April 27, 1965 C. L. DEELY 3,180,439

ROTARY, EXPANSIBLE BORE HOLE REAMERS WITH IMPROVED SAFETY FEATURES

Filed Jan. 8, 1962 2 Sheets-Sheet 1

Fig. 1

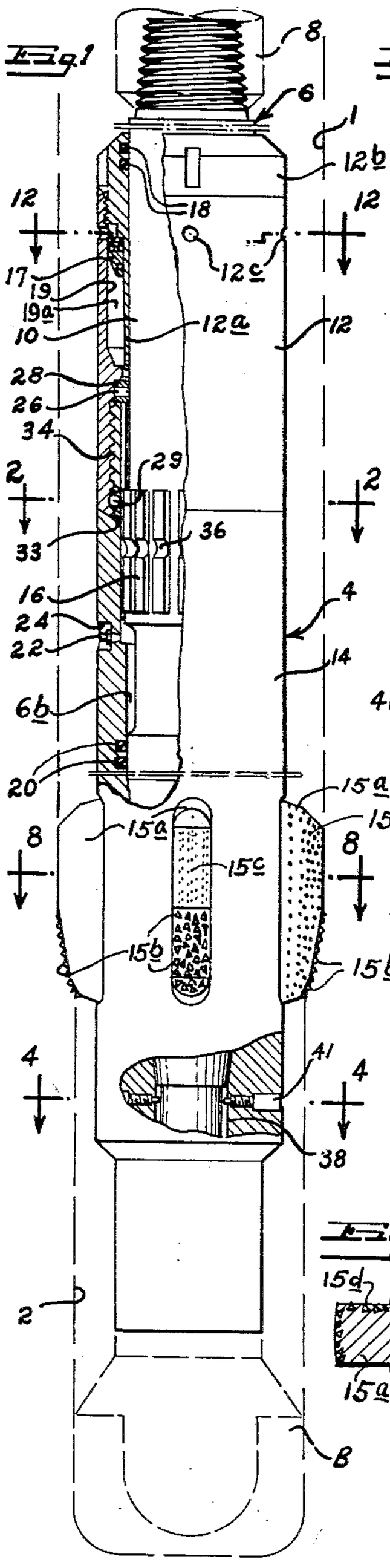

Fig. 2

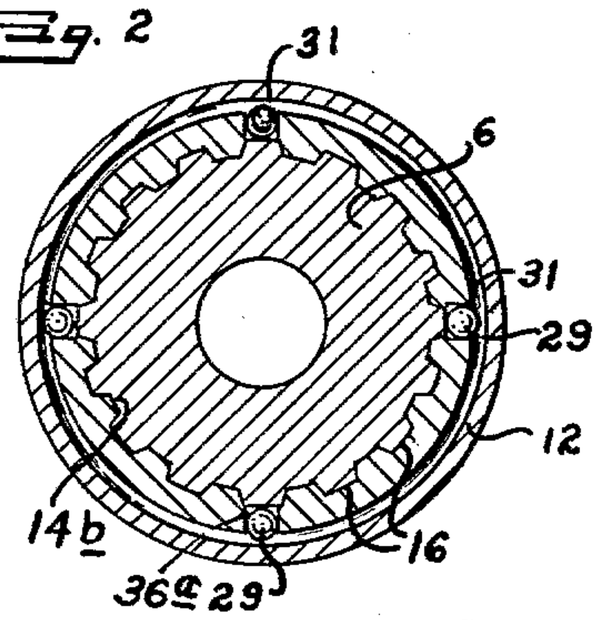

Fig. 3

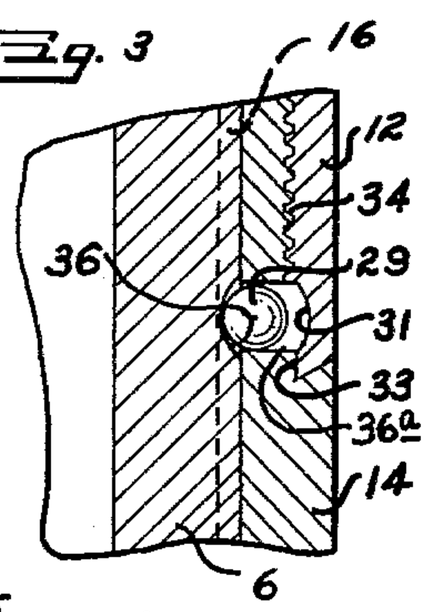

Fig. 4

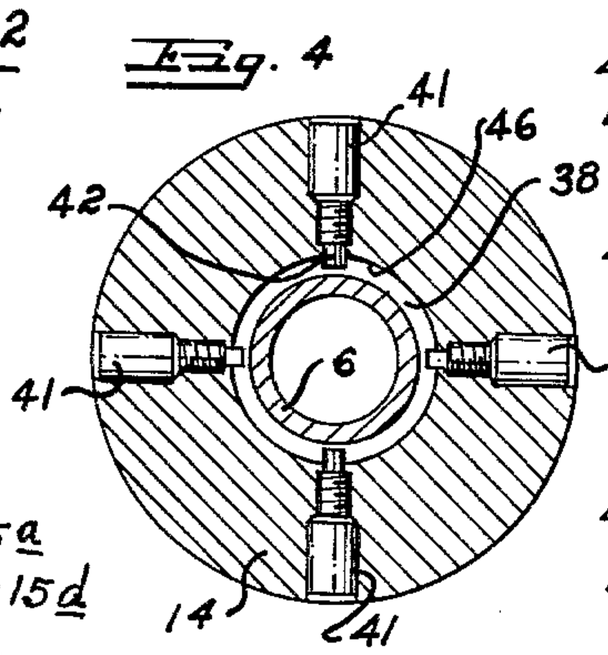

Fig. 5

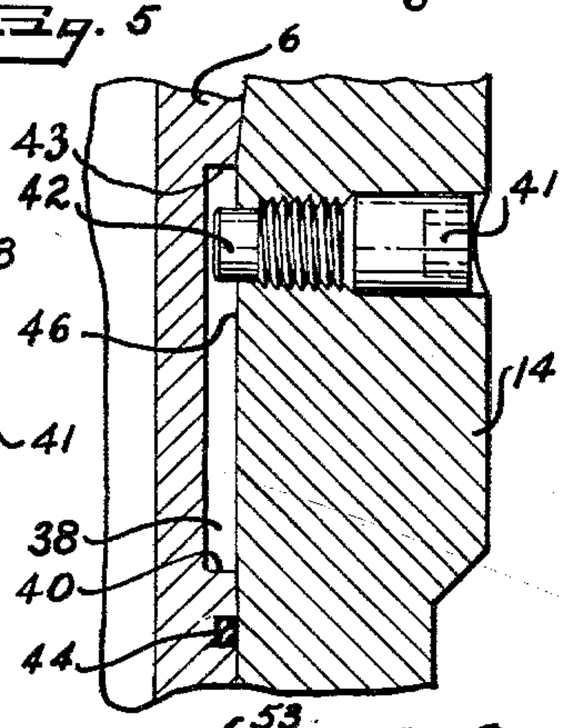

Fig. 6

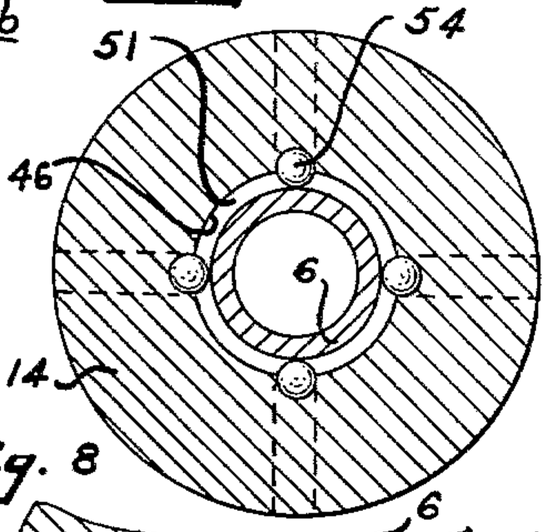

Fig. 7

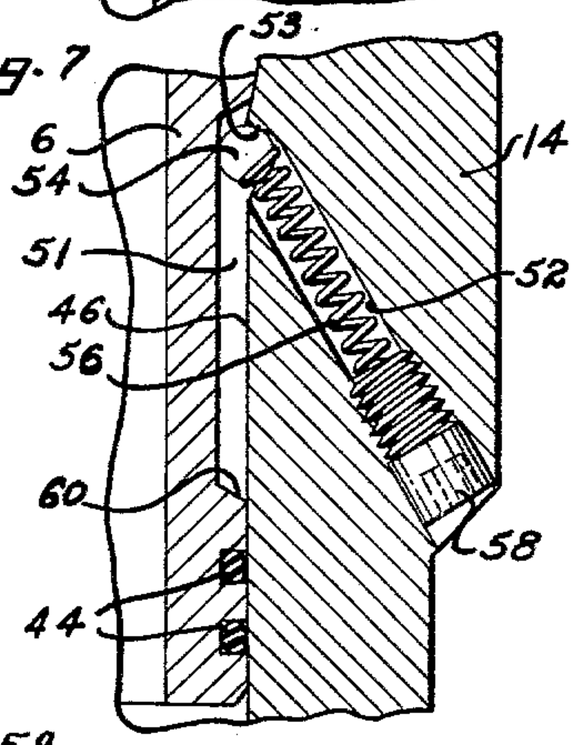

Fig. 8

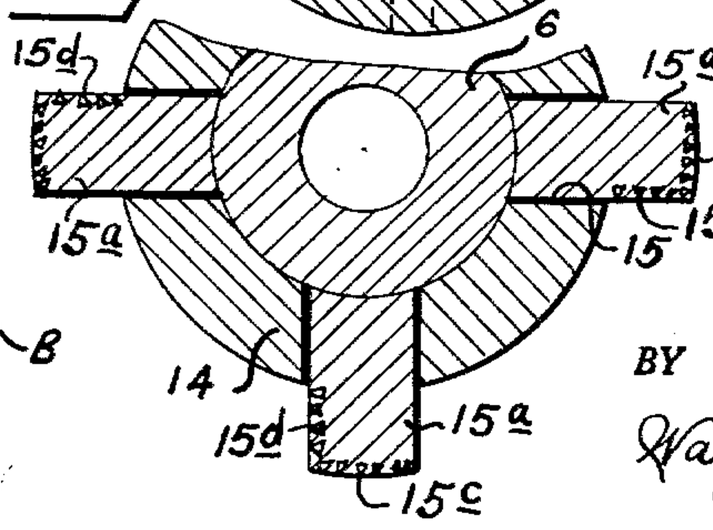

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Fig. 9

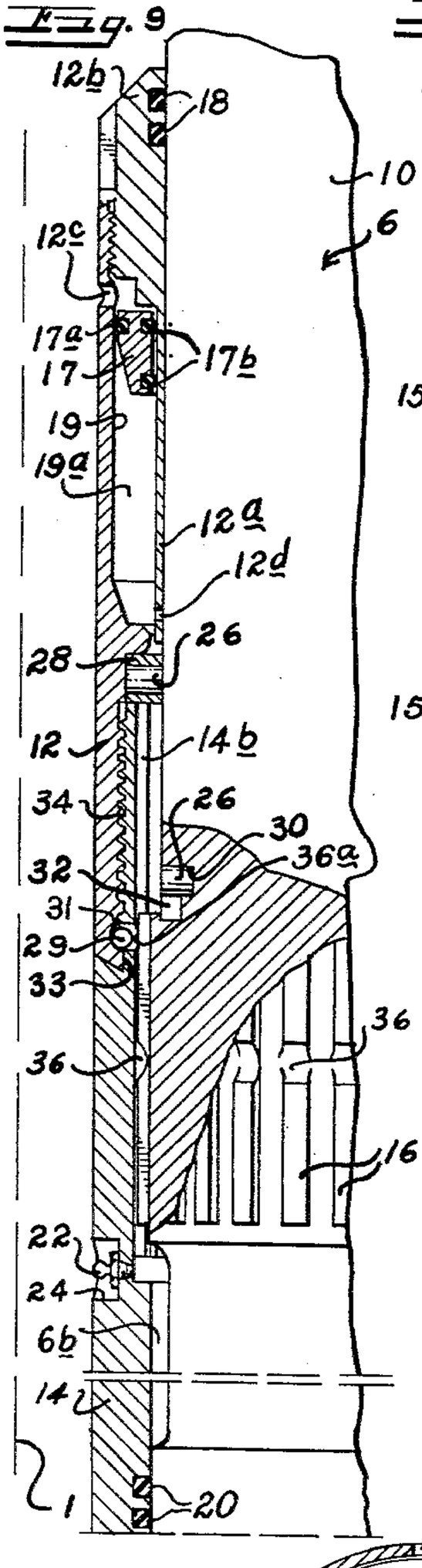


Fig. 10

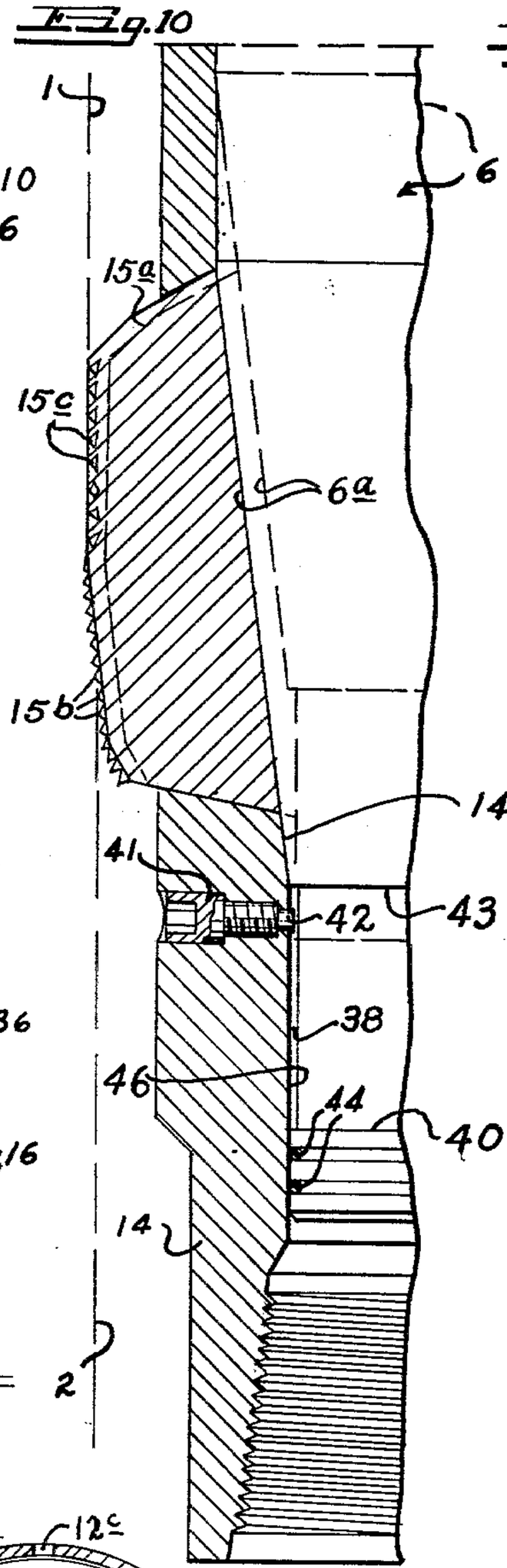


Fig. 11

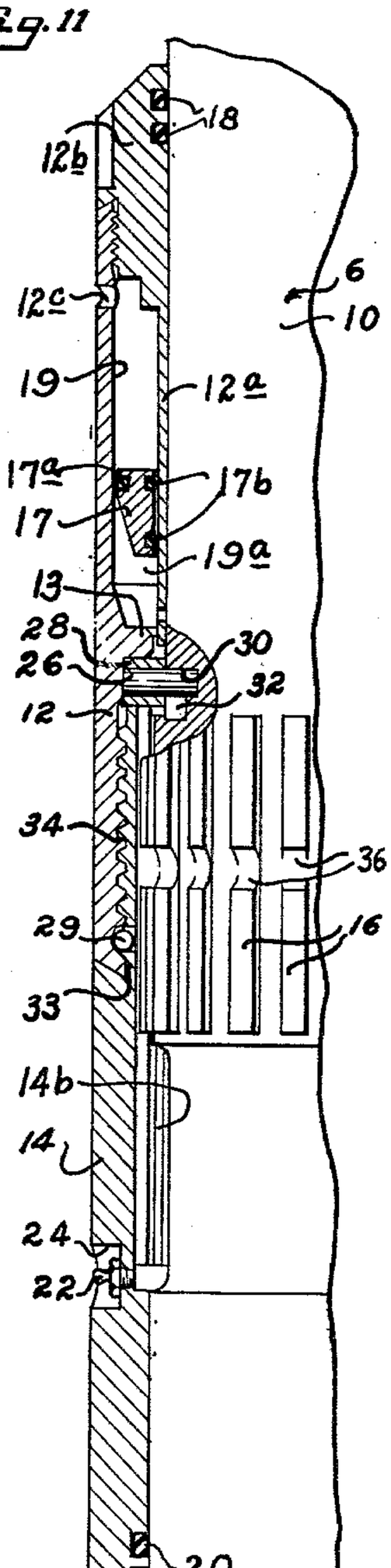
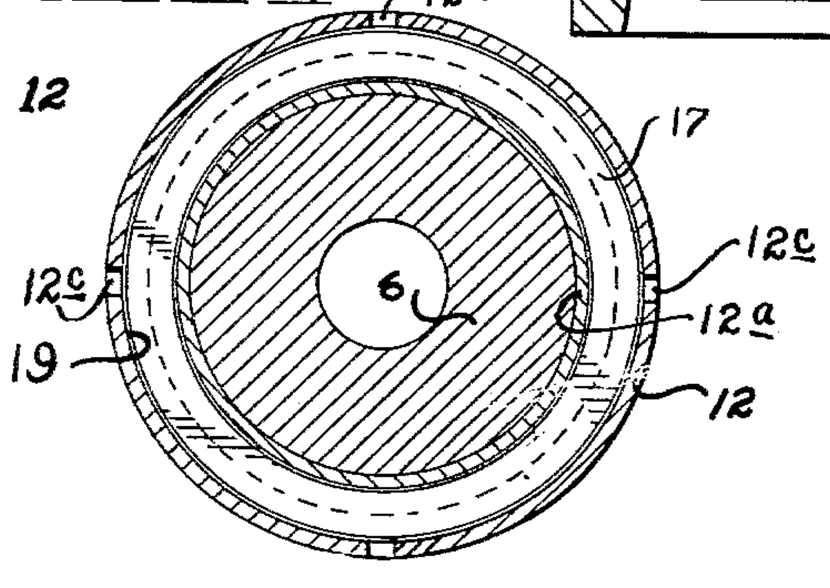


Fig. 12



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ROTARY, EXPANSIBLE BORE HOLE REAMERS WITH IMPROVED SAFETY FEATURES

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Filed Jan. 8, 1962, Ser. No. 164,787
8 Claims. (Cl. 175—286)

This invention relates to bore hole reamers for use with rotary well drilling equipment and more particularly to an expansible bore hole reamer for reaming the bore hole being drilled by a rotary drill bit, wherein locking means is provided for the reamer assembly to retain the same in assembled condition while the reamer is being used in the bore hole. This patent application contains certain improved features over my co-pending application, Ser. No. 29,847, filed May 18, 1960, for Reamer, now United States Patent No. 3,051,255, issued August 28, 1962.

An object of this invention is to provide a reamer for a bore hole, the blades of which reamer will be positively expanded when the weight of the drill stem is placed thereon so as to ream the hole to a larger diameter than the diameter of the drill bit, and wherein the reamer elements will be positively held together to prevent disassembly while in the bore hole.

Another object of the invention is to provide a locking arrangement for the reamer elements of the bore hole reamer, which elements are connected together so as to maintain the reamer elements in assembled relation while in the bore hole.

Still another object of the invention is to provide a locking arrangement to retain the various elements of the bore hole reamer together, which is simple in construction, easy to assemble and disassemble, and which is safe to operate in wells under all conditions.

Yet another object of the invention is to provide a lubrication arrangement to lubricate the relatively movable parts of the bore hole reamer while the reamer is being operated within a well, and to retain the lubricant within the reamer and to exclude foreign matter therefrom.

With these objects in mind and others which will become manifest as the description proceeds, reference is to be had to the accompanying drawings in which like reference characters designate like parts in the several views thereof, in which:

FIG. 1 is an elevational view of a reamer body in a well with parts being broken away and with parts shown in section to bring out the details of construction;

FIG. 2 is a sectional view taken on the line 2—2 of FIG. 1, looking in the direction indicated by the arrows;

FIG. 3 is a fragmentary, longitudinal sectional view through a portion of the reamer body, showing a ball locking arrangement therein, and balls thereof in retracted position;

FIG. 4 is a cross-sectional view taken on the line 4—4 of FIG. 1, looking in the direction indicated by the arrows, showing parts in elevation and with parts being broken away to bring out the details of construction;

FIG. 5 is an enlarged, fragmentary, elevational view, with parts shown in section, of the lower portion of the reamer body and the locking screws therefor, as shown in FIG. 1;

FIG. 6 is a view showing a modified form of locking arrangement, which is an alternate form with respect to the forms shown in FIGS. 4 and 5;

FIG. 7 is an enlarged fragmentary view similar to FIG. 5, but of the alternate form of invention;

FIG. 8 is a sectional view taken on the line 8—8 of FIG. 1, looking in the direction indicated by the arrows;

FIG. 9 is an enlarged fragmentary view of the upper portion of the reamer body;

FIG. 10 is an enlarged fragmentary view of the lower portion of the reamer body, showing the blades and the tapered mandrel in expanded condition, in full outline, and showing the retracted position of the blades in dashed outline with the tapered mandrel being shown in raised position in dashed outline;

FIG. 11 is a view similar to FIG. 9, but showing a floating piston in the lubrication chamber in another position; and

FIG. 12 is a transverse sectional view taken on the line 12—12 of FIG. 1, looking in the direction indicated by the arrows.

With more detailed reference to the drawing, the numeral 1 designates the bore hole of a well after it has been reamed, and the numeral 2 designates the bore hole of the well before it has been reamed. A drill bit B, shown in dashed outline, is mounted on the lower end of the reamer, which reamer is designated generally by the numeral 4. A mandrel 6 connects to the lower end of a drill stem 8, so as to lower the reamer 4 into the bore hole 1 of the well. The mandrel 6 has an internally threaded collar 12 telescoped thereover, which collar threadably engages the upper end of the shell 14, as will best be seen in FIGS. 1, 9 and 11. The mandrel 6 has a cylindrical portion 10 adjacent the upper end thereof, with a raised splined portion 16 therebelow. Below the splined portion 16 the mandrel 6 tapers inwardly and downwardly, as will best be seen in FIGS. 1 and 10. The shell 14 has radial slots 15, in the present instance four, formed therein, which slots 15 are of a width to receive reamer blades 15*a* therethrough. The top and bottom ends of the respective slots 15 each converge outwardly so as to form a complementary seat with the tapered end surface of the respective reamer blades 15*a* when the blades are in the extreme outermost position. However, the taper on each end of each slot is such as to permit each blade 15*a* to move inward from the position as shown in full outline in FIG. 10 to the dashed outline position shown therein, upon upward movement of tapered portion 6*a* of mandrel 6.

The tapered portion 6*a* on mandrel 6 is a relatively steep taper which forms a complementary wedging action with the inner tapered bore 14*a* of shell 14 and complementally engages the respective inner faces of blades 15*a*. The wedging engagement of tapered portion 6*a* of mandrel 6 with the tapered bore 14*a* of shell 14 exerts a friction hold to augment the holding action between the splined portion 16 on mandrel 6 and the complementary splines 14*b* within shell 14, thereby enabling greater torque to be transmitted through drill stem 8 to mandrel 6 and through shell 14 to reamer blades 15*a*. The lower peripheral face portion of the respective reamer blades 15*a* are inset with abrading elements 15*b* which abrading elements project outward from the surfaces thereof. However, the upper portions of the blades 15*a* are inset with abrading elements 15*c* which are embedded within the respective faces of the reamer blades, as will best be seen in FIGS. 1, 8 and 10. Further abrading elements 15*d* are embedded within the leading side of each of the reamer blades 15*a* along the leading edge thereof and a spaced distance inward thereform, as will best be seen in FIGS. 1 and 8.

The internally threaded collar 12 is counterbored, as indicated at 19, near the upper end thereof to receive piston 17 therein between the collar 12 and a downwardly extending sleeve 12*a* formed on the lower end of spanner nut 12*b*, which spanner nut threadably engages the upper end of internally threaded collar 12. The floating piston 17 is located in counterbore 19 of collar 12 and has an O-ring 17*a* on the piston 17 to be in

sealing relation with the counterbore **19**. A pair of O-rings **17***b* are fitted within grooves formed in floating piston **17** and are in sealing relation with the downwardly extending sleeve **12***a*, which sleeve **12***a* is fitted in close sliding relation with the cylinderical portion **10** of mandrel **6**. The collar **12** has an inwardly extending annular boss **13** to form an abutment at the lower end of the counterbore **19** to limit the downward movement of piston **17**, as will best be seen in FIG. 11. The internally threaded collar **12** has one or more vent holes **12***c* formed therein, as will best be seen in FIGS. 1, 9, 11 and 12.

Normally, before the spanner nut **12***b* and piston **17** are assembled on the mandrel **6** and fitted onto collar **12**, the annular space formed between the collar **12** and the mandrel **6**, as is best seen in FIGS. 1 and 9, is at least partially filled with lubricant. The floating piston **17** is positioned in the chamber **19***a* of counterbore **19**, which chamber, below the piston **17**, is partially filled with lubricant. The holes **12***c* provide communication between the bore hole of the well, containing the drilling fluid under pressure, and the chamber **19***a* to exert a pressure on the upper face of floating piston **17**. The sleeve **12***a* has holes **12***d* formed therein, near the lower end thereof, which holes interconnect lubricant chamber **19***a* with the space between the inner bore of sleeve **12***a* and the outer diameter of the cylindrical portion **10** of mandrel **6**. In this manner the pressure exerted by the drilling fluid on the upper face of piston **17** will cause the piston **17** to move downward within chamber **19***a*, which causes the lubricant in chamber **19***a* below piston **17** to be forced through holes **12***d* in sleeve **12***a*, thereby maintaining an oil film between the working surfaces at a pressure which will prevent entrance of foreign matter between the nut **12***b* and the cylindrical portion **10** of the mandrel **6**. Due to the arrangement of the floating piston **17**, pressure may be held thereon so that the lubricant will be discharged to prevent entrance of foreign matter to certain interior parts of the reamer.

The spanner nut **12***b* has O-ring grooves formed therein near the upper end of the bore thereof to receive elastomer O-rings **18** therein for sealing relation between the bore of the spanner nut **12***b* and the cylindrical portion **10** of mandrel **6**. The pressure on O-rings **18** is substantially equalized and the O-rings prevent entrance of foreign matter and will prevent the escape of lubricant in any appreciable quantities.

The shell **14** has annular grooves intermediate the upper end thereof and the reamer blades **15***a*, in which grooves O-rings **20** are positioned, which rings are adapted to form a seal with the cylindrical portion **10** of the mandrel **6** below the splined portion **16**, so as to form a substantially fluid tight chamber between the O-rings **18** and **20**. A lubricant fitting **22** is fitted within a recess **24** in the shell **14**, so the annular space and the working elements between O-rings **18** and **20** may be lubricated under pressure which will prevent ready entrance of foreign matter into the annular space **6***b*.

Shear pins **26** are provided within semi-cylindrical ring segments **28** within spanner nut **12***b*, so as to hold the internally threaded collar **12** and shell **14** in fixed relation with respect to mandrel **6**, while the reamer is being run into the bore hole of the well. Shear pin holes **30**, within reamer mandrel **6**, have interconnecting recesses **32** adjacent to and connected with a side thereof so as to enable a tool to be inserted into contact relation with shear pins **26**, after the pins have been sheared, to enable the ready removal of the remaining portion of the shear pins. The semi-cylindrical ring segments **28**, connected to mandrel **6** by shear pin **26**, maintain the mandrel in fixed relation to shell **14** so long as the shear pins **26** are not sheared. The semi-cylindrical ring members **28** form an abutment for splined portion **16** when the mandrel is in the uppermost position.

Difficulty has heretofore been experienced with the

threaded elements of reamers becoming separated within the bore hole of a well, and it is to this end that certain safety and precautionary devices have been provided in the present reamer, thereby to prevent the separation of one threaded part from another threaded part, the separation of which threaded elements frequently results in delay in the completion of a well, and possible loss of the well.

The present reamer provides a particular manner of locking the collar **12** in place so that, as long as the reamer is being used for reaming, the collar **12** and mandrel **6** will be moved to the position as shown in full outline in FIG. 10, which will shear pins **26**, whereupon, steel balls **29**, positioned in the respective holes **36***a* formed in the wall of the shell **14** intermediate mandrel **6** and internally screw threaded collar **12**, will be moved from the position as shown in FIG. 3, into the annular recess **31** in collar **12**, as shown in FIG. 2, with the distance between the mandrel **6** and the root diameter of the recess **31** being less than the opening between the mandrel **6** and the bore **33** formed in collar **12**. Therefore, the balls **29**, when moved into the position as shown in FIG. 2, will prevent threads **34** becoming unscrewed until the mandrel **6** is moved into a position intermediate the length of travel thereof so the balls **29** will be urged into annular recess **36** in mandrel **6**, when in register therewith as shown in FIG. 3.

The lower end of the mandrel **6** has an annular groove **38** formed therein, as shown in FIGS. 1, 4, 5, and 10, so as to receive the dog points **42** of set screws **41**, which are screw threaded through shell **14**, with the dog points **42** of the set screws **41** extending into annular groove **38**, so upon movement of the mandrel **6**, the shell **14** will remain stationary unitl the upper end of the splined portion **16** abuts with the semi-cylinder ring segments **28** in collar **12**, which will move the dog points **42** of set screws **41** to within a short distance of the lower shoulder **40** of mandrel **6**, so that the dog points **42** will extend into bore **46** of shell **14** between shoulders **40** and **43** of mandrel **6** and will normally be spaced above the shoulder **40** so long as the collar **12** is screw threaded in place. However, should the threaded collar **12** become loosened and the shell **14** be moved relative to the collar **12**, the dog points **42** of the set screws **41** will rest upon shoulder **40** and lift the shell **14** to the surface of the well. O-rings **44** are provided within annular grooves formed in the lower end of mandrel **6**, so as to form a fluid tight seal with the inner bore of the lower end of shell **14**.

The set screws **41** are of the self-locking type, which resist being unscrewed once they are screwed in place. Such screws are well known in commerce, and no claim is directed to the locking feature of the screws per se, as screws produced and sold by various companies possess this self-locking feature.

Modified form of invention

An alternate form of locking arrangement for securing the mandrel **6** against becoming disconnected from the shell **14** is provided, which is shown in the form of the invention disclosed in FIGS. 6 and 7, wherein an annular groove **51** is provided around the mandrel **6**, near the lower end thereof, and wherein a series of holes **52** are drilled upwardly within shell **14**, which holes converge inwardly and are of such size as to receive balls **54** respectively therethrough, one-half the diameter of each ball being the depth of the annular groove **51**. The holes **52** are drilled in such manner as to form the respective seats **53** in the shell **14**, at the respective upper ends of the holes. A spring **56** is positioned below each ball **54**, to urge the respective balls **54** upward against the respective seats **53**, and into contact relation with the bottom of annular groove **51**. A screw threaded plug **58** is fitted into the lower end of each hole **52** to retain the respective springs **56** in place, and to apply the correct pressure to the

springs to urge the respective balls 54 upward into seating relation with the respective seats 53 and the outer diameter of mandrel 6 within annular groove 51.

With the collar 12 screw threaded into place on shell 14, and with mandrel 6 slidably fitted therein, the mandrel 6 will be permitted to move a limited distance, however, the lower face 60 of annular groove 51 will not normally abut with balls 54. However, upon screw threads 34 becoming loosened or disengaged, the balls 54 will seat on face 60 of groove 51, and will sustain and support the shell 14 thereon until the reamer can be removed from the bore hole of the well.

The present form of the invention is for the same purpose and performs the same operation as the reamer disclosed in my co-pending application Ser. No. 29,847, Reamer, as set out above. The safety features, as described herein, then to make the reamer elements, as set out in the aforementioned application, relatively free from accidental separation within the bore hole of a well, while the reamer is in use.

The feature of providing lubricant within chambers 19*a* and 6*b* lubricates the interior working surfaces of the reamer, which lubricant is under pressure, also normally prevents entrance of foreign matter, such as dirt, sand, and the like, from entering the interior portions of the reamer.

Having thus clearly shown and described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A safety device for a multi-blade bore hole reamer, comprising:

(*a*) a shell,

(1) the upper end of said shell being screw threaded,

(2) splines within said shell within the length thereof,

(*b*) a mandrel,

(1) a raised splined portion formed on said mandrel intermediate the length thereof, and being in complementary, longitudinal sliding relation with said splines within said shell, and being in relative non-rotatable relation with respect thereto,

(*c*) an internally screw threaded collar complementally engaging the screw threads on the upper end of said shell,

(*d*) an inwardly extending, annular boss within said threaded collar intermediate the length thereof,

(*e*) an abutment fitted within the bore of said collar immediately below and in abutting relation with said inwardly extending, annular boss in said threaded collar and being adapted to complementally abut the upper end of said raised spline portion of said mandrel when said mandrel is in the uppermost position,

(*f*) the wall of said shell having a hole formed therethrough within the length of the complementally engaging portions of said screw threaded collar and said shell,

(*g*) said mandrel having an annular recess formed within the length of said splined portion thereof,

(1) said threaded collar having a recess formed therein, which recess is complementary to said hole in the wall of said shell when said screw threaded portions of said collar and said shell are in fully engaged relation,

(*h*) a ball fitted within said hole in the wall of said shell,

(1) said ball being of a diameter greater than the depth of said hole in the wall of said shell and of less diameter than the combined depth of either of said recesses and said hole in the wall of said shell, so when said mandrel is moved into a position intermediate the length of travel thereof, the annular recess therein will be in register with said hole in the wall of said shell, where-

upon said screw threaded collar will threadably disengage from said threads of said shell,

(2) when said mandrel is in a lowered position said ball within said hole in the wall of said shell will extend into said recess in said screw threaded collar to prevent disengagement of said screw threaded collar from the screw threads on said shell,

(*i*) the lower end of said mandrel being tapered downwardly and inwardly,

(*j*) said shell having a plurality of elongated, longitudinally extending slots formed therein,

(*k*) said shell having the bore thereof tapered to complementally fit the downwardly and inwardly tapered portion of said mandrel,

(*l*) reamer blades complementally fitted within said elongated, longitudinally extending slots in said shell,

(1) said reamer blades having faces thereof adjacent said mandrel tapered to complementally engage said mandrel,

(2) said reamer blades being of greater length within said shell than exterior of said shell,

(*m*) said shell having screw threads on the lower end thereof for complementary attachment of a screw threaded drill bit, and

(*n*) said mandrel having an axial opening formed therethrough.

2. A safety device for a multi-blade bore hole reamer as defined in claim 1; wherein

(*a*) said recess formed within said threaded collar is an annular recess.

3. A safety device for a multi-blade bore hole reamer as defined in claim 1, wherein

(*a*) O-ring seals are fitted within the bore of said shell and which O-ring seals are in complementary sealing relation with said mandrel.

4. A safety device for a multi-blade bore hole reamer as defined in claim 1; wherein

(*a*) said mandrel has a recess formed therein,

(1) which groove has a length of at least the length of the longitudinal movement of said mandrel slidably mounted within said shell,

(*b*) at least one projection extending through said shell and into said groove in said mandrel in such position as to normally allow full relative sliding movement between said mandrel and said shell,

(1) which projection is engageable with a shoulder of said groove upon said mandrel moving longitudinally relative to said shell a distance greater than the normal relative travel of said mandrel.

5. A safety device for a multi-blade bore hole reamer as defined in claim 4, wherein

(*a*) said projection is a set screw threadably engaging said shell, and

(*b*) said set screw has a dog point on the inner end thereof, which dog point is the portion of said projection which extends into said groove.

6. A safety device for a multi-blade bore hole reamer as defined in claim 4, wherein

(*a*) said projection which extends into said groove is a spring pressed ball.

7. A safety device for a multi-blade bore hole reamer for wells, comprising:

(*a*) a shell,

(1) the upper end of said shell being exteriorly screw threaded,

(2) said shell having splines formed interiorly thereof within the length thereof,

(*b*) a mandrel,

(1) a raised splined portion formed exteriorly on said mandrel intermediate the length thereof, and being in complementary, longitudinal sliding relation with said splines within said shell, and being in relative non-rotatable relation with respect thereto,

(*c*) an internally screw threaded collar complementally engaging the screw threads on the upper end of said shell,

(*d*) an inwardly extending, annular boss within said threaded collar intermediate the length thereof,

(*e*) an abutment fitted within the bore of said collar immediately below and in abutting relation with said inwardly extending, annular boss in said threaded collar and being adapted to complementally abut the upper end of said raised spline portion of said mandrel when said mandrel is in the uppermost position,

(*f*) the wall of said shell having a hole formed therethrough within the length of the complementally engaging portions of said screw threaded collar and said shell,

(*g*) said mandrel having an annular recess formed within the length of said splined portion thereof,

(1) said threaded collar having an annular recess formed therein, which recess is complementary to said hole in the wall of said shell when said screw threaded portions of said collar and said shell are in fully engaged relation,

(*h*) a ball fitted within said hole in the wall of said shell,

(1) said ball being of a diameter greater than the depth of said hole in the wall of said shell and of less diameter than the combined depth of either of said recesses and said hole in the wall of said shell, so when said mandrel is moved into a position intermediate the length of travel thereof the annular recess will be in register with said hole in the wall of said shell, whereupon said screw threaded collar will threadably disengage from said threads of said shell,

(2) when said mandrel is in the lowermost position said ball within said hole in the wall of said shell will extend into said annular recess in said collar to form a block to prevent disengagement of said screw threaded collar from the screw threads on said shell,

(*i*) said mandrel having an annular groove formed therein of at least the length of the longitudinal sliding movement of said mandrel in said shell,

(*j*) a plurality of projections extending through said shell into said annular groove in said mandrel in such manner as to normally allow full relative sliding movement between said mandrel and said shell,

(1) said projections being engageable with a shoulder of said groove upon said mandrel moving longitudinally relative to said shell a distance greater than the relative normal travel of the mandrel with respect thereto,

(*k*) the lower end of said mandrel being tapered downwardly and inwardly,

(*l*) said shell having a plurality of elongated longitudinally extending slots formed therein,

(*m*) said shell having the bore thereof tapered to complementally fit the downwardly and inwardly tapered portion of said mandrel,

(*n*) reamer blades complementally fitted within said elongated, longitudinally extending slots in said shell,

(1) said reamer blades having faces thereof adjacent said mandrel tapered to complementally engage said mandrel,

(2) said reamer blades being of greater length within said shell than exterior of said shell,

(*o*) said shell having screw threads on the lower end thereof for complementary attachment of a screw threaded drill bit, and

(*p*) said mandrel having an axial opening formed therethrough.

8. A safety device for a multi-blade bore hole reamer as defined in claim 7, wherein

(*a*) said plurality of projections are set screws, which set screws threadably engage said shell, and

(*b*) each said set screw has a dog point on the inner end thereof, which dog point is the portion of said set screws which extends into said groove.

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CHARLES E. O'CONNELL, *Primary Examiner.*