

May 5, 1959

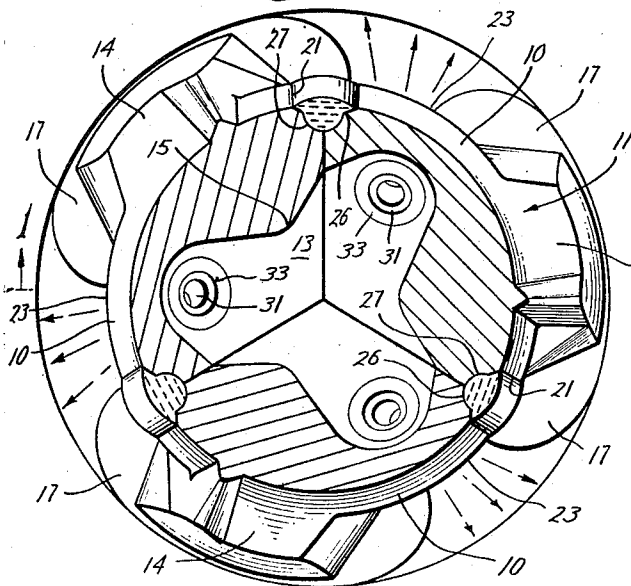
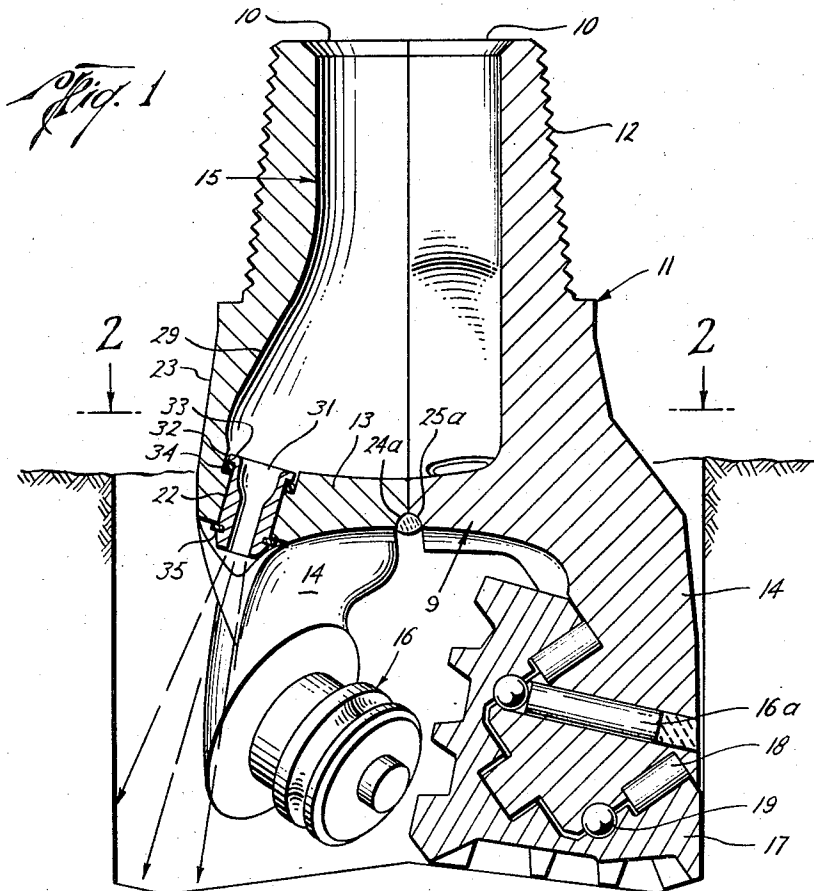
O. HAMMER

2,885,186

DRILL BIT

Filed Nov. 21, 1956

3 Sheets-Sheet 1



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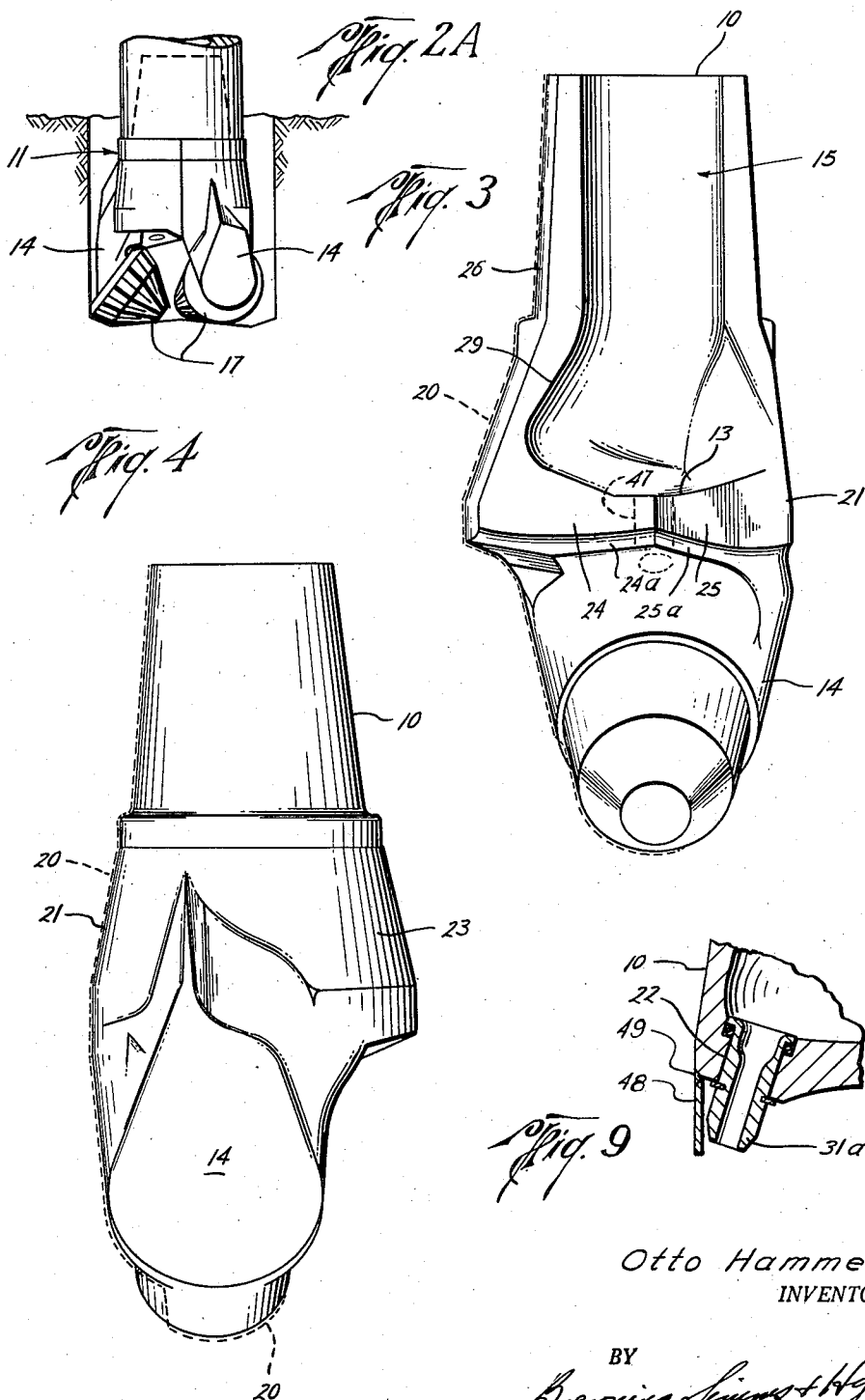
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3 Sheets-Sheet 2



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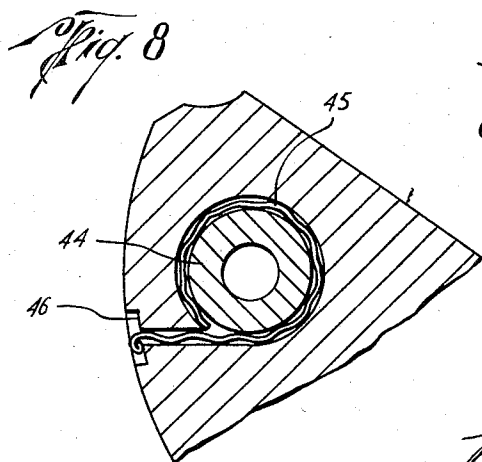
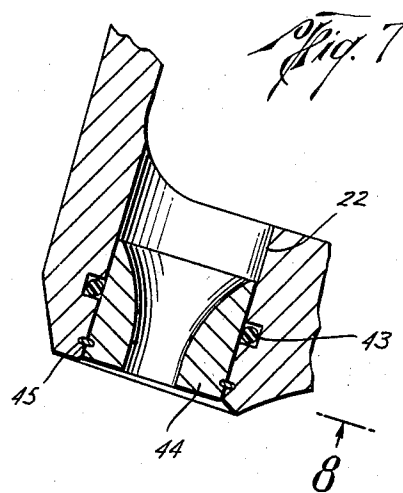
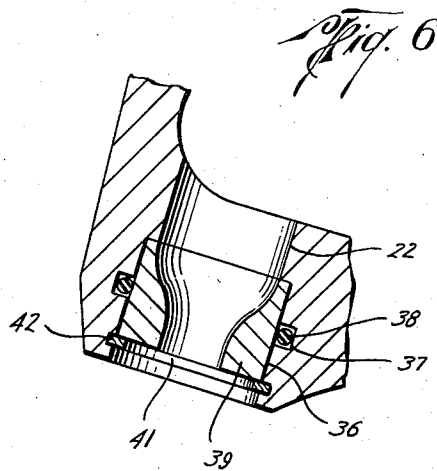
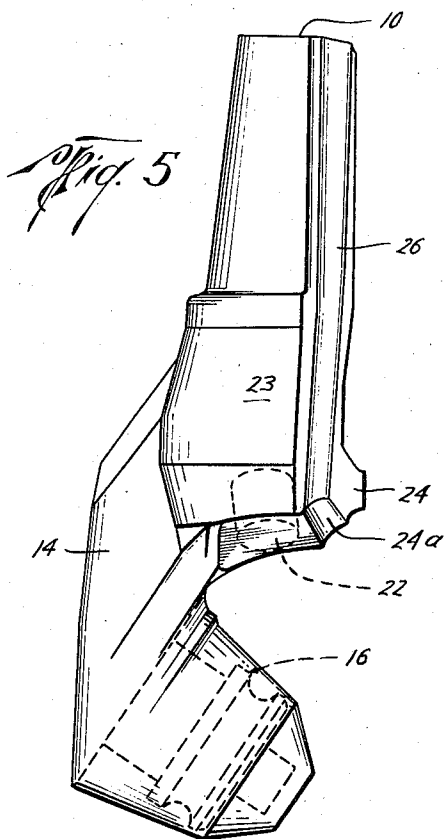
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3 Sheets-Sheet 3



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DRILL BIT

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2 Claims. (Cl. 255—314)

This invention relates to bits for boring earth formations and more particularly to bits in which drilling fluid is jetted against the bottom of the hole instead of against the cutters on the bit.

Roller bits may be classified according to the manner of handling the drilling fluid passing from the drill bit. In what may be termed the normal flow, the outlets from the bits are located in the central part of the bit dome and direct fluid directly against the cutters of the bits to wash cuttings therefrom. In another type of bit, known as the jet bit, well fluid is directed between the heel teeth of adjacent cutters and directly onto the bottom of the formation. This action sweeps the bottom of the hole and removes the finely ground cuttings from the bottom of the hole to permit the cutters to engage virgin rock and large chunks of formation left in the bottom of the hole.

In the jet type of bit, it has been thought necessary to provide a hollow boss on the cutter body which projects radially outward and also downward from the remainder of the body, through which drilling fluid could be jetted onto the bottom of the hole.

Due to the nature of manufacture and assembly of the components of roller bits, these bosses have been the source of considerable difficulty. It is customary to forge longitudinal segments of the bit head, which are machined, provided with cutters, and then welded together. In forging three cone bit sections, the jet bosses necessitate small diameter pockets and fingers on the dies. The fingers sometimes break off during the forging process. The small diameter pockets and fingers wear more rapidly than the remainder of the dies. The additional metal necessary to provide the bosses increases cost of the bits.

The bosses are of necessity located adjacent to or fall within the welding seams of the bit head. This presents vexatious problems to the welder who must weld a seam across the dome with the cutters in place and the small area available to him to work in is partially obstructed by the bosses.

Where the weld seam swings around a boss in a curve, the weld is extremely difficult to make. Where the weld seam passes through the boss, it is difficult to obtain a seal through the boss which extends from the bore through the boss to the exterior of the boss. Such complete seal is desirable to prevent washing of well fluid between the wall of the bore and the nozzle insert which is usually inserted therein.

The area about the body of a bit head and between the cutter arms depending therefrom usually provides a passageway for upward flow of well fluid. Where this area is partially obstructed by jet bosses, the return flow area is considerably reduced.

The boss type of bit also provides in the bosses protrusions which can form pockets where cuttings, mud or debris can lodge to form a swabbing surface when the bit is withdrawn from the well.

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It has heretofore been thought that the radially outward bosses could not be eliminated without either making the bit head too large in diameter or locating the jet nozzle too close to the center of the bit and/or too far from bottom.

It was discovered that the bosses could be eliminated and the bit head streamlined. Unexpectedly this invention resulted in more efficient washing of the bottom of the hole which made it immaterial that the outlet from the jet nozzles was a little further from the bottom of the hole than with bit heads having downwardly extending bosses. It was found that my invention eliminated the difficult welding job heretofore necessary, the draft of forging segments was improved, the forging weight was reduced, forging cost was reduced, a less tortuous line of flow in the bit head was made possible, and it was possible to eliminate the upstanding deflector in the bottom of the bit head bore which was previously employed to direct fluid flow into the bosses.

It is the general object of this invention to provide a drill bit not subject to the foregoing problems.

Another object is to provide a streamlined bit which will offer less resistance to return flow, to flow around the bit when going in and out of the well, and to present a more pleasing appearance to the eye.

Another object is to provide a jet bit in which the usual jet bosses are eliminated without making the bit head too large in diameter or decreasing the efficiency of the jet action.

Another object is to provide a jet bit head made-up of longitudinally split forged segments which may be simply and easily welded together.

Another object is to provide a jet bit head made-up of longitudinally split forged segments in which the draft of the forging is improved.

Another object is to provide a jet bit in which both the weight and cost of the forgings are reduced.

Another object is to provide a jet bit in which the jet nozzles may be removed from the bottom of the hole a distance further than usually employed without impairing the washing action of the jetted fluid.

Another object is to provide a jet bit in which the fluid flow path within the bit head is less tortuous than in the bits employing jet bosses.

Another object is to provide a jet bit having an open internal bore in which it is not necessary to provide deflectors to direct fluid flow into the jet outlets.

Another object is to provide a bit in which the bit body's side wall is circular in cross section in planes normal to the bit axis except for the downwardly extending cutter legs and in which jet nozzles are provided in the body which jet drilling fluid directly onto the bottom and side wall of the hole being drilled.

Another object is to provide a jet bit in which no jet bosses are present and in which the welding seams for securing several segments of the bit head together extend in substantially straight lines to facilitate welding the segments together.

Another object is to provide a jet bit in which jet outlets are provided without the use of jet bosses to make forging easier and reduce die wear and breakage.

Another object is to provide bit head segment forgings which may be finished for either conventional or jet flow without the provision of jet bosses.

Another object is to provide a jet bit in which the fluid from the jet nozzle is directed in part onto the track of the heel teeth of the cutters and in part onto the side wall of the hole to increase the velocity of the jet stream flowing along the bottom of the hole toward the central axis thereof.

Other objects, features and advantages of this invention will be apparent from the drawing, the specification and the claims.

In the drawings, wherein like reference numerals indicate like parts and wherein there is shown illustrative embodiments of this invention:

Fig. 1 is a view in vertical cross section through a bit constructed in accordance with this invention and taken along the lines 1—1 of Fig. 2;

Fig. 2 is a horizontal cross section of the bit of Fig. 1 taken along the lines 2—2 of Fig. 1;

Fig. 2A is an elevational view of the bit of Fig. 1;

Fig. 3 is an internal elevational view of a forging segment for the bit body of a modification of the drill bit shown in Fig. 1 wherein the bore is positioned for conventional mud flow onto the bit cutter teeth, the configuration of the segment being otherwise unchanged;

Fig. 4 is an external elevational view of the forging segment of Fig. 3;

Fig. 5 is a side elevational view of the forging of Figs. 3 and 4 with the forging rotated approximately 90 degrees from the position in Figs. 3 and 4 and showing in dashed outline the position of the nozzle bore and the cutter spindle of the finally machined segment;

Fig. 6 is a fragmentary section through the bit of Fig. 1 showing a modified form of jet nozzle;

Fig. 7 is a view similar to Fig. 6 showing a further modified form of jet nozzle;

Fig. 8 is a view along the lines 8—8 of Fig. 7; and

Fig. 9 is a fragmentary view showing a further modified form of jet nozzle and a shroud for protecting the nozzle.

Referring now more particularly to the drawings, the bit head is made-up of a plurality of substantially identical segments welded together. In the three-cone bit shown, three segments 10 are employed, each extending circumferentially over one-third of the bit head indicated generally at 11. The upper end of the bit head 11 terminates in a threaded pin 12 to permit the bit to be attached to a drill pipe.

The segments, above the dome, indicated generally at 9, are arcuate in cross section in a plane normal to the bit axis. Thus, when the sections are assembled into a bit head, there is formed a hollow bore indicated generally at 15 which terminates above dome 9 and which opens to the exterior of the body at the upper end of the threaded pin 12 and receives drilling fluid from the drill string.

On the lower end of each segment is a cutter leg 14 having on its lower end a downwardly and inwardly projecting spindle indicated generally at 16 which is machined before the legs are joined together to permit the cutters 17 to be mounted on the legs before the segments are secured together. The mounting for the cutter may be provided by the conventional roller bearings 18 and ball bearings 19. The balls are inserted after the cutters are in place on the spindle. The balls are inserted through a bore from the exterior of the leg 14. The bore is closed by a plug 16a which is welded in place. This method of assembly is extensively used with roller cone bits.

The cutter legs 14 extend radially outward from body 11 as well as downwardly. The cutter legs are also positioned closely adjacent one longitudinal edge 21 of each segment. Thus, room is left between adjacent cutter legs for both downward passage of fluid from the nozzles adjacent the side wall of the hole and for upward flow of fluid after it has been jetted against the bottom of the hole. The same space is utilized for passage of fluid adjacent the side wall of the hole while the bit is being lowered or raised in the hole. By positioning the cutter legs 14 adjacent one longitudinal edge of each forging segment, the nozzle bores 22 for the jet nozzles may each be entirely contained within a forging section and direct drilling fluid between adjacent

cutters 17 and against the bottom and side wall of the hole.

From Figs. 1 and 2 it will be seen that in any plane of the bit head normal to the bit axis, the side wall of the bit head, except for the projecting cutter legs, is circular in configuration and in particular the side wall portion 23 intermediate the radial extension of cutter legs 14 is circular and free from protrusions. Thus, there is no radially extending boss which would interfere with upward flow of drilling fluid past body 11. Furthermore, the elimination of the conventional jet boss at this point increases the draft of the forging and no difficulty is experienced in removing the forging from the dies. Note the dashed die parting lines 20 on Figs. 3 and 4.

The pie shaped dome sections 13 are provided with an exterior surface which extends substantially in a plane perpendicular to the central axis of the bit. The outwardly diverging edge faces 24 and 25 of the sections are provided with complementary welding grooves 24a and 25a respectively which extend in substantially straight lines radially outward from the center of the body. It is particularly pointed out that there is no downwardly extending jet boss which would intersect the weld seams in the dome, cause the weld seams to circle about the boss, or in any way interfere with the welding of these seams. One particular advantage is the room provided between the cutters and dome to permit easy access to the weld grooves 24a and 25a for welding.

The weld grooves 24a and 25a extend to a juncture with upwardly extending substantially straight weld grooves 26 and 27 and permit welding of adjacent segments together with a weld in which there is only one sharp turn. This greatly simplifies the job of welding the segments together.

The hollow internal bore indicated generally at 15 is substantially Y-shaped at its lower end as best shown in Fig. 2. The jet nozzle bores 22 are positioned at the extremities of each leg of this Y. It will be noted from Fig. 1 that the jet nozzle bores are positioned much closer to the center line of the bit than would be the case if a jet nozzle boss were provided which projected radially from the body and hence the curve 29 in bore 15 is much gentler than in the case of the boss-type bit head. Therefore, less energy is required by the mud pumps to force drilling fluid out the jet nozzles since the flow through the bore 15 to the jet nozzle entrance is at a minimum angle of curvature.

The jet nozzle bore is positioned adjacent to but slightly removed from one side edge of dome section 13 so that the weld will not pass through or around the nozzle bore. As the cutter legs 14 are positioned adjacent one longitudinal edge of each forging section, the nozzle bores 22 will lie adjacent the other longitudinal edge of the forging section and direct drilling fluid downwardly between the heel portion of adjacent cutters 17. The nozzle bores 22 diverge downwardly a few degrees to direct drilling fluid against the side wall and the bottom of the hole. The projected central axis of the nozzle bore would lie closely adjacent the juncture between the side wall and the bottom of the hole. As best seen in Fig. 2, the divergence of nozzles 31 is along a line which substantially bisects the space between adjacent cutters 17.

It will be seen that a portion of the fluids from each nozzle in bores 22 will strike the track of the heel teeth of cutters 17 and a portion will strike the side wall and then travel downwardly to the bottom of the hole. This portion of the jetted fluid striking the side wall of the hole will tend to turn radially inwardly toward the center of the hole and provide a high velocity stream moving toward the center of the hole. This should be contrasted with the conventional jet bit in which the jet stream strikes the bottom of the hole in its entirety and is free to spread about 360 degrees. Obviously, the portion of

the fluid striking the side wall will tend to flow toward the center of the hole and when added to the fluid which strikes the bottom of the hole and tends to flow toward the center of the hole will provide a large volume high velocity stream which will remove small cuttings from the bottom of the hole and permit the cutters to engage either large chunks of formation which have been broken off or virgin rock.

High velocity drilling fluid is very abrasive and for this reason it is preferred that the fluid be jetted through nozzles of very hard material such as tungsten carbide. Therefore, instead of providing jet nozzles as part of the body, it is preferred that bores 22 be provided and special hardened nozzles such as nozzle 31 be positioned in these bores. Any desired form of nozzle and means for securing a nozzle in place may be used. In the form illustrated in Fig. 1, the bore 22 is counterbored at 32 and the nozzle 31 is provided with an outwardly extending flange 33. A suitable seal such as O-ring 34 is positioned in the counterbore under the flange and after the nozzle has been inserted from the interior of the bit head, a snap ring 35 is positioned in a groove in the protruding end of the nozzle to hold it in place.

Referring to Fig. 6, a different form of nozzle is shown in which bore 22 is counterbored at 36 from the exterior of the body and a groove 37 having an O-ring 38 therein is formed in the counterbore. Nozzle 39 is inserted from the exterior of the body and a snap ring 41 is positioned in a groove 42 below the nozzle 39.

In Fig. 7, there is shown a still further form of nozzle in which an O-ring 43 seals between the nozzle bore 22 and nozzle 44. Mating grooves are provided in the bore 22 and exterior of nozzle 44 to receive a key 45 which is inserted through a hole 46 in the side wall of the bit body. The key 45 is resilient and crinkled as shown in Fig. 8. The key is locked in place by the frictional engagement between the keeper and groove, but may be removed by pulling the loop on its outer end. This form is distinguished from those in Figs. 1 and 6 in that no counterbore is required, the key holding the nozzle against displacement in both directions. It will be understood that this key may take other forms than the crinkled member shown, so long as it is flexible enough to be forced in and removed from the mating grooves when desired.

Referring to Fig. 9, there is shown a still further form of nozzle which is identical with that shown in Fig. 1 except that the nozzle 31a is somewhat longer to position its outlet closer to the bottom of the hole. In some cases this is desirable to obtain maximum jetting action. As the nozzle is of very hard brittle material, it is subject to damage from protrusions on the side wall of the hole, etc., and a shroud 48 may be welded to or otherwise formed on the bottom of the body at 49 to protect the nozzle against damage. Preferably, the shroud 48 extends circumferentially at least a slight distance on either side of nozzle 31a to provide protection and may be joined to one or both adjacent cutter legs to give it added strength.

In the fabrication of bits in accordance with this invention, the segments shown in Figs. 3, 4 and 5 are forged in the usual manner. Then the jet nozzle bores are drilled and the bearing surfaces machined to provide the bearing races 16. Roller bearings are then placed about the bearing surfaces on each spindle and cutters 17 are installed on each cutter leg. The balls 19 are then introduced one at a time in the bore in the side wall of the arm. The bore is then closed by plug 16a. The three segments are then placed in a jig and the weld grooves in the side wall of the body and in the outside wall of the dome are filled with weld material. Thereafter the threads 12 may be cut on the pin at the upper end of the body and the jet nozzles installed. Where the long jet nozzle 31a is used with a separate, welded-

on shroud, the welder will attach shroud 48 after the body seams have been completed.

It will be noted that the inner and outer walls of the dome are substantially flat and nearly parallel to each other. This permits ready drilling of holes in the center portion of the body inboard from the jet holes illustrated, for instance as shown in dashed outline at 47 in Fig. 3. Thus, one or more holes 47 may be drilled in the dome in lieu of the jet nozzle bores 22 and what may be referred to as normal flow conducted through the center portion of the bit body and directly onto the cutters 17. It will thus be seen that the single forged segment may be used in both the jet bit and the conventional flow type bit. The elimination of the jet bosses both reduces the amount of metal in a forging and increases die life. When these factors are weighed with reduced raw material inventories and reduced manufacturing costs, it will be seen that the use of a single segment for both types of bit will compare favorably with specially designed segments for each type of bit.

From the above it will be seen that all the objects of this invention have been attained. There has been provided a jet type roller bit in which no jet bosses are necessary. The welding of the three segments together is much simpler than in the boss form of jet bit as the welds are in substantially straight lines. There are no bosses to obstruct access to the dome welds and these welds are readily made. The jetted fluid is in part thrown against the side wall of the hole to improve the flow characteristics of the fluid on the bottom of the hole. In other words, the fluid velocity washing across the hole from the side to the center of the hole is increased.

Problems of sticking of the forging segments in the dies are overcome with this invention. Also, the segments may be used for conventional fluid flow bits as well as the so-called jet bits.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth, together with other advantages which are obvious and which are inherent to the apparatus.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood and acknowledged that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

The invention having been described, what is claimed is:

1. A drill bit comprising, a plurality of substantially identical elongate segments arcuate in cross section secured together to form a hollow head, each of said segments having a downwardly extending cutter leg adjacent one longitudinal edge of the segment and an inwardly projecting wedge-shaped section, cutters on said legs below said wedge-shaped sections, said bit head having a circular side wall and a transverse dome over said cutters formed by the assembly of said wedge-shaped sections and said dome having substantially flat and parallel upper and lower walls, said side wall and dome being free from protrusions except for the legs which project beyond the dome and radially beyond the side wall of the head, said segments being secured together by welding the dome sections together along the outside edges thereof and by welding along the longitudinal edges of the segments, and a downwardly extending jet nozzle bore in each segment adjacent the other longitudinal edge thereof and connecting with the hollow interior of the bit head and having its lower terminus at said lower dome wall, a nozzle removably secured in said bore and arranged to direct flow from the head downwardly between adjacent cutters and in part toward the track of the heel teeth of the cut-

ters at the bottom of the borehole and in part against the wall of the borehole drilled by the cutters.

2. The drill bit of claim 1 in which said jet nozzle bore directly enters the hollow interior of the bit head through the upper wall of the said dome and has its lower terminus at substantially the same vertical level as said lower dome wall.

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The present invention relates to a drill bit for drilling holes in hard materials, and more particularly to a drill bit of the type in which a jet of fluid is directed against the cutting edge of the bit to assist in the drilling process. The invention is particularly adapted for use in drilling holes in hard materials such as rock, concrete, and the like.

In the prior art, drill bits of various types have been used, including bits with cutting edges, bits with scrapers, and bits with jets of fluid directed against the cutting edge. However, the present invention provides a drill bit of a new and improved design, which is particularly adapted for use in drilling holes in hard materials.

The present invention is particularly adapted for use in drilling holes in hard materials, and more particularly to a drill bit of the type in which a jet of fluid is directed against the cutting edge of the bit to assist in the drilling process.

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