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Lorenz et al.

[54] METHOD AND ARRANGEMENT FOR PROTECTING AND GUIDING DRILLING BITS

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Related U.S. Application Data

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[52] U.S. Cl. .................................................. 175/307, 175/57

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[58] Field of Search .......................................... 175/57, 307, 383

References Cited

UNITED STATES PATENTS
2,296,939 9/1942 McMahon ...................................... 175/307
2,723,836 11/1955 Fraser ........................................ 175/307 X
2,644,672 7/1953 Mathews ...................................... 175/307

FOREIGN PATENTS OR APPLICATIONS
547,714 10/1957 Canada ........................................ 175/307

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[57] ABSTRACT

A drilling bit for use in drilling wells such as oil and gas well boreholes in the earth is protected from damage prior to actual use at the bottom of the hole by enclosing the drilling bit with a molded jacket arrangement of impact resistant material. The jacket arrangement includes a fluid passageway system which cooperates with the fluid outlets of the bit, to accommodate fluid communication between the well bore and the interior of the drill string with which the bit is connected. The jacket means is preferably generally convex so that its forward central portion projects beyond the surrounding edge portion. The passageway means terminates in outlets in the central portion which further protects the bit, and aids in keeping it from becoming "balled up." The fluid passageway system also enables fluid under pressure to be discharged through the bit and jacket arrangement without premature removal of the jacket arrangement so that the streams of fluid act on any backfill and debris present in the well bore to circulate such debris and backfill as the bit is lowered in the well bore to properly position it for further drilling operations before removal of the protective jacket arrangement.

The fluid passageway system may include a pressure responsive arrangement to enable at least partial removal of the protective jacket arrangement at any desired position of the bit in the borehole, or the jacket arrangement may be drilled off when the bit reaches bottom, if desired.

In one form of the invention, the protective arrangement is molded onto the bit. In another form of the invention, a pre-molded or pre-formed arrangement is provided which is expanded as it is forced over the bit and thereafter returns to its original configuration to retain the jacket arrangement on the bit. It may also be provided with portions which fit into the fluid outlets of the bit to further aid in supporting and retaining it in such position on the bit. In either case, the protective arrangement is constructed and arranged on the bit to also serve as a guide device for guiding the bit past various obstructions which may be present in a previously drilled portion of the earth borehole, or obstruction in the cased portion of the borehole. The invention also prevents balking of the drill bit and damage to the filter cake on the walls of the well bore.

20 Claims, 25 Drawing Figures
METHOD AND ARRANGEMENT FOR PROTECTING AND GUIDING DRILLING BITS

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation of our prior co-pending application Ser. No. 107,786 filed Jan. 19, 1971, now abandoned, which in turn is a continuation in part of our prior co-pending application Ser. No. 832,673, filed June 12, 1969, now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to protective devices and guide devices for drill bits which are used to drill boreholes into the earth.

In drilling an oil well type borehole into the earth, it is from time to time necessary to pull the drill bit and drill pipe back out of the hole. This may be necessary in order to change a worn bit, to set a protective casing pipe into a part of the hole already drilled or to conduct some type of testing or logging operation or the like. Not infrequently, some form of partial obstruction may be present in the borehole. For example, there may be a protruding ledge or shoulder at the upper boundary of a hard rock layer. Thus, when running the drill bit back into the borehole, a substantial danger exists that the drill bit may be damaged by striking this obstruction.

Drill bits of the type used with rotary drilling rigs are remarkably strong, tough tools capable of withstanding heavy loads while being rotated at considerable speeds while drilling through hard, tough, abrasive rock formations. Such rock bits are manufactured to close tolerances to permit the incorporation therein of precision bearings so as to obtain the longest possible service life. Nevertheless, there is some evidence tending to indicate that the bits may be damaged before they actually come into contact with the earth formation to be drilled. The total cost involved in damaging a bit prior to its actual use may be substantial. For example, such damage can reduce the drilling life of the bit from one hundred hours to ten hours. In such case, the cost would be several thousand dollars, considering the cost of the bit itself as well as the rig time consumed in removing the damaged bit prematurely and replacing it with another bit.

Additionally, the bit may become balled up by contact with the well bore wall which may interfere with the bit bearing lubrication system, or proper fluid circulation system.

Drill bits are also sometimes damaged during the transportation of the drill bit to the well site. They are likewise sometimes damaged during the handling of the drill bit at the drilling rig, such as during the affixing of the drill bit to the drill pipe.

The guide and protector arrangements of the prior art, such as shown by McMahen U.S. Pat. No. 2,296,939 do not adequately protect the cutting surfaces or the lubrication system of a drilling bit, since they are not encapsulated in a manner to do so.

Additionally, in some instances it is extremely undesirable to introduce a metallic object, such as the wire in McMahen into the well bore, because if it comes off, it may cause further damage to the bit.

While Mathews U.S. Pat. No. 2,644,672 shows a molded bit protector, its arrangement and configuration do not provide any way to assure removal of the backfill and debris from the well bore by circulating the backfill and debris away from the cutting surfaces of the bit, before removal of the bit protector. Also, the configuration of the protector does not necessarily lend itself to being lowered in boreholes which have casing that may be offset due to I.D. and O.D. out of round, or tolerances, and wall thickness tolerance which causes protruding ledges where the casing is threaded together.

SUMMARY OF THE INVENTION

It is an object of the invention, therefore, to provide new and improved devices and methods for protecting rock bits; whether diamond or cone, prior to their actual use at the bottom or some other desired level in a borehole drilled into the earth.

It is another object of the invention to provide a new and improved rock bit, diamond or cone, protector and guide device which can be removed, if desired, from the bit at a selected level in the borehole, before reaching the level at which normal drilling operations are to be conducted, or which may be removed during normal drilling operations.

In accordance with one feature of the invention, a rock bit protector and guide device comprises molded jacket means for enclosing the cutting surfaces of a drilling bit. The jacket means includes fluid passage means arranged to jet fluid therethrough to aid in circulating any backfill and debris on the bottom of the well bore before seating the bit on the bottom of the well bore to thereby aid in inhibiting damage to the bit. Thereafter, the protector arrangement can be at least partially removed from the bit by hydraulic action of drilling fluid in the string of drill pipe and fluid pressure responsive means in association with the passage means in the jacket means, or it may be drilled off during normal drilling operations.

In accordance with another feature of the invention, a method of protecting roller cone rock bits comprises placing a roller cone rock bit in a molding form and then pouring a molding material into the molding form and allowing same to harden to form a protective jacket enclosing at least the roller cone portion of the rock bit. Appropriate passageway and cavity forming elements or pressure responsive means are placed in the molding form and positioned in the proper manner with respect to the rock bit prior to the pouring of the molding material for purposes of subsequently forming within the hardened molding material fluid passage- ways and cavities, or pressure responsive means, which enable the removal of the hardened molding material by drilling fluid hydraulic action at the time it becomes desirable to expose the roller cones for drilling purposes.

A further object is to provide a bit guide and protector having a plurality of fluid passages therethrough arranged to enable fluid to be discharged under pressure immediately forward of the guide in a manner to aid in agitating and circulating debris and solids in the well bore.

A further object is to provide a bit guide and protector having a plurality of fluid passages therethrough arranged to enable fluid to be discharged under pressure immediately forward of the guide in a manner to aid in agitating and circulating debris and solids in the well bore and including a protruding blade arrangement on
the forward end of the guide to further aid in agitation of debris and like in the well bore.

A further object of the invention is to provide a bit guide for protecting the lubrication arrangement in the bit.

Still a further object of the invention is to provide a bit guide and protector of a generally convex configuration to thereby provide a bit guide and protector with less tendency to hang up on obstructions in an open borehole or cased borehole and which configuration aids in streamline fluid flow therearound as the protected bit is guided into the well bore, as well as preventing “balling up” of the bit.

A further object is to provide a bit guide and protective arrangement which is constructed and arranged to maintain circulation between the interior of the drill string and well bore.

Yet a further object of the invention is to provide a guide and protector means with a solid forward portion of substantial thickness which is of generally convex configuration without sharp corners or edges to aid in guiding the bit past obstructions in a borehole.

Yet a further object of the invention is to provide a bit guide and protector means with a solid forward portion of substantial thickness which is of generally convex configuration without sharp corners or edges to aid in guiding the bit past obstructions in a borehole and incorporating an indicator such as a dye, or radio active material so that it may be determined at the earth’s surface when the guide is removed.

For a better understanding of the present invention, together with other and further objects and features thereof, reference is had to the following description taken in connection with the accompanying drawings, the scope of the invention being pointed out in the appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a rock bit of the cone type having located thereon a protective arrangement constructed in accordance with an embodiment of the present invention;

FIG. 2 is a perspective view from a different angle of the rock bit and protective arrangement of FIG. 1;

FIG. 3 is a bottom view of the protective arrangement of FIG. 1;

FIG. 4 is a longitudinal cross-section of a cone rock bit located in a molding form for purposes of molding thereon the protective and guide arrangement shown in FIG. 1;

FIG. 4A is a partial longitudinal cross-section taken at a somewhat different angle from that of FIG. 4;

FIG. 5 is a transverse cross-section taken along section line 5—5 of FIG. 4;

FIG. 6 is a transverse cross-section taken along section line 6—6 of FIG. 4;

FIG. 7 is a view similar to FIG. 5 except that FIG. 7 shows a modified form of the cavity and passageway forming means for use with a somewhat different form of cone rock bit;

FIG. 8 is a cross-sectional view taken along section line 8—8 of FIG. 7 except that a different form of roller cone teeth are shown in FIG. 8;

FIG. 9 shows a cross-sectional view of an earth borehole and illustrates the manner in which the protective and guide arrangement in accordance with the present invention functions to guide the drill bit past an obstruction;

FIG. 10 is a perspective view of a cone rock bit having located thereon a protective arrangement constructed in accordance with a further embodiment of the present invention;

FIG. 11 is a perspective view of the protective arrangement of FIG. 10 before it is mounted on the rock bit;

FIG. 12 is a plan view of the protective arrangement of FIG. 11;

FIG. 13 is a longitudinal cross-section of the rock bit and protective arrangement of FIG. 10;

FIG. 14 is a perspective view showing how the protective arrangement of FIG. 11 may be constructed from three separate pre-molded parts;

FIG. 15 is a partial sectional view of a cone bit illustrating one form of lubricating arrangement and the bearing means for supporting the cone for rotation on the shank of the bit with he protecting arrangement over the cone bit shurttail to aid in protecting the bearing lubrication arrangement.

FIG. 16 is a sectional view illustrating the encapsulating arrangement with the fluid passage means therein for circulating fluid through the encapsulating means as well as providing fluid communication to the bearing means from interiorly of the bit to maintain the pressure thereon at substantially the pressure within the well string, or within the well bore as may be desired;

FIG. 7 illustrates the present invention applied to a rock bit of a diamond type bit and the details of the fluid passage arrangement for directing fluid immediately forward of the bit for circulating debris;

FIG. 18 is a partial perspective view of the bottom of the protecting and guiding arrangement of FIG. 17 to better illustrate the fluid openings in the end thereof and a blade arrangement on the end of the guide to further aid in circulation of debris and backfill in the well bore;

FIG. 19 illustrates the form of the guiding and protecting arrangement of FIG. 18 in connection with a cone bit and illustrates the fluid passage means and blade arrangement for aiding in circulation of debris in the well bore;

FIG. 20 is a partial perspective of the bottom of FIG. 19;

FIG. 21 illustrates the manner in which the fluid jetted through the guiding and protecting arrangement along with well bore;

FIG. 22 is a perspective view to illustrate one form of water course means formed in a diamond bit;

FIG. 23 is a partial sectional view of FIG. 22 illustrating the method of applying the present invention to a diamond rock bit; and

FIG. 24 illustrates a step in the preferred method of forming the protecting and guiding arrangement on a diamond bit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1-3, there is shown a roller cone rock bit 10 of the type used in drilling oil and gas well boreholes in the earth. For sake of example only and not by way of limitation, it will be assumed that the rock bit 10 is of the three-cone type. The rock bit 10 includes a body portion 11 and an upper externally threaded portion 12. In use, the portion 12 is threaded
into the drill collar forming the bottom end of the string of drill pipe. Extending downwardly at 120° intervals from the body portion 11 are three shanks 13, only two of which are visible in FIGS. 1 and 2. An individual roller cone 14 is rotatably mounted on each one of these shanks 13. The over-all outline of each roller cone 14 is of a conical shape, and the teeth on the three roller cones 14 are located to interfit with one another in a manner which will not interfere with rotation of the individual cones when the rock bit 10 is rotated for drilling purposes. The rock bit 10 further includes three nozzle ribs 15 which protrude from the body portion 11 and which are located intermediate the shanks 13. As will be seen, a jet nozzle means is located at the lower extremity of each of these nozzle ribs 15.

There is shown mounted on the rock bit 10 a protector and guide arrangement constructed in accordance with a first embodiment of the present invention. This protector and guide arrangement comprises molded jacket means 16 which encloses the roller cone portion of the rock bit 10. This jacket 16 may be formed of any material which may be poured onto and molded in and around the roller cones 14. For example, a cementitious material, including a suitable aggregate such as by way of example only, sand may be mixed with cement. Also, any plastic material such as epoxy resin, polyvinyl chloride, and the like may be employed to form the jacket. The aggregate for the plastic may be silica sand. The jacket means 16 includes a nose portion 17 which extends longitudinally a short distance, on the order of a few inches, beyond the lower extremities of the roller cones 14. Preferably it extends downwardly and gradually inward to form a generally convex configuration on its forward end as illustrated in FIG. 1. Preferably, then the central part of the nose portion thus projects beyond the surrounding edge portions of the guide. While the projecting and guiding jacket 16 is substantially the same diameter, or gauge, as the bit to which it is applied, the generally convex arrangement of its forward portion aids in streamline flow of liquids therearound as it is lowered in the well bore, and inhibits hanging on ledges or irregularities in the well bore. It also prevents "balling up" of the bit, as well as inhibiting damage to the well bore wall.

The jacket means or arrangement 16 further includes support legs 18 which extend between the shanks 13 of the bit 10 and more or less provide a seal with the edges of the bit shanks 13 and the extremities of the body portion 11 and the nozzle ribs 15. The seal with the shanks 13 is more clearly shown in FIG. 15. The exterior of the jacket means or arrangement 16 is shaped to provide longitudinal recesses 19 which enable well fluid to move past the jacket 16 as the jacket 16 and the bit 10 are lowered into a borehole in the earth. In other words, and as particularly illustrated in FIG. 3, in most bit constructions, the cross-sectional area of these recesses 19 are of the same general order of magnitude as the cross-sectional area of the clearances provided around the bit 10 in the absence of the jacket 16. The jacket 16 is further provided with one or more fluid outlets 20 on the exterior of the central part of the nose portion 17. The fluid outlets 20 will be considered in greater detail hereinafter.

Referring now to FIGS. 4-6, there will be described a process by which the jacket 16 is molded on the bit 10. As indicated in FIG. 4, the rock bit 10 is placed in an upside-down manner in a molding form 22 which, in turn, rests on a support table 23. As indicated in the cross-sectional view of FIG. 5, the molding form 22 as shown and described may be approximately cylindrically shaped which corresponds to the general over-all contour of the rock bit 10. As indicated by the section line 4-4 in FIG. 5, the longitudinal cross-sectional view of FIG. 4 is taken in such a manner as to show the details of the fluid passageways within two of the nozzle ribs 15 of the bit 10.

As indicated in FIG. 4, the threaded portion 12 of the bit 10 is provided with a relatively large diameter interior passageway 24 which extends longitudinally into the bit body portion 11. The inner extremity of this passageway 24 is provided with a set of ports 25 which communicate with passageways 26 that extend to and terminate at enlarged cylindrical recesses 27 which are formed in the extremities 15a of the nozzle ribs 15. A cylindrical jet nozzle 28 is mounted in each of these recesses 27.

In use and assuming for the moment that the protective jacket 16 is not present, then drilling fluid pumped down the drill pipe to the passageway 24 flows through the branch passageways 26 and is emitted from the jet nozzles 28 for purposes of cleaning the roller cones 14 and to aid in removing drill cuttings from the bottom of the earth borehole.

As further indicated in FIG. 4, the roller cones 14 are provided with cutting teeth 29. In the illustrated form of rock bit, these teeth 29 are in the form of small tungsten carbide inserts which are embedded in the conical surfaces of the roller-cones 14; however, other teeth configurations may be used which are milled on the cones. The cone cutting surface shown in FIG. 4 is best seen in the longitudinal cross-sectional view of FIG. 4A which, as indicated in FIG. 5, is taken along the axis of one of the roller cones 14. Note, however, that the bearing pin and ball bearing and roller bearing assemblies for securing the roller cone 14 to the bit shanks 13 have been omitted from FIG. 4A for sake of simplicity.

The jacket means 16 may be formed in any suitable manner and the following is given by way of illustration only. After the rock bit 10 is placed in the molding form 22, the lower portion of the form 22 exterior to the bit 10 is filled with a suitable filler such as sand 30. The sand 30 is built up to a level just slightly below the extremity 15a of the nozzle ribs 15. The upper surface of the sand 30 defines the lowermost extremity for the protective jacket 16 which is to be molded onto the bit 10.

At this point, fluid conduit forming means represented by relatively short lengths of flexible tubing 31 are inserted into the jet nozzles 28. A core 32 of easily pulverizable material is then built up in the center area beneath the roller cones 14. This core 32 may, for example, be formed of a moist sand material having sufficient moisture content to enable the material to maintain its form during the molding process. A set of three cavity or void forming elements 33 is then embedded in or otherwise affixed to the upper extremities of the tubing pieces 31. Following this, a set of three additional conduit means represented by three additional lengths of tubing 34 are embedded in or otherwise secured to the upper sides of the cavity forming elements 33. These additional tubing pieces 34 extend upwardly past the top of the molding form 22 and may be tied together by a tie string or rubber band or the like, as indi-
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cated at 35. In some cases the tubing 31 may be of suffi-
cient length to extend through cavity forming elements 33 and above the form. Also, after the jacket is formed, the tubing may be removed. The cavity forming ele-
ments 33 may, for example, be formed of paraffin or other relatively rigid was-like material.

A set of molding form members 36 is then inserted into place between the lower ends of the nozzle ribs 15 and the inner wall of the molding form 22. The cross-
sectional shape of these molding form members 36 is indicated in FIG. 5. Members 36 may be made of wood or other suitable material. Returning to FIG. 4, a cylin-
drical molding form member 37 is then placed in the molding form 22 on top of the molding form members 36. Such molding form member 37 includes skirt por-
tions 37a which extend downwardly and occupy the upper portion of the space between the members 36 and the molding form 22. Member 37 is further provided with an enlarged cylindrical opening or passageway 37b at the upper end thereof. The tubing elements 34 ex-
tend through this passageway 37b. The inner surface 37c of the member 37 is of an approximately spherical shape and defines the shape of the exterior surface of the nose portion of the protective jacket 16 which is to be molded. Member 37 may also be made of wood.

The molding material is now poured into the molding form 22 through the opening or passageway 37b in the top member 37. The molding material is allowed to flow down into and to fill up the various remaining un-
occupied regions in and around the roller cones 14, as well as the unoccupied regions extending therabove up to the top of the opening 37b. The distribution of the molding substance may be facilitated by vibrating the support table 23 during the pouring process. This sub-
stance is then allowed to harden to form the protective jacket 16 which is shown in FIGS. 1-3. Note that the molding form members 36 of FIG. 4 are shaped to pro-
duce the desired longitudinal recesses 17 on the exter-
ior surface of the protective jacket 16.

After the material has hardened, the molding form pieces 37 and 36 are removed from the molding form 22, whereupon the rock bit 10 and protective jacket 16 may also be removed from such molding form 22. The tubing pieces 34 which extend beyond the surface of the protective jacket 16 are cut off flush with the surface of the jacket 16 to thereby provide the fluid outlets 20 shown in FIGS. 1 and 3, or they may be removed. Tubing pieces 34 and 31 may be formed of one piece of tubing, and where they are to be removed, they may be provided with a suitable release agent to prevent ad-
hering to the molding material.

At any event, tubing pieces 31 and 34 form passage means in the jacket means 16 referred to generally at 85, whether they remain in place or are removed. One end of the passage means terminates at the jet nozzle means 28 and the other end at outlets 20 in the central portion of the jacket means 16, which central portion extends forwardly beyond the edges of the jacket means 16. In the form of the invention shown, the pas-
sage means 85 communicates with or is intersected in-
mediate the ends thereof by the pressure responsive means 33a formed by cavity forming elements 33. It should be noted that the surface of the pressure responsive means provides a pressure responsive surface area which is larger in cross-sectional area than the passage means 85 with which it intersects, to provide a surface area of predetermined size so that at a predetermined

liquid pressure within the drill string and connected bit 10, the jacket means 16 will be removed.

It should be noted that FIGS. 5 and 6 are not entirely complete cross-sectional views. FIG. 5 is, more accu-
rately, a cross-sectional view looking down into the molding form 22 with the form member 37 removed and showing the situation before the forming material is poured. In FIG. 6, the view is complete with the ex-
ception that the material has not been poured.

Some types of rock bits employ what are known as "long jets" or "extended jets." In such cases, the jet nozzle is located at the lower ends of tubular mem-
ers which extend downwardly from the nozzle ribs to a level closer to the lower extremities of the roller cones. Such bits may be provided with protective jack-
ets in the same manner as described above, the main difference being in the layout of the tubing pieces which are inserted into the jet nozzles and which run to the cavities formed in the body of the protective jacket.

Referring now to FIGS. 7 and 8, there is shown a modified form of construction for use with a rock bit 40 which does not have jet nozzles for ejecting the drill-
ing fluid. Instead, as indicated in FIG. 8, the end 41 of the bit 40 is provided with an interior passageway 42 which extends into a body portion 43. A series of smaller passageways 44 are drilled through the body portion 45 located at the inner extremity of the passage way 42. In use, the drilling fluid is ejected through these passageways 44 for purposes of washing the roller cones 46 and flushing the drill cuttings back to the sur-
face.

It is noted that the roller cones 46 in FIG. 8 are pro-
vided with teeth 47 which are of a different form of construction than the teeth 47' provided for the corre-
sponding roller cones 46' of FIG. 7. Except for this dif-
ference, the rock bit 40 of FIG. 7 is the same as that of FIG. 8.

For the "non-jet" type of rock bit shown in FIGS. 7 and 8, the passageway and cavity forming means for use in forming the protective jacket includes flexible tubing pieces 48 which are inserted into the fluid pas-
segeways 44 and then bent around the roller cones 46 (or 46') so that their free ends are located adjacent one another above the roller cones 46 (or 46'). These free ends are then embedded in a piece of cavity forming material 49 which, as indicated in FIG. 7, is in the form of a single piece, as opposed to the three separate pieces 33 of the earlier embodiment. Further flexible tubing pieces 50 are embedded or otherwise attached to the upper side of the cavity forming piece 49 for forming the fluid passageways which extend to the out-
lets to be formed on the outer surface of the protective jacket. As before, the cavity forming piece 49 may be composed of a paraffin or wax material, while the flexible tubing pieces 48 and 50 may be wax cores or short lengths of nylon, elastomer, composition, or other plas-
tic tubing.

As indicated in FIG. 8, the cavity forming piece 49 is preferably positioned sufficiently close to the roller cones 46 so that at least some of the roller cone teeth 47 extend into such cavity forming material 49. The cavity forming material 33 or 49, when made of wax is melted by heating the jacket to enable the wax to flow out the outlets 20 or the other end of the bit. Other forms of material which can be readily dissolved or flushed from the cavities 33 after the molding material hardens may be used in place of paraffin or wax. Also,
certain non-dissolvable forms of material can be used for forming the cavities 33. For example, some form of sintered or cellular type material may be used. In the latter cases, the essential requirement is that the material be fairly permeable to the flow of well fluid. Thus, it forms a fluid pressure responsive means, as does the cavity elements 33, that intersects or communicates with the passage means 85 formed in the jacket means 16 intermediate the ends of the passage means 85 to aid in removal of the jacket means 16 when desired. The cellular arrangements provide a surface area which is larger than the passage means 85 for fluid action there-against in a manner as previously described.

Referring now to FIG. 9, there will be described a typical manner of use of the rock bit and protective jacket 16 of FIGS. 1-6. FIG. 9 shows a cross-section of a borehole 51 passing through a subsurface earth formation 52. It is assumed that the portion of the borehole 51 shown in FIG. 9 was drilled at an earlier point in time and that the drill pipe and drill bit were removed from the hole for purposes of replacing a worn bit or for any other reason. With the drill pipe back at the surface of the earth, a new rock bit 10 having a protective jacket 16 is attached to the end of the lowermost section of a string of drill pipe 53. This lowermost section may comprise the usual drill collars foradding weight to the bit. With the new bit 10 and protective jacket 16 attached thereto, the drill pipe 53 is run back into the borehole 51. During the running in operation, the protective jacket 16 protects the roller cones, bearings and bearings races of the bit 10 from damage in the event that a rock ledge or shoulder or some other obstruction should be encountered. In addition, the protective jacket 16 serves to guide the drill bit 10 past any obstruction. In this regard, FIG. 9 shows an example of a somewhat different type of obstruction, namely, a key seat section 54 in the well bore. Without the protective jacket 16, the roller cones, bearings, races, or other components of the bit 10 may become damaged by the bit wedging in this key seat section 54 as the drill pipe is lowered into the bore hole. Also, such wedging may cause the bit 10 and drill pipe 53 to stick in the key seat. With the protective jacket 16, however, any wedging and damage to the bit as well as sticking is largely eliminated and the rock bit 10 is guided smoothly past the key seat section 54.

When the rock bit 10 reaches the approximate level at which the drilling process is to be performed, then it becomes necessary to remove the protective jacket 16. Typically, this level will be the bottom of the hole, though it may instead be some intermediate level at which it is desired to perform a reaming operation. In some situations, it may be desirable to circulate lost circulation material into the well bore, and in such event it would be desirable to remove the jacket means 16 to increase the flow rate.

Removal of the protective jacket 16 is accomplished by pumping drilling fluid down the drill pipe 53 to the bit 10 in such manner as to dislodge at least a portion of the protective jacket 16. In particular, the drilling mud pumps located at the surface of the earth are operated so as to apply a predetermined volume of drilling fluid at a predetermined pressure to the drill bit 10. The resulting hydraulic action of this drilling fluid when it reaches the interior cavities 33 (FIG. 4) formed in the body of the protective jacket 16 and the relationship of the pressure responsive surfaces of the cavities causes the portion of the protective jacket 16 located on the downhole side of such cavities 33 to break off from the remainder of the protective jacket 16. These interior cavities 33 are located so that this breaking away of the nose portion 17 exposes the cutting teeth of the roller cones 14. Where the cavities are provided with a sintered or cellular material, the pressure increase causes a pressure buildup which aids in removal of the nose portion 17.

The bit is rotated and weight applied to resume normal drilling. This causes any portion of the protective jacket 16 which remains in contact with the roller cones to fail in shear and permit normal operation and use of the rock bit 10. In the drilling process, the nose portion which was previously broken off, is chewed up and debris flushed back to the surface along with the earth formation drill cuttings.

The outlets 20 enable the drill string to fill as it is lowered into the well bore, or if desired, fluid may be circulated down the well string and out the outlets 20. Also, the passage means 85 aid in removal of debris from the well bottom as will be later described.

The size, location and configuration of the fluid conduits provided by the tubing pieces 31 and 34 and the size, location and configuration of the cavities 33 depend upon the size and style of the rock bit, the strength of the material used in forming the protective jacket 16, and the mud pump pressure desired to shear off the nose portion of the protective jacket. The size of the cavities 33 is selected so that sufficient fluid pressure is build up in such cavities to exert a force against the cavity surfaces and the nose portion of the protective jacket sufficient to cause its removal by exceeding the tensile strength of the jacket material lying laterally of the cavities 33. The size of the fluid conduits provided by the tubing pieces 31 and 34, on the other hand, is preferably such that at the pressure required to shear off the nose portion, the much smaller force generated in such conduits due to their smaller diameter is insufficient to overcome the tensile strength of the material surrounding such conduits. In other words, it is desired that the cavities 33 should define the location at which the nose portion of the protective jacket 16 is broken away from the bit.

Considering briefly the choice of material for forming the protective jacket 16, such material should possess adequate compressive strength and impact resistant characteristics in order to adequately protect the roller cones, bearings, races and other components of the rock bit 10 from damage when the rock bit 10 strikes an obstruction in the borehole or is dropped on the drilling rig floor or the like. On the other hand, the tensile strength of the material should be such that the nose portion of the protective jacket 16 may be readily removed with the application of a reasonable amount of mud pump pressure.

Referring now to FIGS. 10-13, there is shown a somewhat different embodiment of a protector and guide arrangement for use with roller cone rock bits. As indicated in FIG. 10, a rock bit 60 is provided with a protective jacket 61 which fits over and encloses the roller cone portion of the bit 60. This protective jacket 61 is in the form of a pre-cast or pre-molded jacket which, subsequent to the forming thereof, is expanded as it is forced over the bottom portion of the rock bit to be protected. The pre-molded jacket 61 by itself is shown in FIGS. 11 and 12. The manner of mounting it...
on the rock bit 60 is indicated in the cross-sectional view of FIG. 13.

As indicated in these various views, the pre-molded protective jacket 61 includes a nose portion 62 which is adapted to fit over and cover the roller cones 63 (FIG. 13) of the rock bit 60. The nose portion 62 is generally convex as shown in the drawings, and its central position projects beyond the surrounding edges. The pre-molded jacket 61 further includes leg portions 64 which extend longitudinally from the nose portion 62 and which have extremities 65 which are adapted to fit into the fluid outlets 66 (FIG. 13) of the rock bit 60. These fluid outlets 66 are located immediately below jet nozzles 67 which are mounted in nozzle ribs 68. The reduced diameter extremities 65 are sized to fit in the fluid outlet recesses 66 of the bit 60. The interiors of the leg portions 64 are shaped to enable drilling fluid to flow from the fluid outlet recesses 66 of the rock bit 60 to the interior of the nose portion 62. In particular, the leg portions 64 are provided with interior recesses 69 for allowing such fluid flow. The recesses 69 slope inwardly relative to the longitudinal axis of the bit and provide an arrangement to aid in removing the jacket 61 from the bit. That is, the fluid from the bit will impinge thereagainst and aid in expanding the leg portions 64 to dislodge the extremities 65 from the fluid outlets 66 when the pressure is increased to remove the jacket 61.

The nose portion 62 is provided with a concave inner surface 70 for receiving the roller cones 63. The nose portion 62 is further provided with upper edges 71 which are shaped to conform to the cylindrical contour of the roller cones 63 at their point of engagement with the nose portion 62. The nose portion 62 is also provided with a fluid passageway 72 which extends from the interior surface 70 to the exterior surface of the nose portion 62. A plurality of passage means as shown in FIG. 1, may be provided for jetting fluid from the bit to cause circulation in advance of the bit guide and protector. The exterior surface of the nose portion 62 is provided with longitudinal recesses 73 located at the sides of the leg portions 64 for enabling passage of well past the exterior of the protective jacket 61 when the rock bit 60 is being lowered into a borehole.

The pre-molded protective jacket 61, including the nose portion 62 and the leg portions 64, is formed of a resilient plastic material. Typical plastic materials which can be employed are phenolic resin, fiberglass reinforced vinyl or epoxy resins. The material should possess sufficient elasticity so that the leg portions 64 may be flexed outwardly during application of the jacket on the bit and thereafter return inwardly for inserting the extremities 65 into the fluid outlets 66 of the bit 60. This provides a clamping action which serves to hold the protective jacket 61 in place on the rock bit 60.

A further step in the mounting process is indicated in FIG. 13. In particular, the upper edges 71 of the nose portion 62 are covered with a layer of resilient material 74 immediately before the jacket 61 is fitted over the roller cones 63. This resilient material 74 is preferably a semi-hard elastomer material having any suitable hardness, which by way of example may be in the range of 70 to 95 durometer. A suitable material is, for example, polyurethane. When the jacket 61 is placed on the rock bit 60, this resilient material 74 provides a seal between the peripheries of the roller cones 63 and the upper edges 71 of the nose portion 62. This materi-

rual 74 also helps absorb and distribute the impact loading when the protective cover 61 strikes an obstruction in the borehole or when the rock bit 60 is mishandled on the floor of the drilling rig or the like.

The pre-molded protective jacket 61 serves to protect the roller cones 63 of the rock bit 60 both before the bit 60 is lowered into the borehole and during the running in of the bit 60 into the borehole. When the bit 60 reaches the desired level in the borehole at which it is desired to commence the drilling or reaming operation, then the protective jacket 61 is removed by operating the drilling rig mud pump to supply a sufficient volume of drilling fluid at a sufficient pressure to, in effect, blow the jacket 61 off of the end of the bit 60. The jacket 61 is chewed up by the roller cones 63 and the debris is flushed back to the surface in the same manner as previously described.

Referring to FIG. 14, there is shown a modified manner of forming the pre-molded protective jacket. In particular, a pre-molded jacket 75 for a three-cone bit may be formed in three separately molded sections 76, 77 and 78. These sections 76-78 are formed of a resilient plastic material the same as before. The three sections are then bonded together by a suitable adhesive material such as, for example, epoxy, to provide the complete protective jacket. In some cases, it will be preferable to do the bonding after the pieces 76-78 are mounted in position on the rock bit.

A feature of the pre-molded form of the protective jacket device is that it may be used on rock bits for which no protective jacket is provided at the factory by the manufacturer of the rock bit. In other words, the pre-molded protective arrangement can be installed at a later date by a drilling equipment distributor or by a driller at the well site.

FIG. 15 illustrates one form of lubrication arrangement for a cone rock bit 10. As previously noted, the lubrication arrangement of a bit sometimes becomes damaged as the bit 12 is lowered in the well bore. The jacket means 16 of the present invention overcomes this in that it protects the lubrication arrangement as the bit is lowered in the well bore.

In FIG. 15, it will be noted that the molded jacket means 16 extends longitudinally of the bit shanks 13 to approximately the point represented at 80 so as to cover all portions of the shanks 13 to inhibit fluid communication between the well bore and the edges 13a of the shanks 13 and the portion represented by the numeral 13b which is designated the shirrtail of the bit.

Any suitable number of cones as previously noted may be carried by the bit, and for purposes of illustration only, a bit having three cones is illustrated, but as noted, any suitable number of cones may be employed on the bit. The cones 14 are each rotatably supported on their respective shank 13, and it will be noted that the shirrtail 13b protrudes radially slightly relative to its respective cone 14 which provides an overhanging ledge that may tend to collect debris if the bit contacts the well bore wall as it is lowered therein.

A suitable sealed lubricated bearing arrangement referred to generally at 81 is provided for rotatably supporting each of the cones 14 on their respective shank 13, and each cone 14, is also provided with suitable cutting surface arranged thereon to accomplish the desired drilling operations within the well bore. A lubricating arrangement 82 provides lubrication to the sealed bearings referred to at 81 and provides lubrica-
tion between the cone 14 and the inner surface of the shank 13 on which each cone is mounted during drilling operations to increase bit life and the efficiency of the bit, as the bit is rotated as well as for other reasons. As previously noted, it has been found that for some reason during lowering operations, the lubrication system 82 or the bearings 81 may become damaged or incapacitated. For example, mud or debris might collect within the interior of the bit to interfere with the proper functioning of the lubrication system 82 which supplies lubrication to the bearing arrangement 81 and to the surfaces between the shank 13 and its respective cone 14.

The molded jacket arrangement of means 16 of the present invention, by encapsulating the shanks 13 and the shirrtails 13b of the shanks, prevents engagement of the shanks and shirrtails with the well bore wall as the bit is lowered into the well bore and inhibits debris or undesirable matter from clogging the bearings 81 or the lubrication system 82.

It is also to be noted that the molded jacket means 16 is approximately the gauge of the bit even though it covers the shanks 13 of the bit and provides a generally outer convex arrangement as illustrated by the noise portion 17 to aid in laminar flow of fluid or liquid in the well bore as the bit is lowered therein. The molded jacket means 16 not only inhibits contact of the bit in a deleterious manner with the well bore wall, but the molded jacket means also prevents fluid communication between the liquid in the well bore wall and the surfaces of each shank adjacent the surfaces of the cone 14 carried thereby. The molded jacket means 16 may be of any suitably material such as an epoxy resin and a suitable aggregate such as silica sand as previously described and is of a suitable strength to accomplish the intended function. Of course, it may be formed of other materials that can be easily molded or cast. The jacket means 16 also include fluid passage means referred to generally by the numeral 85 which communicates one end 84 with the jet nozzle means referred to at 28 in the bit and at their other end 84a through the outlets 20 in the nose portion 17 of the jacket means 16.

During forming of the jacket means 16, a core of pressure responsive material is provided in chamber 32a within the jacket means 16 which chamber 32a, as more clearly shown in FIG. 16, communicates the passage means 85 with the lubrication arrangement 82 for each of the shanks and cones carried thereby. Thus, the pressure of liquid within the passage 24 of the bit body may be communicated through the passage means 26 that communicates with its respective jet means 28 and then through the passage means 85 to the chamber 32a. The pressure responsive material may be any suitable foam such as by way of example only, an elastomer foam, a polyurethane foam, or styrofoam. If desired the pressure responsive material may be eliminated and chamber 32a left as a void. This aids in equalizing the pressure on the sealed lubrication arrangement 82 with the liquid in the drill string, or between the sealed lubrication arrangement 82 and the liquid within the well bore.

If desired, suitable pressure responsive means as illustrated at 33a may be provided intermediate the ends of the passage means 85, which pressure responsive means also communicates with the chamber 32a as indicated. The pressure responsive means 33a provides a surface area against which fluid pressure may be exerted to aid in removal of the jacket means 16 when desired.

In this regard, it is again noted that the passage means 85 is in the form of a plurality of passages, one each of which communicates with a jet means 28 in the bit so that if desired fluid may be jetted through the passage means without causing removal of the jacket means 16 to circulate liquid in the well bore in advance of the jacket means in a desired manner. The molded jacket means 16 is of a suitable configuration and strength to accomplish this function. The passage means 85 again terminates in outlets 20 formed in the central part of nose portion 17 of the jacket means 16, as shown in FIG. 16.

When it is desired to remove the molded jacket means 16, the bit 10 may be lowered on bottom and drilling operations started whereupon the jacket means 16 may be ground off, or if desired it may be removed by increasing the hydraulic pressure within the drill string and bit 10 to act upon the pressure responsive means 33a to remove the portion of the jacket means 16 in advance of the cutting surfaces of the cones 14. The molded jacket means 16 is of a material that will be ground up as the bit is rotated during normal drilling operations and then is circulated up the well bore to the earth's surface.

In FIG. 17 the bit is again referred to generally at 10 and is shown as being a diamond bit having a plurality of diamonds 90 embedded therein for cutting the formation in the well bore. The jacket arrangement referred to generally at 16 is preferably formed in situ on the diamond bit as will be described hereinafter. It will be noted that the jacket means 16 has a nose portion 17 which is of a generally convex configuration to aid in guiding the bit 10 in the well bore. Fluid passage means 85 is provided through the jacket means 16, and the forward portion of the jacket means 16 is of substantial thickness so that fluid may be directed from the drill string referred to at 88 and through the fluid means 85 to accomplish desired jetting action within the well bore as will be described in greater detail.

In addition, the forward portion of the jacket means 16 includes the blade arrangement referred to generally at 89 which acts as stirrers when the bit 10 is rotated to further aid in agitating the liquid in the well bore to aid in causing circulation of debris away from beneath the bit. A preferred configuration of the blade arrangement 89 is more clearly shown in FIG. 18 of the drawings and is illustrated as including a plurality of blades 91, 92 and 93 joined at their inner ends adjacent the center of nose portion 17.

The passage means 85 is formed by a plurality of separate passages 85a, 85b and 85c and terminates in separate outlets 20. It will be noted that the outlets 20 are arranged intermediate the blades 91, 92 and 93 and that the passages 85a, 85b and 85c are arranged relative to each other to aid in directing fluid discharged therethrough to converge towards the center of the well bore immediately in front of the bit guide and protector 16 as the bit 10 is lowered in the well bore.

In FIG. 19, the bit 10 is shown as being of the cone type having the cones 14 with the passage means 85 formed as previously described. In this arrangement also, the nose portion 17 of the jacket means 16 is provided with the blade arrangement referred to generally at 89, comprising blades 91, 92 and 93 and it will be
noted that the passage means is arranged so that the outlets 20 will direct the fluid discharged from the passage means 85 to a position immediately forward of the bit guide and protector 16 as it is lowered into the well bore.

After a bit has been removed from a well bore, it is not uncommon for the well bore to "backfill," which means that some of the portion of the well bore caves in, or some of the drilled portion of the well bore settles back to the bottom of the well bore. It is not uncommon for this backfill to fill anywhere from a few feet to as much as a hundred feet or more of the well bore. It is extremely desirable in drilling operations, whether with a cone or diamond bit to position the bit on bottom as quickly as possible.

In some instances debris may be on the bottom of the well bore. The debris may be of any type and size and may be of a nature which will cause damage either to the cones of a cone bit, or the diamonds in a diamond bit. In order to overcome this problem, the present invention is particularly useful in that as the drill string represented by the numeral 88 is lowered into the well bore with the bit 10 thereon, fluid may be jetted out through passage means 85 so as to be directed in a stream represented at 101 in FIG. 21 to aid in circulating the backfill and any debris on the bottom 102 of the well bore. In addition, the drill string and bit may be rotated so that the blades 89 further agitate the backfill and debris to thereby aid in circulation thereof around the surfaces represented at 103 on the bit past the cutting surfaces, which in the drawing are represented as being in the form of diamonds. This inhibits damage to the cutting surface of the bit and enables the bit to get on bottom much faster than otherwise would be possible. It is of course necessary that the construction and arrangement of the bit guide and the passage means 85 along with the blade arrangement 89 be such to accomplish this function, while not removing the bit guide 16 by hydraulic pressure. The arrangement of the plurality of passages as previously noted and as shown directs the fluid from interiorly of the drill string 88 to a point immediately in front of the bit 10 at a high velocity to aid in circulation of the backfill and debris and washing upward in the well bore around the drill bit and drill string to enable the drill bit to rest on bottom in the well bore.

FIGS. 22, 23 and 24 illustrate the preferred method of forming the present invention when employed with diamond bits. In FIG. 22 a plurality of water passages 104 are shown as being arranged on the diamond bit for a purpose well known in the art. These water courses are shown in sectional view at 104 in FIG. 23 and are shown as varying in size throughout the surface of the bit 10 intermediate the area in which the diamonds are arranged. The jacket means 16 of the present invention is illustrated in FIG. 23 as being formed within the water passage means 104 but a suitable mold release agent 105 may be provided on the water passages 1004 to aid in removal of the jacket means 16 either by drilling it off during normal drilling operations, or when it is removed by a substantial increase in the hydraulic pressure to blow it off, as previously described. It is particularly desirable in connection with diamond bits that no obstruction be present in the water passageway; however, it is desirable for complete protection of the bit that the bit guide and protecting arrangement 16 of the present invention be affixed in the water passages 104 as the bit is lowered into the well bore.

It will also be noted in FIG. 23 that the jacket means 16 shows a conforming surface noted generally at 106 on its outer surface that conforms with the surface 107 on the diamond bit, and where there is a diamond projection such as represented at 108 on the bit surface, there will be a similar projection 108 on the jacket means 16. Similarly, conforming surfaces 109 conform with the passage means 104 as illustrated. This is accomplished by the method employed in the forming of the present invention in connection with diamond bits particularly as illustrated in FIG. 24 of the drawings. The diamond bit there represented by the numeral 110 is shown as first having had a plastic form 111 made, the inner surface 112 of which conforms with the outer surface 113 of the bit 110. A suitable mold release agent may be employed in forming the mold 111, and merely by lifting it up a suitable distance as represented by the arrow at 115, a void 116 is provided for receiving the molding material forming the jacket means 16 of the present invention.

Of course, the mold 111 may be provided with an opening 116a, and a suitable void forming substance 87 may be positioned in the central part of the diamond bit 110. After the mold 111 is raised to the position as illustrated in FIG. 24, and the tubes represented at 120 positioned to form the passage means, the molding material may be poured in the opening 116a, as previously described to thereby form the jacket means 16.

In FIG. 21, debris is represented at 99 as being circulated up off the bottom of the well bore and around the bit 10. This removes the debris from contact with the cutting surfaces of the bit before the jacket means 16 is removed by increasing the pressure, or by abrading it off in normal drilling operations.

If desired, an indicator such as a suitable dye or a radio active material may be placed in the jacket means 16 as it is formed. Thus, by noting at the earth's surface the time it takes to pump the indicator to the earth's surface (after the jacket is blown or ground off) and with a theoretical annular volume of the well bore, it is also possible with this invention to determine well depth when a new bit is lowered onto bottom.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials as well as in the details of the illustrated construction may be made without departing from the spirit of the invention.

What is claimed is:
1. A drilling bit protector and guide comprising: a molded jacket means for covering the forward end of the drilling bit including the cutting surfaces;
b. said jacket means having passage means to accommodate fluid flow therethrough; and
c. said jacket means having longitudinal recesses on the exterior thereof to accommodate fluid flow therearound.
2. The invention of claim 1 including fluid pressure means intermediate the ends of the passage means communicating with the passage means whereby fluid pressure acting on said pressure responsive means aids in removal of said jacket means.
3. The invention of claim 2 wherein said pressure responsive means comprises a permeable material which
communicates with the passage means intermediate the ends thereof.

4. The invention of claim 2 wherein said pressure responsive means includes surface means against which fluid pressure may act for removal of said jacket means.

5. The invention of claim 4 wherein said surface means is formed on a cavity that communicates with said passage means.

6. The invention of claim 1 wherein said passage means is a plurality of passages formed in said jacket means to direct multiple jet streams in advance of the jacket means without removal thereof.

7. A protector and guide for a well bore drilling bit having cones supported adjacent the shirrtails on drilling bit shanks with a sealed, lubricated bearing arrangement for the bit cones comprising:
   a. molded jacket means for covering the forward end of the drilling bit including the cones;
   b. said jacket means having passage means to accommodate fluid flow therethrough;
   c. said jacket means having longitudinal recesses on the exterior thereof to accommodate fluid flow therearound; and
   d. said jacket means encapsulating the shirrtails of the drilling bit to seal off communication between the well bore and bit shirrtails.

8. The invention of claim 7 wherein said jacket means includes a chamber that communicates with the fluid passage means and the sealed lubricated bearing arrangement to maintain pressure thereon at least equal to the fluid pressure in the well bore.

9. The invention of claim 1 wherein said jacket means is of substantial thickness forwardly of the drilling bit cutting surfaces and covering the bit as its forward end to provide a guide surface which will withstand substantial impact.

10. The invention of claim 1 wherein said jacket means includes a central portion having a plurality of outwardly projecting blades thereon.

11. The invention of claim 10 wherein said blades are joined at their inner ends and extend laterally at spaced intervals on said central portion.

12. The invention of claim 11 wherein the discharge outlets from said fluid passage means is in the space between said blades.

13. The invention of claim 12 wherein said fluid passage means are arranged in said jacket means so that fluid discharged from the outlets converges towards a position centrally and in advance of said jacket means.

14. The invention of claim 1 wherein said jacket means includes a central longitudinally projecting portion and wherein said passage means terminates at its outer ends in said central portion.

15. A device in accordance with claim 1 wherein the jacket means is premolded and includes a nose portion and leg portions extending longitudinally therefrom, the leg portions having extremities which are adapted to fit into the fluid outlets of the bit when the nose portion is fitted over and covers the bit.

16. A molded jacket device for protecting roller cone rock bits comprising:
   a. nose portion adapted to fit over and cover the roller cones; and
   b. leg portions extending longitudinally from the nose portion and having extremities adapted to fit into the fluid outlets of the rock bit for holding the jacket device on the rock bit.

17. A device in accordance with claim 16 wherein the leg portions are shaped to enable drilling fluid to flow from the fluid outlets of the rock bit to the interior of the nose portion.

18. A method of forming a protector for a drilling bit with cutting surfaces thereon and having fluid outlets in the drilling bit comprising:
   a. placing a drilling bit in a molding form;
   b. positioning fluid conduit forming means to project from the fluid outlets in the bit through the bit and beyond the cutting surfaces thereon;
   c. positioning pressure responsive surface means intermediate the ends of the fluid forming conduit means to communicate therewith;
   d. pouring a molding material into the molding form and allowing same to harden to form a protective jacket enclosing the bit cutting surfaces, fluid conduit forming means and pressure responsive means.

19. A method of forming a protector for a roller cone drilling bit with cutting surfaces thereon and having fluid outlets in the drilling bit comprising:
   a. placing a roller cone bit in a molding form;
   b. positioning fluid conduit forming means to project from the fluid outlets in drilling bit through the bit and beyond the cutting surfaces thereon;
   c. positioning pressure responsive surface means intermediate the ends of the fluid forming conduit means to communicate therewith;
   d. pouring a molding material into the molding form and allowing same to harden to form a protective jacket enclosing the bit cutting surfaces, fluid conduit forming means and pressure responsive means.

20. A method of forming a protector for a diamond bit having a fluid outlet therein and fluid passage means on the external surface thereof comprising:
   a. placing a diamond bit in a molding form;
   b. positioning fluid conduit forming means to project from the fluid outlet in the bit and projecting outwardly therefrom;
   c. placing a mold release agent on the bit external fluid passage means; and
   d. pouring a molding material into the molding form and allowing same to harden to form a protective jacket that encloses the bit and coats that part of the bit external fluid passage means having a mold release agent thereon.

* * * * *
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION
Patent No. 3,788,407 Dated January 29, 1974
Inventor(s) HOWARD I. LORENZ and EUGENE P. ROSSER

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, Line 52, "but" should be -bit-
Col. 4, Line 20, "he" should be -the-
Col. 5, Line 14, "allocated" should be -located-
Col. 7, Line 18, "furth" should be -further-
Col. 9, Line 26, "foradding" should be -for adding-
Col. 11, Line 42, after "well" insert -fluid-
Col. 13, Line 24, "noise" should be -noise-

Col. 15, Line 59, "1004" should be -104-
Col. 18, Line 4, after "a." insert -a-

Signed and sealed this 6th day of August 1974.

(SEAL)
Attest:

McCoy M. Gibson, Jr.
Attesting Officer

C. Marshall Dann
Commissioner of Patents