

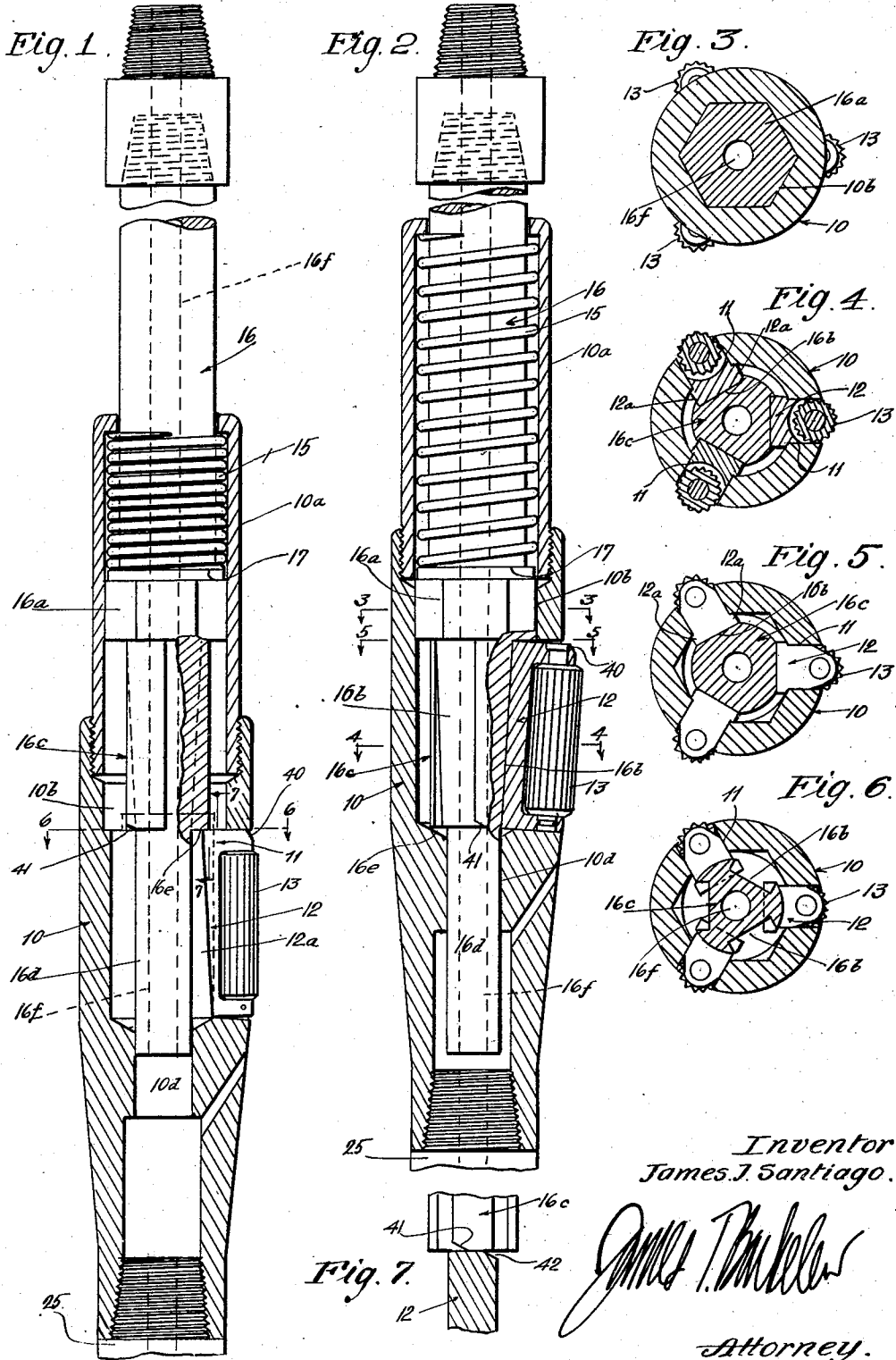
Sept. 2, 1930.

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1,774,764

EXPANSIVE REAMER

Original Filed Feb. 1, 1928



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EXPANSIVE REAMER

Application filed February 1, 1928, Serial No. 250,963. Renewed July 2, 1929.

This invention has to do with expansive cutting tools, reamers or underreamers. The particular design shown and explained herein is adapted specifically to rotary underreaming; but it will be recognized from what follows that, although the invention is particularly useful as a rotary tool, it is not necessarily restricted to such specific use.

In reamers where spring or similar actuation is used for expanding or protracting the cutters, it has been universally the case, so far as my knowledge goes, that the spring action, tending at all times to press the cutters outwardly, has caused them to "ride" the casing while the tool is being lowered or pulled up through the casing. The drag of the cutters on the casing is, in many instances, quite forcible, particularly as the tool is being lowered; because the cutters are usually expanded by some kind of wedging action, actuated by the spring, and the upward drag of the casing on the cutter is accentuated by the wedging action. The cutters thus, in many instances, press outwardly with considerable force against the casing, cutting and scoring the casing, and causing considerable wear on the cutters.

This invention is in the nature of a modification or improvement upon the specific form of expansive reamer set out in the application of Stewart L. Campbell, Serial No. 253,541, filed Feb. 11, 1928, entitled "Expansive reamer".

In said application, Campbell sets out a structure providing a cutter locking or cutter holding means which will hold the cutters inwardly at their contracted positions; such cutter holding or locking means being provided in a spring actuated expanding reamer in such a manner that although the spring is available for performance of its usual cutter expanding function, the expanding action of the spring upon the cutters is temporarily locked. In both said Campbell application and this present application the cutters are shown as having a lateral expanding action by virtue of relative longitudinal movement with reference to an expanding mandrel which has a wedging action on the cutters. In all the broader or generic aspects

common to both these applications, the invention is the subject matter of said Campbell application. The distinguishing and particular invention, which is the subject matter of my present application, is generally in the adaptation of such cutter locking means to an underreamer in which the relative longitudinal movement is one that takes place by reason of the mandrel moving longitudinally in and with reference to the body; and in certain other particular characteristics appertaining to such an arrangement.

Thus in my improved form of locking arrangement I provide a cutter expanding mandrel which is movable both longitudinally and rotatively with respect to the cutter carrying body. That is, the mandrel is rotatable within the body, and the body moves up and down on the mandrel. The mandrel is provided with circumferentially alternating parts, one of which is adapted to seat upon the cutter or cutter carrier and, by longitudinal spring pressure, to thus clamp the cutter carrier in contracted position; and the other of which is in the nature of a slot or groove adapted to take the cutter carrier and, by longitudinal movement of the cutters with relation to the mandrel under pressure of the spring, cause outward movement or expansion of the carrier.

The features of the invention will be best understood from the following detailed description of a preferred, illustrative form, reference for such purpose being had to the accompanying drawings, in which:

Fig. 1 is a central longitudinal section showing the parts in their contracted positions;

Fig. 2 is a similar view showing the parts expanded;

Fig. 3 is a cross-section on line 3—3 of Fig. 2;

Fig. 4 is a cross-section on line 4—4 of Fig. 2, Figs. 3 and 4 showing the tool expanded;

Fig. 5 is a cross-section, on line 5—5 of Fig. 2, showing the tool expanded;

Fig. 6 is a cross-section on line 6—6 of Fig. 1 showing the tool contracted;

And Fig. 7 is a detail section on lines 7—7 of Fig. 1.

In the drawings the numeral 10 designates a suitable and substantially tubular body having a plurality of longitudinally extending slots 11 through its tubular wall adapted to take cutter carriers 12. These cutter carriers fit the slots fairly closely, both longitudinally and laterally, so that their only movement relative to the body is a substantially radial movement in and out. To limit their outward movements the carriers have side wings 12^a along their rear longitudinal edges, these side wings bearing outwardly against the body wall when the cutters are expanded, as shown in Fig. 4. The nature of the ultimate cutters or ultimate cutting elements mounted on the carriers is immaterial to my present invention. I have shown them as being rolling reaming cutters 13; but they may be any kind of cutter or cutting element desired for any particular purpose. In fact the nature of the cutting element is not in my invention limited even to well reaming; the cutting element mounted on the carriers 12 may be for the purpose of perforating or cutting off casing or for similar or other operations.

I have shown the body as having a tubular extension 10^a within which the mandrel moving spring 15 is housed. This spring surrounds the upper part of the mandrel 16 and presses downwardly against a shoulder 17 and thus tends at all times to move the body and carrier relatively upwardly. Immediately below the spring seating shoulder 17 the mandrel has a part 16^a which is non-cylindric, for purposes hereinafter explained, and I have here chosen to show the part 16^a as hexagonal in cross-section. This hexagonal part 16^a is freely rotatable within body extension 10^a but, when the mandrel and body are in the relative positions shown in Fig. 2 this hexagonal part 16^a fits into a corresponding hexagonal part 10^b of the body bore so that in this position the mandrel and body are rotatively locked together in a certain definite position. Below the hexagonal part of the mandrel has a plurality of longitudinally extending grooves 10^b, here shown as three in number because the cutter carriers are chosen to be three in number. The part of the mandrel in which these grooves are cut—the mandrel part designated generally by the numeral 16^c, has a diameter greater than the lowermost reduced part 16^d of the mandrel; so that, between the spaced grooves 16^b, the part 16^c presents three downwardly facing and circumferentially spaced shoulders 16^e.

The lower reduced portion 16^d of the mandrel has a bearing in the body bore 10^a; and the mandrel throughout its length has a water course 16^f adapted to pass circulating water down to a drill bit 25 which is attached in the usual manner to the lower end of the tubular body.

The mandrel grooves 16^b are of proper width to take the inner or rear ends of the cutter carriers 12; and the bottoms of these grooves 16^b are inclined so that as the body and cutters move upwardly to the position of Fig. 2, with the groove 16^b registering with and taking the cutter carriers, the cutter carriers are moved outwardly to their expanded positions. In this expanded condition of the tool the hexagonal body bore 16^b has also moved up onto the hexagonal mandrel part 16^a, and thus the mandrel is rotatively locked directly to the body and is also rotatively locked to the carriers and through the carriers to the body.

For insertion in a well pipe the parts are placed in the relative positions shown in Figs. 1 and 6. The body and cutters are in their relatively lower position and have been rotatively adjusted so that the grooves 16^b do not register with the cutter carriers but the shoulders 16^e are pressing down on the cutter carriers. In this position, therefore, the cutter carriers are clamped, under the force of spring 15, in their contracted positions; and the cutters and body are locked against relative upward movement. When the tool reaches the point at which work is to begin, it is rotated right-handedly through the medium of the drill stem which is attached to the upper end of the mandrel. Friction of the cutters or cutter carriers with the surrounding wall causes the carriers and the body to drag behind and thus allows the mandrel relatively to rotate ahead. As soon as the mandrel has rotated relatively through about one-sixth of a revolution the mandrel grooves 16^b register with the cutter carriers and the spring 15 immediately moves the parts to the relative position of Fig. 2, the cutters being moved to their expanded positions and the mandrel hexagon 16^a entering the body hexagon bore 10^b. In this condition the tool is thus locked rigidly against any relative rotation of its component parts.

Upon pulling the tool up into the casing the casing engages the cutter carriers or cutters and holds the body and cutters down while the mandrel is moved upwardly, the cutter carriers being moved inwardly by casing engagement because of the diagonal upper corner surfaces 40. When the mandrel has been moved up high enough with relation to the body and cutter carriers the mandrel can then be rotated to throw the shoulders 16^e over the cutter carriers and the parts are then in the position of Fig. 1. To provide that the shoulders can be rotatively swung over the carriers, although the casing may not hold the carriers down until the mandrel has quite reached the relative elevated position shown in Fig. 1, one corner of each shoulder surface 16^e may be bevelled as shown at 41 so that rotation of the mandrel will first push the cutters further down to the

position of Fig. 1, so that the square shoulder 16^e of the mandrel can then pass over the cutter carriers. For the same purpose the upper end of each carrier 12 may be given a corner diagonal surface 42. In this position the cutter carriers are again locked or clamped in their contracted positions and the tool may be raised or lowered in the casing without the cutters riding against its interior surface.

I claim:

1. In an expansive tool of the character described, a tubular body with a slotted wall, a cutter carrier movable in and out through the wall slot, a cutter expanding mandrel in the body, the body and mandrel being movable relative to each other both longitudinally and rotatively, a spring tending to move the body and carrier longitudinally on the mandrel in one direction, the mandrel having a carrier engaging shoulder of limited circumferential extent which when engaged with the carrier prevents longitudinal movement of the body and carrier by the spring.

2. In an expansive tool of the character described, a tubular body with a slotted wall, a cutter carrier movable in and out through the wall slot, a mandrel within the body, the body and mandrel being relatively movable longitudinally and rotatably on a longitudinal axis, a spring tending to move the body and carrier longitudinally in one direction, the mandrel and carrier being formed to cause outward movement of the carrier when the body and carriage are moved in said direction by the spring, and a carrier engaging shoulder of limited circumferential extent on the mandrel adapted to engage the carrier in one rotative position of the mandrel to prevent longitudinal movement of the carrier and body by the spring.

3. In an expansive tool of the character described, a tubular body with a slotted wall, a cutter carrier movable in and out through the wall slot, a mandrel within the body, the body and mandrel being relatively movable longitudinally and rotatably on a longitudinal axis, a spring tending to move the body and carrier longitudinally in one direction, the mandrel and carrier being formed to cause outward movement of the carrier when the body and carrier are moved in said direction by the spring, and a plurality of circumferentially extending and circumferentially spaced carrier engaging shoulders on the mandrel each adapted in one rotative position of the mandrel to engage the carrier and prevent longitudinal movement of the carrier and body by the spring.

4. In an expansive tool of the character described, a tubular body with a slotted wall, a cutter carrier movable in and out through the wall slot, a central mandrel in the body and rotatable therein on a longitudinal axis

and the body and carrier being movable on the mandrel on said longitudinal axis, a spring tending to move the body and carrier on the mandrel longitudinally in one direction, the mandrel having a relatively enlarged part presenting circumferentially spaced shoulders facing in the opposite direction and said shoulders adapted to engage with a longitudinal end of the cutter carrier, said enlarged mandrel part having, between said shoulders, carrier receiving slots the bottoms of which are disposed angularly with reference to the longitudinal axis so that longitudinal movement of the carrier on the mandrel causes outward movement of the carrier.

5. In an expansive tool of the character described, a tubular body with a slotted wall, a cutter carrier movable in and out through the wall slot, a mandrel within the body, the body and carrier being relatively movable longitudinally and rotatably on a longitudinal axis, a spring tending to move the body and carrier longitudinally in one direction, the mandrel and carrier being formed to cause outward movement of the carrier when the body and carrier are moved in said direction by the spring, a carrier engaging shoulder of limited circumferential extent on the mandrel adapted to engage the carrier in one rotative position of the mandrel to prevent longitudinal movement of the body and carrier by the spring, and rotative interlocking means on the mandrel and body adapted to be interengaged by said longitudinal movement with relation to the mandrel.

6. In an expansive tool of the character described, a tubular body with a slotted wall, a cutter carrier movable in and out through the wall slot, a central mandrel in the body and rotatable therein on a longitudinal axis and the body and carrier being movable on the mandrel on said longitudinal axis, a spring tending to move the body and carrier on the mandrel longitudinally in one direction, the mandrel having a relatively enlarged part presenting circumferentially spaced shoulders facing in the opposite direction and said shoulders adapted to engage with a longitudinal end of the cutter carrier, said enlarged mandrel part having, between said shoulders, carrier receiving slots the bottoms of which are disposed angularly with reference to the longitudinal axis so that longitudinal movement of the carrier on the mandrel causes outward movement of the carrier, and rotative interlocking means on the mandrel and body adapted to be interengaged by said longitudinal movement of the carrier relative to mandrel.

7. In an expansive tool of the character described, a tubular body with a slotted wall, a cutter carrier movable in and out through the wall slot, a mandrel rotatable in the body and the body being movable longitudinally on the mandrel, a spring tending to move the

body and cutter carrier longitudinally in one direction, the mandrel being formed to cause outward expansive movement of the carrier by said longitudinal movement, and the mandrel having circumferentially alternating carrier engaging shoulders and carrier receiving grooves adapted selectively to be registered with the carrier by rotation of the mandrel.

10 In witness that I claim the foregoing I have hereunto subscribed my name this 19th day of January, 1928.

JAMES J. SANTIAGO.

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CERTIFICATE OF CORRECTION.

Patent No. 1,774,764.

Granted September 2, 1930, to

JAMES J. SANTIAGO.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, line 85, claim 5, for the word "carrier" read mandrel; same claim, line 93, for the misspelled word "lmted" read limited; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 21st day of October, A. D. 1930.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.