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OIL WELL DRILLING STRING

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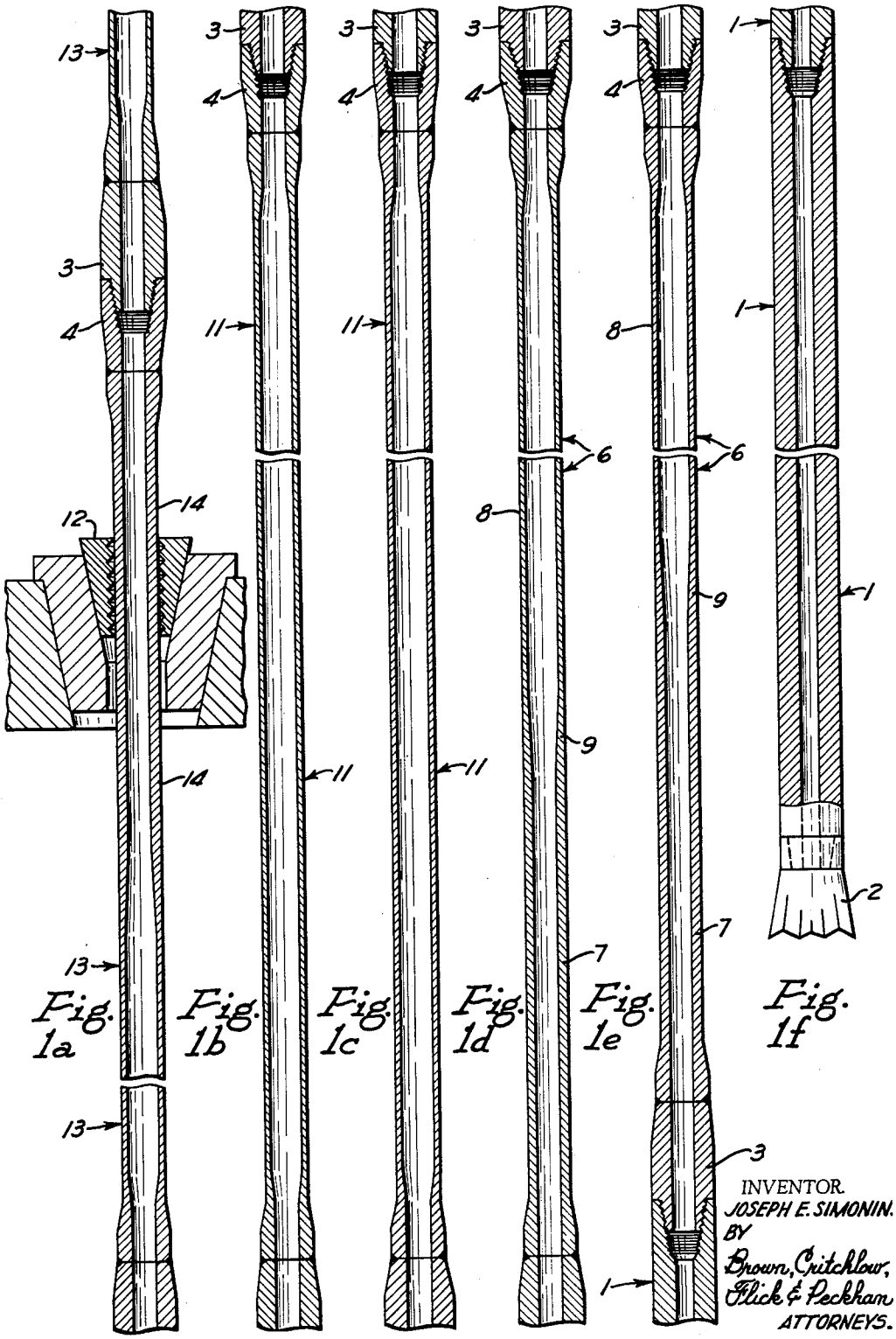


Fig. 1a Fig. 1b Fig. 1c Fig. 1d Fig. 1e Fig. 1f

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OIL WELL DRILLING STRING

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This invention relates to the strings of pipe used in rotary drilling of oil wells, and more particularly to a particular combination of such pipes.

In the rotary drilling of oil wells the drill is fastened to the lower end of a string of pipes, down through which drilling mud is circulated. At the lower end of the string, directly above the drill, there is a section of the string formed from drill collars fastened together end to end. As is well known, drill collars are heavy-wall pipes that are very heavy in comparison with the ordinary drill pipes above them, and their purpose is to put the necessary weight on the drill. The number of drill collars used depends on the formations that must be drilled. The more difficult the drilling, the more drill collars that are used. Since the purpose of the drill collars is to weight down the drill, they are in compression, but the drill pipes extending from the upper end of the drill collar section to the top of the well should be in tension in order not to add to the weight of the drill collars, and also because drill pipes do not stand up very well under compression. It will be seen that in deep wells and especially in directional drilling it is extremely difficult to make sure that the dividing line between the compression and tension forces in the drilling string will be where the lowest drill pipe joins the uppermost drill collar. Therefore, in practice the lowest drill pipe often is exposed to compressive stresses or to alternating compressive and tensile stresses that concentrate at its lower end, which is the pin end, with the result that the drill pipe is likely to crack and fail. When the drill pipes are provided with tool joints, as usually is the case, this failure occurs a short distance above the lowest tool joint, at the upset run-out.

Some of the conditions that cause the drill pipe to be placed in compression are as follows. Uneven drilling feed may result in part of the drill pipe being placed in compression, thereby adding to the drilling weight of the drill collars until the bit descends far enough to relieve the compression. Then the pipe stresses may change to tension until additional weight is fed off at the brake and the cycle is repeated. As the bit descends during each cycle, the point of neutral stress in the drill pipes progresses downward and is subject to considerable rapid movement up and down due to rotation, thereby subjecting the pipe or drill collars to alternating compressive and tensile stresses in this range of fluctuation. Whether accidental or deliberate, if the drill pipes are subjected to compression, the bending stresses in the first pipe above the drill collars can be very severe. Due to rotation of the pipe, the stresses usually are cyclic or alternating in nature. Even in tension, especially in a crooked hole, the alternating range may be severe enough to damage the pipe.

The most elusive and probably most damaging conditions are the result of harmonic vibrations, both torsional and longitudinal, which may be present for extended periods and in widely varying magnitudes in the form of longitudinal bounce or torsional beat. The drill collars may develop a bounce due to bit action and transmit tremendous "blows" to the drill pipe. The drill pipe itself may develop a bounce due to "slapping" in and out of a key seat, or due to a crooked length or section of several lengths developing a slapping "beat," which may try to transmit itself to the drill collars. These conditions may

be very severe down the hole and most destructive at the sudden change of pipe wall thickness at the top of the drill collars. Yet, due to the damping effect of the great length of pipe, hole, and mud column, they may not be noticeable at the kelly or they may be so light that they are disregarded.

Various ways of developing a gradual transition in wall thickness from the top of the heavy drill collar to the comparatively thin wall of the drill pipe are attempted or improvised in the field. Very often a length of the next larger size of drill pipe is used between the regular string of drill pipes and the top of the drill collars. The difficulty with this procedure is that the crossover sub between the two sizes of drill pipe is usually so stiff that it nullifies the beneficial effect of the intermediate length of pipe.

It is among the objects of this invention to provide an oil well drilling string in which the likelihood of failure of the drill pipe attached to the uppermost drill collar is greatly reduced, and in which all of the drill pipes can be of the same size.

The preferred embodiment of the invention is illustrated in the accompanying drawing, in which the figures combined represent a fragmentary vertical section of my drilling string, it being understood that each successive figure should be viewed as if it were directly below the figure at its left.

Referring to the drawing, a few of the large number of pipes are shown that form a drilling string that may be several thousand feet long. The bottom section of the string is formed from a number of drill collars **1** attached end to end in the usual way, as shown in FIGS. 1*e* and 1*f*. The lowest collar carries the drill **2**. The rest of the string is composed of drill pipes. As is the usual practice with drilling strings, the upper end of each collar or drill pipe is shown as being the internally threaded box end, while the lower end of each length is the externally threaded pin end. Although the threads may be formed in the bodies of the pipes, it generally is preferred to weld a tool joint to each upset end of each pipe, a tool joint pin **3** being at the lower end and a tool joint box **4** at the upper end in the illustrated embodiment of the invention.

It is a feature of this invention that an intermediate section of the drilling string immediately above the drill collars is composed of one or more aligned drill pipes **6** that have heavy wall lower ends, as shown in FIGS. 1*d* and 1*e*. That is, the wall thickness of each pipe **6** from its lower upset upward for several feet is considerably greater than the thickness of the wall between the thick wall and the upper upset, for a reason that will be explained presently. In the usual 30 foot length of pipe, the thick wall portion **7** may be from four to six feet long, for example, while the thin wall portion **8** of the pipe is from about 24 to 26 feet long. The thick and thin walls are joined by a long tapered transition portion **9**. This intermediate section of the drilling string, formed of drill pipes **6**, connects the drill collar section with the long main section that extends up to the top of the well.

For reasons of economy, the main section of the drilling string may be composed entirely, or for a great part of its length, of ordinary drill pipes **11** (FIGS. 1*b* and 1*c*) having a uniform wall thickness substantially the same as the thickness of the thin walls **8** of the drill pipes in the intermediate section of the string. If the hole is quite deep so that the weight of the string is likely to cause the slips **12** that support it to crush or otherwise damage the pipes in the upper part of the string, those pipes **13**, as shown in FIG. 1*a*, may have a long slip-receiving upper end portion **14**, the wall thickness of which for several feet may be as great as the thick walls **7** of pipes **6** in the intermediate section of the string. From the thick portion

14 down to the lower upset of each pipe 13, the wall may be as thin as the thin walls of pipes 6.

When the drilling strip has been formed with an intermediate section in the manner explained above, instead of the stresses being concentrated at the pin end upset run-out of a regular thin wall drill pipe connected to the upper drill collar, they are distributed throughout the full length of thick wall 7 of the lowest pipe 6 and gradually blend into the thin wall 8 through the tapered transition wall 9. This greatly increases the life of the drill pipe. Since most of the pipe has a thin wall, the improved pipe will not add materially to the weight of the string above the drill collars, it being desirable for several reasons that the drill pipes be as light as possible. The number of drill pipes 6 with heavy lower ends as described will depend upon how many the driller wants to "rotate" to further prolong the life of the lowest drill pipe by moving one or more pipes from top to bottom of the intermediate section each trip on a prearranged schedule, so that each pipe will take its turn next to the drill collars. This is a customary practice in drilling service, so it is wise to form the intermediate section of the drilling string of several drill pipes having heavy lower ends, thereby permitting the positions of those pipes to be rotated.

In some cases it may be desirable to form the drill pipes in the intermediate section of the string with the pin ends up. If that is done, a pipe can be used at the upper end of the intermediate section that has boxes at both ends in order to connect the intermediate section with the main secion of the string above it. To connect the lower end of the intermediate section to the drill collars, a suitable sub with pins at both ends can be used, or the upper end of the top drill collar can be provided with a pin. In any event, the thick walls of the drill pipes in the intermediate section will be at their lower ends as shown in the drawings.

I claim:

1. An oil well drilling string comprising a lower drill collar section, a long main drill pipe section spaced above the drill collar section, and a short intermediate drill pipe section connecting said main and drill collar sections, said intermediate section being formed of a plurality of aligned drill pipes each having at its lower end a thick wall several feet long and having a thin wall for at least the major portion of the rest of the pipe, and said main section including a plurality of aligned drill pipes in each of which the thickness of the pipe wall from a point close to its lower end upward for at least the major portion of its length is substantially the same as the thickness of said thin wall, the lowest of said main section drill pipes being connected to the upper end of said intermediate drill pipe section.

2. An oil well drilling string comprising a lower drill collar section, a long main drill pipe section spaced above the drill collar section, and a short intermediate drill pipe section connecting said main and drill collar sections, said intermediate section being formed of a plurality of aligned drill pipes each having at its lower end a thick wall several feet long and having a thin wall for at least the major portion of the rest of the pipe connected to the thick wall by a short transition wall of tapering thickness, and said main section being formed of a plurality of aligned drill pipes in each of which the thickness of the pipe wall from a point close to its lower end upward for at least the major portion of its length is substantially the same as the thickness of said thin wall, the drill pipes at the upper end of the string each having at its upper end a thick wall several feet long.

3. An oil well drilling string comprising a lower drill collar section, a long main drill pipe section spaced above the drill collar section, and a short intermediate drill pipe section connection said main and drill collar sections, all of the pipes in said drill pipe sections having upset portions at both ends, and intermediate section being formed of a plurality of aligned drill pipes each having a thick wall extending upwardly several feet from its lower upset portion to a thin wall that extends upwardly for the major portion of the length of the pipe to its upper upset portion, each drill pipe in the lower part of the main section having a wall of substantially the same thickness as said thin wall extending the full length of the pipe between its upset portions, and each drill pipe in the upper part of the string having a thick wall extending downwardly several feet from its upper upset portion to a thin wall that extends downwardly for the major portion of the length of the pipe to its lower upset portion.

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ROBERT C. RIORDON, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,152,458 October 13, 1964

Joseph E. Simonin

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 25, for "connection" read -- connecting --; line 27, for "and" read -- said --.

Signed and sealed this 16th day of February 1965.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents