

[54] **DRILL COLLAR INCORPORATING DEVICE FOR JETTING DRILLING FLUID TRANSVERSELY INTO BORE HOLE**

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[22] Filed: **Mar. 1, 1974**

[21] Appl. No.: **447,371**

[52] U.S. Cl. **175/393; 175/422; 175/406; 175/325; 175/65**

[51] Int. Cl.²..... **E21C 15/00**

[58] Field of Search **175/393, 406, 422, 324, 175/325, 320, 207, 60, 65, 100, 231, 317, 316, 339, 340, 344, 267**

[56] **References Cited**

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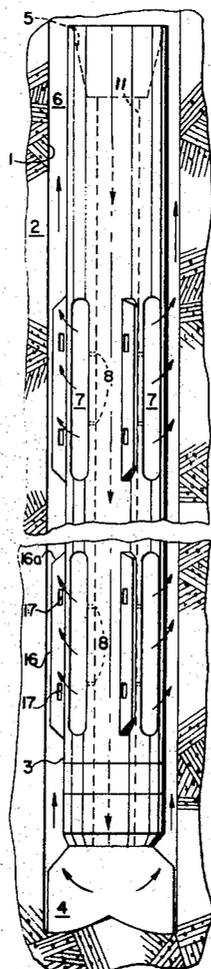
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 Assistant Examiner—Richard E. Favreau
 Attorney, Agent, or Firm—Pierce, Scheffler & Parker

[57] **ABSTRACT**

A self-stabilizing drill collar structure for incorporation into a drill string for deep well rotary drilling includes an elongated cylindrical collar member having an axially extending throughbore for passing drilling fluid downwardly to the lower end of the drill string. An arrangement of easily replaceable and non-fouling nozzles located within slots and protected by the wall of the collar serve to divert clean downwardly flowing drilling fluid from the axial throughbore and discharge it in a jet-like manner laterally outward from the opposite ends of the slots into the annular gap between the collar and bore hole to thereby improve lubrication of the gap and provide better circulation and return of the drilling fluid to the surface for re-cycling, and which enables the drilling to take place at a higher speed and with greater accuracy and stability as regards the desired course of the bore hole. The number of nozzles in operation can be varied as desired by replacing one or more of them with plugs and the collar member can also be provided optionally with reaming flanges to shape the bore hole.

12 Claims, 6 Drawing Figures



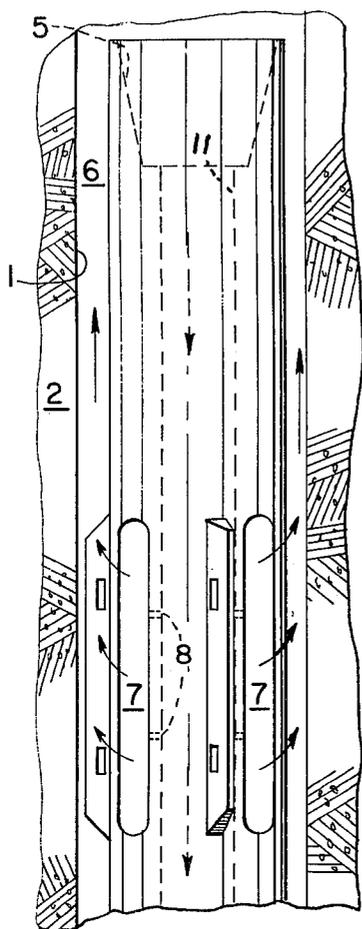


FIG. 1

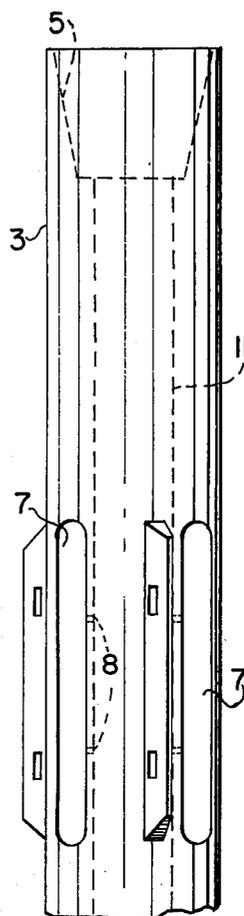


FIG. 2

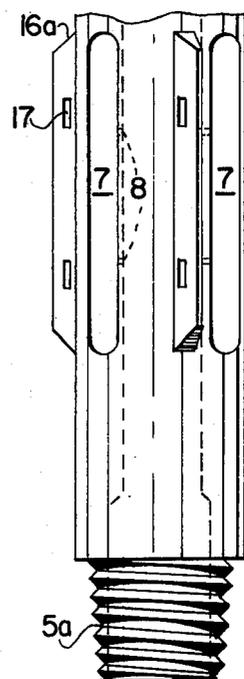
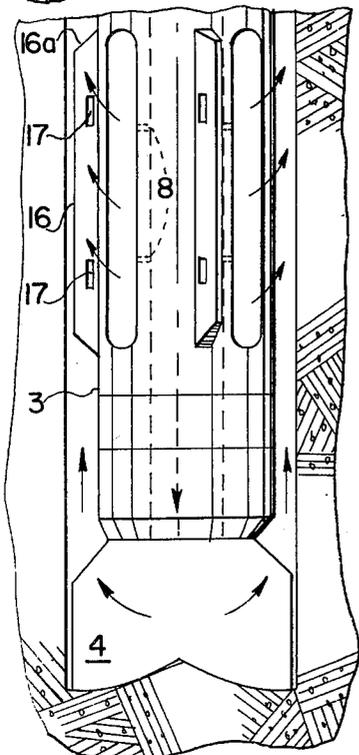
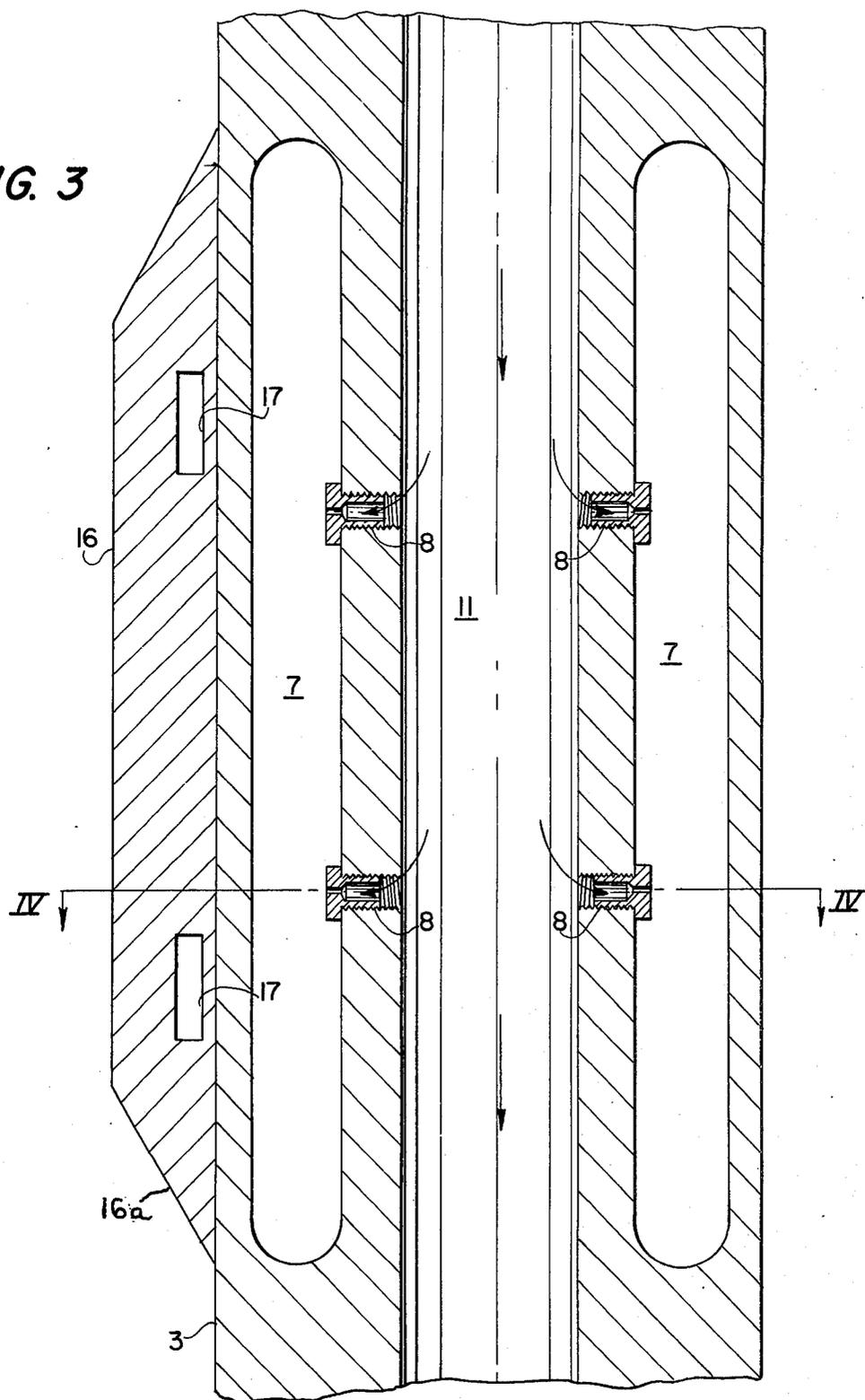


FIG. 3



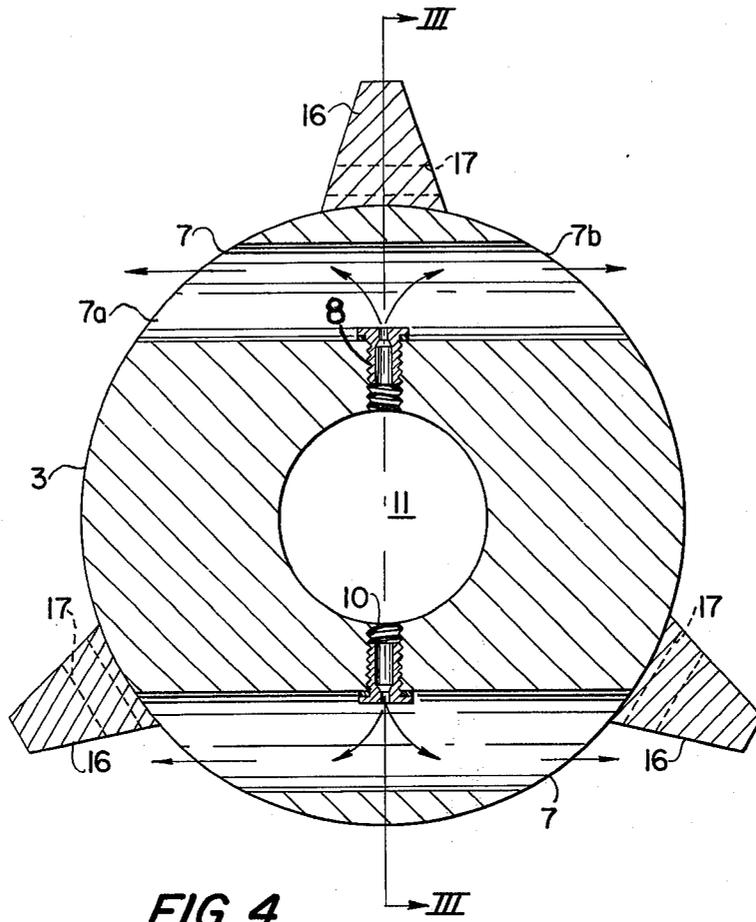


FIG. 4

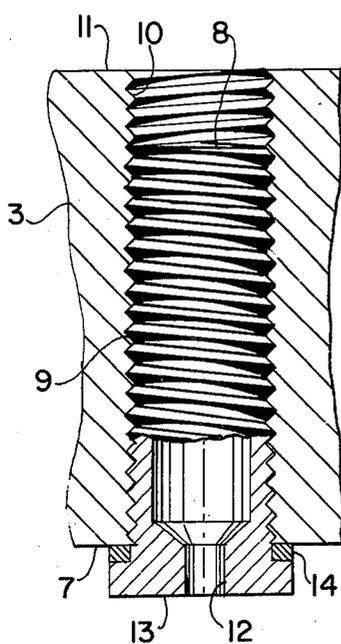


FIG. 5

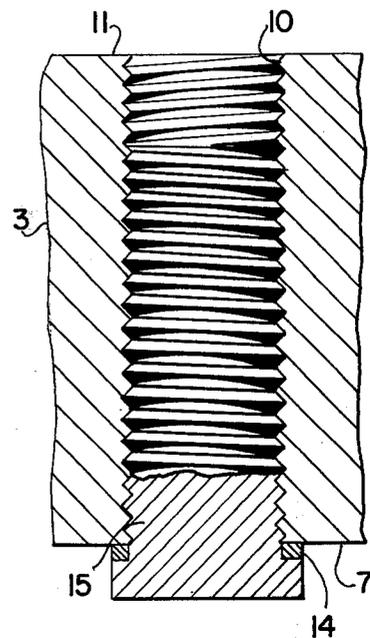


FIG. 6

DRILL COLLAR INCORPORATING DEVICE FOR JETTING DRILLING FLUID TRANSVERSELY INTO BORE HOLE

The present invention relates to the art of drilling deep wells. In the rotary method of deep drilling it has been customary to include one or more drill collars in the drill string above the drill bit. A drill collar is a rather heavy rigid member, or a string of such members connected end-to-end above the drill bit for lending weight and rigidity to the drill string and through its pendulum effect serves to reduce deflection of the bit axis and thereby stabilize and prevent the lower end of the string from deviating from a vertical course. The collars, which are tubular to permit downward passage of drilling mud from the surface through the string to the drill bit, are usually made in sections of various length, e.g. about 40 ft. each, and may extend to a height of several hundred feet above the drill bit depending upon particular circumstances.

Extensive deviation from the vertical is to be avoided for otherwise it may result in a failure to penetrate the desired geological structure. It may also lead to sticking of the drill string in the bore hole, as well as an increase in fatigue failure of pipe section connections due to cyclic stresses generated as the drill string rotates in the crooked hole. It may also complicate the installation of casing and other equipment required to complete the well and may also give rise to later problems such as excessive wear on sucker rods used to actuate the pump in the well. In some cases, extensive deviation may also lead to violations with respect to well spacing, proximity of the bottom of the bore hole to lease lines, and the like.

It has also been proposed to provide measures for facilitating return circulation of drilling mud from the drill bit area in the annular space between the drill string and the wall of the bore hole. These include the use of jets which discharge drilling mud from the interior of the drill string into the bore hole at one or more locations above the drill bit and which may be designed, for example, as disclosed in U.S. Pat. Nos. 2,805,043 and 2,765,146 to provide an upward lift to the returning mud and reduce hydrostatic pressure below the jets.

The principal object of the present invention is to provide an improved self-stabilizing drill collar, or a series of such collars, at the lower end of the drill string for producing straighter bore holes, improved lubrication and with an improved jet action to provide for better circulation and return flow of drilling mud. The improved collar structure also enables the drill string to be rotated at a higher speed than heretofore possible thus resulting in a corresponding speed-up in cutting action at the drill bit which is reflected by a reduction in drilling costs.

One feature of the improved drill collar structure is an improved arrangement of non-fouling nozzles located within and protected by the wall of the collar for discharging i.e. jetting downwardly flowing drilling mud laterally from the bore in the collar into the annular gap between the periphery of the collar and the surface of the bore hole. This lateral discharge of clean drilling mud from the collar into the bore hole serves to lubricate the gap and thereby reduces any tendency for build-up of undesirable counter-torque forces that

increase stress in the drill string and reduce its turning speed.

A further feature of the improved drill collar structure is that the nozzles for jetting drilling mud into the annular gap between the collar and the surface of the bore hole are housed within slots extending through the wall of the collar parallel with the axis of the drill string, whereby the main blasting force of the mud as it leaves the nozzle is attenuated somewhat by the time it is discharged from the opposite ends of the slot thus minimizing the possibility of making wash cuts in the surface of the bore hole which are undesirable since they increase the amount of drilling mud lost in the bore hole as it returns upwardly to the surface for cleaning and re-cycling. By locating the nozzles within the slots they thus become protected from fouling by particulate matter entrained in the upwardly returning drilling mud, such as shale, rock or other earth chips or other solid matter.

A further feature of the improved drill collar structure is that it can include radially extending reaming flanges that serve to shape the bore hole and cut away any solid obstructions such as rock that may project therein, these flanges being provided with apertures to reduce its turning resistance through the annular column of the returning drilling mud.

Still another feature of the improved drill collar structure is that the nozzles, which are preferably made from stainless steel or monel, may be easily screwed into place within the slotted portion of the collar wall thus making it possible to easily increase or decrease the number of nozzles in the slot, the nozzles which are removed being replaced by threaded solid plugs, which plug up the threaded openings into which the nozzles are normally screwed.

The foregoing as well as other objects and advantages inherent in the invention will become more apparent from the following detailed description and the accompanying drawings wherein:

FIG. 1 is a vertical section through the lower portion of a bore hole being drilled into the earth by a drill bit secured to the lower end of a rotatable string of drill pipe and which is supplied with drilling mud under sufficient pressure to carry the cuttings to the top of the bore hole in the annular gap formed between the latter and the drill pipe, the pipe section at the bottom end of the string being constituted by a drill "collar" which is provided along the length thereof with jetting devices in accordance with the invention;

FIG. 2 is view illustrating a collar structure similar to FIG. 1, one or more of which may be incorporated in the drill string by tool joints, as in conventional practice, above the collar shown in FIG. 1 to provide jetting action at any desired higher locations along the drill string;

FIG. 3 is a partial central longitudinal section through the collar structure depicted in FIG. 1 but drawn to a larger scale, the view being taken on line III—III of FIG. 4;

FIG. 4 is a transverse section taken on line IV—IV of FIG. 3; and

FIGS. 5 and 6 are views partly in section of the nozzle and plug structures per se drawn to an even larger scale.

With reference now to the drawings, FIG. 1 depicts the lower end of the bore hole 1 in the earth 2 in which a drill string is located, the drill string being composed

of the required number of drill pipe sections, not shown, coupled together by tool joints in accordance with conventional practice in drilling deep holes. The lower end of the drill string terminates in a tubular drill collar 3 to the lower end of which is secured a drill bit 4. As will become readily apparent hereinafter, the particular drill collar structure depicted in FIG. 1 is a combined unit which functions both as a pilot to guide the drill as well as a device for also jetting drilling fluid transversely from the collar into the bore hole. The upper end of the collar 3 terminates in a tapered threaded socket 5 for coupling onto a complementary threaded tapered plug 5a of the next-above section of the string. This may be a plain pipe section or it may be another collar in accordance with the invention, as depicted in FIG. 2, when one or more such collar structures are desired to be incorporated in the drill string above the bit.

The drill string is rotated from above ground and a drilling fluid commonly known as mud is pumped into the upper end of the drill string for flow downwardly through the bore to the bit 4 to cool it and also wash the cuttings to the top of the bore hole, the drilling mud moving upwardly in the annular gap 6 between the bore hole 1 and collar 3 as well as the other such collars or plain pipe sections located above this collar to the surface where it is cleaned and re-cycled. The flow path of the mud is indicated by directional arrows.

The drill collar 3 is provided with an arrangement of elongated slots 7 forming ducts extending through the wall of the collar parallel to the axis of drill string in which are located one or more nozzles 8, see FIGS. 3 and 4, for jetting drilling mud into the gap between the collar and bore hole. Location of the nozzles within the slots 7 protects them from contact by any solid matter entrained in the upward return flow of drilling mud such as shale, small rocks, earth chips and cuttings made by the drill bit and hence prevents the nozzles from fouling and plugging up. Moreover, the main blasting force of the mud as it leaves the nozzles is somewhat attenuated by the time it leaves the opposite ends 7a, 7b of the slots thus minimizing the possibility of making wash cuts into the surface of the bore hole which are undesirable since they increase the amount of the comparatively expensive drilling mud lost in the bore hole during its return flow to the surface.

In the particular embodiment illustrated in FIGS. 1, 3 and 4, a pair of such slots 7 each with two longitudinally spaced nozzles 8 are located symmetrically on opposite sides of the axis of the drill collar, one pair of slots being located towards the upper end of the collar and another pair of slots towards the lower, bit end of the collar which can have an overall length of up to 40 feet, for example. However, other arrangements of these slots and nozzles with respect to number and location are possible and hence the depicted embodiment is to be regarded as typical rather than limitative.

Each nozzle 8, as shown most clearly in the larger scale view of FIG. 5 includes an externally threaded barrel portion 9 which is adapted to be screwed into a threaded bore 10 which, as shown in FIGS. 3 and 4, extends transversely through the wall of the collar from the axial through bore 11 to the slot 7. The barrel portion 9 terminates in an opening 12 of restricted diameter which forms the nozzle per se and through which clean drilling mud is jetted into slot 7, the blasting force of the jet being somewhat attenuated as it divides at the

center of the slot and flows in opposite directions to the opposite ends 7a, 7b from which it is discharged into the annular gap 6 to lubricate the latter and thus reduce any tendency for build-up of undesirable counter-torque forces that increase stress in the drill string and reduce its speed as well as sometimes result in breakage of the string.

The nozzle opening 12 is located in a head portion 13 which is preferably hexagonal or some other polygonal configuration to receive a wrench for screwing in or removing the nozzle structure 8, and a washer 14 is seated between the underside of the head 13 and the surface of slot 7 to establish a seal.

If fewer nozzles are desired, solid plugs 15 as shown in FIG. 6 having identical exterior dimensions as the nozzles 7 may be screwed in to replace one or more of the latter.

The drill collar 3 is also seen to include, as an optional feature, a plurality of radially extending flanges 16, for example, three arranged in uniformly spaced relation around the periphery of the collar. The opposite ends 16a of these flanges can be tapered as indicated in FIGS. 1 and 3 and are provided with a plurality of apertures 17 to reduce its turning resistance through the annular column of drilling mud being returned to the surface. The flanges 16 perform a reaming function to shape the bore hole and cut away any solid obstructions such as rock that may project into it.

The collar structure depicted in FIG. 2, as previously explained is not associated with the drill bit as in FIG. 1 but has the same arrangement of slots, nozzles and reaming flanges and along with one or more others like it is intended to be incorporated into the drill string above the drill bit when deemed desirable to provide a transverse jetting action in the bore hole farther upwards along the string.

While the nozzle structures 8 are preferably made in such manner as to enable them to be easily removed for exchange, or replacement with solid plugs, a permanent type of nozzle installation within the body of the drill collar is obviously possible.

Also, the novel collar structure which functions both as a drill guide and jetting device can be combined in the drill string with other drill collars or drill tools of a less caliber or design.

I claim:

1. A drill collar structure for incorporation into a drill string for deep well rotary drilling comprising an elongated cylindrical collar member having an axially extending throughbore for passing a drilling fluid downwardly to the lower end of the drill string, said collar member including at least one slot forming a duct extending transversely through the wall thereof intermediate said throughbore and its periphery, opposite ends of said slot reaching to the surface of said collar member at corresponding locations on the periphery thereof, and at least one nozzle member located in a bore extending transversely between said throughbore and said slot intermediate the ends of said slot for jetting drilling fluid diverted from said throughbore into said slot and thence outwardly from the opposite ends thereof into the bore hole.

2. A drill collar structure as defined in claim 1 wherein each slot is provided with a plurality of nozzle members arranged in spaced relation in the longitudinal direction of the collar.

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3. A drill collar structure as defined in claim 1 wherein the transverse bore in which said nozzle member is received extends in a radial direction and intersects the slot at the middle thereof.

4. A drill collar structure as defined in claim 1 and which is incorporated into the drill string at the bottom thereof to serve as a pilot, one end of said collar having the drill bit secured thereto and the opposite end thereof being provided with means for connection to the adjoining end of the next-above section of the drill string.

5. A drill collar structure as defined in claim 1 and which is provided with connection means at each end thereof for incorporation into the drill string above the lowermost section mounting the drill bit.

6. A drill collar structure as defined in claim 1 and which includes a plurality of said slots and nozzle members therein spaced longitudinally along the collar member.

7. A drill collar structure as defined in claim 1 which includes a plurality of said slots and nozzle members associated therewith disposed symmetrically about the axis of the collar.

8. A drill collar structure as defined in claim 7 which includes two of said slots and nozzle members associ-

ated therewith located symmetrically to opposite sides of the collar axis.

9. A drill collar structure as defined in claim 1 wherein said nozzle member includes an externally threaded barrel portion engageable with an internally threaded portion of said transverse bore thereby to facilitate installation and removal of said nozzle member.

10. A drill collar structure as defined in claim 9 and which is also provided with a threaded plug for use in lieu of a threaded nozzle to close off said transverse bore and block flow of drilling fluid therethrough when jetting action is not desired.

11. A drill collar structure as defined in claim 1 and wherein said collar member is provided with flanges extending radially at the location of said slots for effecting a reaming action to shape the bore hole.

12. A drill collar structure as defined in claim 11 wherein said reaming flanges are arranged in uniform spaced relation around the periphery of the collar member and include apertures therethrough from one side to the other for reducing the turning resistance of the collar through the annular column of drilling fluid which is returned to the surface in the annular space between the drill collar and the bore hole.

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