Oct. 12, 1965 J. R. BROWN 3,211,233

WELL ANCHOR COMPRISING PRESSURE OPERATED MEANS ENGAGING THE EXPANDING MEANS FOR PREVENTING MOVEMENT THEREOF BECAUSE OF PRESSURES SURGES INSIDE INNER CONDUIT

Filed Oct. 8, 1962

2 Sheets-Sheet 1

Fig. 1

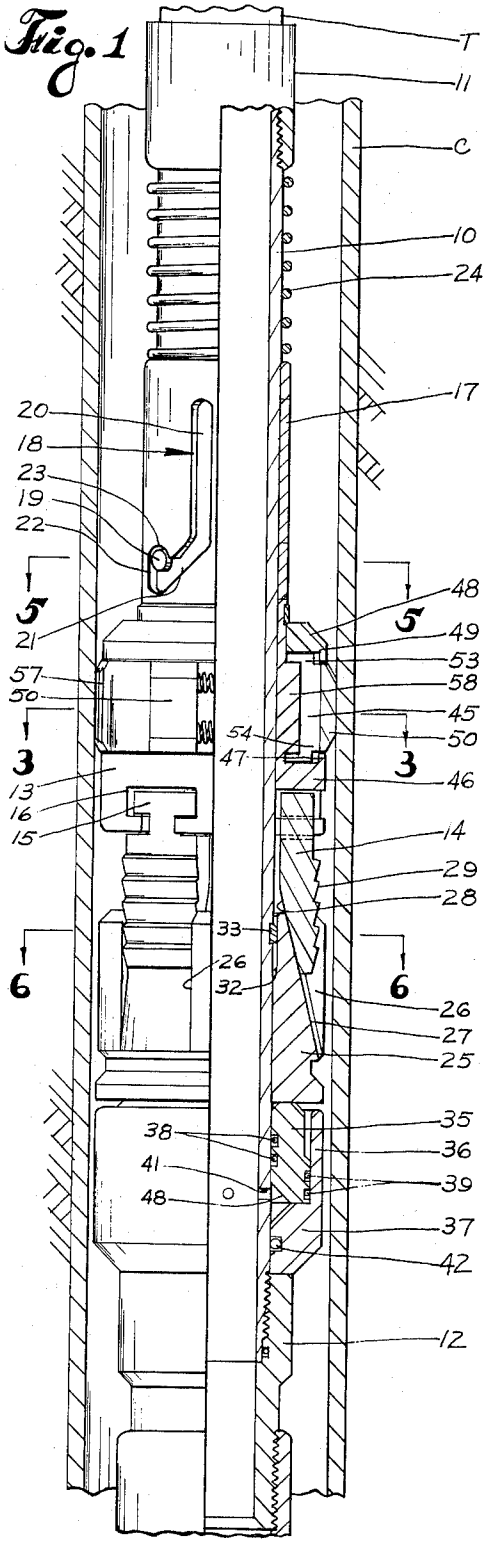
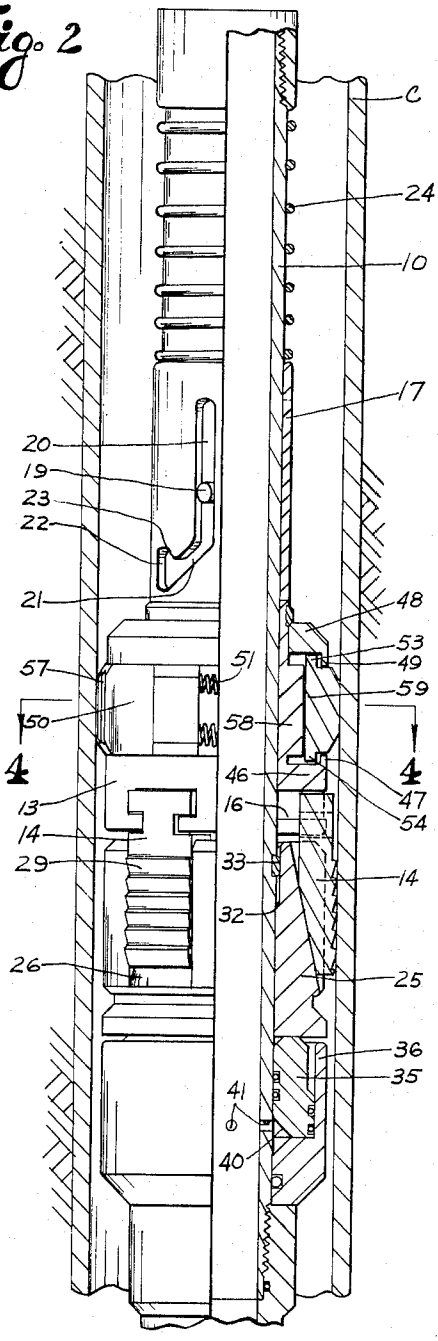


Fig. 2



JOE R. BROWN
INVENTOR.

BY

ATTORNEY

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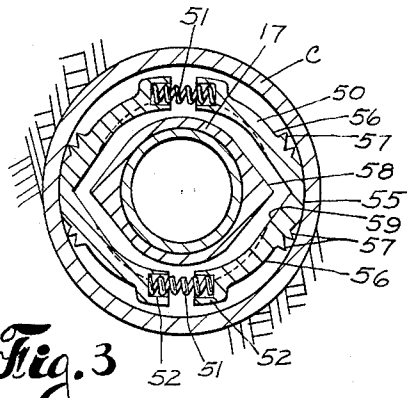


Fig. 3

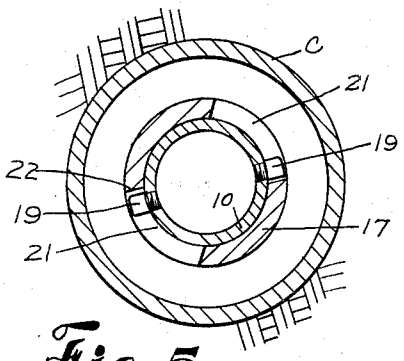


Fig. 5

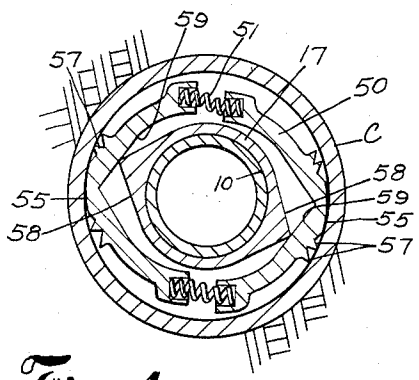


Fig. 4

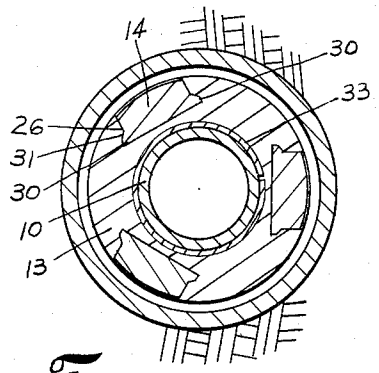


Fig. 6

JOE R. BROWN
INVENTOR.

BY

ATTORNEY

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WELL ANCHOR COMPRISING PRESSURE OPERATED MEANS ENGAGING THE EXPANDING MEANS FOR PREVENTING MOVEMENT THEREOF BECAUSE OF PRESSURE SURGES INSIDE INNER CONDUIT

Joe R. Brown, Houston, Tex., assignor to
Cicero C. Brown, Houston, Tex.

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This invention relates to an anchor for well tubing and the like.

Tubing anchors are commonly of the hook wall type which generally comprise a set of anchor slips supported on a suitable carrier and longitudinally movable relative to an expander by which the slips are wedged into gripping engagement with the surrounding pipe by relative longitudinal movement between the expander and the slips.

These devices normally employ a latching arrangement by which the relatively movable parts are held in inoperative relation when run into the well and upon release of the latching member, relative movement between the anchor elements is effected by employing some type of drag block or friction spring on the slip carrier for engaging the surrounding casing to hold the slip cage stationary while relative movement of the expander is effected in order to set the slips. These drag blocks or friction devices are commonly a source of difficulty. If they employ sufficient spring force to develop sufficient friction to effectively support the weight of the slips and hold them against movement, they may interfere with the running of the anchor device into the well pipe. On the other hand, if the friction pressure is too light, they may be ineffective in holding the slip carrier stationary in order to permit the necessary relative movement of the expander elements.

A second difficulty commonly experienced by more conventional tubing anchors of the type described is that if the tubing is subjected to pressure surges after the anchor has been set, these surges will cause the tubing string to flex and change in length so as to loosen the anchor and allow it to move upwardly in the well bore. This reduces the tension in the tubing string, which is normally employed to hold the slips in place, and will render the anchor ineffective.

It is a primary object, therefore, of the present invention to provide an improved type of anchor for tubing and the like which overcomes the aforementioned difficulties.

A further object is to provide an improved tubing anchor which is relatively simple in construction and operable by very simple manipulations of the tubing string.

An important object is to provide a tubing anchor in which pressure surges occurring in the tubing string are employed to intensify the holding pressure on the anchor.

Still another important object is the provision of a tubing anchor employing a novel form of friction member which, while developing comparatively little friction when the tool is run into the well, is operable through cam elements carried by the tool to be strongly engaged with the surrounding well pipe when setting of the anchor is to be effected.

Other and more specific objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjuction with the accompanying drawing which illustrates one useful embodiment in accordance with this invention.

In the drawing:

FIG. 1 is a longitudinal quarter sectional view of the anchor in accordance with this invention, showing parts

of the device in the positions occupied while being run into the well;

FIG. 2 is a view similar to FIG. 1 showing the parts of the device in anchored position;

FIG. 3 is a cross-sectional view taken generally along line 3—3 of FIG. 1;

FIG. 4 is a cross-sectional view taken generally along line 4—4 of FIG. 2; and

FIGS. 5 and 6 are cross sections taken, respectively, along lines 5—5 and 6—6 of FIG. 1.

Referring to the drawing, the device comprises a tubular support or mandrel 10 having its opposite ends threadedly received in upper and lower collars 11 and 12, respectively, by means of which the device is connected into tubing string T. Mounted on mandrel 10 is a tubular slip cage 13 which supports a plurality of angularly spaced depending slips 14. The latter are provided at their upper ends with conventional T-heads 15 which are received in correspondingly shaped T-slots 16 formed in the lower margin of slip cage 13, the arrangement being one by which the slips are free to move radially in slots 16. Slip cage 13 is supported on a tubular neck or stem 17 which slidably surrounds mandrel 10. A pair of J or bayonet-type connections, disposed on opposite sides of the device, releasably connect slip cage 13 to mandrel 10. The J-connection comprises J-slots, designated generally by the numeral 18, cut through the wall of neck 17 and cooperating pins 19 (see particularly FIG. 5) projecting radially from mandrel 10 and engageable in the J-slots. The latter each comprises a longitudinally extending long leg 20, a downwardly inclined laterally extending transverse leg 21 connecting to a longitudinal short leg 22 terminating at its upper end in a pin-receiving recess 23. A coil spring 24 is mounted in compression between the upper end of neck 17 and the lower end of collar 11, and normally tends to urge the slip cage downwardly with respect to the mandrel 10. With pin 19 engaged in recess 23 of the J-connection, the slip cage will be locked in its uppermost position, with spring 24 compressed, as shown in FIG. 1. Release of the J-connection is effected by relative downward movement of the mandrel and rotation thereof in the left-hand direction, as will be described more fully hereinafter.

Slidably mounted about the mandrel beneath slips 14, is a slip expander 25 provided with slots 26 adapted to slidably receive slips 14. Slots 26 have downwardly and outwardly inclined wedging surfaces 27 complementing similarly inclined inner wedging surfaces 28 on the slips, whereby relative longitudinal movement of the expander and slips toward each other will urge the slips radially outwardly to effect engagement of the upwardly facing buttress wickers 29 provided on the outer faces of the slips with the wall of casing C into which the device is run.

As best seen in FIG. 6, the side edges of the slips have dove-tailed splines 30 receivable in correspondingly shaped grooves 31 provided in the side walls of slots 26, whereby longitudinal and radial movement of the slips relative to the expander 25 may occur while the slips are retained against displacement from slots 26. The bore of expander 25 is counterbored from the upper end for a short distance to provide the internal upwardly facing shoulder 32 which cooperates with an external shoulder formed by a snap ring 33 mounted in the exterior of mandrel 10 and positioned so as to limit the upward movement of expander 25 on mandrel 10 to an extent such as to prevent expansion of the slips sufficiently to engage casing C, particularly while the device is being run into the well. Expander 25 is seated on the upper end of an annular piston 35 which slidably surrounds mandrel 10 and is enclosed within a cylinder 36 having its upper end open through which the upper end of pis-

ton 35 projects. Cylinder 36 is closed at its lower end by a cylinder head 37 which surrounds mandrel 10 and abuts the upper end of collar 12. Piston 35 and cylinder 36 constitute an abutment member which serves to prevent downward movement of expander 25 on the mandrel. Annular seals 38 and 39 provide internal and external sealing engagement, respectively, between piston 35 and the exterior of mandrel 10 and between piston 35 and the inner periphery of cylinder 36. The lower end of piston 35 defines, with the inner face of cylinder head 37, a pressure chamber 40 which is in communication with the bore of mandrel 10 by means of ports 41 extending through the wall of the mandrel. A packing 42 is provided between cylinder head 37 and mandrel 10 to prevent leakage of fluid downwardly past the cylinder head.

At a point above slips 14, slip cage 13 is provided with an annular recess 45 which is defined on its lower side by an annular flange 46 having an upwardly extending annular lip 47 about its outer edge and on its upper side by a collar 48 vertically spaced from flange 46 and provided with a downwardly extending annular lip 49. Mounted within recess 45 surrounding stem 17 is a pair of generally semi-circular friction shoes 50 which are normally urged apart radially by means of relative light coil springs 51 seated in suitable sockets 52 in the opposing inner ends of the shoes 50, as best seen in FIG. 3, the spacing between the inner ends of the shoes permitting limited independent movement of the shoes. The upper and lower edges of the shoes are provided with oppositely extending upper and lower flanges 53 and 54, respectively, which are adapted, respectively, to engage lips 47 and 49, whereby the latter will prevent the shoes from being radially expelled from recess 45. Each of the shoes is provided centrally on its external surface with a convex smooth arcuate surface portion 55 which has a circular radius adapted to provide smooth engagement with the inner wall of casing C. Surface portion 55 extends for a relatively short arcuate distance about the outer periphery of the shoe. On each side of surface portion 55 the exterior of the shoes is offset slightly radially inwardly at 56 and this radially offset portion is provided on each side of surface portion 55 and adjacent thereto with a plurality of vertically extending radially projecting teeth 57 which are normally out of contact with casing C. These teeth are adapted, upon relative rotation between the shoes and casing C, to engage the casing and prevent further relative rotation between the shoe and the casing, and thereby securely engage the shoes with the casing. To effect this relative rotation or rocking movement, the portion of stem 17 within recess 45 is provided with a pair of oppositely extending radial cams 58, which are generally triangular in transverse cross-section (FIGS. 3 and 4). The inner periphery of shoes 50 on each side of the center thereof is provided with relatively flat or non-circular cam surfaces 59 which are engageable by cams 58 in response to relative rotation between the slip cage and the friction shoes. As best seen in FIG. 4, cam surfaces 59 are shown engaged with the cooperating cams 58 to rock shoes 50 angularly relative to casing C, so as to project teeth 57 into gripping engagement with the wall of casing C.

Operation of the device is as follows: When run into the casing, the parts of the tubular anchor will be in the positions shown in FIG. 1 in which J pins 19 will be latched in recesses 23, in which position the anchor slips 14 will be held in inactive or retracted position relative to expander 25. As the tool is run into the well, any surges of pressure which would tend to move expander 25 upwardly relative to anchor slips 14, will be limited, in effect, by cooperation between shoulder 32 and snap ring 33, so as to prevent premature setting of the anchor slips. With the parts so arranged, it will be seen that as the tool is run into the well, its movement will be opposed only by the light pressure exerted by springs 51 against

shoes 50. The smooth surfaces of the latter will thus be lightly engaged with the wall of casing C and the tool may thus be run into the well with a minimum amount of resistance.

When the depth at which the tool is to be set has been attained, the tubing string will be rotated in the left-hand direction. The rotational movement will be transmitted through the engagement of pins 19 in recesses 23 to stem 17 of the slip cage and will impart left-hand rotation to the latter. The frictional force between shoes 50 and casing C, although light, will be sufficient to hold the shoes stationary while this relative rotation occurs and results in engagement of cams 58 with cam surfaces 59, as shown particularly in FIG. 4. This small amount of relative rotation will, through the engagement of the cams, rotate or rock the shoes about their central portions so as to effect engagement of teeth 57 with the wall of casing C. This will, of course, stop further relative rotation between the slip cage and casing C and the force exerted through the continued rotational pressure on the tubing string will merely serve to cause teeth 57 to be more tightly engaged with casing C, thereby preventing any further longitudinal, as well as rotational, movement of the slip cage.

Thereafter, the tubing string will be lowered sufficiently to disengage J-pins 19 from recesses 23, so that the pins enter the transverse legs 21 of the J-slots. Thereupon, continued rotation to the left of the tubing string will correspondingly rotate mandrel 10 until the J-pins are aligned with the longitudinal legs 20 of the J-slots and thereby free the tubing string for relative longitudinal movement with respect to the slip cage. Upward tension will now be applied to the tubing string which will serve to raise expander 25 and draw it upwardly inside anchor slips 14, moving the latter outwardly into anchoring engagement with casing C, as best seen in FIG. 2. Tension will be maintained on the tubing string in order to hold the anchor in its casing-engaging position.

In the event pressure surges occur inside the tubing string which would tend to flex the tubing and cause loosening of the anchor engagement, these pressure surges will necessarily be transmitted through ports 41 into pressure chamber 40 and will act against the lower end of piston 35 to urge the latter upwardly with respect to cylinder 36 and the upward movement of piston 35 will apply upward force against the lower end of expander 25 driving it more tightly between the slips and thereby increase the expansive force on anchor slips 14, which will serve to tighten the holding force exerted by the slips on casing C.

To release the device in order to remove it from the well, tubing string T with mandrel 10 will be lowered until snap ring 33 strikes shoulder 32 in the bore of expander 25. The continued downward force thus exerted by the tubing string will push the expander downwardly relative to the slips and out from under the slips, thereby drawing the slips inwardly and releasing them from the casing. This downward movement will be accompanied by downward movement of J-pins 19 in long legs 20 until they strike transverse legs 21 and by reason of the inclination of the latter, will be automatically rotated to alignment with short legs 22. At this point, if the cams on the slip cage and the friction shoes are still engaged, it may be necessary to rotate the mandrel and slip cage in the right-hand direction to release this camming engagement and thereby release the shoes for return to the position as shown in FIG. 3. Thereupon, the tubing may be raised, and since pins 19 will be latched into recesses 23, the entire anchor structure may be drawn upwardly from the well bore.

The tubing anchor of this invention possesses an important additional advantage over more conventional designs in providing means for compensating for increases in length or "stretch" of the tubing during pumping operations which are commonly conducted in the tubing by

means of conventional reciprocating rod strings. This compensating feature prevents reciprocation of the tubing string and "rod-cutting" of the tubing resulting from such reciprocation.

As previously noted, when the anchor is set the tubing string is placed in tension to hold the tubing string stationary. With the structure of the present invention, whenever the tubing string tends to stretch or lengthen out, the anchor can move downwardly under the force exerted by the lengthened tubing to compensate for such stretching and will automatically be re-set at the point of greatest stretch. However, the anchor cannot move upwardly by reason of the hydraulically actuated slips, and reciprocation of the tubing is thereby prevented.

From the foregoing, it will be seen that the above described device provides a simple construction, easily operative, which is effective to accomplish the several objects recited above and to provide a highly effective anchor for tubing and the like.

It will be understood, of course, that the anchor may be employed not only with tubing, but as an anchor for a packer or other tool which it is desired to securely anchor in a well pipe against movement in a direction which would otherwise tend to release such packer or other well tool.

It will be evident that various changes and modifications may be made in the details of the illustrative embodiment within the scope of the appended claim but without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

An anchor device adapted to be anchored in a well casing, comprising, a tubular mandrel, a tubular slip cage slidably surrounding the mandrel, a plurality of angularly spaced slips supported by said slip cage for radial movement thereon, a slip expander mounted for limited longitudinal movement on the mandrel beneath the slips in initially spaced relation thereto and movable upwardly with the mandrel relative to the slips to expand the latter into engagement with the well casing, cooperating shoulder means on the mandrel and the slip expander limiting upward movement of the latter on the mandrel to a point below initial expansive engagement with the slips,

an abutment member carried by the mandrel preventing downward movement of the expander on the mandrel, said abutment member comprising an annular piston slidably disposed about the mandrel with its upper end in supporting engagement with said slip expander, a cylinder surrounding said piston and defining with the lower end of the piston a pressure chamber, and port means through the mandrel wall providing pressure fluid communication between said pressure chamber and the bore of the mandrel, laterally movable friction means carried by said slip cage and resiliently biased to project therefrom into relatively light frictional engagement with said casing, cooperating cam elements on said slip cage and on said friction means carrying cooperating surfaces engageable by relative rotation between said slip cage and said friction means and shaped to urge the latter into relatively strong holding engagement with the casing whereby to anchor said slip cage to the casing to permit said upward movement of the mandrel and slip expander to expand said slips, and cooperating latch elements arranged between the mandrel and the slip cage for movement between latched and released positions by relative longitudinal and rotational movement between the mandrel and slip cage and operable in latched position to hold said expander out of engagement with said slips and when released to permit said upward movement of the mandrel and slip expander relative to said slips, said latch elements being engageable in response to rotation of said mandrel to effect said relative rotation between said slip cage and said friction means.

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BENJAMIN HERSH, *Primary Examiner.*