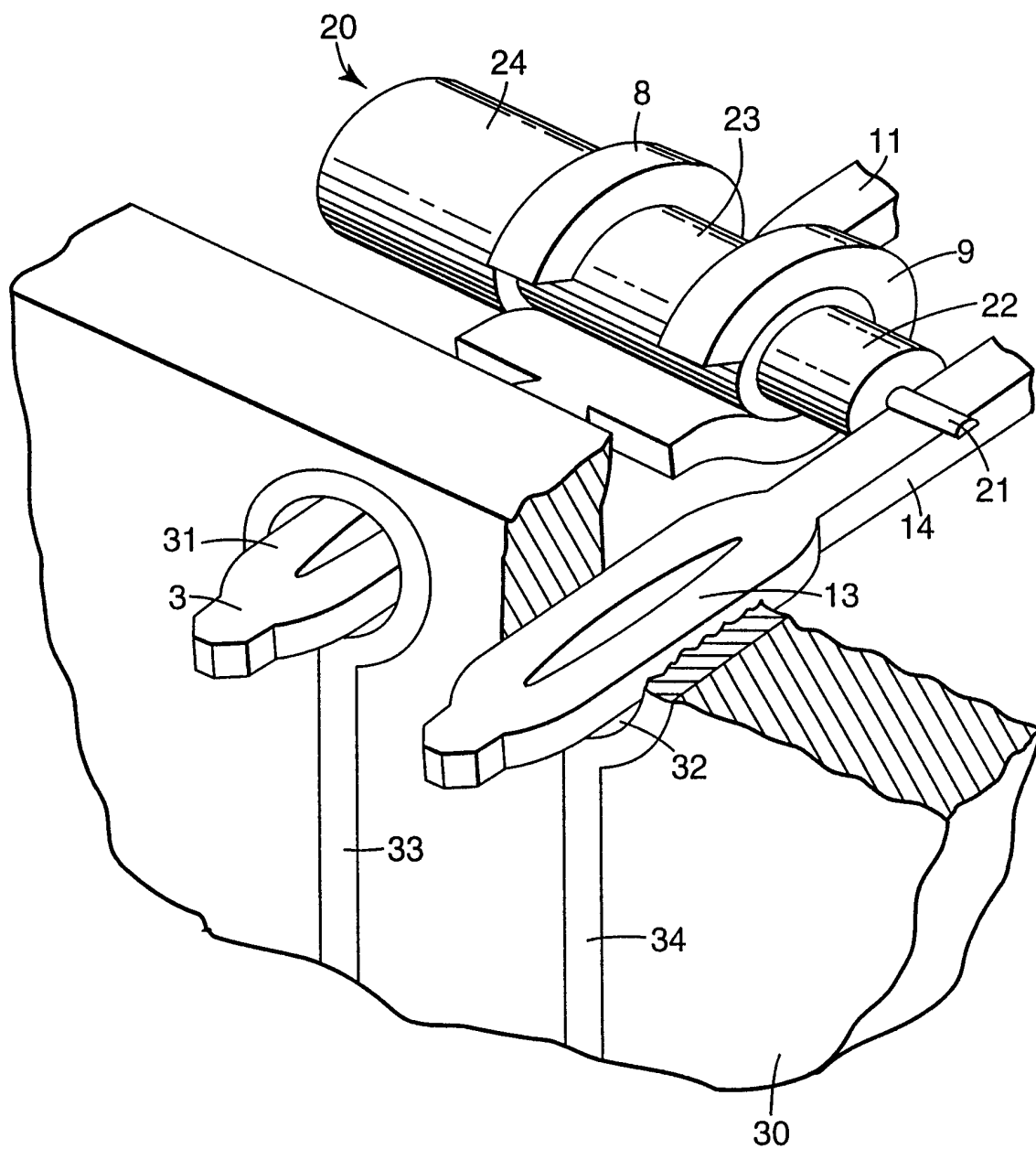
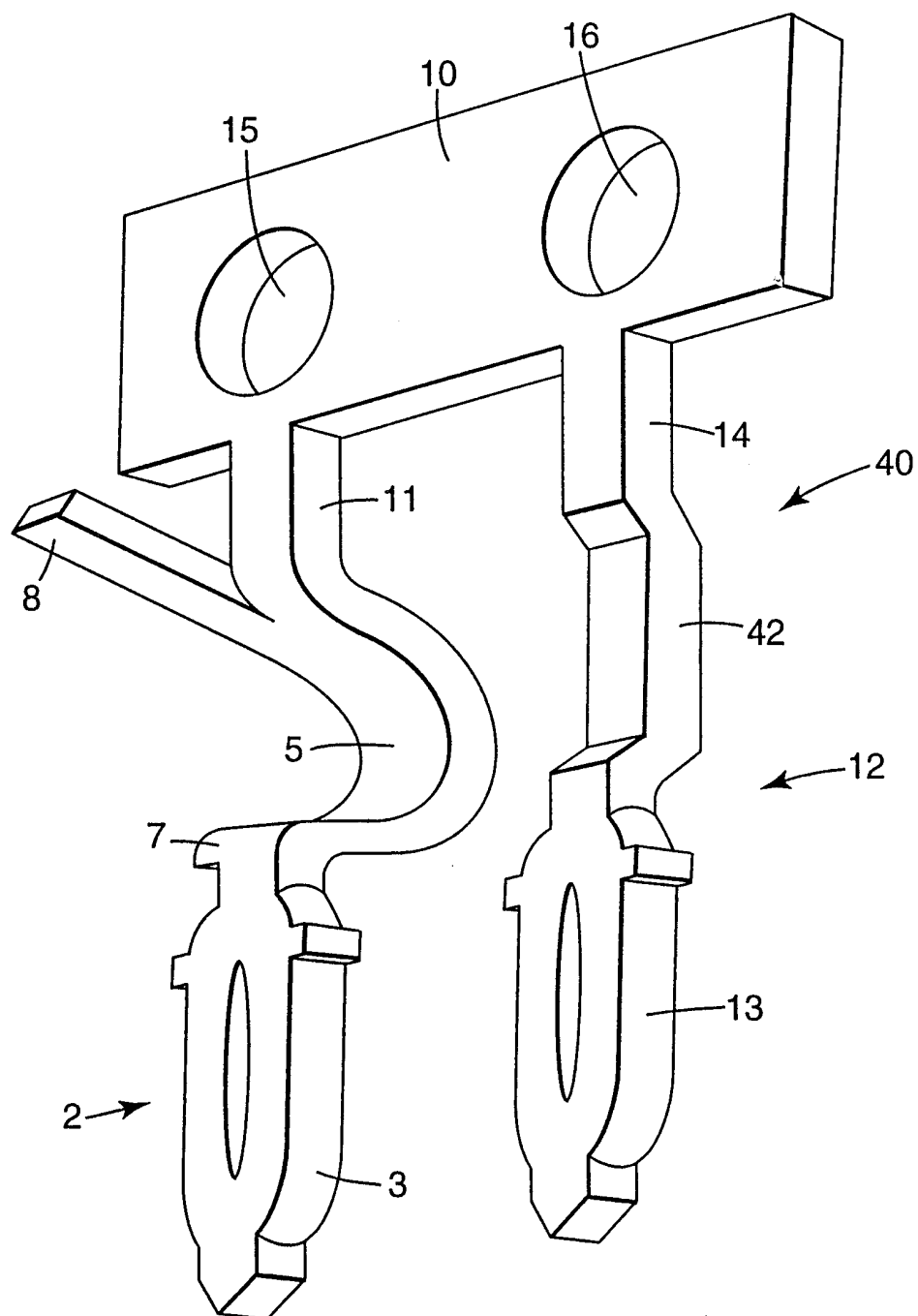


Fig. 2

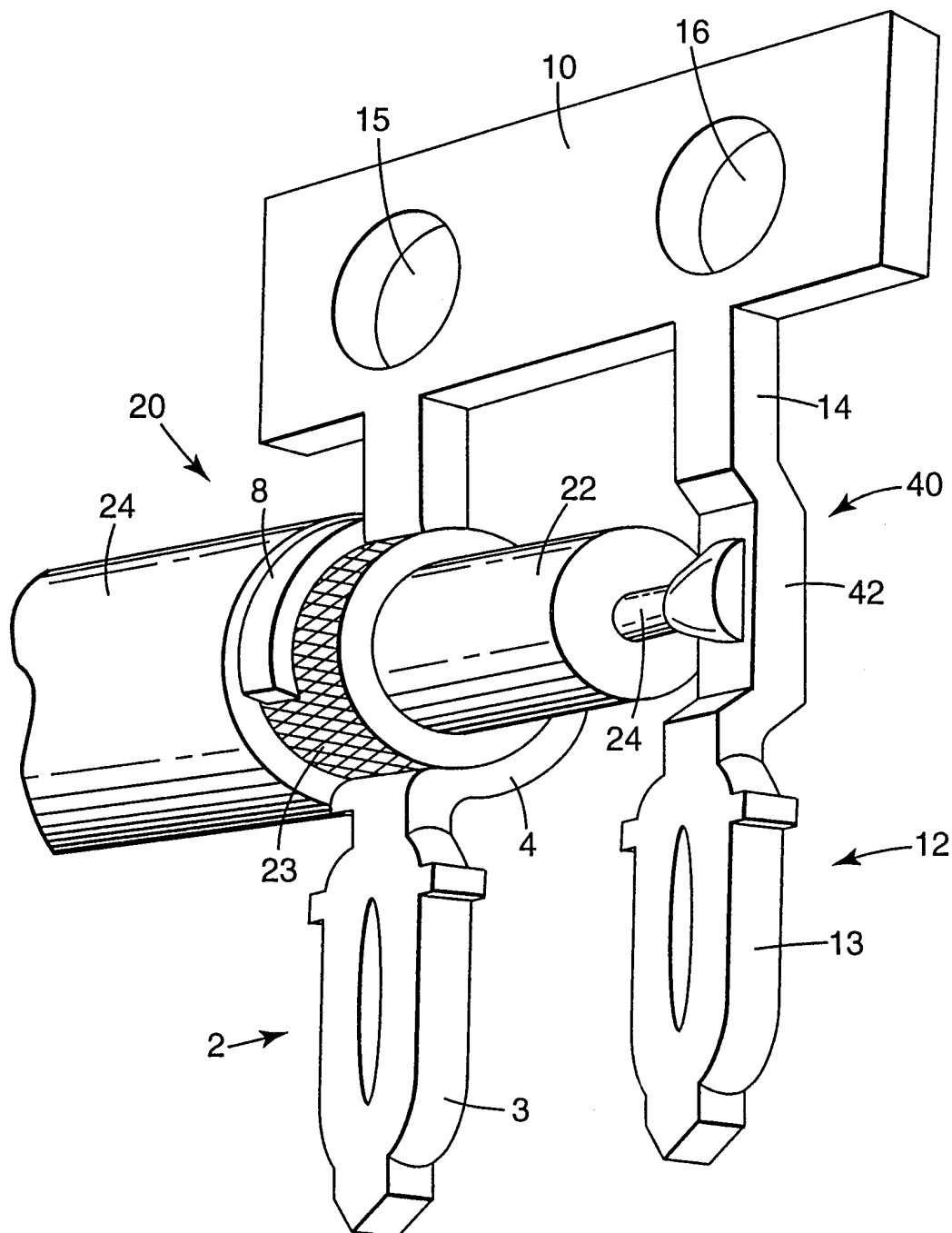
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**Fig. 3**

4/8

**Fig. 4**

5/8

**Fig. 5**

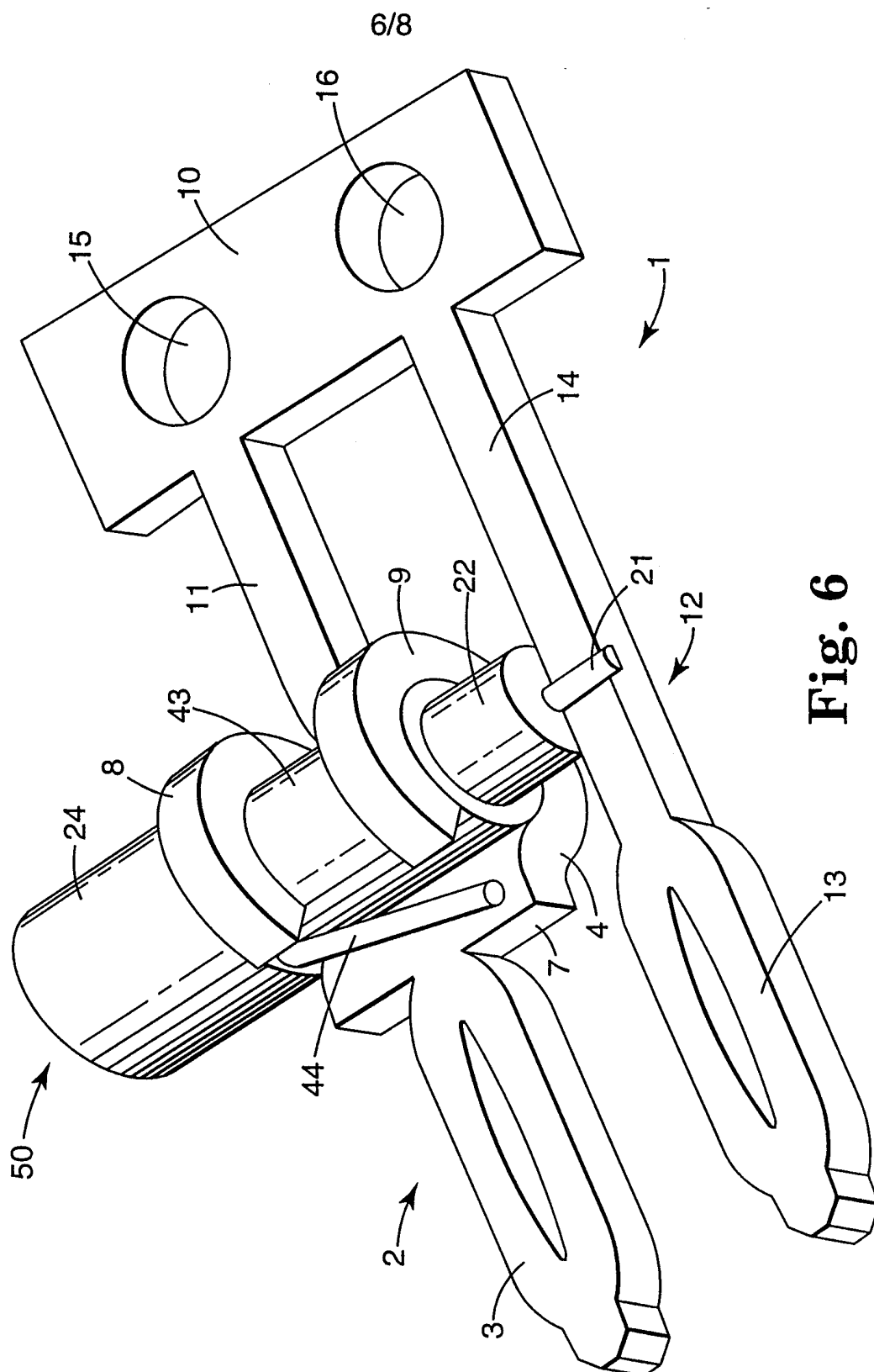
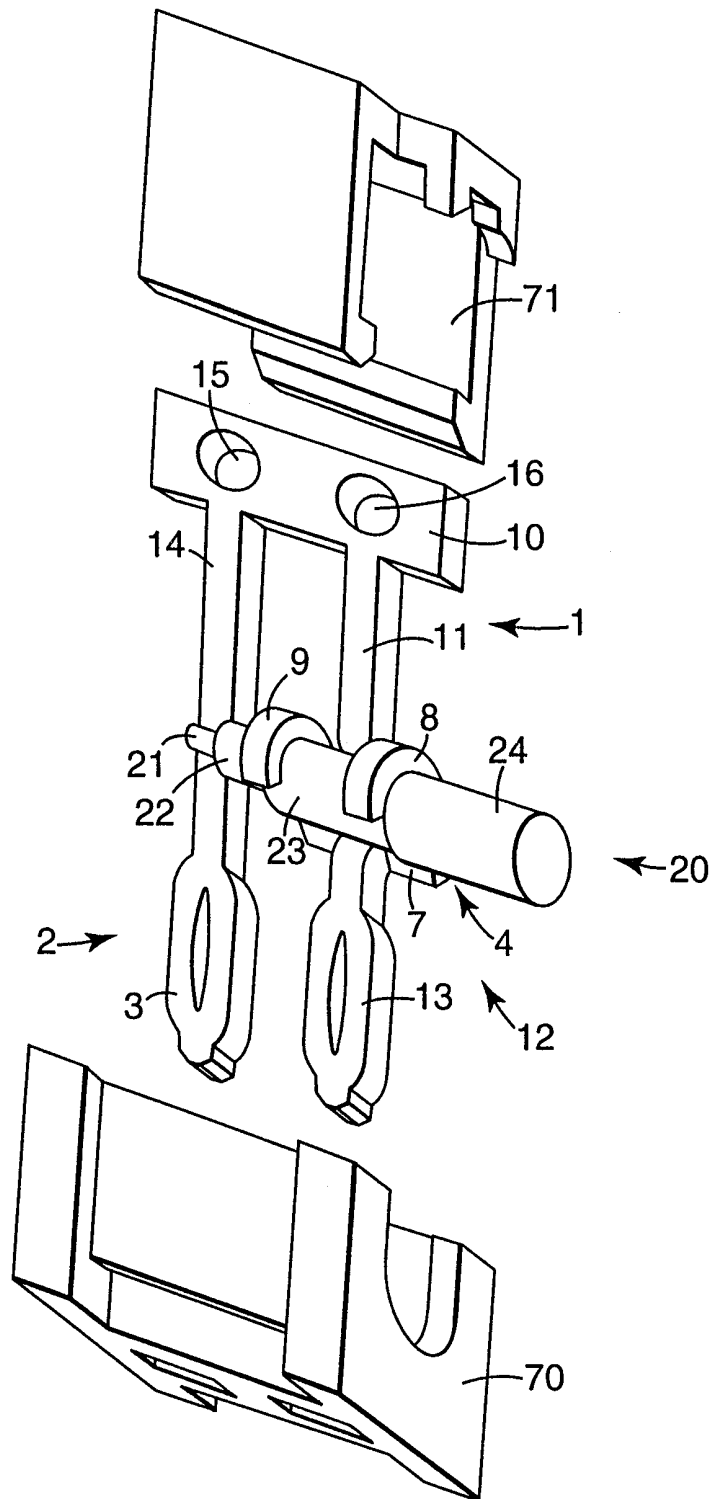
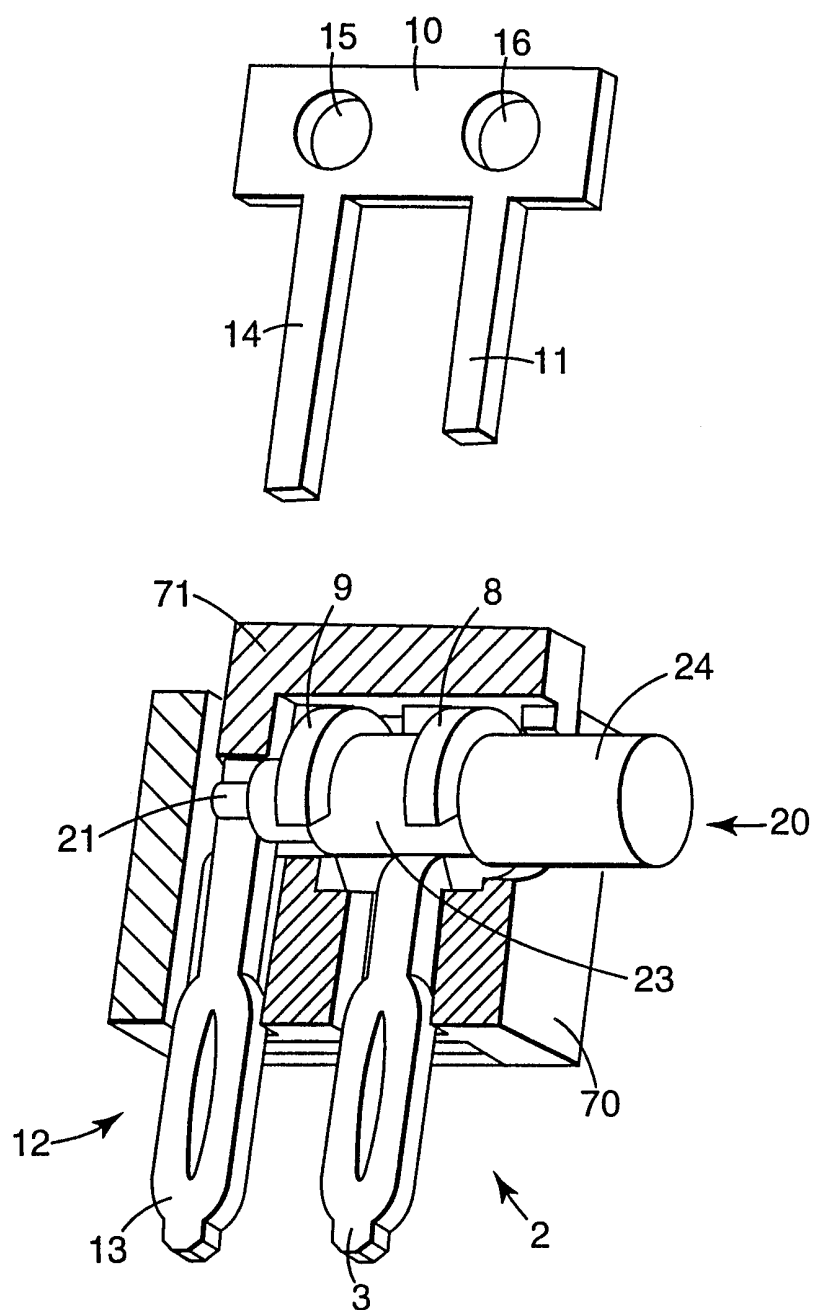


Fig. 6

7/8

**Fig. 7**

8/8

**Fig. 8**

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/13536

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H01R9/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3 743 748 A (REEDER L) 3 July 1973 cited in the application	1-3,5-12
Y	see column 3, line 33 - column 5, line 35 see column 5, line 55 - line 57; figures 1-6	4
Y	GB 2 254 495 A (THOMAS & BETTS CORP) 7 October 1992 see page 4, paragraph 1; figure 2	4
X	PATENT ABSTRACTS OF JAPAN vol. 016, no. 478 (E-1274), 5 October 1992 & JP 04 171997 A (FUJITSU LTD), 19 June 1992 cited in the application see abstract	1,2,4,5, 12
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search

23 September 1998

Date of mailing of the international search report

30/09/1998

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 98/13536

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 750 366 A (MINNESOTA MINING & MFG) 27 December 1996 cited in the application see abstract; figure 7 -----	1,11,12

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 98/13536

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		CA 1021420 A	22-11-1977
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