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DRILL COLLAR FOR OIL WELLS

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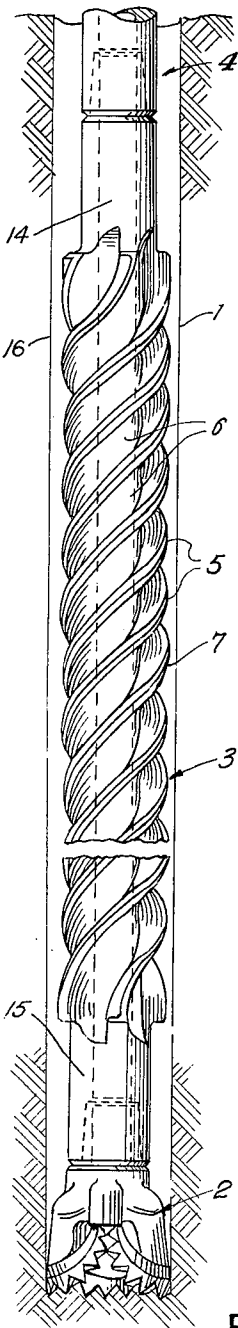


Fig. 1

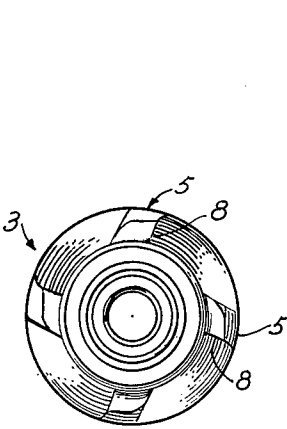


Fig. 3

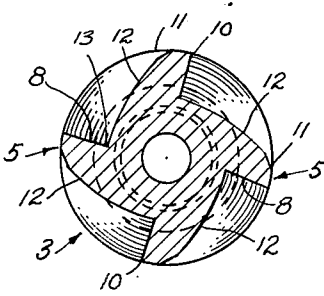


Fig. 4

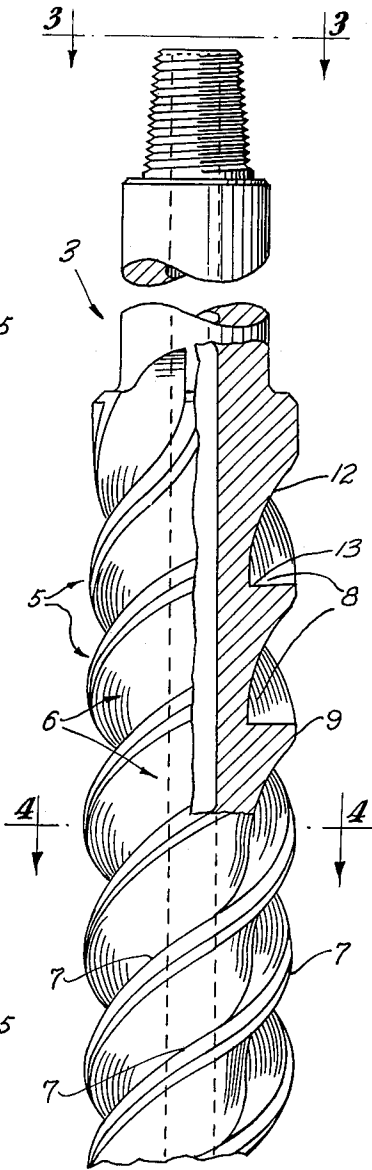


Fig. 2

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DRILL COLLAR FOR OIL WELLS

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2 Claims. (Cl. 175-323)

This invention relates to a drill pipe for use in the rotary drilling of wells, and it concerns more particularly a drill pipe having a plurality of circumferentially and longitudinally spaced screw flights formed thereon for use as guides for the drill pipe, to thereby produce a straight hole, and as conveyor screws adapted to coact with the well bore to remove from the well bore the cuttings produced by the action of the drilling bit.

In one application thereof the drill pipe of the invention may be substituted for a conventional drill collar, attached directly to the drilling bit. Alternatively, one or more lengths of drill pipe embodying the invention may be operatively connected in a string of drill pipe at any point above the drilling bit. A plurality of lengths of drill pipe embodying the invention may be connected together if desired.

An object of the invention is to continuously remove from the vicinity of the drilling bit, as formed, the earth cuttings produced by operation of the bit, so that it is not necessary for the bit to rotate the cuttings simultaneously with its cutting action.

Another object of the invention is to assist in the removal of earth cuttings from the well bore, thereby reducing the load on the pump which is used to circulate the drilling fluid.

Another object of the invention is to clean the well bore and to smooth the surface thereof.

A still further object of the invention is to provide guide means integral with the drill pipe for progressive sliding, non-cutting engagement with the well bore, as the drill pipe is advanced downwardly therein, by operation of the bit, to thereby produce a straight hole.

This application is a continuation in part of applicant's co-pending application, Serial No. 738,856, filed May 29, 1958.

The invention will be readily understood by referring to the following description and the accompanying drawing, in which:

FIGURE 1 is an elevational view showing a length of drill pipe embodying the invention connected directly to a drilling bit, whereby it serves as a drill collar, in association with a well bore.

FIGURE 2 is a fragmentary elevational view on an enlarged scale, partly in section taken on a median line, of the drill pipe shown in FIGURE 1.

FIGURE 3 is a top plan view taken on the line 3-3 of FIGURE 2; and

FIGURE 4 is a sectional plan view taken on the line 4-4 of FIGURE 2.

Referring to FIGURE 1 of the drawing, the numeral 1 designates a well bore which is in the process of being drilled by the action of a drilling bit, indicated by the numeral 2.

A length of drill pipe embodying the invention, indicated generally by the numeral 3, is connected directly at its lower end, by threads (not shown), to the bit 2 whereby it serves as a drill collar.

The length of drill pipe 3 is connected at its upper end, by threads (not shown), to an adjoining length of drill pipe 4, which is shown fragmentarily, operatively positioned in the well bore 1.

The length of drill pipe 4 may be operatively connected in a string of drill pipe which is supported at the surface and is rotated from the surface while simultaneously circulating a drilling fluid in and out of the well, through the bit 2, in the usual manner.

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As shown best in FIGURES 2 to 4, the drill pipe 3 has a plurality of screw flights, each indicated generally by the numeral 5, formed thereon for use as guides for the drill pipe 3, to thereby produce a straight hole, and as conveyor screws adapted to coact with the well bore 1 to remove from the well bore 1 the cuttings produced by the action of the bit 2.

The screw flights 5 are equally spaced helically about the drill pipe 3, and extend radially outwardly therefrom for progressive sliding, non-cutting engagement with the well bore 1, as the drill pipe 3 is advanced downwardly therein, by operation of the bit 2, to thereby produce a straight hole.

The diameter of the screw flights 5 approaches, but is less than, the diameter of the well bore 1, and their design is such that they are adapted to coact with the well bore 1 as explained hereinafter to form a screw conveyor adapted to continuously remove from the vicinity of the bit 2, as formed, the earth cuttings produced by operation of the bit 2 and to assist in the removal of the cuttings from the well bore 1.

The screw flights 5 are integral with the drill pipe 3, and advantageously may be formed by turning the drill pipe 3 in a lathe whereby helical grooves 6, each having a contour described more particularly hereinafter, are cut.

The screw flights 5 have incorporated therein features which are commonly employed in the design of screw conveyors, whereby the screw flights 5 may be employed effectively as conveyor screws, for the purpose described.

When drill pipe, or drill collar, 3 is machined to form screw flights 5, material is removed from the collar to form grooves 6, between each two of which is created a screw flight, or thread, 5. As more clearly illustrated in FIG. 2, each groove 6 is bounded by a surface 8 and a surface 12 which connect along and form a helical line, or junction, 13. When viewed in vertical cross-section (as shown in part in FIG. 2) each thread 5 has an outer surface 7 which is essentially parallel to the longitudinal axis of the drill collar; also, surface 8 is perpendicular to surface 7 and at 10 defines the leading edge of surface 7 and, hence, thread 5.

Of course, surface 8 is inclined upwardly and backwardly from a plane perpendicular to the longitudinal axis of collar 3. As shown in FIG. 4, surfaces 8 extend radially from junction 13.

From junction, or helical line, 13 surface 12 curves outwardly and upwardly to the lower edge 11 of the thread 5 immediately thereabove to form the trailing edge of that thread and its surface 7. In this manner each thread 5 has an essentially "flat" leading surface 8 which acts as a "scoop" for the cuttings produced by bit 2 when drill collar 3 is rotated in a clockwise direction as viewed in FIG. 4. Due to its peculiar configuration surface 12 tends to cause the cuttings so produced to remain on surface 8, thereby causing them to be removed more efficiently and rapidly from bit 2. Also, this surface 12 configuration provides a larger mass at the underside of each thread 5, thereby giving of each thread added strength.

As depicted in FIG. 1, the radius of threads 5 is less than the radius of the largest portion of bit 2. Experience and extensive experimentation has shown that the radius of threads 5 should be just slightly less than that of the largest portion of bit 2 in order that two essential functions can be performed, to wit: First, effective lifting action of the cuttings of bit 2 will be more efficiently produced; and secondly, a straighter hole will be obtained. Experimentation has shown, for example, that for a size 7½ inch (outermost diameter) bit 2, the radius of threads 5 should be 3¾ inches. With these dimensions threads 5 do not constantly co-act with the walls of well bore 1 and ream the bore further; however, these threads do contact bore 1 more frequently than would an ordinary

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drill collar and, thus, accomplish: (1) keeping bit 2 directed more vertically; and (2) providing more nearly "closed" channels (through grooves 6) through which the cuttings from bit 2 and the drilling mud must flow upwardly for the purpose aforesaid. (The illustrative bit 2 size used above, to wit: 7 $\frac{7}{8}$ inches, is one of the most frequently and commonly used sizes in the oil industry.) As shown in FIGS. 1 and 2, grooves 6 are open at their upper and lower ends. Since the diameter of collar 3 through grooves 6 is approximately the same as its diameter through necks 14 and 15, and the ends of grooves 6 are open, the mud and material loosened by bit 2 is not restricted in any manner from passing necks 14 and 15 when forced upwardly by the "auger" effect of collar 3 when the collar is rotated.

Drill collar 3 produces a "straight hole" because it reduces the "play" or "wobble" in bit 2 permitted by conventional drill collars. Eliminating this "play" prevents the bit's being diverted in its direction, or attitude. The conventional drill collar has an outer diameter approximately that of necks 14 and 15 (the upper and lower portions of drill collar 3 shown in FIG. 1) much smaller than the largest diameter of bit 2; and, the purpose of this is to permit the drilling mud and cuttings (produced by bit 2) to flow upwardly therepast, the mud, of course, having been forced downwardly through drill collar 3 via bore 16. In this invention threads 5 prevent the "play," grooves 6 permit the flow of mud and cuttings upwardly, and surface 8 (inclined upwardly) facilitates such flow.

Threads 5 are not intended to act as "cutting" surfaces since they have a radius less than that of well bore 1. Yet, they may well serve to eliminate any protruding surface of bore 1. Essentially, threads 5 do not "cut" bore 1, although in contact intermittently therewith, and simply "slide" or "scrape" past bore 1. Were threads 5 of the radius (or diameter) of bore 1, they inherently would tend to cut into the wall of bore 1; however, this radius, or diameter, is less than that of bore 1, as produced by bit 2, and, therefore, threads 5 do not perform a "cutting" action with said bore. Threads 5 are "adapted to co-act with bore 1" in the manner aforesaid, both as to removing the "mud" and "cuttings" from bit 2 and as to aligning, or keeping straight, bit 2.

Experimentation has shown that when the pitch of threads 5 is approximately 15 times the threads' radius most effective results will be obtained. However, this pitch (though, of course, fixed in any one drill collar) will vary with a number of factors, and the particular drill collar to be employed can be determined only by experience. Among the major factors which will determine this pitch are the density of the formation being drilled, the drilling speed (i.e., the r.p.m. of bit 2), the pressure applied to the drilling mud, and the weight applied to bit 2 (i.e., the weight of the drill string and the force applied to it from the earth's surface).

The invention may be modified in various ways without departing from the spirit and scope thereof.

What is claimed is:

1. A drill collar connected intermediately of a drill

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bit and a string of drill pipe for drilling a well bore in the earth, comprising: an elongate, tubular stem having upper means and lower means for connecting said stem to said drill pipe and said drill bit, respectively; and a plurality of helical threads intermediate said upper and lower means, the radius of said threads being greater than the radius of said drill pipe and said upper and lower means and only slightly less than the radius of said bore to limit lateral movement of said drill collar thereby keeping said bit directed along the longitudinal axis of said drill collar, but without substantial cutting action, each two adjacent threads creating a helical groove therebetween having a first or lower wall essentially perpendicular to the longitudinal axis of said drill collar on which material loosened from the earth by said bit is transported from said bit upwardly into said bore above said drill collar and having a second or upper wall intersecting said first wall along a helical line extending throughout the length of the groove and said second wall curving upwardly and outwardly therefrom to form the lower surface of the thread thereabove, said second wall serving to maintain said loosened material on said first wall, whereby said loosened material is more effectively moved upwardly from the bit.

2. A drill collar connected intermediately of a drill bit and a string of drill pipe for drilling a well bore in the earth, comprising: an elongate, tubular stem having upper means and lower means for connecting said stem to said drill pipe and said drill bit, respectively; and a plurality of helical threads intermediate said upper and lower means, the radius of said threads being greater than the radius of said drill pipe and said upper and lower means and only slightly less than the radius of said bore to limit lateral movement of said drill collar, thereby keeping said bit directed along the longitudinal axis of said drill collar, each two adjacent threads creating a helical groove therebetween defined by a lower wall surface essentially perpendicular to the longitudinal axis of said drill collar on which material loosened from the earth by said bit is augered from said bit upwardly into said bore above said drill collar and said groove further defined by an upper substantially concave surface curving upwardly and outwardly from said perpendicular surface to form the lower surface of the thread thereabove, said concave surface intersecting said perpendicular surface and serving to maintain said loosened material on said lower surface, whereby said loosened material is removed from said bit.

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