

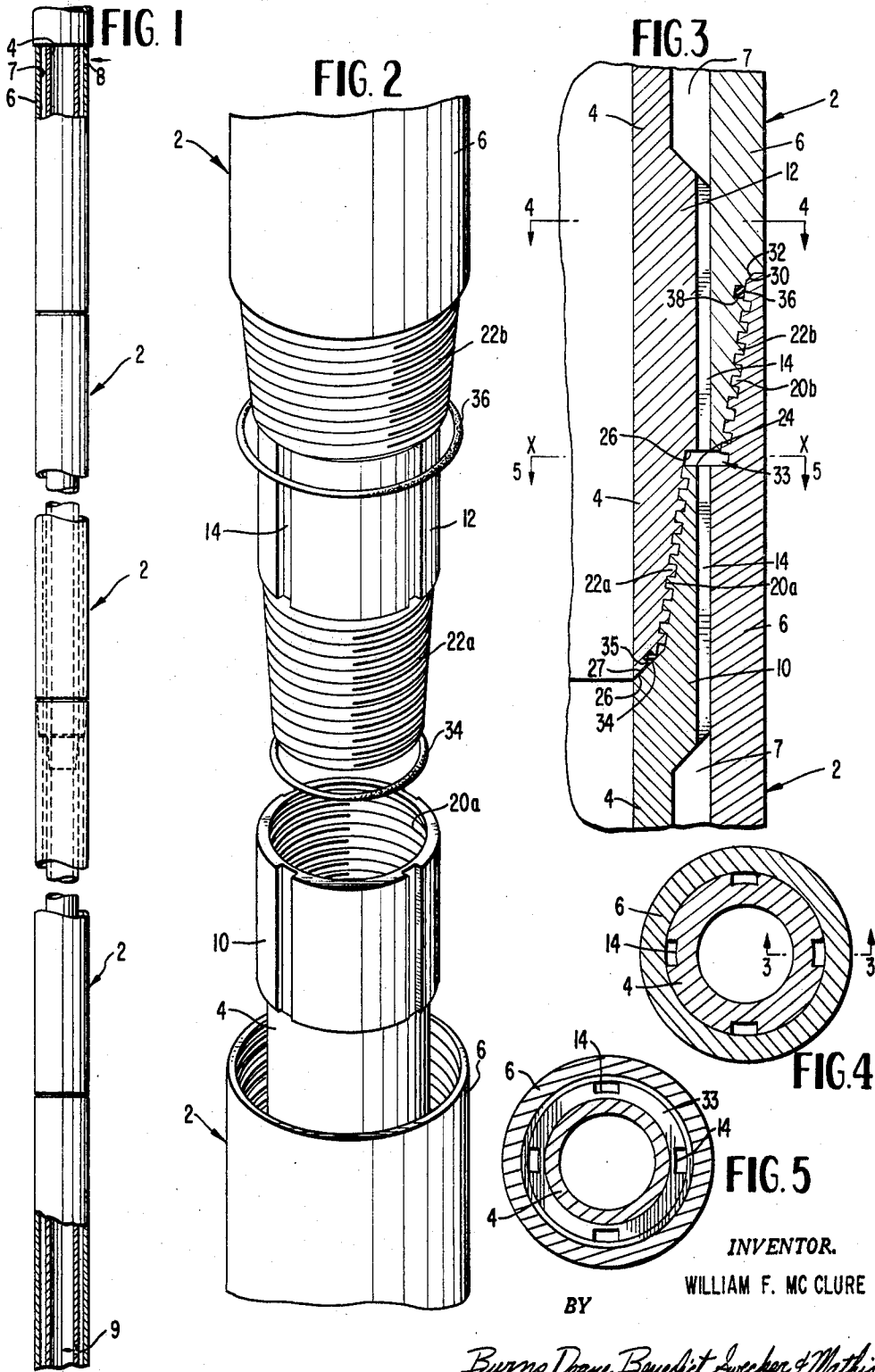
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W. F. MCCLURE

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OIL WELL TUBING HAVING NONCOMMUNICATING FLUID PASSAGES

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INVENTOR.

WILLIAM F. MCCLURE

BY

Burns, Deane, Benedict, Swicker & Mathis
ATTORNEYS

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OIL WELL TUBING HAVING NONCOMMUNICATING FLUID PASSAGES

William F. McClure, Anchorage, Alaska, assignor to Denali Services Co., Inc., Anchorage, Alaska

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ABSTRACT OF THE DISCLOSURE

A length of well tubing includes an inner pipe and an outer pipe spaced about the inner pipe to define an outer fluid passage between the pipes. The pipes at one axial end include axially extending first threaded portions, and at the other axial end include axially extending second threaded portions of complementary shape to the first threaded portions. First and second collars positioned at opposite ends of the inner pipe, fixedly connect the pipes. Each collar includes at least one collar passage extending axially of the collar in fluid communication with the adjacent outer passage. When adjacent tubing lengths are threadedly connected with the inner pipes in fluid communication, the adjacent collars are axially spaced to provide a peripheral passage placing the outer fluid passages of adjacent connected tubing lengths in fluid communication.

Background of invention

This invention relates to oil well tubing having noncommunicating fluid passages extending along the tubing, and to a method of manufacture for such tubing.

In performing oil field operations, it is sometimes necessary to utilize some form of a fluid actuated, downhole tool interposed in a string of oil well tubing disposed in an oil well bore. Some types of downhole tool cannot be actuated by the usual gas or liquid passing through the tubing string, but instead require the provision of special sources of fluid power such as compressed air, or hydraulic liquid. For this purpose a tool supply fluid conduit (of rigid or flexible construction) may sometimes be provided extending from the surface to the downhole tool, positioned either internally or externally of the tubing string. However, with the fluid conduit in such an exposed position, problems may arise due to the extreme vulnerability of the conduit to damage both from blows and to abrasion by drilling or producing fluids. In addition it is often necessary to rotate the string of oil well tubing which cannot be done when an external tool supply conduit is affixed to the outside of the tubing string.

In an attempt therefore to avoid these problems, it has been previously proposed to utilize double walled lengths of well tubing (provided by spaced concentric pipes) with a tool supply passage between the pipes. Adjacent tubing lengths are connected together by threaded engagement between one pair of threaded pipes in the tubing lengths, with the adjacent other pipes concurrently entering into sliding or abutting engagement.

Although such prior structure may sometimes be satisfactory, certain significant disadvantages may be encountered for a number of reasons. For example, with the prior structure described, the slidingly connected pipes are incapable of direct transmission of torque and tensile load between adjacent tubing lengths, thus reducing the torque capacity of the tubing string.

Additionally such prior structures commonly used relatively small or sheet metal spacers to support the pipes in spaced relation, with the disadvantage that under heavy torque loads, the spacers might tend to become sheared or otherwise distorted. Even minor distortion may be

sufficient to cause some leakage between the inner and outer pipes, which could allow some of the liquid within the inner pipe (which may be drilling or production fluid) to mix with the clean actuating fluid used for the downhole tube with possible disastrous results. Furthermore, major distortion at the joint could lead to complete failure of the pipe string under heavy load.

Other problems may arise in the manufacture of lengths of well tubing of the type described in that it may be necessary to provide complicated jiggling for maintaining the inner pipe in centralized relation to the outer pipe while the supporting spacers are welded into position. In addition, the welding process may be difficult to carry out in view of the restricted accessibility existing within the annulus defined by the inner and outer pipes.

Summary of invention

It is therefore a general object of the invention to provide oil well tubing having noncommunicating fluid passages, which obviates or minimizes problems of the type previously noted.

It is a particular object of the invention to provide a length of oil well tubing having noncommunicating fluid passages, so designed as to permit a particularly rigid and rugged joint to be provided between adjacent tubing lengths.

It is another object of the invention to provide a pipe string of the type comprising plural lengths of tubing connected end to end with each length formed of spaced inner and outer pipes, wherein the torque and tensile carrying capacity of both pipes in each tubing length may be fully utilized.

It is a further object to provide oil well tubing for conducting two different media along different noncommunicating passages in which the possibility of admixture of the fluids at junctions between adjacent tubing lengths is obviated or minimized.

An additional object of the invention is to provide a method of manufacture of a pipe string of the type described which method may be performed in a simple and convenient manner and at a low cost.

A length of well tubing according to a preferred embodiment of the invention, intended to accomplish at least some of the foregoing objects includes an inner pipe having axially opposite first and second ends. An outer pipe is spaced concentrically about the inner pipe with the pipes defining an outer fluid passage between them. First and second annular collars positioned adjacent the first and second ends of the inner pipe respectively, extend transversely and peripherally of the outer passage and fixedly connect the pipes together. Each collar includes at least one collar passage extending entirely axially of the collar in fluid communication with the adjacent outer passage. The first collar and both of the inner and outer pipes adjacent the first axial end include axially extending, first threaded portions. The second collar and both of the inner and outer pipes adjacent the second axial end also include axially extending, second threaded portions shaped to be complementary to the respective first threaded portions. Each of the previously mentioned collars further includes a peripherally extending, radial end surface facing axially outwardly of the inner pipe and intersecting the adjacent collar passage. Abutment means are connected with at least one of the pipes adjacent its opposite axial ends. When one end of the tubing length is threadedly connected to an opposite end of another identical length of the tubing, the abutment means maintains the adjacent collar radial end surfaces in sufficient, axially spaced relation to define a peripheral passage placing the outer passages of the connected lengths of tubing in fluid communication. In this way continuous,

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noncommunicating inner and outer passages are provided through the junctions between adjacent tubing lengths.

Additionally, each of the collars extends axially inwardly of the pipes to a point beyond the adjacent threaded portions, to provide particularly rigid supporting structure at the junction between adjacent lengths of well tubing.

In a further aspect of the invention, first seal means are connected with the threaded portions of the inner pipe to prevent leakage of the fluid between adjacent inner pipes of the connected tube lengths. Similarly, second seal means are connected with the threaded portions of the outer pipes to prevent leakage of fluid outwardly between the adjacent outer pipes of the connected tube lengths.

To assist ease of connection of adjacent lengths of well tubing, the first threaded portions are shaped to provide an axially recessed, internally threaded female socket of generally frustoconical configuration with the axially extending second threaded portions providing an axially projecting, male connector of complementary configuration to the female socket.

A method aspect of the invention is intended to provide a length of oil well tubing having noncommunicating fluid passages. The method includes a step of providing an inner pipe with radially projecting peripheral collars adjacent each of its end. At least one groove is formed in each collar extending entirely axially there-through. An outer pipe is then sleeved over the inner pipe at one axial end of the pipes with the inner pipe projecting beyond the outer pipe at the other axial end. The one end of the length of tubing is then provided with an internally threaded axially recessed female socket while the other end of the tubing is provided with an externally threaded male connector of complementary configuration to the female socket.

The drawings

A length of oil well tubing constructed in accordance with a preferred embodiment of the invention is illustrated in the accompanying drawings in which:

FIGURE 1 is a side view of a tubing string formed from a plurality of lengths of well tubing according to the preferred embodiment;

FIGURE 2 is an exploded perspective view of a junction between two adjacent lengths of the well tubing shown in FIGURE 1;

FIGURE 3 is a cross sectional, side view through a portion of the junction between two adjacent lengths of well tubing taken on the line 3—3 of FIGURE 4;

FIGURE 4 is a cross sectional top view of the joint between two adjacent lengths of tubing shown in FIGURE 3 taken along the lines 4—4 therein, but with a full peripheral section of the tubing shown; and

FIGURE 5 is a cross sectional top view of the tubing joint shown in FIGURE 3 taken along the lines 5—5 therein, but with a full peripheral section of the lengths of tubing shown.

Detailed description

Referring to FIGURE 1 of the drawings, a tubing string formed of a plurality of lengths of tubing 2 according to a preferred embodiment of the invention, is there shown. Typically the tubing string may be installed in a well bore with an upper end of the tubing string above ground level and with a fluid actuated downhole tool (not shown but comprising, for example, a safety valve) positioned several hundred feet down the well bore. The present invention is intended to provide a fluid path for the fluid to actuate the downhole tool, which is separate from and does not communicate with the main central annulus of the tubing string through which drilling mud and the like passes.

For this purpose each of the lengths of tubing 2 comprises spaced concentric inner and outer pipes 4 and 6

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respectively, defining an annular outer passage 7 between the pipes. At the upper end of the tubing string a transverse port 8 in the outer pipe 6 of one of the tubing lengths 2 above the ground, is provided for the admission of actuating fluid to the outer passage 7. At the lower end of the tubing string a port 9 in the inner pipe 4 of another of the lengths 2 of the tubing is provided, for delivering the actuating fluid to the tool. Of particular interest in the context of the present invention is the structure provided at the junction between adjacent tubing lengths to simultaneously connect them and provide a fluid path between the adjacent outer passages.

Each length of tubing 2 (FIGURES 2 and 3) as previously mentioned includes one of the inner pipes 4 which is of uniform external and internal diameter. Each inner pipe 4 is provided with a first or upper collar 10 at its upper end, and a lower or second collar 12 at its lower end. The upper collar 10 projects axially upwardly of the upper end of the inner pipe 4 and the lower collar 12 has its lower end spaced above the lower end of the inner pipe 4. The collars 10 and 12 which are annular, extend completely about the inner pipe 4 and are fixedly secured thereto, extending radially across the outer passage 7. The collars 10 and 12 may be formed in any conventional manner such as by forging them integrally upon the pipe ends, or by securing an externally applied collar to the inner pipe by welding, press fitting, heat shrinking or the like, with subsequent machining of the exterior of the collars to a uniform external diameter.

Each of the collars 10 and 12 is provided with four equally spaced, groove-like, collar passages 14 extending axially the full length of the collar. The collar passage 14 (FIGURE 4) are preferably produced by a milling cutter and the number of them may be varied as desired. However, in general the aggregate radial cross sectional area of the grooves 14 comprises only a minor portion of the total radial area of the collar on which the grooves are formed. Portions of the collar extending peripherally between adjacent collar passages 14 comprises collar segments which reinforce the outer pipe against inward collapse adjacent the joint. Preferably these segments each extend for almost a quarter of the periphery of the pipe.

The previously mentioned outer pipe 6 of each length 2 of tubing is maintained in fixed spaced relation about the associated inner pipe 4 by heat shrinking the outer pipe 6 onto the upper and lower collar 10 and 12, to form a tight fit therewith, resisting both axial and rotational displacement. Each outer pipe 6 at its upper end extends axially upwardly beyond the adjacent upper collar 10 and at its lower end, is spaced upwardly above the lower extremity of the adjacent lower collar 12. The collar passages 14 in the upper and lower collars 10 and 12 are in fluid communication with the outer passage 7 at the upper and lower extremities thereof.

To facilitate threaded connection between adjacent lengths 2 of the tubing, each tubing length 2 at its upper end includes a threaded female socket. The socket is provided by axially extending, upwardly diverging, upper and lower, first internally threaded portions 20a and 20b (FIGURE 3) formed on the upper collar 10 and upper internal portion of the outer pipe 6, respectively. The lower, first threaded portion 20a on the collar 10 extends from a point adjacent the upper extremity of the associated inner pipe 4 upwardly and outwardly to the upper extremity of the collar 10. The upper, first threaded portion 20b on the outer pipe 6 extends from a position generally on a level with the upper extremity of the collar 10, spaced radially outwardly therefrom, to a position adjacent the upper extremity of the outer pipe 6. The threaded portions 20a and 20b are of generally equal length and similar thread characteristics to define the threaded female socket.

At its lower end each of the lengths 2 of tubing is provided with a threaded male connector, complementary to the female socket on the next adjacent length of tubing 2. Such male connector is defined by a lower, second externally threaded portion 22a provided on the lower collar 12 and adjacent portions of the inner pipe 4, and an upper, second externally threaded portion 22b provided on the outer pipe 6. The threaded portions 22a and 22b are generally coextensive with an configured to separately, threadedly engage the respective first threaded portions 20a and 20b in complementary relation.

It will be understood that tubing lengths 2 may readily be connected together by threadedly engaging the male connector at the lower end of one tubing length with the female socket at the upper end of the next succeeding length of tubing. The inclined relation of the various threaded portions assists in rapid centralizing and threading of tubing lengths together.

Significantly the separate threaded connection between adjacent inner pipes afforded by the threaded portions 20a and 22a, and the separate connection between adjacent outer pipes afforded by the threaded portions 20b and 22b, permits both the inner and outer pipes to separately and directly transmit torque through the junction between adjacent tubing lengths. In this manner the combined torque carrying capacity of both the inner and the outer pipes may be fully utilized.

It will further be appreciated that threaded connection of adjacent lengths of tubing in the manner described, places the central inner passages of the adjacent inner pipes 4 in fluid communication. Provision is also made for concurrently placing the outer passages 7 of adjacent lengths of tubing 2, in fluid communication through the joint between adjacent tubing lengths.

For this purpose the collars 10 and 12 are provided with radially extending end faces 24 and 26 (FIGURE 3) respectively, each of which faces axially outwardly of its associated length of tubing 2 and is positioned generally axially intermediate of the associated first and second threaded portions. Each of the radial end faces 24 and 26 intersects the adjacent previously mentioned collar passages 14.

To maintain the radial end surfaces 24 and 26 of connected lengths of tubing 2 in spaced opposed relation on opposite sides of a radial plane $x-x$ for a purpose to be described, abutment means are provided adjacent the axial extremities of the previously mentioned threaded portions. The abutment means includes a first pair of downwardly and radially inwardly inclined, mating abutting surfaces 26 and 27 at the lower extremity of the previously mentioned lower, first and second threaded portions 20a and 22a respectively. A second pair of matingly configured abutting surfaces 30 and 32 is provided at the upper extremities of the threaded portions 20b and 22b despectively. The pairs of abutting surfaces 26, 27 and 30, 32 move into abutting contact to limit further threaded engagement of adjacent tubing lengths to maintain the adjacent radial end faces 24 and 26 of the collars on the connected tubing lengths in axially spaced relation. Significantly, these mating faces also form a metal-to-metal seal.

Thus, the axially spaced, adjacent end faces 24 and 26, together with adjacent peripherally extending portions of the collars and pipes, provide a peripherally extending passage 33 (FIGURE 5) communicating with the various collar passages 14 in the adjacent collars 10 and 12. The peripheral passage 33 completes a continuous fluid passage between the outer fluid passage 7 in one tubing length and the outer passage 7 in the adjacent tubing length, through the respective collar passages 14, even though the passages 14 in the adjacent collars may not be axially aligned at the time threaded engagement of the lengths of tubing is completed. In this manner, noncommunicating inner and outer fluid passages are simultaneously

provided through connected lengths 2 of tubing merely by threadedly engaging the adjacent lengths.

In order to prevent the possibility of admixture of the fluids in the inner and outer passages along and between adjacent threads, a compressible annular seal ring 34, of the O-ring type, is interposed between the previously mentioned first pair of abutment surfaces 26 and 27, partially received within a peripherally extending groove 35 provided in the abutment surface 27. A similar annular compressible seal ring 36 is mounted between the second pair of abutment surfaces 30 and 32, partially received within a peripherally extending recess 38 provided in the abutment surface 32. It will be appreciated that the seal rings 32 and 36 preserve the fluid-tight nature of the adjacent outer passages 7 to prevent radial leakage of any of the actuating fluid from the outer passages, and to prevent ingress of fluid from the interior of the pipes that might otherwise contaminate the actuating fluid in the outer passages.

In another important aspect of the invention, each of the collars 10 and 12 extends axially inwardly of its associated length of tubing 2 beyond the adjacent threaded portions. Thus the upper collar 12 extends upwardly beyond the upper extremity of the associated upper, second threaded portion 22b while the lower collar 10 extends downwardly beyond the lower extremity of the associated lower, first threaded portion 20a. In this manner considerable reinforcement is provided for both lengths 2 of tubing at their junction, by the collars extending axially in both directions beyond the junction. This added rigidity provides a valuable margin of safety and significantly reduces the possibility of pipe failure at the junction.

A method of manufacture of a length of tubing of the type described, includes an initial step of providing a length of the inner pipe. The inner pipe is then provided at its opposed axial extremities with the radially projecting collars. This step may be performed by heating and upsetting the pipe to provide integral collars on the pipe. Alternatively, each separate collar may be fixedly secured to the pipe ends by welding, threading, press fitting or other well known methods. The axially extending collar passages are then cut in each of the collars extending entirely axially through the collars. The outer pipe having an internal diameter slightly less than that of the collars is expanding by heating, and in an expanded condition sleeved over the inner pipe, with the outer pipe projecting beyond the inner pipe at one end and with the inner pipe projecting beyond the outer pipe at the other end. The outer pipe is cooled to heat shrink it in fixed position about the collars. An internally threaded female socket is then formed on the pipes at the one end and an externally threaded male connector formed on the pipes at the other end.

Although the invention has thus far been described for use in supplying actuating fluid, it will be appreciated that it is suited for use in other applications involving noncommunicating fluid paths, such as for example coring operations. Additionally, the invention may be utilized in above ground piping applications including oil field applications as well as applications entirely outside the oil field environment. In addition, circulation of fluid in the outer passage may occur in both upward and downward directions.

Summary of advantages

In utilizing the method and apparatus of the present invention, it will be appreciated that certain significant advantages are provided.

In particular the provision of the peripherally extending collars between the concentric inner and outer pipes, provides for particularly rigid joint construction adjacent the junction between adjacent lengths of tubing.

In this respect, the manner in which the collars extend axially to a point beyond the adjacent threaded portions

of the pipes provides massive reinforcement for the lengths of tubing at the joints.

Also significant is the provision of a peripheral fluid passage for providing a fluid path between collar passages in adjacent connected tubing lengths, even when the collar passages are not axially aligned after connection.

Of great importance is the fact that the construction described permits the tubing string to be rotated, as is frequently required in oil field operations, without posing any possible interference to the supply of actuating fluid to the downhole tool.

Other advantages are provided by the seals between the inner pipes and the seals between the outer pipes, which safeguard the fluid tight integrity of the communicating outer passages.

Also significant is the method of manufacture utilizing an outer tube heat sleeved over an inner pipe provided with collars to provide an interference fit therewith. This simple method of manufacture eliminates the need for complicated jiggling or difficult welding procedures in connecting the pipes in spaced concentric relation.

Although the invention has been described with reference to one preferred embodiment, it will be appreciated by those skilled in the art that numerous additions, deletions, modifications, substitutions, and other changes not specifically described for the preferred embodiment may be made.

What is claimed is:

1. A length of well tubing comprising:

- (a) an inner pipe,
- (b) an outer pipe spaced concentrically about said inner pipe,

(c) said pipes defining

an outer fluid passage between said pipes;
first and second annular collars positioned adjacent first and second axially opposed ends of said inner pipe respectively, said collars extending transversely of said outer passage fixedly connecting said pipes, each said collar further including,

at least one collar passage extending entirely axially of said collar, a peripherally extending, outwardly facing, radial end surface; said first collar and both of said inner and outer pipes adjacent said first axial end further including,

axially extending first threaded portions; said second collar and both of said inner and outer pipes adjacent said second axial end including,

axially extending second threaded portions shaped to be complimentary to the respective said first threaded portions;

abutment means connected with at least one of said pipes adjacent opposite axial ends thereof, said abutment means upon threaded connection of the length of tubing to another, similar length of tubing causing the adjacent collar radial end surfaces to be spaced sufficiently apart to define a peripheral fluid passage communicating with the adjacent collar passages of the lengths of tubing; and

said first and said second axially extending threaded portions, upon threaded connection of said length of tubing with complimentary threaded portions of another length of said tubing, causing said outer pipe of said length to be in direct torque transmitting relationship with the outer pipe of said other length of tubing and said inner pipe of said length to be in direct torque transmitting relationship with the inner pipe of said other length of tubing.

2. A length of well tubing as defined in claim 1, wherein said abutment means includes,

inclined, nonthreaded, axially extending first and second pairs of mating abutment surfaces on said threaded portions of said inner and outer pipes respectively for limiting axial approaching motion of adjacent said collar radial end faces of connected tubing lengths during threading engagement thereof.

3. A length of well tubing as defined in claim 2 further including,

first seal means interposed between and connected with the adjacent mating abutment surfaces of said first pairs thereof for providing a seal between adjacent said inner pipes of connected lengths of well tubing to prevent leakage of fluid from said inner pipes, and second seal means interposed between and connected with the adjacent mating abutment surfaces of said second pair thereof for providing a seal between adjacent said outer pipes of connected lengths of well tubing to prevent leakage from said outer passages.

4. A length of well tubing as defined in claim 2 wherein: each of said collars extends axially inwardly of said pipe to a point spaced remotely from the adjacent threaded portions.

5. A length of well tubing as defined in claim 4 wherein, said first threaded portions are configured to provide an axially recessed, internally threaded, female socket of generally frustoconical shape; and said second threaded portions are configured to provide an externally threaded male connector of complementary configuration to said female socket.

6. A length of wall tubing as defined in claim 1 wherein each collar includes,

a plurality of said collar passages,
a plurality of collar segments extending peripherally between adjacent collar passages in contiguous abutting contact with said outer pipe, said collar segments being of substantially greater peripheral extent than said collar passages to reinforce said outer pipe against transverse collapse.

7. A length of well tubing according to claim 1 further including:

an axially extending outer surface formed on each side first and said second annular collars; and said at least one collar passage comprising a groove formed on said axially extending outer surface.

8. A pipe string providing noncommunicating axially extending fluid passages, the pipe string comprising:

at least two lengths of well tubing disposed in end-to-end relation extending axially on opposite sides of a radial plane, each said tubing length including,

an inner pipe,
an outer pipe spaced concentrically about said inner pipe, said pipes defining,

an outer fluid passage between said pipes;

one of said tubing lengths including,

axially extending threaded portions on each of the associated said inner and outer pipes adjacent said radial plane;

the other of said tubing lengths including,

axially extending threaded portions on each of the associated said inner and outer pipes threadedly engaged with the corresponding said threaded portions of said one tubing length to fixedly connect said tubing lengths in engaged relation with said inner pipes thereof in fluid communication;

with said inner pipes of said two lengths of tubing in direct torque transmitting relationship and said outer pipes of said two lengths of tubing in direct torque transmitting relationship;

each said tubing length further including,

at least one annular collar fixedly connected to said inner and outer pipes extending across said outer passage adjacent said radial plane,

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said collar including,

a peripherally extending, outwardly facing radial end surface,

a collar passage extending entirely axially of said collar in fluid communication with said outer passage;

abutment means connecting with at least one of said pipes in each tubing length adjacent opposite axial ends thereof, said abutment means of adjacent tubing lengths being in abutting contact to cause the adjacent collar radial end surfaces to be spaced sufficiently apart to define a peripheral fluid passage communicating with the adjacent collar passages of the length of tubing.

9. A pipe string as defined in claim 8 further including, first seal means connected with said threaded engaging portions of said inner pipes of said tubing lengths for preventing radial leakage between adjacent said inner pipes; and second sealing means connected with said threaded engaging portions on said outer pipes of said tubing lengths to prevent radial leakage of fluid between adjacent said outer pipes.

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THOMAS F. CALLAGHAN, Primary Examiner

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