Jan. 5, 1932. E. F. RAYMOND 1,839,588

PLUNGER ACTUATED UNDERREAMER

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Fig 4

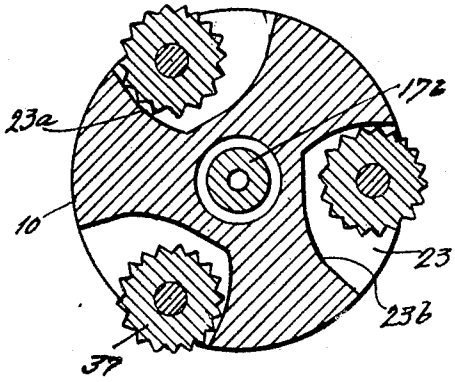


Fig 1.

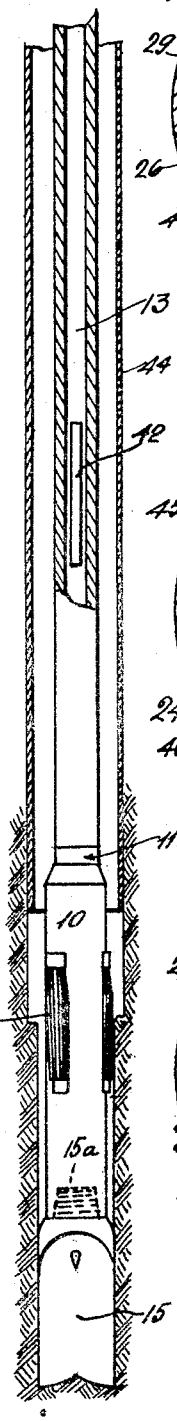


Fig 7

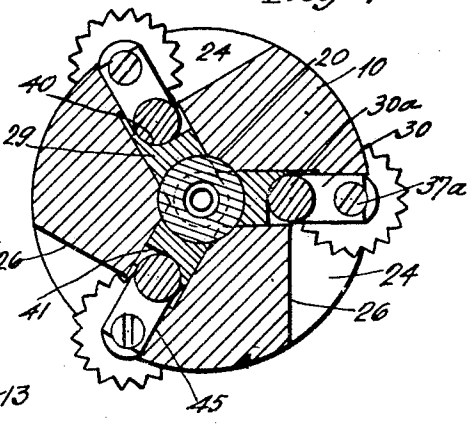


Fig. 5.

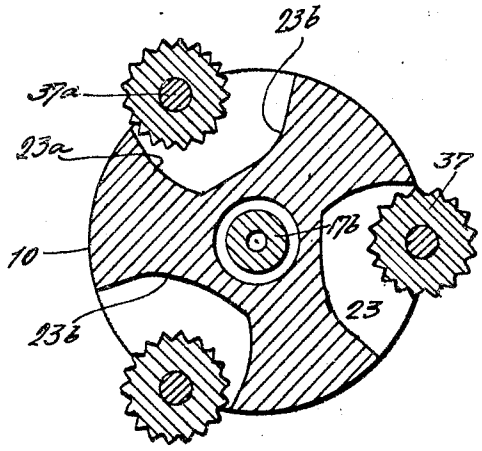


Fig 8

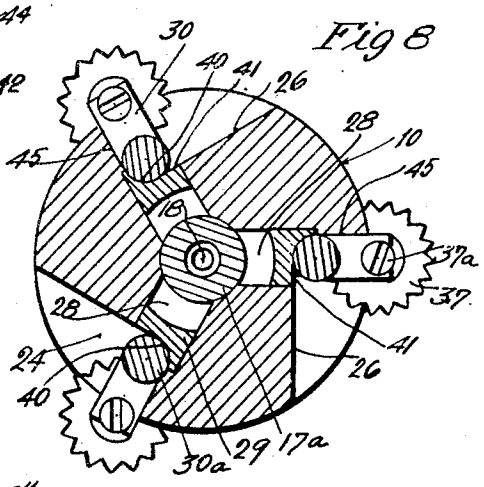


Fig. 6.

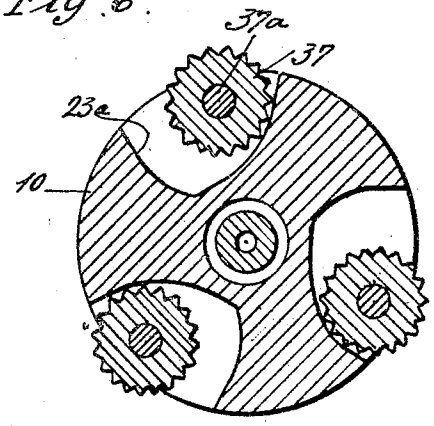
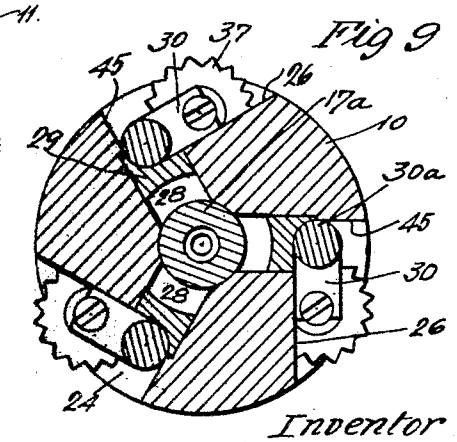


Fig 9



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Fig. 2.

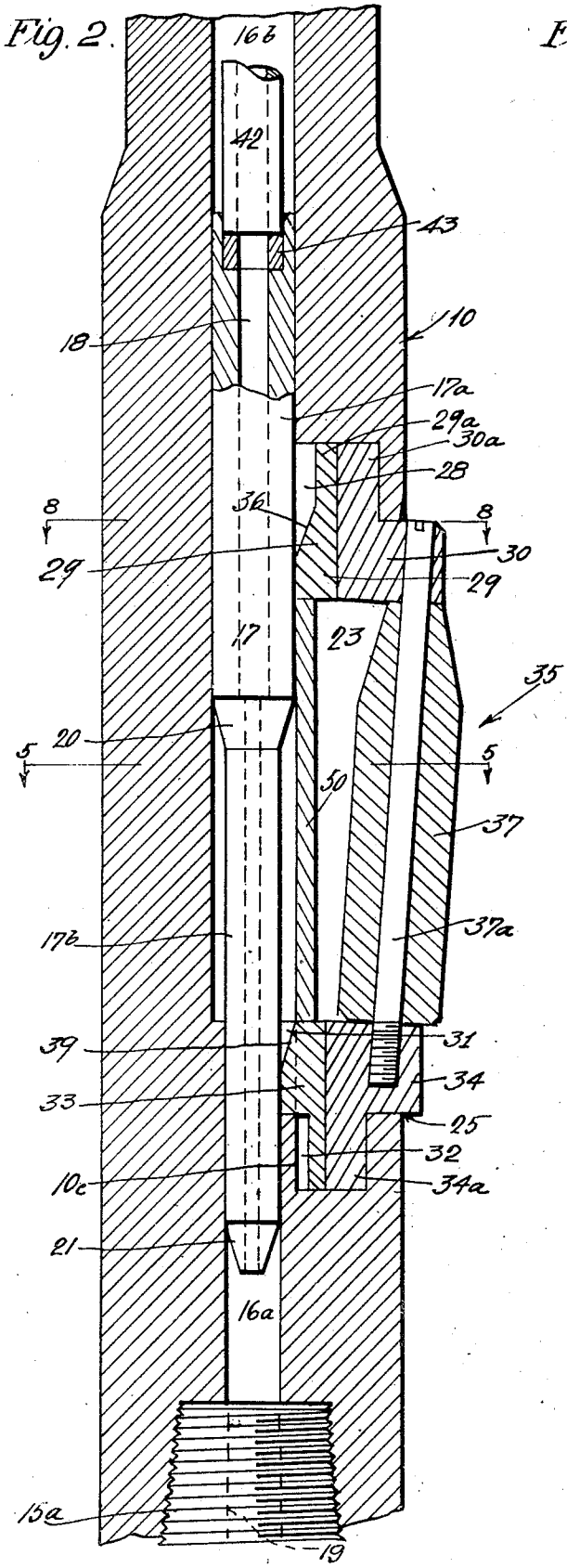
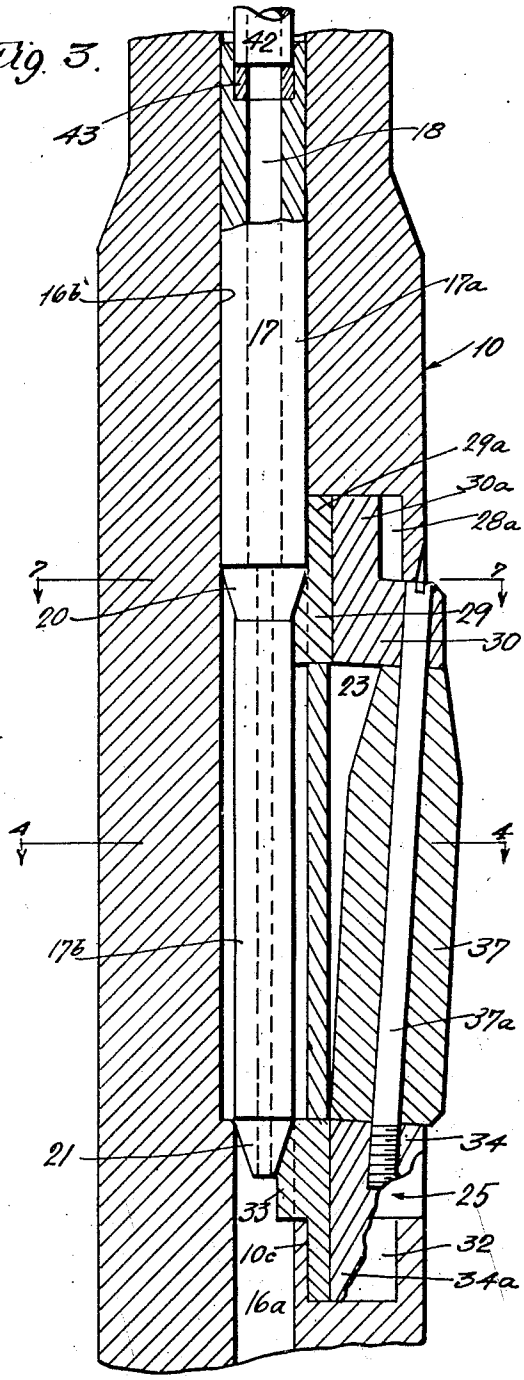


Fig. 3.



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UNITED STATES PATENT OFFICE

EDWARD F. RAYMOND, OF LONG BEACH, CALIFORNIA, ASSIGNOR TO JOHN GRANT, OF LOS ANGELES, CALIFORNIA

PLUNGER ACTUATED UNDERREAMER

Application filed September 20, 1929. Serial No. 393,953.

This invention has reference to underreamers of the type in which the cutter assemblies are moved radially to expanded positions by the action of a vertically movable plunger in the reamer body, it being one purpose of the invention to provide in a reamer of this character, means for moving the cutters to their expanding positions, or starting with the cutter carriers in expanded positions, means for expanding the cutter supporting elements, by the action of an object dropped within the drill pipe, such means comprising preferably a plunger adapted to be moved through its cutter expanding movement by the impact of said object. In another of its aspects, the invention has to do with the provision of means whereby the cutters may be moved to contracted positions to enable the underreamer to be withdrawn through the well casing, without the necessity for returning the plunger to its starting position to accommodate inward radial movement of the cutters. It may be mentioned however that under certain conditions and with certain types of cutter assembly structures it may be desirable to release the cutters for inward contracting movement from their expanded positions by returning the plunger to its corresponding position, for example by way of a suitable connection therewith through the drill pipe, but in general I prefer to effect the radial contacting movement of the cutters by mounting them in such a manner that such movement is accomplished by reverse rotational movement of the drill pipe, as will be fully explained hereinafter.

The invention may be characterized more particularly as comprising in its preferred embodiment, a tubular body in which is mounted radially movable cutter assemblies adapted to be actuated to hold the cutters in expanded positions by wedging action with a downwardly movable plunger in the body bore, the plunger as mentioned being actuated in its downward movement by an object dropped within the drill pipe. In order to allow movement of the cutters to contracted positions without the necessity for raising the plunger to accommodate such movement, the cutters are mounted on pivoted carriers whereby they may be swung laterally on the body from expanded to contracted positions while the plunger is in its cutter expanding position. Thus in a single operation of expanding and contracting the cutters, the latter may be moved radially from one contracted position to expanded position, and then swung from expanded to another contracted position. Also, as will later be explained, the cutters may first be adjusted in their swinging contracted positions and after movement of the plunger to expand the cutter supporting elements, the cutters may be expanded upon rotation of the reamer.

The above features and additional characteristics of the invention will be understood most readily and clearly from the following description of a preferred embodiment of the invention, reference being had throughout the description to the accompanying drawings, in which:

Fig. 1 is a general view illustrating the underreamer suspended within a well on the usual drill pipe;

Fig. 2 is an enlarged medial section through the body of the underreamer and one of the cutter assemblies, the cutter being shown in expanded position;

Fig. 3 is a view similar to Fig. 2 showing the cutter in one contracted position;

Fig. 4 is a section on line 4—4 of Fig. 3;

Fig. 5 is a section on line 5—5 of Fig. 2;

Fig. 6 is a view similar to Figs. 4 and 5 showing the cutters in another contracted position corresponding to Fig. 9;

Fig. 7 is a section on line 7—7 of Fig. 3;

Fig. 8 is a section on line 8—8 of Fig. 2; and

Fig. 9 is a view similar to Figs. 7 and 8, showing the cutters swung with their carriers to contracted position.

The typical embodiment of my invention shown in the drawings comprises a reamer body 10, preferably made in a single solid piece, and having the usual tool joint connection at 11 with the drill pipe 13. The body is provided at its lower end with the tool joint box 14 within which pin 15a of the drill bit 15 is threaded to join the underreamer and

bit for operation in the usual manner. The body 10 is drilled longitudinally to provide the lower bore 16*a* and the upper and comparatively longer counterbore 16*b*. Within the bores is a vertically movable cutter actuating plunger 17 having enlarged and reduced portions 17*a*, 17*b*, and having a substantially sliding fit within the bores 16*b*, 16*a*, respectively. The plunger has a central bore 18 through which circulating fluid is delivered from the drill pipe 11 to fluid passages 19 in the drill bit 15. Downwardly tapering conical wedge faces 20 and 21 are formed on the plunger at the lower ends of sections 17*a*, 17*b*, respectively, these faces being adapted to coact with corresponding wedge faces on the cutter assembly to move the latter radially outward upon downward movement of the plunger, as will be described later.

Longitudinal recesses 23 are formed in the sides of the body to take the cutters, the recesses having preferably curved sides 23*a*, 23*b* against which the cutters are backed in their two respective contracted positions shown in Figures 4 and 6. At the upper and lower ends of recesses 23, the body is cut away to form recesses 24 and 25 which may be of somewhat less depth than recesses 23, and shaped to provide flat bearing surfaces 45 and 26 for the sides of the cutter carrier, hereinafter described, when swung to the respective positions shown in Figs. 8 and 9. Radial slots 28 are formed in the body between bore 16*b* and recesses 24, the slots being extended above the upper end of the recesses as at 28 to provide confinement for the upper end of the cutter supporting blocks 29 and pins 30*a* of cutter carrier heads 30. Radial slots 31 are formed between recesses 25 and the lower bore 16*a*, and openings 32 are formed in the body below the slots to take the lower ends of the cutter supporting blocks 33 and the pin ends 34*a* of cutter carrier heads 34.

The swinging cutters embodied in the present type of reamer may be of any suitable form and character, and it may be mentioned that although for purposes of illustration I show herein a reamer having three swinging cutter assemblies, any other suitable number and arrangement of the cutters may be used. By the cutter assembly I refer to the combined cutter and cutter supporting and carrying parts generally indicated at 35, and which in its preferred form embodies the roller cutter 37 mounted on the cutter carrier which comprises the upper and lower heads 30 and 34 and a radially inclined interconnecting stem 37*a*, which also forms the shaft for roller 37, and the radially movable cutter supporting blocks 29 and 33. The upper supporting block 29 has an inclined conical wedge face 36 adapted to coact with wedge face 20 on the plunger to cause the supporting block and the upper cutter carrier head 30 to move radially outward. And as previously mentioned, the block and carrier are guided in such radial movement by their upper ends extending within the upper portion 28*a* of the slot. The lower supporting block 33 likewise is moved radially outward, together with the lower carrier head 34, by virtue of the engagement of its inner inclined wedge face 39 with the lower plunger wedge face 21, the lower block and cutter carrier being confined for radial movement by their lower pin ends 33*a*, 34*a* respectively, extending in the body slot 32. In the contracted position of the cutter assembly shown in Fig. 3, the upper supporting block 29 has bearing on its inner side against the plunger, the lower supporting block 33 bearing against the body wall 10*c* at the inner side of the opening 32 and against plunger wedge face 21. Upon downward movement of the plunger to the position of Fig. 2, the cutter assemblies are moved radially outward, preferably to the point of engagement of the cutter carrier head pins with the body at the outer ends of slot 28 and the opening 32. It will be readily apparent that the supporting block structure for each cutter assembly may conveniently be made in one piece should it be desired, for instance by forming a continuous slot (not shown) in the body at 50 between slots 28, and 31, and interconnecting blocks 29, 33 to form a single supporting member for both carrier heads.

The roller cutters together with the carrier heads 30 and 34 thus swing horizontally about the pin ends 30*a*, 34*a* of the carriers, pin 34*a* being offset radially inward relative to pin 30*a* in accordance with the inclination of the cutter from true vertical position, in order to enable the cutter to remain at all positions of its swinging movement in a vertical axial plane of the body. It may be mentioned that insofar as the characteristic relative movements between the carrier heads and the supporting blocks are concerned, the heads may be pivotally mounted on the blocks themselves instead of being journaled in the body. However, for purposes of construction the illustrated pivotal mounting of the cutters in the body is preferred. The outer ends of the blocks preferably have cylindric faces 40 fitted to the inner cylindric ends of the carrier blocks and their pin ends, in order to provide maximum surface engagement of the carriers within the supporting blocks for all positions of the cutters. As shown in Figs. 8 and 9, in the expanded positions of the cutter assemblies, the straight end faces 41 of the supporting blocks are brought flush with the backing surfaces 26 on the body, thereby enabling the cutters to swing from the positions of Fig. 8 to those in Fig. 9 in which the sides of the carriers are brought to bear against the surfaces 26.

With the cutter assemblies in the contracted

positions of Fig. 3, the relative positions of the cutters within body recesses are as shown in Figs. 4 and 7, the cutters preferably bearing against the curved sides 23*a* of recesses 23, and appreciable swinging movement of the carrier heads being prevented by their engagement with the sides of slots 28 and 31. Upon downward movement of the plunger, the cutter assemblies are moved radially outward to the positions of Figs. 2, 5 and 8, as previously described, and to such positions that the carriers are free to swing about their pins to move the cutters to the contracted positions shown in Fig. 9, and in which positions the cutters preferably are brought to bear against sides 23*b* of recesses 23. Thus it will be noted that the cutters have two contracted positions, the one (Fig. 7) in radial alinement with the guide slots when the cutter assemblies are in contracted positions, and the other as shown in Fig. 9 in which the carriers are swung to allow the cutters to be backed into recesses 23.

The plunger is actuated in its downward movement from the position of Fig. 1 to that of Fig. 2 by the impact of a suitable object shown typically herein as a tubular segment 42 dropped within the drill pipe from the ground level. Preferably a washer 43 of copper or other comparatively soft metal is placed within the upper end of the plunger to deaden the impact or driving force of the tubular segment 42 against the plunger. Although the described expansive movement of the cutter assemblies may be effected by dropping the plunger itself within the drill pipe, it is preferred that the plunger be driven through its cutter expanding movement in the manner described in order to prevent damage to the plunger which might result from its being dropped through the drill pipe. The cutter impelling member 42 being tubular, circulation through the reamer to the drill bit is maintained after the plunger is driven to its lower position.

In carrying out operations, the reamer may be lowered to the working region in the well below casing 44 with the plunger in raised position and with the cutter assemblies in the contracted position shown in Fig. 7, or with the carrier heads in their outermost radial positions and the cutters swung to the positions shown in Fig. 9. If the diameter of the well bore below the casing is sufficient to permit complete expansive movement of the cutters, the reamer may be lowered with the cutter assemblies contracted (Fig. 7) and cutters then expanded by driving the plunger downward. However, in case the well bore is of insufficient size to permit complete expansive movement of the cutters, thereby preventing the plunger from being driven to its lowermost position, the reamer may be lowered with the cutters swung to the contracted positions shown in Fig. 9, expansive movement of the cutters thereafter being effected by rotation.

Assuming the reamer to be lowered below the casing with the cutter assemblies in the positions of Fig. 3, or with the plunger supported in raised position by the supporting blocks 29, 33, and the carrier heads and cutters swung to the position of Fig. 9, the tubular segment 42 is then dropped within the drill pipe and upon impact with the upper end of the plunger drives the latter downward to expand the cutter assemblies (Fig. 2) or to move the supporting blocks outward to back up the carrier heads, as the case may be. Upon rotation of the reamer in clockwise direction as viewed in Fig. 8, the carrier heads are brought to engage the sides 45 of recess 24 to provide rotative backing for the cutters, the radial inward thrust of the cutters being taken by the supporting blocks and the plunger. In order to contract the cutters to enable the reamer to be withdrawn through the casing, the drill pipe is rotated in a reverse direction, counter clockwise as viewed in Fig. 9, whereupon the carrier heads by virtue of their inertia, or by the engagement of the cutters with the well bore wall, are swung to back the cutters into recesses 24. Thus by providing cutter assemblies adapted to be actuated by the plunger to move the cutters from one contracted position to expanded position, and carrier assemblies having such characteristics that the cutters may be swung from their expanded positions to another contracted position without operating the plunger, the necessity is obviated for having to return the plunger to its starting position.

I claim:

1. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a radially movable cutter assembly within a slot in said body, and a cutter operating plunger within the body and having a pair of vertically spaced wedge faces adapted to coact with correspondingly spaced wedge faces on said cutter assembly to expand the latter radially, said plunger being adapted to be actuated by an object dropped within the drill pipe, said cutter operating plunger being vertically movable relative to both the drill pipe and said cutter assembly.

2. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a cutter actuating plunger within said body, a radially movable cutter assembly within a slot in the body comprising, a cutter supporting block having wedging engagement with the plunger, and a cutter carrier at the outside of said supporting block; the plunger being adapted to be actuated by an object dropped within the drill pipe to move said cutter assembly radially, said cutter operating plunger being vertically mov-

able relative to both the drill pipe and said cutter assembly.

3. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a cutter actuating plunger within said body, said plunger being vertically movable relative to the drill pipe, a radially movable cutter assembly comprising, a pair of supporting blocks mounted in vertically spaced slots in the body, a pair of pivotally mounted cutter carriers bearing against the outside of said supporting blocks, a shaft interconnecting said carriers and a cutter mounted in the shaft said cutter being capable of lateral swinging movement relative to the body when said cutter assembly is moved to its outermost radial position, and the body being slotted longitudinally to take the cutter in its swinging movement from expanded to radially contracted position.

4. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a cutter mounted on said body, a radially movable cutter supporting assembly comprising means for pivotally mounting said cutter for lateral swinging movement relative to the body, and a plunger within the body for operating said cutter assembly, said plunger being vertically movable relative to both said cutter assembly and the drill pipe.

5. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a cutter mounted on said body, a radially movable cutter supporting assembly comprising means for mounting said cutter for lateral swinging movement relative to the body, and a vertically movable plunger within the body adapted to be actuated by an object dropped within the drill pipe to move said cutter assembly radially.

6. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a plunger within said body, said plunger being vertically movable relative to both said body and the drill pipe, a radially movable cutter assembly within a slot in the body and adapted to be actuated by the plunger, said cutter assembly comprising a cutter supporting block having wedging engagement with the plunger and a pivotally mounted cutter carrier at the outside of said supporting block and adapted to swing laterally on the body to move the cutter from expanded to contracted position.

7. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a vertically movable plunger within said body and adapted to be actuated by an object dropped within the drill pipe, a plunger actuated cutter assembly movable radially within a slot in the body; said cutter assembly comprising a cutter supporting block having wedging engagement with the plunger, and a pivotally mounted cutter carrier at the outside of said supporting block and adapted to swing laterally on the body to move the cutter between expanded and contracted positions.

8. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a cutter mounted on said body, a radially movable cutter supporting assembly comprising means for pivotally mounting said cutter for lateral swinging movement relative to the body, means for actuating said cutter assembly to move it from contracted to expanded position, and means confining the cutter against appreciable swinging movement except at substantially the expanded position of the cutter supporting assembly.

9. An underreamer comprising a tubular body connected with the lower end of a drill pipe, a vertically movable plunger within said body, a radially movable cutter assembly within a slot in the body and adapted to be actuated by the plunger, said cutter assembly comprising a cutter supporting block having wedging engagement with the plunger and a pivotally mounted cutter carrier at the outside of said supporting block and adapted to swing laterally on the body to move the cutter from expanded to contracted position, said cutter carrier being confined within said slot against free swinging movement except at substantially the outermost radial position of the cutter assembly.

In witness that I claim the foregoing I have hereunto subscribed my name this 9th day of August, 1929.

EDWARD F. RAYMOND.