June 14, 1938. J. F. CHAPPELL 2,120,240

DRILLING APPARATUS

Filed May 25, 1936 3 Sheets-Sheet 1

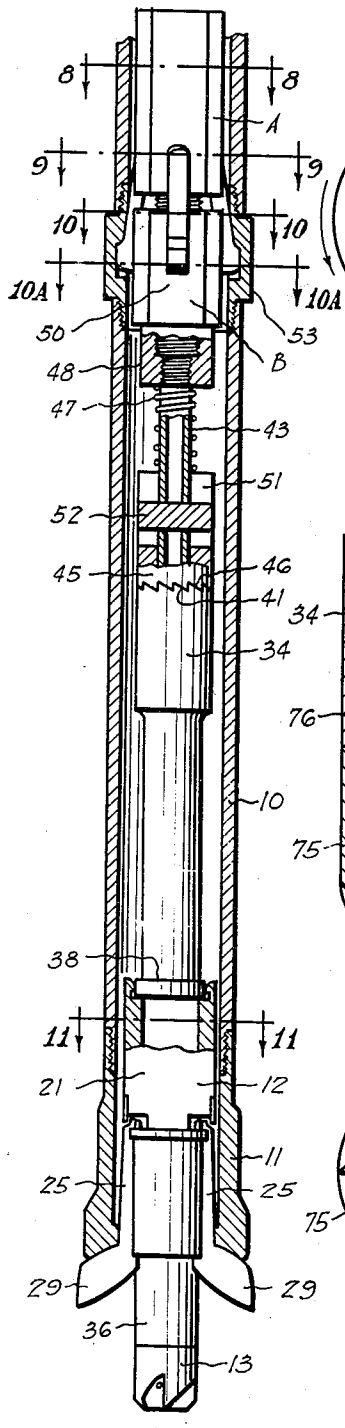


Fig. 1.

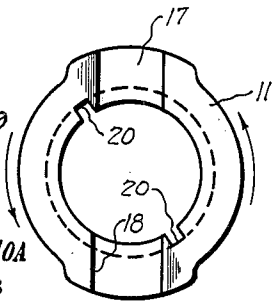


Fig. 5.

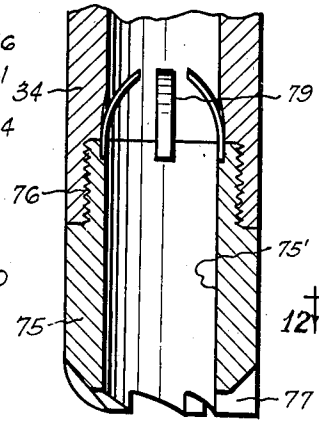


Fig. 15.

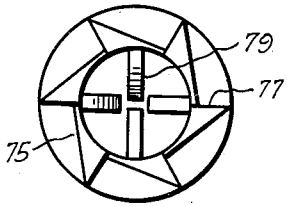


Fig. 16.

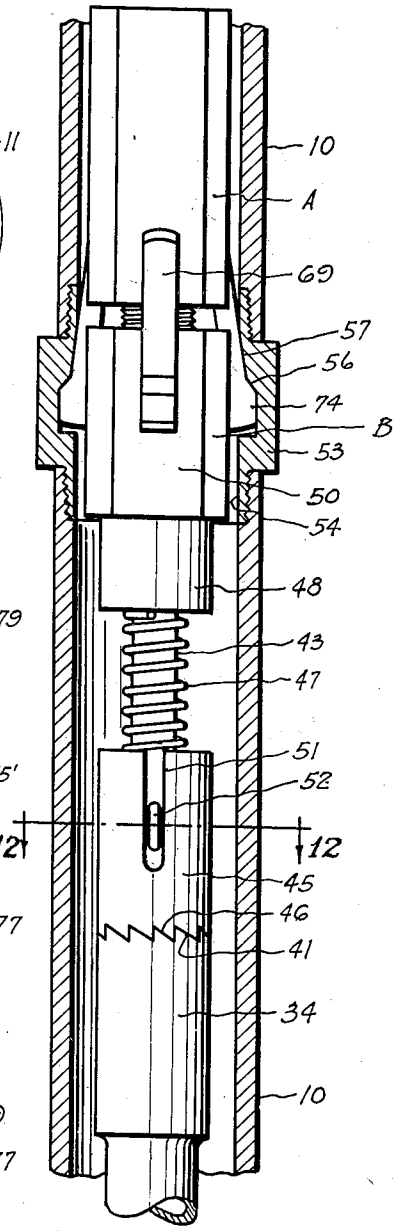


Fig. 2.

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DRILLING APPARATUS

Filed May 25, 1936 3 Sheets-Sheet 2

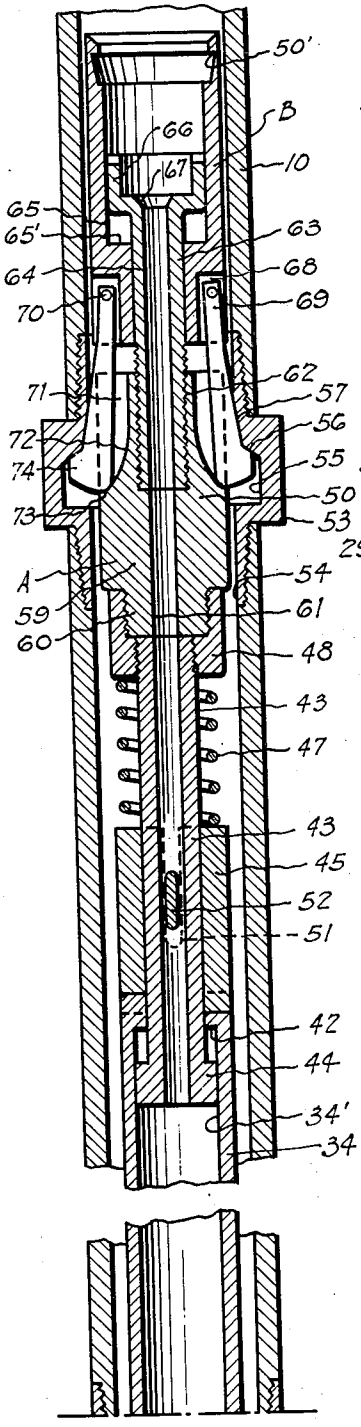


Fig. 4.

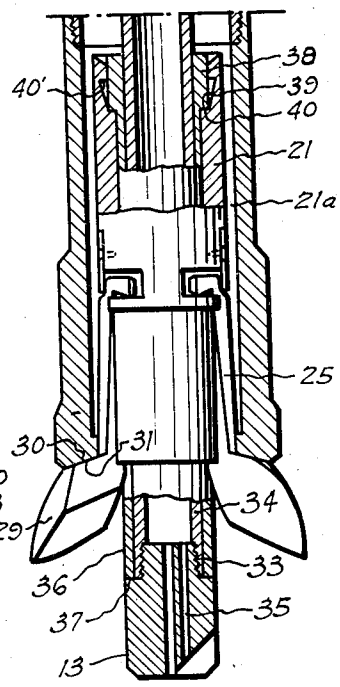


Fig. 3.

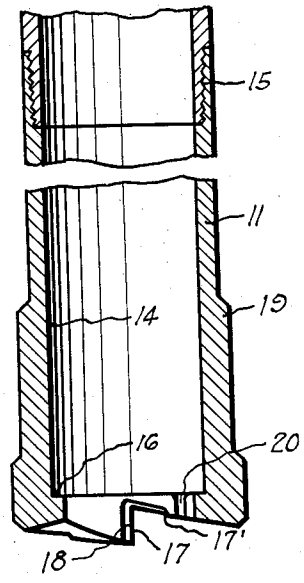


Fig. 7.

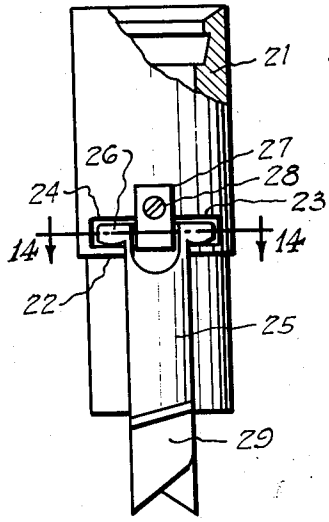


Fig. 13.

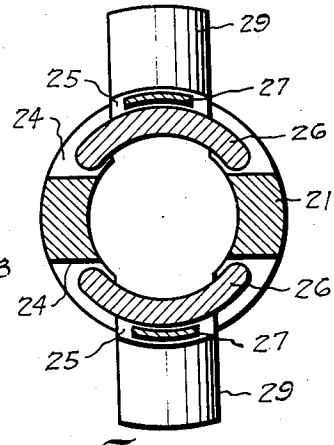


Fig. 14.

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DRILLING APPARATUS

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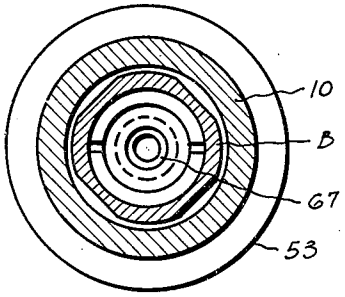


Fig. 8.

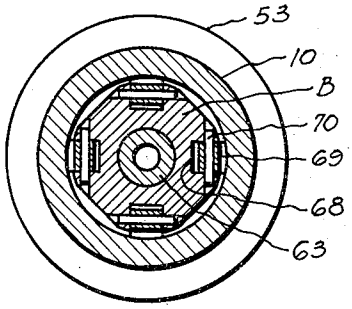


Fig. 9.

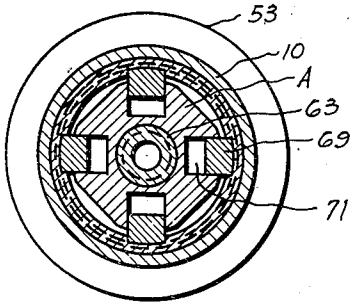


Fig. 10.

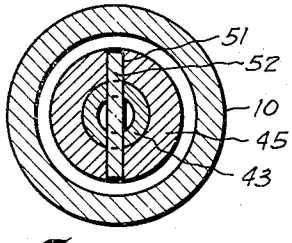


Fig. 12.

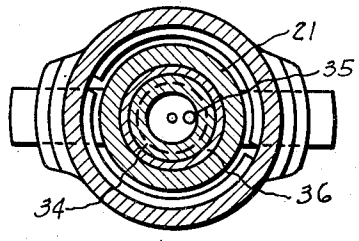


Fig. 11.

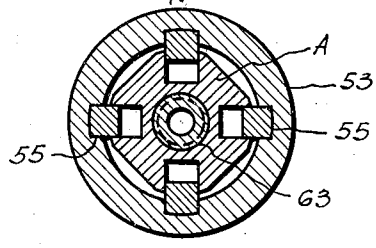


Fig. 10A.

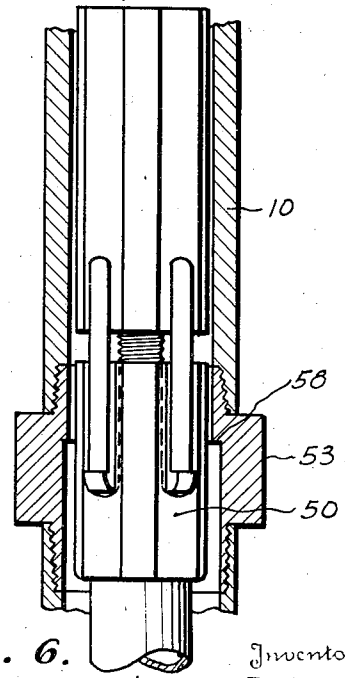


Fig. 6.

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Patented June 14, 1938

2,120,240

UNITED STATES PATENT OFFICE

2,120,240

DRILLING APPARATUS

James F. Chappell, Mineola, Tex.

Application May 25, 1936, Serial No. 81,647

13 Claims. (Cl. 255—74)

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

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

Another object of the invention is to provide an improved drilling apparatus wherein the drill pipe 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, whereby the time, labor and expense incidental to the removal of the drill pipe is obviated and the drilling facilitated.

Another object of the invention is to provide drilling apparatus including a rotatable drill pipe which forms the well casing, and a drill bit having retractible cutting blades, whereby said bit may be dropped or lowered on a cable or wire line and anchored at the bottom of the pipe, with means for expanding the blades into cutting position after said bit has reached the bottom of the pipe; the retractibility of the blades of said bit permitting the bit to be readily inserted in, or removed from, the hole without removing the drill pipe.

A further object of the invention is to provide an improved drill bit having retractible blades pivotally secured, whereby they may be swung outwardly into cutting position, said blades coacting with the drill pipe to lock the bit to the pipe, whereby rotation of the pipe will rotate the bit; the cutter blades being readily removable from the bit body, whereby they may be replaced when worn, which eliminates the necessity of replacing the entire bit body.

A particular object of the invention is to provide an improved apparatus for coring wells, which is so constructed that a core may be taken without subjecting said core to the water pressure, the coring bit being readily removable from the well without removing the drill pipe.

Still another object of the invention is to provide an improved drilling apparatus wherein a main bit is employed at the lower end of the drill pipe, and a second smaller bit depending below the main bit, with improved means for imparting a hammering action to the smaller bit while rotating the main bit, whereby drilling in hard formations is more readily accomplished.

A still further object of the invention is to provide an improved drilling and coring apparatus, wherein all the drilling and coring bits may be lowered into, or removed from, the pipe on a wire line, or cable, and the drill pipe need never be withdrawn, said pipe serving as the well casing after the well is drilled.

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 bit blade in drilling position,

Figure 2 is an enlarged view showing the upper portion of the apparatus in elevation, with the drill pipe in section,

Figure 3 is a view partly in elevation and partly in section of the drill collar having both the inner bit and the outer bit in drilling position,

Figure 4 is a view similar to Figure 2 showing all of the parts in transverse section,

Figure 5 is a bottom view of the drill pipe with the drill bit removed,

Figure 6 is an elevation of the upper connecting collar with the drill pipe in section, said connecting collar being viewed at a right angle from the part as shown in Figure 2,

Figure 7 is a transverse, vertical, sectional view of the lower end of the drill pipe,

Figure 8 is a horizontal, cross-sectional view taken on the line 8—8 of Figure 1,

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 10*a* is a horizontal, cross-sectional view taken on the line 10*a*—10*a* 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 2,

Figure 13 is a view partly in elevation and partly in section of the lower drill collar which carries the cutting blade of the outer bit, said collar being viewed at a right angle from that shown in Figure 3,

Figure 14 is a horizontal, cross-sectional view taken on the line 14—14 of Figure 13,

Figure 15 is a transverse, vertical, sectional

view of a core drill which is adapted to be substituted for the inner pilot bit, and

Figure 16 is a bottom view of the same.

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 connected with the drill pipe. The connection between the inner bit and the drill pipe is such that a reciprocating or vertical movement is imparted thereto, as will be explained. 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 to the outer bit 12, and will also reciprocate the inner or pilot bit 13.

The bottom drill collar 11 is clearly shown in Figures 5 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 5. 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, 13, and 14. 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 lower portion of the body 21 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 13, 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-slots 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 14, 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 14), 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. 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. In order that the inner bit will perform its piloting function and particularly when the drilling is in a hard formation, it is desirable that the inner bit be non-rotatable. Also, it is desirable to impart a hammering or jarring motion to the inner bit by reciprocating the same vertically, while the outer bit 12 is rotated. The inner bit may be of any suitable construction and is provided with an upwardly extending nipple 33 at its upper end, whereby the bit may be threaded on the lower end of a tubu-

lar mandrel 34. The bit is, of course, formed with the usual vertical passages 35 whereby the drilling fluid flowing downwardly through the mandrel may flow through said passages to lubricate the cutting surface of the bit as well as to wash the cuttings upwardly in the well bore. A tubular sleeve 36 surrounds the lower end of the mandrel 34 and has its lower end resting on a shoulder 37 provided externally of the bit 13. The upper end of the sleeve is formed with an external integral collar 38 whereby an external annular shoulder 39 is formed at the upper end of the sleeve. The sleeve has an external diameter which is substantially equal to the internal diameter of the body 21 of the outer bit 12 and the lower edge of the collar 38 is adapted to rest on a shoulder 40 which is provided within the body 21 at the upper end thereof. When said collar engages the shoulder 40, it will be manifest that further downward movement of the sleeve 36 is prevented. The tubular mandrel 34 which has its lower end secured to the bit 13 extends upwardly from the sleeve 36 through the drill pipe 10 and has its upper end secured to an actuating means, as will be hereinafter explained. By supporting the inner bit in this manner, it will be obvious that the drill pipe 10 and outer bit 12 may be rotated without imparting rotation to the inner bit 13, since rotation of the outer bit will merely rotate the sleeve 36. The mandrel 34 which has the bit 13 attached to its lower end may undergo a vertical movement with relation to the rotating outer bit, whereby a hammering action may be imparted to the inner bit 13 while the outer bit is rotating.

From the above, it will be seen that the outer bit 12 is first lowered within the drill collar 11 to a position where the external shoulder 22 on 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 an annular space 21*a* is provided between said body and the collar. After the bit has been lowered to this position, 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 34, sleeve 36 and the 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 bit and sleeve serve to expand the lower end of the blades 25 and these blades are held in this expanded position so long as the inner bit remains in position within the body with the sleeve 36 extending therethrough. The downward movement of the sleeve is limited by the collar 38 on said sleeve striking the internal shoulder 40 at the upper end of the bit body 21. The mandrel 34 is of such length that the inner bit 13 extends below the cutting members 25 of the outer bit 12, whereby said inner bit engages the formation first and acts as a pilot or guide bit to maintain the drilling of the hole in a straight line.

As before stated, it is desirable to impart a reciprocating or vertical motion to the inner bit 13 while the outer bit 12 is rotating. To accomplish this vertical movement of the inner bit, the mandrel 34 which carries said inner bit extends upwardly above the lower drill collar 11 within the drill pipe 10 and is provided with a plurality of ratchet teeth 41 at its upper end. The bore 34' of the mandrel is reduced at its extreme upper end whereby an annular internal shoulder 42 is formed within the upper end of said mandrel (Figure 4). A tubular shank 43 extends downwardly through the reduced portion of the bore of the mandrel and is provided with an enlarged head 44 at its lower end. The head has a sliding fit within the bore 34' of the mandrel 34 and it will be obvious that upward movement of the shank with relation to the mandrel is limited by the head 44 striking the internal shoulder 42 of said mandrel.

A sleeve 45 surrounds the tubular shank 43 above the upper end of the mandrel 34 and this sleeve is slidable vertically on said shank. The sleeve is provided with ratchet teeth 46 at its lower end, which teeth are complementary to the ratchet teeth 41 at the upper end of the mandrel 34, whereby the teeth of the sleeve are arranged to engage the teeth of said mandrel. The teeth 46 are held in engagement with the teeth 41 by a coiled spring 47 which surrounds the shank 43 and has its lower end engaging the upper end of the sleeve 45. The upper end of the spring 47 engages the underside of a collar 48 which is threaded on the upper end of the shank 43. The collar 48 is also screwed onto the lower end of a coupling member 50 which member connects the shank 43 with the drill pipe 10, as will be hereinafter explained. It will be obvious that the coiled spring 47 constantly exerts its pressure to hold the sleeve 45 downwardly on the shank 43 whereby its teeth 46 are held in constant engagement with the teeth of the mandrel 34.

For imparting motion from the shank 43 to the sleeve 45 and also for limiting the movement of said sleeve with relation to the shank, said sleeve is formed with a pair of diametrically opposite slots 51 (Figure 12), which are formed in the upper end thereof. A transverse pin or bar 52 is secured in the shank 43 and has its outer ends engaging in the slots 51 of the sleeve 45. It is obvious that this bar not only limits the movement of the shank with relation to the sleeve, but also acts to impart a rotation to the sleeve when said shank is rotated.

From the above, it will be seen that the shank 43 is connected to the drill pipe 10 by means of the coupling member 50 and therefore when the drill pipe is rotated to rotate the outer bit 12, as has been explained, the shank 43 is also rotated. This rotation of the shank is imparted to the sleeve 45 by means of the transverse pin 52 and slots 51. The mandrel 34, which is attached to the inner or pilot bit 13, is of course extending through the outer bit and is stationary with relation to the rotating outer bit. Therefore, as the sleeve 45 rotates with relation to the stationary mandrel 34, the ratchet teeth 46 on said sleeve will be rotated with relation to the ratchet teeth 41 formed at the upper end of the mandrel. As the teeth 46 ride into and out of engagement with the teeth 41 upon rotation of the sleeve, it will be obvious that a cam action is had, whereby a hammering action is imparted to the mandrel 34 and inner bit 13. This hammering or jarring action against the inner bit 13 forces said inner bit into the formation whereby regardless of how hard said formation is, the inner bit will efficiently guide or pilot the outer bit during the drilling operation. The stroke imparted to the inner bit may be increased or decreased by varying the tension of the spring 47 which is acting against the sleeve 45 for, obviously as this tension is increased a greater jar or force is imparted against the upper end of the mandrel.

While the drilling operation is being performed, the drilling fluid is, of course, circulated downwardly through the drill pipe 10 and flows around the outer bit 12 through the clearance space 21a which is formed between the body 21 and the drill collar 11 (Figure 3). This drilling fluid will then escape to the cutting members 29 of the outer bit through the vertical passages 20, which are formed in said drill collar, as is clearly shown in Figure 5. At the same time, the drilling fluid will pass downwardly through the tubular shank 43 and mandrel 34, from where it will flow through the passages 35 provided in the inner bit 13. The drilling fluid will thus serve to wash the cutting members 29 and will also keep the bit 13 clean, as well as washing the cuttings which are removed from the formation upwardly in the well bore.

Any suitable means may be provided for connecting the shank 43 with the drill pipe 10, but it is preferable to employ the coupling member 50 which is clearly shown in Figures 2 and 4. The coupling member is adapted to be connected to a coupling collar 53, which is connected in the drill pipe 10. The bore 54 of the collar is preferably of the same diameter as the bore of the drill pipe and a plurality of notches 55 are cut in said collar. As is clearly shown in Figure 10a, four notches are provided but it is to be clearly understood that any desired number may be employed. The tops of the notches are beveled as shown at 56 and the wall of the bore 54 of the collar immediately above the bevel 56 is inclined as shown at 57 (Figure 4). An annular shoulder 58 is provided immediately above the notches 55 and, as shown in Figure 6, this shoulder extends between said notches.

The coupling member 50 which is arranged to be connected with the coupling collar 53 is constructed of a lower section A and an upper section B. The lower section A comprises a cylindrical body 59 which has a depending externally threaded nipple 60 at its lower end and this nipple receives the collar 48 which is secured to the upper end of the tubular shank 43. The body 59 is provided with an axial bore 61, which extends vertically therethrough and the upper end of this bore is enlarged and internally threaded at 62 so as to receive the lower threaded end of a tubular shank 63. The shank 63 extends upwardly through an axial bore 64 provided in the upper section or member B of said coupling. The upper end of the bore 64 of the section B is enlarged as shown at 65 and the shank 63 is formed with an annular head 66 which is slidable vertically within the enlarged portion 65 of said bore. It is noted that the annular head 66 extends upwardly from the shank 63 as is clearly shown in Figure 4.

The upper end of the bore of the shank 63 is formed with an annular beveled seat 67. With the arrangement above described, it will be seen that the lower member or section A of the coupling member 50 is rigidly fastened to the upper end of the tubular shank 43. The upper member or section B of said coupling member is slidable on the tubular shank 63 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 B is provided with a plurality of vertical slots 68 which receive the upper ends of elongate vertical dogs 69, said upper ends being pivoted therein on pins 70. The lower ends of the dogs depend from the upper section B and engage in vertical slots 71, which are formed in the lower section A of the coupling 50. The rear face 72 of each slot is curved upwardly and the extreme lower end of the slot is formed with a shoulder 73. It is obvious that when the upper section B is moved with relation to the lower section A with the rear faces of the dogs 69 riding on the rear curved faces 72 of the slots in the lower section, said dogs will be expanded or retracted depending upon which way the upper section B is moved. In other words, if the lower ends of the dogs engage the upper ends of the slots 71 in the lower section A, said dogs will be retracted so that their outer edges do not extend beyond the outer periphery of the lower section. However, if the upper section B is lowered with relation to the lower section A, the rear face of the dog 69 riding on the curved rear face 72 of the slot 71, will be expanded.

The lower end of each dog is formed with an outwardly extending lug 74 and the upper edge of this lug is inclined so as to be complementary with the upper beveled surface 56 of the notches 55 in the coupling collar 53. The outer side of each dog inclines from the upper beveled surface of the lug 74 toward the upper portion of the dog and this inclined surface is complementary to the incline 57 formed above each notch 55 within the collar 53. With such arrangement, it is obvious that when the coupling member 50 is lowered within the drill pipe 10 and the dogs are expanded outwardly into the notches 55 of the coupling collar, a rotation of the drill pipe and collar will impart a rotation to the coupling member 50 and the shank 43 secured to its lower end. Therefore, it will be seen that the inner bit 13 carried by the lower end of the mandrel will be given a vertical reciprocating movement when the shank 43 is rotated through the medium of the ratchet teeth 41 and 46. Rotation of the outer bit 12, as has been explained, is imparted through the engagement of the cutting members 29 of the blades 25 of said outer bit with the notches 17 formed in the lower edge or bottom 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 bit may be dropped or lowered by any suitable means, as by a tool engaging an internal annular shoulder 40' which is provided at the upper end of the bit body 21 above the shoulder 40 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, 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. 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-slots 23. The expansion of the blades during the lowering operation is prevented by the outer edges of the cutting members 29 of said blades engaging the inner periphery of the drill pipe 10 and the drill collar 11.

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 ends of the blades, which have their cutting members 29 made integral therewith, to be located at some distance

below the bottom of the drill collar 11. With the bit in such position, the cutting members 29 thereof are below the bottom of the collar and are not engaging the notches 17 in the lower end or bottom of said collar and, therefore, if the drill pipe 10 is rotated at this time no motion is imparted to the 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 34 and which has the coupling member 50 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 50 is provided with a shoulder 50' at its upper end, which shoulder is similar to the shoulder 40' within the bit body 21, whereby the same tool may be employed for lowering both bits. Thus, a cable can be employed for lowering the inner bit 13. As the inner bit and its mandrel 34 and sleeve 38 enter the bore of the bit body 21, they act to expand the blades 25 of the outer bit 12. It is noted that this expansion takes place at a point below the bottom of the drill collar 11 because the inner bit is supported on the annular shoulder 16 of said collar at this time. The mandrel and inner bit continue their downward movement until the collar 38 on the sleeve 36 engages the shoulder 40 within the bit body 21.

During the time that the mandrel 34 and bit 13 are moving downwardly through the body 21, the coupling member 50 has moved downwardly through the drill pipe 10 because it is fastened to the upper end of the tubular shank 43 which is connected to the mandrel 34. It is pointed out that since the tool (not shown) by which the mandrel is lowered, is secured to the upper section B of the coupling member 50, this upper section will be separated as far as possible from the lower section A. This is true because the weight of the mandrel and bit 13, which are secured to the lower section A of the coupling member, will pull the shank 63 downwardly until the head 66 of said shank rests on the shoulder 65' formed between the bore 64 and the enlarged portion of said bore 65 of the upper section B. Thus it will be seen that the lower section A which carries the mandrel 34 is suspended from the upper section B during the lowering operation. At this time the lugs 74, formed on the lower ends of the dogs 69 which are carried by the upper section B, are located at the upper end of the slots 71 in the lower section A, whereby said lugs are in their retracted position which permits them to clear the wall or the interior of the drill pipe 10. Therefore, so long as the lowering operation of the inner bit 13 and mandrel 34, together with the coupling 50 at the upper end thereof, continues the dogs 69 are in their retracted position.

The coupling member 50 is so located with relation to the inner bit 13 and the coupling collar 53 is so mounted within the drill pipe 10, that when the collar 38 on the sleeve 36 strikes the shoulder 40 within the bit body 21, the coupling member has moved downwardly beyond the coupling collar 53. 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 74 of the pivoted dogs 69 have moved downwardly below the notches 55 which are formed in the coupling collar 53. At this time a rotation of the drill pipe would not impart a rotation to the coupling member 50 and the shank 43 because the lugs 74 are not in engagement with the notches 55, 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.

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 the bottom of the hole. After the two bits have been positioned, they are in reality suspended from the drill collar 11 at the lower end of the pipe 10. To establish the connection between the drill 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 from which said bits are suspended. As this lowering operation continues, the drill bit 13 will eventually strike the bottom of the hole and when this occurs, continued lowering of the drill pipe 10 will cause said pipe and the coupling collar 53 to move downwardly with relation to the sleeve 36 and the coupling member 50 carried by the mandrel. 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, the outer 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 53 to move downwardly toward the lugs 74 on the outer ends of the dogs 69. The dogs are, of course, engaging the inner wall of the drill pipe just below the coupling collar because the weight of the upper section B of the coupling 50 is tending to force the dogs downwardly in the slots 68 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 55 in the collar 53 to move opposite the lugs 74 of the dogs 69, 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 55, it will be obvious that the shoulder 58 which is located between each of the notches 55 would strike the upper ends of the lugs 74 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 occurs, it is only necessary to rotate the drill pipe 10 slightly in either direction so that the notches 55 are vertically alined with the lugs 74. Thus, it will be seen that the provision of the shoulder 58 provides a positive means for finding the notches 55 with the lugs 74. As soon as the lugs are expanded into the notches 55 the weight of the drill pipe is resting on the beveled upper edge of the lugs 74. The expansion of the dogs 69 is limited by the inclined face of each dog engaging the inclined surface 57 which is formed above each notch 55 within the collar 53.

As is clearly shown in Figure 4, when the dogs 69 are expanded, the inner bottom edge of said dogs is resting on the shoulders 73, which are formed at the lower ends of the vertical slots 71 in the lower section A of the coupling member. In this way, the weight of the drill pipe 10 which is suspended on the beveled upper edge of the lugs 74 is transferred through the lugs to the shoulders 73. Therefore, the entire weight of the drill pipe is not carried by the pins 70 on which the dogs 69 are pivoted, but is transmitted to the coupling member 50, which is carried by the upper end of the shank 43, whereby the entire weight of the drill pipe is carried on both the inner bit and the outer bit. By the time the drill

pipe 10 and drill collar 11 have moved downwardly a sufficient distance to permit the engagement of the lugs 74 in their respective notches 55, the drill collar 11 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 31 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, 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, 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.

After the parts have moved to these positions, it will be obvious that continued rotation of the drill pipe 10 will impart a rotation to the outer bit 12. At the same time, the shank 43 will be rotated by means of the coupling member 50 and rotation of said shank will impart a vertical hammering or reciprocating motion to the inner bit 13. The inner bit may thus move through very hard formation and will serve to pilot the outer bit 12 during the drilling operation.

When it is desired to remove the bit for any purpose whatever, it is only necessary to lower a suitable tool (not shown) which will engage beneath the shoulder 50' in the upper end of the coupling member 50. When this is done the drill pipe 10 is then raised a slight distance so as to relieve the lugs 74 on the expanded dogs 69 of the weight of the drill pipe. This causes the lugs to move downwardly within the slots 71 and an upward pull on the upper section B of the coupling member will immediately cause the dogs 69 to be retracted along the inner curved faces 72 of the slots 71 in the lower section A of said member. It is noted that the upward raising of the drill pipe will cause the bottom of the notches 55 to strike the inclined underside of the lugs 74 and due to this inclined surface will tend to help move said lugs inwardly within their slots 68 and 71. Thus it will be seen that the coupling member 50, shank 43, mandrel 34 and inner bit 13 may be readily removed from the drill pipe. After such removal of these parts, the tool may again be lowered and engage with the internal shoulder 40' at the upper end of the bit body 21, whereby said body may be withdrawn from its position at the lower end of the drill pipe within the drill collar 11.

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. It is never necessary to remove the drill pipe from the well in order to replace or change the bit and this results in an enormous saving of time and labor, as well as expense. After the well is drilled in the drill pipe 10 may take the place of the usual well casing and by utilizing the drill pipe as the casing expense, time and trouble are saved.

In some instances, it might be desirable to take a core of the formation while the drilling operation is being performed and to accomplish this purpose a core bit 75 may be substituted for the inner bit 13. As clearly shown in Figures 15 and 16, the bit 75 is provided with a threaded nipple 76 at its upper end which is arranged to be screwed into the lower end of the mandrel 34. The bit is provided with a bore 75' which has substantially the same diameter as the bore of the mandrel. Suitable cutting teeth 77 are provided at the lower end of the bit 75. When it is desired to take a core, it is only necessary to remove the coupling 50, mandrel 34 and bit 13 from within the drill pipe. These parts are, of course, connected together as has been described and are pulled to the surface of the well. At the surface, the inner bit 13 is removed from the mandrel 34 and the core bit 75 is substituted therefor. The parts are then returned to their original position within the drill pipe with the coupling 50 connected through the keys or dogs 69 with the collar 53. The bit 75, of course, extends below the cutting members 29 of the outer bit blades 25. After the parts are in this position a ball (not shown) is dropped downwardly through the drill pipe and enters the upper section B of the coupling 50 and finally comes to rest on the annular seat 67 provided at the upper end of the bore of the tubular shank 63. When the ball is so seated, it will be obvious that the water or other drilling fluid which is pumped downwardly through the drill pipe 10 cannot enter the bore of the shank 63 and, therefore, cannot pass through the mandrel 34 to the bit 75. The seating of the ball does not, however, prevent the drilling fluid or water from passing downwardly around the coupling 50 and into the bottom drill collar 11 from which it escapes through the slots 20 to the forward portion of the outer cutting blades 25 of the bit 12.

Rotation of the drill pipe will, of course, impart a reciprocating or hammering motion to the core bit 75, with a rotation to the outer bit 12. The ball prevents the fluid pressure from acting against the core which is being taken and, therefore, it will be obvious that the core will move upwardly into the mandrel 34 as the drilling continues. Suitable spring fingers 79 (Figure 15) may be located in the lower end of the mandrel 34 when a core is being taken, whereby after the core passes upwardly into the mandrel, said fingers will serve to hold the same therein. With this arrangement, the same apparatus shown in Figures 1 to 14 may be utilized for taking the core by merely substituting the core bit 75 for the inner bit 13. It is noted that it is not necessary to pull the outer bit 12 from the drill collar 11 in order to take the core. The only removal necessary is that of the inner bit 13, mandrel 34 and coupling 50, which must be lifted to the surface in order to permit the substitution of the core bit 75 for the inner bit 13.

What I claim and desire to secure by Letters Patent, is:

1. A drilling apparatus including, a rotatable drill pipe, means for rotating said pipe, an outer drill 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 of the pipe, a mandrel adapted to be inserted within the outer drill bit for expanding and holding in their expanded positions the blades of said bits, an inner pilot carried by the lower end of the mandrel and projecting below the outer bit, means for connecting the outer bit with the drill pipe whereby rotation of said drill pipe will rotate the outer bit, means for imparting a hammering motion to the inner bit, and means for connecting the last named means with the drill pipe, whereby rotation of

the drill pipe will impart a hammering action to the inner drill bit.

2. A drilling apparatus including, a rotatable drill pipe, means for rotating said pipe, an outer drill bit having expansible blades adapted to be lowered through the pipe to the bottom thereof, means within the lower end of the pipe for supporting the bit at the bottom of the pipe, a tubular mandrel adapted to be inserted within the outer drill bit for expanding the blades of said bit into cutting position, an inner tubular core bit carried by the lower end of the mandrel and projecting below the outer bit, means for connecting the outer bit with the drill pipe for imparting rotation to said bit when the pipe is rotated, means for imparting a reciprocating motion to the inner bit whereby the inner bit is driven into the formation, and means for connecting the last named means with the drill pipe whereby rotation of the drill pipe will operate said last named means to impart a hammering action to the inner bit whereby a core is forced upwardly through the core bit and into the mandrel.

3. A drilling apparatus including, a rotatable drill pipe, means for rotating said pipe, an outer drill bit having expansible blades adapted to be lowered through the pipe to the bottom thereof, means within the lower end of the pipe for supporting the bit at the bottom of the pipe, a tubular mandrel adapted to be inserted within the outer drill bit for expanding the blades of said bit into cutting position, an inner tubular core bit carried by the lower end of the mandrel and projecting below the outer bit, means for connecting the outer bit with the drill pipe for imparting rotation to said bit when the pipe is rotated, means for imparting a reciprocating motion to the inner bit whereby the inner bit is driven into the formation, means for connecting the last named means with the drill pipe whereby rotation of the drill pipe will operate said last named means to impart a hammering action to the inner bit whereby a core is forced upwardly through the core bit and into the mandrel, and means for conducting drilling fluid downwardly through the drill pipe and directing said fluid to the blades of the outer bit during the drilling operation.

4. A drilling apparatus including, a rotatable drill pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into cutting position when the bit reaches the bottom of the hole, an inner bit adapted to be lowered through the outer bit, and means for imparting a hammering motion to the inner bit when the outer bit is rotated.

5. A drilling apparatus including, a rotatable drill pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into cutting position when the bit reaches the bottom of the hole, an inner bit adapted to be lowered through the outer bit and projecting below the outer bit, means for imparting a hammering motion to the inner bit when the outer bit is rotated, means for rotating the drill pipe to rotate the outer bit, and means for connecting said drill pipe to the means for imparting the hammering to the inner bit, whereby the latter is operated when the outer bit is rotated.

6. A drilling apparatus including, a rotatable drill pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into cutting position when the bit reaches the bottom of the hole, an inner bit adapted to be lowered through the outer bit and projecting below the outer bit, said inner bit acting to hold the blades of the outer bit in an expanded position, and means for imparting a hammering motion to the inner bit when the outer bit is rotated.

7. A drilling apparatus including, a rotatable drill pipe, a drill collar having notches in its lower edge portion secured on the lower end of the pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into the notches of the drill collar to connect said bit with the drill pipe, whereby rotation of the pipe rotates the bit, an inner bit adapted to be lowered through the outer bit and projecting therebelow, rotatable means for imparting a hammering motion to the inner bit, and a coupling for connecting said rotatable means with the drill pipe whereby the inner bit is reciprocated while the outer bit is rotating.

8. A drilling apparatus including, a rotatable drill pipe, a drill collar having notches in its lower edge portion secured on the lower end of the pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into the notches of the drill collar to connect said bit with the drill pipe, whereby rotation of the pipe rotates the bit, an inner bit adapted to be lowered through the outer bit and projecting therebelow, rotatable means connected with the inner bit and adapted to be lowered therewith into the drill pipe for imparting a hammering motion to said inner bit, and a coupling on the upper end of said rotatable means adapted to be connected with the drill pipe, whereby rotation of said drill pipe rotates the outer bit and imparts a hammering motion to the inner bit, the coupling being removably connected with the drill pipe to permit the removal of the inner bit and its associated parts at any time.

9. A drilling apparatus including, a rotatable drill pipe, a drill collar having notches in its lower edge portion secured on the lower end of the pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into the notches of the drill collar to connect said bit with the drill pipe, whereby rotation of the pipe rotates the bit, an inner bit adapted to be lowered through the outer bit and projecting therebelow, rotatable means connected with the inner bit and adapted to be lowered therewith into the drill pipe for imparting a hammering motion to the inner bit, a second drill collar in the drill pipe, and a coupling carried by the rotatable means and having expansible dogs for engaging said second drill collar to connect the rotatable means with the drill pipe, whereby rotation of said pipe imparts a hammering motion to the inner bit while rotating the outer bit.

10. A drilling apparatus including, a rotatable drill pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into cutting position when the bit reaches the bottom of the hole, an inner bit adapted to be lowered through the outer bit and projecting therebelow, rotatable means connected with the inner bit and adapted to be lowered therewith into the drill pipe for imparting a hammering motion to said inner bit, and a coupling on the upper end of said rotatable means adapted to be connected with

the drill pipe, whereby rotation of said drill pipe rotates the outer bit and imparts a hammering motion to the inner bit, the coupling being removably connected with the drill pipe to permit the removal of the inner bit and its associate parts at any time.

11. A drilling apparatus including, a rotatable drill pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into cutting position when the bit reaches the bottom of the hole, an inner bit adapted to be lowered through the outer bit and projecting therebelow, rotatable means connected with the inner bit and adapted to be lowered therewith into the drill pipe for imparting a hammering motion to the inner bit, a second drill collar in the drill pipe, and a coupling carried by the rotatable means and having expansible dogs for engaging said second drill collar to connect the rotatable means with the drill pipe, whereby rotation of said pipe imparts a hammering motion to the inner bit while rotating the outer bit.

12. A drilling apparatus including, a rotatable drill pipe, a drill collar having notches in its lower edge portion secured on the lower end of the pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into the notches of the drill collar to connect said bit with the drill pipe, whereby rotation of the pipe rotates the bit, an inner bit adapted to be lowered through the outer bit and projecting therebelow, rotatable means for imparting a hammering motion to the inner bit, a coupling for connecting said rotatable means with the drill pipe whereby the inner bit is reciprocated while the outer bit is rotating, and means for conducting drilling fluid downwardly through the drill pipe and directing said fluid to the blades of the outer bit during the drilling operation.

13. A drilling apparatus including, a rotatable drill pipe, an outer drill bit adapted to be lowered through the pipe to the bottom thereof and having blades arranged to be expanded into cutting position when the bit reaches the bottom of the hole, an inner bit adapted to be lowered through the outer bit and projecting therebelow, rotatable means connected with the inner bit and adapted to be lowered therewith into the drill pipe for imparting a hammering motion to said inner bit, a coupling on the upper end of said rotatable means adapted to be connected with the drill pipe, whereby rotation of said drill pipe rotates the outer bit and imparts a hammering motion to the inner bit, the coupling being removably connected with the drill pipe to permit the removal of the inner bit and its associate parts at any time, and means for conducting drilling fluid downwardly through the drill pipe and directing said fluid to the blades of the outer bit during the drilling operation.

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