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NASA Case No. MFS-14741

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.

NASA Case No. MFS-14741 Joseph H. Beumer

APPLICATION FOR LETTERS PATENT

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT Bobby W. Kennedy, a citizen of the United States of America, employee of the United States Government and a resident of Arab, Marshall County, Alabama, has invented certain new and useful improvements in ELECTRICAL CONNECTOR of which the following is a specification:

NASA Case No. MFS-14741
Marshall Space Flight Center

TECHNICAL ABSTRACT

"Electrical Connector"

The instant invention is directed to an electrical connector for flat or round conductor cables. The connector is primarily adapted for space applications involving service under severe vibration conditions or a pure oxygen or vacuum atmosphere.

The connector 10 includes a pair of rectangular insulating blocks 11, 12 having female sockets 16 and male contact pins 17 disposed therein in axial alinement perpendicular to mating faces 13 and 14. The blocks are encased by metal housings 20 and 21 having face portions 22 and 23 for engagement with one another and flange portions 26 and 27 extending rearward from the faces. The rear ends of sockets 16 and contact pins 17 are joined to the exposed ends of insulated conductors 41, 42 of flat conductor cables 37 and 38. Potting boots 33 and 34 enclose the space between the rear ends of flange portions 26 and 27 and cables 37 and 38. Void spaces within the potting boots are filled with "CNR" resin potting compound, and a seal 32 of the same material is provided between the mating housing faces. One of the blocks 11 has a shoulder 18 spaced apart from its mating face 13 and defining a peripheral recess and the opposing block 12 has a projecting skirt 19 coextensive with the recess to guide the connector halves into alinement. The potting boots and insulating blocks are preferably made of Teflon. Screw jacks 48 and 49 are disposed in one of the housing faces to provide for disengagement.

The novelty of the invention appears to reside in the use of pin-and-socket contacts in rectangular insulating blocks and in one or more of the materials used for the seal, potting compound, potting boots and insulating blocks. The pin-and-socket contacts provide reliable contact even under severe vibration conditions and the listed combination of potting and structural materials results in non-flammability in pure oxygen and freedom from outgassing in vacuum.

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Initial Evaluator: Wilhelm Angele, MSFC

Patent Application No.: 880,247

Filing Date: November 26, 1969

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 vaccum or pure oxygen atmosphere, and non-flammability 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 non-flammability 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 hermatic 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 non-flammable 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 non-flammable 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:

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

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

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

FIGURE 4 is a plan view of the connector shown in FIGURES 1 through 3, partially in section substantially as indicated by line 4-4 of FIGURE 3; and

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

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGURES 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 alinement 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 recesses 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 FIGURE 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.

FIGURE 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 FIGURES 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 non-flammability 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 non-flammability in pure gaseous oxygen at a pressure of 16.5 pounds per square inch 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 non-flammability. 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 non-flammability 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 examplary and that various changes and modifications thereof can be employed without departing from the scope of the invention.

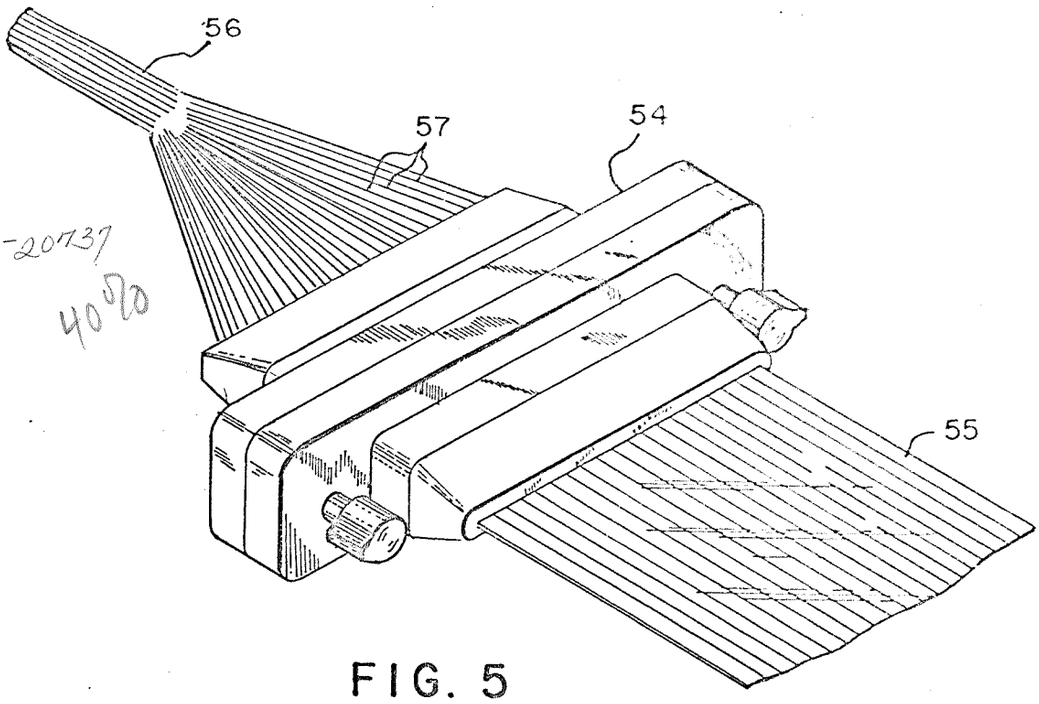

FIG. 5

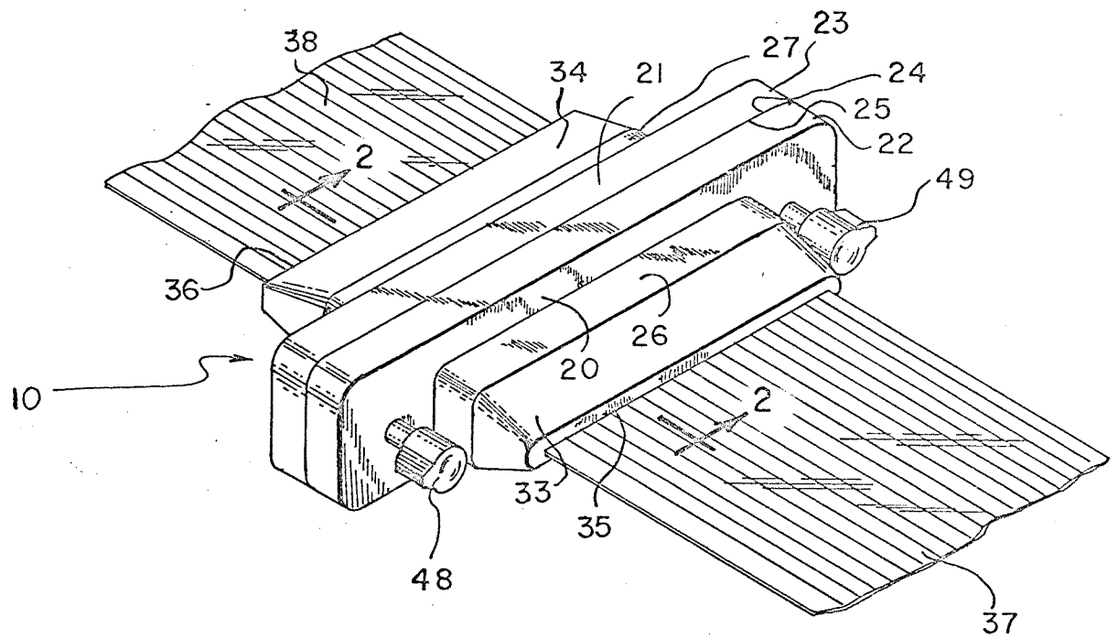

FIG. 1

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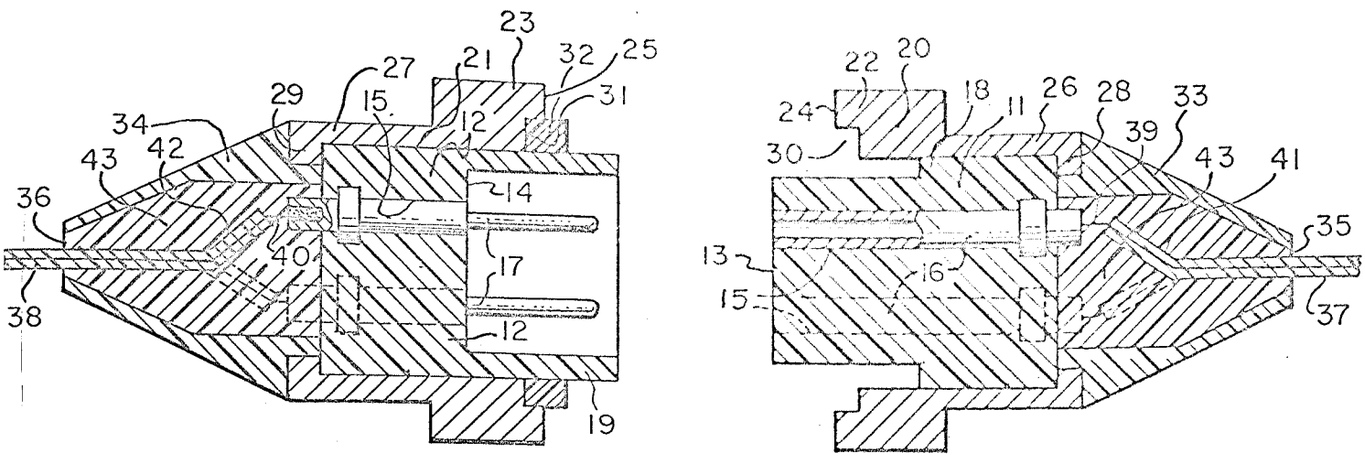

FIG. 2

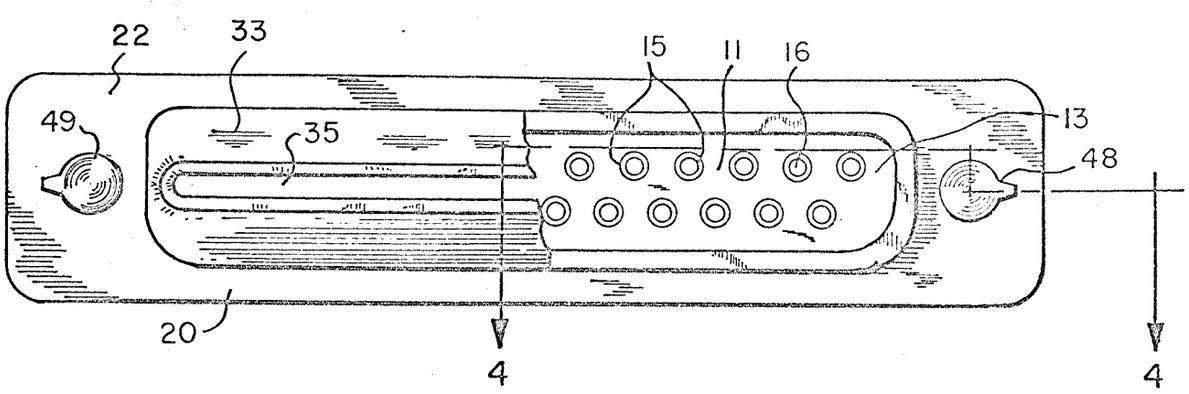

FIG. 3

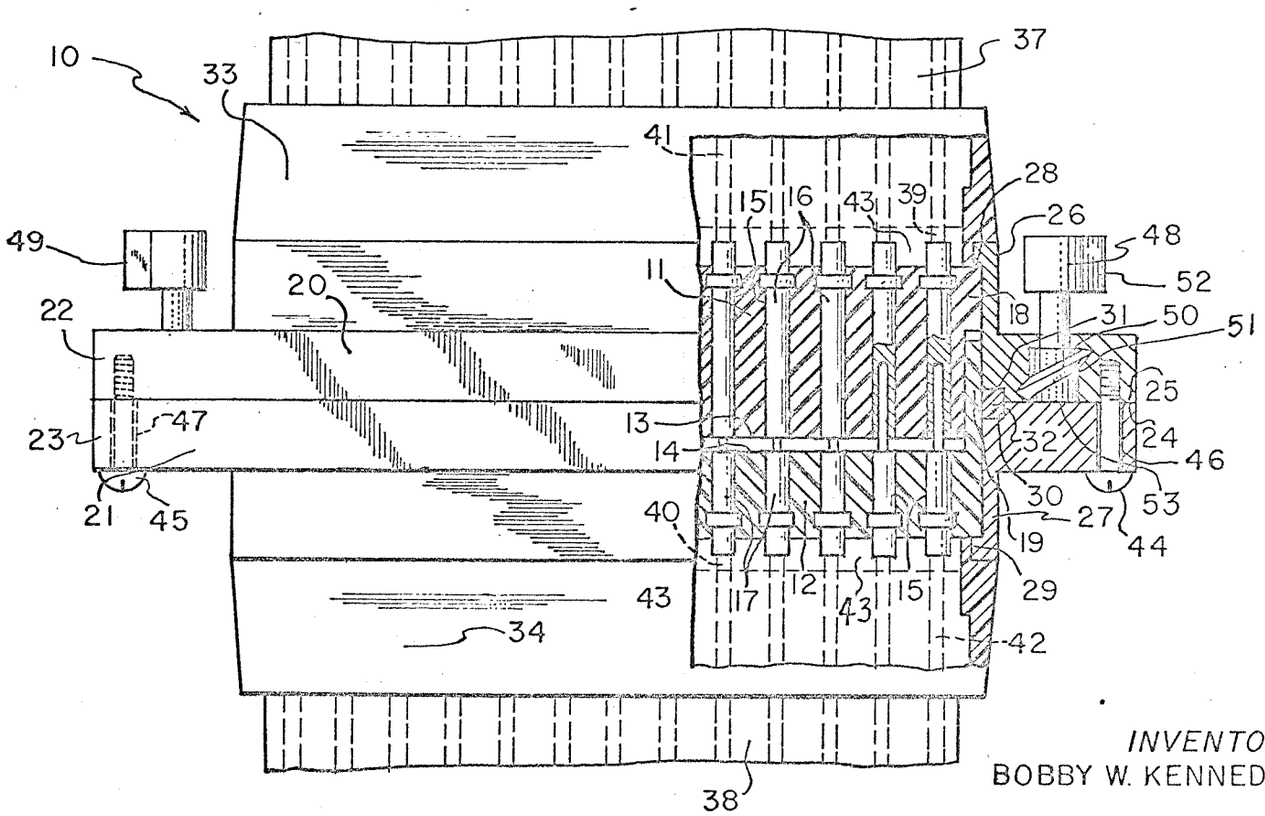

FIG. 4

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