

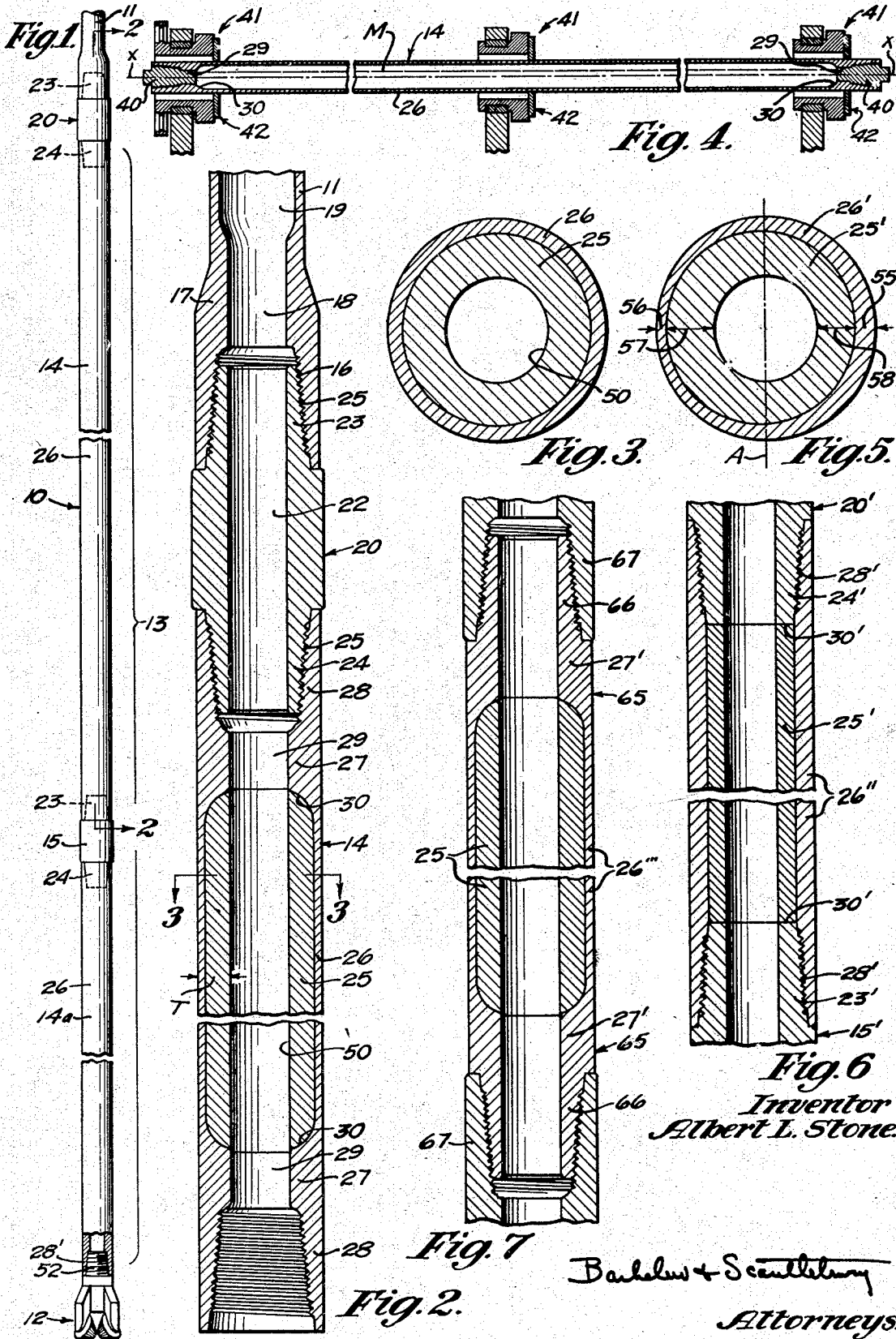
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COMPOSITE DRILL COLLAR

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## UNITED STATES PATENT OFFICE

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## COMPOSITE DRILL COLLAR

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5 Claims. (Cl. 255—28)

This invention relates generally to drill collars for well-drilling strings and is more particularly concerned with an economically manufactured, composite drill collar which will have a number of points of advantage over those now commonly in use.

As is well known, drill collars are heavy sections of pipe arranged immediately above a drilling tool whereby requisite drilling weight may be imposed directly on the tool, the weight of the drill stem, proper, being taken, in the main, at the ground surface by the draw works or rotary table. Ideally, the bottom joint of drill pipe immediately above the drill collar should be supported in tension. The reasons for establishing and maintaining these conditions are well known to those familiar with the art.

Drill collars, to give them sufficient weight to serve their purpose, are necessarily thick-walled and it is important that their bores be as nearly as possible concentric with their outer faces in order that the collars may be dynamically balanced. Furthermore, the collars must be made so as to avoid concentration of bending stresses and gyrational forces on relatively weak sections.

These requirements have resulted in excessive costs and manufacturing difficulties, and it is therefore an object of my invention is to provide a drill collar having proper weight and balance and load-distributing characteristics and yet which is producible in a manner to reduce sharply the cost of manufacture.

How the above advantageous conditions are brought about, as well as other objects and features of novelty of the invention, will be made apparent in the following detailed description, reference being had to the accompanying drawing, in which:

Fig. 1 is an elevation showing my improved drill collar in connection with a usual drilling string;

Fig. 2 is an enlarged scale, longitudinally contracted section on line 2—2 of Fig. 1, but with the lower tool-joint pin member removed;

Fig. 3 is an enlarged section on line 3—3 of Fig. 2;

Fig. 4 is a schematic view showing one step in the method of producing the drill collar;

Fig. 5 is a transverse section through a finished drill collar showing, in exaggerated form, certain conditions which may prevail;

Fig. 6 is a fragmentary detail showing a variation of composite collar; and

Fig. 7 is a fragmentary detail showing another variation.

In Fig. 1 I have illustrated a fragment of a drilling stem 10 consisting of a usual drill pipe 11, cutter 12 and a drill collar 13 intermediate the two. The collar is here shown as made up of two sections 14 and 14a detachably connected by a coupling or sub 15. However, it will be understood that the number of sections, whether one, two or more, depends upon the particular circumstances of any given drilling operation and therefore the instant showing of two sections is not to be considered as limitative. The several sections may be identical in construction, and I will therefore need to describe only one in detail.

Though this is not at all limitative, drill pipe 11 is shown as being of the integral-box type, the internally threaded box 16 being formed in the upset end 17 of the pipe. The effective bore 18 of the box is of slightly restricted diameter as compared with the major bore 19 of the pipe, proper.

While any suitable form of coupling may be utilized for detachably connecting the drill collar to pipe 11, I have here shown a tool-joint double-ended pin member 20, the body portion of the member being approximately the same outside diameter as that of upset 17 and bores 18 and 22 being of approximately the same diameter. The pin portions 23 and 24 of member 20 are identical, being provided with threads 25 adapted to mate at one end with the threads in box 16 and at the other end with threads in collar section 14, as will be described. The threads are preferably, though not at all necessarily, of the quick make-and-break type, here being shown as relatively coarse and of relatively steep taper.

Coupling member 15 may be of identically the same construction as member 20 and therefore the description of one will suffice for the other.

Now, drill collar section 14 (and, of course, if only one section is used, it may be considered the drill collar, proper) is composite in nature, being made up of inner and outer nested, tubular members 25 and 26, respectively. The outer member 26 is preferably, though not necessarily, made of drill-stem stock, such as carbon steel with some manganese content, usually heat-treated, adapted to take the extremely severe tensile and torsional stresses incident to drilling operations. While the outer member may be of stock originally in the form of rolled steel tubing of uniform thickness throughout its length with threads later formed in its opposite ends, externally flush, internally upset drill pipe is particularly well suited to the instant purpose and I have therefore illustrated the outer members of

sections 14 and 14a as made up of this particular stock, without, however, intending to limit my broader claims thereto.

Such stock may have an outside diameter about equal to that of upset 17 and hence of coupling 20, while its opposite ends are internally upset at 27 and then formed with internally threaded boxes 28 to take, for instance, the threaded pins 23 or 24 of coupling members 15 or 20. The upsets each have a bore 29 of approximately the same diameter as bores 18 and 22, and the two upsets present opposed annular shoulders 30 spaced apart by the distance between boxes.

Generally, it may be assumed that any tubing of the length requisite for drill-collar sections will not be thick enough to have the weight requisite for drill-collar purposes. It is extremely difficult to drill bores from the opposite ends of solid stock and yet maintain variances of wall thickness within the allowable limit.

I accomplish the end of giving requisite weight to the drill collar and yet cheaply and simply insuring a bore which is smooth, uninterrupted and concentric with the outer peripheral face of the collar (thus insuring equal wall thickness throughout) by lining the relatively thin-walled member 26 with the relatively thick-walled tube 25 of metal having a much higher degree of pliability than member 26. For instance, tube 25 may be of lead, zinc or alloys thereof.

The lining may be applied, in molten state, by the use of a suitable horizontal centrifuge, schematically represented at C1 in Fig. 4.

The lining or core 25, which is preferably bonded to pipe 26, extends into contact with shoulders 30, and its bore 50 is of a diameter approximately equal to the common diameter of bores 18, 22 and 29. Further, bore 50 is concentric with the outer peripheral face of pipe 26, it following that the total wall thickness T of the composite tube is equal at all points along and around the full extent thereof. If the bore and other peripheral face of pipe 26 be not concentric, the thinner portions of the pipe wall are complemented by correspondingly thicker portions of tube 25.

Shoulders 30 prevent any longitudinal bodily shifting of core 25 should there be no bond between the pipe and core or should a bond, originally established, be later ruptured.

It will be seen that the long bore 50 is smooth and true throughout its length and is in axial alignment with bores 18, 22 and 29.

Section 14 is thus formed as a composite drill collar consisting of a relatively rigid outer shell 26 of strong material having a relatively high modulus of elasticity and particularly well adapted to take high stresses of tension and torque and having proper characteristics to provide threaded connections capable of sustaining great loads, and of a much less rigid inner, tubular core 25 of relatively weak, pliant metal which adds most appreciably to the weight of the collar. The core is solely a weighting member and plays no connective or load-bearing function, so its weaker, softer characteristics are in no way detrimental, in fact the characteristic of softness is advantageous in that it enables the core to take the effects of the mud-laden circulating fluid better than does steel and the core thus represents a protective lining for the bore-wall of the outer tube. On the other hand, the steel pipe 26, which will take the abrasive wear incident to contact with the rough bore-wall much better than the

core-material, protects the outer face of the core from such wear.

But even more important than this, the relatively pliant core adds extra weight to the outer tube without appreciably adding to the stiffness and rigidity thereof. I therefore provide a very thick composite collar which is much more "limber" than would be a collar of equal thickness made entirely of steel. Consequently, the bending stresses may be absorbed by the collar, proper, rather than being concentrated on the relatively thin coupling ends, as is the case where the body proper is as rigid as is the usual collar made of thick-walled steel.

With the sections all fabricated as described above, it will be seen that threaded boxes are provided at each end of each section, the boxes being fashioned in the outer, steel pipe. Accordingly, the upper end of section 14 may be coupled to the drill stem as described above while the lower end of that section may be coupled to section 14a by coupling member 15, which, as has been said, is similar to member 20. The lower box 28' is adapted to take the threaded pin 52 of drill 12.

It is found in connection with ordinary drill collars, that the coupling members between drill-collar sections are most apt to fail, because there are thick, rigid sections at both sides thereof and both sections concentrate the bending stresses at the common point of connection. It is therefore in connection with such intermediate couplings as member 15 and the mating boxes, that my invention has particular merit, though this statement is not at all to be considered as indicating that the merit is limited to this particular use.

Now the choice of core material will depend upon several circumstances. If it is desired to have a very heavy collar and the bore of the tube 26 is true with respect to its outer peripheral face, or if the drilling speed is to be relatively slow—even though the bore of the outer tube be not exactly true, a very heavy metal such as lead may be used, this metal having a specific gravity of about 11.35 as against about 7.8 for the steel, outer tube.

Or, of course, if less weight is needed, pliant metal or alloys having the characteristics set forth above, but of less specific gravity than lead, may be used.

On the other hand, if the drilling speed is to be high and the bore of the outer tube is out of true to any appreciable extent, it is preferable that the choice be otherwise. The reason for this may be pointed out by reference to Fig. 5, wherein an exaggerated condition of eccentricity is represented. Steel tube 26' is here indicated as having a much thicker wall at 55 than at the diametrically opposite point 56. With the metal of core 25' applied as described above, it will be apparent that the thickness of the core at 57 is much greater than at 58. Consequently the added mass of the core-metal at the left side of axis A is much greater than at the right side, and if the specific gravity of the core material were different from that of the outer-tube-metal, the whole collar would be out of dynamic balance when the drill stem is rotated, with obviously undesirable vibratory and gyratory effects resulting therefrom. This would be the case if the core material were lead.

So, under these circumstances, it is desirable to use a core metal having not only the above characteristics of pliability, but also a specific gravity the same, or as closely as practicable the same.

as that of outer-tube metal. For instance, zinc, having a specific gravity of 7.2 may be used in connection with certain alloys: Or if the steel has a specific gravity of 7.8, there may be provided an alloy of zinc with a relatively small lead-content, the proportions of zinc and lead being such that the alloy has a specific gravity of 7.8. In this manner, dynamic balance will be assured.

In Fig. 6, I have shown a variation which I have mentioned before, namely the use of plain tubing as the outer wall. Here, tubing 26' has no internal upsets, its ends, however, being provided with internal threads 28' to take, for instance, threaded pins 23' or 24' of coupling members 20' or 15'. The opposed ends 30' of pins 23' and 24' may be utilized as shoulders to perform the same function as ascribed to shoulders 30 in Fig. 2.

In Fig. 7, I have shown a situation where the end of outer tube 26''' is formed as an integral pin-end 65 instead of the box 28 of the form of Fig. 2. Here, a threaded pin 66 is provided on upset 27', this pin being adapted to take a sleeve-coupling 67 for attachment to adjacent sections of drill collar or to other elements of the drilling string. Or, of course, a given drill collar section may have a pin at one end and a box at the other.

In both Figs. 6 and 7, the associations and the relative natures of the inner and outer tubes, are the same and have the same function as described for the similar members of Fig. 2.

It is to be noted that in the event a composite drill collar, made in accordance with the invention, has been used to an extent that the outer tube or any of its parts have become fatigued or damaged to an extent which precludes further safe use, the inner core may be melted out and re-used in the making of a new drill collar.

While I have shown and described a preferred embodiment of my invention, it will be understood various changes may be made without departing from the spirit and scope of the appended claims.

I claim:

1. A composite drill collar embodying an outer torque transmission tube of steel and an inner

tube of relatively pliant metal, the inner tube tightly fitting the bore of the outer tube and stopping short of the ends of the outer tube, and an internal thread at each end of the outer tube beyond the ends of the inner tube.

2. A composite drill collar embodying an outer torque transmission tube of steel, a pair of longitudinally-spaced opposed annular shoulders projecting into the tube bore, and an inner tube of relatively pliant metal tightly fitting within the said bore and extending longitudinally from shoulder to shoulder, the diameter of the inner tube bore being at least as great as the diameters of the bores defined by the annular shoulders.

3. A composite drill collar embodying a relatively rigid outer torque-transmission tube whose inner peripheral face is eccentric with relation to its outer peripheral face, and a relatively pliant inner tube of metal tightly fitting the bore of the outer tube and varying circumferentially in wall thickness in such relation to the specified eccentricity of the peripheral faces of the outer tube that the aggregate wall-thickness of the composite collar is circumferentially uniform; the material of the outer and inner tubes having substantially the same specific gravity.

4. A composite drill collar embodying a relatively rigid outer torque transmission tube and an inner tube of relatively pliant metal, the inner tube tightly fitting the bore of the outer tube and stopping short of at least one end of the outer tube, and an internal thread at said one end of the outer tube beyond the associated end of the inner tube.

5. In a drill stem, a pipe section, a threaded pin on the pipe section, a composite drill collar embodying a relatively rigid outer torque transmission tube and an inner tube of relatively pliant metal, the inner tube tightly fitting the bore of the outer tube and stopping short of at least one end of the outer tube, an internal thread at said one end of the outer tube beyond the associated end of the inner tube; the threaded pin fitting said internal thread and the end of the pin presenting an annular shoulder adapted to contact the end of the inner tube of the composite collar at said one end of the collar.

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