This invention relates to a frictional holding device for use in connection with the tubing string in wells, particularly oil wells.

It is one object of this invention to provide for releasably anchoring a tubing string in a well through the medium of anchoring members which, without biting into or penetrating the surface of the tubing casing or a part of a tool positioned in the well, and solely by frictional contact with the casing or such tubular part, will restrain axial movement of the tubing string relative to the casing or such tubular member.

It is another object of this invention to provide a novel and highly efficient method of frictionally restraining axial movement of the tubing string in a well and of providing for axial movement of the tubing string when forces developed in or applied to the string and tending to move the string axially, overcome the frictional restraining force.

It is another object to provide a device of the character described, wherein holding members are urged by the pressure of fluid in the tubing string into frictional engagement with a tubular member in the well to releasably hold the string and tubular member against relative axial movement.

In accordance with this invention fluid pressure actuated anchoring members having substantially smooth anchoring surfaces are employed instead of the conventional toothed or serrated anchoring surfaces which tend to bite into and interlock with the casing. These substantially smooth anchoring surfaces make it possible to restrain axial movement of the tubing string solely by friction, but permit the tubing string to move axially without damaging the string or casing, when a force developed in or applied to the string and tending to move it axially, overcomes the frictional holding force of the anchoring members.

In tubing anchors of the type employing fluid pressure-actuated anchoring members having toothed or serrated casing-contacting surfaces, such members sometimes become locked in the well. Accordingly, means are usually provided for relieving the fluid pressure holding the anchoring members in anchoring engagement with the casing, in order that the tubing string and anchoring means may be moved axially without damaging the string, casing and/or the anchors. The means for relieving the fluid pressure on such an anchor is costly and the use thereof hazardous as it entails the lowering of a tool in the well or the manipulation of the tubing string to actuate valve means for relieving the pressure into the casing annulus. Accordingly, it is another object of this invention to provide a tubing anchor, such as described, for releasably restraining axial movement of a reciprocating pump and the tubing string to which the pump is attached, by the use of anchoring members mounted on the tubing string and having smooth casing-contacting surfaces urged against the casing responsive to fluid pressures developed in the tubing string during operation of the pump.

It is another object hereof to provide tubing anchoring means wherein casing gripping members, such as described, are urged to frictionally grip the casing by means of pistons and cylinder units proportioned and arranged according to the fluid pressures which are developed in the tubing string of given cross sectional area. With this arrangement, the anchoring members are urged into frictional contact with the casing under a force sufficient to restrain axial movement of the tubing string, but will release the tubing string when a force developed in or applied to the string and tending to move the string axially, overcomes the frictional holding force of the anchoring members.

Another object of this invention is to provide anchoring means, such as described, wherein elongated members may be employed to advantage as the anchoring members having smooth casing engaging surfaces, inasmuch as such members will facilitate the lowering and raising of the string in the well casing.

This invention possesses many other advantages and has other objects which may be made more easily apparent from a consideration of two embodiments of the invention. For this purpose there are shown two forms in the drawings accompanying and forming part of the present specification. These forms will now be described in detail, illustrating the general principles of the invention; but it is to be understood that this detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Fig. 1 is a fragmentary vertical sectional view of a typical producing well wherein the tubing string is provided with fluid pressure actuated anchoring means embodying the present invention;

Fig. 2 is an enlarged elevational-sectional view, partly in elevation, of the anchoring means shown in Fig. 1;

Fig. 3 is a sectional view taken on the line 3-3 of Fig. 2 with the casing omitted;

Fig. 4 is a fragmentary sectional view taken on the line 4-4 of Fig. 2, showing two of the pistons in elevation; and

Fig. 5 is a fragmentary horizontal sectional view of a modified form of this invention.

As one example of the uses of the present invention, it is shown in the accompanying drawing and first described in the following description in a producing well. Thus, as shown in Fig. 1, a tubing string 1 connected with a reciprocating pump 2 is releasably anchored to the well casing 3 by anchoring means constituting the present invention. The pump 2, here shown, is of the reciprocating type having the usual plunger P, standing valve V and travelling valve W and being operated by the usual sucker rod string R.

The anchoring means generally comprises a plurality of anchoring members 4 mounted on the exterior of the tubing string 1 for lateral movement into frictional contact with the casing. Each of these anchoring members is provided with a casing-contacting surface 5 which is contoured in accordance with the casing wall and urged to frictionally contact the casing 3 by fluid pressure actuated means 6 carried by the tubing string.

The casing-contacting surfaces 5 of the members 4 are formed so as to restrain axial movement of the tubing solely by frictional contact with the casing and will not bite into or penetrate the surface of the casing as in the case with conventional toothed or serrated slips. Accordingly, the surfaces 5 are preferably substantially...
smooth so that the members 4 may slide axially while in contact with the casing when forces applied to or developed in the tubing string and tending to move the string axially, exceed the frictional holding force developed by fluid pressure during pumping of the well. The anchoring members 4 and the fluid pressure actuated means 6 are constructed, proportioned and arranged in consideration of the inside diameter of the tubing string and the fluid pressure developed therein under pumping operations, so that the fluid pressure will cause the anchoring members to effect and maintain a frictional contact with the casing sufficient to restrain axial movement of the pump and adjacent portion of the tubing string during pumping operations.

A tubing anchor embodying the present invention will permit the tubing string to hang in natural repose under the total load thereon, but will restrain by frictional, axial movement of the pump and tubing string during operation of the pump.

The anchor readily may be set and reset as desired by manipulation of the tubing string from the surface and will be instantly upset ends and readily responsive to expansion or contraction of the tubing string and responsive to the fluid pressure developed in the string, respectively. Thus, it is seen that the anchor provides for an automatic compensation of destructive tubing stretch or contraction such may be caused by temperature changes in the well, varying differential fluid levels between the interior of the tubing and the casing annulus, gas to oil ratio changes, and similarly developed forces.

The anchoring members 4 may be of any suitable form having smooth casing-engaging surfaces, provided they are movable laterally under pressure of fluid in the tubing string to cause the smooth surfaces to frictionally engage the casing and restrain movement of the tubing string, and will slide and permit of axial movement of the tubing string in the casing when a force developed in or applied to the string and tending to move the string axially, becomes greater than the fluid-pressure-affected frictional holding force of the anchoring members.

In the present embodiment of this invention each of the anchoring members 4 is in the form of a bowed leaf spring or similar flexible member. The smooth and contoured casing-engaging surface 5 of each of the anchoring members is provided on the exterior of a comparatively straight elongated portion 7 intermediate the ends of each anchoring member.

As here shown, three of the anchoring members 4 are moved on the exterior of a section tubular body 8. The body 8 consists of two end sections 8a and 8b threadedly connected to the ends of an intermediate section 8c. The body 8 is connected in the tubing string above the pump 2. The three anchoring members 4 are angularly spaced about the axis of the body 8 and extend longitudinally thereof, being here shown as equidistantly spaced.

As a means for mounting the anchoring members 4 on the body 8, the upper ends 9 thereof may be hooked and fixedly engaged in slots 10 formed in retaining blocks 11 welded to the end section 8a of the body. housings 12 have upper ends 13 and are movably secured by screws 14, as shown in Fig. 2, to the blocks 11 so as to cover the ends 9 and retain them in engagement with the blocks 11.

The lower hooked ends 15 of the members 4, as shown in Fig. 2, may be slidably retained on the section 8b of the body 8 by means of blocks 15 and removable housings 17 similar to the blocks 11 and housings 12. The lower ends of the blocks 16 and the closed ends of the housings 17 serve as stops to limit the sliding movement of the lower ends 15 of the members 4. The removable housings 12 and 17 provide for readily replacing the anchoring members 4.

Fluid pressure-operated means 6 for operating each anchoring member 4, as here shown, includes a pair of cylinders 18 formed one above the other in an enlarge-
pressure responsive means having an area sufficiently greater than the internal cross sectional area of the tubing string to cause the anchoring means to restrain axial movement of the tubing string during operation of the pump. Under this method, the string is restrained against axial movement until a force tending to move the string axially as developed in or applied to the string, overcomes the frictional holding force of the anchoring member, thereby relieving the string of excessive loads and preventing damage to the string and the casing.

As shown in Fig. 5, a modified form of this invention contemplates the use of a plurality of pistons as the anchoring members, wherein the pistons have smooth "anchoring" surfaces.

Accordingly, a tubular body 30, similar to the body shown in Figs. 1-4, is mounted in the tubing string and provided with cylinders 31 and pistons 32 corresponding to the cylinders and pistons shown in Figs. 1-4, except that the pistons have smooth casing-contacting surfaces 32a. These pistons may be retained in the cylinders by means of pins 33 extending through the cylinders and slots 34 in the pistons in substantially the same manner as shown in Figs. 1-4.

The smooth surfaces 32a of the pistons 32 are shown as curved to conform to the curvature of the tubing string 35 and to facilitate movement of the pistons past the joints in the casing string. Obviously, the smooth surfaces may be integral with the pistons or provided on separate members fixed to the ends of the piston.

Any suitable number of the pistons angularly spaced about the axis of the body 30, and, if desired, axially spaced from one another, may be employed to provide the desired piston area exposed to fluid pressure in the string, as against the average internal cross section area of the tubing string and body 30, which latter is in effect is a part of the string. For example, the total area of the pistons exposed to the fluid pressure in the string, may be between five and six and one-half times the average internal cross sectional area of the tubing string. It should be noted that a tubing anchor embodying the present invention is not limited to use with the tubular strings of reciprocating pumps, as it may be used to anchor tubing strings employed with well tools in the operation of which fluid pressures are developed in the tubing string, or with a string where it is desired to anchor the latter to a tubular member which is to be withdrawn from or repositioned in a well.

Whether the anchoring means of the present invention is employed to anchor a tubing string to a well casing or to engage a tubular member in a well so as to restrain relative movement between the tubing string and such tubular member, the frictional holding force of the anchoring means will be sufficient to achieve the purposes hereinbefore noted. However, should a force tending to move the tubing string axially relative to the casing or tubular member and exceeding the frictional holding force of the anchoring means, be applied intentionally or unintentionally developed in the tubing string, the smooth surfaces of the anchoring means will slide freely relative to the casing or tubular member so as to prevent damage of the tubing string, casing or tubular member.

1 claim:

1. An anchor for releasably restraining axial movement of a tubing string in a well comprising: anchoring members mounted on the tubing string for movement into frictional contact with a tubular member positioned in the well; each of said anchoring members having a hard smooth metallic surface for engaging said tubular member; and fluid pressure operated means embodied in the tubing string for urging said surface of said anchoring members into frictional gripping contact with said tubular member for frictionally holding the anchor with respect to the casing under normal stresses, and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

2. An anchor for releasably restraining axial movement of a tubing string in a well comprising: a tubular body adapted to be connected in a tubing string; anchoring members mounted on said body for lateral movement relative thereto; each of said anchoring members having a hard smooth metallic surface engageable with a tubular member in the well, and fluid pressure operated means on said body responsive to fluid pressure therein for urging said surfaces of said anchoring members into frictional gripping contact with said tubular member for frictionally holding the anchor with respect to the casing under normal stresses, and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

3. An anchor for releasably restraining axial movement of a tubing string in a well comprising: anchoring members mounted on the tubing string for movement into frictional contact with the casing of the well; each of said anchoring members being flexible and having a hard smooth metallic casing-engageable surface of sufficient area to prevent biting thereof into said casing; and fluid pressure operated means on said tubing string responsive to fluid pressure in the string for urging said surfaces of said anchoring members against said casing for frictionally holding the anchor with respect to the casing under normal stresses, and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

4. An anchor for releasably restraining axial movement of a tubing string in a well comprising: anchoring members mounted on the tubing string for movement into frictional contact with the casing of the well; each of said anchoring members being resilient and having a hard smooth metallic casing-engageable surface; and fluid pressure operated means on said tubing string responsive to fluid pressure in said string for urging said surfaces of said anchoring members into engagement with said casing for frictionally holding the anchor with respect to the casing under normal stresses, and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

5. An anchor for releasably restraining axial movement of a tubing string in a well comprising: a tubular body adapted to be connected in the tubing string; anchoring members mounted on said body for movement relative thereto; each of said anchoring members being flexible and having a hard smooth metallic surface engageable with the casing of the well; and fluid pressure operated means embodied in the tubing string for urging said surfaces of said anchoring members into frictional gripping contact with said tubular member for frictionally holding the anchor with respect to the casing under normal stresses, and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

6. An anchor for releasably restraining axial movement of a tubing string in a well comprising: a tubular body adapted to be connected in the tubing string; elongated flexible metallic anchoring members; means mounting said members on the exterior of said body for movement into frictional contact with the well casing; and fluid pressure operated means on said body engaging said members responsive to fluid pressure in the tubing string for urging said anchoring members into frictional contact with said casing for frictionally holding the anchor with respect to the casing under normal stresses, and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

7. An anchor for releasably restraining axial movement of a tubing string in a well comprising: a tubular body adapted to be connected in the tubing string; elongated flexible metallic anchoring members
each having an effective portion between its ends providing a surface for frictionally contacting the well casing; means on said body engaged with the ends of said members mounting said members for movement relative to said body; cylinders on said body; said body having ports which open into said cylinders and pistons in said cylinders having their outer ends engaged with surfaces of said members opposite said casing-contacting surfaces said pistons being fluid pressure operated for urging the anchoring members into frictional gripping contact with the casing, the anchoring members fric tionally holding the anchor with respect to the casing under normal stresses and permitting sliding frictional movement of the anchor relative to the casing under abnormal stresses.

8. An anchor for releasably restraining axial movement of a tubing string in a cased well comprising: a tubular body adapted to be connected in the tubing string; elongated metallic anchoring members each having an effective portion between its ends providing a smooth surface for frictionally contacting the well casing; means on said body engaged with the ends of said members for movement relative to said body; cylinders on said body; said body having ports which open into said cylinders and pistons in said cylinders having their outer ends engaged with surfaces of said members opposite said casing-contacting surfaces said pistons being fluid pressure operated for urging the anchoring members into frictional gripping contact with the casing, the anchoring members frictionally holding the anchor with respect to the casing under normal stresses and permitting sliding frictional movement of the anchor relative to the casing under abnormal stresses.

9. An anchor for releasably restraining axial movement of a tubing string in a cased well comprising: a tubular body adapted to be connected in the tubing string; elongated metallic anchoring members each having an effective portion between its ends providing a smooth surface for frictionally contacting the well casing; means fixedly mounting one end of each of said members on said body; means securing the other end of each of said members for axial movement relative to said body; cylinders on said body; said body having ports which open into said cylinders and pistons operable in said cylinders; said pistons contacting the surfaces of said members opposite said casing-contacting surfaces said pistons being fluid pressure operated for urging the anchoring members into gripping contact with the casing, the anchoring members holding the anchor with respect to the casing under normal stresses and permitting sliding frictional movement of the anchor relative to the casing under abnormal stresses.

10. An anchor for releasably connecting a tubing string in a cased well comprising a tubular body adapted to be connected in the tubing string; metallic anchoring members mounted on said body for movement relative thereto; said anchoring members being flexible and having smooth surfaces for frictionally engaging the well casing; cylinders on said body; said body having ports which open into said cylinders; said pistons being fluid pressure operated for urging the anchoring members into gripping contact with the casing, the anchoring members holding the anchor with respect to the casing under normal stresses and permitting sliding frictional movement of the anchor relative to the casing under abnormal stress.
inders and said slots for limiting said lateral movement of said pistons; the pistons being fluid pressure operated for urging the leaf spring members into frictional gripping contact with the casing, said leaf spring members holding the anchor with respect to the casing under normal stresses and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

17. An anchor for releasably holding a tubing string against axial movement in a closed well comprising: a tubular body adapted to be connected in the tubing string; a plurality of piston and cylinder units carried by said body with the pistons being moveable toward the casing under the pressure of fluid in the tubing string; a plurality of leaf spring members; means fixing one end of each of said spring members on said body and means mounting the other end of each spring member on said body for axial movement relative to said body; each of said spring members having a continuous hard and smooth metal surface extending axially thereof for frictionally engaging the well casing; the pistons of said units being engaged with said spring members opposite said surfaces; the pistons being fluid pressure operated for urging the leaf spring members into frictional gripping contact with the casing, said leaf spring members holding the anchor with respect to the casing under normal stresses and for permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

18. An anchor for releasably anchoring tubing string in a cased well comprising: a tubular body adapted to be connected in the tubing string; a plurality of piston and cylinder units carried by said body with the pistons moveable laterally toward the casing of the well under pressure of fluid in the tubing string; the pistons of said units each having a hard smooth surface for frictionally engaging the well casing; said pistons having slots therein; and stop pins extending through said cylinders and said slots for limiting said lateral movement of said pistons.

19. In a tubing anchor for anchoring a tubing string in a well casing, wherein anchoring means are forced into engagement with the casing by fluid pressure in the tubing, the anchoring means including a plurality of fluid pressure responsive pistons: that improvement wherein the casing engaging surfaces of the anchoring means are constituted by smooth metallic surfaces, the fluid pressure operated pistons urging the anchoring means into frictional gripping contact with the casing, the anchoring means holding the anchor with respect to the casing under normal stresses but permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

20. In a tubing anchor for anchoring a tubing string in a well casing, wherein anchoring means are forced into engagement with the casing by fluid pressure in the tubing, the anchoring means including a plurality of fluid pressure responsive pistons: that improvement wherein the casing engaging surfaces of the anchoring means are constituted by smooth metallic faces substantially conforming to the curvature of the casing, the fluid pressure operated pistons urging the anchoring means into frictional gripping contact with the casing, the anchoring means holding the anchor with respect to the casing under normal stresses but permitting sliding frictional movement of the anchor relative to the casing responsive to abnormal tubing stresses.

21. An anchor as set forth in claim 2 wherein the fluid pressure operated means include pistons, the anchoring members are elongated and straddle the outer ends of the pistons, and said outer ends are recessed for reception of said elongated members.

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