Jan. 26, 1965 H. C. HUMPHREY 3,167,137

WEIGHTED DRILL COLLAR

Filed Dec. 19, 1961

(PRIOR ART) FIG. 1.

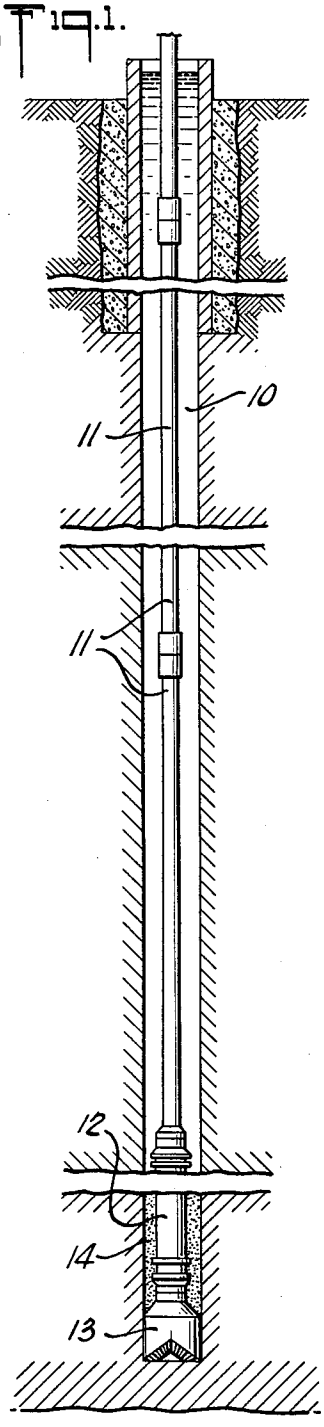
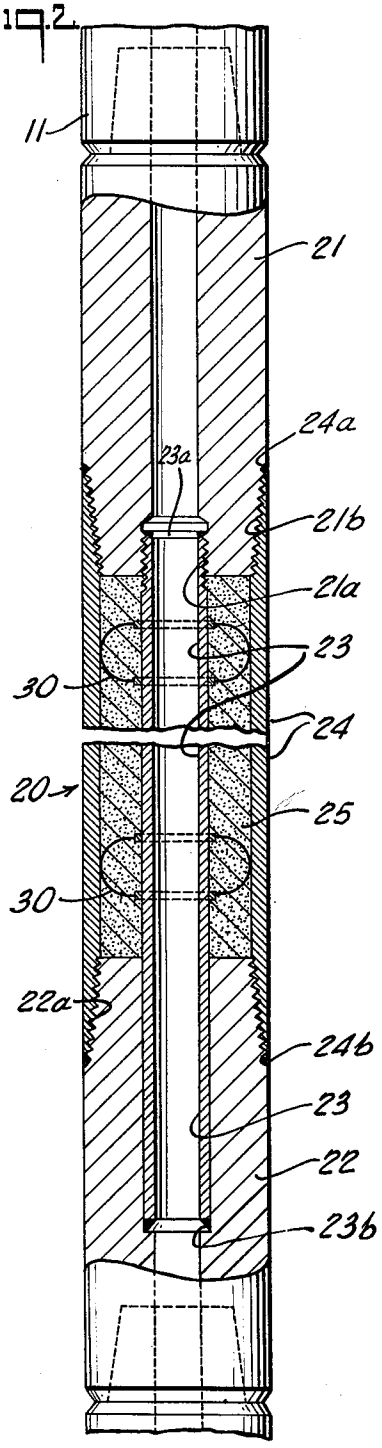


FIG. 2.



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WEIGHTED DRILL COLLAR

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This invention relates generally to well drilling and specifically is concerned with an improvement in drilling tools.

In rotary drilling, the bit is rotated, with weight being applied to it in order to obtain effective cutting. As the well bore increases in depth, lengths of drill pipe, each 30 feet long are added to form the drill stem. Through this drill pipe, drilling fluid is provided to the bottom of the well bore, where the bit cuttings are picked up and brought to the surface.

Frequently, these cuttings and other detritus form such a compact mass at the bottom of the well bore that the drilling fluid is unable to carry such matter away, the drill stem becomes wedged in the well bore and is unable to rotate the bit for further drilling. When such an incident occurs, as much as possible of the drill stem is salvaged by unscrewing individual lengths of the drill pipe and the remainder of the drill stem is abandoned.

This is an expensive proposition since the drill stem adjacent the bit comprises the drill collar, which is distinct from the drill pipe. This collar is essential to drilling operations because it functions through its weight and rigidity to keep the hole straight. It keeps weight on the big without compression on the drill pipe and thereby aids in avoiding hole deviation.

The drill pipe, on the other hand, transmits torque, circulates mud, and is relatively too flexible to contribute much weight at the bottom of the drill hole without bending.

Conventional drill collars are made of solid steel billets to obtain the necessary weight, with the center machined out to the desired inside diameter. A costly limitation is associated with this method of construction because the outside diameters often are large enough to prevent adequate "washing over" in those cases where the drill collars become stuck.

These collars are commonly 30 feet in length, with from 1 to 20 of them joined together for drilling a single well through soft formations, while up to 40 or more may be required for hard formation drilling. Each collar ranges in cost from $500 to $1000 or more, so that it becomes expensive when drill collars have to be abandoned when the drill stem becomes stuck. The conventional drill collar ranges in inside diameter from 1½" to 4" and outside diameter from 4¼" to 8¼".

There is no fixed rule for the relationship of the outside diameter of a drill collar to the diameter of drill pipe used. The essential thing is to use a drill collar whose diameter will permit a standard casing size inside diameter to slip over it, if "washing-over" becomes necessary. The inside diameter of the wash pipe will also have to be large enough to pass over the drill pipe joints and pipe protectors. In other words, the outside diameter of a drill collar should be that of a diameter less than the diameter of well bore which will permit a wash-over pipe to slip over it. This permits a considerable variation in the selection of drill collars.

Accordingly, it is an object of the invention to provide an improved drill collar which has a lesser outer diameter and yet is substantially as heavy as those of conventional construction.

It is another object of the invention to provide an improved drill collar which is simple and inexpensive to manufacture.

Still another object of invention is to provide an improved drill collar which is more susceptible to salvage and recovery operations.

These and other objects, advantages and features of the present invention will become apparent from the following description of the inventiton and by reference to the accompanying drawing wherein:

FIG. 1 is a partial diagrammatic vertical section of a prior art bore hole indicating a typical condition therein; and

FIG. 2 is a cross section of my improved drill collar.

In accordance with the illustrated embodiment of my invention, there is shown a composite structure in which an annulus formed by spaced, high tensile tubes is filled with an alloy having a specific gravity greater than conventional steel to provide the required weight in a drill collar; and a method for constructing the same is disclosed.

Referring to FIG. 1, a typical prior art bore hole extending into the earth is disclosed at **10**, in which the drilling means are shown as comprising a string of drill pipe **11**, connected to the drill collar **12**, to the lower end of which is secured a rotary drill bit **13**, which, upon rotation of the drilling means, produces the bore hole. As an example, when drilling at approximately 9,000 feet, a 12¼" or 12½" bit would be attached to a 7¾" outside diameter drill collar string, which, in turn, would be attached to a 5" drill pipe string. As the drilling progresses, cuttings and other chips **14**, removed by the bit **13**, accumulate at the bottom of the bore hole and are carried to the surface and deposited in a manner well known and so not fully illustrated here.

FIG. 2 discloses the composite drill collar **20**, as comprising tool joints or threaded end sections, with the section having the external taper threaded pin at **21** and the section having the internal taper threaded socket at **22**. High tensile strength, tubular steel pipes, shown at **23** and **24**, the latter with internal taper threaded ends, respectively form the inner and outer walls of the drill collar, and are fastened to the end sections, either by screw threading and/or welding, thereby defining an annular chamber. Because of the relatively long length of the chamber (about 30') as compared with its short diameter (about 8"), centering guides between the inner and outer pipes are used. These guides, shown at **30**, are commercially available and are installed 5 to 6 feet apart, and being of the spring steel "spider" type may be welded to either tube before assembly. The annular chamber is then filled with lead or lead alloy **25** prior to final fastening. The fastening is shown exemplarily by the threaded connections at **21***a* and **21***b* between the tool joint **21** and the pipes **23** and **24** and by the welds at **23***a* and **24***a*, and by the threaded connection **22***a* between tool joint **22** and pipe **24** and by the weld connections between tool joint **22** and the pipes **23** and **24** at **23***b* and **24***b*. The notch welds at **24***a* and **24***b* lock the screw joints and prevent any "backing off" or unscrewing.

The spacing guides **30**, fixed to either one of the pipes, serve not only as partial partitions but also as anchors to hold the lead filling in position and thus preserve the bond to the filling exposed surfaces of the pipe to prevent independent motions between the pipe and the lead filling and to provide continuity in the cross section of the composite drill collar. If necessary, the surfaces of the pipe to be exposed to the lead filling may be treated specially in order to obtain a better bond between the lead filling and the spaced pipe.

The drill collar can be fabricated to any dimension for use in drilling, and usually is based on standard size drill pipe. Thus, when such a composite drill collar, using standard size drill pipe, is attached to a drill string of drill pipe having the same outer diametral dimension as the

composite drill collar, then the drill string would have a uniform outer diametral dimension (see FIGURE 2). When a 7 inch outside diameter pipe is used with a 2½ inch drill pipe centered internally, with both joined to 7 inch tool joints or end sections and the annulus thus formed filled with lead or a lead alloy, the following comparison of dimensions and weights of drill collars illustrates the advantages to be gained:

	Conventional Drill Collar	Improved Drill Collar
Outside diameter, inches	7¾	7
Wgt. with 2" I.D., lbs.	4,500	4,600

While drill pipe for either the inner or the outer wall may be used, a high tensile strength, tubular steel, heat treated for hardness, is necessary. Tubular steel of the desired specifications for the 2½" inner pipe and the 7" outer pipe may be found in three types of tubular steel approved by the American Petroleum Institute. These three A.P.I. steels are designated as N–80, J–55 and P–110, and the tabulation below lists the relative strengths of these three types of tubular steel.

Table 1

Type	J–55	N–80	P–110
Minimum yield strength (p.s.i.)	55,000	80,000	110,000
Average yield factor (p.s.i.)	65,000	85,000	123,000
Minimum tensile strength (p.s.i.)	75,000	100,000	125,000

With the use of a conventional 7¾" drill collar for drilling a 9⅞" bore hole, the clearance on each side of the drill collar is 1 1/16". In the event the drill collar becomes stuck, this small clearance to get over the drill collar with a rotary shoe and wash pipe in order to "wash over" and clear away the wedged detritus between the drill collar and the bore hole is such that more failures to complete the "wash over" than successes result.

With the improved drill collar, having an outside diameter of 7", the clearance on each side is 1 7/16", which is enough to permit the rotary shoe and wash pipe to "wash over" it and clear out the detritus.

The weights and strengths of materials used are also advantageous. Steel specific gravities fall in the approximate range of 8.2 and lower, while lead and lead alloys fall in the range of 9.4 to 11.3. ASTM Grade 19 lead-base Babbitt has a tensile strength of 10,000 p.s.i. as compared to the tensile strength of 1,500 p.s.i. for cast lead. This particular Babbitt contains about 5% tin, 9% antimony and 86% lead. A comparative lead alloy with 10% antimony has a tensile strength of 8,000 p.s.i.

One method of fabricating the disclosed composite drill collar is to fasten the inner pipe of the drill collar to a composite or built-up A.P.I. threaded pipe joint, either by welding, as shown at **23***b*, FIG. 2, or alternatively, by a screw thread joint and an anchor weld to lock the joint, as shown at **21***a*, **23***a*, FIG. 2. The spacing guides or "spiders" (**30**, FIG. 2) are fastened as by flash welding, either to the outer surface of the inner pipe or the inner surface of the outer pipe. Then, the part of the drill collar assembly with the pipe joint would be positioned and centered in the outer tubes, which makes up the external part of the drill collar, the pipes being spaced apart from each other by the centering guides. This partial assembly then is lowered into a "rat hole" in a metal fabricating shop, and the annulus between the spaced pipes is poured full of molten lead or a lead alloy. After cooling of the poured material, the other fabricated A.P.I. tool joint is

attached to the partial assembly in a similar manner, either by threading and/or welding. In the case of a threaded connection, a notch weld provides positive locking of the screw joint, as shown at **24***a*, FIG. 2.

The disclosed drill collar is an improvement over that disclosed and claimed in my prior Patent No. 2,958,512, issued on November 1, 1960.

Thus, there has been disclosed and described a novel method and improved drill collar made thereby which is adapted to be attached to the drill string of drill pipe having the same outer diametral dimension, and when compared with the conventional drill collar, is relatively easy to salvage, is less costly to fabricate, and has greater weight with smaller outside diameter.

Obviously, other modifications and variations of the invention as hereinbefore set forth may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. In combination, in a drill collar of composite construction subject to rotation, end sections and inner and outer pipe members joined thereto in concentrically spaced relationship to each other thereby defining an annular chamber therewith, said drill collar being adapted to be attached to a rotatable drill pipe string having the same outer diametral dimension, each of said end sections having the same outer diametral dimension as the outer pipe member and having a passageway in coaxial communication with and with a diameter equal to the inner diameter of the inner pipe member, a metallic material completely occupying said annular chamber and having a higher specific gravity than said pipe members and said end sections to provide a drill collar of substantially the same or greater weight and of lesser outer diametral dimension in comparison with a conventional integral drill collar, said metallic material being selected from the group consisting of lead and an alloy of lead having a specific gravity ranging from 9.4 to 11.3, and a plurality of resilient metallic members fixedly fastened to and spaced along the length of one of said pipe members within said annular chamber, said metallic members projecting equidistantly from said one of said pipe members into contact with the other of said pipe members for concentric positioning of said pipe members with respect to each other, said metallic members being imbedded in said metallic material to serve as anchors therefor.

2. In a drill collar in accordance with claim 1, said end sections and said outer pipe member are taper threaded for fastening to each other, and a weld at the external end of each of the screw joints between said end sections and said outer pipe member seals each of said joints and prevents unscrewing.

3. In a drill collar in accordance with claim 1, said inner and outer pipe members comprise standard size drill pipe, said inner and outer pipe members being lock fastened to said end sections by welds.

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