Jan. 23, 1968 T. D. HOWELL ET AL 3,365,010

EXPANDABLE DRILL BIT

Filed Jan. 24, 1966 3 Sheets-Sheet 1

Fig. 1

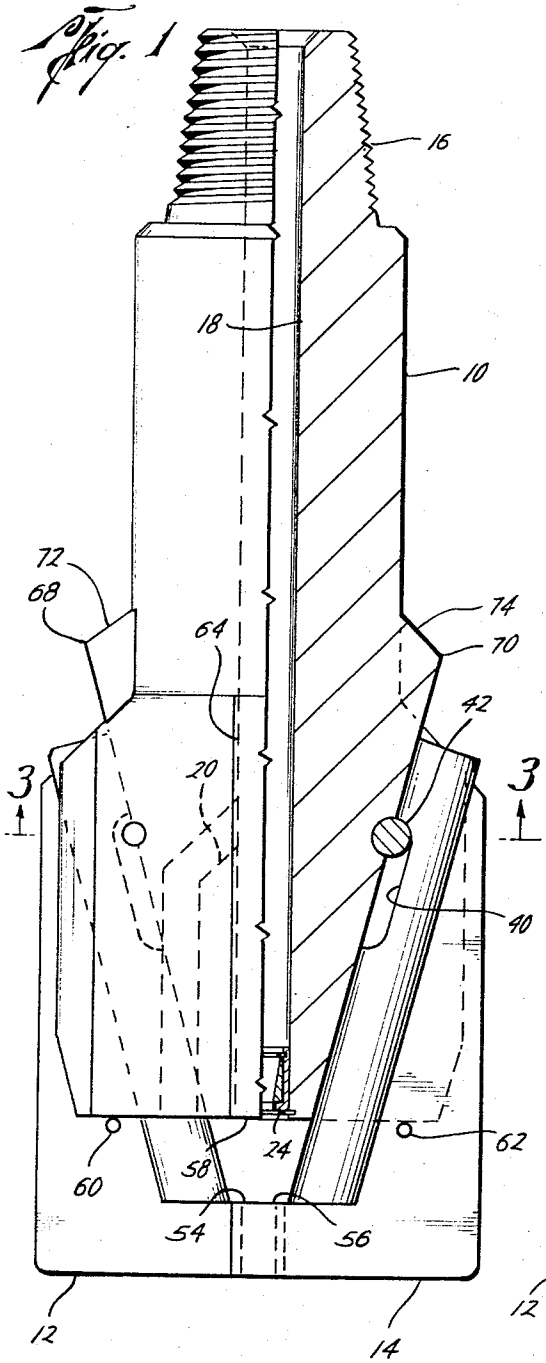
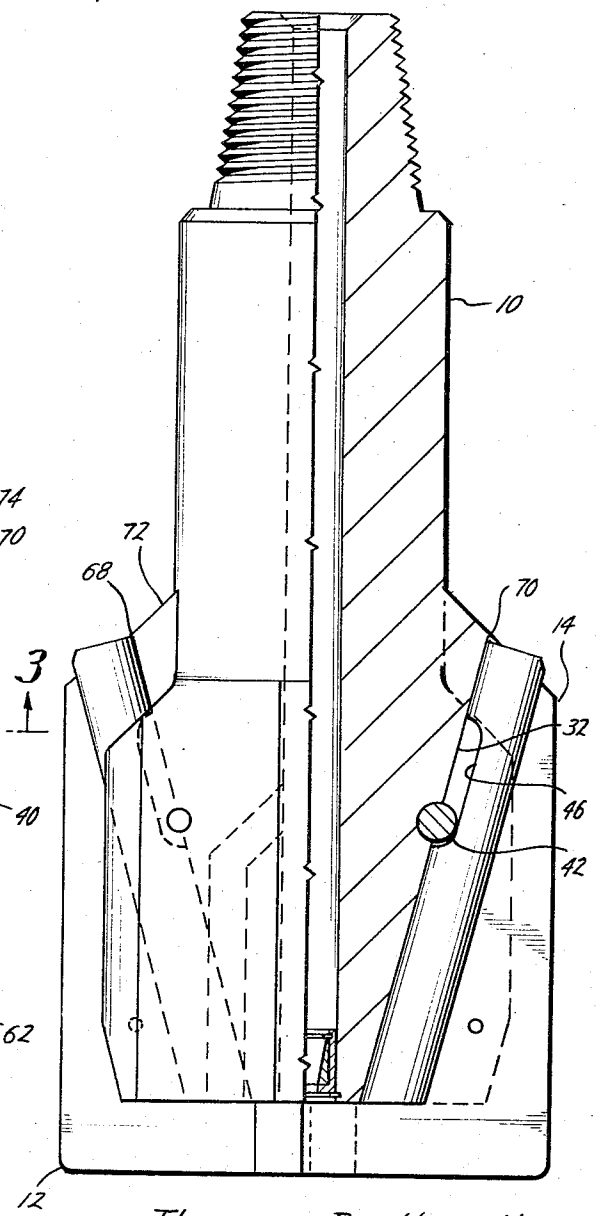


Fig. 2



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3 Sheets-Sheet 2

Fig. 3

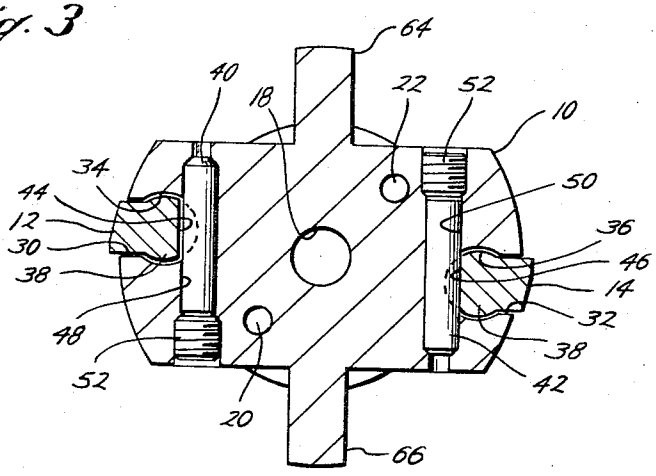
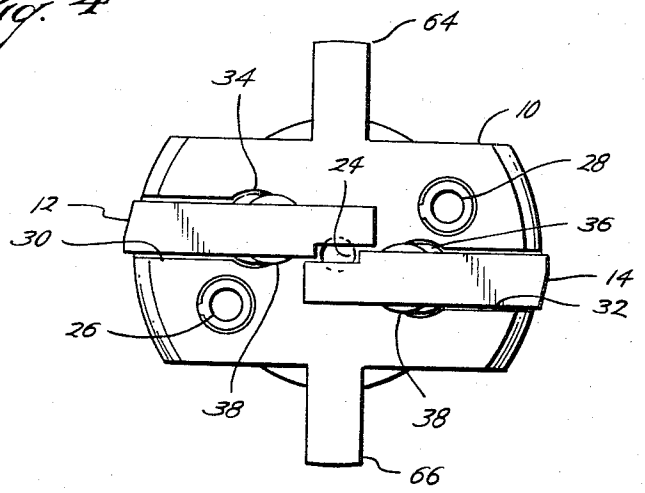


Fig. 4



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Filed Jan. 24, 1966 3 Sheets-Sheet 3

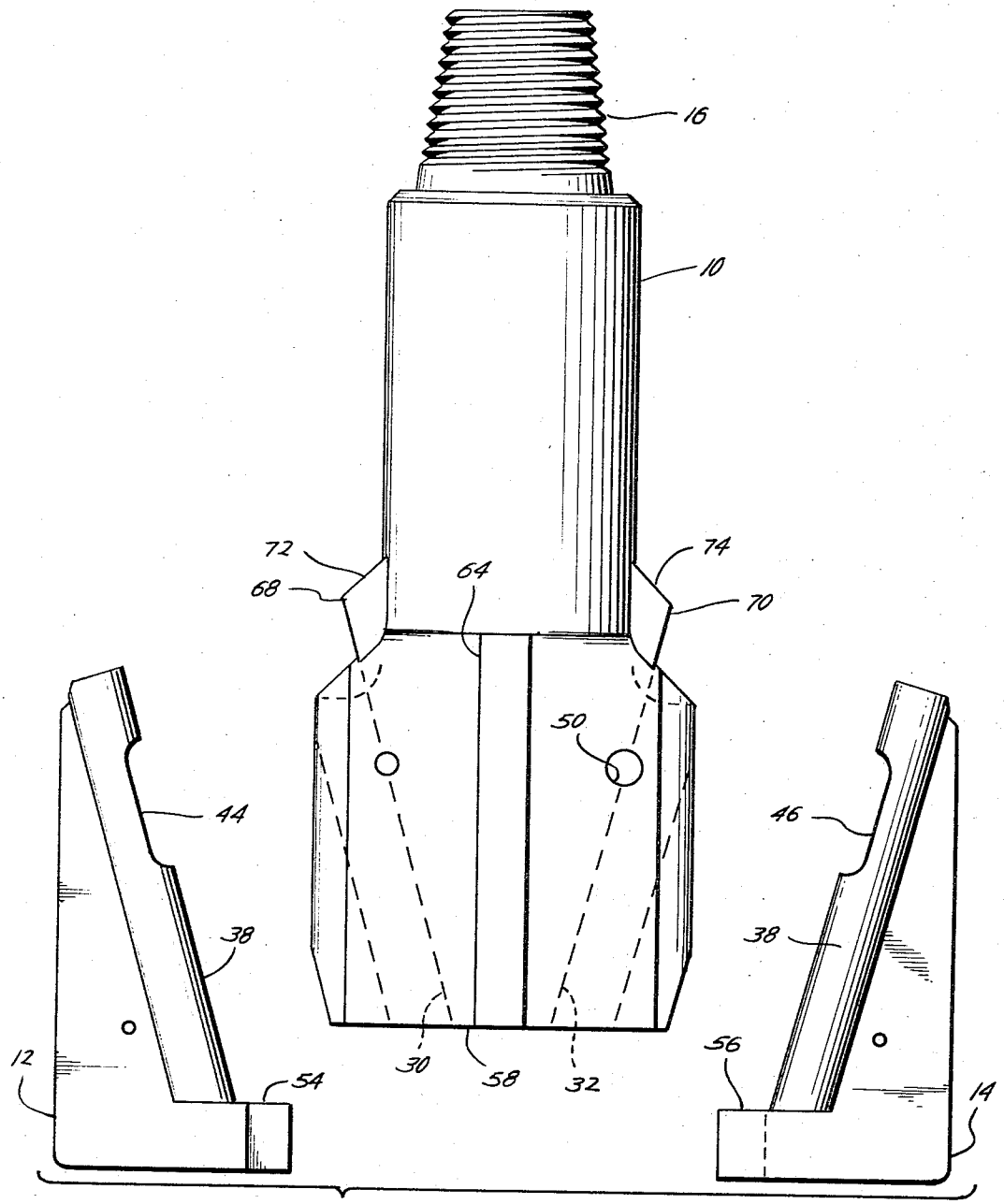

Fig. 5

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EXPANDABLE DRILL BIT

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8 Claims. (Cl. 175—286)

The present invention relates to an improved expandable drill bit.

Prior to the present invention expandable drill bits and underreamers have been used. Some of these prior drill bits have been actuated hydraulically and some have been actuated mechanically. The hydraulically actuated expandable drill bits have relied on the pressure from the circulation of drilling fluids to expand the drill bit. In certain drilling conditions it is desirable to continue circulation even though the drill bit is being removed. Such hydraulically actuated drill bits will expand the bit whenever the drilling fluid is circulated and, therefore, prevent removal of the drill bit or damage the well bore. Prior mechanical type of expandable drill bits have had several disadvantages including lack of rotational stability, limited bearing surfaces between the tool body and the cutter blades, the load transmission area between the body and cutter blades is a substantial distance above the cutting surfaces on the cutter blades and some drill bits have a tendency for the cutter blades to remain in expanded position upon removal.

It is, therefore, an object of the present invention to provide an improved expandable drill bit in which circulation of drilling fluids may be maintained at all times.

Another object is to provide an improved mechanically expandable drill bit having amplified bearing surfaces between the cutter blades and the body with a low load area in respect to the cutting load on the cutter blades.

A further object is to provide an improved mechanically expandable drill bit with means to stabilize the drill bit during rotational cutting.

Still another object is to provide an improved mechanically actuated, expandable drill bit with means protecting the upper end of the cutter blades to prevent the cutter blades from locking in their expanded position.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

FIGURE 1 is a quarter-sectional view of the expandable drill bit of the present invention in position for running into a well bore;

FIGURE 2 is a similar sectional view of the drill bit of FIGURE 1 expanded to a position for drilling;

FIGURE 3 is a cross-sectional view of the drill bit taken along line 3—3 in FIGURE 1;

FIGURE 4 is a view of the bottom of the drill bit illustrated in FIGURE 1; and

FIGURE 5 is an exploded view of the body and cutter blades of the drill bit of the present invention.

The expandable drill bit of the present invention includes a body **10** and a pair of cutter blades **12** and **14** which are so mounted on the body **10** to be retained in a running position and expanded to a drilling position to commence drilling.

The body **10** has an upper threaded portion **16** which provides the means of attaching the drill bit to a drill string. Drilling fluid is circulated through the bore **18** in the body **10** and is fed by the bore **18** to the passages **20** and **22**. The drilling fluid is discharged from the body **10** through the usual insert nozzles **24**, **26** and **28** which are inserted into bore **18** and the passages **20** and **22**, respectively.

The cutter blades **12** and **14** are L-shaped and are slidably mounted in slots **30** and **32**. The slots **30** and **32** are inclined upwardly and outwardly so that a downward movement of body **10** with respect to blades **12** and **14** causes the blades to be displaced or expanded outwardly into drilling and underreaming position. Also, upward movement of body **10** with respect to blades **12** and **14** causes the blades to retract inwardly to running position. The inner end of each of slots **30** and **32** terminates in inclined circular holes **34** and **36** which have a diameter larger than the width of the flat portion of slots **30** and **32**. The holes **34** and **36** provide the aforementioned inclination.

Each of cutter blades **12** and **14** has a circular inner portion **38** which is inclined with respect to the side cutting surface of the blade and is adapted to be positioned within one of the holes **34** and **36**. With the cutter blades **12** and **14** positioned in the slots as described and shown, the bearing surfaces for transmitting forces between the body **10** and the cutter blades **12** and **14** are greatly amplified as compared to other expandable drill bits since they extend over the entire length of the slots **30** and **32**, including the holes **34** and **36**. The engagement between the circular portions **38** of the cutter blades in the holes **34** and **36** will control the lateral positioning of the cutter blades solely responsive to a relative movement between the body and the blades.

Suitable stop means is provided to limit the relative movement of the cutter blade with respect to the body. Such means includes the engagement of pins **40** and **42** with the recesses **44** and **46** on the inner inclined edges of the cutter blades. The body is provided with bores **48** and **50** which extend across body **10**, as best seen in FIGURE 3, and intersect with slots **30** and **32**. Pins **40** and **42** are positioned in bores **48** and **50** to extend through recesses **44** and **46** and are held in such position by any suitable means, such a reduced portion at one end of the bores and a plug **52** threaded into the opposite end of such bores. The recesses **44** and **46** are located on the cutter blades so that pins **40** and **42** engage the upper end of such recesses in running position (FIGURE 1) but do not engage the lower end of such recesses in drilling position (FIGURE 2). With this structure, the cutter blades **12** and **14** may move a limited distance in the slots **30** and **32**.

The cutting surfaces on the cutter blades **12** and **14** may be provided with suitable cutting inserts or a build up of carbide cutting material (none of which is shown). The outer and lower portion of each of the cutter blades **12** and **14** define the cutting surfaces, and, because of the matching inclinations of the blades and the slots, these cutting surfaces will retain their relationship to the body **10**. The inclined inner edge of the cutter blades **12** and **14** terminate in the load bearing surfaces **55** and **46**. The load bearing surfaces **54** and **56** are a relatively short distance above the lower cutting surfaces of the cutter blades. These load bearing surfaces **54** and **56** come into engagement with the lower surface **58** of body **10** during drilling and, therefore, provide a stop for the downward movement of the body **10** with respect to the cutter blades **12** and **14** and also transmit the weight on the body **10** to the cutter blades during drilling. The cutter blades **12** and **14** below body **10** are offset at their overlapping portions as best seen in FIGURE 4.

By allowing the body to move downwardly with respect to the cutter blades, the area of transmission of rotational torque during drilling is relatively low with respect to the

cutter blades. If the body were to remain at a relatively high position within respect to the cutter blades during drilling, the lower portion of the blades will be unsupported and the blades might have a tendency to absorb a portion of the drilling torque to thereby reduce drilling efficiency. The bearing surfaces **54** and **56** also carry all of the weight loading rather than have a portion of such loading carried by the pins **40** and **42**. A loading on the pins **40** and **42** could have a tendency to cause the cutter blades **12** and **14** to cock or move out of their desired positions with respect to body **10**.

Since it is possible that during the running of the drill bit of the present invention into a well bore the cutter blades may engage the wall of the well bore and have a tendency to move upward in relation to body **10** toward expanded position, means is provided to hold the cutter blades **12** and **14** in running position until drilling is to start. Such means is supplied by the shear pins **60** and **62** which extend through the cutter blades **12** and **14** and engage the lower side of the body **10**. Thus, the shear pins **60** and **62** hold the cutter blades in retracted or running position until positively sheared by the weight on the drill bit when the device is to commence drilling.

The drilling or underreaming of a well bore with a drill bit having two cutter blades has been found to be relatively unstable for usual drilling purposes. The stabilizer blades **64** and **66** extend from the body **10** and may be made integral therewith. These stabilizer blades **64** and **66** have an outer diameter no greater than the retracted diameter of the cutter blades **12** and **14** for running purposes. This is, therefore, a smaller diameter than the expanded diameter of the cutter blades **12** and **14** but has been found to be sufficient to stabilize the drilling and underreaming of the drill bit of the present invention for drilling a uniform and relatively straight well bore.

Projecting outwardly from the body **10** at a position above the slots **30** and **32** are the protecting ears **68** and **70**. The upper surfaces **72** and **74** of ears **68** and **70** are at the same level as the upper edge of the cutter blades **12** and **14** when expanded (as best shown in FIGURE 2) to close the space between the cutter blades and the body. By closing this space, these ears **68** and **70** will prevent cuttings and even the lower edge of casing from catching between the cutter blades and the body and assure that the cutter blades will retract whenever an obstacle is encountered in raising the drill bit of the present invention from a well bore. For example, without the ears **68** and **70**, the cutter blades **12** and **14** in expanded position extend above the lower body section and, on lifting a cutting or even one side of the lower edge of casing, could become wedged in such space and prevent retraction of the cutter blades and thus prevent easy removal of the drill bit from the well bore. Without this assurance of retraction of cutter blades **12** and **14**, serious damage could result to the well bore or the drill bit during removal.

In operation, the drill bit is run into the well bore, as shown in FIGURE 1, with the shear pins **60** and **62** in place holding the cutter blades **12** and **14** from relative upward movement with respect to the body **10**. The pins **40** and **42** bear the weight of the cutter blades. When the drill bit is lowered to the bottom of the well bore, drilling is commenced by increasing the weight on the bit to an amount sufficient to shear the shear pins **60** and **62**. Thereafter, this weight forces the body **10** downwardly with respect to the cutter blades **12** and **14** and to wedge them outwardly into expanded position. Circulation of drilling fluid may be started at any time since the expansion of the cutter blades is not dependent upon hydraulic pressure.

During drilling, the weight on the bit is transmitted from the body **10** through the bearing surfaces **54** and **56** to the cutter blades **12** and **14**. The position of bearing surfaces **54** and **56** is relatively close to the lower cutting surface of the cutter blades **12** and **14** providing a desirable low loading of the cutter blades. During rotation of the drill bit by the usual drill string, amplified bearing surfaces are provided between the body and the cutter blades to provide efficient drilling and underreaming. The stabilizer blades **64** and **66** extend outwardly a sufficient distance at the level of the cutter blades **12** and **14** to provide rotational stability during drilling. Upon completion of drilling, the drill bit is readily removed from the well bore with the assurance that the cutter blades are retracted and may not become wedged in their expanded position.

From the foregoing it can be seen that the present invention provides an improved expandable drill bit for drilling and underreaming having rotational stability, large bearing surfaces between the body and the cutter blades. A low load transmission area between the body and the cutter blades and means to prevent the wedging of material between the cutter blades and the body to assure blade retraction.

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 within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. An expandable drill bit comprising

a body having a pair of opposed downwardly and inwardly inclined slots in its lower portion, a central bore therethrough for circulation of drilling fluid and means for connection to a drill string,

a pair of cutting blades adapted to engage in said inclined slots in said body,

said cutting blades being slidably mounted in said slots whereby relative longitudinal movement between said body and said blades expands and retracts said blades, and

stop means engaging said body and said blades to limit the relative longitudinal movement between said body and said blades.

2. An expandable drill bit according to claim **1** wherein each of said blades has an upwardly facing bearing shoulder adapted to be in contact with the lower surface of said body when said blades are expanded to drilling position by a downward movement of said body with respect to said blades.

3. An expandable drill bit according to claim **1** including

fixed stabilizer blades on said body extending outwardly from said body to a diameter less than the diameter of said sliding cutting blades to stabilize said drill bit during drilling and underreaming.

4. An expandable drill bit according to claim **1** wherein said stop means includes

a recess in the inner edge of said cutter blades,

pins extending transversely through said body and intersecting said inclined slots, and adapted to engage in said recess in each of said blades to limit the upward movement of said body with respect to said blades.

5. An expandable drill bit according to claim **1** wherein the surface engagement of said cutting blades in said slots provides extended bearing surfaces between said blades and said body.

6. An expandable drill bit according to claim **1** including

projecting ears on said body in alignment with and above said slots,

the upper surface of said projections being at least as high and adjacent to the upper edges of said sliding blades when in their expanded position to prevent locking of said blades in said expanded position by material collecting between the upper portion of said blades and said body.

7. An expandable drill bit according to claim 1 including

a shear pin extending through each of said blades and engaging the lower surface of said body to retain said blades in retracted position,

said shear pins adapted to be sheared to allow expansion of said blades for drilling.

8. An expandable drill bit according to claim 1 wherein the inner end of said slots includes a circular portion having a diameter greater than the width of the outer portion of said slots, and

each of said blades has an inner circular portion adapted to be received in said circular portion of said slots.

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