United States Patent [19]

Stauffer

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[45] **July 29, 1975**

[54] **SEALED ELECTRICAL CONNECTING MEANS**

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[73] Assignee: **AMP Incorporated,** Harrisburg, Pa.

[22] Filed: **May 13, 1974**

[21] Appl. No.: **469,157**

Related U.S. Application Data

[63] Continuation of Ser. No. 333,241, Feb. 16, 1973, abandoned.

[52] **U.S. Cl.** ..... **339/220 R**

[51] **Int. Cl.** **H01r 9/16**

[58] **Field of Search** 339/59–62, 339/153, 154, 205, 206, 208, 209, 210, 220, 221

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Attorney, Agent, or Firm—Frederick W. Raring; Robert W. Pitts; Jay L. Seitchik

[57] **ABSTRACT**

A sealed electrical connector comprises a plastic housing having one or more electrical contact terminals mounted therein. The housing is of a hard polymeric material which is elastically deformable. The contact terminals are driven into cavities in the housing and have peripherally extending teeth. The teeth deform the cavities in the walls which elastically bear against the teeth and form an extremely tight seal between the opposite faces of the housing.

6 Claims, 8 Drawing Figures

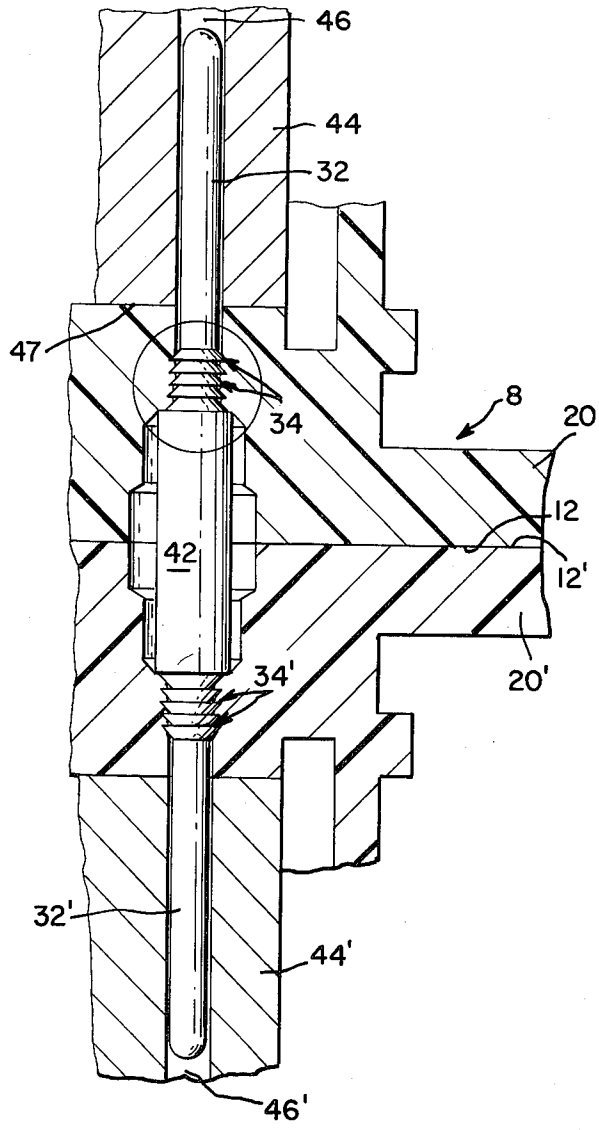


FIG 1

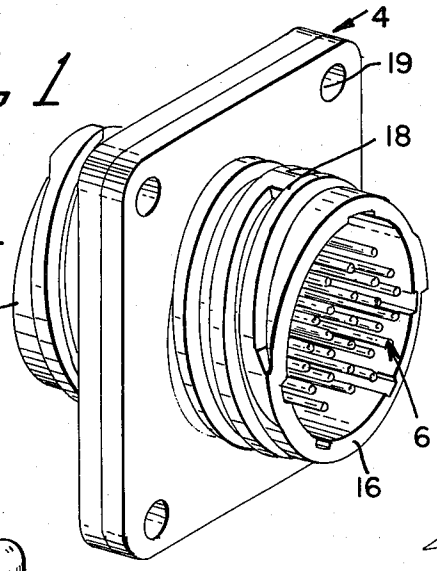
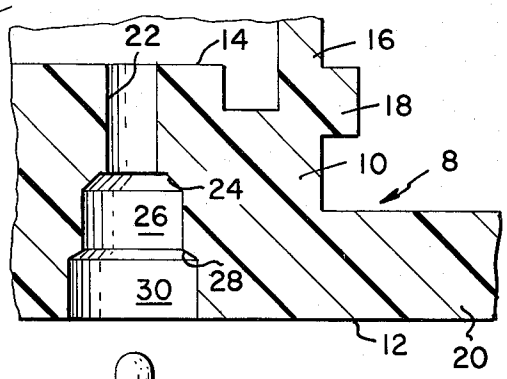
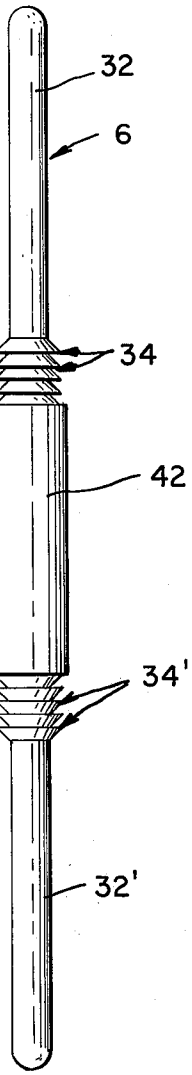


FIG 2





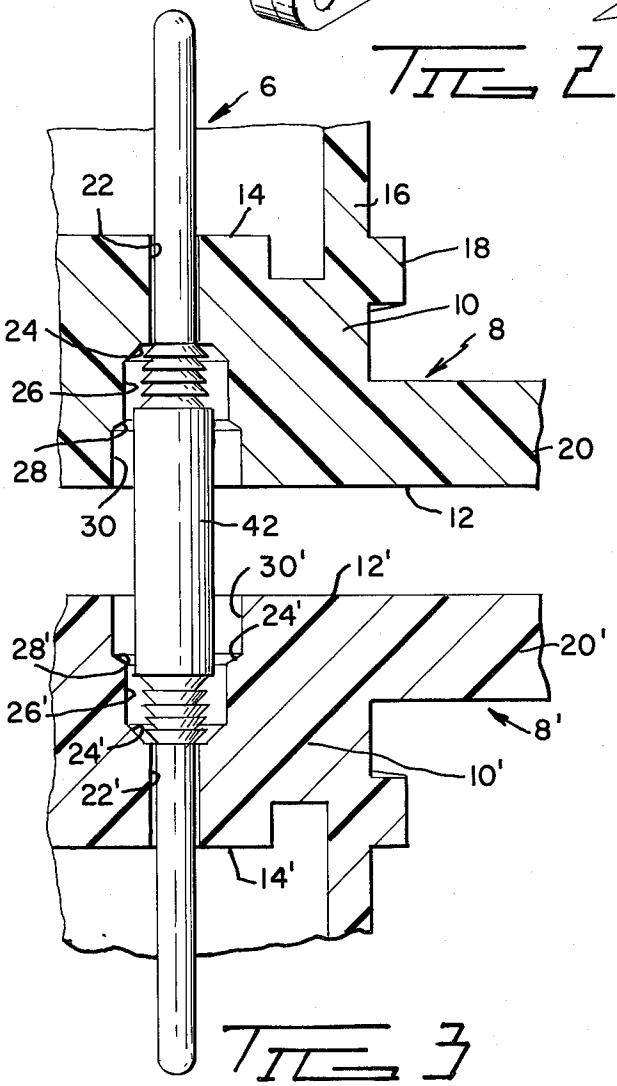
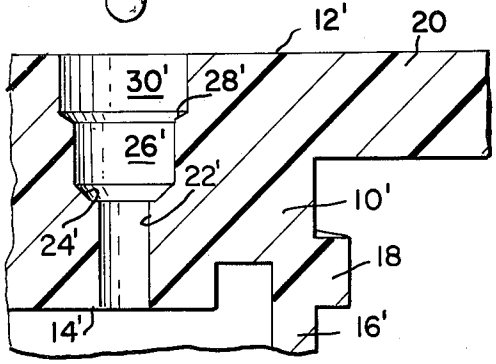


FIG 3



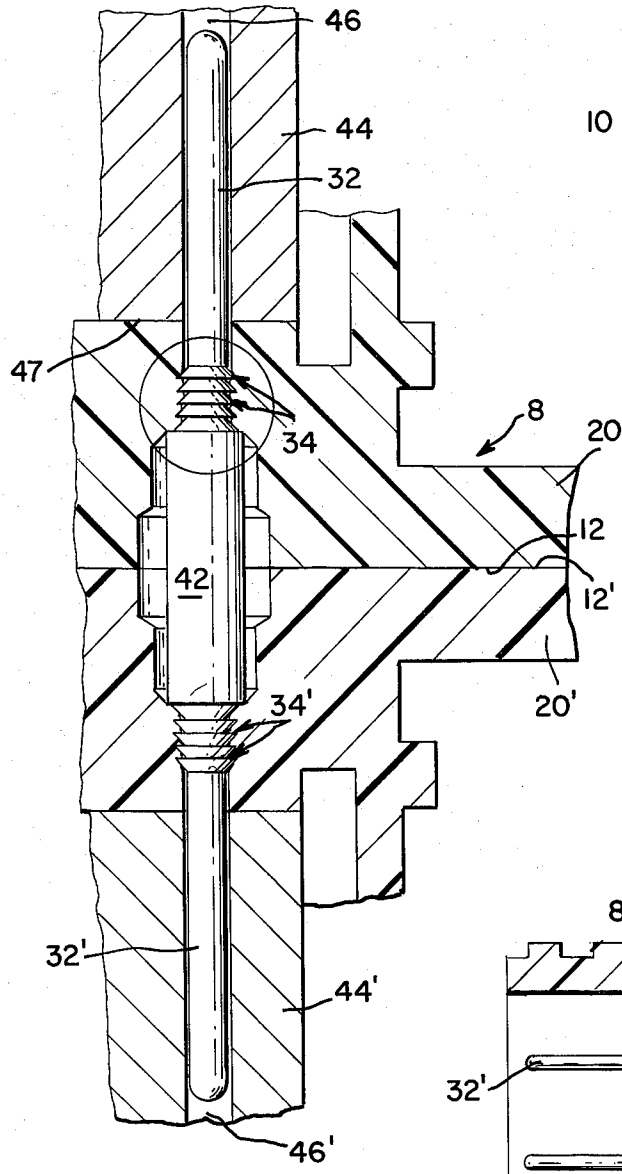


FIG 4

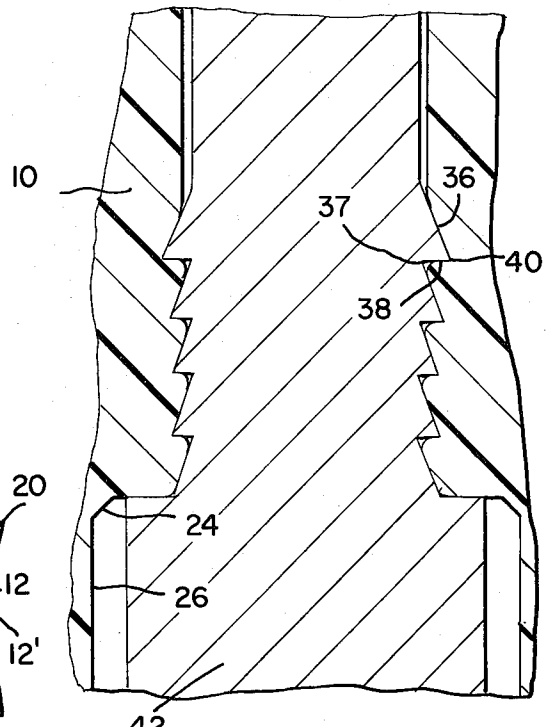


FIG 5

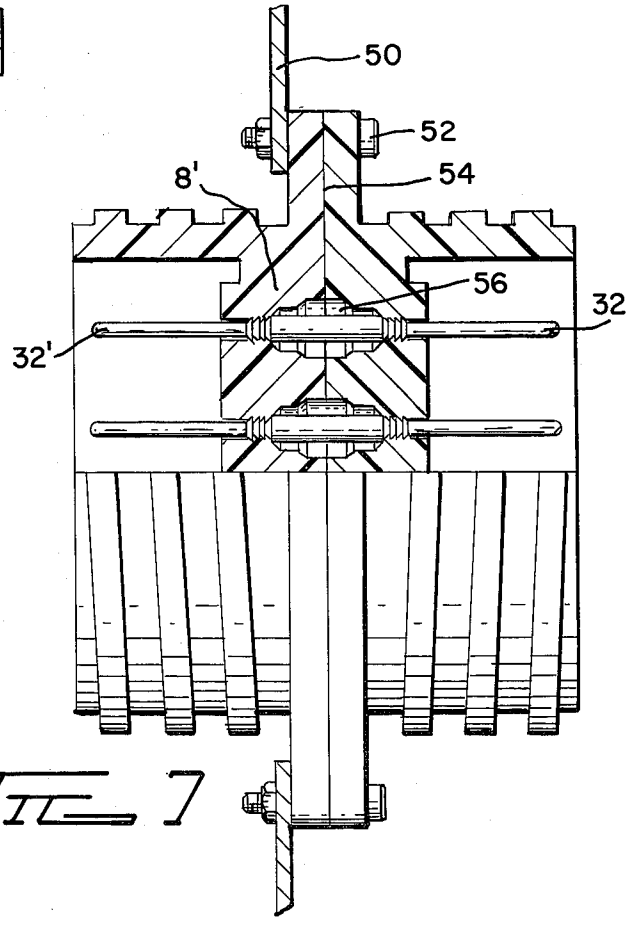


FIG 7

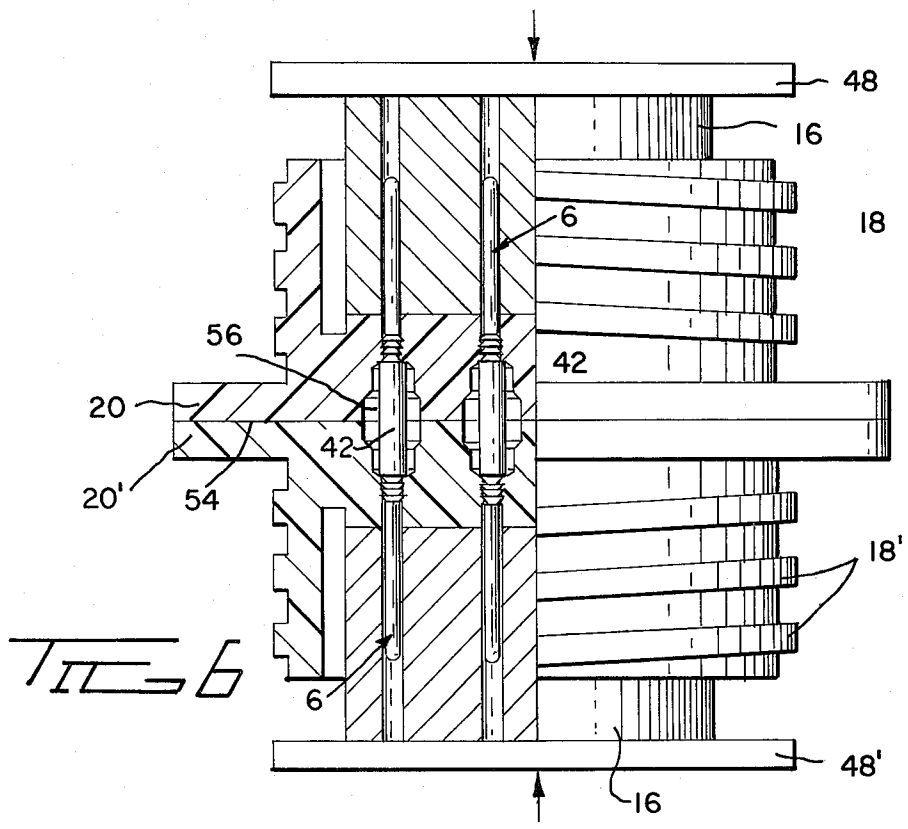

48
16
18
6
56
42
20
42
20'
54
18'
6
48'
16

FIG 6

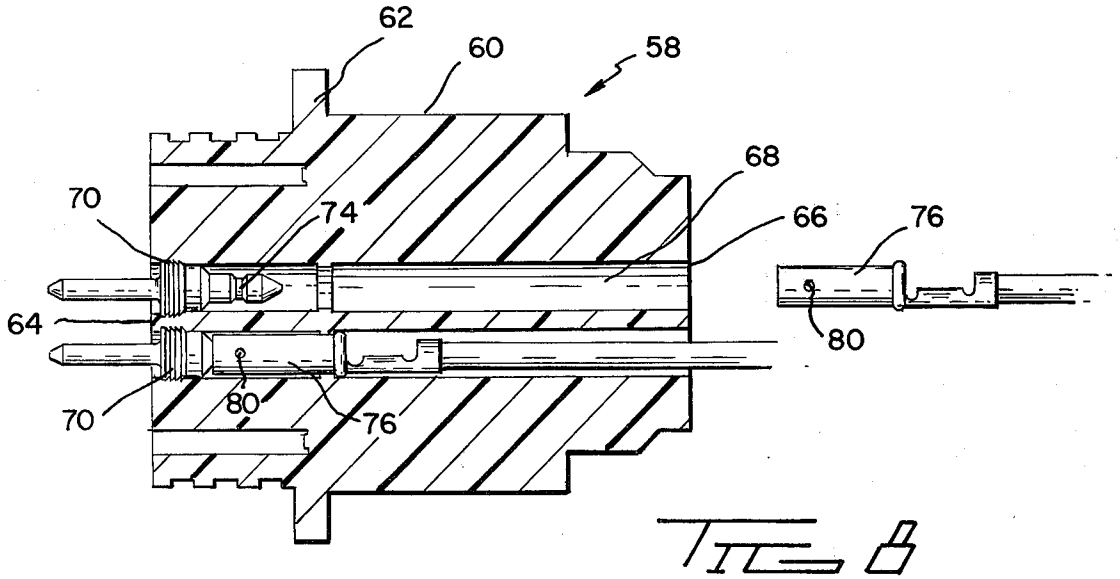

62
60
58
68
70
74
66
76
64
80
70
80
76

FIG 8

SEALED ELECTRICAL CONNECTING MEANS

This is a continuation of application Ser. No. 333,241 filed Feb. 16, 1973, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to sealed electrical connecting devices of the type comprising a housing through which one or more electrical contact terminals extend. Connectors of this type are adapted to be disengageably coupled to complementary connectors to form disengageable connections between conductors to which the terminals are attached. The disclosed embodiments of the invention are directed to the achievement of a hermetically sealed connector and will be described with reference to the requirements of hermetic connectors however, the principles of the invention are applicable to connecting devices having a degree of sealing which is less than hermetic.

Most, if not all, of the presently available hermetic connectors comprise a metallic shell and an insulating insert in the shell in which the contact terminals are mounted. In order to achieve a high quality seal, which will qualify as a hermetic seal, it is common practice to use glass or other ceramic in the insert and to bond the glass to the contact terminals and the shell. A number of specific designs are available but all require this ceramic-to-metal or glass-to-metal seal between the insert and the terminals.

Hermetically sealed connectors as described above present substantial manufacturing difficulties requiring, as they do, a careful selection of the materials from which they are manufactured, painstaking preparation of the surfaces of the metal parts for the bonding processes, and firing at an extremely high temperature to bring about the bonding of the parts. It follows that these hermetic connectors are very expensive and are subject to damage for the reason that they require glass seals. It should also be mentioned that the contact terminals are ordinarily of a ferrous alloy rather than a copper or copper alloy for the reason that the terminals must have a coefficient of thermal expansion which is very nearly the same as that of the glass or ceramic. A ferrous alloy terminal is, of course, much less desirable from an electrical standpoint than a copper or copper alloy terminal and the electrical performance of hermetic connectors is thus less than would be tolerated in ordinary electrical connectors.

I have found that a sealed connector can be achieved with an all plastic connector housing, the plastic being of a hard material which will elastically deform when stressed. The contact terminals are driven or pushed into cavities in the plastic and have surface portions which deform the cavity walls. After the terminals have been pushed to their fully inserted positions, the cavity walls, which were elastically deformed during the driving process, are resiliently urged against the surfaces of the terminals with a stress which produces an extremely high quality seal. The seal can be hermetic if the parts are properly selected as to their materials and are dimensioned in accordance with the principles of preferred embodiments of the invention as described below.

It is accordingly an object of the invention to provide an improved sealed electridal connecting device. A further object is to provide a low cost electrical connector which is hermetically sealed. A still further object is to provide a hermetically sealed connector having copper or copper alloy contact terminals therein. A further object is to provide an improved seal between a block of plastic insulating material and a contact terminal extending through the block of insulating material.

These and other objects of the invention are achieved in a preferred embodiment of the invention which are briefly described in the foregoing abstract, which are described in detail below, and which are shown in the accompanying drawings in which:

FIG. **1** is a perspective view of one form of multicontact electrical connector in accordance with the invention.

FIG. **2** is a fragmentary exploded view showing portions of the two housing sections of the connector of FIG. **1** separated from each other and showing an electrical contact terminal in alignment with the cavities in the sections.

FIG. **3** is a view showing the positions of the housing sections and a contact terminal extending through the cavities in the housing sections, this view illustrating the positions of the parts immediately before the sections are assembled to each other and to the terminal.

FIG. **4** is a view similar to FIG. **3** but showing the fully assembled connector.

FIG. **5** is a fragmentary view on an enlarged scale of the circled area of FIG. **4.**

FIG. **6** is an overall view of the connector parts and the tooling for assembling the parts to each other.

FIG. **7** is a sectional view illustrating the manner in which the connector of view **1** is mounted in a wall or bulkhead.

FIG. **8** is a cross-sectional view of an alternative form of connector in accordance with the invention.

Referring first to FIGS. **1–3**, one form of electrical connecting device **2** in accordance with the invention comprises an insulating housing **4** having a plurality of electrical contact terminals **6** mounted therein and extending beyond the faces **14, 14'** thereof. The housing, as will be explained in more detail below, is of a plastic material which is relatively hard but which is capable of undergoing elastic deformation when subjected to a stress. The housing **4** is formed from two identical or substantially identical, sections **8, 8'**. In the description which follows, only the housing section **8** is described in detail and the same reference numerals, differentiated by prime marks are used to identify corresponding structural features of the two sections.

The housing section **8** has a generally cylindrical body portion **10** having a mating side or face **14** and a rearward face **12.** A cylindrical hood **16** extends axially beyond the mating face **14** and surrounds and protects the contact terminals mounted in the housing. This hood has helical threads **18** on its external surface of the type described in application Ser. No. 226,689 so that it can be coupled to a complementary connector having a locking unit thereon. A flange **20** extends from the body portion **10** at the rearward side **12** and has openings **19** in its corners to facilitate mounting of the connector in a bulkhead opening.

A plurality of contact receiving cavities extend through the body portion **10** from the side **12** thereof to the mating face **14.** Each cavity has a portion **22** of uniform diameter *d* which extends inwardly from the mating face **14** to an intermediate location in the body **10.** This portion **22** of the cavity merges, by means of a conical cavity portion **24,** with an intermediate enlarged diameter cavity portion **26** which in turn merges

with a second conical cavity portion **28.** The conical cavity portion **28** extends to a further enlarged cavity portion **30** which extends to the rearward face **12.**

The contact terminals **6** of this embodiment are in the form of double ended contact pins each of which has contact portions **32, 32'** on its ends, the diameter of these contact portions being no greater than, and preferably slightly less than the diameter *d* of the cavity portions **22, 22'**. The inner ends of the contact portions **32** merge with gripping or sealing portions which have plurality of frusto-conical teeth **34.** These teeth have inclined sides **36** which are directed towards the contact portions **32** of the terminal and rearwardly or centrally facing sides **38** which advantageously extend normally of the axis of the terminal. The sides **36, 38** and **36', 38'** intersect to define edges **40** which extend endlessly around the circumference of the terminal. The central portion **42** of the contact terminal is of an enlarged diameter but fits easily within the intermediate cavity portion **26** as shown in FIG. **3.** As mentioned previously, the contact terminals can be of a hard copper or copper alloy such as cartridge brass and are advantageously manufactured from bar stock by a screw machine operation in order to produce the sharp edges **40** on the teeth.

The connector **2** is assembled with the aid of assembly tools **44, 44'** which are simple metal dies dimensioned to fit within the hoods **16, 16'** and which have openings **46** extending therethrough that receive the ends **32, 32'** of the contact terminals. To assemble the connector, a pin **6** is located between each pair of aligned cavities with the ends **32, 32'** extending through the uniform diameter portions **22, 22'** of the housing sections. The assembly tools **44, 44'** are then positioned against the mating faces **14, 14'** and the assembly of the connector parts and the tools are placed between a pair of plates **48, 48'** as shown in FIG. **6.** The plates are then forced towards each other by means of a suitable press such as a simple arbor press until the sides **12, 12'** of the housing sections are against each other as shown in FIG. **4.** During such relative movement of the housing sections towards each other, the teeth **34, 34'** will be driven into the uniform diameter **22, 22'** of the housings, the contact portions **32, 32'** functioning as guides so that the movement of the terminals into the cavities will be true and straight.

The teeth **34, 34'** deform portions of the cavity walls immediately adjacent to the cylindrical cavity portions **24, 24'** and because of the fact that the conical surfaces **36, 36'** slope away from the ends of the terminal, the plastic material of the cavity walls will be displaced outwardly and somewhat forwardly towards the mating faces **14, 14'**. When the sides **12, 12'** are against each other, further movement of the parts is stopped and the mounting portions or teeth **34, 34'** will be located in the uniform diameter portions **22, 22'** of the cavities.

In the assembled connector, the plastic material of the cavity walls elastically flows against the surfaces **36,** 36' and into the corners **37** (FIG. **5**) defined by the intersections of each surface **36** with the next adjacent surface **38** although it does not necessarily fill all of the space in these corners. There will usually remain a slight void defined by a maniscus of the plastic material.

An extremely high quality seal is obtained in the plastic of the invention and it is believed that this high quality seal is a result of the fact that the elastically deformed plastic material bears with an extremely high pressure against the surfaces **36, 36', 38, 38'**, and particularly against the edges **40, 40'** of the teeth. The edges have only a very small area so that the stress concentration of the plastic against these edges is extremely high.

As shown in FIG. **7,** the connector **2** is used on a bulkhead when it is necessary to maintain the one side of this bulkhead at a different pressure from the pressure on the other side. The need for sealed connectors in bulkheads frequently arises in aircraft construction when it is necessary to lead an electrical cable from the interior of a pressurized compartment to an unpressurized zone of the aircraft. The connector is mounted on the bulkhead **50** by forming a hole in the bulkhead, positioning the flange **20** against the bulkhead with the hood **16** extending through the bulkhead and securing the flange to the bulkhead.

When the connector is mounted on a bulkhead as shown in FIG. **7,** the interface **54** between the surfaces **12** and **12'** is not necessarily hermetically sealed and the central chambers **56** in the connector which surround the central portions of the contact pins will not be tightly sealed from the atmosphere which exists on the righthand side of the bulkhead. The seals in the connector which effectively seal the righthand side of the bulkhead from the lefthand side are those seals between the lefthand portions of the pins and the housing section **8'**. If the connector were mounted on the lefthand face or side of the bulkhead **50,** the seals on the righthand portions of the terminals would be effective to prevent the passage of gasses between the two chambers or compartments.

As previously implied, the plastic material for the housing is an important consideration in the achievement of best results in the practice of the invention. Connectors of the type shown in FIG. **2** must be of a material which is hard and firm, at least in a tactile sense; even the hood **16** must be hard and unyielding in normal handling because of the need to provide screw threads on its external surface and a threaded coupling cannot be provided between soft or rubbery pacts. At the same time, the plastic material of the housing **4** must be capable of undergoing elastic deformation without fracture when the contact terminals **6,** 6' are driven into the cavities so that the plastic will resiliently bear against the teeth **34, 34'** as discussed above. Accordingly, a suitable material for the housing can be described as being rigid but substantially elastically deformable.

Excellent results can be obtained in the practice of the invention with a material such as a **6—6** nylon reinforced with **25** percent glass fibers. One molding powder which has been used with a high degree of success is Ultramid A3XG5 which is supplied by Badische Anilin & Soda Fabrik AG and is available in the United States P. O. Box **289** Paramus, N.J. This material has the following properties:

Tensile Strength	23,000 psi
Elongation at Break	4%
Tensile Modulus	1.3×10^6 psi
Flexural Strength	31,800 psi
Flexural Modulus	1.0×10^6 psi
Izod Impact Strength	1.6ft. lb / in. O.N.
Rockwell Hardness	M108

Other thermoplastics having substantially the same properties can be used.

As also previously implied, the dimensions of the parts must be carefully considered to achieve maximum sealing effect. A connector in accordance with the above-described embodiment has been found to be hermetic when the following dimensions are set forth in the uniform diameter portion **22** of the cavity and the contact portion **32** and mounting teeth **34** of the terminals.

Contact Terminal:	
Contact end 32	0.040 inches
Teeth - diameter at edges 40	0.048 inches
Teeth - diameter at roots	0.040 inches
Teeth - length of each tooth	0.008 inches
Cavity:	
Diameter of portion 22	0.0425 inches
Diameter of portion 26	0.092 inches
Angle of transition section 24	45°

A connector in accordance with the invention and in accordance with the dimensions and material discussed above was found to be hermetically sealed within the requirements of an accepted specification Mil C **26500,** section **3.6:18.1** in accordance with this specification. A connector can be classified as hermetically sealed if "When subjected to a pressure differential of **15** psi they shall not exhibit a leakage rate of greater than **0.01** micron of mercury per cubic foot per hour (1×10^7 standard cc per second at one atmosphere)". Connectors in accordance with the invention have been found to exceed this requirement by as much as two orders of magnitude.

As pointed out previously, copper or copper alloy contact terminals can be used in the practice of the invention for the contact terminals rather than the ferrous alloy terminals required, for thermal expansion characteristics, in previously known hermetic connectors having glass to metal seals. The practice of the invention thus permits the achievement of superior electrical permission along with the achievement of low-cost sealing.

FIG. **8** shows an alternative form of connector **58** having a one piece housing **60** from which a mounting flange **62** extends. This housing has a mating face **64,** a rearward face **66,** and a plurality of cavities **68** which extend between the faces. Contact terminal pins **70** are mounted in the cavities adjacent to the mating face **64** and have contact portions which extend beyond the mating face as shown. In this embodiment, the contact pins are driven inwardly from the mating face side **64** of the housing and have teeth with conical surfaces which slope towards the rearward face. The seal is then obtained in the same manner as in the previously described embodiment.

The righthand ends of the contact pins of this embodiment are formed with circumferential recesses **74** and are adapted to be coupled to electrical contact sockets **76** which are crimped onto the ends of wires **78.** These sockets are provided with spring detents **80** which are adapted to cooperate with the recesses **74** to disengageably couple the sockets **76** to the ends **72** of the contact terminals in the housing. It will be noted that the length of the connector is such that the sockets **76** will be completely contained in the cavities when the sockets are coupled to the contact pins.

The connector **58** can be used under the same circumstances as the previously described embodiment, that is to provide a connector in a sealed bulkhead. The embodiment of FIG. **8** is adapted to be directly coupled to a complementary connector plug containing socket contacts.

Changes in construction will occur to those skilled in the art and various apparently different modifications and embodiments may be made without departing from the scope of the invention. The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only.

What is claimed is:

1. a sealed multi-contact electrical connector intended for use on a bulkhead, said connector comprising:

a housing comprising first and second housing parts, said parts being identical,

each of said parts comprising a cylindrical body portion having a mating face and a rearward face, a plurality of contact receiving cavities extending through each of said housing parts, each of said cavities having an enlarged portion extending inwardly from said rearward face and having a constricted portion adjoining said enlarged portion,

said first and second parts having said rearward faces against each other with said mating faces facing in opposite directions and with said cavities in axial alignment,

an electrical contact pin in each of said cavities, each of said contact pins having a central enlarged diameter portion, adjacent sealing portions on each side of said enlarged portion, and a contact portion at each end thereof extending from said sealing portions,

said enlarged portion of each pin being in said enlarged cavity portions of said housings, and said sealing portions being driven relatively into said constricted portions of said cavities and being in sealing relationship whereby, said connector is sealed between said mating faces.

2. A connector as set forth in claim **1,** each of said parts having a mounting flange extending laterally from said body portion, said mounting flanges having surfaces which are co-planar with said rearward faces.

3. A connector as set forth in claim **1,** each of said housing parts being of hard thermoplastic material.

4. A connector as set forth in claim **3,** localized portions of said housing parts which are immediately adjacent to said constricted portions of said cavities being elastically deformed and internally stressed whereby said localized portions are resiliently held against said sealing portions of said contact terminals, the remaining portions of said housing parts which are remote from said cavities being unstressed and undeformed.

5. A connector as set forth in claim **4,** said sealing portions of said contact terminals having at least one radially projecting tooth extending endlessly thereabout, said tooth having an edge, said tooth having a diameter at said edge which is greater than the diameter of said constricted portions of said cavities.

6. A sealed multi-contact electrical connector intended for use on a bulkhead, said connector comprising:

a housing comprising first and second housing parts, each of said parts comprising a body portion having a mating face and a rearward face, a plurality of contact receiving cavities extending through each of said housing parts, each of said cavities having

an enlarged portion extending inwardly from said rearward face and having a constricted portion adjoining said enlarged portion,

said first and second parts having said rearward faces against each other with said mating faces facing in opposite directions and with said cavities in axial alignment,

an electrical contact terminal member in each of said cavities, each of said contact terminal members having a central enlarged diameter portion, adjacent sealing portions on each side of said enlarged portion, and a contact portion of reduced diameter at each end thereof extending from said sealing portions,

said enlarged portions of each terminal member being in said enlarged cavity portions of said housings, and said sealing portions being driven relatively into said constricted portions of said cavities and being in sealing relationship whereby, said connector is sealed between said mating faces.

* * * * *