April 29, 1941. J. F. CHAPPELL 2,239,996

DRILLING APPARATUS

Original Filed May 25, 1936 3 Sheets-Sheet 1

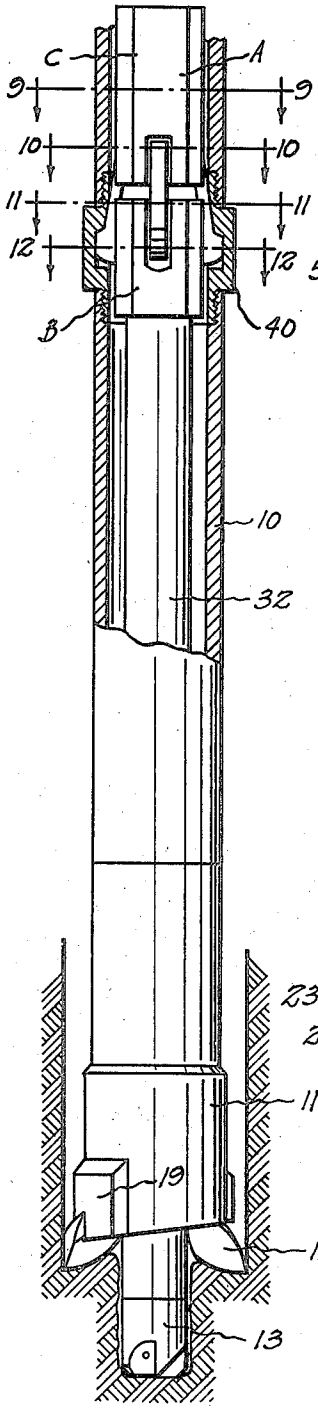


Fig. 1.

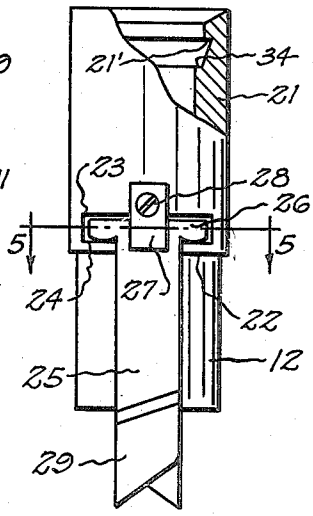


Fig. 4.

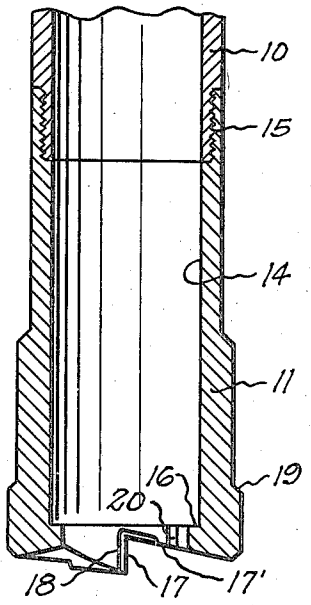


Fig. 6.

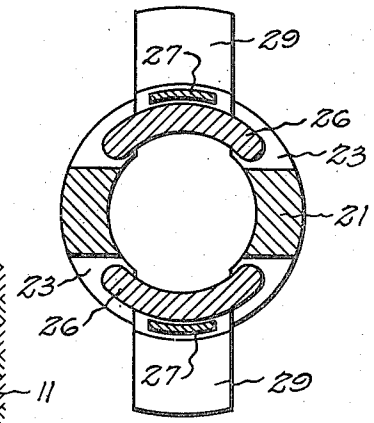


Fig. 5.

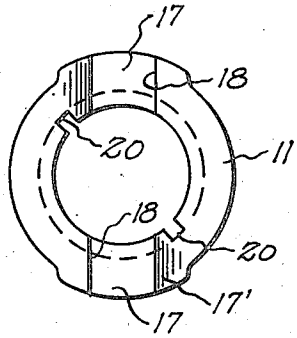


Fig. 7.

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DRILLING APPARATUS

Original Filed May 25, 1936 3 Sheets-Sheet 2

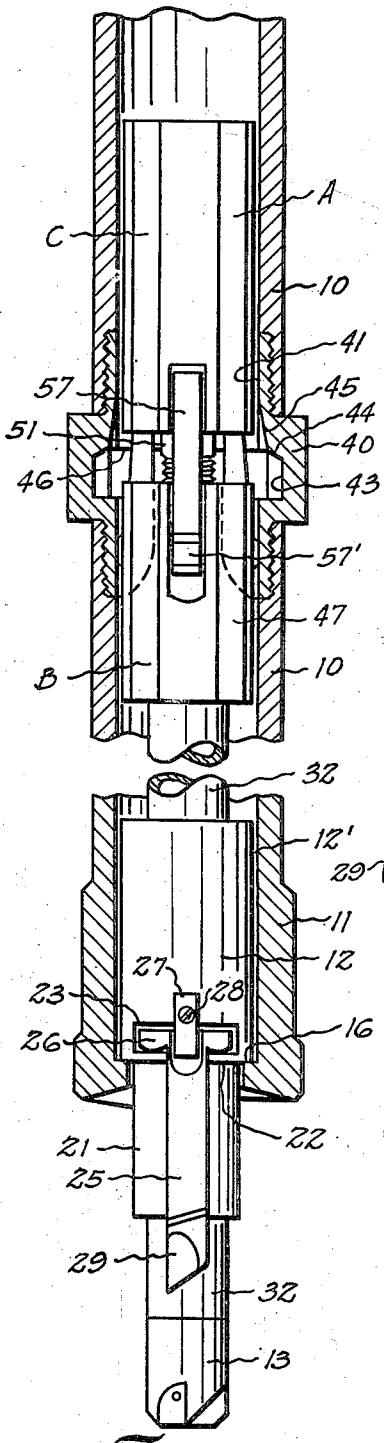


Fig. 2.

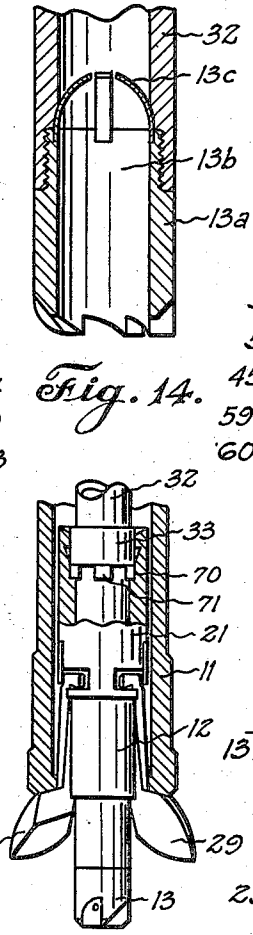


Fig. 14.

Fig. 15.

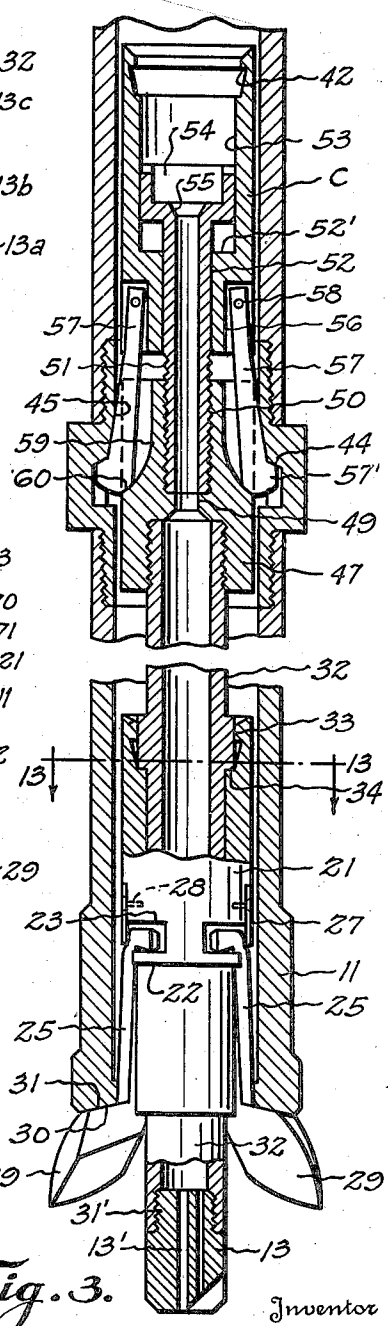


Fig. 3.

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DRILLING APPARATUS

Original Filed May 25, 1936 3 Sheets-Sheet 3

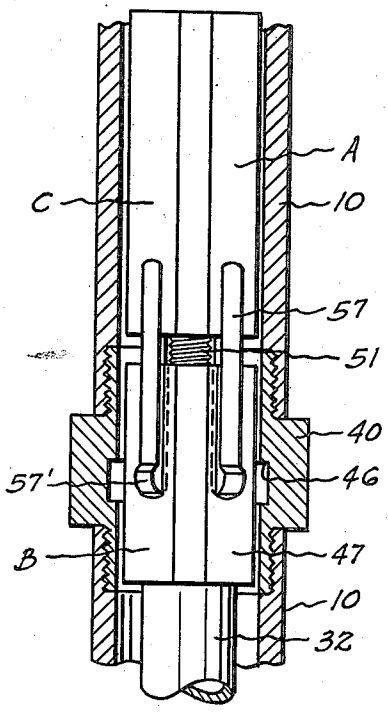


Fig. 8.

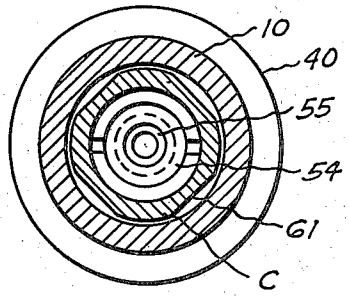


Fig. 9.

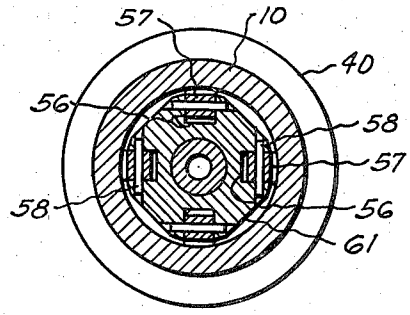


Fig. 10.

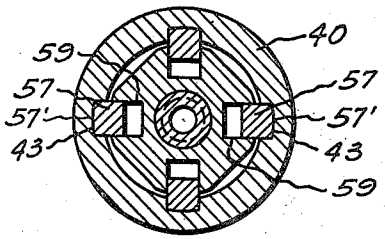


Fig. 12.

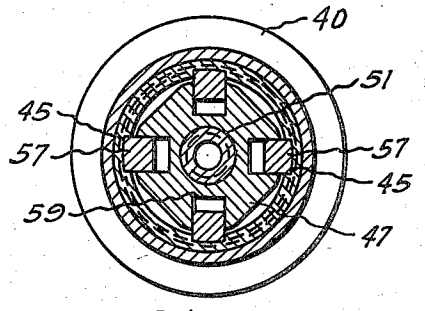


Fig. 11.

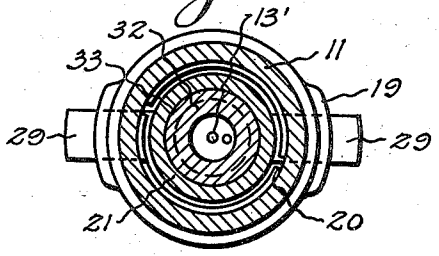


Fig. 13.

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Patented Apr. 29, 1941 2,239,996

UNITED STATES PATENT OFFICE

2,239,996

DRILLING APPARATUS

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Original application May 25, 1936, Serial No. 81,647. Divided and this application April 14, 1938, Serial No. 201,905

9 Claims. (Cl. 255—74)

This invention relates to new and useful improvements in drilling apparatus.

This application is filed as a division of my copending application, filed May 25, 1936, Serial No. 81,647, now Patent No. 2,120,240 of June 14, 1938.

One object of the invention is to provide an improved apparatus for the drilling of oil wells.

Another object of the invention is to provide an improved drilling apparatus wherein the drill pipe or stem forms the well casing, whereby the usual casing is eliminated.

An important object of the invention is to provide an improved apparatus for drilling wells, which is so constructed that the cutting tool may be inserted in, or removed from, the well for replacement or other purposes, without pulling the entire length of drill pipe which results in a saving of time, labor and expense which is incidental to the removal of the drill pipe.

A particular object of the invention is to provide an improved drilling apparatus including a drill pipe having a drill bit removably supported in its lower end, and an inner, smaller bit depending below said drill bit and serving as a lead bit to guide the drilling of the hole to gauge; both bits being rotated by the rotation of the drill pipe, and both being readily removable from the hole without pulling the entire string of drill pipe.

A further object of the invention is to provide an improved drilling apparatus, wherein a drill bit having retractible blades is supported at the lower end of the drill pipe to rotate therewith, and a second bit extending axially through the drill bit and acting to hold the blades thereof in cutting position, said second bit having an improved connection with the drill pipe, whereby rotation is imparted thereto by said pipe.

Still another object of the invention is to provide an improved drilling apparatus, wherein both the inner and outer drill bits may be lowered into, or removed from, the pipe on a wire line or cable, and the drill pipe need never be withdrawn whereby said pipe acts as the well casing after the drilling operation is complete.

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

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

Figure 1 is a view, partly in elevation and partly in section, of a drilling apparatus constructed in accordance with the invention, and showing the same within the well bore,

Figure 2 is an enlarged elevation of the drilling apparatus, showing the same within the drill pipe prior to the time that the drilling operation begins,

Figure 3 is a transverse, vertical, sectional view showing the parts of Figure 2 in drilling position within the drill pipe,

Figure 4 is a view, partly in elevation and partly in section, of the lower drill collar which carries the cutting blades of the outer bit, said collar being viewed at a right angle from its position as shown in Figure 3,

Figure 5 is a horizontal, cross-sectional view, taken on the line 5—5 of Figure 4,

Figure 6 is a transverse, vertical, sectional view of the lower end of the drill pipe,

Figure 7 is a bottom view of the drill pipe,

Figure 8 is an elevation of the upper connecting collar which connects the drill pipe with the inner or pilot bit,

Figure 9 is a horizontal, cross-sectional view, taken on the line 9—9 of Figure 1,

Figure 10 is a horizontal, cross-sectional view, taken on the line 10—10 of Figure 1,

Figure 11 is a horizontal, cross-sectional view, taken on the line 11—11 of Figure 1,

Figure 12 is a horizontal, cross-sectional view, taken on the line 12—12 of Figure 1,

Figure 13 is a horizontal, cross-sectional view, taken on the line 13—13 of Figure 3,

Figure 14 is a vertical, sectional view of a core bit which may be substituted for the inner bit, and

Figure 15 is a view, partly in elevation and partly in section, of a modified form of connection between the bits.

In the drawings, the numeral 10 designates a tubular drill pipe which has its upper end connected to the usual square kelly or other drive member (not shown) whereby said pipe may be rotated. The pipe extends downwardly within the well bore and has a bottom drill collar 11 threaded on its lower end. The bottom drill collar is constructed to receive an outer drill bit 12 so as to impart rotation to said bit as the drill pipe and collar are rotated, as will be explained. An inner or pilot bit 13 extends downwardly through the outer bit 12 and is also rotatably connected with the drill pipe. It will be obvious by observing Figure 1, that with such arrangement a rotation of the drill pipe 10 through the medium of the kelly (not shown), will impart rotation not only to the outer bit 12, but also to the inner or pilot bit 13.

The bottom drill collar 11 is clearly shown in Figures 6 and 7 and this collar is provided with a bore 14, which extends substantially throughout the length thereof. The upper end of the bore is threaded at 15 so that the collar may be readily screwed onto the lower end of the drill pipe 10. Near its lower end the drill collar is provided with an internal, annular offset or

shoulder 16. The construction of the underside of said collar is important and this bottom or underside is provided with a pair of diametrically opposite notches 17. The trailing side of each notch is comparatively deep so as to form a flat contact face 18 as is clearly shown in Figure 6. The forward or leading side of the notch 17' is reduced and the bottom edge of the drill collar is gradually inclined from this reduced leading side 17' of one notch to the enlarged trailing side 18 of the opposite notch. Thus, it will be seen that the bottom of the drill collar is formed with two inclines which connect or extend between the diametrically opposite notches 17. To strengthen the construction, the drill collar may be enlarged as shown at 19, these enlargements being adjacent the notches 17. Vertical slots 20 are formed internally of the lower end of the drill collar and lead from the interior of the drill collar above the shoulder 16 to a point forwardly of the reduced leading face 17' of each notch 17. It will be seen that when water or other drilling fluid, is introduced into the drill pipe 10 and flows downwardly within the drill collar 11, said water or drilling fluid may flow downwardly through the vertical slots 20 whereby the water will escape at the forward edges or faces of the notches 17.

As above stated, the drill collar 11 supports the outer or enlarged drill bit 12 and serves to impart a rotation to this bit. The construction of this bit is clearly shown in Figures 3, 4 and 5. The bit comprises a tubular body 21 which is provided with an annular external shoulder 22 located slightly below the central portion thereof. A pair of T-shaped slots 23 are cut in the intermediate portion of the body 21 above said shoulder and are located diametrically opposite each other. The horizontal leg 24 of each T-slot is disposed slightly above the annular shoulder 22. A pair of cutting blades 25 are provided with outwardly extending arms 26 at their upper ends and each blade is arranged to be supported within the slots 23. As is clearly shown in Figure 4, the extending arms 26 on the upper end of each blade are positioned within the horizontal portion 24 of the T-slots. The body or vertical portion of the blade depends downwardly through the vertical portion of the T-slot and the length of the blade body is such that the extreme lower end of the blade extends beyond the lower end of the bit body 21. The extended arms 26 of each blade are held within the T-slots 23 by a suitable retaining member 27, which may be fastened to the body 21 by machine screws 28. It would be possible to weld this retaining member in place.

The lower end of each blade is provided with an outwardly extended cutting member 29 (Figure 3). The particular shape of this cutting member is, of course, subject to variation and by observing Figure 5, it will be seen that the cutting members 29 of the blades extend outwardly in a radial direction from the bit body 21. When the bit 12 is in position within the drill collar 11, the cutting members 29 of each blade are arranged to engage in diametrically opposite notches 17 formed in the bottom of said collar. The top or upper edge of each cutting member 29 is inclined as shown at 30 and each notch 17 is provided with a complementary incline 31. When the cutting blades are located within the notches, the outer and lower edges of said cutting members extend beyond the drill collar 11. Therefore, when the collar is rotated in a clockwise direction (Figure 5), it will be obvious that the trailing contact face 18 of each notch engages the side of the cutting members 29 whereby a rotation is imparted to said members. Since the cutting members extend beyond the drill collar, it will be seen that a rotation thereof will cause said members to drill the hole.

It is noted that the mounting of the blades 25 within the body 21 is such that said blades are pivotally mounted in the body at their upper ends. Since the T-slots 23 extend entirely through the side wall of the body 21, it is obvious that the blades may be swung to a retracted position whereby the outer surface of the cutting members 29 will swing inwardly so as to lie flush with the outer periphery of the body 21. With such arrangement, it is obvious that the blades may be swung inwardly and the body 21 lowered within the drill pipe 10 and drill collar 11. The body may be dropped or lowered by a cable and when lowered, it will continue a downward movement until the shoulder 22 on said body strikes the internal annular shoulder 16 formed within the lower end of the drill collar, as shown in Figure 2. When the shoulder 22 is resting upon the shoulder 16 in this manner, it will be manifest that the cutting members 29 of the blades 25 are spaced from the bottom of the drill collar and this is the initial position of the drill bit prior to the commencement of the drilling.

It is obvious that since the blades 25 are pivoted at their upper ends to the body 21 that some means must be provided for expanding or swinging the lower ends of the blades outwardly into their cutting position. For this purpose, the inner bit 13 is provided. The inner bit may be of any suitable construction and is provided with an upwardly extending nipple 31' at its upper end, whereby the bit may be threaded on the lower end of a tubular mandrel 32. The outer diameter of the mandrel 32 is substantially equal to the inner diameter of the bore of the tubular bit body 21. Therefore, when the bit 13 and mandrel 32 are lowered through the bit body, it will be obvious that they will serve to expand the cutting blades 25 outwardly at their lower ends. So long as the mandrel 32 remains within the bit body, it will be obvious that the cutting members 25 will be held in their expanded or cutting position.

For supporting the mandrel 32 and the inner bit 13 within the bit body 21 and also for preventing said mandrel from falling through said body, the mandrel is provided with an external annular collar 33 which is preferably made integral therewith. The lower edge of this collar is arranged to seat on an internal annular shoulder 34 which is formed near the upper end of the body 21 (Figure 3). Thus, when the mandrel and inner bit are lowered within the outer bit 12, such lowering will continue until the lower edge of the collar 33 strikes the shoulder 34 of the body 21, at which time further downward movement of the mandrel and its bit 13 is prevented. From the above, it will be seen that the outer bit 12 is first lowered within the drill collar 11 to the position shown in Figure 2, in which position the external shoulder 22 of the bit body 21 rests on the internal annular shoulder 16 of the drill collar. It is noted that the diameter of the bit body 21 is slightly smaller than the internal diameter of the drill collar whereby a small annular space 12' is provided between said body and the collar.

After the bit 12 has been lowered to this posi-

tion (Figure 2), the blades 25 which are pivoted to the body are still in their retracted position since they are hanging or suspended from their pivot point in the horizontal portion 24 of the T-slots 23. The mandrel 32 and inner bit 13 are then lowered through the drill pipe 10 and enter the tubular body 21 of the bit 12. As this occurs, the mandrel and the bit 13 serve to expand the lower end of the blades 25 and these blades are held in this expanded position so long as said mandrel is located within the body 21. It is pointed out that the downward movement of the mandrel and inner bit is limited by the collar 33 on said mandrel striking the internal shoulder 34 at the upper end of the bit body 21. In the drawings, the mandrel has been shown of such length that the bit 13 extends below the cutting members 29 of the outer bit 12. However, it is noted that the length of this mandrel is subject to variation as it would be possible to have the inner bit 13 at the same elevation as the cutting members 29 of the outer bit.

For imparting rotation from the rotating drill pipe 10 to the inner bit 13 which is carried by the tubular mandrel 32, a coupling collar 40 is connected in the drill pipe. This collar is clearly shown in Figures 2, 3 and 8 and is arranged to be connected with a coupling member A which is carried by the upper end of the mandrel 32. The bore 41 of the collar is preferably of the same diameter as the bore of the drill pipe 10 and a plurality of notches 43 are cut in said collar. As clearly shown in Figure 12, four notches are provided but it is to be clearly understood that any desired number may be provided. The top of the notches are bevelled as shown at 44 and the wall of the bore 41 of the collar immediately above said bevel 44 is inclined as shown at 45. An annular shoulder 46 is provided immediately above the notches 43 and as shown in Figure 8 this shoulder extends between said notches.

The coupling member A which is arranged to be connected with the coupling collar 40 is constructed in two sections B and C. The lower section B comprises a cylindrical, bored body 47 which has the lower end of its bore 49 internally threaded, whereby the body may be connected with the mandrel 32. The axial bore 49 extends vertically therethrough. The upper end of this bore is internally threaded at 50 so as to receive the lower threaded end of a tubular shank 51. The shank 51 extends upwardly through an axial bore 52 of the upper member C of said coupling. The upper end of the bore 52 of the member C is enlarged as shown at 53 and the shank is formed with an annular head 54 which is slidable vertically within the enlarged portion 53 of the bore. It is noted that the annular head 54 extends above the shank 51 as is clearly shown in Figure 3.

The upper end of the bore of the shank 51 is formed with an annular bevelled seat 55. With this arrangement, it will be seen that the lower member or section B of the coupling member A is rigidly fastened to the upper end of the mandrel 32. The upper section C of said coupling member is slidable on the tubular shank 51 which is rigidly connected to the lower section and, therefore, the upper section is movable a limited distance with relation to said lower section.

The lower end of the upper section C is provided with a plurality of vertical slots 56 which receive the upper end of elongate vertical dogs 57, which upper end is pivoted therein on a pin 58. The lower ends of the dogs depend from the upper section C and engage in vertical slots 59 which are formed in the lower section B of the coupling. The rear face of each slot 59 is curved upwardly and the extreme lower end of the slot is formed with a shoulder 60 (Figure 3). It is obvious that when the upper section is moved with relation to the lower section with the rear faces of the dogs 57 riding on the rear curved faces of the slots in the lower section B, said dogs will be expanded or retracted depending on which way the upper section C is moved. In other words, if the lower ends of the dogs engage the upper ends of the slots 59 in the lower section B, said dogs will be retracted so that their outer edges do not extend beyond the outer periphery of the lower section B. However, if the upper section C is lowered with relation to said lower section, the rear face of the dog 57 riding on the curved rear face of the slot 59 will be expanded.

The lower end of each dog is formed with an outwardly extending lug 57' and the upper edge of this lug is inclined so as to be complementary with the upper bevelled surface 44 of the notches 43 in the coupling collar 40. The outer side of each dog inclines from the upper bevelled surface of the lug 57' toward the upper portion of the dog and this inclined surface is complementary to the incline 45 formed above each notch 43 within the collar 40. With such arrangement, it is obvious that when the coupling member A is lowered within the drill pipe 10 and the dogs are expanded outwardly into the notches 43 of the coupling collar 40, a rotation of the drill pipe and collar 40 will impart a rotation to the coupling member A and mandrel 32 secured thereto. Therefore, it will be seen that the inner bit 13 carried by the lower end of the mandrel will be rotated through the engagement of the coupling member A with the coupling collar 40. Rotation to the outer bit 12, as has been explained, is imparted through the engagements of the cutting members 29 of the blades of said outer bit 12 with the notches 17 formed in the lower edge of the drill collar 11.

In the operation of the apparatus, the outer or large drill bit 12 is first lowered through the drill pipe and into the drill collar 11 at the lower end thereof. This drill bit may be dropped or lowered by any suitable means, as by a tool engaging an internal annular shoulder 21' which is provided at the upper end of the bit body 21 above the shoulder 34 for this purpose. Any suitable tool which may be suspended from a cable may be employed for engaging beneath this shoulder. Thus, it will be obvious that the bit 12 may be quickly and easily lowered through the drill pipe by a cable. When the bit body 21 enters the collar 11 it will be obvious that the external shoulder 22 on said body will engage the internal shoulder 16 provided at the lower end of said collar, whereby further downward movement of the body 21 is prevented. This position of the outer bit 12 is clearly shown in Figure 2 and at this time the blades 25 of the bit 12 are in their retracted position since they are hanging from their pivot point within the T-slot 23. The expansion of the blades during the lowering operation is prevented by the outer edges of the cutting members 25 of said blade engaging the inner periphery of the drill pipe and drill collar.

It is noted that when the shoulder 16 within the drill collar is supporting the bit body 21, the pivot point of the blades 25 is just above said

shoulder 16. This causes the lower end of the blades which have the cutter members 29 made integral therewith to be located at some distance below the bottom of the drill collar 11. With the bit 12 in this position, it is obvious that the cutting members 29 thereof, being below the bottom of the collar, are not engaging the notches 17 in the lower end of said collar and, therefore, if the drill pipe is rotated at this time no motion would be imparted to the drill bit 12.

After the bit 12 has been lowered within the collar, as above explained, the inner bit 13 which is carried by the mandrel 32 and which has the coupling member A secured to its upper end is lowered within the drill pipe. This lowering operation may be accomplished by dropping or by the same tool by which the bit 12 has been lowered since the coupling member A is provided with a shoulder 42 for receiving a suitable tool at its upper end. Therefore, a cable can be employed in lowering the inner bit 13. As the inner bit and the mandrel 32 enter the bore of the bit body 21, it is obvious that they will serve to expand the blades 25 of said outer bit 12. It is noted that this expansion takes place at a point below the bottom of the drill collar 11 because the outer bit 12 is supported on the annular shoulder 16 of said collar at this time. The mandrel and inner bit 13 continue their downward movement until the collar 33 on said mandrel engages the shoulder 34 within the bit body 21.

During the time that the mandrel 32 and bit 13 are moving downwardly through the body 21, the coupling member A has moved downwardly through the drill pipe because it is fastened to the upper end of the mandrel 32. It is pointed out that since the tool (not shown) by which the mandrel is lowered is secured to the upper section C of the coupling member A, this upper section C will be separated as far as possible from the lower section B. This is true because the weight of the mandrel and bit 13 which are secured to the lower section B of the coupling member will pull the shank 51 downwardly until the head 54 of said shank rests on the shoulder 52' formed between the bore 52 and enlarged portion of said bore 53 of the upper section C. Thus it will be seen that the lower section B which carries the mandrel 32 is suspended from the upper section C during the lowering operation. At this time the lugs 57' formed on the lower end of the dogs 57 which are carried by the upper section C are located at the upper end of the slots 59 in the lower section B, whereby said lugs are in their retracted position which permits them to clear the wall or interior of the drill pipe. Therefore, so long as the lowering operation of the inner bit and mandrel 32, together with the coupling A at the upper end thereof, continues the dogs 57 are in their retracted position.

The coupling member A is located with relation to the inner bit, and the coupling collar 40 is so mounted within the drill pipe 10, that when the collar 33 on the mandrel 32 strikes the shoulder 34 within the bit body 21, the coupling member A has moved to the position shown in Figure 2. That is, the dogs 57 which are provided with the lugs 57' have moved downwardly beyond the coupling collar 40. Therefore, when the inner bit 13 is first lowered into the drill pipe and within the outer bit 12 to expand the blades thereof, the lugs 57' of the pivoted dogs 57 have moved downwardly below the notches 43 which are formed in the coupling collar 40 (Figure 2). At this time a rotation of the drill pipe would not impart a rotation to the inner bit 13 because the lugs 57' are not in engagement with the notches, and similarly no motion would be imparted to the outer bit 12 because the cutting members 29 of the blades 25 of this outer bit are not in engagement with the notches 17 formed in the lower end of the drill collar 11.

It is noted that while both the inner and outer bits 12 and 13 are being lowered into the drill pipe 10 the bottom of said drill pipe is held off bottom of the hole. Therefore, after the two bits have been positioned as shown in Figure 2, they are in reality suspended from the drill collar 11 at the lower end of the pipe 10. To establish the connections between the drilling collar 11 and the outer bit 12 and the drill pipe 10 and the inner bit 13, it is only necessary to lower the drill pipe 10 from which said bits are suspended. As this lowering operation continues it will be obvious that eventually the drill bit 13 will strike the bottom of the hole. When this occurs, the continued lowering of the drill pipe 10 will cause the pipe and the coupling collar 40 carried thereby to move downwardly with relation to the mandrel 32 and coupling member A carried thereby. The outer drill bit 12 will move downwardly with the drill pipe until such time as this bit strikes the bottom formation and as soon as this occurs this bit will become stationary. However, as soon as the inner bit 13 is stopped the lowering of the drill pipe 10 will cause the coupling collar 40 to move downwardly toward the lugs 57' on the outer end of the dogs. The dogs are, of course, engaging the interior wall of the drill pipe just below the coupling collar because the weight of the upper section C of the coupling A is tending to force the dogs downwardly in the slots 59 so that the curved faces of said slots are tending to expand the lower end of the dogs at all times.

As soon as the drill pipe has been lowered a sufficient distance to permit the notches 43 in the collar 40 to move opposite the lugs 57' of the dogs 57, it will be obvious that said lugs will immediately engage in said slots. In the event that the lugs are not in vertical alinement with the notches 43 it is obvious that the shoulder 46 which is located between each of the notches 43 would strike the upper end of the lugs 57' and would halt any further downward movement of the drill pipe because said pipe would be suspended from the lugs engaging under said shoulder. When this occurred, it would only be necessary to rotate the drill pipe 10 slightly in either direction so that the notches 43 would be vertically alined with the lugs 57'. Thus, it will be seen that the provision of the shoulder 46 provides a positive means for finding the notches 43 with the lugs 57'. As soon as the lugs are expanded into the notches 43 it will be seen that the weight of the drill pipe is resting on the bevelled upper edge of the lugs 57'. The expanding of the dogs 57 is limited by the inclined face of each dog engaging the inclined surface 45 which is formed above each notch 43 within the collar 40.

As is clearly shown in Figure 3, when the dogs 57 are expanded, the inner bottom edge of said dog is resting on the shoulder 60 which is formed at the lower ends of the vertical slots 59 in the lower section B of the coupling member. In this way, the weight of the drill pipe 10 which is suspended on the bevelled upper edge of the lugs 57',

is transferred through the lugs to the shoulder 60. Therefore, the entire weight of the drill pipe is not carried by the pins 58 on which the lugs 57 are pivoted but is transmitted to the coupling member A which is carried by the upper end of the mandrel, and therefore, the entire weight of the drill pipe is carried on both the inner bit 13 and outer bit 12.

By the time the drill pipe 10 and drill collar 11 have moved downwardly a sufficient distance from the position shown in Figure 2 to permit the engagement of the lugs 57' in their respective notches 43, the drill collar has moved downwardly with relation to the outer bit 12 which has been held stationary because of its engagement with the formation. As the underside of the drill collar 11 moves downwardly, it will strike the upper inclined edge 30 of the cutting members 29 of the blades of the outer bit 12. If the notches 17 in the lower edge of said collar are vertically alined with the cutting members 29 it will be obvious that said cutting members will enter said notches as has been explained. However, in the event that the cutting members are not vertically alined with the notches 17, the upper edge of said members will strike the inclined bottom surface or edge of the collar 11. A rotation of the drill pipe 10 and collar 11 will immediately cause the blades to ride into their respective slots.

It will be seen from the above that when the drill pipe has moved downwardly so as to engage the cutting members 29 and the slots 17, and also to engage the dogs 57 of the coupling member A with their respective notches 43, that the parts are in drilling position. The rotation of the drill pipe 10 by means of the kelly (not shown) will cause a motion to be imparted through the coupling collar 40 and coupling member A to the mandrel 32 and inner bit 13. At the same time the collar 11 which is rotating with the drill pipe will impart a rotation to the cutting members 29 of the outer bit 12 because the flat contact faces 18 of the notches 17 will engage the blades and rotate the same. The outer bit will be held in its raised position with relation to the drill collar (Figure 3) so that its cutting members 29 are held within their notches 17 by the engagement of said cutting members with the formation.

Water, or other drilling fluid, is pumped downwardly through the drill pipe 10 and is supplied to the inner bit 13 by passing through the tubular shank 51 of the coupling member A and then downwardly through the tubular mandrel 32 and outwardly through the ports 13' provided for this purpose in the bit 13. In passing through the outer bit 12, the water passes downwardly around the coupling member A. This coupling member is cylindrical in shape but has its sides flattened as shown at 61 (Figures 9 and 10) whereby the annular space between this member and the interior of the drill pipe is increased. After flowing downwardly past the coupling member A the water flows around the tubular mandrel 32 and into the annular space 12' between the outer bit body 21 and the interior of the drill collar 11. From this space the water strikes the internal annular shoulder 16 of the drill collar and finally passes out through the vertical slots 20 which are provided in the lower end of said drill collar (Figures 6 and 7). It is noted that the slots 20 are positioned so that the water or other drilling fluid escapes at the forward or leading edge of the notches 17 whereby this water washes the leading or forward face of the cutting members 29.

The provision of the inner bit not only provides a positive means for holding the blades 25 of the outer bit in expanded or cutting position, but also provides a pilot or lead bit which engages the center of the hole. This pilot bit aids in drilling the hole to gauge because it serves as a guide for the outer bit 12 which does the main cutting. When it is desired to remove the bits for any purpose whatever, it is only necessary to lower a suitable tool (not shown) which will engage beneath the shoulder 42 in the upper end of the coupling member A. When this is done the drill pipe 10 is then raised a slight distance so as to relieve the lugs 57' on the expanded dogs 57 of the weight of the drill pipe. This causes the lugs to move downwardly within the slots 43 and an upward pull on the upper section C of the coupling member will immediately cause the dogs 57 to be retracted along the inner curved faces of the slots 59 in the lower section B of said member. It is noted that the upward raising of the drill pipe will cause the bottom of the slots 43 to strike the inclined underside of the lugs 57' and due to this inclined surface will tend to help move said dogs inwardly within their slots 59. Thus, it will be seen that the coupling member A, mandrel 32 and inner bit 13 may be readily removed from the drill pipe. After such removal of these parts, the tool may be again lowered and engage with the internal shoulder 21' at the upper end of the bit body 21.

It is noted that as soon as the inner bit 13 and mandrel 32 are removed the blades 25 of the outer bit 12 may move inwardly within their slots. Therefore, after the tool has been engaged with the shoulder at the upper end of the bit body 21 an upward pull thereon will readily remove the entire body 21 from within the collar 11. It is pointed out that the inclination of the upper edge of the cutting members 29, as well as the inclination of the underside of the collar 11, will aid in causing the retraction or inward movement of the blades after the mandrel 32 has been removed from the body. After the body 21 has been brought to the surface and it is found that the blades 25 need replacing, it is only necessary to remove the retaining plates 27 after which the blades 25 may be readily removed from the T-slots 23. Thus, a new blade may be readily substituted for the worn blade. The inner bit 13 may be just as easily removed from the mandrel 32 for replacement or other purposes.

From the above, it will be seen that a drilling apparatus is provided wherein the drill bit is readily removable from or insertable within the drill pipe. The bit may be dropped or quickly lowered within the pipe on a cable and may be just as quickly removed by the same means. During the lowering operation, the retracted cutting blades of the bit cannot move into their expanded position because they are held retracted by engagement with the inner wall of the drill pipe. After the outer bit has moved to its lower position the inner bit may be lowered by a cable into its proper position. It is pointed out that it would be possible to eliminate the inner bit and to merely lower the mandrel 32 within the outer bit 12 to hold the blades thereof expanded. In such case, the mandrel would, of course, terminate at a point above the bottom of the cutting members 29. It is obvious that with the above arrangement, it is never necessary to remove the drill pipe from the well in order to replace or change the bits. This results in an enormous saving of time and labor, as well as expense.

Also, after drilling is complete, the bits are removed and the drill pipe 10 serves as the well casing.

It is noted that, if desired, a core bit 13a, as shown in Figure 14, may be substituted for the bit 13 on the lower end of the mandrel 32. In such instance, as the drilling continues, a core will enter the bore 13b and be retained by spring fingers 13c provided for the purpose. To prevent downward circulation of the drilling fluid through the mandrel 32 and core bit 13a, a ball (not shown) may be dropped through the drill pipe 10 so as to engage the seat 55 within the head 54 of the shank 51, whereby the bore of the mandrel is closed.

Although it is desirable to rotate the outer bit 12 by means of the notches 17 provided in the underside or lower edge of the drill collar 11, and to rotate the inner or pilot bit 13 through the medium of the coupling collar 40 and the member A, it is not essential, for it would be possible to eliminate either one or the other of these drive mediums. In Figure 15, a modified form of the invention is shown, wherein the coupling member A and the coupling collar 40 are eliminated. In this form, the bit body 21 of the outer bit 12 is provided with a plurality of recesses 70 which are disposed vertically and which are located just below the internal shoulder 34 at the upper end of the housing. The collar 33 of the mandrel 32 has lugs 71 which are arranged to engage within the recesses 70, when the collar 33 is rested on the shoulder 34. With this arrangement, it will be manifest that the drill pipe 10 imparts a rotation to the outer bit 12 and due to the connection between the outer bit and the mandrel 32, the inner or pilot bit 13 is thereby rotated. Therefore, by connecting the outer bit housing with the mandrel carrying the inner bit, the coupling A and the coupling collar 40 may be eliminated. Similarly, it would be possible to eliminate the notches 17 in the lower edge of the drill collar 11 and to rotate the inner bit through the coupling A. In such case, the connection formed by the lugs 71 and the slots 70 would impart a rotation from the mandrel 32 of the inner bit to the housing of the outer bit, whereby both inner and outer bits are rotated simultaneously.

The foregoing description of the invention is 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 I claim and desire to secure by Letters Patent is:

1. A drilling apparatus including, a rotatable drill pipe having its lower end open, means for rotating said pipe, an outer bit body adapted to be lowered through the pipe to the bottom thereof and having its outer surface recessed to provide lateral supporting shoulders thereon, cutting blades having their upper ends supported on said shoulders and arranged to be swung outwardly, said blades normally being held in a retracted position by gravity, means at the bottom of the pipe for supporting the bit body within the pipe so that the cutting blades project from the lower end of the bit, a tubular mandrel adapted to be inserted within the outer bit for swinging the blades outwardly into cutting position, an inner pilot bit carried by the lower end of the mandrel and projecting below the outer bit, means on the lower end of the pipe engaging the blades for imparting rotation to the outer bit, and means on the upper end of the mandrel arranged to be connected with the drill pipe for imparting rotation to the inner bit.

2. A drilling apparatus including, a rotatable drill pipe having its lower end open, means for rotating said pipe, an outer bit body adapted to be lowered through the pipe to the bottom thereof and having supporting shoulders formed thereon, cutting blades, each blade being provided with a T-shaped shank, the lateral portion of which is supported on one of said shoulders whereby the blades are pivotally mounted on the body so as to be swung outwardly, said blades normally being held in a retracted position by gravity, means at the bottom of the pipe for supporting the bit body within the pipe so that the cutting blades project from the lower end of the bit, a tubular mandrel adapted to be inserted within the outer bit for swinging the blades outwardly into cutting position, an inner pilot bit caried by the lower end of the mandrel and projecting below the outer bit, means on the lower end of the pipe engaging the blades for imparting rotation to the outer bit, a coupling in the drill pipe having a plurality of notches therein, and a coupling member on the mandrel having retractible elements arranged to engage said notches, whereby the mandrel is coupled to the pipe and rotation is imparted by the inner bit.

3. A drilling apparatus including, a rotatable drill pipe having its lower end open, means for rotating said pipe, an outer bit body adapted to be lowered through the pipe to the bottom thereof and having recesses in its exterior surface to provide supporting shoulders thereon, cutting blades, each blade having a vertical shank provided with a laterally extending arm at its upper end, the arm of each shank being supported on one of the shoulders on the body, whereby the blades are pivotally mounted on the body and may be swung outwardly, said blades normally being held in a retracted position by gravity, means at the bottom of the pipe for supporting the bit body within the pipe so that the cutting blades project from the lower end of the bit, a tubular mandrel adapted to be inserted within the outer bit for swinging the blades outwardly into cutting position, an inner pilot bit carried by the lower end of the mandrel and projecting below the outer bit, means on the lower end of the pipe engaging the blades for imparting rotation to the outer bit, a coupling in the drill pipe having a plurality of notches therein, a coupling member on the mandrel having retractible elements arranged to engage said notches, whereby the mandrel is coupled to the pipe and rotation is imparted to the inner bit, and means for conducting a drilling fluid downwardly through the drill pipe and directing said fluid onto the cutting blades of both the inner and outer bits during the rotation thereof.

4. A drilling apparatus including, a rotatable drill pipe, means for rotating said pipe, an outer cutter bit having expansible blades adapted to be lowered through the pipe to the bottom thereof, means at the lower end of the pipe for supporting the bit at the bottom thereof, a mandrel adapted to be inserted within the outer bit for expanding the blades of said bit into cutting position, an inner pilot bit carried by the lower end of the mandrel and projecting below the outer bit, the lower end of the drill pipe having vertical shoulders thereon and having its lower edge inclined away from said shoulders, whereby when the

blades of said outer bit are expanded and moved into engagement with said lower edge, said blades are guided into contact with the shoulders so that rotation of the pipe will rotate the outer bit, and means for connecting the mandrel directly to the pipe whereby the inner bit is also rotated upon rotation of the pipe.

5. A drilling apparatus including, a rotatable drill pipe, means for rotating said pipe, an outer cutter bit having expansible blades adapted to be lowered through the pipe to the bottom thereof, means at the lower end of the pipe for supporting the bit at the bottom thereof, a mandrel adapted to be inserted within the outer bit for expanding the blades of said bit into cutting position, an inner pilot bit carried by the lower end of the mandrel and projecting below the outer bit, the lower end of the drill pipe having vertical shoulders thereon and having its lower edge inclined away from said shoulders, whereby when the blades of said outer bit are expanded and moved into engagement with said lower edge, said blades are guided into contact with the shoulders so that rotation of the pipe will rotate the outer bit, means for connecting the mandrel directly to the pipe whereby the inner bit is also rotated upon rotation of the pipe, and means for conducting a drilling fluid downwardly through the drill pipe and directing said fluid onto the cutting blades of both the inner and outer bits during the rotation thereof.

6. A drilling apparatus including, a rotatable drill pipe, means for rotating said pipe, an outer cutter bit having expansible blades adapted to be lowered through the pipe to the bottom thereof, means at the lower end of the pipe for supporting the bit at the bottom thereof, a mandrel adapted to be inserted within the outer bit for expanding the blades of said bit into cutting position, an inner pilot bit carried by the lower end of the mandrel and projecting below the outer bit, the lower end of the drill pipe having vertical shoulders thereon and having its lower edge inclined away from said shoulders, whereby when the blades of said outer bit are expanded and moved into engagement with said lower edge, said blades are guided into contact with the shoulders so that rotation of the pipe will rotate the outer bit, a coupling in the drill pipe having a plurality of notches therein, and a coupling member on the mandrel having retractible elements arranged to engage said notches, whereby the mandrel is coupled to the pipe and rotation is imparted to the inner bit.

7. A drilling apparatus including, a rotatable drill pipe, an outer cutter bit adapted to be lowered through the pipe to the bottom thereof, said bit comprising a tubular body having expansible blades suspended from the exterior surface of said body, whereby the blades may swing radially outwardly from the body, means at the lower end of the drill pipe for supporting the bit and disposed so as to support the bit with the blades thereof projecting from the lower end of the pipe, a mandrel adapted to be separately lowered into the outer bit after the latter has been lowered and landed in the drill pipe and co-acting with the blades of the bit for expanding said blades radially outwardly while said blades are below the lower end of the drill pipe, an inner pilot bit carried by the lower end of the mandrel and lowered therewith so as to project below the outer bit blades, and connecting means adapted to effect a connection between the drill pipe and the outer and inner bits, said connection being in a disengaged position when the outer bit is landed in the drill pipe and the mandrel and inner bit is extending through said outer bit, said connecting means being moved to an engaged position to effect a connection between the drill pipe and the outer and inner bits upon a relative downward movement of the drill pipe with respect to said bits.

8. A drilling apparatus including, a rotatable drill pipe, an outer cutter bit adapted to be lowered through the pipe to the bottom thereof, said bit comprising a tubular body having expansible blades suspended from the exterior surface of said body, whereby the blades may swing radially outwardly from the body, means at the lower end of the drill pipe for supporting the bit and disposed so as to support the bit with the blades thereof projecting from the lower end of the pipe, a mandrel adapted to be separately lowered into the outer bit after the latter has been lowered and landed in the drill pipe and co-acting with the blades of the bit for expanding said blades radially outwardly while said blades are below the lower end of the pipe, an inner pilot bit carried by the lower end of the mandrel and lowered therewith so as to project below the outer bit blades, means on the lower end of the drill pipe for imparting rotation to the outer bit upon rotation of the pipe located to be engaged by the expanded blades when the drill pipe is lowered relative to the outer bit to move the support away from said bit, and means for connecting the upper end of the mandrel with the drill pipe, said connection being effected upon downward movement of the drill pipe with relation to the mandrel pipe after the said mandrel has been lowered to expand the blades of the outer bit.

9. A drilling apparatus including, a rotatable drill pipe, an outer drill bit adapted to be dropped or lowered through the pipe to the bottom thereof, said bit comprising a tubular body having slots therein and also having expansible blades mounted on the exterior of the body, said blades being freely movable within the slots radially of the body, an inwardly extending projection within the lower end of the pipe for limiting the downward movement of the outer bit, whereby the bit is supported in a predetermined position within the pipe, a mandrel independent of the outer bit and adapted to be lowered through the pipe and through the bit after said bit is in position within the pipe, said mandrel co-acting with the blades to expand the same radially outwardly into a cutting position, an inner pilot bit carried by the mandrel and projecting below the outer bit blades, and connecting means adapted to effect a connection between the drill pipe and the outer and inner bits, said connection being in a disengaged position when the outer bit is landed in the drill pipe and the mandrel and inner bit is extending through said outer bit, said connecting means being moved to an engaged position to effect a connection between the drill pipe and the outer and inner bits upon a relative downward movement of the drill pipe with respect to said bits.

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