Jan. 26, 1937. L. E. POWELL 2,068,704

WELL DRILLING AND CORING APPARATUS

Filed July 25, 1932 3 Sheets-Sheet 1

FIG. 1

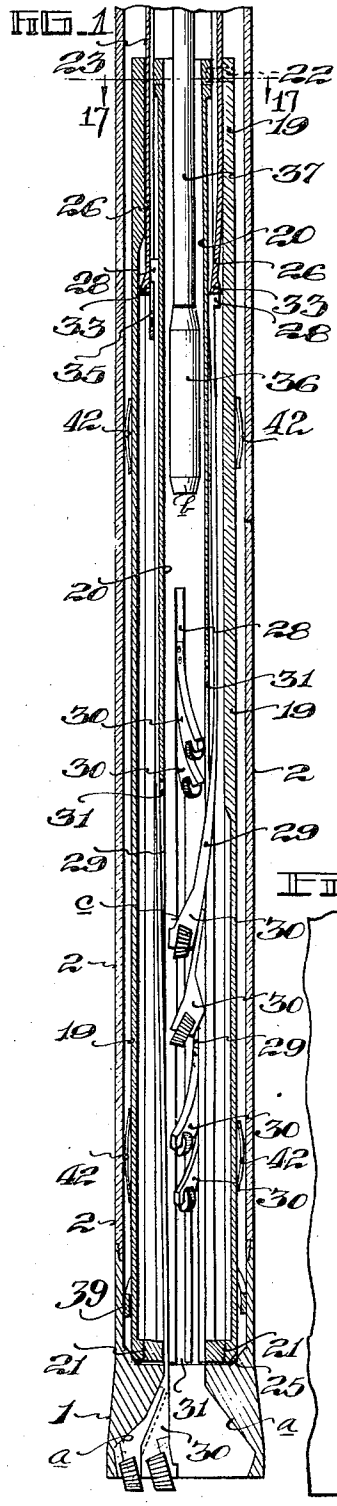


FIG. 2

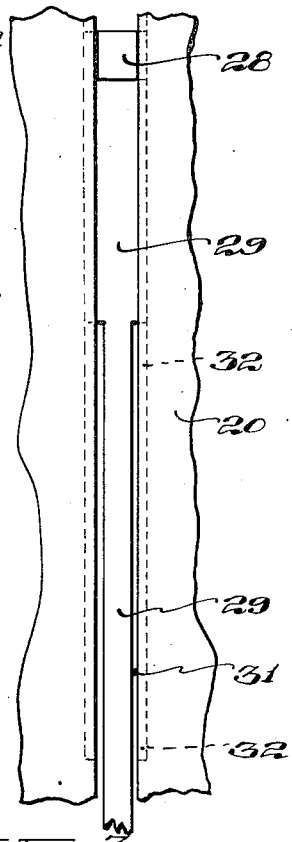


FIG. 4

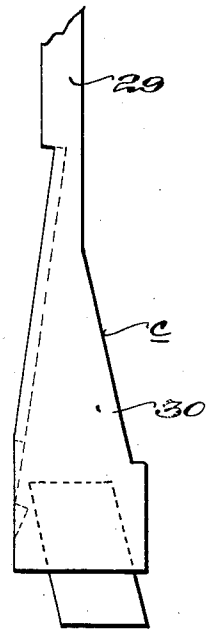


FIG. 3

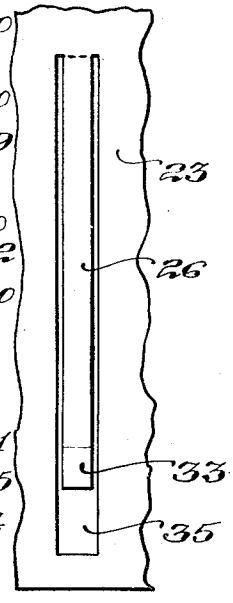
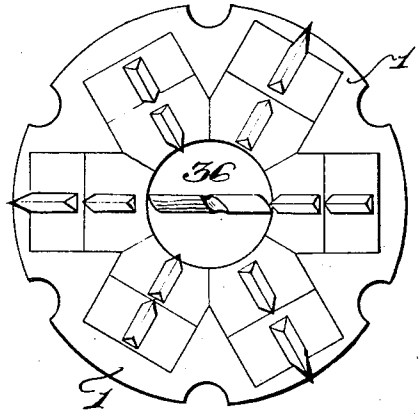


FIG. 5



Leonard E. Powell
INVENTOR

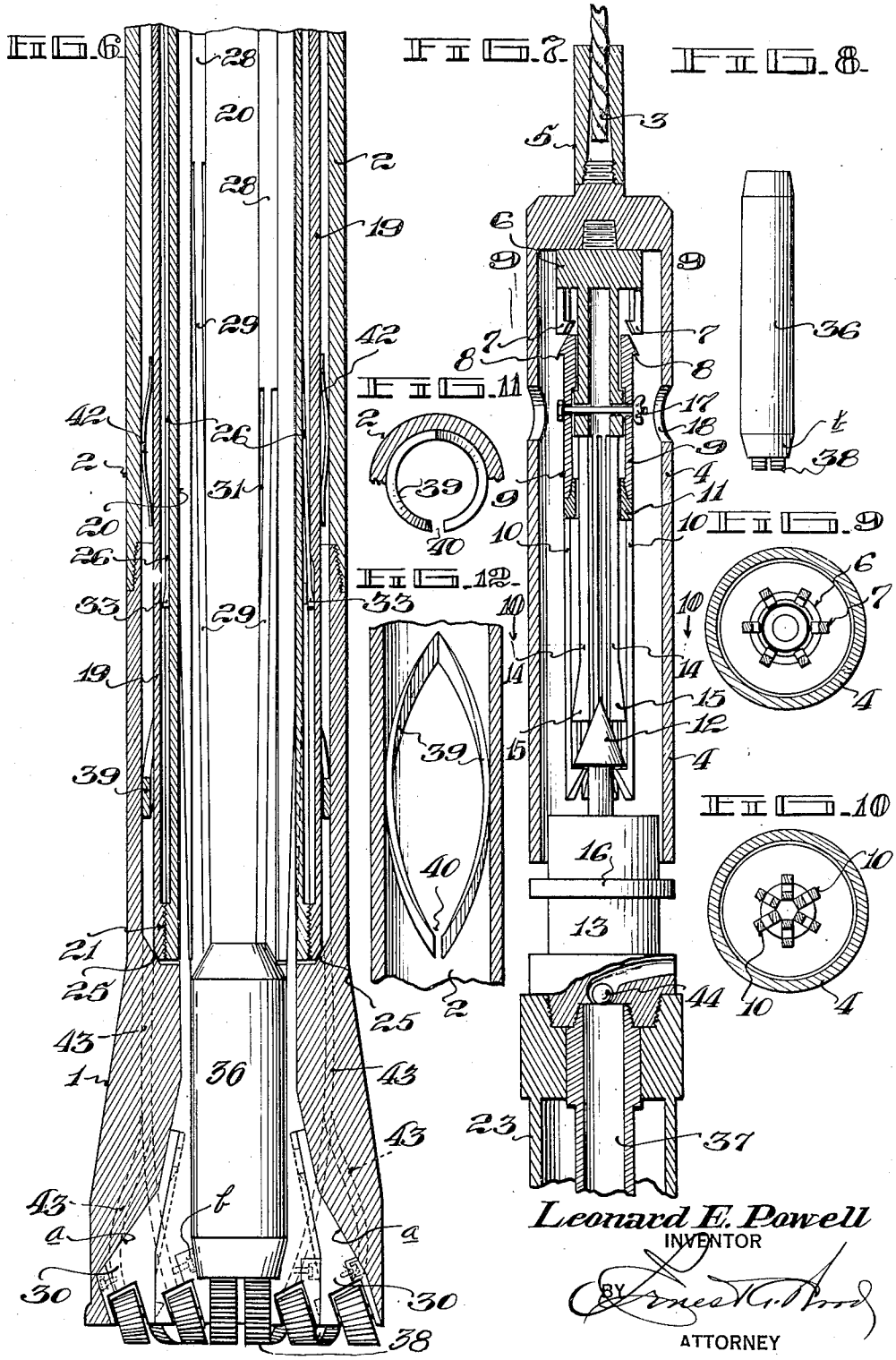
BY Ernest V. Ford

ATTORNEY

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FIG. 13

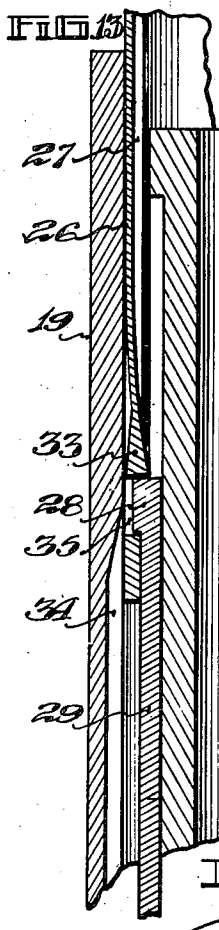


FIG. 14

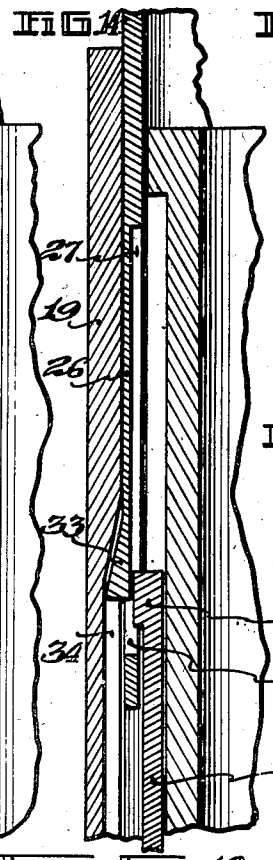


FIG. 15

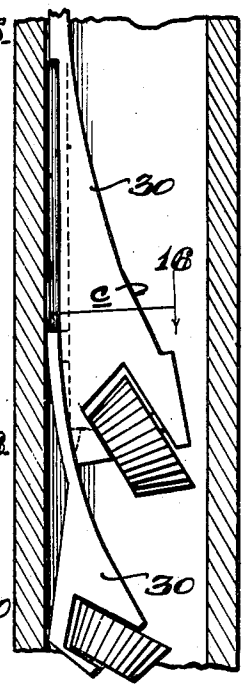


FIG. 16

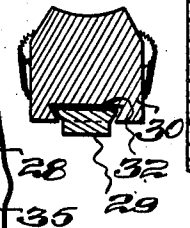


FIG. 18

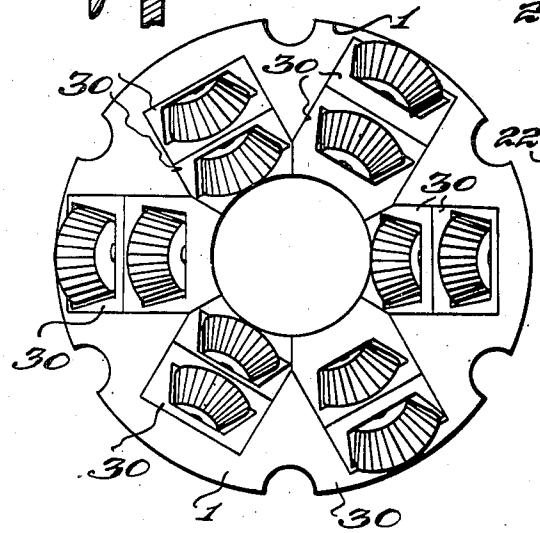
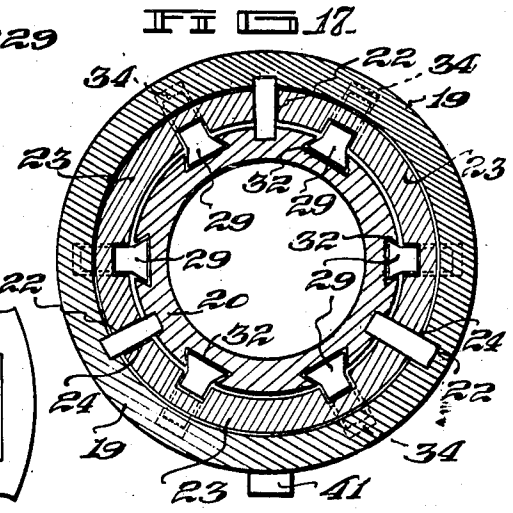


FIG. 17



Leonard E. Powell
INVENTOR

BY Ernest G. Hoop

ATTORNEY

Patented Jan. 26, 1937 2,068,704

UNITED STATES PATENT OFFICE

2,068,704

WELL DRILLING AND CORING APPARATUS

Leonard E. Powell, Dallas, Tex.

Application July 25, 1932, Serial No. 624,392

5 Claims. (Cl. 255—72)

This invention relates to well drilling equipment and it has particular reference to new and novel apparatus for drilling oil and other wells.

The principal object of the invention is to provide a combination of elements so constructed and arranged as to minimize the time and expense of running in and pulling out drill bits and cores.

Heretofore, the practice has been to withdraw the drill stem in sections, replace or repair the drill bit, coring tool or the like, extract the core and reassemble the drill stem assembly, before drilling can be resumed. Particularly in deep wells, this conventional practice is expensive and requires considerable time and must be frequently done, when the bit encounters hard rock formation.

The present invention comprehends the provision of an apparatus for drilling, through the medium of which a drilling or coring unit may be introduced into the hole for the purpose of drilling either hard or soft formations, and for the taking of cores, without the necessity of withdrawing the drill stem in sections. Accordingly, the drill bits can be kept in drilling condition without the usual loss of time, and faster drilling is accomplished. In addition to these novel features, a core barrel can be inserted to replace the core barrel filler cutter bit and samples of the stratum may be withdrawn with little difficulty and with a great saving of time. When coring is not required, a novel form of core barrel filler cutter is employed and the hole is drilled in the usual manner.

Another object of the invention is to provide in an apparatus of the character specified, a novel form of bit cutter carrier of which there is a series, and a means for lowering and elevating the cutter carriers into a drill collar in such manner that the bits will be successively deposited in operative position in the bit head.

Still another object of the invention is to provide a novel form of grabbing and releasing means by which to effectively engage and disengage the invention for raising and lowering the same.

With the foregoing objects as paramount the invention has particular reference to its salient features of construction and arrangement of parts to be hereinafter described and illustrated in the accompanying drawings, wherein:

Fig. 1 is a view in vertical cross section showing the lower end of the drill collar and its associated elements.

Fig. 2 is a fragmentary view of the slotted tubular cutter supporting member.

Fig. 3 is a fragmentary view showing a portion of the pusher barrel for advancing the cutters in the setting operation.

Fig. 4 is a detail fragmentary view of one of the soft formation blade cutter carriers.

Fig. 5 is a bottom view of the tool showing a set of soft formation blade cutters in operative position.

Fig. 6 is an enlarged view of the lower portion of Figure 1 in vertical cross-section showing the assembled positions of the hard formation cutters and cutter carriers.

Fig. 7 is a view in vertical section showing the upper ends of the cutter supportng member and the pusher barrel, also the raising and lowering means.

Fig. 8 is a detail view of a hard formation cutter attachment which may be used in lieu of the core barrel end.

Fig. 9 is a transverse section on lines 9—9 on Fig. 7.

Fig. 10 is a transverse section on lines 10—10 on Figure 7.

Fig. 11 is a detail view of the guide for positioning the bit cutters.

Fig. 12 is an elevation of Figure 11, showing the drill stem in vertical cross-section.

Fig. 13 is a fragmentary side view in vertical section showing the relationship of the guide barrel, pusher barrel and cutter carrier barrel.

Fig. 14 is a view similar to Figure 13, showing the elements in a different position in the guide barrel and is an enlarged fragmentary view of the upper portion of Fig. 1.

Fig. 15 is a fragmentary view in vertical cross-section showing the cutter carrier barrel and the manner in which the cutters are actuated therein.

Fig. 16 is a transverse section of one of the cutter carriers on line 16 on Figure 15.

Fig. 17 is a transverse section across the extreme upper end of Figure 1, and

Fig. 18 is a bottom view of the assembly shown in Figure 6, illustrating the relationship of the hard formation cutters and is similar to the showing in Figure 5.

For the purpose of clarification and in support of the objects of the invention hereinbefore set forth, it is pointed out that a special type of drill collar is provided which is suspended in the usual manner by a drill stem assembly. Within the drill stem is suspended an elongated, tubular barrel which will be hereinafter referred to as the guide barrel and whose primary function is to guide the assembly, preparatory to setting the drill bits in their proper relationship in the drill collar. Within the guide barrel is another tubu-

lar member which will be hereinafter referred to as the cutter carrier barrel. This barrel, while in fixed relation with the guide barrel, is provided with a series of longitudinal slots and grooves of various lengths and in each of which slots and grooves there is arranged to slide a flexible cutter suspension member on flexible rod and which will be hereinafter termed a cutter carrier.

The assembly is lowered into the drill stem, which has already been set up and the cutters in pairs are suspended in spaced relationship in the cutter carrier barrel and remain so suspended until the pusher barrel is actuated to advance the pairs of cutters toward the lower end of the drill stem assembly preparatory to assembling the same in the operative position shown in Figure 6. When so assembled, there is provided a member which serves the dual function of locking the cutters in their operative assembled relationship in the head of the drill collar and for furnishing a central cutting element or core barrel, that is to say, a cutter about which the assembled cutters are arranged, or a core barrel about which the cutters are arranged.

When the cutters become dulled or otherwise impaired, the locking member, which it may later be termed, is withdrawn upon upward movement of the pusher barrel, and the cutters proper are successively elevated in pairs from their assembled relationship in the drill collar head.

The foregoing brief explanation is given to clarify the description for the specific construction, relationship and operation of parts to follow.

Accordingly, 1 designates a special type of drill collar which is threaded upon the lower section of the drill stem assembly 2. The drill collar is shown only in Figures 1, 5, 6 and 18.

The drill collar has a peculiarly shaped cutter receiving head in that it is provided with a beveled recess whose walls are designated at *a*. These walls serve to receive the cutters whose carriers or suspending rods are normally under tension and when the cutters are lowered to such point where they will recede into the bevel provided therefor in the head, this tension is relieved.

Suspended within the drill stem 2, by means of a wire line 3, is a grab and release attachment shown in Figure 7. This attachment serves to lower the invention into the drill stem, release the same for operation and elevate it when desired. The attachment is comprised of the outer barrel or casing 4, having a detachable rope socket 5 on its upper end. Removably mounted in the barrel 4 is a member 6 having a series of radially spaced and depending hooks 7 which are adapted to engage under the flange 8 of the tubular member 9 in order to lock the arms 10 in an expanded position which releases them from spear shaped member 12 when it is desired to elevate the invention.

However, when the assembly is lowered into the drill stem, the elevator attachment is in the position shown in Figure 7 except that bolt 17 is removed, that is to say, the arms 10, depending from the collar 11 which is threadedly attached to the member 9, are engaged at their lower ends under the spear shaped member 12, which extends upwardly from the weight stem 13. A series of arms 14 are also provided in parallel relation to the depending arms 10 and have flared lower ends 15 which normally repose on the conical surface of the spear 12. Thus, when the lower end of the barrel 4 is allowed to advance against the annular stop 16, carried by the weight stem 13, the ends 15 of the arms 14 will spread and in so doing, they will engage and expand the lower ends of arms 10, thereby releasing the hooks carried thereby from engagement beneath the bottom of the spear 12. Also when the pin is removed, the lower portion of the member 6, which, as apparent in Figure 7 is of tubular shape and shouldered, may slide further down into the member 9, which is correspondingly shouldered. Thus it may be seen that the upper fingers 7, carried by the upper portion of member 6 will engage under the flange 8 of member 9 and being thus locked, will, through the release of the grab mechanism comprised of the lower arms 10 and spear 12, release the assembly.

In the raising operation, however, the pin 17, which locks the lower portion of member 6 in fixed relation with the member 9 is put in place through the opening 18 in the barrel 4 provided for this purpose. However, when it is merely a matter of lowering the assembly, the pin 17 is removed from position since it serves the purpose of rendering the upper grab mechanism inoperative.

The guide barrel 19 is in fixed relationship with the cutter carrier barrel 20, due to the fact that they are threaded together at 21, at their bottoms, as shown in Figures 1 and 6 and, as apparent in Figure 17, they are joined together at their tops by means of a series of webs 22. This is also borne out in dotted lines in the upper part of Figure 1.

It will be understood that the pusher barrel 23, which, as apparent in Figure 1, is disposed between the guide barrel 19 and cutter carrier barrel 20, is capable of sliding movement up and down between these barrels, but due to the webs 22, shown in Figure 17, is incapable of independent rotation. Slots 24 in the barrel 23, which receive the webs 22, prohibit such rotation.

From the foregoing, it is apparent that the barrels 19, 20, and 23 are in concentric relationship with the drill stem and that the guide barrel 19 is fixed with the carrier barrel 20 and has a beveled lower end 25, as shown in Figures 1 and 6, corresponding with a bevel in the upper portion of the drill collar 1. These corresponding bevels are effective for insuring proper alignment of the assembly with the cutter drill collar, as well as a tight fit when in place in the drill collar. It is also apparent that the intermediate pusher barrel 23, which is suspended from the weight stem 13, is constrained to move perpendicularly in the operation of assembling the cutters in the head.

Referring specifically to the construction of the pusher barrel 23, it is pointed out that this barrel has a series of narrow, flexible strips 26 cut out of its sides and these strips are only half the thickness of the walls of the barrel proper. This is shown clearly in Figures 13 and 14. The fact that these strips are thinner than the sides of the barrel not only lends flexibility to the strips but also defines a channel 27 therebehind, in which slides the lugs 28 carried by the upper end of each of the cutter carriers or shanks 29 from which is suspended the cutters 30. A detailed description of these cutters and their manner of suspension will follow presently.

The cutter carrier barrel, as apparent in Figures 1 and 6 is slotted from its lower end upwardly, the slots being designated by the common reference character 31 and exemplified in Figure 2.

These slots terminate at unequal points intermediate between the ends of the barrel and as indicated by the dotted lines in Figure 2, the upper portions 32 of the slots are dove-tailed in cross-section. This is also apparent and perhaps more clearly shown in Figures 16 and 17.

Each slot 31 is longer than the length of the shank disposed therein to permit of retraction since the shanks are of necessity of unequal lengths and but a portion of each reposes in its respective slot and each is required to be moved through a distance greater than its length.

The purpose of the dove-tailing of the slots 32 is in order to receive the correspondingly shaped upper ends of the shanks 29 of the cutting elements 30 and allow the shanks to slide up and down without becoming released from the slots. On the extreme upper end of each shank 29 is an outwardly projecting lug 28, mentioned previously, and by bearing upon this lug, the shank will slide downwardly, thereby urging the cutting element carried thereby into position in the drill collar. To accomplish this, the narrow, flexible strips 26 of the pusher barrel 23 are provided with lugs 33 which are urged against the lugs 28 of the shanks 29 and as the pusher barrel 23 is lowered into the space between the guide barrel 19 and the cutter carrier barrel 20, the lugs 33 come successively into engagement with the lugs 28 of the shanks 29 and since the barrels 19 and 20 are stationary when this operation occurs, the shanks are moved to a point predetermined by their lengths to bring the cutters 30 to the proper position in the drill collar head 1 and due to the flexibility of the shanks 29 and to the fact that they are under a continuous tension while suspended in the barrel 20, as shown particularly in Figure 15, the sudden release of this tension, as the cutter moves under the bevel *a* in the drill collar head 1, is sufficient to cause the cutter to adjust itself in its respective place in the head preparatory to the successive setting of the remaining cutters.

With particular reference to Figures 13 and 14, it is pointed out that the guide barrel 19 has a number of interior, longitudinal grooves 34 corresponding to the number of cutter shanks 29 and of corresponding lengths. In other words, the shortest groove 34 will be of such length as to accommodate the shortest shank 29 and will be in register therein. This is also true of the remaining grooves and shanks around the barrels. Therefore, when the lugs 28 upon the ends of the shanks 29 are all disposed in the openings 35 below the flexible strip 26 of the pusher barrel 23, (see Figure 3), movement of the barrel 23 up and down will accordingly move the shanks 29. However, as the lugs 33, on the lower ends of the flexible strips 26 of the barrel 23 ride into the interior grooves 34 of the guide barrel 19, as shown in Figure 14, tension thereon is relieved and they immediately fall within the grooves, which action causes the lugs 28 of the shanks 29 to be released to the position shown in Figure 14, in which position the cutters 30 are in assembled position in the drill collar head 1.

When all of the cutters 30 are assembled operatively in the drill head or drill collar 1, as shown in Figure 18, they must be locked in such position. This is accomplished by means of the member 36, of the core barrel assembly 37 connected to the weight stem 13. The member 36 serves the dual purpose of locking the cutter assembly and forming the lower end of the core barrel, exemplified in Figure 1. It will be observed that the lower end of the member 36, is beveled at *b* to correspond with the bevel *c* of the cutters 30. This arrangement insures a locked condition of the cutters when assembled in the head 1.

Within the drill stem 2 is arranged a guide flange 39 which may be seen in Figures 6, 11 and 12. The construction and arrangement of this flange is obvious but it is specifically pointed out that an opening 40 is provided in the lower end. It will also be noted in Figure 17 that the barrel 19 has a lug 41 integral with its exterior, as the barrel 19 is lowered into the drill collar, lug 41 contacts with the flange 39 and it rotates to such position that the lug 41 will pass through the opening 40 of the flange 39, thereby bringing the elements into proper alignment with the head 1, preparatory to the cutter assembling operation. Reference is also made to the spring guides 42, affixed to the exterior of the barrel 19 and slidingly engaging the interior walls of the drill stem 2 to effect centering of the barrel 19.

When the cutters are assembled and drilling is proceeded with, drilling fluid is passed into the hole through water courses 43, shown in Figure 6; this drilling fluid is prevented from entering the assembly by the valve 44, shown only in the lower portion of Figure 7 and which also acts as an escape for any foreign matter collected in the core barrel as the core enters.

In operation, the lowering mechanism shown in Figure 7 is connected as illustrated and suspends the barrel 23 and the tubing 37 carrying the coring and locking member 36. The locked relationship between the lugs 28 of the cutter shanks 29 and the barrel 23 suspends the barrel 20 and due to the fixed relation between barrel 20 and barrel 19, the latter barrel is likewise suspended. The entire assembly described is thus lowered until the beveled lower end of the barrel 19 at 25 engages the internal recess of the drill head 1, as shown in Figure 6. When such engagement is made, continued downward movement of the barrel 23 between barrels 19 and 20 will cause the lugs 33 carried by the flexible strips 26 of barrel 23 to engage the outwardly projecting lugs 28 of the shanks 29, carrying the cutters 30, and as the pusher barrel 23 continues to move downward, the shanks 29 are urged downwardly until the cutters 30 are successively arranged in operative position in the head 1. The elevator is then released and withdrawn from drill pipe after which operation the kelly joint is connected and drilling proceeded with.

When it is desired to elevate the assembly, the elevator is lowered into the drill stem 2 with the pin or bolt 17 in place which allows the arms 10 to spring outward and clamp under the spear head 12 of the member 16. Thus the entire assembly may be elevated.

The arrangement of the cutters 30 in the head as shown in Figure 18 as well as in Figure 5, provides a central space for the reception of a coring tool if it is required to take a core during the drilling operation. Moreover, there is no limitation intended by the specific showing of the rotary cutters shown in the several views since cutters of the type illustrated in Figure 5 may be employed if the character formation encountered demands.

Manifestly the construction shown and described is capable of considerable modification and such modification as is considered within

the scope and meaning of the appended claims is also considered within the spirit and intent of the invention.

In the foregoing specifications wherein the words "assembly" and "invention" are separately employed they are synonymous except where "assembly" is modified by the association therewith of another term such as "core barrel assembly", "cutter assembly" and like expressions, each of which is to designate but a part of the complete assembly or invention.

What is claimed is:—

1. Apparatus for drilling and coring wells including a drill collar and head, a plurality of concentric pipes, the inner pipe comprising a cutter carrier barrel and having longitudinal guide slots in its sides of varying lengths, a series of cutting elements having shanks of varying lengths corresponding to the lengths of and guided in said slots and whose free ends are bent outwardly, means to engage successively the bent ends of said shanks whereby to urge said cutting elements into operative position and means for successively withdrawing said cutting elements.

2. Apparatus for drilling wells including in combination, a drill stem assembly, a drill collar attached thereto at its lower end and having a recessed head, a cutter assembly comprising a series of concentric pipes within the drill stem, the inner pipe comprising a cutter carrier barrel and having longitudinal slots of different lengths in its sides terminating in stepped relationship intermediate its ends, disposed within said cutter carrier barrel when in retracted position, a series of flexible shanks of varying lengths in accordance with the lengths of the slots in said cutter carrier barrel, each of said shanks having a cutter element in its lower end and having its other or free end mounted in one of said slots for constrained slidable movement therein, means for urging said shanks downwardly into operative position in recesses in said head, means for collectively locking the shanks in operative position and means for successively withdrawing said shanks from operative position in the head into the cutter carrier barrel.

3. Apparatus of the character described including in combination, a drill stem assembly, a drill collar having a recessed head, a barrel having longitudinal slots in its sides terminating in stepped relationship intermediate its ends, a guide barrel surrounding said slotted barrel and in concentric and fixed relation thereto, a series of rotary cutting elements having flexible shanks of varying lengths in accordance with the lengths of the slots in said slotted barrel and whose free ends are arranged to slide in said slots, flexible means arranged to be lowered in said drill stem assembly to engage successively the free ends of said shanks whereby to urge said cutting elements successively into operative position in said recessed drill collar head, means for locking said rotary cutting elements in assembled relationship in said head and means for successively withdrawing said rotary or blade cutting elements.

4. Apparatus of the character described including in combination, a drill stem assembly, a drill collar having a recessed head, a barrel having longitudinal slots in its sides terminating at unequal points intermediate its ends, a guide barrel surrounding said slotted barrel and in fixed relation thereto a series of cutting elements having flexible shanks of varying lengths in accordance with the lengths of the slots in said slotted barrel and whose free ends are constrained to slide in said slots, means arranged to be lowered in said drill stem assembly to engage successively the ends of said shanks whereby to urge said cutting elements successively into operative position in said drill collar, means for locking said cutting elements in assembled relationship in said head and means for successively withdrawing said cutting elements.

5. Apparatus for coring and drilling wells including a drill collar having a recessed head and a series of confined drilling elements, a tubular member for slidingly and flexibly suspending said elements for movement into radial relation in said head to define a central opening, means embracing and slidable over said tubular member for moving said elements, and means receivable in said opening for collectively locking said drilling elements.

LEONARD E. POWELL.