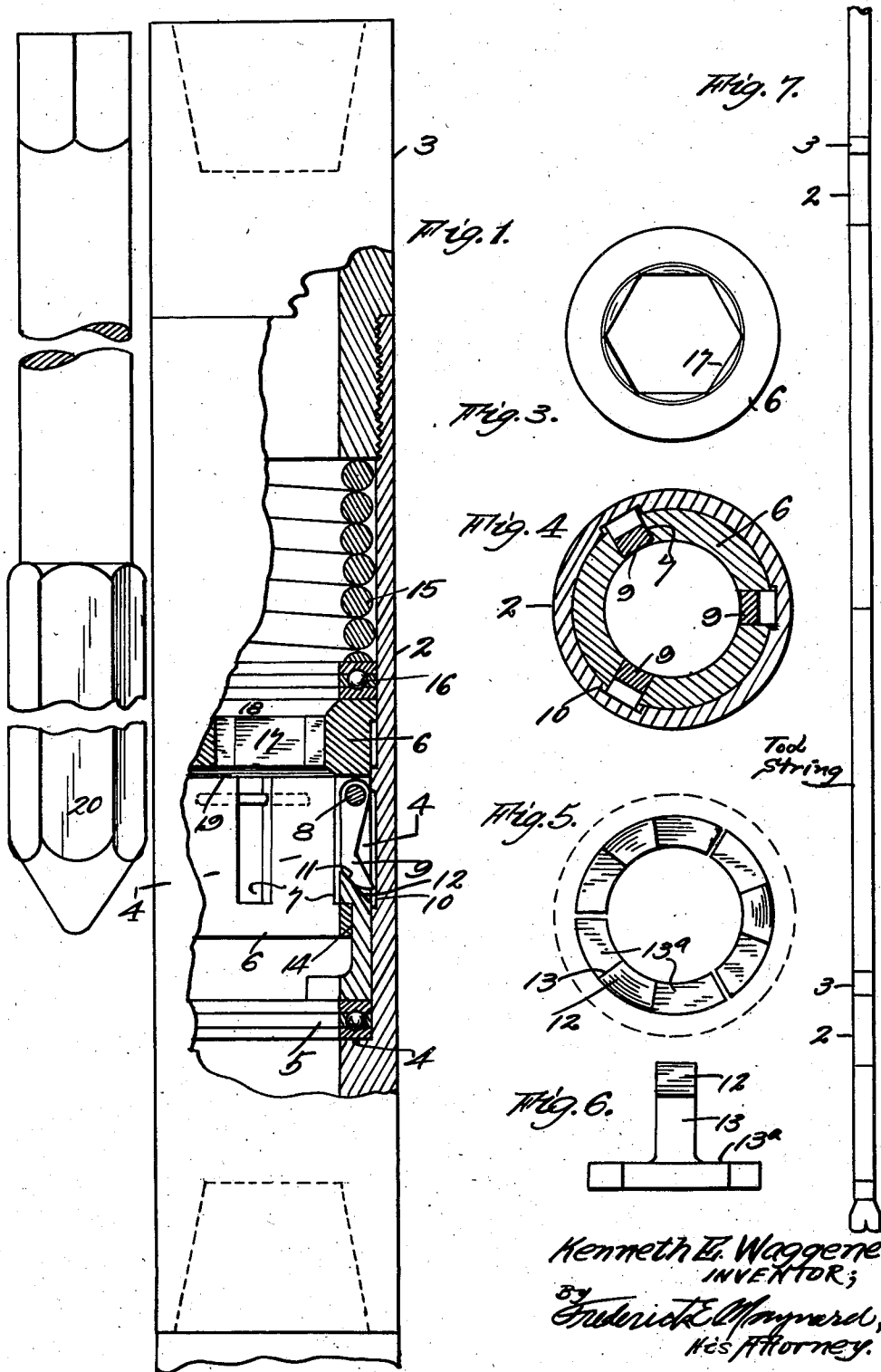


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DRILLING STRING WITH AN INSIDE CUTTING-OFF SUB INCORPORATED THEREIN

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14 Claims. (Cl. 164—0.7)

This invention has to do with earth boring apparatus and particularly deep well drilling tools and is an inside cutting off device in the form of what is known in the industry as a "sub," and which device in this invention comprises a cutting-off tool designed to be directly incorporated as a make-up part of the pipe and drill collar assembly and to remain in situ in the string during regular drilling operations, and other adaptational use as may arise in the ken of operatives and others justified in adaptations of the tool.

It is a common event in the deep well industry to have to introduce what is known as an inside cutting-off tool into a string of drill pipe or other tubular drilling assembly parts to cut off and recover as much as possible of the assembly in such instances where the working tool or employed implements may be so firmly lodged in the hole or a well that only an upper and free portion of the string or of string parts can possibly be fished out of the hole; that is as much as is possible is cut off from the frozen and lower parts. The common practice is when cutting off a drill string in a hole to employ a special whole made up string and provide it with one or another form of inside cutting tool, or possibly an outside cutter (if space is available) and run this special string down in the well string which is to be cut off. Stated in its broadest terms, the present invention has for an object to entirely eliminate making up a special string and cutting off tool assembly and the use thereof, and, instead, to provide a drill or other tool string cutting off sub joint or assembly adapted to be directly incorporated in the drill or other tool make-up string so that in event the working drill or other tool of the string freezes for any of the various well known causes and cannot be pulled from the hole, then the originally incorporated sub joint cutting off bits may be brought into effective cutting-off function.

A further object of the invention is to provide a simple, substantial, compact, easily installed and as easily removed, cutting-off sub assembly to be incorporated as a unit in a drill tool string, or other adaptation and which is provided with normally inactive cutting-off bits, and means in the unit for constantly pressing the idle bits into cutting position, and means for rotating the bits in the unit at will.

An additional object of the invention is to provide a drill string incorporated cutting-off unit which provides for the flow of the usual circulation fluid or mud down the drilling string.

Another object of the invention is to provide a

combination set including an incorporated, drill string cutting-off tool of an inside type and a peculiar wrench and stem to actuate a complementary element of the cutting off tool.

More definitely, an object of the invention is to provide an inside-cutting-off tool having a barrel adapted to be joined up in a drill or other tool string as a normal section of the string and which is provided with means operative at will whereby to cut the barrel transversely to free all upper part of the tool, that is the drill string, to the largest extent possible in the event that lower parts of the string may be unpullably frozen.

The invention consists in certain advancements in the deep well drilling industry as set forth in the ensuing disclosure and having with the above, additional objects and advantages as hereinafter developed, and whose construction, combinations, and details of means, and the manner of operation will be made manifest in the following description of the herewith illustrative embodiment; it being understood that modifications, variations and adaptations may be resorted to within the scope, principle and spirit of the invention, and that its range of industrial application is not intended to be limited.

Figure 1 is an elevational, axial section of the string cutting-off assembly or unit, in normal, non-cutting position of its cutting bits and their cage (one bit only being shown in place).

Figure 2 is a side elevation of a longitudinally broken stud-wrench by which the bit cage is rotated to effect a cut-off operation.

Figure 3 is a top plan of the disassembled cage to show its wrench socket.

Figure 4 is a cross-section on line 4—4 of Fig. 1.

Figure 5 is a top plan of the disassembled group of stationary cutter-thrusting cams, and

Figure 6 is an inner side face view of one of the cutter cams.

Figure 7 is a side view of a drill string incorporating the inside cutting-off tools.

Careful distinction should be made as between the instant cutting-off tool and the conventional types of cutting-off tools which require to be made up in a tool string having for its only purpose to cut off recoverable parts from a working or drill string which in part is lost or frozen in a hole or well. In contrast to such special string, cutting-off tool string, this invention is an incorporated cutting-off tool to be directly mounted in a string made up for some other primary purpose, of which the commonest example is a drill string including drill pipe, drill collars and an attached drilling bit, and one or more of these

novel cutting-off units may be located as deemed most desirable in the length of the drill string as it is made up during drilling operations.

For the purposes thus and above severally specified the unit includes a relatively short and substantial barrel 2 whose lower end is internally threaded for tight reception of a complementary drill joint pin or other fitting (not needed to be shown), whilst the upper end of the barrel is pipe threaded internally for the reception of the near end of a conventional drilling sub 3.

A shoulder 4 of and in the bore of the barrel 2 supports a ball bearing 5.

The barrel cutting-off device

Turnably fitted in the barrel 2 is a short tubular cage 6 having a plurality of longitudinally extending and through windows 7 having across their upper ends suitable pivot rods 8 on which are hung relative, pendent cutting bits 9 whose bite ends face outward toward the near bore face of the barrel 2 and rest in cut-starting channels 10 in the barrel. The lower, innerside end portions of the bits 9 have cam heels 11 which constantly bear on upwardly facing bevel cams 12 formed on the upper ends of stiff cam posts 13 inserted in respective slots 14 in the lower margin of the cage 6. Constructionally to facilitate assembly of the parts the cam posts 13 have wide, segmental feet 13a grouped in ring form and carried on the upper race of the said ball bearing 5. It will be seen, therefore, that the cage 6 is adapted to readily rotate in its enclosing barrel 2 and that during such rotation the bits will bear directly on the bore face of the barrel for cutting function. To produce this cutting it is essential that the points of the bits 9 be powerfully pressed down onto the cams 12 and by reaction thereof forced out and into the metal of the barrel presented thereto.

The bit pressing means includes a strong, suitably compressed helical spring 15 upwardly lodging against the near butt end of the sub 3, and at its lower end seating on the near race of an upper ball bearing 16 seated on the upper end of the bit cage 6. It will be obvious at once that the action of the spring on the cage is to force it down to the extent permitted by the bit cams 12 and the confining wall of the barrel 2. But this constant pressure contact of the bits on the barrel face has no disadvantage since the entire unit turns and axially moves bodily with any motion which the tool string in which it is mounted is given or has during normal function of the tool carried and actuated by the tool string. This brings out the distinction that the cutting-off device of this invention is not operated by, but operates on, its parent string.

To operate the cutters or bits 9 the cage is here shown as having a non-circular top mouth or socket bore section 17 with back-bevelled lips 18—19 for the ready longitudinal pass of a complementary, polygonal headed stud-wrench 20, Fig. 2, the stem of which is adapted to be made up of suitable rod sections to the length needed to lower the wrench head to the socket section 17 of the one, of say several cutting-off units in a drill string, that is to be made, by action of its bits 9, to sever the barrel; preferably the one closest above the ascertained vibration point of the jammed string of the worked, well tool. As the cut-off proceeds the bits are forced outwardly on and by the cams coincidentally with which action the bit cage 6 drifts, under bit control, down the bore of the barrel. When the final

cut is made the spring forces the bits out under the raw bottom edge of the upper cut off part of the barrel.

It is understood that this type of cutting-off unit is in the nature of an emergency measure and frequently there may be no need of bringing it into cutting operation; since no part of the drilling string, in many cases, is frozen.

The unit elements are severally so constructed as to provide a clear central passageway for circulation flow.

What is claimed is:

1. A deep well string cutting off unit including a barrel having at its ends means for connecting upper and lower parts of the string and to constitute a regular connection in the string without interference of the usual string operations, a rotary mechanism housed in the barrel and carrying expansible cutters, means normally expanding the cutters against the wall of the barrel, and means independent of and insertible into the barrel for rotatively moving said mechanism in and effecting severance of the barrel.

2. A deep-well, tool-string incorporated cutting-off mechanism including a string sub and cutter means mounted therein, and means insertible into and removable from the string for actuating said mechanism, said cutter means including a carrier turnably mounted on the sub and cutters movably mounted on the carrier for cutting engagement with the wall of the sub, means for feed-in the cutters into the wall; said insertible means co-rotatively interengaging the carrier and operatively independent of the string sub.

3. A unitary cutting off apparatus adapted for incorporation in a well tool operating string and through which usual fluid circulation may be maintained and including a barrel connective at its ends to adjacent string pipe sections, and a rotary barrel wall cutting means supported in the barrel and adapted for actuation by and the free passage therethrough of an extraneous tool device; said means including a carrier having a set of expansible bits and being turnably mounted on the barrel, means yieldably pressing the bits into cutting engagement with the wall of the barrel; the said presser means and the carrier having a coaxial passageway for the application of the turning tool.

4. A self-contained, self-cutting-off apparatus for use with a well-tool, operating string and including a barrel member attachable at its ends to and for making an intermediate joint section between upper and lower string pipe sections, a system of cutting bits operative in said member, means in the member for thrusting the bits into cutting position on the member, a cutter carrier supported by said member for relative rotation and a device acting on said rotary carrier to effect a constant thrust of the bits onto said means, a rotative tool splining into the carrier by insertion through the said member.

5. A unitary self-cutting-off assembly for attachment in a well tool operating string and including a barrel member attachable at its ends to string sections, a system of cutting bits operative in said member, actuable means in said member for thrusting the bits into effect on said member to sever it and including a cage in which the bits are operatively disposed and which is axially movable in said body member, means reacting on the bits during such axial movement to force the bits outwardly for cutting effect, and means

for actuating the actuable means to effect an orbital cutter action.

6. A unitary cutting-off apparatus for use in a well-tool operating string and including a barrel member attachable to and between upper and lower sections of the string and having end parts for effecting such attachment and being hollow for usual interior well tool operations, a system of cutting bits operative on said member to sever it, means for rotating the system of bits for cutting function, said member rotatively supporting said means; said means including a rotary carrier for the cutters, means to expand the cutters while rotating in said member to sever the same, and a tool relatively rotative as to and insertible axially through said member to engage and turn the carrier.

7. The apparatus of claim 6; and means independent of the rotating means for subjecting the bits to forced feed.

8. A unitary cutting-off tool for incorporation in a well tool operating string and connecting to and between sections thereof and including an external barrel, means thereon adapted for such connection; a cage slidably and rotatively mounted in the barrel, a system of radially movable cutting bits mounted in the cage to be rotated thereby, abutments in the barrel to expand the bits during their rotation, orbitally, and means mounted in the barrel to exert cutting pressure on the several bits, and means independent of the cutter bits for rotating the cage.

9. A unitary cutting-off tool for combination in a given well, apparatus string and including an external barrel directly connective to sections of the string, a cage rotatively mounted in the barrel, a system of movably mounted bits in the cage to transversely sever the barrel, means to expand the cutting ends of the bits and means constantly acting to force the bits against the said expanding means; said cage being rotative independently of said barrel to effect severance of the barrel.

10. The tool of claim 9; and an extraneous implement for motivating the bit cage as to the barrel and being insertible through the barrel and interlockable with the cage to rotate it.

11. A unitary self-cutting-off assembly for attachment in a well tool operating string and including a body member having means at its ends to attach said member to string sections, a system of cutting bits operative in said member, actuatable means in said member for thrusting the bits into cutting action against said member to sever it and including a cage in which the bits are operatively disposed and which is axially movable in the body member, means reacting on the bits during such axial movement to force the bits outwardly for cutting effect, and means for actuating the actuable means to effect rotation of said bits.

12. A deep well-tool string connector body fixably fixed and removably attached at its ends to upper and lower sections thereof for torque and tension transmission in usual string section operations when made up, said connector provided with means for its own severance to divide the string sections, when connected thereto, at will and independently of any operations of the made-up connector and string sections; said means including a carrier mounted in and rotatively supported by said body, a set of cutting bits expansively mounted on the carrier and engaging the body wall to sever it, and means for rotating the carrier relative to the body to effect cut by the cutters.

13. The connector of claim 12; the last named means including a rotary stem insertible axially into and through the made-up string and said body.

14. The connector of claim 12, and bit feeder means including a device constantly pressing the bits to said body.

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