(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 165 479**
B1

(12) # EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **10.01.90**

(51) Int. Cl.[5]: **E 21 B 17/18,** E 21 B 17/00

(21) Application number: **85106086.3**

(22) Date of filing: **23.02.83**

(60) Publication number of the earlier application in accordance with Art. 76 EPC: **0 087 917**

(54) **Drill pipe.**

(30) Priority: **24.02.82 CA 396947**
24.02.82 CA 396949

(43) Date of publication of application:
27.12.85 Bulletin 85/52

(45) Publication of the grant of the patent:
10.01.90 Bulletin 90/02

(84) Designated Contracting States:
AT BE CH DE FR GB IT LI LU NL SE

(56) References cited:
GB-A-2 074 629
US-A-2 512 116
US-A-4 241 789
US-A-4 280 535

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EP 0 165 479 B1

Courier Press, Leamington Spa, England.

Description

This invention relates to a dual-wall drill pipe section for use in a drill string for drilling in earth formations.

Background of the Invention

The use of dual-walled drill pipe used for drilling bore holes in earth formations is well known. Generally, bore holes are formed by rotating or percussively-rotating a drill string, which may be up to several hundred feet in length, into an earth formation using a drilling apparatus or rig. The drill string is comprised of an outer pipe string, to the lower end of which is connected a drill bit, and an inner pipe string. The inner and outer pipe strings together define an annular passageway for communicating fluid, such as air, to the bottom of the borehole while the inner pipe string defines a bore which serves to return the air and cutting bits to the surface.

The outer pipe string is formed by a plurality of serially, threadedly connected lengths of pipe, each being normally about ten feet in length. The outer pipe string serves to transfer the rotary and/or percussive forces to the cutting or drill bit, absorbs pull up forces, which must be sufficient to overcome the weight of both the outer and inner pipe strings, when extracting the drill string and must carry its own weight, which may be substantial depending upon the length of the drill string. Accordingly, the outer pipe string is a high strength assembly which must be designed to withstand these loads.

The inner pipe string is also formed by a plurality of serially connected lengths of pipe, although not necessarily threadedly connected, each being normally about ten feet in length. The primary function of the inner pipe string is to define the two above-mentioned fluid passageways. It need not transfer rotary or percussive forces of the drill bit and, accordingly, need not meet the same high strength requirements of the outer pipe string and may be constructed of thinner walled tube. Nevertheless, since the drill string may have considerable length, the weight imposed upon the lower lengths of inner pipe is still substantial. Thus, heretofore, it has been necessary to provide an inner pipe member having a larger thickness than would be necessary if the substantial weight of the inner pipe string were not a factor. This results in greater weight and cost of the drill string.

A further difficulty associated with drill strings is the storage, handling and assembling of pipe members. Conventionally, the outer and inner pipe members are stored in separate racks adjacent the drilling site and the inner pipe members are inserted within the outer pipe members when the drill string is being assembled. The inner pipe member may be pre-mounted in an associated outer pipe member but this results in difficulty in handling in that the inner pipe member telescopically slides inwardly and outwardly of the outer pipe member with the not infrequent result of damage to one or both ends of the rather fragile inner pipe member.

United States Patent No. 4,280,535 granted on July 28, 1981 for "Inner Tube Assembly for Dual Conduit Drill Pipe" discloses an arrangement in which the inner tube is secured to the outer tube at one point along each pipe section by a heat meltable adhesive which bonds an anchor ring secured to the inner tube to the inner surface of the outer tube. The arrangement further includes centering lugs between the inner and outer tubes. It has been found that inner tube securely fastened to an outer tube as described in this patent can be particularly damaging to the inner tube when percussive loads are applied during drilling.

United States Patent No. 2,512,116 granted on June 20, 1950 for "Composite Pipe Structure" discloses a spacing element for maintaining two pipes in annularly spaced relation. The spacing element comprises a split resilient band encircling the inner pipe and having its opposite ends detachably joined together and a plurality of spaced protuberances on the band for engaging the outer tube. This patent is not specifically concerned with drilling in earth formations and accordingly does not contemplate percussive and axial loads applied to either pipe member.

UK Patent Application 2 074 629 A filed February 18, 1981 for "Drilling Rod System for a Sinking Drilling Tool" discloses a triple wall arrangement in which the pipes are held fixedly spaced from one another by spacers which may take the form of studs, protuberances, plates or balls. That application is not specifically concerned with the problems discussed above.

Summary of the Invention

The present invention seeks to provide a dual-walled drill pipe arrangement which overcomes the aforementioned difficulties and, in particular, an arrangement which minimizes the wall thickness of the inner pipe string and facilitates the storage, handling and assembling of drill strings.

The present invention provides a dual-wall drill pipe assembly for a drill string used for drilling in earth formations, the assembly having an outer pipe member and an inner pipe member adapted to be concentrically disposed within and telescopically movable inwardly and outwardly of the outer pipe member and defining therewith an annular fluid passage, the assembly being characterized by:

the outer pipe member having internal shoulder means extending inwardly from the bore of the outer pipe member and the inner pipe member having external shoulder means extending outwardly of the outer periphery of the inner pipe member and being engageable with the internal shoulder means for axially supporting the inner pipe member against downward movement only in the outer pipe member when the assembly is disposed in an upright position whereby axial loads applied to the inner pipe member in a downward direction are transferred to the outer pipe member; and

resilient detent means interposed between the inner and outer pipe members for producing a biasing force maintaining the inner pipe member in a predetermined axial position within the outer pipe member while permitting relative axial displacement of the pipe members upon application of opposed axial forces to the pipe members tending to move the internal and external shoulders apart and sufficient to overcome the biasing force whereby axial forces applied in a downward direction to the outer pipe members are transmitted to the inner pipe member only to the extent required to overcome the biasing force.

Brief Description of the Drawings

These and other features of the invention become more apparent from the following description in which reference is made to the appended drawings wherein:

Figure 1 is a broken, partial cross-sectional view of a drill pipe section of the present invention;

Figure 2 is a broken, cross-sectional view of the outer pipe member of the drill pipe of the present invention;

Figure 3 is a broken, cross-sectional view of the inner pipe member of the drill pipe section of the present invention;

Figure 4 is a top end view of the inner pipe member illustrated in Figure 3;

Figure 5 is a bottom view of the inner pipe member 20 illustrated in Figure 3;

Figure 6 is an edge view of the inner pipe member resilient retaining together the inner and outer pipe members;

Figure 7 is a top view of the string illustrated in Figure 6; and

Figure 8 is a cross-sectional view taken along line 8—8 of Figure 2.

Detailed Description of a Preferred Embodiment

With reference to Figure 1, the dual-wall drill pipe section of the present invention, generally designated by reference numeral 10, is generally comprised of an outer pipe member 12 and an inner pipe member 14. The inner and outer pipe members together define an annular passageway 16 which serves to communicate a fluid, such as air, from the surface to the cutting bit at the bottom of the bore hole. The inner pipe member defines a fluid passageay 18 for communicating the fluid and cutting chips from the bottom of the bore hole to the surface.

The dual-wall drill pipe section of the present invention provides an arrangement whereby the inner and outer pipe members are resiliently retained together during handling. Further, the pipe section of the present invention provides an arrangement whereby each outer pipe member supports its associated inner pipe member so as to minimize the strength requirements of the inner pipe member as well as failure of the inner pipe tubing. Still further, the drill pipe arrangement of the present invention is arranged such that that portion of the inner pipe which protrudes from the outer pipe section during storage and handling is effectively and conveniently reinforced so as to again minimize damage to the inner tubing.

With particular reference to Figure 2 of the drawings, the outer pipe is generally comprised of three components in order to facilitate manufacture of the outer pipe member. In particular, the outer pipe member is comprised of a box 20, an elongated tube 22 and a pin 24. The three components are of uniform outside diameter as shown. As is well known, the box 20 usually constitutes the upper end of the drill pipe while the pin 24 constitutes the down hole end of the pipe.

The box 20 includes an internal thread 26 at its free end while the pin 24 is formed with an external thread 28 for engagement with the thread 26 of the box of another outer pipe member. The opposite end of the box 20 is formed with a portion 30 of reduced diameter for reception in one end of tube 22. Similarly, the end of pin 24 remote from thread 28 is formed with a portion 32 of reduced diameter for reception within the opposite end of the tube 22. The box 20 and pin 24 are welded to their respective ends of tube 22 as by welds 34 and 36, respectively.

The bore of box 20 is stepped at 38 and 40 so as to define a first bore portion 42 of reduced diameter and a second bore portion 44 of reduced diameter. The steps 38 and 40 are chamfered so as to facilitate insertion of the inner pipe member within the outer pipe member. As will become clearer later, step or shoulder 38 serves to transmit axial loads which may be imparted on the inner pipe member directly to the outer pipe member. Step 40 is provided in order to provide adequate wall thickness in the vicinity of a pair of opposed flattened, transverse recesses 46. As is explained in co-pending Canadian Application Serial No. 496,947 filed February 24, 1982, now Patent No. 1,119,542 dated December 27, 1983, the recesses are provided for engagement with pipe coupling tools associated with the drill rig for dismantling a drill string. Similarly, the pin 24 is formed with opposed, flattened transverse recesses 48.

Reduced diameter portion 42 of the box 20 is also formed with a circumferential inwardly facing groove 50 which in the preferred form of the invention is arcuate in cross-section. Groove 50 is engageable with leaf springs mounted on the inner pipe member as will become clearer hereinafter.

With reference to Figure 3 of the drawings, inner pipe member 14 is formed with spacer means at each end thereof for maintaining concentricity between the inner and outer pipe members.

The spacer means 60 disposed at the upper end 62 inner pipe 14 is comprised of four pairs of elongated, longitudinally extending spacer members or plates 64. As best shown in Figure 4, the four pairs of spacer members are equally angularly spaced about inner pipe 14. Each pair of spacer members 64 define a radially outwardly

facing channel or chamber 66 in which is disposed an elongated leaf spring 68 as shown in Figure 1. Each spacer member is of the form of a bar of metal or plate welded to the outer periphery of inner pipe 14 and having an outer edge 70 which conforms to the shape of the inner bore of the outer pipe and dimensioned with respect to the axis of the inner pipe so as to be in sliding contact with the bore of the outer pipe. Members 64 each define a shoulder 72 abuttingly engageable with shoulder 38 of the outer pipe whereby the inner pipe is vertically supported in the outer pipe when the pipe section is held in an upright position.

As shown in Figures 6 and 7, each leaf spring 68 is generally V-shaped in edge view and has a pair of arms 75 and 76 which diverge from one another from an apex 77 shaped to mate with arcuate groove 50 in outer pipe 12. The end of arm 75 is formed with an eye 78 for receiving a transverse pin 80 (Figure 1) extending between the upper ends of a pair of spacer members 64. End 86 of arm 76 is formed to abuttingly engage and, to a limited extent, slide along the outer periphery of inner pipe 14. To prevent springs 68 from moving about and facilitate assembly of the pipe section, a transverse pin 88 is provided at the lower ends of spacer members 64 so as to confine end 86 of arm 76 between pin 88 and the inner pipe, as best shown in Figure 1.

Thus, when the inner pipe member 14 is inserted into the box end of outer pipe member 12 and telescopically moved inwardly thereof, springs 68 are radially inwardly depressed until apices 77 reach and engage groove 50. So positioned, leaf springs 68 serve to frictionally and releasably retain the inner pipe member 14 within an outer pipe member 12 thereby facilitating storage and handling of the assembly.

Secured to the lower end 90 of the inner pipe member 14 is a tubular connector member 92 having a bore 94 formed with an annular rib 96 defining opposed annular shoulders 98 and 100. Rib 96 defines an upper bore portion 102 and a lower bore portion 104. Bore portion 102 telescopically receives the lower end 90 of tube 14 to which the upper end of the connector is welded at 106 as shown in Figure 3. The lower bore portion 104 of bore 94 is adapted to telescopically and sealingly receive the upper end 62 of another inner pipe member. A pair of O-rings 108 disposed in grooves 110 serve to seal adjacent ends of connected inner pipe members.

Extending longitudinally upwardly from the connector member 92 are a plurality of equally angularly spaced spacer members 112 which serve to both concentrically dispose the lower end 90 of the inner pipe member 14 within the outer pipe member 12 and reinforce lower end 90 of inner pipe member 14. As is indicated in Figure 1, the lower end of the inner pipe projects axially outwardly of the lower end of the outer pipe member and, thus, is subject to damage during storage and handling. However, spacer members 12 and connector 92 serve to protect and reinforce the end of the inner pipe member.

In order to assemble a pipe section, the lower end 90 of an inner pipe member is inserted into box end 20 of an outer pipe member and telescopically moved along the outer pipe member until projection 84 of the leaf springs 68 enter and resilienty engage groove 50 in box 20 of the outer pipe member 12 and shoulders 38 and 72 of the outer and inner pipe members, respectively, abuttingly engage. When so assembled, springs 68 serve to retain the inner pipe member within the outer pipe member, even if the pipe section is inverted. In order to dismantle a pipe section, an axial, upwardly directed force of a magnitude which is sufficient to radially inwardly depress springs 68 is applied to the lower end 90 of the inner pipe member. The inner pipe member may then be readily telescopically removed from the outer pipe member.

In order to assemble a drill string formed of the above described assembled pipe sections, the lower end 90 of the inner pipe member is inserted into the box end of a drill string and telescopically moved downwardly there within until the pin 24 of the pipe section being assembled engages the upper box 20 of the drill string. Thereafter, the pipe section being assembled is rotated with respect to the drill string so as to threadedly engage the pin 24 of the new section with the box 20 of the drill string.

It will be appreciated that the spacer members 64 and springs 68 need not necessarily be disposed at the upper end of the inner pipe. Indeed, they may be disposed at the lower end of the pipe with the pin 24 suitably modified to receive these members. In this case, the connector member 92 and spacer members 112 would be disposed at the upper end of the inner pipe.

Claims

1. A dual-wall drill pipe assembly (10) for a drill string used in drilling in earth formations, said assembly having an outer pipe member (12) and an inner pipe member (14) adapted to be concentrically disposed within and telescopically movable inwardly and outwardly of said outer pipe member (12) and defining therewith an annular fluid passage (16), said assembly being characterized by:

said outer pipe member having internal shoulder means (38) extending inwardly from the bore (42, 44) of said outer pipe member and said inner pipe member having external shoulder means (72) extending outwardly of the outer periphery of said inner pipe member and being engageable with said internal shoulder means (38) for axially supporting said inner pipe member against downward movement only in said outer pipe member when said assembly is disposed in an upright position whereby axial loads applied to said inner pipe member in a downward direction are transferred to said outer pipe member; and

resilient detent means (68) interposed between said inner and outer pipe members for producing a biasing force maintaining said inner pipe member

in a predetermined axial position within said outer pipe member while permitting relative axial displacement of said pipe members upon application of opposed axial forces to said pipe members tending to move said internal and external shoulders apart and sufficient to overcome said biasing force whereby axial forces applied in a downward direction to said outer pipe member are transmitted to said inner pipe member only to the extent required to overcome said biasing force.

2. A dual-wall drill pipe section as defined in claim 1, said detent means including recess means (50) formed on one of said pipe members and means (68) associated with the other of said pipe members releasably engageable with said recess means.

3. A dual-wall drill pipe section as defined in claim 2, said recess means being a circumferential recess (50) formed in the bore (42) of said outer pipe member.

4. A dual-wall drill pipe section as defined in claim 3, said recess (50) being arcuate in longitudinal section of said outer pipe member.

5. A dual-wall drill pipe section as defined in claim 2, said associated means being spring means (68) secured to the outer periphery of said inner pipe member.

6. A dual-wall drill pipe section as defined in claim 5, said spring means (68) being generally V-shaped, and having an apex (77) engageable with said recess means, the end (78) of one of the arms of said spring means being pivotally secured to said inner pipe member.

7. A dual-wall drill pipe section as defined in claim 2, said recess means being a circumferential recess (50) formed in the bore (42) of said outer pipe member and said detent means being at least one V-shaped spring means (68) connected to the outer periphery of said inner pipe member and having its apex (77) formed to seat in said recess, said spring means being inwardly depressed and biased by said bore of said outer pipe member when said inner pipe member is telescopically inserted into bore.

8. A dual-wall drill pipe section as defined in claim 7, said recess being arcuate in longitudinal section of said outer pipe member and said apex having an arcuate, convex protuberance matingly engageable with said recess.

9. A dual-wall drill pipe section as defined in claim 1, one of said pipe members having spacer means (60) adapted to be disposed within said passage (16) for maintaining said inner pipe member concentrically disposed within said outer pipe members.

Patentansprüche

1. Doppelwand-Bohrstangengerät (10) für einen Bohrstrang, der zum Bohren in Bodenformationen verwendet wird, mit einem äußeren Rohrelement (12) und einem inneren Rohrelement (14), das konzentrisch innerhalb des äußeren Rohrelements (12) anzuordnen ist und teleskopartig in das Rohrelement (12) und aus ihm heraus zu bewegen ist und damit einen ringförmigen Flussigkeits-Durchgang (16) bestimmt, dadurch gekennzeichnet,

daß das äußere Rohrelement innere Ansatzmittel (38) aufweist, die sich nach innen von der Bohrung (42, 44) des äußeren Rohrelements erstrecken, und daß das innere Rohrelement äußere Ansatzmittel (72) aufweist, die sich nach außen von dem äußeren Umfang des inneren Rohrelements erstrecken und mit den inneren Ansatzmitteln (38) in Eingriff gebracht werden können, um das innere Rohrelement gegen Bewegung nach unten nur in dem äußeren Rohrelement axial abzustützen, wenn das Gerät in aufrechter Stellung angeordnet ist, wodurch axial Belastungen, die auf das innere Rohrelement in Richtung nach unten aufgebracht werden, auf das äußere Rohrelement übertragen werden, und

daß elastische Rastmittel (68) zwischen dem inneren und dem äußeren Rohrelement eingefügt sind, um eine Vorspannkraft zu erzeugen, die das innere Rohrelement in einer vorbestimmten axialen Stellung innerhalb des äußeren Rohrelements hält, während sie relative axiale Verschiebung der Rohrelemente bei Anlegung von entgegengesetzten axialen Kräften an die Rohrelemente erlaubt, die dazu neigen, die inneren und äußeren Ansätze auseinander zu bewegen, und genügend groß sind, um die Vorspannkraft zu überwinden, wodurch die axialen Kräfte, die in Richtung nach unten an das äußere Rohrelement angelegt werden, auf das innere Rohrelement nur in dem Ausmaß übertragen werden, der erforderlich ist, um die Vorspannkraft zu überwinden.

2. Doppelwand-Bohrstangenabschnitt nach Anspruch 1, dadurch gekennzeichnet, daß die Rastmittel Ausnehmungsmittel (50) umfassen, die auf einem der Rohrelemente ausgebildet sind und Mittel (68), die dem anderen der Rohrelemente zugehörig und lösbar mit den Ausnehmungsmitteln in Eingriff zu bringen sind.

3. Doppelwand-Bohrstangenabschnitt nach Anspruch 2, dadurch gekennzeichnet, daß die Ausnehmungsmittel eine Umfangs-Ausnehmung (50) sind, die in der Bohrung (42) des äußeren Rohrelements ausgebildet sind.

4. Doppelwand-Bohrstangenabschnitt nach Anspruch 3, dadurch gekennzeichnet, daß die Ausnehmung (50) im Längsschnitt des äußeren Rohrelements bogenförmig ist.

5. Doppelwand-Bohrstangenabschnitt nach Anspruch 2, dadurch gekennzeichnet, daß die zugehörigen Mittel Federmittel (68) sind, die an dem äußeren Umfang des inneren Rohrelements gesichert sind.

6. Doppelwand-Bohrstangenabschnitt nach Anspruch 5, dadurch gekennzeichnet, daß die Federmittel (68) allgemein V-förmig sind und einen Scheitelpunkt (77) aufweisen, der mit den Ausnehmungsmitteln in Eingriff zu bringen ist, wobei das Ende (78) eines der Arme der Federmittel schwenkbar an dem inneren Rohrelement gesichert ist.

7. Doppelwand-Bohrstangenabschnitt nach

Anspruch 2, dadurch gekennzeichnet, daß die Ausnehmungsmittel eine Umfangs- Ausnehmung (50) sind, die in der Bohrung (42) des äußeren Rohrelements gebildet ist, und

daß die Rastvorrichtung wenigstens eine V-förmige Federeinrichtung (68) ist, die mit dem äußeren Umfang des inneren Rohrelements verbunden ist und deren Scheitelpunkt (77) so geformt ist, daß er in der Ausnehmung sitzt, wobei die Federneirichtung nach innen niedergedrückt und durch die Bohrung des äußeren Rohrelements vorgespannt wird, wenn das innere Rohrelement teleskopartig in die Bohrung eingefügt wird.

8. Doppelwand-Bohrstangenabschnitt nach Anspruch 7, dadurch gekennzeichnet, daß die Ausnehmung im Längsschnitt des äußeren Rohrelements bogenförmig ist, und daß der Scheitel einen bogenförmigen, konvexen Vorsprung aufweist, der passend mit der Ausnehmung in Eingriff zu bringen ist.

9. Doppelwand-Bohrstangenabschnitt nach Anspruch 1, dadurch gekennzeichnet, daß eines der Rohrelemente Abstandshaltermittel (60) aufweist, die in dem Durchgang (16) anzuordnen sind, um das innere Rohrelement innerhalb der äußeren Rohrelemente konzentrisch angeordnet zu halten.

Revendications

1. Ensemble (10) à tiges de forage à double paroi (10) pour un train de tiges de forage utilisé dans le forage de formations géologiques, ledit ensemble ayant un élément de tube extérieur (12) et un élément de tube intérieur (14) adapté à être disposé concentriquement à l'intérieur, et mobile de manière télescopique vers l'intérieur et vers l'extérieur dudit élément de tube extérieur (12) et définissant avec celui-ci les passages annulaires pour les fluides (16), ledit ensemble étant caractérisé par:

— le fait que ce tube extérieur présente des moyens formant un épaulement interne (38) se prolongeant vers l'intérieur à partir de l'alésage (42, 44) dudit élément formant tube extérieur, et par le fait que ledit élément formant tube intérieur présente un moyen formant épaulement externe (72) se prolongeant vers l'extérieur de la périphérie extérieure dudit tube intérieur et pouvant s'engager sur ledit épaulement interne (38) pour soutenir axialement ledit tube intérieur afin d'en empêcher les mouvements vers le bas seulement dans ledit tube extérieur lorsque ledit ensemble est disposé en position verticale, ce par quoi les charges axiales appliquées audit tube intérieur vers le bas sont transférées vers ledit tube extérieur; et

— des moyens de détente élastiques (68) interposés entre lesdits tubes intérieur et extérieur pour produire un force de rappel maintenant ledit tube intérieur en une position axiale prédéterminée à l'intérieur dudit tube extérieur tout en permettant un déplacement axial relatif desdit tubes lors de l'application de forces axiales opposées auxdits tubes qui tendent à écarter lesdits épaulements interne et externe l'un de l'autre et suffisantes pour surmonter ladite force de rappel, ce qui a pour effet que les forces axiales appliquées vers le bas audit tube extérieur ne sont transmises audit tube intérieur qu'à un degré suffisant pour surmonter ladite force de rappel.

2. Section de tiges de forage à double paroi selon la revendication 1, caractérisée en ce que ledit moyen de détente comporte un moyen formant creux (50) réalisé sur l'un desdits tubes et un moyen (68) associé à l'autre desdits tubes pouvant s'engager de façon amovible sur ledit moyen formant creux.

3. Section de tiges de forage à double paroi selon la revendication 2, caractérisée en ce que ledit moyen formant creux est un creux circonférentiel (50) réalisé dans l'alésage (42) dudit tube extérieur.

4. Section de tiges de forage à double paroi selon la revendication 3, caractérisée en ce que ledit creux (50) est incurvé selon la section longitudinale dudit tube extérieur.

5. Section de tiges de forage à double paroi selon la revendication 2, caractérisée en ce que ledit moyen associé est un moyen à ressort (68) fixé à la périphérie extérieure dudit tube intérieur.

6. Section de tiges de forage à double paroi selon la revendication 5, caractérisée en ce que ledit moyen à ressort (68) ayant globalement la forme d'un V et ayant un apex (77) pouvant s'engager dans ledit moyen formant creux l'extrémité (78) de l'un des bras dudit moyen à ressort est fixée pivotante sur ledit tube intérieur.

7. Section de tiges de forage à double paroi selon la revendication 2, caractérisée en ce que ledit moyen formant creux étant un creux circonférentiel (50) réalisé dans l'alésage (42) dudit tube extérieur et ledit moyen de dètente étant au moins un moyen à ressort en forme de V (68) relié à la périphérie extérieure dudit tube intérieur et dont l'apex (77) est réalisé de façon à prendre appui dans ledit creux, ledit moyen à ressort est abaissé vers l'intérieur et sollicité par ledit alésage dudit tube extérieur lorsque ledit tube intérieur est introduit de manière télescopique dans l'alésage.

8. Section de tiges de forage à double paroi selon la revendication 7, caractérisé en ce que ledit creux est incurvé selon la section longitudinale dudit tube extérieur et ledit apex ayant une protubérance à incurver et convexe pouvant s'engager de façon complémentaire dans ledit creux.

9. Section de tiges de forage à double paroi selon la revendication 1, caractérisée en ce que l'un desdits tubes a un moyen d'espacement (60) adapté à être disposé à l'intérieur dudit passage (16) pour maintenir ledit tube intérieur disposé concentriquement à l'interieur desdits tubes extérieurs.

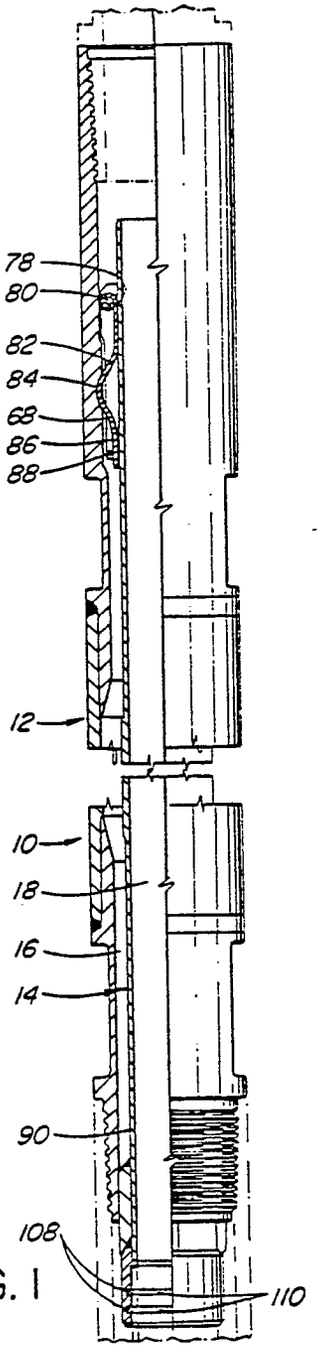
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FIG. 1

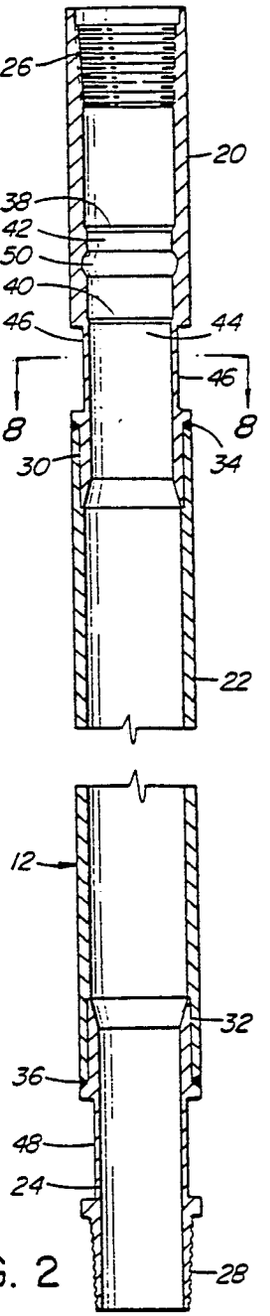
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FIG. 2

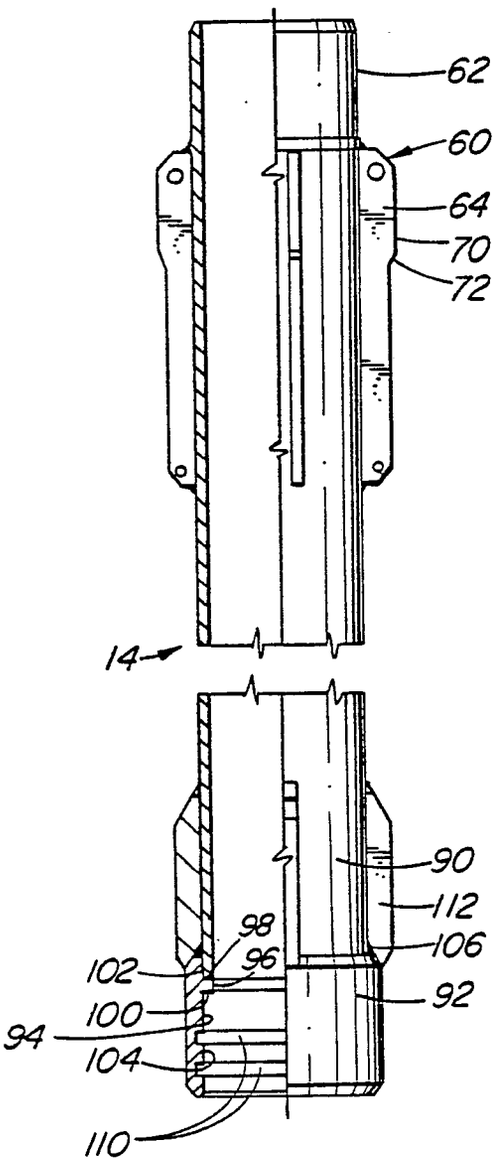

FIG. 3

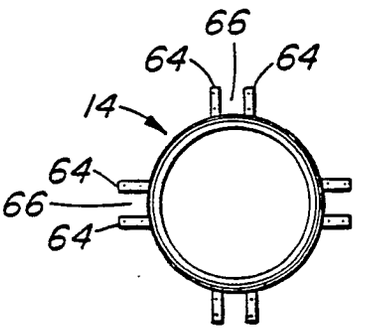

FIG. 4

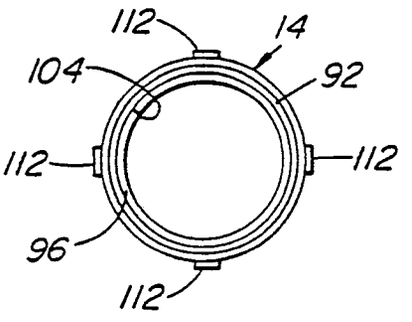

FIG. 5

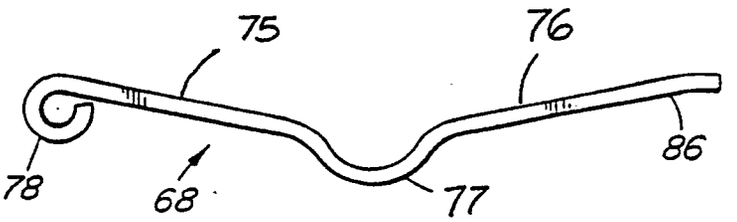

FIG. 6

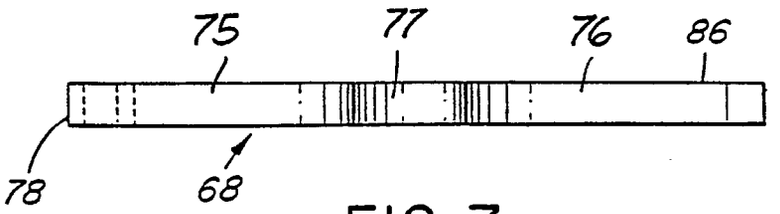

FIG. 7

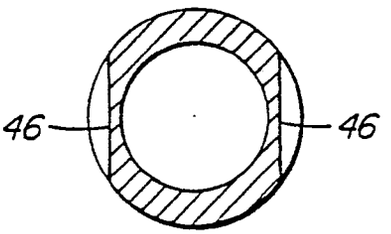

FIG. 8