United States Patent

[11] **3,552,508**

[72] Inventor **Cicero C. Brown**
c/o Brown Oil Tools, Inc. P.O. Box 19236,
Houston, Tex. 77024

[21] Appl. No. **803,911**
[22] Filed **Mar. 3, 1969**
[45] Patented **Jan. 5, 1971**

[54] **APPARATUS FOR ROTARY DRILLING OF WELLS USING CASING AS THE DRILL PIPE**
7 Claims, 4 Drawing Figs.

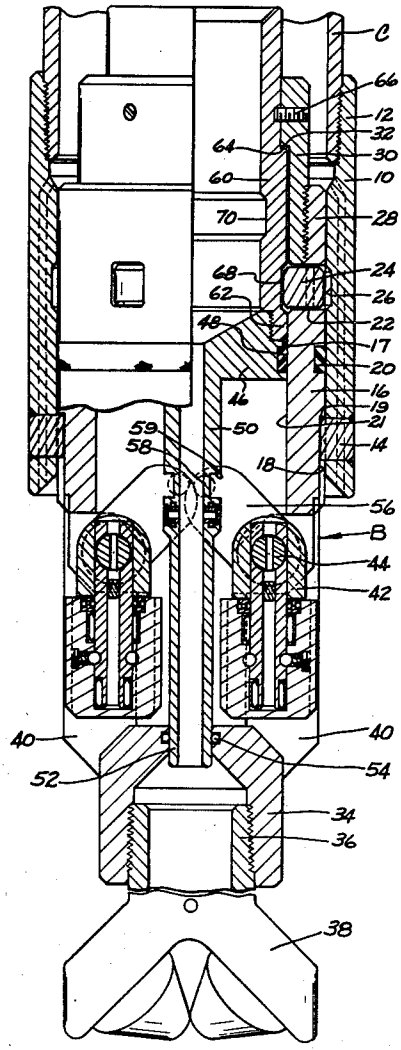
[52] **U.S. Cl.** **175/258,** 175/261
[51] **Int. Cl.** **E21b 9/26**
[50] **Field of Search** 175/257, 258, 259, 263, 267, 271

[56] **References Cited**
UNITED STATES PATENTS

2,330,083	9/1943	Sewell	175/258
2,890,022	6/1959	Brown	175/258
2,997,119	8/1961	Goodwin	175/267X
3,097,707	7/1963	Kammerer	175/258

Primary Examiner—David H. Brown
Attorney—R. Werlin

ABSTRACT: A drilling system employing casing as drill pipe and a bit section which is bodily insertable and removable through the casing and releasably attachable thereto for rotation with the casing.



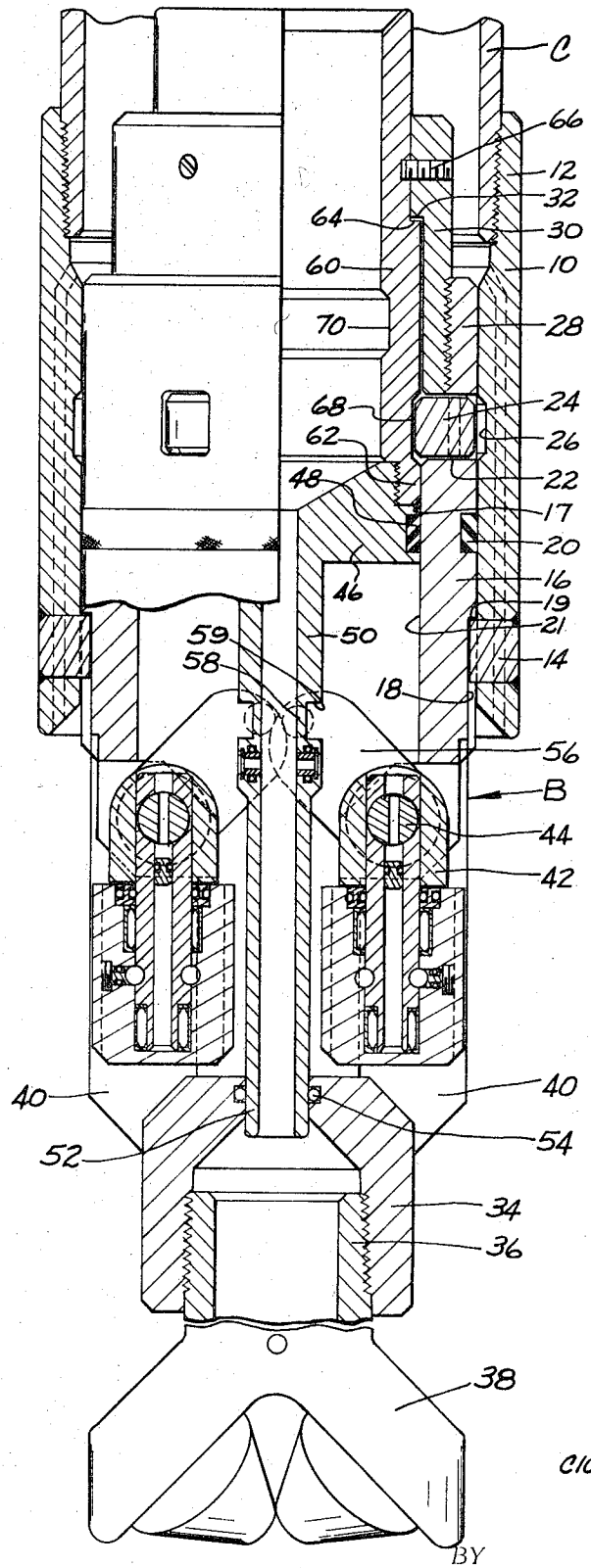


Fig. 1

CICERO C. BROWN
INVENTOR.

BY

ATTORNEY

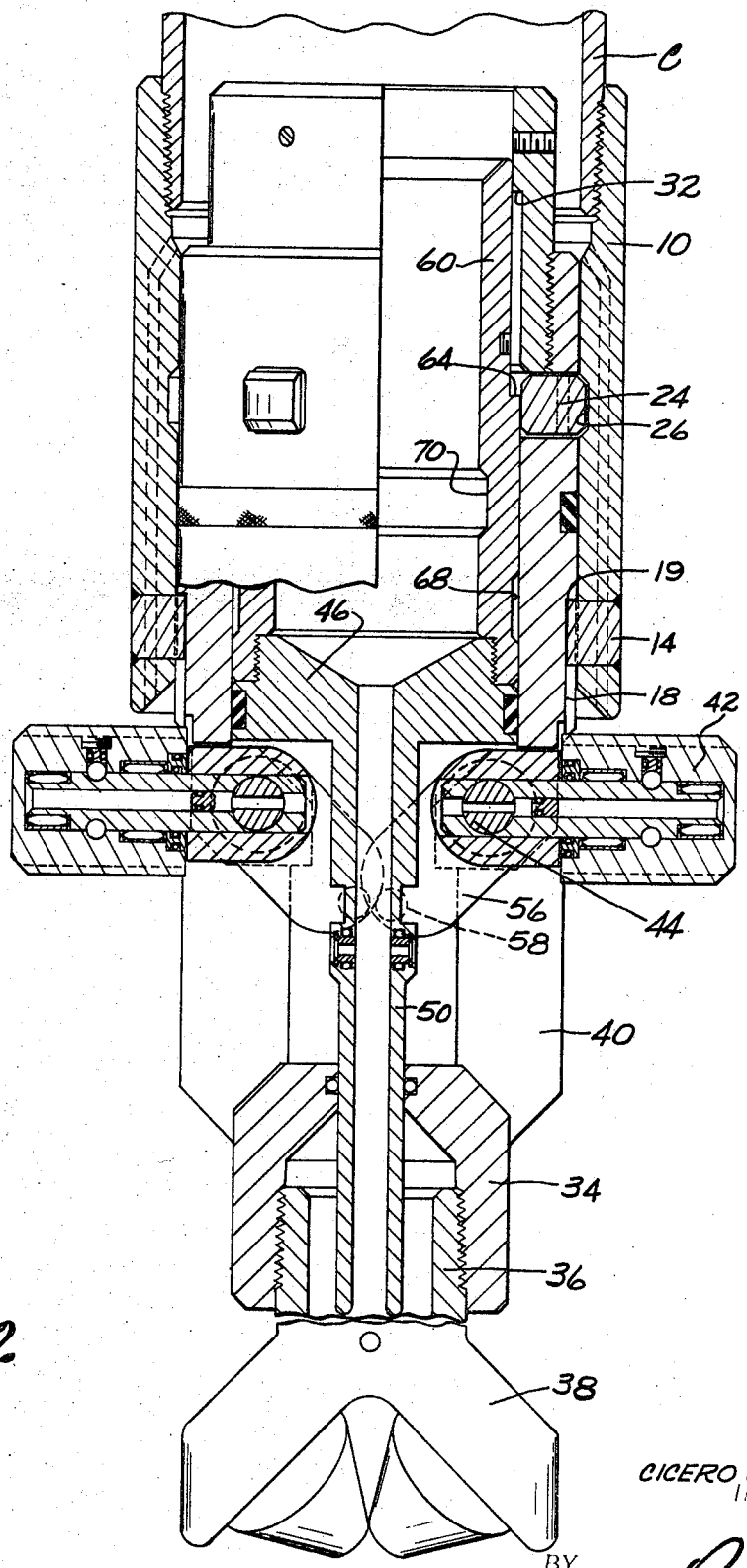


Fig. 2

CICERO C. BROWN
INVENTOR.

BY

ATTORNEY

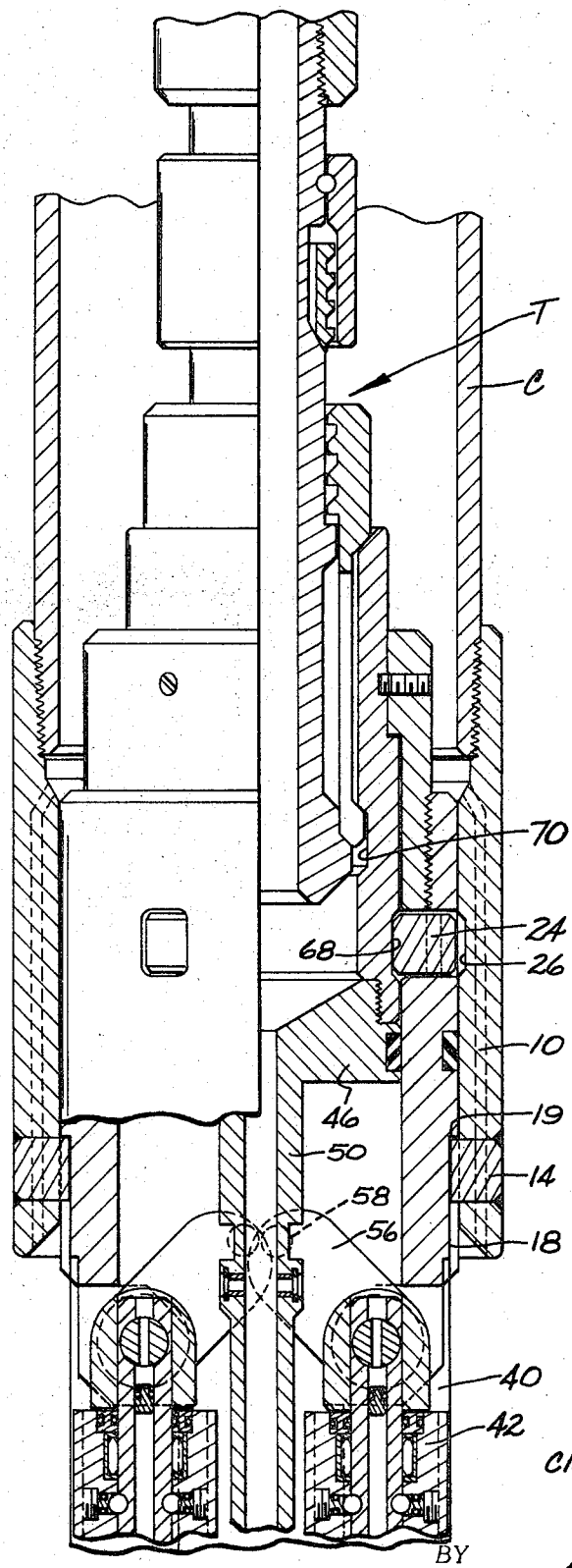


Fig. 3

CICERO C. BROWN
INVENTOR.

BY

ATTORNEY

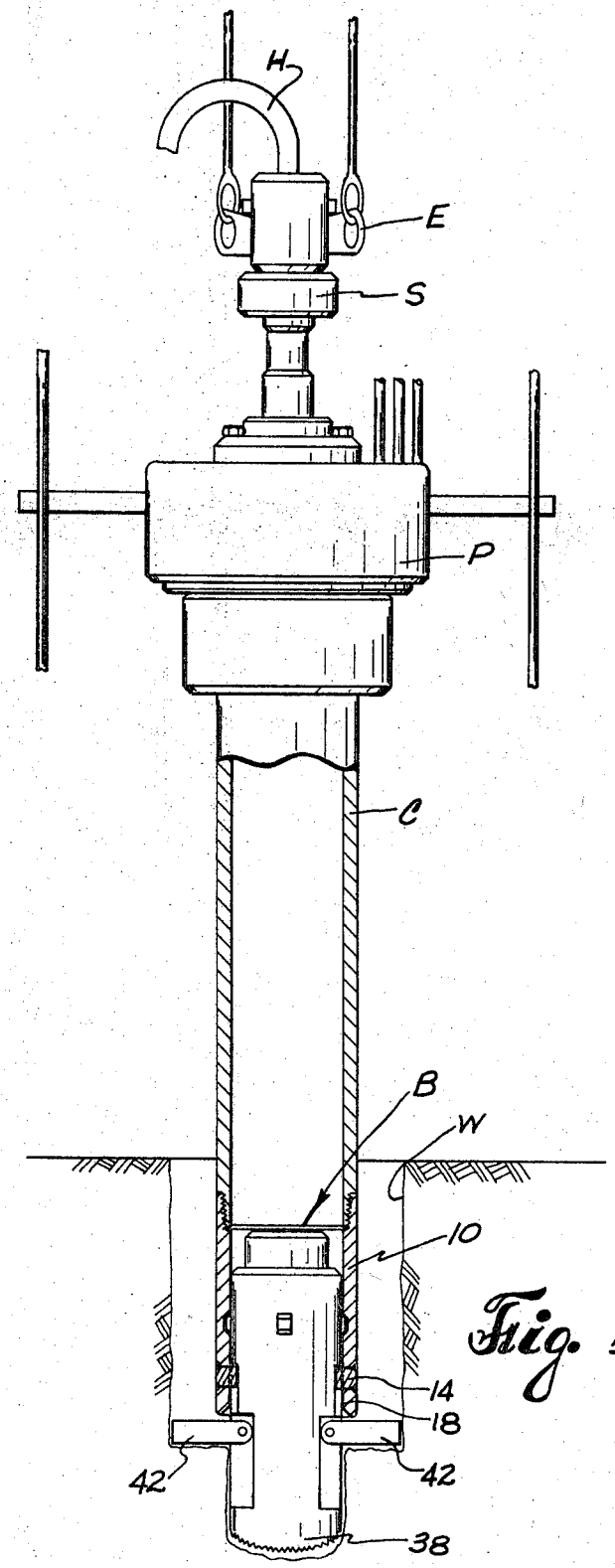


Fig. 4

CICERO C. BROWN
INVENTOR

BY

ATTORNEY

APPARATUS FOR ROTARY DRILLING OF WELLS USING CASING AS THE DRILL PIPE

In the drilling of wells for oil and gas, for example, by the rotary method, the drilling is conventionally done by the employment of relatively small diameter string of drill pipe to which a bit is secured, the entire string being rotated to drill the bore hole. After a suitable interval has been drilled, sometimes only a short distance but at other times for the full depth of the well, casing larger in diameter than the drill pipe will be run into the bore hole and subsequently cemented to seal off the formations through which the bore hole extends. This necessarily involves the series of operations in which the drill string must be extended as the hole deepens, as by the addition of sections to the drill pipe, and also the entire drill string must be withdrawn wherever it becomes necessary to replace the bit and then reinsert it to resume drilling. Thus making of such so-called "round trips" are not only time consuming but also create hazards of blowouts and other undesirable conditions in the well. After the appropriate drilling of the hole has been completed, the drill string must be withdrawn and casing run to the desired depth. This, too, may present hazards because with the drill string out of the well, control of the well becomes more difficult.

Heretofore numerous efforts have been made to provide a system employing the casing itself as the drill pipe in order to overcome some of the hazards enumerated, as well as time loss. However, these prior efforts have not proven satisfactory for various reasons well known to those skilled in the art.

The present invention, therefore, is directed to an improved arrangement by which the casing may be employed as the drilling string and when used in combination with a retractable or removable bit section will perform all of the functions of drilling and casing of a well in a sequence or series of operations which thereby greatly facilitates drilling operations.

In accordance with the present invention a bit section is provided which includes both the primary bit and a plurality of radially extendible and retractable underreamers, the entire bit section being arranged and constructed to be insertable bodily through the bore of the casing and moved to the lower end of the casing either on a wire line or by simply dropping it into the casing, where, either by gravity alone or supplemented by pumped fluid pressure, the bit section will be forced to the bottom of the lower end of the casing string, which is provided with a landing shoe to receive the bit section. The bit section is provided with latch means engageable with appropriate grooves or other latch-receiving structure in the landing shoe. The latter includes a number of keys or splines which are adapted to engage appropriate spline slots or grooves in the bit section to lock the bit section to the casing against relative rotation whereby rotation of the casing string will be effective to rotate the bit for purposes of drilling the well.

The bit section also includes piston means connected by crank means to the underreamers which will be actuatable from the upper end of the casing string by drilling fluid circulating through the system for purposes of extending or actuating the underreamers so as to enlarge the bore hole drilled by the pilot bit sufficiently to allow free downward movement of the casing behind the bit as the hole is being drilled.

To withdraw the bit section a conventional fishing tool or spear is run into the casing on a wire line and connected to the bit section, whereby an upward pull applied to the fishing tool will be effective to retract the underreamers and release the bit section from the landing shoe to which it has been anchored. The spacing arrangement between the underreamers and latching dogs is so designed as to assure that the underreamers are fully retracted before the bit section is released, thereby avoiding damage to the underreamers which might otherwise occur if they were not completely retracted when they pass the lower end of the landing shoe.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates a useful embodiment in accordance with the present invention.

In the drawings:

FIG. 1 is a longitudinal, partly sectional view showing the bit section inserted into the casing shoe preparatory to anchoring the bit section to the casing shoe;

FIG. 2 is a view similar to FIG. 1 showing the bit section anchored to the casing shoe and with the underreamers in their extended position;

FIG. 3 is a view similar to FIG. 1 showing a fishing tool engaged with the bit section, the parts being shown after release of the bit section and with the underreamers in their retracted position; and

FIG. 4 is a longitudinal view of the drilling system in a well bore showing the casing string with the bit section in place and the drive connections at the surface.

Referring to the drawing and considering first FIG. 4, there is shown a string of casing C carrying the bit section, designated generally by the letter B, showing the bit section in place in a landing shoe 10 connected to the lower end of casing C. At its upper end casing C is connected to a power sub P which functions to rotate the casing string during drilling, as will be described. Power sub P is of the general form and construction disclosed in my copending application, Ser. No. 736,179, filed Jun. 11, 1968. A suitable drive connection between the power sub and the casing is disclosed in my copending application, Ser. No. 778,509, filed Nov. 25, 1968 now Pat. No. 3,467,202. Power sub P is suspended form a swivel S carried on elevators E conventionally employed as part of the draw works of a drilling rig. The swivel has a hose connection H by which drilling mud is pumped into the drill string of casing C, thence through the bit section into the annulus defined by the bore hole surrounding the drilling string, the bore hole being designated by the letter W.

Returning now to FIGS. 1 and 2, the landing shoe and bit section B comprise the basic drilling structure which is secured to the casing. Shoe 10 is provided with an internally threaded socket 12 by which it is threadedly secured to the lower end of casing C. Adjacent its lower end shoe 10 is provided with two or more angularly spaced pins 14 which project a short distance inwardly of the bore of the shoe and form splines for purposes which will be explained shortly.

Bit section B comprises a body 16 having a bore 17, and is dimensioned to be insertable through the bore of casing C and into the bore of shoe 10. Body 16 is provided about an intermediate portion thereof with a plurality of longitudinal keyways or spline grooves 18 adapted to receive the projecting ends of the pins 14, whereby body 16 will be locked to shoe 10 against relative rotation so that rotation of casing C will function to rotate body 16 and its appurtenances. Spline grooves 18 terminate in upper end walls 19 which form stops for engagement with pins 14 to limit downward movement of the bit body through shoe 10. An annular seal ring 20 is disposed about the exterior of body 16 above end wall 19 to seal with the bore wall of shoe 10. At a point above seal 20, body 16 is provided with a plurality of radial windows or openings 22 in which are mounted latch dogs 24 which are adapted when projected outwardly to be received in an annular latching groove 26 formed in the bore wall of shoe 10. The latching dogs are positioned in body 16 so that they will be in registration with groove 26 when body 16 is fully inserted in the shoe and end walls 19 abutting pins 14. The upper end of body 16 is internally threaded to define the box or socket 28 adapted to threadedly receive a collar 30 having a downwardly facing internal shoulder 32 spaced a short distance below its upper end. The lower end of body 16 carries a downwardly facing internally threaded socket 34 adapted to receive the externally threaded shank 36 of a bit 38 which constitutes the pilot bit and may be of any conventional design for drilling a bore hole to any desired nominal diameter determined by the dimensions of the pilot bit. At a point between the lower ends of splines 18 and socket 34, body 16 is provided with a plurality of longitudinally extending radially opening slots 40 in which are mounted underreamers 42 of any suitable and known design. These are pivotally mounted on pivot pins 44 which extend transversely of the respective

slots for enabling the underreamers to be angularly moved so as to be radially projected and retracted with respect to the slots 40. The portion of bore 17 of the body which extends between windows 22 and the upper ends of slots 40, defines a cylinder 21 in which is slidably positioned an annular piston 46 having a seal ring 48 mounted in its outer periphery for slidable sealing engagement with the wall of the cylinder. Piston 46 is secured to the upper end of a square piston rod 50 having an axial bore 51 which extends downwardly between the several underreamers and projects through an axial opening 52 in the upper end of socket 34 and is slidable therein in response to the axial movements of piston 46. An annular seal ring 54 is disposed in the wall of opening 52 in sealing engagement about the lower end of piston 50. Each of the underreamers 42 is fixedly connected to an angularly extending crank arm 56 having its free end secured to a crosshead pin 58 mounted in a crosshead slot 59 formed in the related side of exterior of piston rod 50. With this arrangement it will be seen that the movement of piston 46 downwardly will act through crank arms 56 to rotate the underreamers outwardly and upwardly while reverse movement of the piston will act to retract the underreamers.

The upper end of piston 46 is secured to a setting sleeve 60 which is inserted through collar 30 and is secured to the upper end of piston 46 about its periphery by a threaded connection 62. The upper portion of sleeve 60 is reduced in diameter externally to provide the upwardly facing shoulder 64 adapted to abut shoulder 32 on collar 30. Setting sleeve 60 is initially retained in its uppermost position at which shoulder 64 abuts shoulder 32 by means of shear pins 66 which connect collar 30 to setting sleeve 60. Just above connection 62 setting sleeve 60 is provided with an external annular relief groove 68 which is adapted to receive dogs 24 when they are retracted from latching groove 26. Relief groove 68 will be disposed in registration with windows 22 and dogs 24 when the setting sleeve is in its uppermost position, as shown in FIG. 1, so that the dogs are free to move inwardly of body 16 out of grooves 26. In this position it will be also noted that piston 46 is positioned in its uppermost position at which underreamers 42 are fully retracted, also as shown in FIG. 1. The bore wall of setting sleeve 60 is provided with the annular groove 70 for engagement by a fishing tool, as will be described subsequently.

In operation, the bit section will be inserted into the upper end of casing C and will be allowed to fall by gravity through the bore of the casing until the bit is brought to a stop by the engagement of pins 14 with end walls 19 of spline grooves 18. The lower ends of spline grooves 18 ordinarily will be flared or widened circumferentially in the well known manner to guide the spline grooves 18 over pins 14 as the bit section seats in shoe 10. The parts of the bit section will be positioned as illustrated in FIG. 1 in which the setting sleeve is held in its retracted position by shear pins 66. Latching dogs 24 will thus be free to retract and are effectively retracted into relief groove 68, whereby to allow the free movement of the bit section through the casing and into landing shoe 10.

It will be understood, of course, that instead of simply dropping the bit head into the casing and allowing it to fall by gravity to the bottom, it may be lowered on a wire line or other tool string which will be releasably secured to setting sleeve 60 in a manner and by means well understood by those skilled in the art. If the force of gravity is not sufficient to cause the bit section to fall freely into the landing shoe, it will be understood that by pumping fluid, such as water or drilling mud, into the casing this will act against the restriction formed by the bore of piston rod 50 to provide hydraulic pressure sufficient to drive the bit section downwardly through the casing through any obstructing mud or the like, until it is effectively seated in shoe 10.

When the bit section is in place, pumping of fluid such as drilling mud into the casing may be begun, or continued if previously begun to seat the bit section, and as the pressure builds up against the restriction formed by the bore of piston rod 50, a force will be attained sufficient to break shear pins 66, whereupon setting sleeve 60, piston 46, and piston rod 50 will be forced downwardly by the fluid pressure. The downward movement, acting through crosshead pins 58 and crank arms 56 will rotate underreamers 42 outwardly to the positions shown in FIG. 2. As the underreamers move outwardly and setting sleeve 60 moves downwardly the exterior portion of the setting sleeve above relief groove 68 will pass behind dogs 24, and by reason of the enlarged diameter of the sleeve, will force the dogs outwardly into latching groove 26, thereby effectively anchoring the bit section to the landing shoe. The positions of the parts with the reamers extended and the bit section latched to the landing shoe is shown in FIG. 2.

It will be understood, of course, that the casing string will be rotated initially to cause pilot bit 38 to initiate drilling of the bore hole and as drilling proceeds, fluid pressure will be exerted against piston 46 to extend the underreamers which will radially enlarge the bore hole cut by the pilot bit to a diameter which will allow free passage of casing string C so that it will follow directly behind the pilot bit and will continuously line the bore hole as drilling proceeds.

The drilling fluid circulation will be through hose connection H, swivel S and through a conduit in power sub P into the bore of casing C. Thence, through the bit section, the fluid flowing through the bore of piston 46 and piston rod 50 to the discharge passages in the pilot bit and the underreamers. The mud flush will return to the surface through the annulus between well bore W and casing C. The flow restrictions provided by the bore of the piston rod and the bit passages will assure the maintenance of sufficient hydraulic pressure against the piston to keep the underreamers extended as long as pump pressure is being applied.

When necessary to withdraw the bit section from the casing in order to replace or repair the pilot bit, underreamers or any other part of the bit section, a fishing tool, designated generally by the letter T, of any generally conventional form, the details of which do not form a part of this invention, will be run into the casing bore on a wire line, or tubing string if desired, and will be latched into groove 70 of the setting sleeve. On application of upward pull to the fishing string, the setting sleeve will be drawn upwardly pulling piston 46 and piston rod 50 upwardly, thereby causing underreamers 42 to be swung inwardly of slots 40. The spacing provided between relief groove 68 and shoulder 64 is selected so that underreamers 42 will swing inwardly and to the fully retracted position in slots 40 before relief groove 68 moves opposite dogs 24 and shoulders 32 and 64 are engaged. Stated otherwise, the distance through which setting sleeve 60 is moved upwardly in order to allow retraction of dogs 24 will be greater than the length of upward movement of piston rod 50 which will be required to cause the underreamers 42 to be fully retracted. In this way, the underreamers will be fully retracted and will not strike the lower end of the landing shoe before the bit head is released by retraction of dogs 24 and thereby damage to the underreamers will be avoided.

With the underreamers in their fully retracted position, as shown in FIG. 3, and dogs 24 also released for retraction into relief groove 68, the entire bit section can then be pulled out of the casing for repair, replacement or for whatever purpose may be required. If drilling for a desired interval has been completed, withdrawal of the bit section will place the casing in condition for cementing. The landing shoe may be employed to receive the usual cementing valve, if desired.

When drilling is to be resumed, the bit section, with the parts in the original retracted positions, will be returned through the bore of the casing to its lodgment in shoe 10, fluid pressure reapplied to anchor the bit section and extend the underreamers, and drilling will be resumed as previously described.

From the foregoing it will be evident that a drilling system is provided in which the casing itself which is ordinarily required to line the bore hole will be used as the drilling string and will be continuously fed into the hole as the drilling proceeds, thereby obviating all of the additional operations conven-

tionally required in rotary drilling and for casing the well. The hazards accompanying the conventional drilling and casing operations, including those arising from "round trips" of the drill string, will be obviated, drilling operations greatly facilitated, and time of operation substantially reduced.

It will be understood that various changes and modifications may be made in the details of the illustrative embodiment within the scope of the appended claims but without departing from the spirit of this invention.

I claim:

1. Apparatus for rotary drilling of wells using casing as the drill pipe, comprising in combination with a string of casing and means for rotating the same:

a. a bit section bodily insertable and removable through the bore of the casing;

b. cooperating means on the bit section and the lower end portion of the casing for landing the bit section in said lower end portion in nonrotative relation to the casing;

c. said bit section comprising:

I. a generally tubular body;

II. radially movable anchor means mounted on the body for releasably anchoring the body to the casing;

III. a pilot bit carried by the lower end of the body;

IV, a plurality of angularly spaced underreamers mounted on the body for radial movement between extended positions for enlarging the diameter of the bore hole made by the pilot bit and positions fully within the perimeter of said body;

v. piston means operably connected to said underreamers and reciprocable in the bore of the body between upper and lower positions respectively retracting and extending said underreamers;

VI. sleeve means in said body reciprocable with said piston means between upper and lower positions respectively releasing and actuating said anchor means; and

VII. means initially securing said sleeve means and said piston means to said body in said upper positions and releasable for movement to said lower position in response to fluid pressure applied to the piston means through the casing string whereby to actuate said anchor means and to extend said underreamers.

2. The apparatus according to claim 1 wherein said initial securing means comprise shear pins.

3. The apparatus according to claim 1 wherein said sleeve means includes means adapted for engagement by a fishing tool to apply upward pull to the sleeve means.

4. The apparatus according to claim 1 including means operably connecting the piston means to each of the underreamers comprising:

a. a crank arm angularly secured to the underreamer; and

b. crosshead pin-and-slot connections between the free end of the crank arm and the piston means.

5. The apparatus according to claim 1 wherein said cooperating means includes:

a. a tubular landing shoe secured to the lower end of the casing string;

b. inwardly projecting splines in the bore of the shoe; and

c. spline grooves in the bit body open at their lower ends for receiving the splines in response to relative downward movement of the bit body.

6. The apparatus according to claim 5 wherein said anchor means includes:

a. a plurality of angularly spaced latching dogs disposed in openings in the wall of said body; and

b. an annular latching groove in the wall of said landing shoe arranged for latching engagement with said dogs.

7. The apparatus according to claim 5 wherein said sleeve means includes an annular relief groove about its exterior which is registrable with said latching dogs when said sleeve means is in said upper position to permit retraction of said latching dogs from said latching groove.