Sept. 30, 1969 J. W. REYNOLDS 3,469,641

REAMING BIT ASSEMBLY

Filed Dec. 11, 1967 4 Sheets-Sheet 1

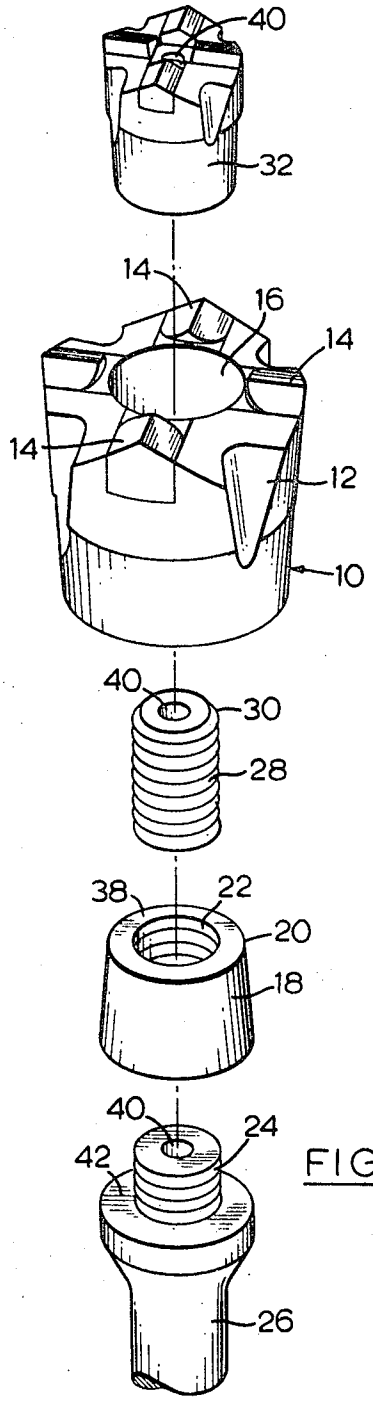


FIG. 1

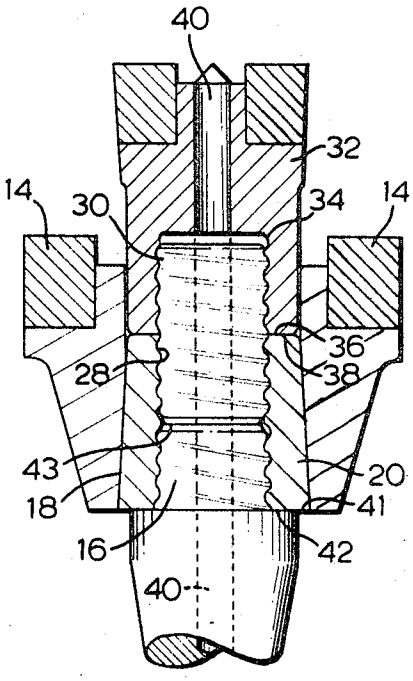


FIG. 2

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REAMING BIT ASSEMBLY

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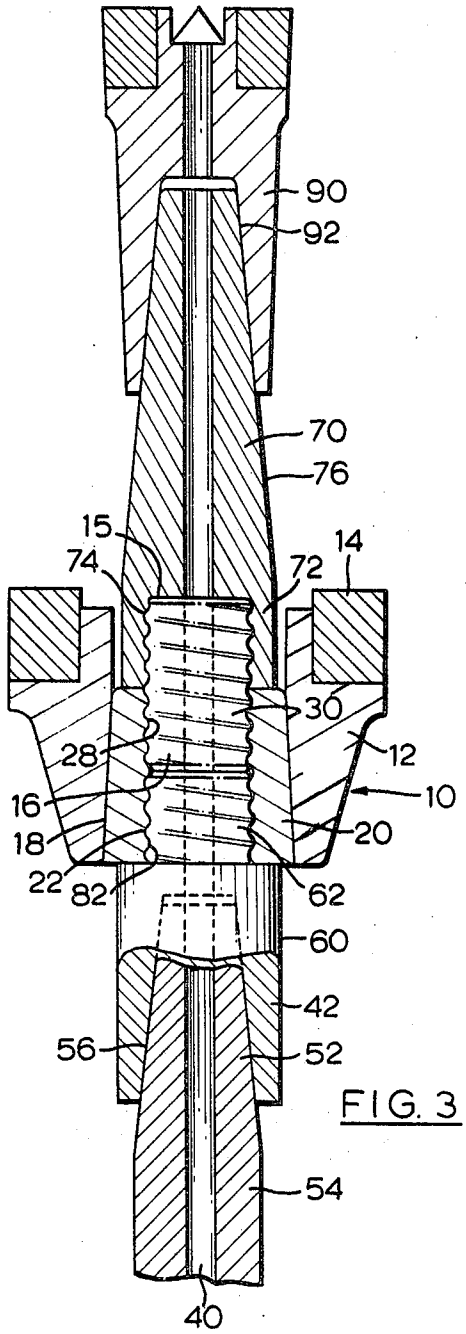


FIG. 3

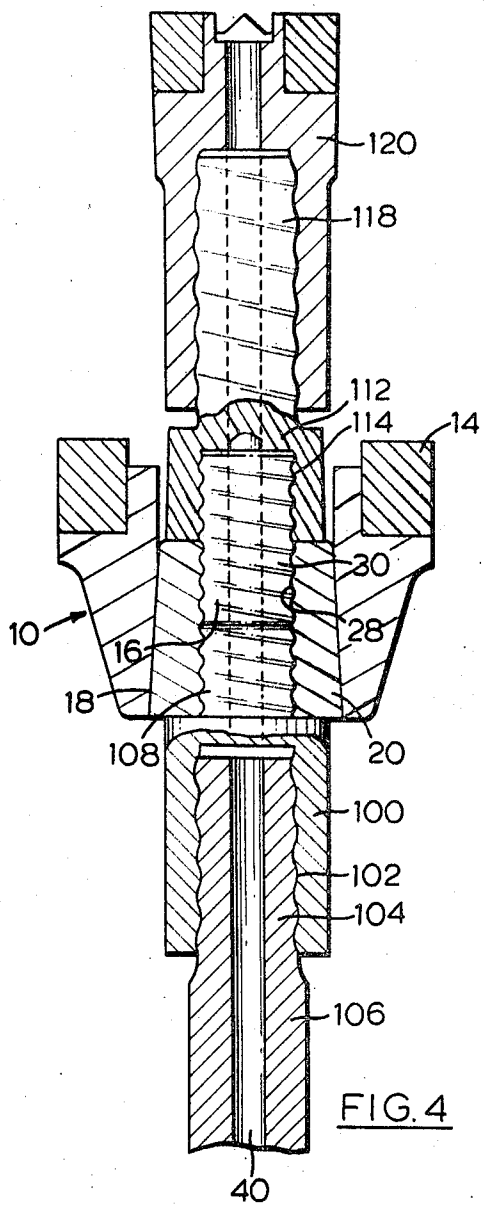


FIG. 4

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REAMING BIT ASSEMBLY

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FIG. 5

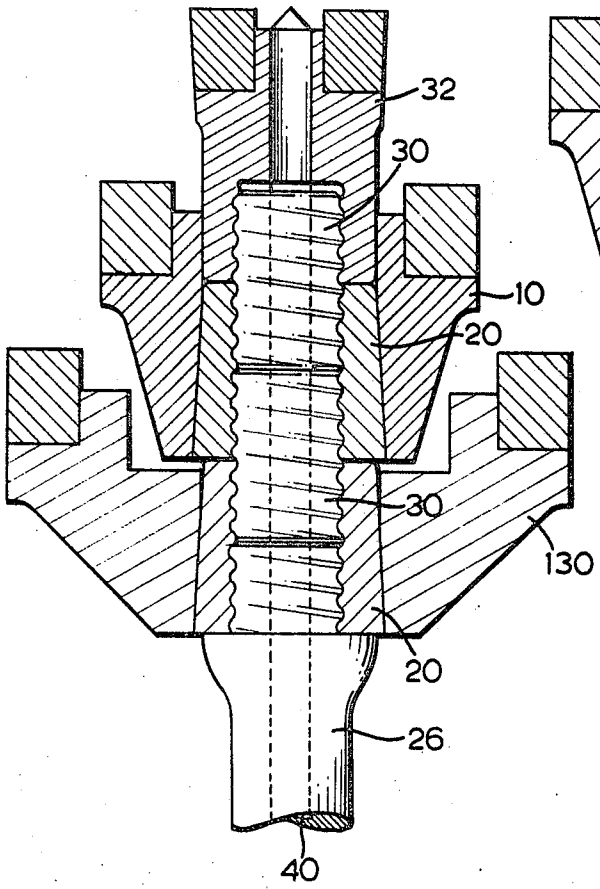
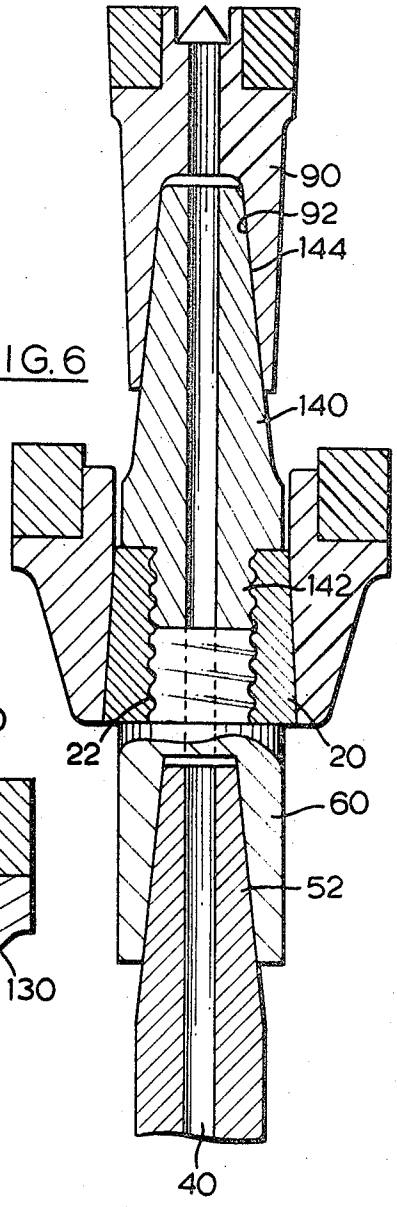


FIG. 6



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REAMING BIT ASSEMBLY

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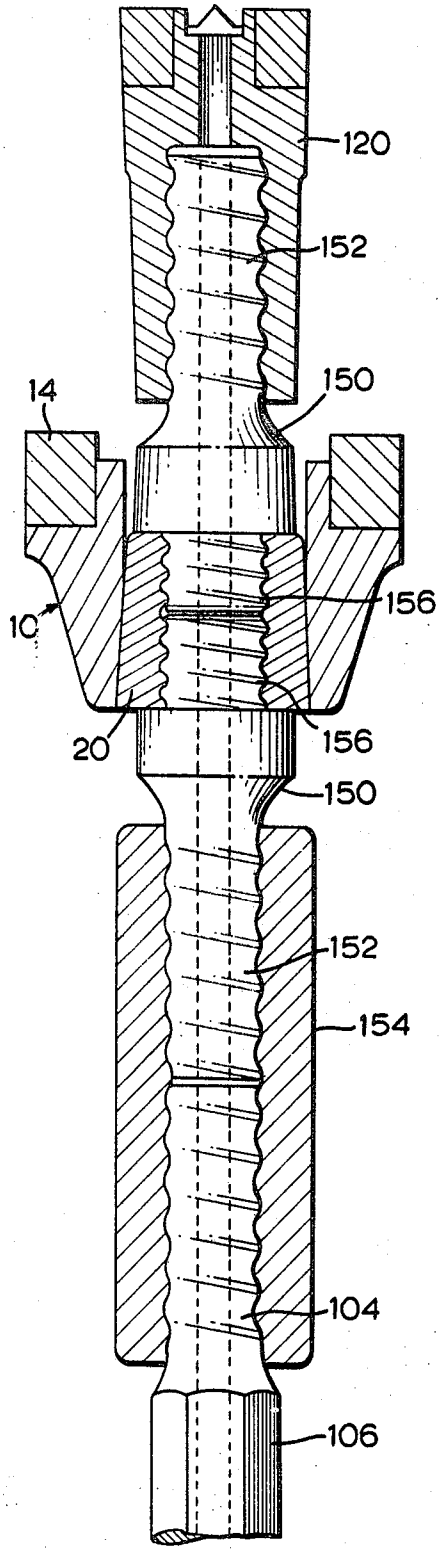


FIG. 7

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3,469,641

REAMING BIT ASSEMBLY

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Int. Cl. E21b 9/22; E21c 23/00
U.S. Cl. 175—389 22 Claims

ABSTRACT OF THE DISCLOSURE

A drill bit assembly comprising a tapered plug for axially interconnecting a pilot bit with a reaming bit and a drill rod. The reaming bit has a tapered axial opening for frictional engagement with the plug.

BACKGROUND OF THE INVENTION

This invention relates to rock drill bit assemblies and is particularly directed to self-piloting reaming bit assemblies for use with percussion drills.

The drilling of large diameter holes in rock is usually accomplished by drilling a pilot hole and reaming the pilot hole out to the desired diameter in a separate second operation by means of a reaming bit having a pilot extension for guiding the reaming bit in said pilot hole. This technique thus necessitates a two-step operation and is time consuming.

In attempting to simultaneously drill a pilot hole and ream said pilot hole to the desired diameter to minimize drilling time, problems have arisen in the provision of a suitable self-piloting reaming bit assembly which can utilize conventional drill bits and drill rod equipment and which will permit ready replacement of worn drill bits with a minimum of component failures.

SUMMARY OF THE INVENTION

I have discovered a novel self-piloting reaming bit assembly which utilizes a conventional pilot bit and an improved reaming bit in a manner which substantially obviates the above problems. In general, I have discovered that the combination of a tapered plug adapted to receive a reaming bit by frictional engagement therewith and secured to the shank of a drill rod by conventional means including friction or threaded attachment, and to the pilot bit by similar conventional means including friction or threaded attachment, or by threaded engagement with an intermediary floating stud, permits optimum functional and metallurgical design of each of the assembly component parts and permits ready exchange of component parts. In addition, further adaptability may be obtained by frictionally or threadably attaching the tapered plug to adapters which, in turn, are attached by conventional means to the drill shank and/or pilot bit. The tapered plug can be made from a steel best suited for mechanical strength properties and heat treated to improve its strength characteristics. These properties are necessarily different from those found in self-hardening steels normally used for a bit body after tungsten carbide inserts have been set in place by brazing. The reaming bit can then be made from a steel best suited for the rock boring operation, for example, from a steel suitable for induction brazing for the setting of tungsten carbide inserts. Accordingly, the plug, which is specifically designed to absorb the wear and impact to which the assembly is subjected during drilling, can be readily replaced when worn or damaged, and the life of the reaming bit is considerably prolonged. The arrangement of component parts of the present invention also provides for an effective transfer of percussion energy from the drill rod shank to the pilot bit via the plug, and

via an intermediary floating stud and/or adapters where a stud and/or adapters form a part of the assembly.

More particularly, the assembly of the invention comprises the combination of a reaming bit having an opening extending axially therethrough, said opening being tapered at one end, a tapered plug having its peripheral surface tapered to correspond to said bit internal taper for frictional engagement therewith, a pilot drill bit, means for rigidly removably securing said plug to said pilot bit, said means in a preferred embodiment comprising an intermediary floating stud adapted to be received in an axial opening formed at one end of said pilot drill bit, and in an axial opening formed in said plug to maintain said pilot bit and said plug in axial alignment and abutment with each other, and means for rigidly removably securing said plug to a drill rod shank.

It is, therefore, a principal object of the present invention to provide a self-piloting reaming bit assembly adapted to utilize conventional pilot bits and drill rods and which will permit the simultaneous drilling and reaming of a pilot hole.

Another object of the present invention is the provision of a novel drill bit assembly which permits percussion drilling of smooth, straight, large diameter holes in a single drilling operation.

It is another object of the invention to provide a reaming bit assembly which is reliable in operation, requires a minimum of maintenance, and permits facile replacement of assembly parts.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects of the invention and the manner in which they can be attained will become apparent from the following detailed description of the drawings, in which:

FIGURE 1 is an exploded perspective view of an embodiment of the invention;

FIGURE 2 is an elevation, partly in section, of the drill bit assembly illustrated in FIGURE 1;

FIGURE 3 is an elevation, partly in section, of another embodiment of the drill bit assembly with adapters for tapered attachments;

FIGURE 4 is an elevation, partly in section, of a further embodiment of the bit assembly with adapters;

FIGURE 5 is an elevation, partly in section, of a bit assembly having more than one reaming bit in combination with the pilot bit; and

FIGURE 6 is an elevation, partly in section, of an embodiment of the bit assembly in which the floating stud has been eliminated; and

FIGURE 7 is an elevation, partly in section, of a further embodiment of the bit assembly in which the floating stud has been eliminated.

Like reference characters refer to like parts throughout the description of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

With reference to FIGURES 1 and 2, the embodiment of assembly of the invention illustrated therein comprises the reaming bit generally designated by numeral **10** having tapered body **12** with surface hardened or carbide tipped wings **14**. Reaming bit **10** may be of the 4-point cross type, as illustrated, or 6-point rose type, or may have any suitable number of points, the spacing of the points not necessarily being equal. Axial opening **16** formed in the reaming bit **10** has a taper of from about 3° to about 4° relative to the bit axis flaring outwardly towards the end of the bit remote from the cutting end for engagement with peripheral surface **18** of tapered plug **20**, said surface having a corresponding mating taper of from about 3° to

4° relative to the plug axis. The axial opening **16** can be tapered throughout its length, but preferably the opening is cylindrical at the cutting end of the bit as shown in the drawings. Axial cylindrical opening **22** of plug **20** is shown in the embodiment illustrated in FIGURES 1 and 2 to be threaded throughout its length for removably engaging threaded shank **24** of drill rod **26** at one end and for engaging the threaded periphery **28** of floating stud **30** at its opposite end.

Pilot bit **32** having axial cylindrical threaded opening **34** formed at one end is adapted to removable engagement with one end of floating stud **30** such that face **36** of pilot bit **32** abuts face **38** of tapered plug **20** allowing the pilot bit to be driven from its base. A central opening **40** may extend through pilot bit **32**, floating stud **30** and drill rod **26** to permit the flow of water or the like drilling fluid to pilot bit **32**.

In use, tapered plug **20** is threaded onto shank **24** of drill rod **26** until face **41** of tapered plug **20** abuts shoulder **42** of drill rod **26**. Floating stud **30** can then be threaded into tapered plug **20** to about threaded shank **24** at face **43**. Reaming bit **10** is then slid over or driven onto tapered plug **20** for frictional engagement therewith, and pilot bit **32** is threaded onto floating stud **30** to abut face **38** of tapered plug **20**. Pilot bit **32** is seated on face **38** of tapered plug **20** and is rigidly held by floating stud **30** in its operative position. This arrangement provides a bit assembly which while providing support to the pilot bit, virtually eliminates thread damage to the pilot bit floating stud or adapters where used. The provision of smooth tapered surfaces between the plug and reaming bit, preferably in this embodiment at a taper angle of about 3.5° relative to the plug axis, provides sufficient frictional grip for efficient operation while permitting easy disassembly when desired to replace assembly parts.

FIGURE 3 illustrates a further embodiment of the invention of the instant application wherein a rod adapter **60** is adapted for frictional engagement with tapered shank **52** of drill rod **54** and threadable engagement with tapered plug **20** by threading end **62** of adapter **60** into cylindrical opening **22** of plug **20**. The internal axial taper **56** formed within a portion of adapter **60** has an angle of about 5° to about 7.5°, preferably about 6°, relative to the plug axis which corresponds with the taper of tapered shank **52**. Reaming bit **10** has an internal taper of about 3° to about 4°, preferably 3.5° relative to the plug axis as indicated to frictionally mate with plug **20**. The range of angles for the external taper of peripheral surface **18** of plug **20** set out above has been found satisfactory to permit disengagement of drill rod shank **54** from adapter **60** before plug **20** will disengage from reaming bit **10**. Normally, however, as long as plug **20** is in good condition, no attempt is made to separate it from reaming bit **10**, even when reaming bit **10** is being sharpened.

Floating stud **30** is adapted to releasably engage the inner threaded surface **82** of plug **20**.

Adapter **70** has a cylindrical portion **72** having a threaded axial opening **74**, and a tapered portion **76**. Floating stud **30** is threaded into axial opening **74** to secure adapter **70** to tapered plug **20** through floating stud **30**. Pilot bit **90** has axial opening **92** which is adapted for frictional engagement with adapted **70**. Pilot bit **90** has an internal taper of about 5° to about 7.5° preferably about 6° relative to the plug axis which corresponds with the taper of taper portion **76**.

FIGURE 4 illustrates an embodiment of the invention for use where the conventional drill rods and bits employ a backhead drive threaded attachment. Rod adapter **100** has, at one end, an axial threaded opening **102** for threadable engagement with threaded shank **104** of drill rod **106**, and at the other end threaded portion **108** for threadable engagement with plug **20**. Adapter **112** similarly, at one end has axially threaded opening **114** for threadable engagement with floating stud **30** and at the other end threaded portion **118** for threadable engagement with pilot bit **120**. Percussion energy is thus transferred from the drill rod shank **104** to pilot bit **120** and reaming bit **10** via adapter **100** and plug **20** and adapter **112**.

FIGURE 5 illustrates an embodiment of the invention wherein the assembly employs more than one reaming bit in graduated sequence of sizes. The components of the assembly are similar to those shown in FIGURES 1 and 2 with the exception that two reaming bits, plugs and floating studs are employed. In use, reaming bit **130** with tis component first plug **20** is threaded onto a drill rod **26**. First floating stud **30** is then threaded into first plug **20**. Reaming bit **10** with its component second plug **20** is threaded onto first floating stud **30**. Finally, second floating stud **30** is threaded into second plug **20** and pilot bit **32** is threaded onto second floating stud **30**. It is evident that more than two reaming bits may form a part of such an assembly.

FIGURE 6 illustrates an embodiment of the invention wherein plug **20** is adapted for engagement with adapter **60** and adapter **140**. As in FIGURE 3, adapter **60** is adapted for frictional engagement with tapered shank **52** and threadable engagement with tapered plug **20**. Adapter **140** has a cylindrical threaded end portion **142** and a tapered portion **144**. Adapter **140** is adapted for threadable engagement with plug **20** by threading end portion **142** into cylindrical opening **22** of plug **20**. Adapter **140** is also adapted for frictional engagement with pilot bit **90** within axial opening **92**. The taper of tapered portion **144** corresponds with the internal taper of pilot bit **90**.

FIGURE 7 illustrates an embodiment of the invention used with jointed rods joined by a sleeve when a drill hole is longer than can be drilled conveniently with a one piece drill rod. Two rod adapters **150** are used, first rod adapter **150** being used to secure plug **20** to sleeve **154** and a second rod adapter **150** being used to secure plug **20** to pilot bit **120**. Each rod adapter **150** has at one end threaded portion **156** for threaded engagement with plug **20**. At the other end of first rod adapter **150** is threaded portion **152** for threaded engagement with sleeve **154** and at the other end of second rod adapter **150** is threaded portion **152** for threaded engagement with pilot bit **120**. As shown, sleeve **154** is screwed into engagement with threaded shank **104** of drill rod **106**.

The present invention provides a number of important advantages. The self-piloting reaming bit assembly effectively, simultaneously drills and reams straight and smooth-walled bore holes at high penetration rates. Component failures formerly inherent in percussion drilling bit assemblies are reduced, resulting in a minimum of maintenance and downtime. The tapered plug, being replaceable when required, extends the life of the reaming bit in the event of gross thread damage prior to total bit life, and conversely permits extension of the life of the plug in the event of its being usable when the reaming bit itself has worn out. A simultaneous drilling and reaming of pilot holes substantially reduces the total drilling time with attendant maximum utilization of drilling equipment and reduced drilling costs. The assembly with its several diameters tends to be mutually supporting and aligning through its plurality of bits and consequently holds a straight line when drilling through faulted rock or strata having different degrees of hardness. This mutually supporting action tends to reduce bending stresses in the threaded links and at the drill rod attachment, hence extending life and thereby reducing drill rod and bit thread failures and minimizing operational difficulties arising from a bit becoming stuck in the hole. Both the reaming bit and the pilot bit are driven from the plug as a result of the assembly being rigid when tightly threaded.

In several of the embodiments of the invention shown, the pilot bit seats on the tapered plug allowing the pilot bit to be driven from its base and allowing a floating stud of constant length to be employed despite changes in total height of the bit parts over their total life due to wear

resulting from use and from sharpening. The constant length of the floating stud simplifies assembly and disassembly, making these tasks easier than has heretofore been possible. The use of a floating stud of standard length simplifies assembly and virtually eliminates thread damage resulting from careless or incorrect assembly, and the elimination of thread damage permits disassembly more easily than has heretofore been possible.

It will be understood, of course, that modifications can be made in the embodiments of the invention described and illustrated hereinbefore without departing from the scope and purview of the appended claims.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. A drill bit assembly for use with a drill rod comprising, in combination, a reaming bit having an axial opening therethrough, said opening being tapered at one end, a tapered plug, the peripheral surface of said plug tapered to correspond to the taper of said bit axial opening for frictional engagement of the reaming bit with the plug, a pilot drill bit, means for rigidly removably securing said plug to said pilot bit and means for rigidly removably securing said plug to a drill rod shank.

2. A drill bit assembly as claimed in claim **1** wherein said reaming bit axial opening has a taper of from about 3° to about 4° relative to the bit axis.

3. A drill bit assembly as claimed in claim **1** wherein said reaming bit axial opening has a taper of about 3.5° relative to the bit axis.

4. A drill bit assembly as claimed in claim **1** wherein said means for rigidly removably securing said plug to said pilot bit includes a stud adapted to be received in an axial opening formed at one end of said pilot bit and in an axial opening formed in said plug.

5. A drill bit assembly as claimed in claim **4** wherein said stud is threaded for removable engagement with said pilot bit and said plug.

6. A drill bit assembly as claimed in claim **5** wherein the axial opening of said tapered plug is threaded for removably engaging a threaded shank of a drill rod.

7. A drill bit assembly as claimed in claim **6** wherein the plug taper is about 3.5° relative to the plug axis.

8. In a drill bit assembly as claimed in claim **5**, said reaming bit axial opening being sufficiently large to receive said pilot drill bit therein in axial alignment and abutment with the plug.

9. A drill bit assembly as claimed in claim **1** wherein said means for rigidly removably securing said plug to said pilot bit comprises an adapter.

10. A drill bit assembly as claimed in claim **1** wherein said pilot bit has a tapered axial opening, said means for rigidly removably securing said plug to said pilot bit includes an adapter and a stud, the peripheral surface of said adapter tapered to correspond to the taper of the axial opening of said pilot bit for frictional engagement of said adapter to said pilot bit, said adapter taper being about 5° to about 7.5° relative to the plug axis, said adapter also having a threaded axial opening at one end, said stud adapter to be received in the axial opening of said adapter and in an axial opening formed in said plug.

11. A drill bit assembly as claimed in claim **10** wherein said adapter taper is about 6° relative to the plug axis.

12. A drill bit assembly as claimed in claim **1** wherein said means for rigidly removably securing said plug to said drill rod shank comprises a rod adapter.

13. A drill bit assembly as claimed in claim **12** wherein the end of said shank is tapered, said rod adapter has an axial opening tapered to correspond to the taper of said shank for frictional engagement of said rod adapter to said shank, the peripheral surface of the end of said rod adapter opposite said rod adapter axial opening is threaded for removably engaging said plug, and said rod adapter taper being about 5° to about 7.5° relative to the plug axis.

14. A drill bit assembly as claimed in claim **13** wherein said rod adapter taper is about 6° relative to the plug axis.

15. A drill bit assembly as claimed in claim **1** wherein said means for rigidly removably securing said plug to said pilot bit comprises an adapter and said means for rigidly removably securing said plug to said drill rod shank comprises a rod adapter.

16. A drill bit assembly as claimed in claim **1** wherein the end of said shank is tapered, said pilot bit has a tapered axial opening, said means for rigidly removably securing said plug to said pilot bit includes an adapter and a stud, the peripheral surface of said adapter tapered to correspond to the taper of the axial opening of said pilot bit for frictional engagement of said adapter to said pilot bit, said adapter taper being about 5° to about 7.5° relative to the plug axis, said adapter also having a threaded axial opening at one end, said stud adapted to be received in the axial opening of said adapter and in an axial opening formed in said plug, said means for rigidly removably securing said plug to said drill rod shank comprises a rod adapter having an axial opening tapered to correspond to the taper of said drill rod shank for frictional engagement of said rod adapter to said shank, the peripheral surface of the end of said rod adapter opposite said rod adapter axial opening being threaded for removably engaging said plug and said rod adapter taper being about 5° to about 7.5° relative to the plug axis.

17. A drill bit assembly as claimed in claim **16** wherein said adapter taper and said rod adapter taper are about 6° relative to the plug axis.

18. A drill bit assembly as claimed in claim **13** wherein said means for rigidly removably securing said plug to said pilot bit comprises a second adapter, the peripheral surface of one end of said second adapter tapered to correspond to the taper of the axial opening of said pilot bit for frictional engagement of said second adapter to said pilot bit, the peripheral surface of the other end of said second adapter threaded for removably engaging said plug.

19. A drill bit assembly as claimed in claim **18** wherein the taper of said second adapter is about 5° to about 7.5° relative to the plug axis.

20. A drill bit assembly as claimed in claim **19** wherein the taper of said rod adapter and said second adapter is about 6° relative to the plug axis.

21. A drill bit assembly as claimed in claim **1** wherein said means for rigidly removably securing said plug to said drill rod shank includes a first adapter and a sleeve, said first adapter having peripheral threaded surfaces at both ends thereof, said threaded surface at one end adapted to removably engage said plug, said threaded surface at the other end adapted to removably engage said sleeve, said sleeve being adapted to secure said first adapter to said drill rod shank, and wherein said means for rigidly removably securing said plug to said pilot bit comprises a second adapter, said second adapter having peripheral threaded surfaces at both ends thereof, said threaded surface at one end adapted to removably engage said pilot bit, said threaded surface at the other end adapted to removably engage said plug.

22. A drill bit assembly for securement to a drill rod shank comprising, in combination, a plurality of reaming bits each having an axial opening therethrough, each of said openings being tapered at one end, a plurality of tapered plugs each having an axial opening therethrough, the taper of said plugs corresponding to the taper of said bit axial openings for frictional engagement of said reaming bits with said plugs, a pilot drill bit having an axial opening formed at one end, a plurality of studs adapted to be received in the plug axial openings and one of which adapted to be received in said pilot bit, means formed on the stud received in the pilot bit for rigidly removably securing said pilot bit to the plug adjacent said pilot bit,

and means formed in the plug adjacent said drill rod shank for rigidly removably securing said assembly to said drill rod shank.

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