

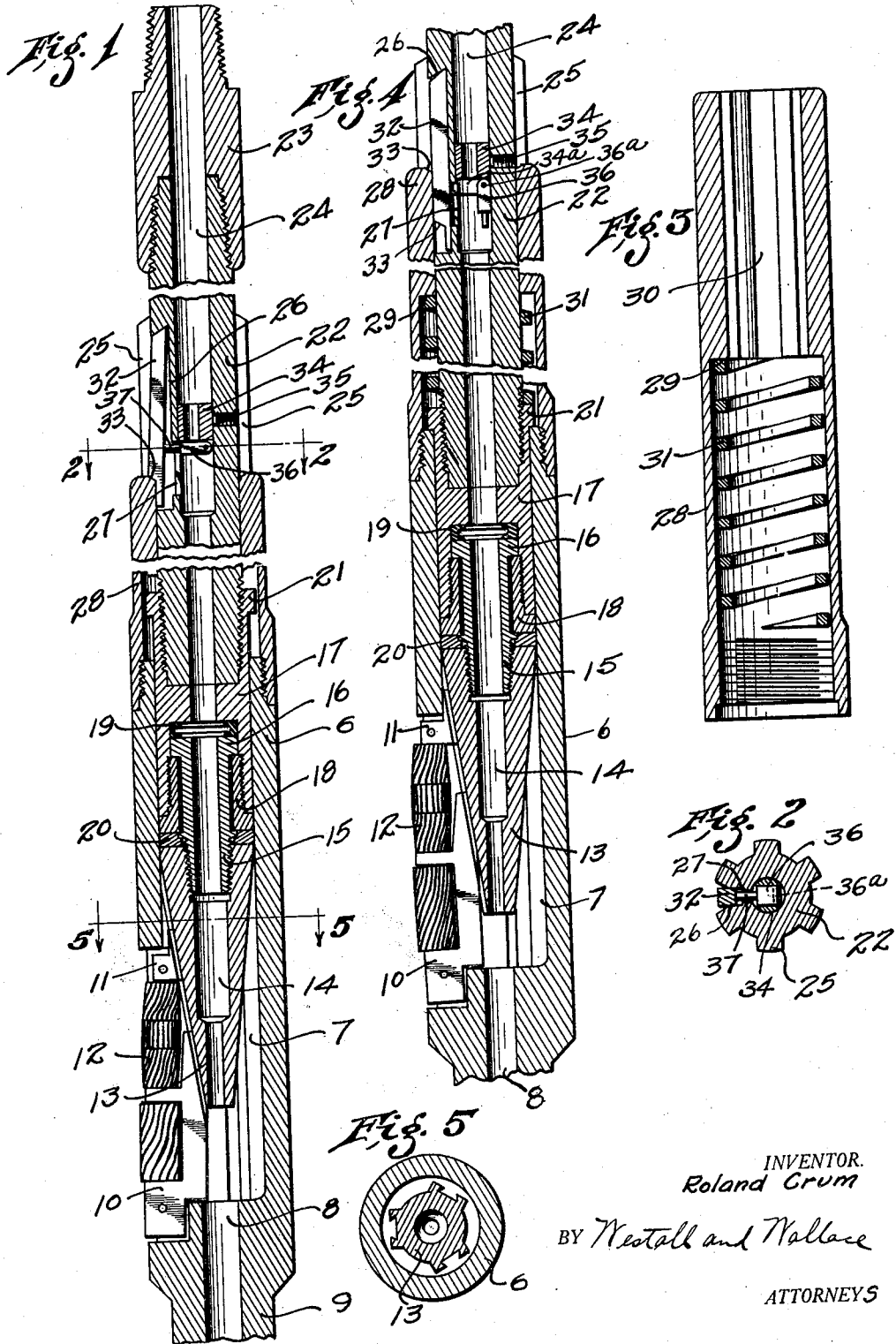
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EXPANSIBLE UNDERREAMER TRIP

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# UNITED STATES PATENT OFFICE

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## EXPANSIBLE UNDERREAMER TRIP

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This invention relates to a trip for holding two longitudinally movable members against movement and actuatable by fluid pressure to release said members.

In tools for well drilling operation having work performing members expansible and collapsible by manipulation of the tool, it is desirable to set and maintain the tool parts in collapsed position and to release them for expansion at a selected time. Thus, it is desirable to run such a tool into the bore hole, and, when the position for expansion has been attained, to release the expansible parts. This invention appertains to a tool wherein fluid is applied to the tool and wherein pressure is caused to be exerted by the fluid, there being a trip mechanism arranged to be operated so as to release the expansible part actuated by fluid pressure. A specific application of the invention is embodied in an underreamer having cutters for expansion and collapse. The present invention contemplates use in a tool provided with a body having expansible work performing members, such as cutters, an expander relatively movable in the body in an axial direction to expand and collapse said cutters, means for urging the expander relatively into position for expanding said cutters, and a novel trip mechanism to restrain the expander from its relative movement into cutter expanding position and operable by circulation fluid. An underreamer embodying these features is disclosed herein.

The objects of this invention are first, to provide a tool of the character described with a catch to retain the parts in collapsed condition and actuatable by fluid pressure to release the same for expansion; second, to provide a tool of the character described used in hydraulic boring of holes, with trip mechanism actuatable by initiation of fluid circulation; and third, to provide details of structure, whereby a strong, durable tool of few parts and easily assembled is obtained.

Other objects and advantages will be made fully apparent from the following specification considered in connection with the accompanying drawings, in which:

Fig. 1 is a longitudinal section through a fragment of an expansible underreamer em-

bodying my invention with parts in collapsed position; Fig. 2 is a section as seen on the line 2—2 of Fig. 1; Fig. 3 is a section through the body sleeve; Fig. 4 is a longitudinal section through a fragment of the underreamer showing parts in expanded position; and Fig. 5 is a section as seen on the line 5—5 of Fig. 1.

Referring more particularly to the drawings, the body is shown as comprising a shell 6 reduced in diameter at the upper end and externally threaded. A bore 7 extends lengthwise of the tool and at the lower end communicates with a passage 8. The lower end of the tool indicated by 9 serves for connection to a bit, not shown, and forming no part of the present invention. The body is longitudinally slotted for accommodation of roller cutters and their mounting. Lower pin blocks 10 are pivotally mounted on the body in the slots so that they may be swung inwardly and outwardly of the body. Upper pin blocks 11 are provided, and between the blocks and journaled therein are shafts or pins carrying sets of rollers 12. The blocks are connected to the wedge end 13 of a stem slidable longitudinally with respect to the body. Tenon and mortise connections are provided between the wedge and the blocks. The construction is such that when the wedge is at its lower position, the cutters will be in their expanded or outer position, and when the wedge is in its upper position, the cutters will be in collapsed position. The exact construction of the cutters, the wedge and their mounting thereon is not pertinent to the present invention. It is sufficient that there is a stem relatively slidable within the body.

The wedge is provided with a circulation passage 14 and at the upper end has a threaded tapered socket to receive the pin 15 on an intermediate portion of the stem. This intermediate portion comprises a pin having a flanged head 16 and is provided with a circulation passage which communicates with the passage 14 and forms a continuation thereof. An intermediate portion 17 has a bore to slidably receive the head 16 of the pin and is threaded at the lower end so that it may be engaged with the bushing 18. A space is provided between the head

16 and the lower wall of the intermediate member, in which is placed a packing ring 19. This may be of rubber. At the lower end of the bushing 18 is a wear ring 20.

5 The construction is such that a swivel connection is provided between the wedge and the intermediate portion of the stem. The upper end of the intermediate portion is enlarged in diameter to provide a flange 21

10 arranged to engage against the top portion of the body. A threaded box is provided at the upper end of the intermediate portion and secured therein is the pin end of the stem shank 22. The upper end of the stem has

15 a threaded pin to which may be attached a sub 23 for attachment to the drill pipe. A bore 24 extends through the shank and communicates with corresponding bores in the sub and in the intermediate portions. Thus

20 the stem unit is provided with a continuous bore. On the periphery of the shank are keys 25 serving to engage corresponding key-ways in a spring sleeve. Extending longitudinally of the shank is a trip key or catch cavity 26,

25 which is open to the bore through a slot 27.

Mounted over the body portion 6 is a spring sleeve 28 forming an extension of the body and having a chamber shouldered at the upper end as indicated by 29. Key-ways

30 30 are provided at the upper end of the spring sleeve to receive the keys 25. Thus the stem is splined to the body. Within the sleeve abutting the shoulder 29 and the head 21 on the stem is a compression spring 31.

35 The construction just described is such that the spring 31 tends to retract the stem relatively into the body and tends to move the body and the cutters upon the stem. In this retracted position, the cutters would be expanded. In the position shown in Fig. 1,

40 the stem is projected from the body, the cutters being in collapsed position.

To retain the stem in its collapsing position, a trip mechanism is provided. This

45 comprises a trip key or catch 32 which is disposed in the cavity 26 and bears against the upper end wall thereof. The key is so mounted in the stem that it may be projected laterally and there is a shoulder 33 on the key for engaging the upper end of the

50 body sleeve 28. When so engaged it acts as a strut and will restrain the body against relative upward movement on the stem, it being urged in the latter direction by the compression spring 31. Within the bore 24 of the stem shank is a sleeve 34. This sleeve has a bore extending through it so that circulation of fluid will be uninterrupted. A set screw

55 35 maintains the sleeve 34 in position. The trip sleeve is transversely slotted as at 34a and pivotally mounted in the slot on pivot 36a is a trigger 36 having a flap portion arranged to be disposed across the bore in the sleeve and a finger 37 which may engage the

65 key 32.

The underreamer is kept in collapsed position by placing the trigger 36 across the bore in the sleeve so that the finger 37 engages the key to hold the latter in its outer position. The stem will have been withdrawn from the body sufficient so that the key rests against the shoulder 33. Immediately upon the initiation of fluid or slush circulation, the flap will be acted upon so as to swing the trigger 36 inwardly to permit the passage of the slush. This releases the strut catch 32. The shoulder 33 is inclined so that the catch will ride over the shoulder and inwardly to clear the body. The spring 31 exerting pressure to cause this movement and move the body upwardly on the stem so as to expand the cutters.

It will be noted that the construction of the stem is such that upon rotation of the tool the torsion is taken by the keys 25 engaging the body. The wedge is free to swivel and is not affected by the rotational efforts.

This application is, in its claimed subject matter, generic to two co-pending applications filed on even date herewith and bearing Serial Numbers 244,126 and 244,127; each of which carries claims to mutually distinct improvements over this application. In the present application certain claims include broadly the body and stem member relatively movable and broadly the trip mechanism. The first mentioned application is directed to an improved type of trip mechanism; the second mentioned to a different type of mechanism for causing relative longitudinal movement of body and stem.

What I claim is:—

1. An expansible underreamer comprising a body and a member longitudinally urgeable with respect to each other, the member having a passage for fluid extending thereinto, and a slot leading from the passage through the member wall, a catch mounted to restrain said member against relative movement in the urged direction; a trigger mechanism for retaining said catch in restraining position including a sleeve mounted in said passage, said sleeve having a transversely extending slot, a trigger trip pivotally mounted in said sleeve slot to be swung across the passage and having a finger for projection through said member slot whereby fluid pressure in said passage will tend to swing said trip in a direction longitudinal of said passage, said finger being arranged so that when transverse of said bore it engages and retains said catch in restraining position and when longitudinal of said bore it releases said catch.

2. An expansible underreamer comprising a body and a relatively longitudinally urgeable member movable therein having a passage extending therethrough for fluid and a slot leading from the passage through the member wall; a catch mounted on said member to engage a surface on said body and re-

strain said member against relative movement in the urged direction; a trigger mechanism for retaining said catch in restraining position including a sleeve mounted in said passage, said sleeve having a transversely extending slot, a trigger trip pivotally mounted in said sleeve slot to be swung across the bore thereof and having a finger for projection through said member slot whereby fluid pressure in said passage will tend to swing said trip toward a direction longitudinal of said passage, said finger being arranged so that when disposed transverse of said bore it engages and retains said catch in restraining position and when longitudinal of said bore it releases said catch.

3. An expansible underreamer comprising a body having a longitudinally extending bore, a relatively longitudinally urgeable member movable in said bore having a passage extending therethrough for fluid, means for urging said member relatively longitudinally in said body, a longitudinally extending key-way in said member; a catch key mounted in said way with one end supported by an end of the wall of said way and the other end disposed to engage an opposing surface on said body when in projected position so as to restrain said member against movement in the urged direction and to release said key when in retracted position so as to clear said surface and release said member; and a trigger for retaining said catch in projected position operable by pressure of fluid in said passage to release said key.

4. An expansible underreamer comprising a body having a longitudinally extending bore, a relatively longitudinally urgeable member movable in said bore having a passage extending therethrough for fluid, means for urging said member relatively longitudinally in said body, a longitudinally extending key-way in said member; a catch key mounted in said way with one end supported by an end wall of said way and the other end disposed to engage an opposing surface on said body when in projected position so as to restrain said member against movement in the urged direction and to release said key when in retracted position by clearing said surface to release said member; and a trigger for retaining said key in projected position disposed at said catch and movable by pressure of fluid therein to release said key.

5. An expansible underreamer comprising a body having a longitudinally extending bore, a relatively longitudinally urgeable member movable in said bore having a passage extending therethrough for fluid, means for urging said member relatively longitudinally in said body, a longitudinally extending key-way in said member; a catch key mounted in said way with one end supported by an end wall of said way and the other end disposed to engage an opposing surface on said body

when in projected position so as to restrain said member against movement in the urged direction and to release said key when in retracted position so as to clear said surface and release said member; and a trigger for retaining said key in projected position pivotally supported at said member and disposed across said passage to be moved by pressure of fluid therein.

6. An expansible underreamer comprising a body having a longitudinally extending bore, a relatively longitudinally urgeable member in said bore having a passage extending therethrough for fluid and a slot leading from the passage through the member walls, means for urging said member relatively longitudinally in said body, a longitudinally extending key-way in said member; a catch key mounted in said way with one end supported by an end wall of said way and the other end disposed to engage an opposing surface on said body when said member is disposed in projected position so as to restrain said member against movement in the urged direction and to release said key when in retracted position so as to clear said surface and release said member; a trigger mechanism for retaining said key in projected position including a sleeve mounted in said passage, said sleeve having a transversely extending slot, a trigger trip pivotally mounted on said sleeve to be swung across the bore thereof and having a finger for projection through said member slot into engagement with said key to retain the latter in projected position and movable by fluid pressure in said bore to be swung into longitudinal position to release said key.

7. An expansible underreamer comprising a tubular body portion, a hollow stem longitudinally movable in the bore of said body and projectable beyond the same, means for urging said stem relatively into said body, there being an outer shoulder at the end of said body and a cavity in said stem; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in outer position and clear said shoulder when in inner position; and a trigger for retaining said catch in projected position operable by pressure of fluid in said passage to release said key.

8. An expansible underreamer comprising a tubular body portion, a hollow stem longitudinally movable in the bore of said body and projectable beyond the same, means for urging said stem relatively into said body, there being an outer shoulder at the end of said body and a cavity in said stem; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in outer position

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and clear said shoulder when in inner position; and a trigger for retaining said key in projected position disposed at said passage and movable by pressure of fluid therein to release said key.

5 9. An expansible underreamer comprising a tubular body portion, a hollow stem longitudinally movable in the bore of said body and projectable beyond the same, means for urging said stem relatively into said body, there being an outer shoulder at the end of said body and a cavity in said stem; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in outer position and clear said shoulder when in inner position; and a trigger for retaining said key in projected position pivotally supported by said member and disposed across said passage being moved by pressure of fluid therein.

10 10. An expansible underreamer comprising a tubular body portion, a hollow stem longitudinally movable in the bore of said body and projectable beyond the same, means for urging said stem relatively into said body, there being an outer shoulder at the end of said body and a cavity in said stem and a slot leading from the cavity to the stem bore; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in outer position and clear said shoulder when in inner position; a trigger mechanism for retaining said key in projected position including a sleeve mounted in said passage, said sleeve having a transversely extending slot, a trigger trip pivotally mounted in said sleeve slot to be swung across the bore thereof and having a finger for projection through said stem slot into engagement with said key to retain the latter in projected position and movable by fluid pressure in said bore to be swung into longitudinal position to release said key.

15 11. An expansible underreamer comprising a tubular body portion, a hollow cutter projecting stem relatively telescopically movable into the bore of said body and projectable beyond the upper end thereof, spring means within said body and about said stem urging said stem relatively into said body, there being an outer shoulder at the end of said body and a longitudinally extending cavity in said stem; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in retracted position; and a trigger for retaining said key in projected position disposed at said passage and movable by pressure of fluid therein to release said key.

20 12. An expansible underreamer comprising a tubular body portion, a hollow cutter

projecting stem relatively telescopically movable into the bore of said body and projectable beyond the upper end thereof, spring means within said body and about said stem urging said stem relatively into said body, there being an outer shoulder at the end of said body, and a longitudinally extending cavity in said stem; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in outer position and to clear said shoulder when in retracted position; and a trigger for retaining said key in projected position disposed at said passage and movable by pressure of fluid therein to release said key.

25 13. An expansible underreamer comprising a tubular body portion, a cutter projecting stem relatively telescopically movable into the bore of said body and projectable beyond the upper end thereof and having a fluid passage, spring means within said body, and about said stem urging said stem relatively into said body, there being an outer shoulder at the end of said body and a longitudinally extending cavity in said stem; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in outer position and to clear said shoulder when in retracted position; and a trigger for retaining said key in projected position pivotally supported by said stem and disposed across said passage to be moved by pressure of fluid therein.

30 14. An expansible underreamer comprising a tubular body portion, a hollow cutter projecting stem relatively telescopically movable into the bore of said body and projectable beyond the upper end thereof, spring means within said body and about said stem urging said stem relatively into said body, there being an outer shoulder at the end of said body, a longitudinally extending cavity in said stem, and a slot through the stem wall; a catch key accommodated in said cavity with one end supported by an end wall of said cavity and the other end transversely projectable to engage said shoulder when in outer position and to clear said shoulder when in retracted position; a trigger mechanism for retaining said key in projected position including a sleeve mounted in said passage, said sleeve having a transversely extending slot, a trigger trip pivotally mounted in the sleeve slot to be swung across the bore thereof and having a finger for projection through said stem slot into engagement with said key to retain the latter in projected position, and movable by fluid pressure in said bore to be swung into longitudinal position to release said key.

35 15. In a tool of the character described, a

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hollow cutter carrying body with cutter receiving slots in its wall, cutters movable in and out in the body slots, a cutter expanding stem entering the body at one end, the body and stem being relatively longitudinally movable, the stem ending within the hollow body, and having a circulation passage leading through it and delivering at the stem end directly into the body interior behind the cutters, and the body having a circulation passage leading from its hollow interior on to its other end for delivery to a tool attached there, whereby the circulating fluid on its way through the body and stem comes into contact with the cutters.

16. In a tool of the character described, a hollow cutter carrying body with cutter receiving slots in its wall, cutters movable in and out in the body slots, a cutter expanding stem splined in the body for relative longitudinal movement and including a cutter expanding wedge rotatively swivelled to the splined part of the stem, all whereby the cutters may be contracted and expanded by relative longitudinal movement between the body and stem and whereby rotary movement may be transferred from the stem through the body to the cutters and no rotary strain is transferred to the cutter through the wedge.

17. In a tool of the character described, a hollow cutter carrying body with cutter receiving slots in its wall, cutters movable in and out in the body slots, a cutter expanding stem splined in the body for relative longitudinal movement and including a cutter expanding wedge rotatively swivelled to the splined part of the stem, the cutters backing up against the wedge and being dovetailed thereto, all whereby the cutters may be contracted and expanded by relative longitudinal movement between the body and stem and whereby rotary movement may be transferred from the stem through the body to the cutters and no rotary strain is transferred to the cutters through the wedge.

18. A rotary tool of the character described comprising a hollow body; work performing members projectable and retractable with respect to said body; a longitudinally urgeable expander for said work performing members mounted in the bore of said body including a stem for rotating said tool, an expander head swivelled to said stem and engaged with said work performing members to project and retract the latter, and coupling means securing said stem to said body to provide for longitudinal movement and to restrain rotation in relation to one another and take the torsional strain of rotating said tool.

19. A tool of the character described comprising a hollow body; work performing members projectable and retractable with respect to said body; a longitudinally urgeable member for said work performing members mounted in the bore of said body including a

stem, an expander head swivelled to said stem and engaged with said work performing members to project and retract the latter, coupling means securing said stem to said body to provide for longitudinal movement and to restrain rotation in relation with one another; and a trip mechanism to restrain said stem and body against longitudinal movement in the urged direction.

20. A rotary tool of the character described comprising a hollow body having slots in the peripheral wall thereof, work performing members projectable and retractable through said slots; a longitudinally urgeable tubular expander for said work performing members mounted in the bore of said body including a stem for rotating said tool, said stem having a socket, an expander head having a pin disposed in said socket to provide a swivel connection, packing for said pin and socket, said head being engaged with said work performing members to project and retract the latter, coupling means securing said stem to said body to provide for longitudinal movement and to restrain rotation in relation to one another, and to take the torsional strain of rotating said tool.

21. A tool of the character described comprising a hollow body having slots in the peripheral wall thereof, work performing members projectable and retractable through said slots; a longitudinally urgeable tubular expander for said work performing members mounted in the bore of said body including a stem having a socket, an expander head having a pin disposed in said socket to provide a swivel connection, packing for said pin and socket, said head being engaged with said work performing members to project and retract the latter; means securing said stem to said body to provide for longitudinal movement and to restrain rotation in relation to one another; and a trip mechanism to restrain said stem and body against longitudinal movement in the urged direction.

22. A rotary tool of the character described comprising a hollow body having slots in the peripheral wall thereof, work performing members projectable and retractable through said slots, a longitudinally urgeable tubular expander for said work performing members mounted in the bore of said body including a stem having a socket, an expander head having a wedge end, said work performing members being mortised to the inclined face of said wedge to cause said wedge to expand and contract said members, said expander head having a pin disposed in said socket to provide a swivel connection, said body and said stem being provided with key-ways to provide for longitudinal movement and to restrain rotation in relation to one another.

23. A rotary tool of the character described, comprising a body, work performing members projectable and retractable with re-

spect to said body, an expander for said work performing members associated with and longitudinally movable relative to the body, said expander including a stem for rotating the tool, an expander head swivelled to the stem and engaged with the work performing members to cause their expansion and contraction, and coupling means securing the stem to the body to provide for relative longitudinal movement and to restrain rotation in relation to one another and take the torsional strain of rotating the tool.

In witness that I claim the foregoing I have hereunto subscribed my name this 5th day of December, 1927.

ROLAND CRUM.

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