April 4, 1961 W. H. DE VAAN 2,978,047

COLLAPSIBLE DRILL BIT ASSEMBLY AND METHOD OF DRILLING

Filed Dec. 3, 1957 4 Sheets-Sheet 1

Fig.1

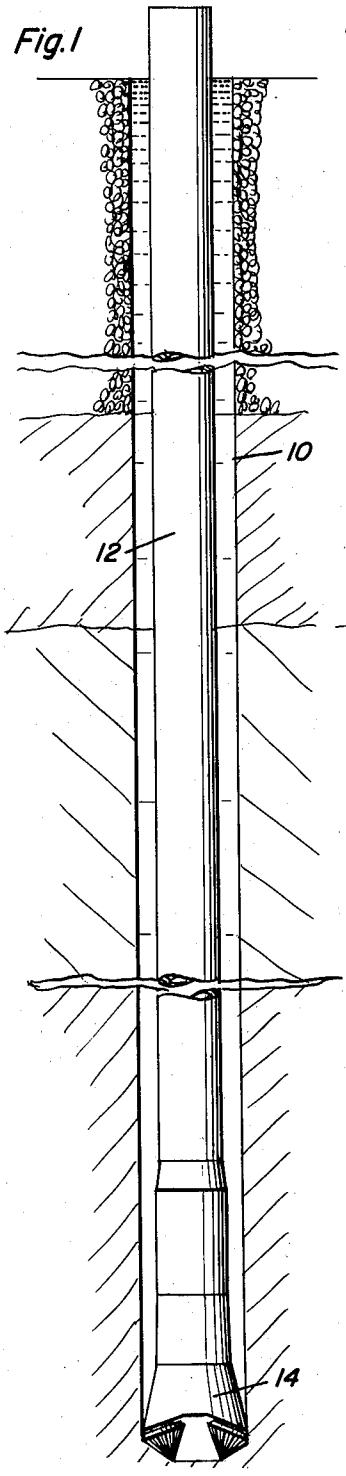


Fig.2

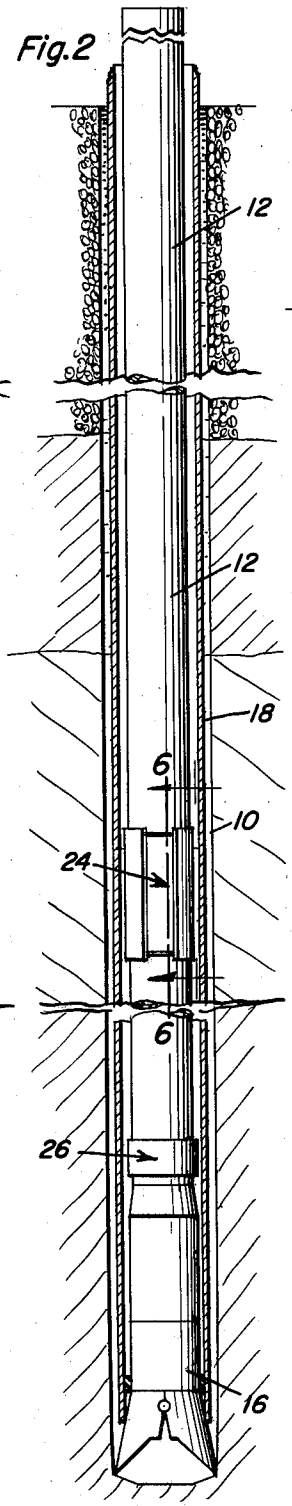
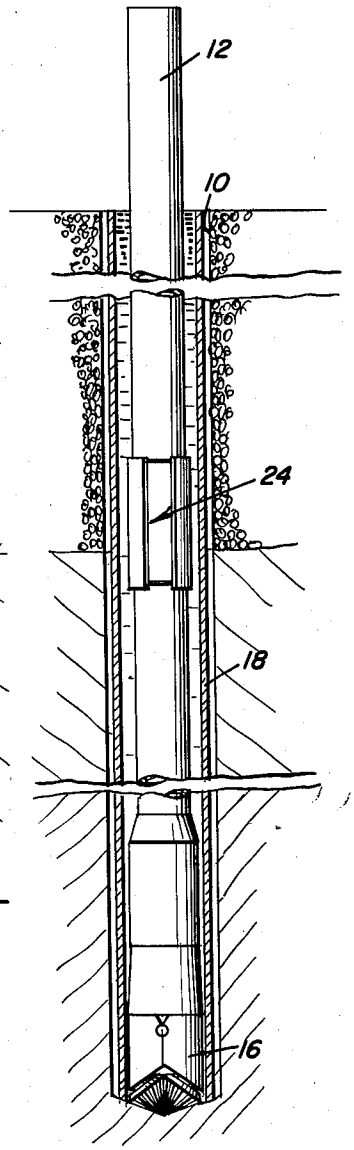


Fig.3



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COLLAPSIBLE DRILL BIT ASSEMBLY AND METHOD OF DRILLING

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Fig. 4

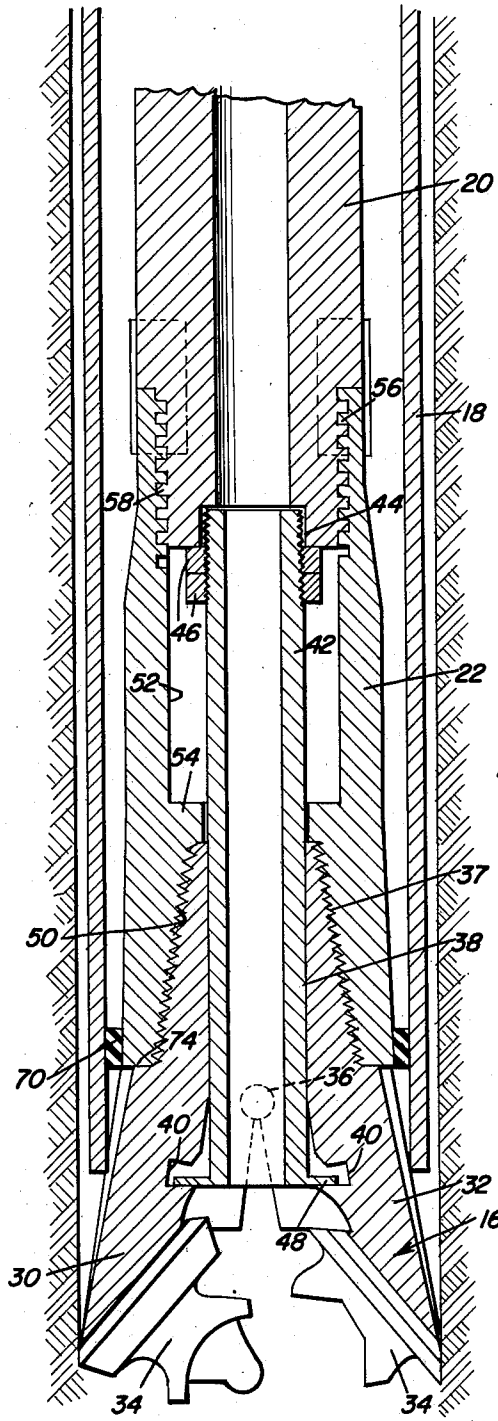
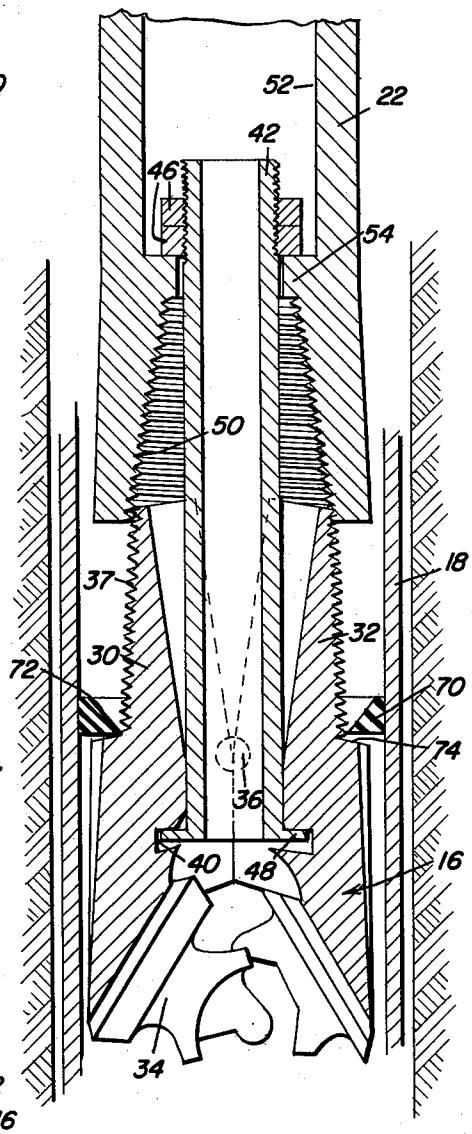


Fig. 5



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COLLAPSIBLE DRILL BIT ASSEMBLY AND METHOD OF DRILLING

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Fig. 7

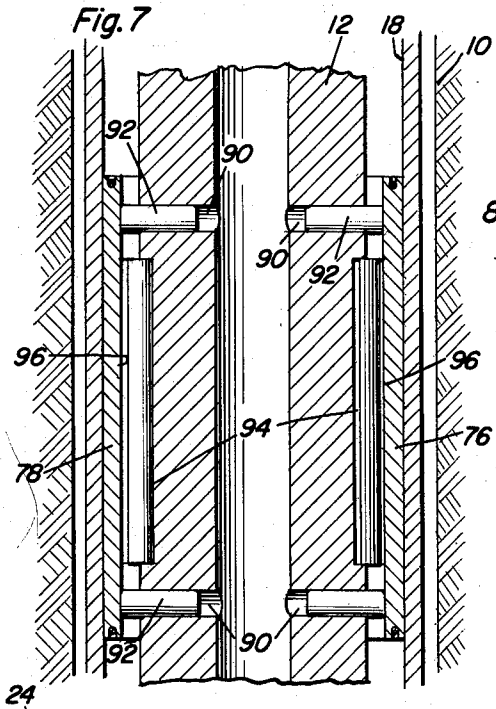


Fig. 6

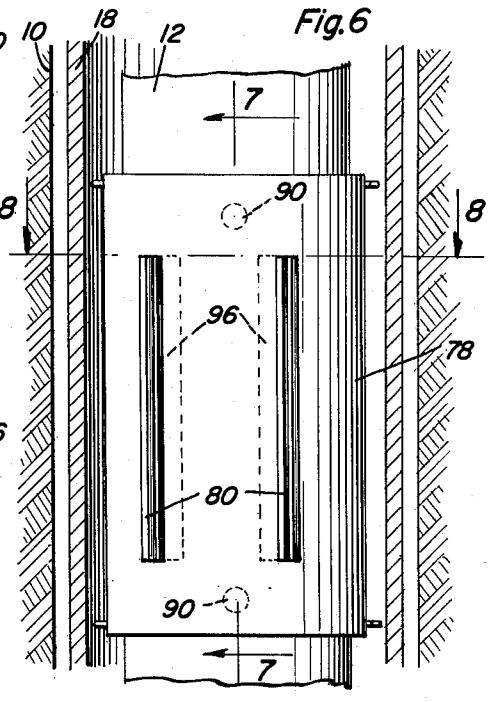


Fig. 10

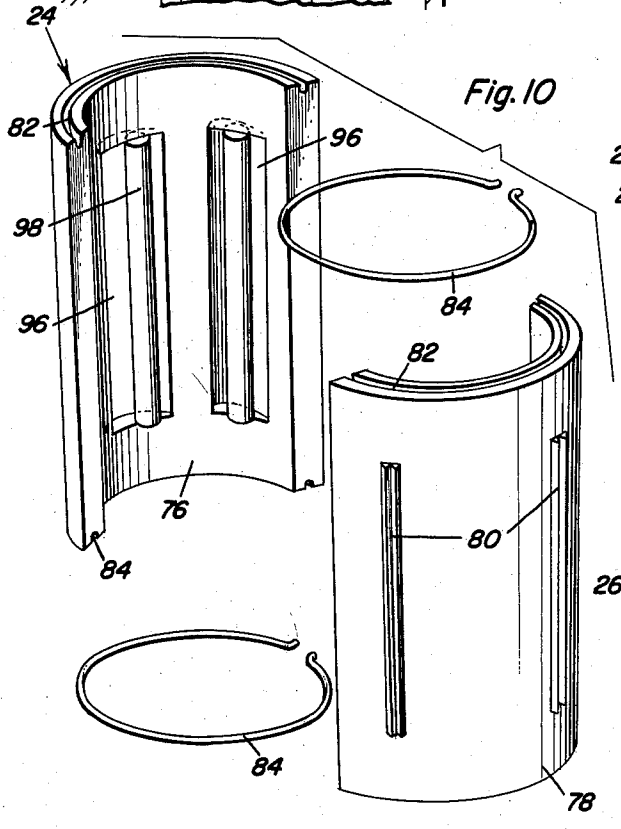
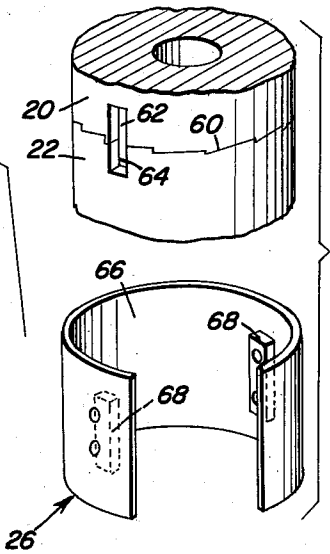


Fig. 11



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COLLAPSIBLE DRILL BIT ASSEMBLY AND METHOD OF DRILLING

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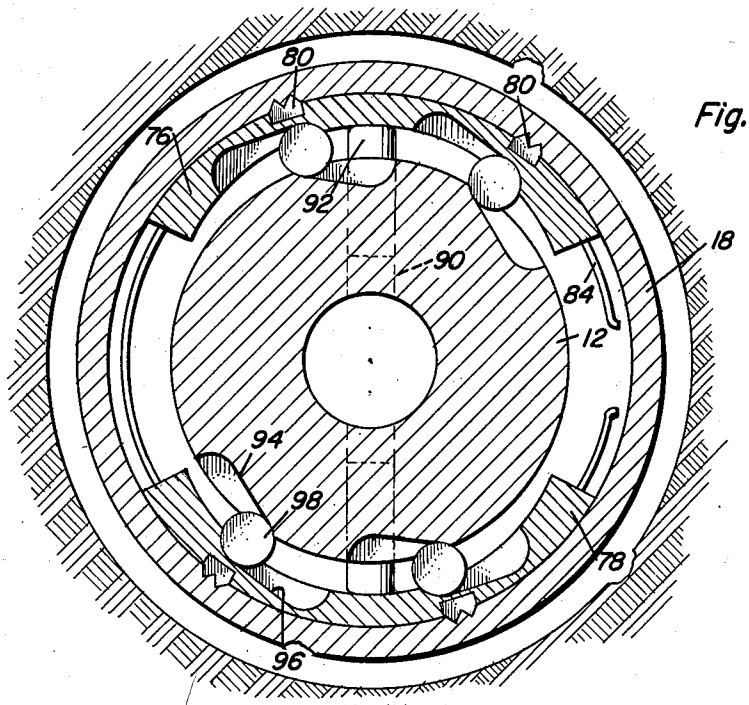

Fig. 8

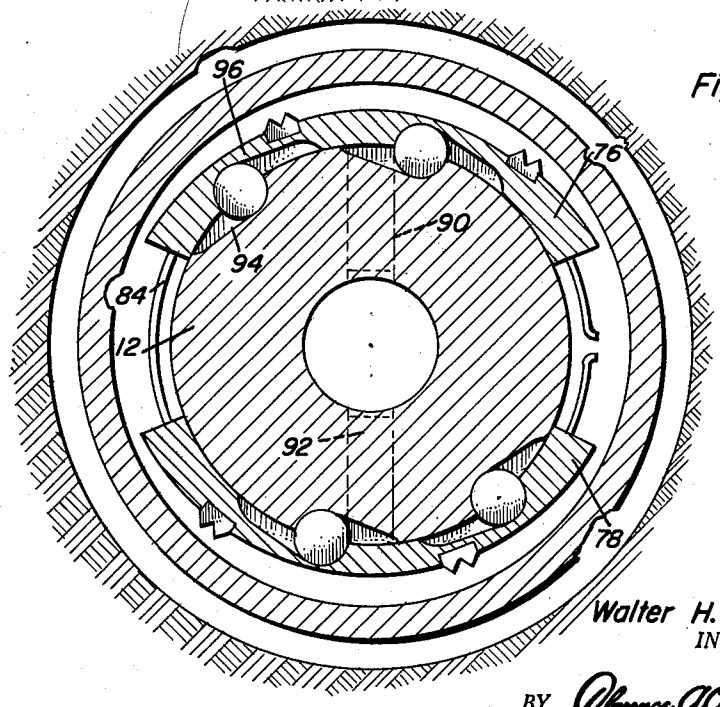

Fig. 9

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2,978,047

COLLAPSIBLE DRILL BIT ASSEMBLY AND METHOD OF DRILLING

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Filed Dec. 3, 1957, Ser. No. 700,447

4 Claims. (Cl. 175—258)

This invention comprises a novel and useful collapsible drill bit assembly and method of drilling and more particularly pertains to an apparatus and method for greatly increasing the efficiency and speed of rotary drilling.

The primary object of this invention is to provide an apparatus and method whereby rotary drilling may be greatly facilitated and increased in speed and efficiency of operation by the provision of means preventing gravel and dirt dislodged from the bore of a well from dropping into the bore below the drill bit or adjacent the same.

A further object of the invention is to provide a method and apparatus for rotary drilling wherein a well casing is installed simultaneously with the drilling operation and without interruption of the latter.

Still another object of the invention is to provide an apparatus and method in accordance with the preceding objects which will enable the driller to drill a stem downward, break off and add a new stem and casing section to the top of the string and continue drilling without the necessity for removing the drill bit from the bottom of the hole.

Another object of the invention is to provide a method and apparatus for rotary drilling whereby a casing may be carried by, secured to and rotated with a drill string for insertion into a well bore therewith together with means for sealing the lower end of the casing against the inlet of fluid therein, and whereby the circulating drilling fluid shall be down the drill string and drill bit and up the exterior of the casing between the same and the wall of the bore.

A still further important object of the invention is to provide a method and apparatus in accordance with the immediately preceding object whereby a casing may be inserted into and cemented in a well bore without the necessity for withdrawing the drilling string during this operation; and whereby when the casing has been inserted in a well bore to the desired depth, the drill bit may be collapsed and withdrawn to thereby leave the casing in place.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompany drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

Figure 1 is a view in vertical section, parts being broken away, and showing a method of rotary drilling in accordance with conventional practice;

Figure 2 is a view similar to Figure 1 but showing a rotary drill in accordance with this invention and with a casing mounted upon and carried by and rotated with the drill string and the collapsible drill bit;

Figure 3 is a view similar to Figure 2 but showing a further step in the invention in which after the casing has been inserted to a desired depth in a well bore the drill bit is collapsed in readiness to be withdrawn from the casing in order to permit a conventional drilling bit to be inserted through the casing to continue the drilling operation;

Figure 4 is an enlarged view in vertical section through a collapsible drill bit in accordance with this invention, showing the manner in which the same is mounted upon a drill stem and carries thereon and has associated therewith a casing, the device being indicated in a well bore in drilling operation therein;

Figure 5 is a view similar to Figure 4 but showing the position of the parts when the collapsible drill bit has been radially contracted in readiness for removal from the casing;

Figure 6 is a view in vertical section, with a portion of a drill stem being shown in elevation together with a portion of a casing mounted thereon, and showing in elevation the locking means by which the stem is secured to the casing, this figure being taken on an enlarged scale substantially upon the plane indicated by the section line 6—6 of Figure 2;

Figure 7 is a view in vertical section substantially upon the plane indicated by the section line 7—7 of Figure 6 and showing further structural details of the locking means for securing the casing to the drill stem;

Figures 8 and 9 are horizontal sectional views taken substantially upon the plane indicated by the section line 8—8 of Figure 6 and showing in different positions, a clutch means for locking the casing section to a drilling stem section;

Figure 10 is an exploded perspective view of a portion of the locking means by which the casing section is secured to the drill stem section; and

Figure 11 is an exploded perspective view, parts being broken away and shown in section, of a fastening means for securing and locking together adjacent sections of a drill stem to prevent separation of the same during reverse rotation of the drilling string.

Figure 1 illustrates in vertical section the method in accordance with conventional drilling operations wherein a bore 10 has been drilled into a formation by means of a drill stem 12 having upon the lower end thereof a conventional cone-type roller cutter bit 14. As will be understood, the drill string 12 is operated by the usual rotary, not shown, at the surface of the ground and drilling fluid is circulated therethrough, this being down the drill stem and drill bit, and then upwards in the bore between the drill stem and the wall of the bore 10. In such drilling operations, when it is necessary to add another section to the top of the drilling stem 12 in order that the bit 14 may be advanced downwardly to further deepen the hole 10, it is necessary to lift the drill stem so that the drill bit is raised above the bottom of the hole in order to remove the kelly therefrom, attach an additional section of drill stem, then lower the same and reapply the kelly and then resume drilling operations. During this operation, especially when drilling through formations which are of a loose gravel or rock character, it frequently occurs that when the drill bit is raised for this purpose, rock or gravel drops to the bottom of the hole therebeneath.

When the drill stem is again lowered to resume drilling operations, it is then necessary for the drill bit to either break and pulverize this gravel, rock or other matter which has dropped into the bottom of the well bore in order that the same may be removed by the circulation of the drilling fluid which was discontinued in order to permit the drill stem to be raised for adding another section thereto, or it is sometimes necessary to remove the added section of the drill stem in order to lower the drill bit upon the foreign matter falling into the bottom of the hole and drill through the same. Frequently, the above-mentioned difficulty will occasion a considerable loss of time to the driller, will sometimes result in losing a large part of the hole due to the falling of rocks or

other material into the bottom of the hole; or the rocks falling alongside of the drill bit may even wedge the same and further interfere with the drilling operation.

In accordance with the present invention there is provided a means and a method which will overcome the above disadvantages by preventing the possibility of rocks falling into the bottom of the hole when a new section is added to the drilling stem.

Figures 2 and 3 illustrate a method of rotary drilling in accordance with the present invention, Figure 2 showing a radially expansible and contractible drill bit **16** secured to the end of the above-mentioned drilling stem **12**, the drill bit in drilling position being radially expanded, while in Figure 3 the drill bit is shown in its radially contracted position. Also shown in Figures 2 and 3 is a string of casing **18** which surrounds and is locked to the drilling stem **12** for rotation therewith for a purpose to be subsequently set forth. The lower end of this casing rests upon and is sealed to the drill bit **16** in such a manner as to prevent the passage of drilling fluid into the open lower end of the casing, the casing being of a lesser external diameter than that of the expanded drill bit **16**.

With the casing secured to the drilling stem and drill bit as set forth hereinafter, the normal drilling operation is performed to thereby produce the bore **10**, drilling fluid being circulated down through the drill string and drill bit, and then up about the side of the casing and between the same and the wall of the bore as will be apparent from Figures 2 and 3. In this operation, it is obvious that the casing which is only slightly smaller than the diameter of the well bore **10**, would prevent any gravel or rock through which the drill bit passes from falling into the bore and getting below the drill bit. When it is desired to add a section to the drill stem and casing, in order to continue drilling to greater depths, the rotation of the drill stem and the casing is stopped, with the drill bit resting on the bottom of the bore, the fluid circulation is stopped, the kelly is removed, a new section of drill tem and casing are added to the drill stem and casing **12** and **18** respectively, the kelly is again attached, circulation of drilling fluid and rotation of the stem and casing is then resumed and drilling operations continued.

When the casing has been inserted into the bore to a desired depth therein, the casing is unlocked from the drill string and the bit is collapsed and then withdrawn through the casing which has then dropped to the bottom of the hole in the manner suggested in Figure 3, after which a conventional drill bit of any conventional design but of smaller diameter than the internal diameter of the casing **18** may then be connected to the drilling stem **10**, introduced into the bore through the casing and the bore may be then continued downwardly below the casing with a reduced diameter.

The novel apparatus in accordance with this invention and one adapted to perform the novel rotary method of this invention consists of a collapsible drill bit **16** of a construction shown especially in Figures 4 and 5; a drill stem lower section **20** of special construction together with a means for mounting upon the collapsible bit, the lower casing section **18**, which mounting means is indicated generally by the numeral **22** and which comprises a connecting sub; together with a locking means for detachably securing the casing **18** to the drill stem lower section **20**, this locking means being designated generally by the numeral **24** and being shown in detail in Figures 6–10; together with a drill stem section locking means designated generally by the numeral **26**; and shown especially in Figure 11, for securing the sections of the drill stem together against relative rotation especially during reverse rotation of a drill string.

Referring now specifically to Figures 4 and 5 it will be seen that the collapsible drill bit **16** consists of sections **30** and **32** carrying at their lower ends conventional types of roller cone cutters **34**. The two sections are pivotally connected together intermediate their ends and at opposite sides thereof as by hinge or pivot pins **36** so that their lower ends together with the cone roller cutters may move towards or from each other upon pivoting of the sections, thereby permitting the cutting surface of the drill bit to be radially expanded or contracted as desired. At their upper ends, these sections are externally tapered and threaded as at **37** and define an axial bore therebetween as at **38**. Below their pivot pins **36** the two sections are provided with complementary opposed lateral recesses **40** for a purpose to be subsequently set forth.

In order to support the drill bit **16** there is provided a pipe or arbor **42** which is externally threaded as at **44** at its upper end for the reception of a pair of lock nuts **46**. The arbor extends through the bore **38** formed upon the interior of the two sections **30** and **32**, and at its lower end is provided with an outturned lateral flange **48** loosely received in the lateral recesses **40**. As will now be apparent from Figures 4 and 5, the arbor **42** has a limited axial movement in the bore **38** of the drill bit **16**, this movement being limited by the travel permitted the flanges **43** in the lateral recesses **40**.

Continuing to refer to Figures 4 and 5 it will be seen that the sub or mounting means **22** comprises a cylindrical body of lesser diameter than that of the drill bit **16** in the radially expanded position of the latter shown in Figure 4, and of substantially the same diameter as that of the drilling stem **12**. This mounting means or sub has a tapered internally threaded bore **50** opening upon its lower surface and which is complementary to and receives the externally threaded portion **37** of the drill bit. The arrangement is such that as the drill bit is moved in screw-threaded engagement upwardly in the bore **50**, the upper ends of the sections **30** and **32** will be drawn together causing radial expansion of the lower end of the drill bit. As the sections are moved downwardly in the bore **50** by reverse rotation, the upper ends of the threaded sections are allowed to expand thus permitting a radial contraction of the drill bit, to the position shown in Figure 5.

The upper end of the sub **22** is provided with a bore **52** therethrough in which the lock nuts **46** are slidably received, with the lower end of the bore having an inwardly projecting portion **54** in the form of a rib or lugs which are adapted to engage the lock nuts **46** and thus prevent further downward movement of the arbor **42** and drill bit as will be apparent from Figure 5.

At its extreme upward end, the sub **22** is provided with internal threads **56** adapted to engage complementary threads **58** carried by the lower drill stem section **20** to thereby detachably lock these parts together.

It will thus be apparent that the mounting means **22** serves as a connector whereby the drill bit and the arbor **42** carrying the same are detachably coupled to the lower end of the drill stem through the drill stem section **20** in such a manner as to permit a limited vertical travel of the drill bit with respect to the mounting means to thereby effect the radially expanding and radially contracting operation of the drill bit.

Referring now to Figure 11 there is disclosed a manner by which each of the drill stem sections and the mounting means **22** are detachably locked together against relative rotation and against loosening of the screw-threaded connections upon reverse rotation of the drilling stem. Although Figure 11 discloses this locking means applied to the connection between the lowermost drilling stem section **20** and the mounting means **22**, it will be understood that the same type of locking means may be secured to each and everyone of the drill stem sections.

As will be apparent from this figure, the adjacent

surfaces of the two sections are provided with a slightly saw-toothed engaging surface **60**. In addition, there are provided vertically aligned complementary slots or grooves **62** and **64** in the two sections for the reception of locking keys to thereby prevent relative rotation between the two sections.

A resilient band **66** is provided having secured upon its interior surface a plurality of keys **68**. Each key is adapted to be received in a pair of vertically aligned slots **62** and **64** when the two drilling stem sections **20** and **22** are properly screwed together. The band **66** is of a resilient nature so that the same will tightly grip the two sections **20** and **22** and force and retain the keys **68** into the slots **62** and **64** previously mentioned. As each section is added to the drill stem, one of these locking means **26** is placed in position, while when the drill stem is withdrawn from the bore, each locking member **26** is in turn removed before the associated stem sections may be uncoupled from each other.

Referring next to Figures 2, 4 and 5, it will be seen that the lower open end of the casing **18** is sealed to the drill bit **16** in such a manner as to prevent the passage of drilling fluid to the interior of the casing. For this purpose there is provided a packing member **70** in the form of a ring of rubber or suitable composition, the same having a beveled or conical upper surface **72**. In operation, the packing member **70** is placed upon the externally threaded upper portion of the drill bit, above a shoulder **74** thereon. When the lower end of the sub **22** is screw-threaded upon the drill bit, it will eventually move downwardly and bear against the conical surface **72** and will wedge the packing member outwardly between the sub and the internal wall of the casing **18**, as will be apparent from comparing Figure 5 with Figure 4. Thus, a fluid tight seal is established between the interior of the casing **18** and the exterior of the drilling stem at the drill bit by means of the sub or mounting means **22**. It will be observed that the conical surface **72** is such that the lower end of the sub **22** will pass downwardly along the same and wedge the sealing ring outwardly between the sub and the casing.

As previously mentioned, locking means **24** are provided between the drilling stem and the casing to lock the casing to the stem for rotation and to secure the casing to the stem. Any desired number of these locking means may be employed, the construction and operation of one such means being illustrated in detail and disclosed in this application.

Referring now especially to Figures 6–10 it will be seen that the locking means consists of a pair of semi-cylindrical sleeves **76** and **78** which are complementary to each other and which are disposed between the stem **12** and the casing **18**. These sleeves constitute shoes which are radially expansible and contractible as set forth hereinafter. Upon the exterior surface these sleeves have inset any suitable clamping means such as the slips **80** for frictional gripping engagement against the internal surface of the casing sections **18** when the shoes are radially expanded. At their upper and lower edges, the shoe sections are provided with annular grooves **82** for receiving resilient split rings **84** which thereby yieldingly urge the shoes into their radially contracted position in which they are out of engagement with the casing **18**.

Actuating means are provided for insuring radial expansion of the shoes into gripping engagement with the casing. This actuating means comprises an initial actuating means adapted to initially place the shoes in engagement with the casing section together with a further or final actuating means utilizing the rotation of the drill stem, to complete the final outward movement of the shoes and perfect their locking engagement with the casing.

As shown in Figure 7, the drill stem **12** at each of the locking devices **24** is provided with sets of laterally extending bores **90** which communicate with the hollow interior of the drill stem. Received in these bores and slidable therein are plungers **92** which project outwardly from the drill stem and into engagement with the shoes **76** and **78**. Under the pressure of the drilling fluid when circulated through the drill stem as indicated in arrows in Figure 7, the plungers **92** are moved outwardly and thus in turn force the shoes outwardly against their return springs **84** until the shoes are in engagement with the casing **18**.

The adjacent surfaces of the drill stem and of the shoes are provided with complementary longitudinally extending clutch recesses **94** and **96** whose surfaces are inclined to each other at a slight angle as will be apparent from Figures 8 and 9, and clutch rollers **98** are received in these recesses and by engagement of their opposite ends with the upper and lower surfaces of the two sets of recesses, serve to mount and support the shoes upon the drill stem.

The arrangement is such, as will be seen by comparison of Figures 8 and 9 that when the drill stem is rotated in a clockwise direction, the relative movement of the rollers **98** in the two sets of recesses **94** and **96** will force the shoes outwardly and cause their slips **80** to firmly and securely engage the casing **18** and lock the same to the stem **12** for rotation therewith. However, when the rotation of the drill stem is reversed, the rollers are moved to the other ends of the two sets of clutch cavities, thereby permitting the shoes to move inwardly under the influence of their return springs **84** and thus radially contract the shoes and disengage the same from the casing.

From the foregoing, it is believed that the operation of the device will be readily apparent. When a casing has been carried by the drill stem to a desired location in a well bore, and the casing can readily move in the well bore since the circulation of the drilling fluid upon the exterior of the casing and within the well bore maintains an annular space or clearance between the bore and casing, the casing may be cemented in place by merely running cementing material through the drilling stem and drill bit and up the exterior of the casing and permitting this cement to set or harden. Thereafter, the drill stem is reversed in rotation causing the joint between **37** and **50** to unscrew from the position shown in Figure 4 to that shown in Figure 5. As the drill bit is lowered from the sub **22**, the drill bit will collapse either under its own weight, or by the upward pull of the sub **22** through the nuts **46** and the arbor **42** and flange **48** in the recess **40**. Thereafter, the collapsed drill bit and the drill stem can be moved upwardly through the casing sections and removed from the well bore. As soon as the drill bit is collapsed, however, the casing will unless cemented, of its own weight drop to the bottom of the well bore as shown clearly in Figure 3 as compared to the position of Figure 2. In this position, the casing prevents any ingress of gravels, rocks or foreign matter below the same. A conventional drill bit, but smaller than the diameter of the casing can then be attached to the drill stem **12** and lowered through the casing and drilling operations resumed and the hole extended downwardly as much as desired.

It will be observed that by this method of drilling and this apparatus, it is not necessary to lift the drill bit from the floor or bottom of the hole in order to add sections to the drill stem or the casing, and thus the casing itself acts as a guard to prevent gravel or rocks falling into the well bore about the bit or the bottom of the hole.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A rotary drilling apparatus comprising a drill stem and a radially expansible drill bit thereon, a casing sur-

rounding said stem, said drill bit being radially expansible to a diameter greater than that of said casing for drilling and collapsible to a diameter less than that of said casing for withdrawal through the latter, means for locking said casing to said drill stem for rotation thereby, said locking means including shoes carried by said drill stem and operable to engage said casing, actuating means for causing locking engagement of said shoes with said casing, said actuating means comprising initial operating means actuatable by the pressure of the drilling fluid to move said shoes into engagement with said casing, and further operating means actuatable by rotation of said drill stem to complete the movement of said shoes into final locking engagement with said casing.

2. A rotary drilling apparatus comprising a drill stem and a radially expansible drill bit thereon, a casing surrounding said stem, said drill bit being radially expansible to a diameter greater than that of said casing for drilling and collapsible to a diameter less than that of said casing for withdrawal through the latter, means for locking said casing to said drill stem for rotation thereby, said locking means including shoes carried by said drill stem and operable to engage said casing, actuating means for causing locking engagement of said shoes with said casing, said actuating means comprising complementary relatively inclined clutch recesses in said drill stem and shoes, clutch rollers each received in both said recesses and operable upon relative rotation of said stem and shoes to move the latter outwardly into final locking engagement with said casing.

3. A rotary drilling apparatus comprising a drill stem and a radially expansible drill bit thereon, a casing surrounding said stem, said drill bit being radially expansible to a diameter greater than that of said casing for drilling and collapsible to a diameter less than that of said casing for withdrawal through the latter, means for locking said casing to said drill stem for rotation thereby, said locking means including shoes carried by said drill stem and operable to engage said casing, actuating means for causing locking engagement of said shoes with said casing, said actuating means comprising initial operating means actuatable by the pressure of the drilling fluid to move said shoes into engagement with said casing, and a further operating means comprising complementary relatively inclined clutch recesses in said drill stem and shoes, clutch rollers each received in both said recesses and operable upon relative rotation of said stem and shoes to move the latter outwardly into final locking engagement with said casing.

4. The combination of claim 3 wherein said clutch rollers comprise means for supporting and mounting said shoes on said stem.

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