# United States Patent

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[54] **ELECTRICAL CONNECTOR**
**8 Claims, 5 Drawing Figs.**


[52] **U.S. Cl.** ..... **339/45,**
339/17, 339/176, 339/195
[51] **Int. Cl.** ..... **H01r 13/50,**
H01r 33/04, H05k 7/00
[50] **Field of Search** ..... 339/17, 45,
63, 94, 176, 184, 191, 192, 195, 196



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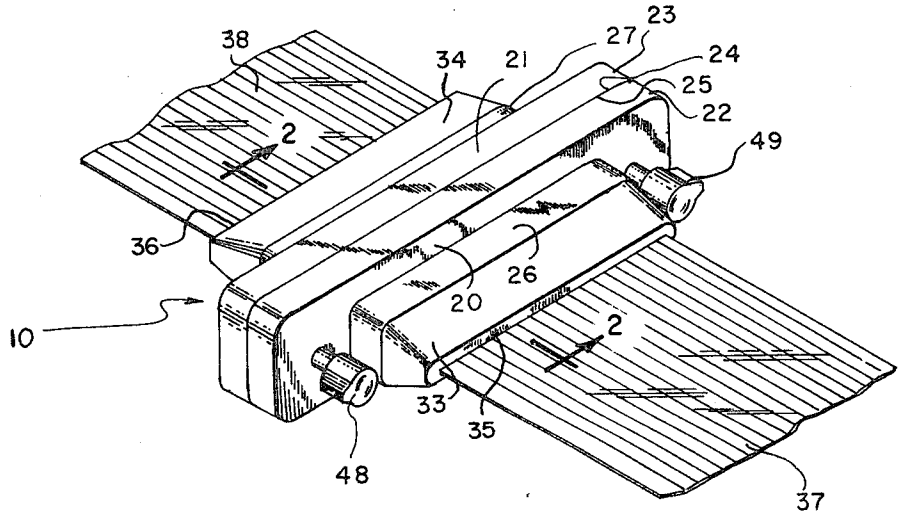
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**ABSTRACT:** A rectangular-shaped connector for flat conductor cables includes a pair of elongated rectangular insulating blocks having pin and socket contacts disposed in opposing spaced apertures. The blocks are encased by mating, flat-faced housings through which the cable conductors extend, the exposed ends of insulated conductors being joined to the contacts. Housing ends are enclosed by potting boots sealed to the conductor insulation. Hermetic sealing and avoidance of arcing are realized by filling void spaced with a potting material, in particular, "CNR" resin for service under extreme conditions, and by providing a seal of such material between the housings.

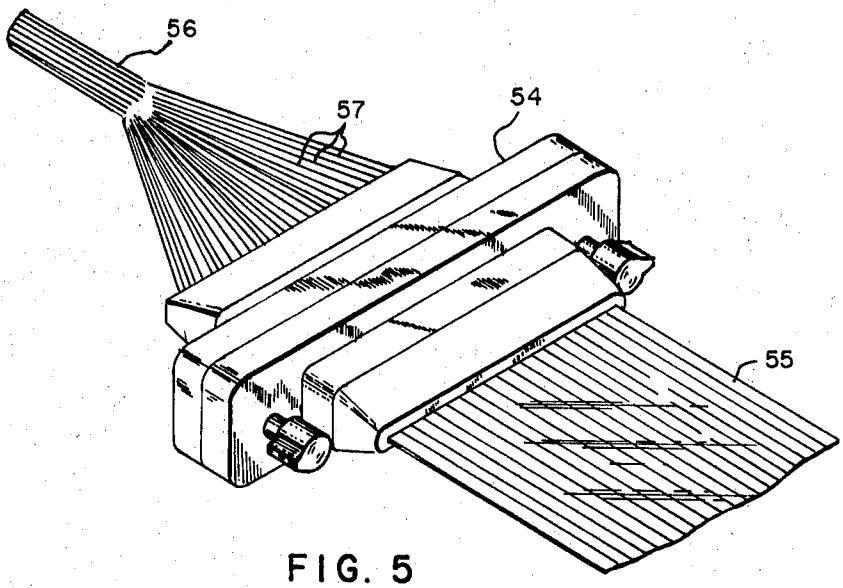



FIG. 5

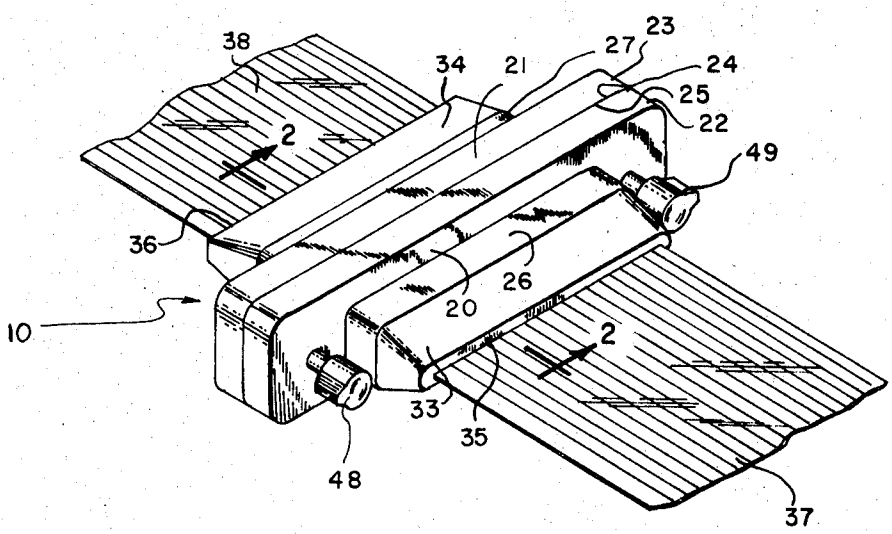



FIG. 1

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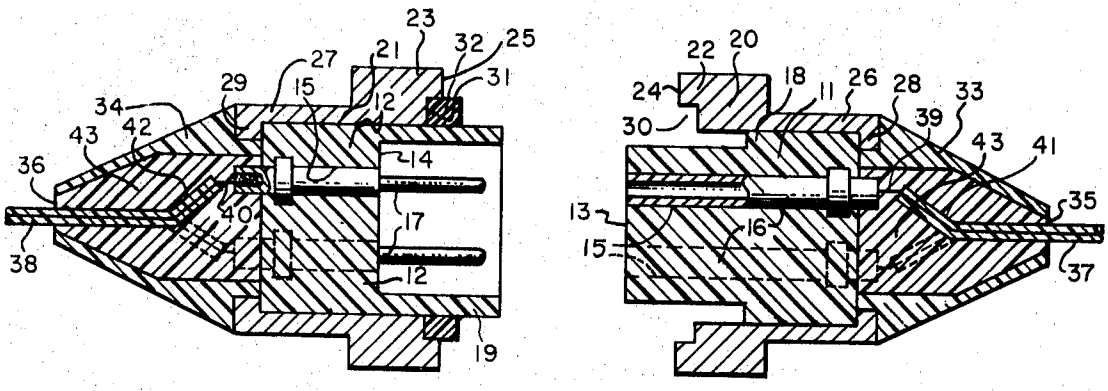



FIG. 2

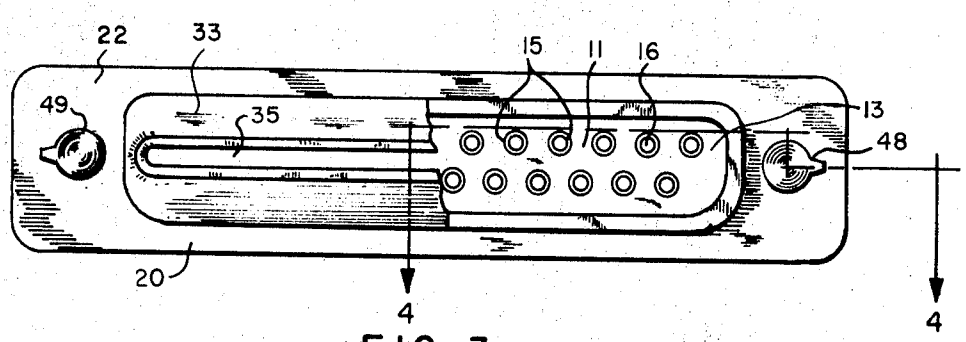



FIG. 3

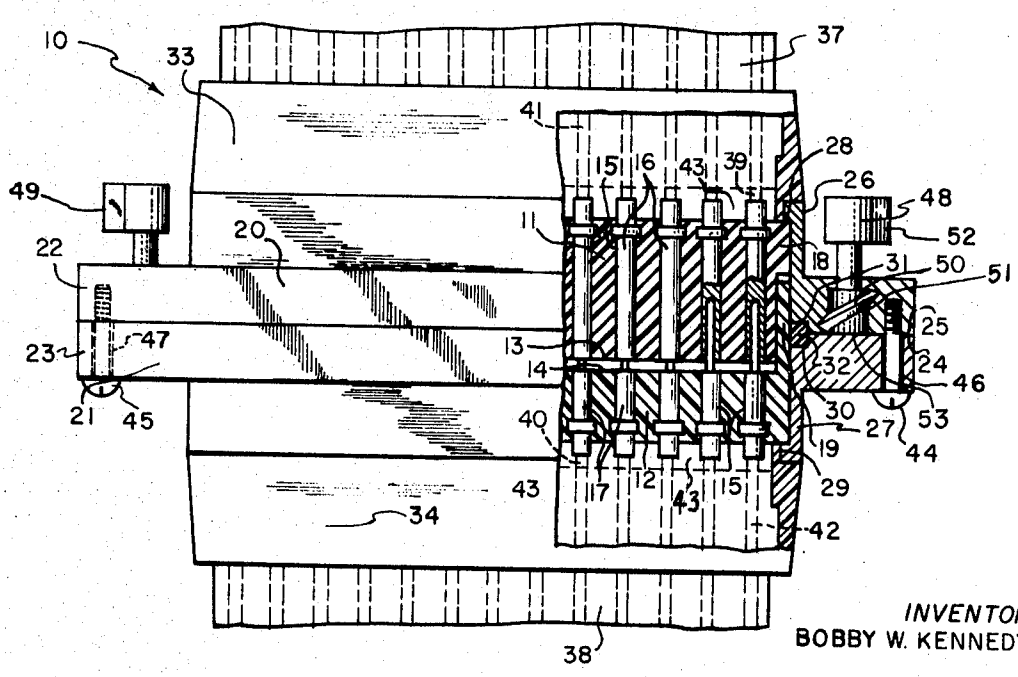



FIG. 4

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# ELECTRICAL CONNECTOR

## ORIGIN OF THE INVENTION

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

## BACKGROUND OF THE INVENTION

This invention relates to electrical cable connectors and more particularly to connectors for flat conductor cables.

Flat conductor cables, which employ multiple ribbon-type electrical conductors disposed edge-to-edge in a strip of insulating material, offer advantages over conventional round wire cables for many applications. Flat cables provide lighter weight, smaller space requirements, better heat dissipation and greater flexibility than round cables having the same electrical capabilities.

One of the problems presented in the design of flat conductor cable systems is the provision of suitable connectors. In order to take advantage of the space-saving capability of flat cables the connector should have a rectangular configuration of minimum thickness. Simple and reliable contact action is required in such connectors, along with ease of engagement and disengagement. Additional requirements are imposed for certain applications relating to space vehicles and equipment, including maintenance of constant electrical contact under severe vibration conditions, hermetic sealing and potting of the connector interior for service under extreme temperatures and a vacuum or pure oxygen atmosphere, and nonflammability in gaseous oxygen.

Various types of connectors have been used previously for flat conductor cable systems, but these connectors have failed to meet one or more of the requirements given above. One type of connector utilizes rectangular molded plugs, with the conductors themselves being folded over to form male contact members. While useful for some applications, such connectors do not maintain reliable electrical contact under vibration conditions. Another approach has been to use round connectors with pin-and-socket-type contacts, such connectors having been developed previously for round wire cables. The latter connectors have been proven to withstand vibration, but the round configuration requires additional space and negates this important advantage of flat cables. In addition the previous connectors have not fully met the potting, sealing and nonflammability requirements for service at extreme temperatures and under vacuum or oxygen atmosphere.

In some instances a transition connection from round wire cable to flat conductor cable is required. The capability to handle either round or flat conductors in the same connector would allow more flexibility in the design of flat cable systems. Other desirable characteristics include ease and economy of fabrication and simplicity of design and operation.

## SUMMARY OF THE INVENTION

In the present invention a rectangular-shaped connector utilizes pin-and-socket-type electrical contacts. The connector includes a pair of elongated opposing rectangular insulating blocks having pin and socket contacts disposed in opposing apertures extending through the blocks. The blocks are encased by mating, flat-faced housings through which insulated flat or round connectors extend, with exposed end portions of the conductors being joined to the rear ends of the contacts. Housing ends are enclosed by potting boots sealed to the conductor insulation. Void spaces are filled with and hermetic sealing is obtained by means of a sealant or potting compound, preferably "CNR" resin. This connector is of simple design and is easily fabricated, and the pin-and-socket engagement therein provide reliable electrical contact, even under severe vibration. By virtue of its using Teflon for the insulating blocks and potting boots and "CNR" resin for potting and hermetic sealing, the connector can withstand extreme temperatures and vacuum or pure oxygen atmosphere, and it is nonflammable in gaseous oxygen. Connectors embodying the invention can therefore be used for rigorous applications in the space program as well as for less demanding applications.

It is therefore an object of this invention to provide a rectangular cable connector capable of maintaining reliable electrical contact under vibration conditions.

Another object is to provide an hermetic-sealable flat cable connector suitable for service under extreme temperature and a vacuum or oxygen environment.

Yet another object is to provide an hermetic-sealable flat cable connector that is nonflammable in gaseous oxygen.

Still another object is to provide a rectangular-shaped cable connector useful for either flat or round conductors, or for a transition from flat to round conductors.

Other objects and advantages of the invention will be apparent from the following detailed description and the appended claims.



## BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is an isometric view showing a flat cable connector embodying the invention;

FIG. 2 is an enlarged transverse section taken along line 2–2 of FIG. 1, with the connector halves disengaged and spaced apart;

FIG. 3 is a side elevational view, partially cut away, of one of the connector halves shown in FIGS. 1 and 2, with conductors and potting compound removed;

FIG. 4 is a plan view of the connector shown in FIGS. 1 through 3, particularly in section substantially as indicated by line 4–4 of FIG. 3; and

FIG. 5 is an isometric view showing a flat-to-round transition connector embodying the invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. 1 through 4 in the drawings a flat cable connector is indicated generally by numeral 10. The connector includes generally rectangular insulating blocks 11 and 12 adapted to be assembled with side 13 of block 11 and side 14 of block 12 in face-to-face relation. Each of the blocks is penetrated by a plurality of circular apertures 15, which are spaced apart parallel to one another and perpendicular to the mating sides 13 and 14, the apertures in block 11 being in axial alignment with the apertures in block 12. Female contact sockets 16 are fixedly disposed in the apertures in block 11 with the open ends of the sockets flush with side 13. Male contact pins 17 fixedly disposed in block 12 extend outward for engagement with sockets 16. Block 11 has a shoulder 18 extending around the periphery thereof and spaced apart from side 13. A projecting skirt 19 extends forward of side 14 of block 12 around the periphery thereof coextensive with the recessed portion of block 11 defined by shoulder 18.

Blocks 11 and 12 are disposed within housings 20 and 21, respectively, which form an outer shell for hermetic sealing and which serve to hold the blocks in position when engaged. The housings 20, 21 include flat base portions 22, 23 having faces 24, 25 adapted to be brought into face-to-face contact when the connector is in the engaged position and flange portions 26, 27 perpendicular to the base portions 22, 23 and defining elongated, generally rectangular openings for reception of blocks 11 and 12. The outer ends of flange portions 26, 27 have projecting shoulders 28, 29 extending inwardly to hold blocks 11 and 12 in position. The housing faces 24, 25 have narrow recesses 30, 31 therein around the peripheries of the cavities in which blocks 11 and 12 are disposed, the recessed 30, 31 being filled with a sealant or gasket 32 to effect an hermetic seal when the housing faces are secured together.

The outer ends of flanged portions **26, 27** of housings **20, 21** are enclosed by wedge-shaped potting boots **33, 34** sealed thereto. The potting boots terminate in narrow slots **35, 36** through which insulated flat conductor cables **37, 38** extend. Exposed end portions **39, 40** of insulated conductors **41, 42** are joined to the ends of socket members **16** and contact pins **17** extending out of the rear faces of housings **11** and **12**, respectively.

Substantially all void spaces within the housings, and in particular the void spaces around the joints between conductors and contact pins and socket members are filled with a sealant or potting compound **43**. The junctures between potting boots and housing ends, between potting boots and insulated cable and between the mating housing faces likewise have a sealant or potting compound disposed between joining surfaces to provide hermetic sealing.

Housing faces **24** and **25** are removably secured to one another when the connector is in the engaged position by means of male-threaded screws **44, 45** extending through apertures **46, 47** in flat base portion **23** and into female-threaded holes in flat base portion **22**. Screw jacks **48, 49** are mounted within flat base portion **22** to provide means for forcing the connector halves apart and thus effecting disengagement. As shown in FIG. **4** screw jack **48** has male threads **50** which mate with female threads **51** in flat base portion **22** and a grippable handle **52** fastened to the exposed end thereof. Upon rotation of handle **52** the opposite end **53** of the screw jack **48** exerts pressure against the opposing base portion **23**. Other means such as spring clips or the like can also be used for removably holding the connector halves in position.

FIG. **5** shows a connector **54** for effecting a transition connection between a flat conductor cable **55** and a round wire cable **56**. Connector **54** is identical to the connector shown in FIGS. **1** through **4**, except that round wire conductors **57** from round cable **56** are inserted in one of the connector halves and joined to the pin or socket members in that half.

The composition of the sealant or potting compound employed within and between the connector housings as described above is critical to attainment of nonflammability and capability for service under extreme conditions. The preferred material for the sealant or potting compound is a copolymer of trifluoronitrosomethane and tetrafluoroethylene cured with benzoic acid, available commercially under the trade name "CNR Resin." This material exhibits a unique combination of properties favorable for connector use; good adhesion and sealing capability, stability at temperatures from −60° F. to 350° F., a low dielectric constant of 2.0 at 60 cycles, low outgassing in vacuum and nonflammability in pure gaseous oxygen at a pressure of 16.5 p.s.i. at temperatures up to 500° F. CNR resin can be applied as a viscous liquid and cured by heating to a temperature of 350° F. for 24 hours. For service under ordinary atmospheric conditions and under less rigid flammability requirements silicone polymers can be used as the sealant or potting compound.

The insulating blocks and potting boots for service under extreme conditions are preferably made of a fluorocarbon polymer such as Teflon, which exhibits the desired electrical and structural properties, along with a high degree of nonflammability. By employing Teflon for the insulating blocks and potting boots and "CNR Resin" for the sealant or potting compound, a useful temperature range from −190° F. to 500° F. can be obtained in connectors embodying the invention. Other polymeric materials such as nylon, diallylphthalate or glass-or mineral-filled epoxy resin can be used; however such materials do not need nonflammability requirements for space vehicle applications.

The contact pins and socket members are selected to obtain effective electrical contact and reliability of such contact under extreme vibration. Gold-plated steel pin and socket members in which contacting actions is obtained by friction fit of the socket against the inserted pin are preferred. Fabrication of the connector is facilitated by using pins and socket members having hollowed out end portions into which the conductors can be inserted for joining. For flat cable connectors it is preferred to use pin and socket members having end openings of a diameter slightly larger than the width of the conductors. Although joining of conductors to pins and socket member can be effected by mechanical means such as crimping, joining by means of soldering or welding is preferred for maximum reliability.

The pins and socket members are spaced apart a sufficient distance to insure effective insulation between one another, and to allow joining of conductors to pins. The most convenient spacing is in the form of two parallel rows along the length of the insulating blocks.

The outer housings are preferably made of metal so as to provide maximum rigidity under vibration. Aluminum alloys or other metals can be used for this purpose.

Fabrication of the connector described above is relatively simple, and conventional machining can be used for forming the various parts. However, to provide effective hermetic sealing of connectors having the preferred Teflon insulating blocks and potting boots, a surface-roughening treatment of the Teflon prior to application of the sealant or potting compound is essential. In the absence of a surface-roughening treatment incomplete bonding would result. A preferred surface treatment for Teflon parts includes contacting the parts with a sodium aryl solution containing butyl alcohol, available commercially under the trade name "Gore Tetraetch" for a period of 2 to 3 minutes.

In addition to the embodiment described in detail above, the invention includes other connector arrangements. For example, either half of the connector can be attached to a bulkhead or other structure by extending the base plate of the housing and securing the housing to the structure by mechanical means. The conductors in either half of the connector can be flat conductors or small diameter wires and in addition, one-half of the connector can form a part of a circuit board assembly so that the second half will be plugged directly into the circuit board.

It is to be understood that the connectors described in detail above are given only as exemplary and that various changes and modifications thereof can be employed without departing from the scope of the invention.

I claim:

1. An electrical cable connector comprising:

a pair of elongated, generally rectangular insulating blocks adapted to be assembled in face-to-face relation along the length thereof;

each of said blocks having a plurality of spaced, mutually parallel apertures extending therethrough perpendicular to its mating face and in axial alignment with apertures in the opposing block;

the first of said blocks having conductive female socket members fixedly disposed in said apertures, the open ends of said sockets being flush with the mating face of said first block and the opposite ends thereof being joined to exposed ends of individual insulated conductors of a first electrical cable;

the second of said blocks having conductive male contact pin members fixedly disposed in said apertures with the pin portions thereof extending outward from the mating face of said second block and adapted for removable insertion in said socket members and the opposite ends thereof joined to exposed ends of individual conductors of a second electrical cable;

each of said blocks being secured in a housing member having a flat face portion parallel to the mating face of one block and adapted to be secured in face-to-face relation with the housing member of the opposing block when said pins are inserted in said sockets and each housing member having an open-ended integral flange portion enclosing the periphery of its corresponding block;

potting boots enclosing the open end of each of said flanged portions and sealed to the insulated conductors extending therethrough;

a hermetic sealant filling substantially all of the void within each of said housing members;

a hermetic seal disposed between said flat face portions of said housing members; and

means for removably securing said flat face portions of said housing members together.

2. The invention as defined in claim 1 wherein said insulating blocks and said potting boots are made of Teflon.

3. The invention as defined in claim 2 wherein said sealant and said seal consist of a copolymer of trifluoronitrosomethane and tetrafluoroethylene cured with benzonic acid.

4. The invention as defined in claim 1 wherein at least one of said cables is a flat cable having a plurality of ribbon-type metallic conductors embedded edge-to-edge in spaced, parallel relation in a flat interior.

5. The invention as defined in claim 1 wherein said first block has a shoulder extending around the outer periphery thereof and spaced apart from its mating face and said second



block has a peripheral skirt extending forward of its mating face coextensive with a recessed portion of the peripheral surface of said first block defined by said shoulder.

6. The invention as defined in claim 1 wherein one of said cables is a round wire cable having a plurality of round-wire conductors.

7. The invention as defined in claim 1 including a pair of disengaging screw jacks threadably mounted one in each end of one of said housings perpendicular to the mating face thereof and adapted to exert pressure on the opposing housing face upon rotation of the screw jacks.

8. The invention as defined in claim 1 wherein each of said potting boots is an open-ended, wedge-shaped member, having a base portion and a point and a point portion, said base portion having edges therealong adapted to mate with the edges of said flanged portion, and said point portion having an elongated narrow slot extending parallel to the base portion.