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3,208,540

EXPANSIBLE ROTARY WELL DRILLING BIT

Filed March 21, 1963

2 Sheets-Sheet 1

FIG. 1.

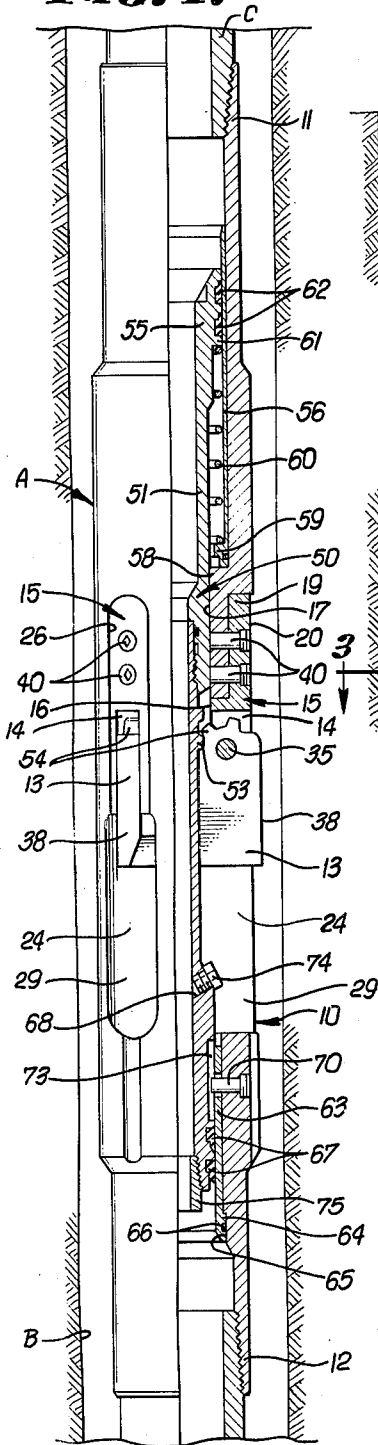
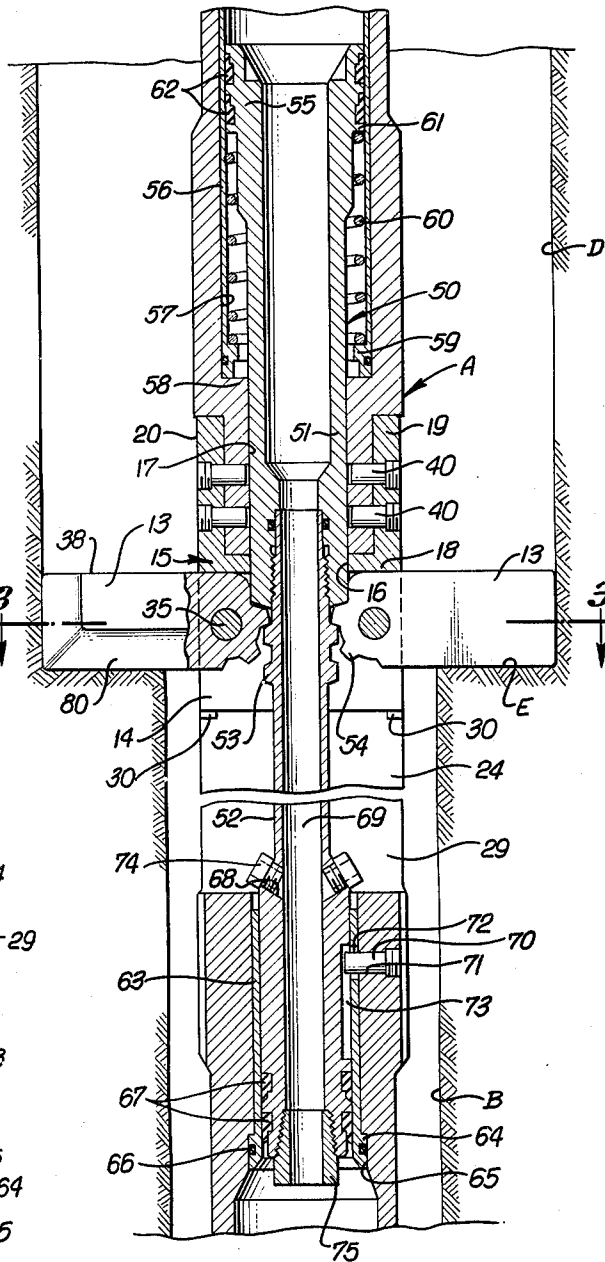


FIG. 2.



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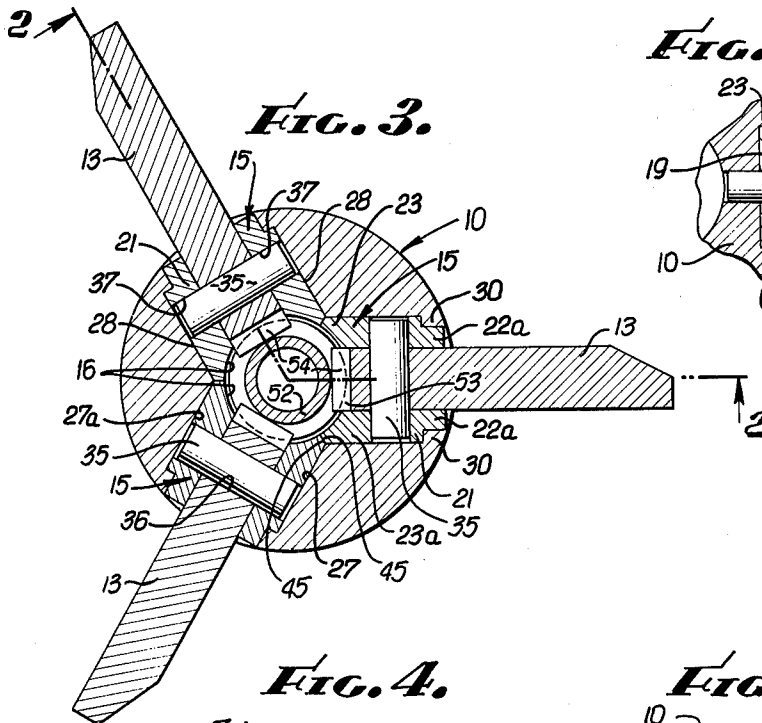
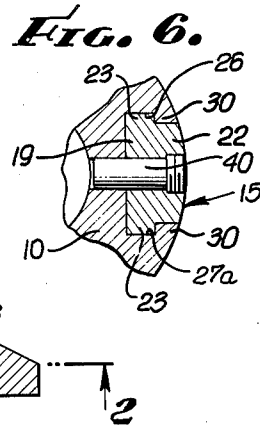
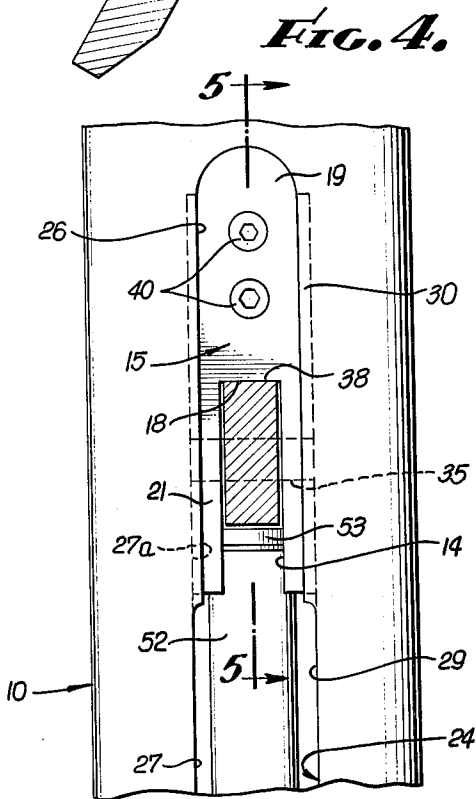
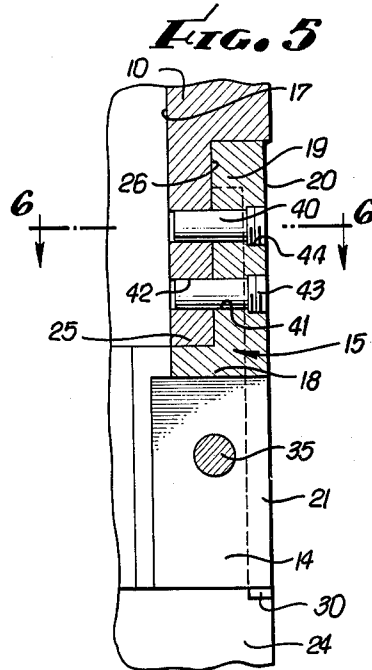
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EXPANSIBLE ROTARY WELL DRILLING BIT

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2 Sheets-Sheet 2



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EXPANSIBLE ROTARY WELL DRILLING BIT
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18 Claims. (Cl. 175-269)

The present invention relates to rotary well drilling bits, and more particularly to bits of the expansible type capable of enlarging the diameters of well bores.

Rotary drill bits of the expansible type include a main body having slots in which the cutter members are mounted for lateral outward movement, for the purpose of enlarging the diameter of a well bore. The provision of the slots in the body and the devices employed for mounting the cutter members on the body have heretofore resulted in body regions having a greatly reduced cross-sectional area at which the body can twist off under high torque loads, or otherwise fail. The mode of mounting the cutter members on the body requires alteration of the body structure to such an extent as to sometimes produce its fatigue failure. Moreover, the coaction between the cutter blade members and body, as well as between the parts of the bit and the body, have been such as to produce wear on the body and substantial reduction of its useful life.

It is an object of the present invention to provide a drill bit of the expansible type having a stronger and sturdier body capable of transmitting greater torque loads safely, and being less susceptible to fatigue failure.

Another object of the invention is to provide a drill bit of the expansible type in which wear on the parts, and particularly the main body of the bit, is greatly reduced, resulting in the main body and cutter parts having a greatly enhanced useful life.

A further object of the invention is to provide a drill bit of the expansible type in which fluid cutting or erosion of its main body is minimized considerably.

An additional object of the invention is to provide a drill bit of the expansible type which is comparatively easy to assemble and disassemble.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a combined side elevational view and longitudinal section through a drill bit of the expansible type with its cutter members in retracted position;

FIG. 2 is an enlarged longitudinal section, taken along the line 2-2 on FIG. 3, of the drill bit disclosed in FIG. 1 with the cutter members in their outwardly expanded position;

FIG. 3 is an enlarged cross-section taken along the line 3-3 on FIG. 2;

FIG. 4 is a side elevational view of a portion of the drill bit, with a cutter member in expanded position;

FIG. 5 is a longitudinal section taken along the line 5-5 on FIG. 4, and with the cutter member removed;

FIG. 6 is a cross-section taken along the line 6-6 on FIG. 5.

A rotary drill bit A of the expansible type is disclosed in the drawings, which is adapted to be lowered in a well bore B on a string of drill pipe C, or other tubular drill-

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ing string, for the purpose of enlarging the diameter of the well bore.

The drill bit includes an elongate tubular body 10 having an upper threaded box 11 for threaded attachment to the lower end of the drill pipe string C, the body also having a lower threaded box or connection 12 for attachment to another tool (not shown), such as a drill bit. The body carries a plurality of circumferentially spaced cutter members 13, such as cutter blades, which can occupy a retracted position substantially completely within the confines of the body 10, and which are adapted to be expanded outwardly to cut an enlarged well bore D, acting upon a transverse formation shoulder E which the cutters themselves can produce.

As specifically disclosed, a set of three cutter blades 13 is carried by the body, the blades being disposed substantially 120 degrees apart. Each cutter blade is mounted within a downwardly opening slot 14 extending completely through a blade support member or block 15 extending from the periphery of the body 10, with the inner surface 16 of the block being curved or made arcuate in shape to conform to the cylindrical surface of the central passage 17 through the tubular body. The transverse slot 14 through each block terminates in an upper downwardly facing shoulder 18, there being an upwardly extending arm portion 19 of the block or support member, the outer surface 20 of which is an upper continuation of the lower portion of the block, the arm portion having a substantially lesser radial extent than the lower portion 21 of the block. The block 15 is essentially T-shaped in cross-section along its lower portion 21, as well as along a substantial extent of its upper portion or arm 19, the outer part 22, 22a of each block being narrower than the inner portion 23, 23a of each block, as shown most clearly in FIGS. 3 and 6. In effect, the inner portion includes oppositely directed side tongues 23, 23a of a narrower lateral extent along the arm portion 19 and of a much broader lateral extent along the lower part 21 of the block.

The body is provided with elongate circumferentially spaced slots 24 extending from its outer surface completely through to its central passage 17, the number of slots conforming to the number of cutter members 13. The upper end of each slot 24 terminates at a downwardly facing inner body shoulder 25, the outer portion of each slot merging into a longitudinal recess or groove 26 in the body exterior. The side walls 27, 27a of the slot and of the groove are parallel to each other, being spaced apart a distance slightly greater than the distance between the sides 28 of a blade block so that the latter will have working clearance in the body slot. The lower portion 29 of each body slot has a uniform width from the interior of the body to its periphery, but the upper portion of each body slot 24, as well as the longitudinal body groove 26, have their outer portions restricted by providing inwardly directed, opposed retaining flanges 30 integral with the body and extending inwardly of each slot and groove, the flanges being spaced apart a distance conforming to the width of the outer portion 22, 22a of each block, including its lower portion and its arm portion.

The lower portion 29 of each slot below the inwardly directed retaining flanges or ribs 30 has a length at least slightly greater than the overall length of the block 15, so that the latter can be moved from the exterior of the body into its lower slot portion 29 and then longitudinally upwardly of the body until the lower body portion 21 engages the body shoulder 25 and the arm portion 19 is disposed within the groove 26, the side portions 23a of the T-shaped block member being disposed within the upper portion of the slot and the side tongues 23 of the

arm being disposed within the groove 26. The retaining flanges 30 are then in overlapping relation with the side tongues 23a, 23 of the lower block portion and its arm portion, as disclosed most clearly in FIGS. 3 and 6.

Each cutter member or blade 13 has a thickness conforming to the width of the support member or block slot 14, being pivotally mounted therein on a hinge pin 35 extending through a hole 36 in the blade and also through aligned bores 37 in the lower portion of the block. Each blade 13 can occupy a retracted or pendant position in the block 15 and body 10 of the tool substantially completely within the confines of the block and main body of the tool, and is swingable upwardly about the axis of its hinge pin 35 to a transverse or horizontal position, such as disclosed in FIG. 2, in which the upper surface 38 of the blade engages the upper end 18 of the block slot 14.

Each cutter blade member 13 is mounted in its block 15 and the hinge pin 35 inserted through the aligned bores 37 of the block and the hole 36 in the blade. The block 15 is then inserted laterally inwardly of the lower portion 29 of the slot and upwardly longitudinally of the body 10 to place the retaining flanges 30 in overlapping relation to the side tongues 23, 23a of the block, with the lower portion 21 of the block engaging the downwardly facing body shoulder 25. One or more retaining screws 40 are then placed through holes 41 in each arm 19 and aligned holes 42 in the body, the retaining members or pins 40 having threaded heads 43 for threaded reception within threaded counterbores 44 in the arm 19. When all of the blade and block assemblies 13, 15 have been mounted in their respective slots 24 and the retaining screws 40 inserted in place, the inner arcuate surfaces 16 of the blocks will all lie on a cylindrical surface, the radius of which conforms substantially to the radius of the cylindrical passage portion 17 of the body, which extends upwardly from the lower portions 21 of the blocks 15, and, in effect, forms a continuation thereof. The inner ends 45 of the blocks abut one another to mutually support each other and assist in resisting movement of the blocks 15 inwardly of the body 10 (FIG. 3). It is evident, particularly from FIGS. 3 and 6, that outward movement of the blocks 15 is prevented by the engagement of the side tongues 23, 23a with the retaining flanges 30. Inward movement of the blocks 15 is also prevented by engagement of the block arms 19 with the longitudinal bases of the grooves 26.

The blades 13 are swingable on their hinge pins 35 between their retracted and expanded positions by the movement of a tubular piston plunger device 50 in the tubular body passage 17. As shown, the piston plunger device includes an upper section 51 insertable into the body 10 through its upper end and a lower section 52 insertable in the body through its lower end. The lower section has upper circular rack teeth 53 thereon adapted to engage gear or pinion teeth 54 formed on the inner portion of each blade 13. The upper portion of the lower section 52 is threadedly secured to the lower portion of the upper plunger section 51, the upper tubular plunger section having a piston head 55 movable in the body. This piston head is slidable along a wear sleeve or liner 56 disposed in an upper counterbore or cylindrical portion 57 of the body 10, the liner bearing against the lower end 58 of the body counterbore and having an inwardly directed flange or spring seat 59 against which the lower end of a compression helical retracting spring 60 bears, the upper end of the spring bearing against the lower end 61 of the piston head. Leakage of fluid between the piston head 55 and the liner 56 is prevented by one or more side seal or piston rings 62 on the head slidably and sealingly engaging the inner surface of the liner.

The lower plunger section 52 is also slidable along a lower sleeve or liner 63 disposed in the body passage below its slots 24. This liner has a lower outwardly directed flange 64 received within a counterbore 65 in

the body, there being a suitable seal ring 66 on this flange engaging the wall of the body to prevent leakage therebetween. The lower portion of the lower plunger member or section 52 also has suitable side seal rings 67 mounted thereon adapted to slidably seal against the inner wall of the lower liner member 63.

The lower plunger member 52 has circumferentially spaced holes 68 directed upwardly and outwardly and communicating with its central fluid passage 69, these holes being spaced apart substantially 120 degrees and adapted to be aligned with the body slots 24. Alignment is secured through use of a retainer and orienting screw 70 threaded in the body 10 and extending through a radial hole 71 in the body and through a companion hole 72 in the lower liner, with its inner end received within a keyway or longitudinal groove 73 in the lower plunger section 52. When the pin or key 70 is received in the groove 73, the plunger holes 68 are appropriately oriented or aligned with respect to the body slots 24. If desired, nozzles 74 can be threaded in the holes 68 for the purpose of directing fluid from the central passage 69 upwardly and laterally outwardly toward the cutter blades or members 13, for the purpose of assisting in removing the cuttings from the well bore B, D and maintaining the blades in a clean and cool condition.

The orienting screw 70 not only orients the fluid nozzles 74 relative to the body slots 24, but it also holds the lower sleeve or liner 63 in assembled position within the lower portion of the body 10.

The retracting spring 60 urges or normally holds the plunger 50 in its upper position in the body 10, in which the rack teeth 53 swing the cutters 13 downwardly in the body 10 to their fully retracted position, such as disclosed in FIG. 1. The lower plunger section 52 has a suitable orifice or bean 75 threaded therein to restrict the flow of fluid through the entire tubular piston plunger device 50, causing a back pressure to be built up above the plunger which acts downwardly on its piston head 55 and shifts the entire plunger device 50 downwardly of the body against the force of the spring, the rack teeth 53 meshing with the teeth 54 on the inner portions of the blades 13 to swing the latter blades upwardly and outwardly to a position substantially normal to the axis of the body, in which their upper surfaces 38 engage the upper ends 18 of the blocks defining the block slots 14.

During outward swinging of the blades 13, the tool A is rotated to cause the blades to enlarge the diameter of the well bore. After the blades have been expanded to their full position, such as disclosed in FIG. 2, downweight can be imposed on the drill pipe C and the drill bit A to force the lower sides 80 of the blades against the transverse shoulder E of the formation, the blades enlarging the hole by progressively digging or cutting away such shoulder as the bit is rotated by the drill pipe. During the drilling action, drilling fluid is being pumped down through the drill pipe C, passing into the plunger 50 and out through its orifice 75 into the well bore therebelow, as well as passing outwardly and upwardly through the nozzles 74. The circulating fluid carries the cuttings around the drill bit A and the drill pipe C to the top of the well bore, in a known manner.

When the drilling operation has been completed, or the blades 13 have become dull and require replacement, the pumping of drilling fluid is discontinued and the drill pipe C and tool A elevated in the well bore B, D. The retracting spring 60 raises the plunger 50 within the body, causing its rack teeth 53 to engage the pinion teeth 54 and swing the blades 13 downwardly to their pendant retracted position within the confines of the body 10 and supporting members or blocks 15. The tool can now be elevated in the well bore, and through any casing or other tubular member (not shown) that might be disposed therein above the open hole D, to the top of the well bore.

With the expansible rotary drill bit device A illustrated and described, a large cross-sectional area through the

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slotted portion of the body 10 remains, capable of safely withstanding high torque loads. The necessity for inserting hinge pins through transverse holes in the body, for the purpose of pivotally mounting blades therein is completely eliminated. The hinge pins 35 only extend into the aligned bores 37 of the blocks 15, each pin being prevented from being removed by the opposed side walls of the body slot 24. Not only does the body 10 possess a high degree of strength, but the absence of any holes for hinge pins, and the like, also eliminates regions where fatigue failure might develop.

The pivotal mounting of each cutter member in the replaceable block 15 results in the absence of any contact between each cutter member 13 and the body 10 of the tool. The downweight or drilling weight is transmitted between the cutter member or blade 13 and the block 15 at the upper end 18 of its slot 14; whereas, the transmission of torque occurs between the side walls of the block defining its slot 14 and the leading and trailing sides of the blade 13. Thus, any wear which occurs as a result of movement of the blade 13 in the block slot 14, the transmission of torque, or vibration or chattering of the blade 13, occurs on the block 15, which is a readily replaceable part.

Each block 15 itself is firmly retained in the body 10, any inward thrust of the formation on the blades 13 being transmitted through the pins 35 to the blocks and from one block to the other two blocks, in view of their abutting inner surfaces 45. Outward thrusts are transmitted from the side tongues 23, 23a of each block to the retaining flanges 30, the length and area of such thrust being very great and subjecting the retaining flanges 30 to a comparatively small unit loading. If any wear does occur on the blades 13, hinge pins 35 and blocks 15, such items are readily replaceable, representing a cost that is a comparatively small part of the cost of replacing an entire tool body 10, in the event that material wear were to occur in any of its vital regions.

The inner portion of the body 10 is also subjected to very little, if any, wear, as a result of movement of the plunger 50 within its passage, or due to the passage of fluid downwardly through the body and the plunger. The piston member 55 shifts downwardly along the liners 56, 63 and not along any surface of the body itself. Wear may occur on the liners, but such liners or sleeves are comparatively inexpensive and readily replaceable. They protect the body 10 itself against wear, and greatly enhance its useful life.

The apparatus is capable of easy assembly and also disassembly. The assembly of each cutter blade member 13 on its hinge pin 35 and within the block 15 has been described above, as well as the mode of mounting each block in the body slot 24 and groove 26, being retained in place by the retainer pins or screws 40. After such assembly has occurred, the lower plunger section 52 is inserted upwardly through the body 10 and lower sleeve or liner 63, the blades 13 being swung outwardly to their fully expanded position, and the lower plunger section 52 shifted upwardly to its fullest extent, at which time, a circular rack tooth 53 on the plunger will engage a tooth 54 on each of the blades 13, the parts being in the relative position shown in FIG. 2. The plunger 52 is then turned to orient its longitudinal groove 73 with the holes 72, 71 in the sleeve 63 and body 10, and the orienting screw 70 inserted in place, which will then appropriately align the fluid holes 68 with the body slots 24. At this time, the nozzles 74 have not been mounted in the holes 68, but they can then be threaded therinto. The upper liner 56 is then inserted into the upper portion of the body and the spring 60 placed around the plunger section 51 with its upper end engaging the piston head 55. The plunger 51 is moved downwardly in the body, the spring 60 engaging its companion seat 59, whereupon a downward force is imposed on the plunger, as by means of a suitable tool (not shown) received within piston head

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recesses 80 to compress the spring and thread the lower portion of the upper section 51 onto the upper portion of the lower plunger section 52, the orienting pin 70 preventing the lower section 52 from turning. When the upper section 51 has been appropriately assembled to the lower section 52, the tool (not shown) can be removed, the spring 60 forcing the entire plunger assembly 50 upwardly to swing the cutter blades 13 downwardly within their slots 14, 24 to their fully retracted position.

The expansible rotary drill bit A can be disassembled by reversing the above-described assembly procedure.

The body slots 24 are preferably made relatively long so that different lengths of cutter blades 13 can be used, depending upon the enlarged hole diameter D desired. The thickness and widths of the blades 13 will be the same for all size blades. It is only their length from the axis of each hinge pin 35 to their outermost end which will change, and which determines the diameter of the enlarged well bore D.

I claim:

1. In a rotary drill bit: a body having a slot; a support member in said slot, said support member having a slot opening downwardly into said body slot; means securing said support member to said body against movement with respect thereto; cutter means in said support member slot; means mounting said cutter means for lateral movement in said support member between retracted and expanded positions, said mounting means extending along its axis no further than the sides of said body slot; and means for expanding said cutter means laterally outwardly of said support member and body and into engagement with said support member at the upper end of said support member slot.

2. In a rotary drill bit: a body having a slot; a support member in said slot, said support member having a slot opening downwardly into said body slot; means securing said support member to said body against movement with respect thereto; cutter means in said support member slot; a pivot pin extending through said cutter means and mounted in said support member on opposite sides of its slot, said pivot pin extending along its axis no further than the sides of said body slot; and means for shifting said cutter means about the axis of said pivot pin between a retracted position substantially fully within said body and an expanded position outwardly of said body and in engagement with said support member at the upper end of said support member slot.

3. In a rotary drill bit: a body having a slot and opposed flanges extending toward each other inwardly of said slot; a support member in said slot and engaging said flanges to be prevented thereby from moving laterally outwardly of said body, said support member having a slot; means securing said support member to said body against movement with respect thereto; cutter means in said support member slot; means mounting said cutter means for lateral movement in said support member between retracted and expanded positions, said mounting means extending along its axis no further than the sides of said body slot; and means for expanding said cutter means laterally outwardly of said support member and body.

4. In a rotary drill bit: a body having a slot and opposed flanges extending toward each other inwardly of said slot; a support member in said slot and engaging said flanges to be prevented thereby from moving laterally outwardly of said body, said support member having a slot; means securing said support member to said body against movement with respect thereto; cutter means in said support member slot; a pivot pin extending through said cutter means and mounted in said support member on opposite sides of its slot, said pivot pin extending along its axis no further than the sides of said body slot; and means for shifting said cutter means about the axis of said pivot pin between a retracted position substantially fully within said body and an expanded position outwardly of said body.

5. In a rotary drill bit: a body having a slot and a groove opening into said slot; a support member in said slot and having an arm portion in said groove; means securing said arm portion to said body against movement with respect thereto; said support member having a slot opening into said body slot; cutter means in said support member slot; means mounting said cutter means for lateral movement in said support member between retracted and expanded positions, said mounting means extending along its axis no further than the sides of said body slot; and means for expanding said cutter means laterally outwardly of said support member and body.

6. In a rotary drill bit: a body having a slot and a groove opening into said slot; a support member in said slot and having an arm portion in said groove; means securing said arm portion to said body against movement with respect thereto; said support member having a slot opening into said body slot; cutter means in said support member slot; a pivot pin extending through said cutter means and mounted in said support member on opposite sides of its slot, said pivot pin extending along its axis no further than the sides of said body slot; and means for shifting said cutter means about the axis of said pivot pin between a retracted position substantially fully within said body and an expanded position outwardly of said body.

7. In a rotary drill bit: a body having a slot and a groove opening into said slot, said body having opposed flanges extending toward each other inwardly of said slot and groove; a support member in said slot and having an arm portion in said groove, said support member and its arm portion engaging said flanges to be prevented thereby from moving laterally outwardly of said body; means securing said support member to said body against movement with respect thereto; said support member having a slot opening into said body slot; cutter means in said support member slot; means mounting said cutter means for lateral movement in said support member between retracted and expanded positions, said mounting means extending along its axis no further than the sides of said body slot; and means for expanding said cutter means laterally outwardly of said support member and body.

8. In a rotary drill bit: a body having a slot and a groove opening into said slot, said body having opposed flanges extending toward each other inwardly of said slot and groove; a support member in said slot and having an arm portion in said groove, said support member and its arm portion engaging said flanges to be prevented thereby from moving laterally outwardly of said body; means securing said support member to said body against movement with respect thereto; said support member having a slot opening into said body slot; cutter means in said support member slot; a pivot pin extending through said cutter means and mounted in said support member on opposite sides of its slot, said pivot pin extending along its axis no further than the sides of said body slot; and means for shifting said cutter means about the axis of said pivot pin between a retracted position substantially fully within said body and an expanded position outwardly of said body.

9. In a rotary drill bit: a body having a central longitudinal passage therethrough and a plurality of circumferentially spaced slots extending from the periphery of said body to said passage; support members in said slots and engaging each other to limit their movement inwardly of said slots; each of said support members having a slot; means securing said support members to said body against movement with respect thereto; cutter means in each support member slot; means mounting each of said cutter means for lateral movement in its support member between retracted and expanded positions; and means for expanding all of said cutter means laterally outwardly of said support members and body.

10. In a rotary drill bit: a body having a central longitudinal passage therethrough and a plurality of circumferentially spaced slots extending from the periphery of

said body to said passage; support members in said slots and engaging each other to limit their movement inwardly of said slots; each of said support members having a slot; means securing said support members to said body against movement with respect thereto; cutter means in each support member slot; a pivot pin extending through each cutter means and mounted in its support member on opposite sides of its support member slot; and means for shifting each of said cutter means about the axis of its pivot pin between a retracted position substantially fully within said body and an expanded position outwardly of said body.

11. In a rotary drill bit: a body having a central longitudinal passage therethrough and a plurality of circumferentially spaced slots extending from the periphery of the body to said passage, said body having circumferentially spaced grooves opening into said slots; said body having opposed flanges extending toward each other inwardly of each slot and groove opening therein; a support member in each of said slots and having an arm portion in its adjacent groove, said support member and its arm portion engaging said flanges extending across said slot and groove to be prevented thereby from moving laterally outwardly of said body; said support members engaging each other to limit their movement inwardly of said slots; each of said support members having a slot opening into a body slot; means securing said arm portions to said body; cutter means in each support member slot; a pivot pin extending through each cutter means and mounted in its support member on opposite sides of its support member slot; and means for shifting each of said cutter means about the axis of its pivot pin between a retracted position substantially fully within said body and an expanded position outwardly of said body.

12. In a rotary drill bit: a body having a central longitudinal passage therethrough and a plurality of circumferentially spaced slots extending from the periphery of said body to said passage, said body having grooves above said slots opening therein; said body having opposed flanges extending toward each other inwardly of each of said slots and its associated groove; support members in said slots and engaging each other to limit their movement inwardly of said slots, each support member also including an upper arm portion in a groove; each of said support members and its arm portion engaging said flanges to be prevented thereby from moving laterally outwardly of said body; each of said support members having a slot opening into its body slot; a cutter blade in each support member slot; a pivot pin extending through each blade and mounted in its support member on opposite sides of its support member slot; and means for shifting each of said blades about the axis of its pivot pin between a lower retracted position substantially fully within said body and an expanded position outwardly of said body and in engagement with its support member at the upper end of said support member slot.

13. In a rotary drill bit: a body having a central passage; cutter means mounted on said body for expansion laterally outwardly of said body; a sleeve in said body passage having a spring seat; means for expanding said cutter means laterally outwardly of said body, including a plunger slidable along said sleeve and movable longitudinally in one direction in said passage in response to fluid pressure in said passage; and a spring engaging said seat and plunger to shift said plunger in the opposite direction to retract said cutter means.

14. In a rotary drill bit: a body having a central passage and circumferentially spaced slots opening into said passage; cutter means mounted on said body in said slots for expansion laterally outwardly of said body; an upper sleeve in said passage above said slots and having a spring seat; a lower sleeve in said passage below said slots; means for expanding said cutter means laterally outwardly of said body, including a plunger slidable along said sleeves and movable longitudinally in one direction in said pas-

sage in response to fluid pressure in said body passage; and a spring engaging said seat and plunger to shift said plunger in the opposite direction to retract said cutter means.

15. In a rotary drill bit: a body having a central passage and circumferentially spaced slots opening into said passage; cutter means mounted on said body in said slots for expansion laterally outwardly of said body; an upper sleeve in said passage above said slots and having a spring seat; a lower sleeve in said passage below said slots; means for expanding said cutter means laterally outwardly of said body, including a plunger having a central passage communicating with said body passage and slidable along said sleeves and movable longitudinally in one direction in said body passage in response to fluid pressure in said body passage; a spring engaging said seat and plunger to shift said plunger in the opposite direction to retract said cutter means; said plunger having nozzles communicating with the plunger passage to direct fluid laterally outwardly through said body slots; and means on said body engaging said plunger to maintain said nozzles aligned with said slots.

16. In a rotary drill bit: a body having a central passage and circumferentially spaced slots opening into said passage; cutter means mounted on said body in said slots for expansion laterally outwardly of said body; an upper sleeve in said passage above said slots and having a spring seat; a lower sleeve in said passage below said slots; means for expanding said cutter means laterally outwardly of said body, including a plunger having a central passage communicating with said body passage and slidable along said sleeves and movable longitudinally in one direction in said body passage in response to fluid pressure in said body passage; a spring engaging said seat and plunger to shift said plunger in the opposite direction to retract said cutter means; said plunger having nozzles communicating with the plunger passage to direct fluid laterally outwardly through said body slots; and a pin on said body extending through said lower sleeve into a longitudinal groove in said plunger to retain said lower sleeve in said body and to maintain said nozzles aligned with said slots.

17. In a rotary drill bit: a body having a central passage and circumferentially spaced slots opening into said passage; cutter means mounted on said body in said slots for expansion laterally outwardly of said body; an upper sleeve in said passage above said slots; a lower sleeve in said passage below said slots; means for expanding said cutter means laterally outwardly of said

body, including a plunger having a central passage communicating with said body passage and slidable along said sleeves and movable longitudinally in one direction in said body passage in response to fluid pressure in said body passage; a spring engaging said plunger to shift said plunger in the opposite direction to retract said cutter means; said plunger having nozzles communicating with the plunger passage to direct fluid laterally outwardly through said body slots; and a pin on said body extending through said lower sleeve into a longitudinal groove in said plunger to retain said lower sleeve in said body and to maintain said nozzles aligned with said slots.

18. In a rotary drill bit: a body having a slot and a groove opening into said slot, said body having opposed flanges extending toward each other inwardly of said slot and groove; a support member in said slot and having an arm portion in said groove, said support member and its arm portion engaging said flanges to be prevented thereby from moving laterally outwardly of said body; means securing said support member to said body against movement with respect thereto; said body slot having a portion extending longitudinally to one side of said flanges by a distance exceeding the length of said support member to enable said support member to be disposed in said slot portion and then shifted longitudinally of said body to position said support member and its arm portion in engagement with and overlapped by said flanges; said support member having a slot opening into said body slot; cutter means in said support member slot; means mounting said cutter means for lateral movement in said support member between retracted and expanded positions, said mounting means extending along its axis no further than the sides of said body slot; and means for expanding said cutter means laterally outwardly of said support member and body.

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50 BENJAMIN HERSH, *Primary Examiner.*