United States Patent [19]

Oertle

[11] **3,879,097**

[45] **Apr. 22, 1975**

[54] **ELECTRICAL CONNECTORS FOR TELEMETERING DRILL STRINGS**

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[52] **U.S. Cl.**..... **339/16 R;** 174/47; 339/60 R; 339/94 R; 340/18 LD

[51] **Int. Cl.**..... **H01r 3/04**

[58] **Field of Search**..... 339/16 R, 16 C, 16 RC, 339/60 R, 60 M, 94 R, 94 M; 340/18 LD; 174/47, 104

[56] **References Cited**

UNITED STATES PATENTS

452,506	5/1891	Klumpp, Jr.	339/16 R X
3,170,137	2/1965	Brandt	340/18 LD

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Assistant Examiner—DeWalden W. Jones
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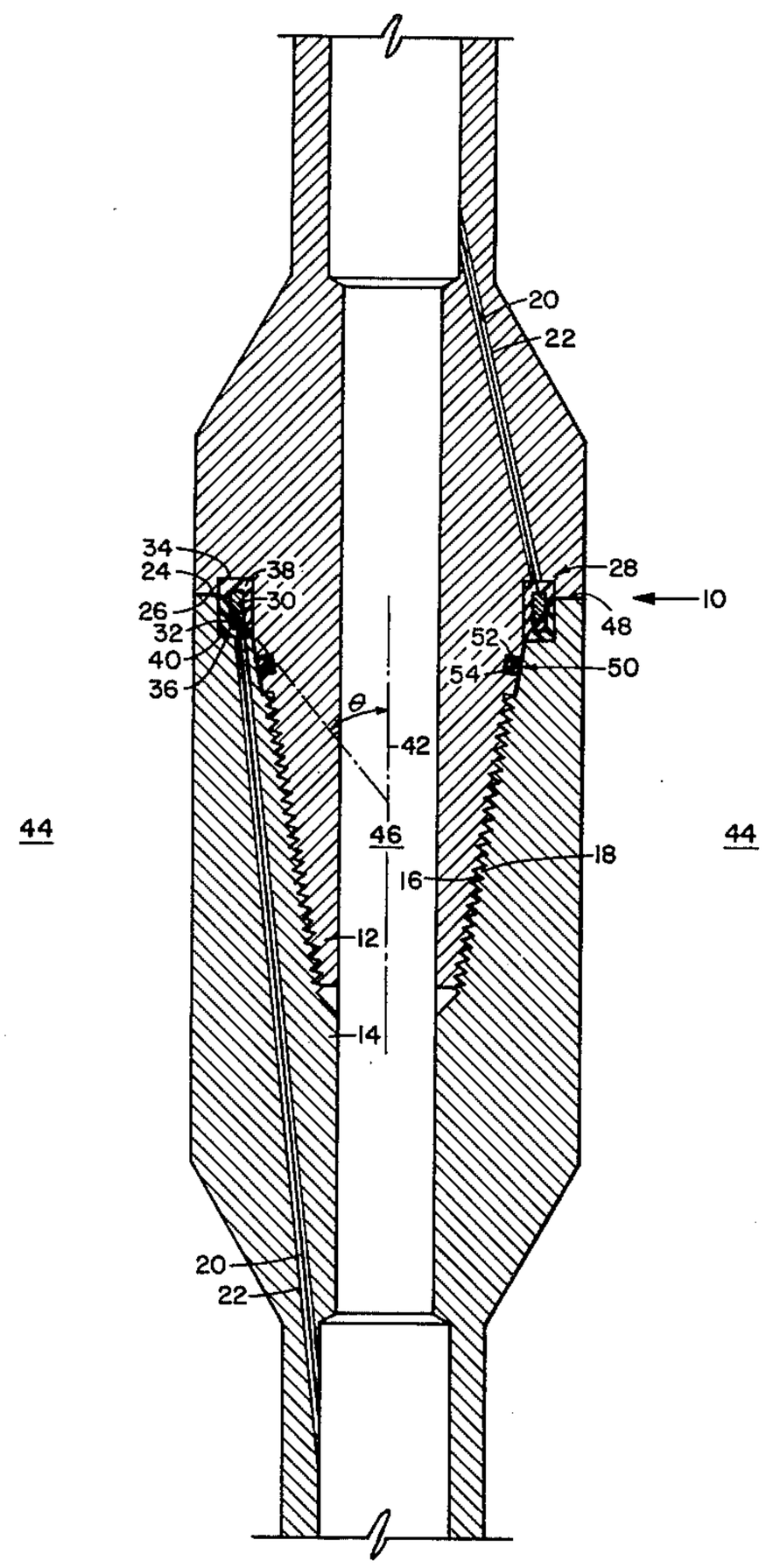
[57] **ABSTRACT**

An improvement in the arrangement of electrical connectors positioned in the joints of drill string pipe sections which are joined together to form a telemetering drill string. The improved electrical connectors are positioned in the pipe joints and connect insulated segments of an electrical connector positioned in the drill string pipe sections.

10 Claims, 6 Drawing Figures



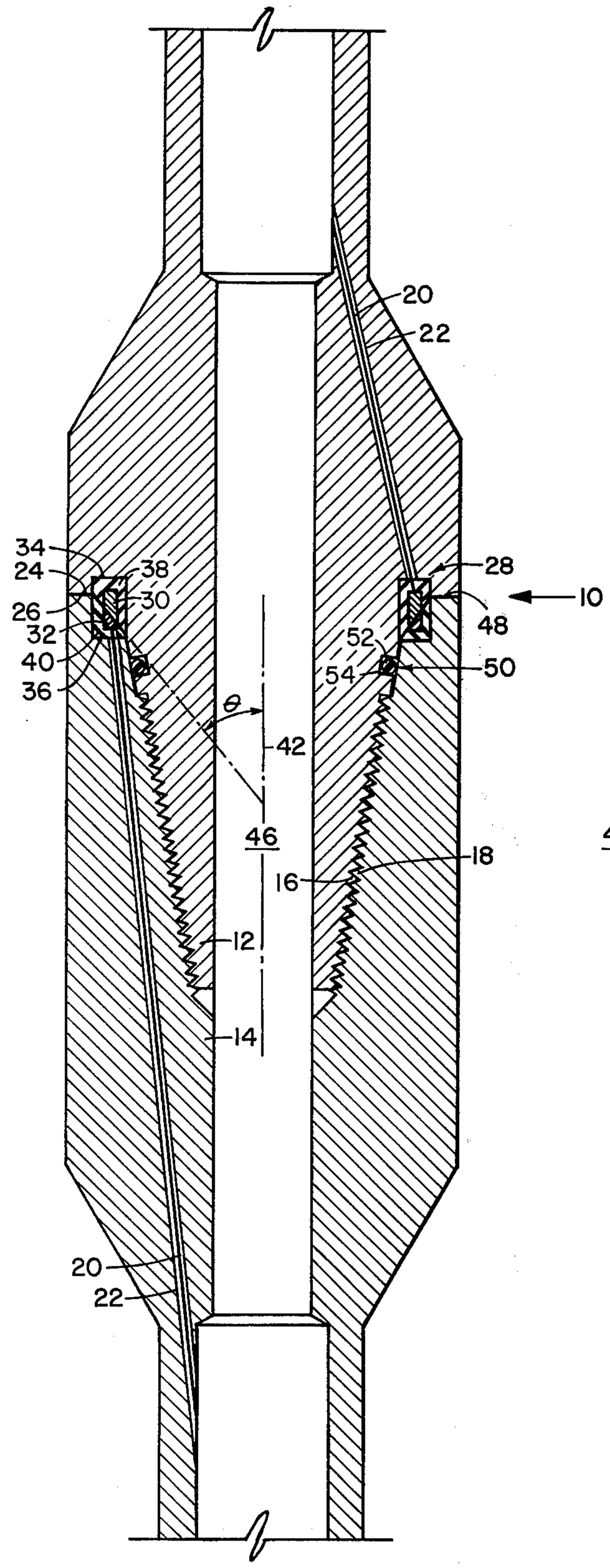

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FIG. 1

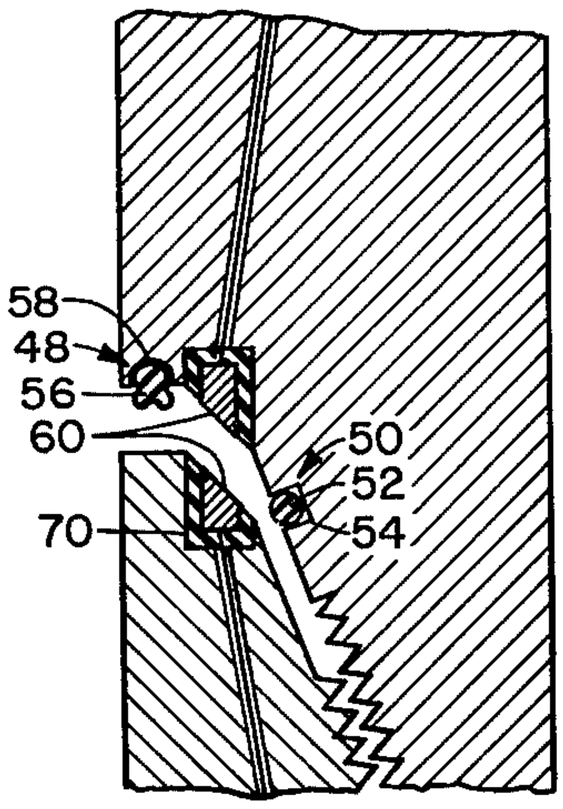

FIG. 2

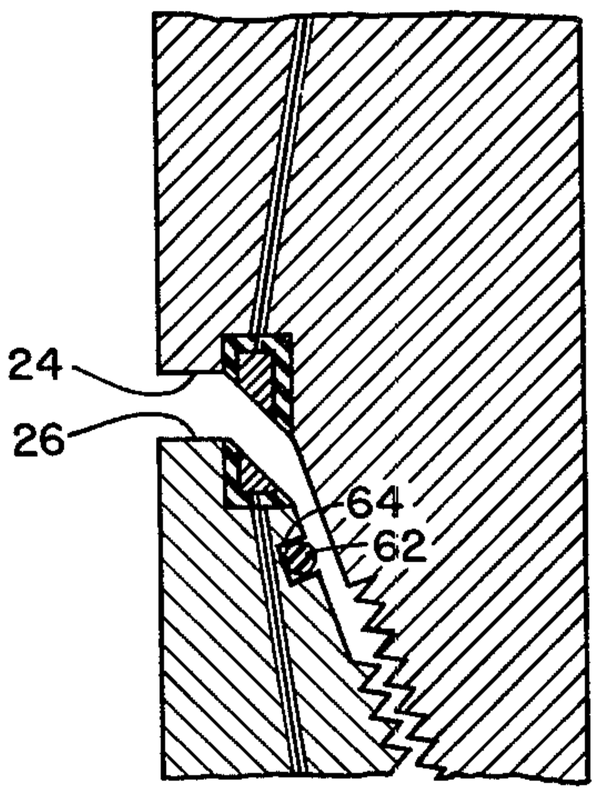

FIG. 3

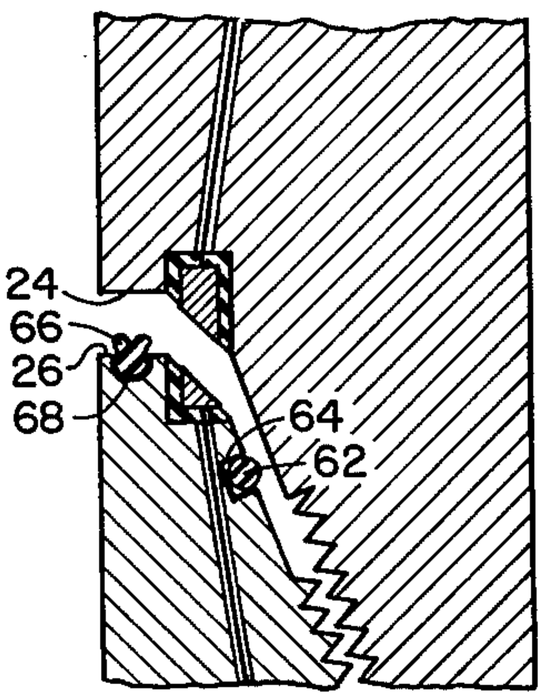

FIG. 4

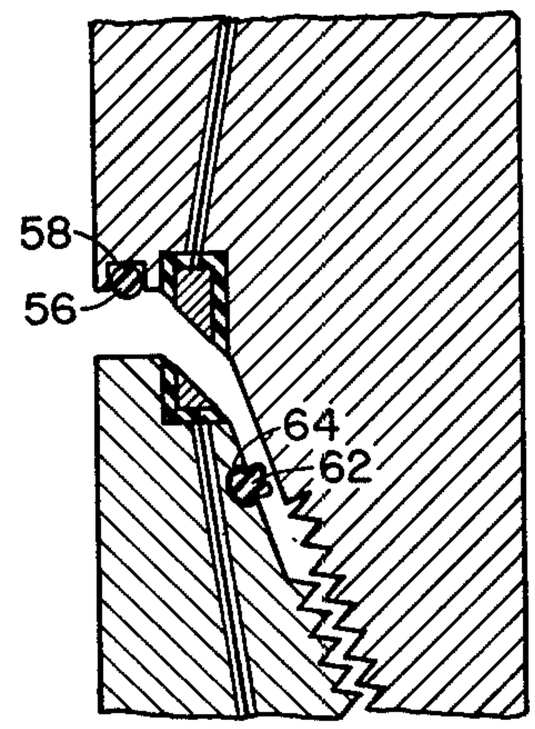

FIG. 5

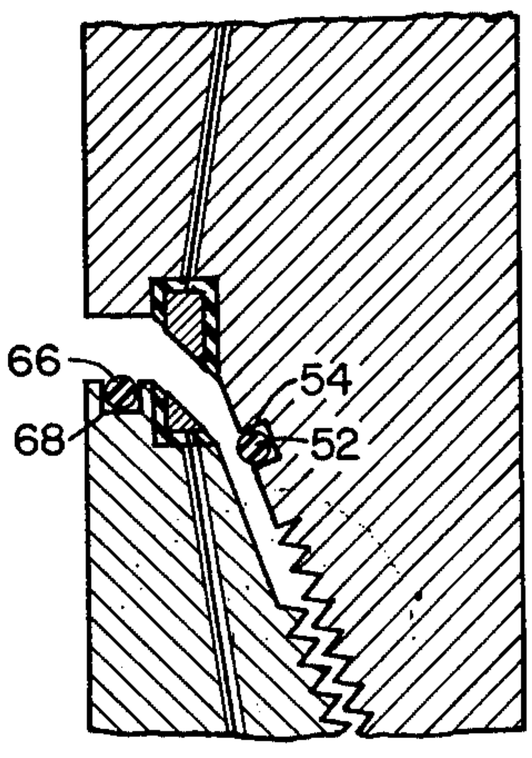

FIG. 6

ELECTRICAL CONNECTORS FOR TELEMETERING DRILL STRINGS

This invention relates to transmitting an electrical signal along a drill string while it is in the borehole of a well. More particularly, the invention relates to an information telemetering drill string which can be assembled and used without special drill string manufacturing and/or drilling techniques or precautions.

The desirability of transmitting an electrical signal along a drill string was recognized over 30 years ago. Numerous systems have been proposed. Typical earlier proposals required specially constructed drill pipe sections such as those described in U.S. Pat. No. 2,178,931 or required internally mounted electrical connector arrangements that cause a significant reduction in the internal diameter of the drill pipe such as those described in U.S. Pat. Nos. 2,301,783 and 3,253,245.

U.S. Pat. No. 2,531,120 describes a system for transmitting electrical power along a drill string to drive an electrical drilling motor. It uses ring and contact-pin electrical connectors which are mounted within mating portions of the pipe joints and avoids the need for specially constructed drill pipe sections or restrictions of the drilling fluid passageway. The ring and contact pin arrangement is disadvantageous with respect to transmitting an electrical information signal. In an information signal connector-introduced noise may mask the information or provide misleading information.

In the procedures usually employed for assembling and disassembling or "round tripping" a drill string, the mating portions of the pipe joints become coated with fluids having varying degrees of electrical conductivity. Any electrical connectors which are mounted in such portions of the drill pipe joints are almost inevitably smeared with various non-conductive fluids such as oils, greases, pipe thread lubricant and the like. An information conveying electrical signal tends to become noisy and relatively severely attenuated when it is conveyed across a plurality of pipe joints containing electrical connectors in which the contacting elements are rings and contact-pins. In such a situation each metal-to-metal contact area is relatively small and the effective contact resistance tends to vary widely due to the presence of differing amounts of nonconductive fluids that tend to remain between the contactpins and rings.

U.S. Pat. No. 3,696,332 describes an arrangement of electrical connectors positioned in drill pipe joints. The electrical connectors are rings positioned in the shoulders of the drill pipe joints. The mating surfaces appear to be flat and rely primarily on the wiping action as the two rings are joined during make-up of the pipe joint to clean the surfaces of the rings and secure a good electrical contact therebetween. Apparently, the means for sealing fluids inside and outside the drill pipe away from the rings consists of a metal-to-metal seal consisting essentially of sealingly mating shoulders on the pipe sections.

One disadvantage of such an arrangement is that it is difficult to obtain sealing mating in the shoulders when more than one surface must be precisely machined. For instance it is difficult to get both the inner and the outer shoulders to mate closely enough to achieve a complete seal in all instances. As is obvious to those skilled in the art it is undesirable that the drill pipe require such precise machining since such machining increases the expense, is vulnerable to damage in the field and the like. Additionally, the contacting faces of the rings tend to become smooth and flat and minute particles wedged therebetween tend to have a large effect on the conductivity across the metal-to-metal junction. It is also difficult to remove all contaminants between the rings by the wiping action when large amounts of viscous contaminants are present during the joint make-up.

It is an objective of the present invention to provide an improved arrangement of electrical connectors positioned in the drill string pipe joints.

The objective of the present invention is achieved in a telemetering drill string in which segments of an insulated electrical conductor are joined by electrical connectors in mating portions of drill string pipe joints that contain mating shoulders by an improvement in the arrangement of the electrical connectors comprising: (a) positioning in each drill string pipe joint, the joints comprising the union of a male and a female threaded member; a first and a second ring-shaped substantially full-circle contact-making ring, the first ring being positioned in the male member in a groove between the shoulder and the threaded portion of the member, the second ring being positioned in the female member in a cavity between the shoulder and the threaded portion of the member, each of the rings being in electrical contact with a segment of the insulated electrical conductor, electrically insulated from the member in which it is positioned and having a contact surface forming an angle from 15° to 65° with the longitudinal axis of the drill string; (b) a first and second sealing means positioned in each drill string pipe joint to sealingly separate the rings from fluids inside and outside the drill string, the first sealing means being positioned between the rings and the outer diameter of the drill string pipe and the second sealing means being positioned between the rings and the threaded portion of the joint; and (c) resilient biasing means operatively associated with at least one of the rings to urge the ring toward a position from which it is displaced by the adjacent contact-making ring as the members are screwed together.

FIG. **1** shows an embodiment of the improved connector of the present invention in a drill string pipe joint.

FIG. **2** is a sectional view of a portion of a similar drill string pipe joint showing a further embodiment of the improvement of the present invention.

FIG. **3** is a sectional view of a portion of a similar drill string pipe joint showing a further embodiment of the present invention.

FIG. **4** is a sectional view of a portion of a similar drill pipe string joint showing a further embodiment of the improvement of the present invention.

FIG. **5** is a sectional view of a portion of a similar drill string pipe joint showing a further embodiment of the improvement of the present invention.

FIG. **6** is a sectional view of a portion of a similar drill string pipe joint showing a further embodiment of the improvement of the present invention.

In FIG. **1** a drill string pipe joint **10** comprising the union of a male member **12** and a female member **14** is shown. The male member includes threads **16** and the female member includes threads **18.** The drill string pipe sections joined include segments of an insulated electrical conductor **20.** The insulated electrical conductors are positioned in passageways **22** in the drill

string pipe sections and are connected to electrical connectors at each end of the drill string pipe sections. The male member has positioned thereon a shoulder **24** and the female member has positioned thereon a shoulder **26.** The electrical connectors **28** comprise a first ring-shaped, substantially full-circle contact-making ring **30** positioned on the male member and a second ring-shaped, substantially full-circle contact-making ring **32** positioned on the female member. The first ring is positioned in a groove **34** between the shoulder and the threads on the male member. The second ring is positioned in a cavity **36** between the shouldler and the threads on the female member. The first ring is insulated from the male member by insulation **38** positioned in the groove between the ring and the male member. The second ring is insulated from the female member by insulation **40** positioned in the cavity between the ring and the female member. The rings are each in contact with a segment of the insulated electrical conductor and each ring includes a contact surface which forms an angle θ from about 15° to about 65° with the longitudinal axis **42** of the drill string. The insulation **38** and **40** is of a resilient nature and tends to urge the rings into a position from which they are displaced as the pipe joint members are screwed together. The insulation **38** positioned on the male member is desirably more resilient than the insulation **40** used on the female member. The electrical connectors include means for sealingly separating the rings from fluids **44** outside the drill pipe and from fluids **46** inside the drill pipe. The sealing means include a first sealing means **48** and a second sealing means **50.** In the embodiment shown in FIG. **1,** the first sealing means comprises a sealingly mating junction of shoulders **24** and **26.** The second sealing means is a generally ring-shaped, substantially full-circle resilient member shown as an O-ring **52** positioned in a groove **54** on the male member. The O-ring has a substantially round cross-section.

It is readily seen that as the male and female members are screwed together the contact rings are moved into contact with each other and as they are joined, the angle causes a wedging action between the rings thus providing a reliable electrical contact therebetween. The rings are sealingly separated from fluids inside and outside the drill string by the sealingly mating shoulders and the O-ring seal. In addition to the sealing effects thereby achieved, the insulation which is positioned on each side of the rings to insulate the rings from the members in which they are positioned tends to sealingly contact by a wedging action when the members are screwed together thus providing a further sealing action. The combination of sealing effects thereby achieved results in an effective seal preventing the rings from contacting fluids inside or outside the drill string.

Many variations in the placement of the sealing means are possible. For instance, in FIG. **2** the first sealing means **48** is shown as a generally ring-shaped substantially full-circle resilient member **56** in a groove **58** positioned on the shoulder of the male member of the drill string pipe. The second sealing means **50** is shown as an O-ring **52** in a groove **54** positioned on the male member of the drill string pipe. The contact surfaces **60** are more particularly shown.

In FIG. **3** a still further embodiment of the invention is shown wherein the sealing means comprises sealingly mating shoulders **24** and **26** in conjunction with an O-ring **62** positioned in a groove **64** on the female member.

In FIG. **4** the first sealing means comprises a generally ring-shaped substantially full-circle resilient member **66** positioned in a groove **68** on the shoulder of the female member. The second sealing means comprises an O-ring **62** positioned in a groove **64** on the female member.

In FIG. **5** a further embodiment of the present invention is shown wherein the first sealing means comprises an O-ring **56** positioned in a groove **58** on the male member. The second sealing means comprises a generally ring-shaped substantially full-circle resilient member **62** positioned in a groove **64** on the female member.

In FIG. **6** a still further embodiment of the invention is shown wherein the first sealing means comprises an O-ring **66** positioned in a groove **68** on the female member. The second sealing means comprises an O-ring **52** positioned in a groove **54** on the male member.

The O-rings are of any suitable configuration known to those skilled in the art and are desirably fabricated of a suitable resilient material which is resistant to the temperatures and chemical environments encountered in drilling operations. Such O-rings are well-known to those skilled in the art and are commercially available. Desirably the O-ring may be of an other than round configuration as shown in FIGS. **2, 4** and **5** so that it is more readily retained in positions wherein the resilience of the O-ring is insufficient to retain the O-ring in position as for instance O-ring **56** in FIG. **2.** In the embodiment shown in FIG. **1** it will be noted that the resilience of the O-ring tends to hold it in position in the groove between the ring and the threads on the male member.

The embodiment shown in FIG. **1** is a particularly desired embodiment since the shoulders are readily machined to tolerances such that the junction of the drill pipe sections results in a sealing junction. It is much less difficult to achieve a sealing junction of such shoulders when only one such junction is attempted; in other words, no attempt is made to machine the remaining sections of the drill pipe members to a tolerance such that other metal-to-metal seals are achieved. It is readily seen that in the embodiment shown in FIG. **1** the O-ring is positioned in an area where it is extremely unlikely that it will be damaged by oil field handling and the like. The rings **30** and **32** are also positioned in positions which are not susceptible to damage during oil field handling and the like. The ring positioned in the female member is desirably positioned as shown since it is somewhat protected by the shoulder of the female section. The ring positioned in the female section may be positioned in a cavity as shown in FIG. **1** or in a groove **70** as shown in FIG. **2.** Such variations are within the scope of the present invention and many such variations and modifications are possible within the scope of the present invention. The remaining embodiments shown are desirable; however, for a variety of reasons the embodiment discussed above is prefered.

It is noted that the O-ring positioned on the male member between the ring and the threads is much more readily retained in position prior to make-up of the joint than are O-rings positioned on the shoulders of the male and female members or the O-rings positioned between the ring and the threads on the female member. In such embodiments it is desirable to use O-rings

or the like shaped to be retained in a groove, cavity or the like. It is readily seen that the resilience of the O-ring **52** alone retains it in position in the embodiments shown in FIG. **1** and FIG. **2.**

The sealing means may be formed of suitable resilient materials such as rubbers, silicon rubbers, silicon rubber resins, plastics and the like as is well-known to those skilled in the art.

The insulation may be any suitable insulating material such as rubbers, silicon rubber-like resins, plastics fiberglass filled rubbers, resilient reinforced plastics, fiberglass reinforced plastics and the like. Desirably the insulation used to insulate the ring positioned in the male member therefrom is more resilient than the insulating material used to insulate the ring positioned in the female member therefrom. It is desirable that the insulation positioned in the female member be less resilient since it is more likely that this ring and the insulating material in which it is positioned will be subjected to contact with other objects during handling as it is somewhat more exposed than is the ring positioned in the male member and accordingly it is desirable that this insulation be more rigid and damage resistant.

The contact surfaces of the rings tend to wedge together upon screwing the male and female members together thus insuring a good electrical contact between the rings. The wedging action tends to cause the contact surfaces to mate with more force than a non-wedging action and tends to over-come the possibility of small particulate matter being lodged between the rings, preventing electrical contact and the like. Desirably, the angle θ formed with the longitudinal axis of the drill pipe by the contact surfaces is from about 15° to about 60°. Preferably, the angle is from about 40 to about 55°. The contact rings are fabricated from any suitable electrically conductive material. Particularly preferred materials are copper, brass and the like.

As will be obvious to those skilled in the art a plurality of such joints is required to join a pluarlity of drill string pipe sections together to form a telemetering drill string suitable for drilling to various depths. The insulated electrical conductor is positioned in the drill string pipe by affixing it to the inner diameter of the pipe with adhesives, positioning it in a plastic lining inside the drill pipe, positioning it between the walls of double-walled drill pipe and the like. Many such methods are known to those skilled in the art and need not be discussed further since such variations are suitable for use in conjunction with the improvement of the present invention.

Having thus described the invention, it is pointed out that the foregoing descrition of preferred embodiments is illustrative rather than limiting in nature and that many variations and modifications are possible within the scope of the present invention. In fact, it is anticipated that many such variations and modifications may appear obvious and desirable to those skilled in the art upon a review of the foregoing description of preferred embodiments.

Having thus described the invention, I claim:

1. In a telemetering drill string in which segments of an insulated electrical conductor are joined by electrical connectors in mating portions of drill string pipe joints that contain mating shoulders, an improvement in the arrangement of electrical connectors comprising:

a. in each drill string pipe joint, said joints comprising the union of a male and a female threaded member, positioning in each of said joints a first and a second ring-shaped substantially full-circle contact-making ring, said first ring being positioned in said male member in a groove between said shoulder and the threaded portion of said member, said second ring being positioned in said female member in a cavity between said shoulder and the threaded portion of said member, each of said rings being in electrical contact with a segment of said insulated electrical conductor, electrically insulated from the member in which it is positioned and having a contact surface forming an angle from 15° to 65° with the longitudinal axis of said drill string;

b. a first and second sealing means positioned in each drill string pipe joint to sealingly separate said rings from fluids inside and outside said drill string, said first sealing means being positioned between said rings and the outer diameter of said drill string pipe and said second sealing means being positioned between said rings and the threaded portion of said joint; and,

c. resilient biasing means operatively associated with at least one of said rings to urge said ring toward a position from which it is displaced by the adjacent contact-making ring as the members are screwed together.

2. The improvement of claim **1** wherein said angle is from 40° to 55°.

3. The improvement of claim **1** wherein said first sealing means consists of sealingly mating shoulders and said second sealing means is a generally ring-shaped substantially full-circle resilient sealing member.

4. The improvement of claim **3** wherein said sealing member has a substantially round cross-section and is positioned in a groove on said male member.

5. The improvement of claim **3** wherein said sealing member is positioned in a groove on said female member.

6. The improvement of claim **1** wherein said first sealing means consists of a generally ring-shaped substantially full-circle resilient sealing member positioned in a groove on said male member and said second sealing means consists of a generally ring-shaped, substantially full-circle resilient member positioned in a groove on said male member.

7. The improvement of claim **1** wherein said first sealing means consists of a generally ring-shaped substantially full-circle resilient sealing member positioned in a groove on said male member and said second sealing means consists of a generally ring-shaped, substantially full-circle resilient member positioned in a groove on said female member.

8. The improvement of claim **1** wherein said first sealing means consists of a generally ring-shaped, substantially full-circle resilient sealing member positioned in a groove in said female member and wherein said second sealing means comprises a generally ring-shaped, substantially full circle resilient sealing member positioned in a groove on said male member.

9. The improvement of claim **1** wherein said first sealing means consists of a generally ring-shaped, substantially full-circle resilient sealing member positioned in a groove in said female member and wherein said second sealing means comprises a generally ring-shaped, substantially full circle resilient sealing member positioned in a groove on said female member.

10. The improvement of claim **1** wherein said insulating material used to insulate the ring on said male member therefrom is more resilient than the insulation used to insulate the ring on said female member therefrom.

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