Aug. 3, 1965 E. JOHNSON ETAL 3,198,555

PIPE COUPLING WITH LUG ENGAGING ROTATABLE COLLAR

Filed March 8, 1961

FIG. 1.

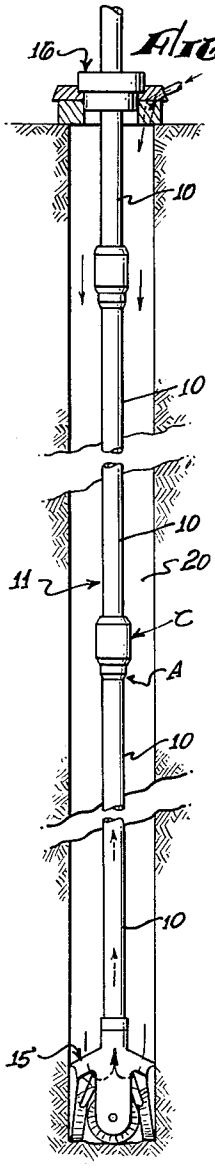


FIG. 5.

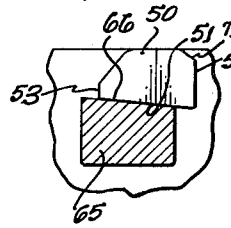
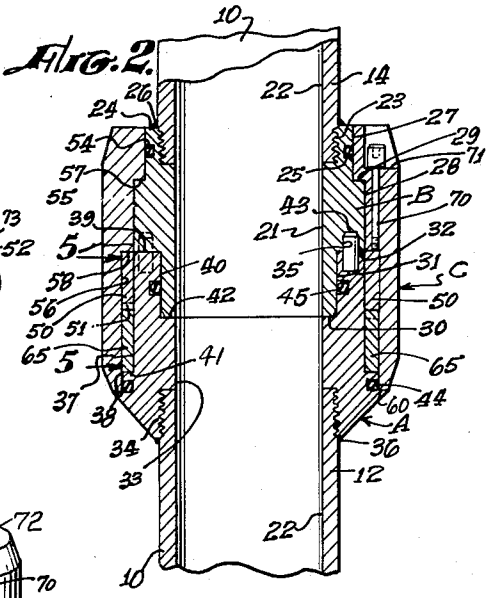
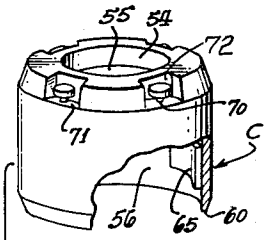


FIG. 2.





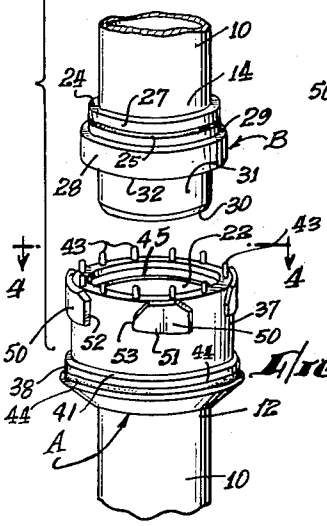
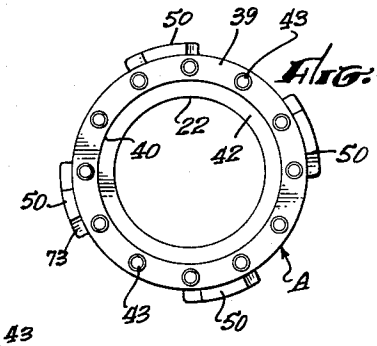


FIG. 3.

FIG. 4.



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3,198,555

PIPE COUPLING WITH LUG ENGAGING ROTATABLE COLLAR

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This invention relates to earth drilling apparatus and more particularly to a drill string tool joint for use with drilling apparatus utilized to drill holes of large diameter into the earth.

The drilling of holes of large diameter by the rotary drilling method is becoming increasingly important and the depth to which such holes are drilled has also increased. Large holes having diameters up to several feet have heretofore been drilled by the rotary drilling method, however, most of such holes have been shallow and the tools used for the purpose have been unsatisfactory for deep drilling and have entailed considerable expense. "Large diameter holes" are typically in excess of 20 inches in diameter. The conventional or forward circulation systems utilized in earth drilling operations are in general unsatisfactory for large diameter drilling to any substantial depth. That is, in the conventional forward circulation system as the hole is drilled within the earth, fluid is pumped down the tubular drill string and is forced upward in the annular space between the exterior of the drill string and the wall of the hole to remove the debris and cuttings from the bottom of the hole. So long as the drill hole does not reach an excessive diameter such that the cross-sectional area of the annulus surrounding the drill string is much greater then the cross-sectional area of the interior of the drill string, the system is satisfactory for carrying cuttings and debris upward. It can be seen however that as the annulus increases in size the volume of fluid which can be passed downward through the drill string will cause the level of fluid in the annulus to rise only slowly and without sufficient velocity to carry with the fluid objects such as cuttings and debris which are heavier than the fluid. The circulation system thus becomes inefficient for carrying materials from the bottom of the drill hole.

When the reverse circulation system is used whereby fluid is moved downward through the annulus and passes upward through the interior of the drill string it can be seen that when the annulus is of substantial cross-sectional configuration as compared to the cross-sectional area of the drill string fluid will achieve considerable velocity from the bottom of the hole upward and will efficiently carry cuttings and debris to the surface. Reverse circulation drilling is a well known art and as shown above is particularly useful in the drilling of large diameter holes to obtain sufficient circulation velocity to lift the cuttings from the bottom of the hole. In drilling large diameter holes, for example 46 inches and greater, reverse circulation is virtually essential in order to obtain sufficient upward velocity of the drilling fluid to carry the cuttings upward. In reverse circulation as the fluid reaches the bottom of the hole under pressure or gravity it is forced or sucked upward through the drill string, Kelly, swivel, etc., into a ditch or shaker system where the cuttings are separated from the drilling fluid. The fluid is then recirculated back into the hole surrounding the drill string. In drilling by reverse circulation to substantial depths, i.e., to depths of for example 2000 feet, it is necessary to supplement the pressure of the fluid in the annulus. One such method is by injecting air or a gaseous medium into the drill string at a point well below the surface. The injection of air

causes the fluid within the drill string to rise at a faster rate to make the fluid circulation more efficient.

Conventional means for coupling together the lengths of drill pipe as the drill string increases in length are not satisfactory for large diameter drilling and particularly for large diameter reverse circulation drilling. Conventional pipe joints and coupling means by which the pipe lengths forming the drill string are assembled together during the drilling operation are not sufficient in size for use with large diameter drill string. The diameter of the drill string presently used in connection with an exemplary large diameter drilling operation, i.e., a hole diameter of 46 inches is of the order 5$\frac{9}{16}$ inches—6$\frac{3}{4}$ inches.

It has been found that for efficiency of circulation by the reverse method it is essential that the interior surface of the drill string be smooth to allow maximum velocity and unimpeded travel of the fluid upward through the string to carry the cuttings and debris from the bottom of the drill hole. In addition, since large numbers of drill pipes will be coupled to form a long drill string for deep drillings, it is essential that the assembly and disassembly or coupling and uncoupling of the pipe lengths be accomplished with a minimum of effort and a maximum of speed.

Accordingly, it is a primary object of the present invention to provide an improved pipe joint for coupling sections of large diameter drill pipe together to form a drill string for large diameter drilling operations.

It is another object of the present invention to provide such a tool joint which has a smooth interior surface of constant diameter equal to the inside diameter of the drill pipe forming the drill string.

It is a further object of the present invention to provide such a tool joint which will present no shoulders or obstructions at the interior surface where lengths of drill pipe are coupled together in the drill string.

It is a further object of the present invention to provide such a tool joint whereby adjacent sections of a drill string can be quickly and efficiently coupled and uncoupled in forming the drill string.

Yet another object of the present invention is to provide such a tool joint for large diameter earth drilling drill strings, which joints will carry a very large force in torque.

A still further object of the present invention is to provide such a drill string which connects the adjacent length of drill pipe in rigid axial alignment and which maintains a high compressive force between the adjacent ends of the drill pipe to withstand high tensile forces exerted upon the drill string.

It is a still further object of the present invention to provide a tool joint for coupling lengths of large diameter drill pipe together to form a large diameter drill string especially adapted for reverse circulation and air lift reverse circulation earth drilling operations.

The novel features which are believed to be characteristic of the present invention, both as to its organization and method of operation, together with further objects and advantages thereof, will be better understood from the following description considered in connection with the accompanying drawing in which a presently preferred embodiment of the invention is illustrated by way of example. It is to be expressly understood, however, that the drawing is for the purpose of illustration and description only and is not intended as a definition of the limits of the invention.

In the drawing:

FIGURE 1 is a partially schematic view in elevation of a large diameter drill string utilized for the drilling of large diameter holes in the earth showing illustrative

sections of drill pipe coupled by means of a tool joint in accordance with the present invention;

FIGURE 2 is a cross-sectional view in elevation of the presently preferred embodiment of the present invention;

FIGURE 3 is an exploded view in perspective of the component parts of the embodiment shown in FIGURE 2;

FIGURE 4 is a top plan view taken along line 4—4 of FIGURE 3; and,

FIGURE 5 is a partial detail view taken along line 5—5 of FIGURE 2 showing the locking and tensioning means of the present invention.

Referring now to the drawing, there is shown a presently preferred embodiment of the present invention as used in coupling lengths of large diameter drill pipe together to form a large diameter drill string. As shown in FIGURE 1, the tool joints of the present invention are fixed at each end of the drill pipe sections. For purposes of orientation, it can be said that the drill pipe is vertically extended and that the section A of the tool joint of the present invention is affixed to the upper end **12** of a drill pipe while the section B is connected to the lower end **14** of the adjacent drill pipe. An assembly section C makes up the third section of the tool joint. Although not limited thereto the present invention is particularly suited and adapted for the assembly of drill strings for large diameter reverse circulation drilling as described hereinbefore.

Thus, referring to FIGURE 1, the utility and operation of the present invention in connection with such use will be described as illustrative. In FIGURE 1 a large diameter drill bit or hole enlarger **15** is affixed at the lowermost end of the drill string **11** composed of sections **10** of drill pipe and is rotated with the drill string by means of a rotating force **16**, such as a Kelly or other conventional rotary drilling means at the upper surface of the hole. An annular space **20** is defined between the exterior of the drill string **11** and the interior wall of the hole being drilled. Means are provided at the lower end of the drill string **11** in conjunction with the drill bit or hole enlarger **15** for passing fluid from the annulus **20** to the interior of the drill string. Fluid is then pumped or allowed to circulate downward through the annulus **20** and upward through the drill string **11**. It is necessary that the upwardly moving fluid within the drill string has sufficient velocity to carry with it the cuttings and debris from the bottom of the hole. When air injection or an air lift is utilized, air is forced into the upwardly moving column of fluid at the point beneath the surface within the interior of the drill string to increase the upward velocity of the fluid with the string. As shown in FIGURE 1, a tool joint in accordance with the present invention is utilized to couple additional lengths of drill pipe to the string as it descends into the hole during the drilling operation. Conversely, as the drill string is removed from the hole, the tool joint is utilized to uncouple each length of drill pipe from the string. The tool joint of the present invention is utilized for coupling of drill pipes which are typically 10¾ inches in diameter, for example.

In general, the tool joint in accordance with the present invention, as shown in FIGURE 2, a female section A affixed to the upper end **12** of one drill pipe, a male section B affixed to the lower end **14** of the upwardly adjacent drill pipe and a connecting section C by means of which the male and female components are interlocked. Referring now particularly to FIGURES 2 and 3, the male section B is of generally cylindrical configuration with an inside wall **21** of uniform diameter equal to the inside diameter **22** of the drill pipe sections **10** forming the drill string. Female threads **23** are formed extending inwardly from the upper end **24** of the male section B and are adapted to threadably engage the male threads of the lower end **14** of a drill pipe section **10**. The male section B is threaded onto the drill pipe end **14** and permanently affixed thereto as by means of a weld shown at **26**. The outside configuration of the male section B is defined by three longitudinally extending portions of different diameters. The first portion **27** is defined by an outside diameter substantially greater than the inside diameter of the female threads **23**, and extends downwardly from the upper end **24** of the male section B. Disposed within a peripheral groove in the portion **27** is a resilient O-ring **25**. Spaced downwardly from the upper end **24**, the second portion **28** is of substantially greater diameter than the first diameter **27** and thereby defines a transverse extending upwardly facing shoulder **29**. Extending upwardly from the lower end **30** of the male section B, the third portion **31** is of substantially lesser diameter than the second diameter **28** to thereby define a downwardly facing transverse extending shoulder **32** of substantial width. A plurality of circular openings **35** are extended upwardly from the downwardly facing shoulder **32** into the male section B. The openings are of equal diameter, are longitudinally extending, that is, parallel to the axis of the tool joint, and are spaced at equal circumferential intervals about the shoulder **32**. In the presently preferred embodiment, twelve such openings are utilized at 30° intervals.

As shown particularly in FIGURES 2 and 3, the female section A of the tool joint is also of generally cylindrical configuration with an inside wall equal in diameter to the inside diameter **22** of the drill pipe **10**. The female section A is female threaded at **34** extending upwardly from the lower end of the section A and the threads **34** are mateable with the male threads of the upper end **12** of a drill pipe **10** such that the pipe **10** can be threaded into engagement with the female section A and affixed therein by means such as a weld **36**. Where pipe **10** bottoms in section A at shoulder **33**, it is a tight-fit shoulder. The female section A is of substantially constant outside diameter as at **37** except for a step portion near the bottom end which defines a vertical surface portion **38** and a peripheral, transverse shoulder **41**. Disposed within a peripheral groove in the surface portion **38** is a resilient O-ring **44**. A counter bore is formed extending downwardly from the upper end **39** of the female section A along a portion of its length to define a section of greater inside diameter **40**, which diameter **40** is equal to the lower portion of outside diameter **31** of the male section B and is equal in length to the length of the portion of diameter **31**. The lower end **30** of the male section B will thus abut the upwardly facing transverse shoulder **42** formed between the diameter **40** of the female member A and the inside diameter **22**. Disposed within a peripheral groove in the section of inside diameter **40** is a resilient O-ring **45**. A plurality of pins **43** mateable with the openings **35** are affixed to the upper end **39** of the female member A and are spaced circumferentially at intervals equal to the intervals of the openings **35** and at the same radius such that when the male section B is mated with the female section A by inserting the lower section **31** of the male section B into the recess **40** of the female section A, the pins **43** will mate with the openings **35** to prevent relative rotation between the male and female sections. The spacing of the pins **43** circumferentially along the upper end **39** of the male section B is shown particularly in FIGURE 4. The pins **43** can be affixed in the orientation as shown by means which allow their removal and renewal after wear has occurred. That is, in the presently preferred embodiment, hardened inserts are formed to define the openings in the femal section A and the pins **43** are slip-fitted into the inserts. The hardened inserts are removable.

Upon the exterior wall of the female section A adjacent the upper end **39** thereof, there are provided a plurality of circumferentially spaced affixing lugs **50**,

which are generally arcuate in configuration with an inside radius conforming to the outside radius of the female section A with a substantially greater outside diameter **37**. The lugs **50** each define a bottom bearing surface **51** as shown in FIGURES 2 and 4. The bearing surface **51** is slightly tapered as shown particularly in FIGURE 5. In the presently preferred embodiment, four such lugs **50** are utilized and are spaced at 90° intervals with the interval between opposed vertically extending edges **52** and **53** spaced apart by a substantial distance to allow entry of mating lugs formed upon the coupling section C, all described in greater detail hereinafter.

The coupling section C comprises in general a cylindrical collar as shown in FIGURES 2 and 3 with an interior surface formed at three diameters **54**, **55**, and **56**. The first diameter **54** substantially equal to but greater than the outside diameter **27** of the male section B and is equal in longitudinal extent to the diameter **27**. The second diameter, similarly, substantially equal to but greater than the diameter **28** of the male section B such that a downwardly facing shoulder **57** is defined which is mateable in bearing relationship with the upwardly facing shoulder **29** of the male section B. The section of third diameter **56** extending upwardly from the lower end **60** of the coupling section C is substantially greater than the outside diameter **37** of the female section A, and is at least greater than the diameter **37** by an amount equal to the radial thickness of the lugs **50** integral with the exterior wall of the female section A, to thereby form a downwardly facing shoulder **51**. A plurailty of lugs **65** are integral with the interior wall **56** of the coupling section C and are adapted to be mated by a partial turn of the coupling section with the lugs **50** on the female section A. Thus in the presently preferred embodiment, four lugs **65** are provided and integral with the interior wall **56** of the coupling section C. The lugs **65** are spaced at 90° intervals in this embodiment and are of arcuate extent less than the interval between adjacent edges **52** and **53** of the lugs **50** such that the lugs **65** can be inserted between the lugs **50** as the coupling section C is placed over the sections A and B as described hereinafter.

The upper surface **66** of the lugs **65** as shown in FIGURE 5 is tapered oppositely to the bearing surface **51** of the lugs **50**. That is, for example, the surfaces **51** and **66** are inclined at an angle of 4° from the horizontal such that by rotation of the coupling section with respect to the lugs **50**, the coupling section C is pulled towards the female section A as the coupling section C is rotated.

The coupling section C is provided with a plurality of fastening bolts **70**, one each of bolts **70** being disposed in vertical alignment above each of the lugs **65**. Each of the bolts **70** extends downwardly from a recessed shoulder **71** formed in the upper surface of the coupling section C, passing through a longitudinally extending threaded hole to the downwardly facing shoulder **58**. The bolts **70** are long enough so that their lowermost ends will protrude downwardly from the shoulder **58** when the bolt heads are screwed down towards the shoulders **71** to engage the chamfered upper edge **73** of the lug **50**. The exterior surface of coupling section C is substantially cylindrical, except for the pockets **72** which are comprised in part of the shoulder **71** and which receive the heads of the bolts **70**. The bolts **70** lie interiorly of the outer surface of coupling section C, so that a relatively smooth exterior is provided to thereby facilitate flow past the joint.

Thus, each drill pipe **10** is equipped with a female section A mounted to its top end with a coupling section C slidably disposed above the male section B. To couple drill pipe together to form a drill string the male member B at the bottom of one drill pipe is mated with the female section A at the upper end of the drill pipe projecting from the drill hole, the pins **43** in the female section A mating with the holes **35** in the male section B.

Provided that the male section B and female section A mate as indicated, the coupling section C may be slid down over the male section B until the lugs **65** abut against the shoulder **41**, which thereby functions as a locating shoulder. Then the coupling section C is rotated in a counter-clockwise direction to bring the lugs **65** and **50** into bearing contact to thereby lock the male and female sections together. However, if the male section B does not properly seat on or in the female section A, due to a pebble on shoulder **29** or shoulder **39**, for example, the lugs **65** of coupling section C will not seat on shoulder **41**, and they will abut against the edges **52** of the lugs **50**. There will thereby be provided an indication of improper seating of the sections A and B, which must be corrected prior to proceedings further, after which the fastening bolts **70** in the coupling section C are screwed down until their lower ends are in bearing contact with the upper bevel **73** of the lugs **50** on the female section A, thereby assuring that the coupling will remain locked upon rotation of the drill string. The O-rings **25**, **45** and **44** insure that the coupling is fluid-tight.

It is to be understood that various modifications in the construction and arrangement of elements of the tool joint of the present invention can be made without departing from the scope of the present invention and that the described embodiment is illustrative only. For example, various means for radially interlocking the tool joint can be utilized such as by forming mating serrations or gear surfaces on end or shoulder surfaces **39** and **32** has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination, and arrangement of parts may be resorted to without departing from the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A drill string tool joint for use with drilling apparatus and for interconnecting in end to end relationship two adjacent lengths of drill pipe having exterior threads adjacent their ends comprising; a female section having internal threads at one end for connection to the end of a first drill pipe, a generally cylindrical exterior surface extending to the other end thereof, a plurality of spaced lugs extending outwardly from said exterior surface, a peripheral, transverse shoulder longitudinally below said lugs, and means for receiving a portion of a male section at the end opposite said threads; a male section having internal threads at one end for connection to the end of a second drill pipe, a portion seating in the receiving means of said female section, an upwardly facing exterior peripheral shoulder between an upper relatively small exterior diameter portion and a lower and adjacent relatively large exterior diameter portion; a coupling section having an upper portion having an internal diameter slightly greater than and of approximately the same longitudinal extent as said upper portion of said male section, an intermediate portion having an internal diameter slightly greater than said last-mentioned portion of said male section, a lower portion having an internal diameter slightly greater than the diameter defined by the external surfaces of said lugs of said female section, and spaced lugs for engagement with said lugs of said male section extending inwardly from said lower portion, the longitudinal distance between the upper edge of said intermediate portion and the lower edge of the lugs of said coupling section being substantially the same as the longitudinal distance between said shoulder of said female section and said shoulder of said male section; and means to seal said tool joint sections.

2. The tool joint of claim **1**, and means interconnecting said male and female sections against relative rotation.

3. The tool joint of claim **1**, said lugs of said male section

having beveled upper edges, said coupling section having bolts extending longitudinally therethrough with their lower ends engaging said beveled upper edges, said coupling section having a series of pockets receiving the heads of said bolts, the exterior surface of said coupling section being relatively smooth other than at said pockets.

4. The tool joint of claim 1, said seal means comprising elastic O-rings.

References Cited by the Examiner

UNITED STATES PATENTS

227,170	5/80	Lechner	285—359
793,869	7/05	Anderson	285—330
1,610,414	12/26	Bernard	285—330
2,165,163	7/39	Waters	285—361
2,684,860	7/54	Rafferty	285—374

FOREIGN PATENTS

151,430	3/32	Switzerland.

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