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PULLING TOOL ASSEMBLY

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Fig. 1

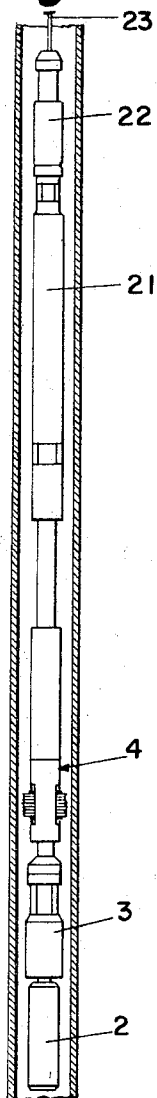


Fig. 2

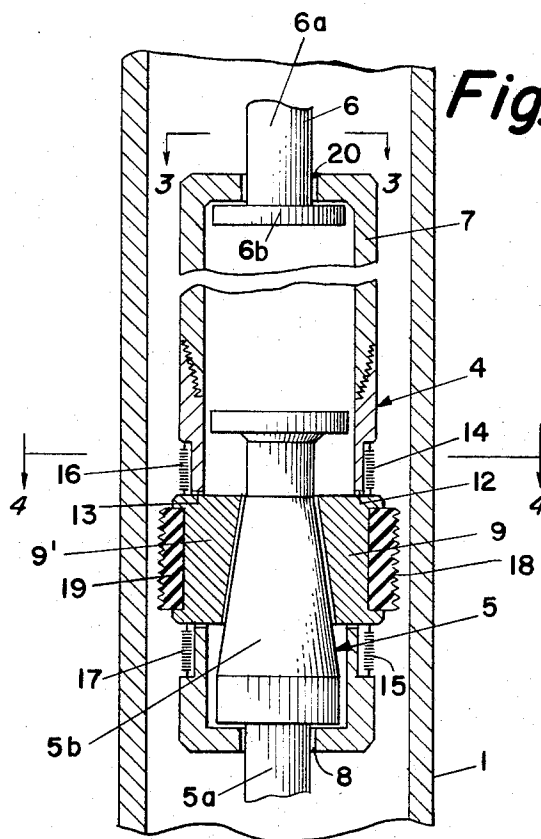


Fig. 4

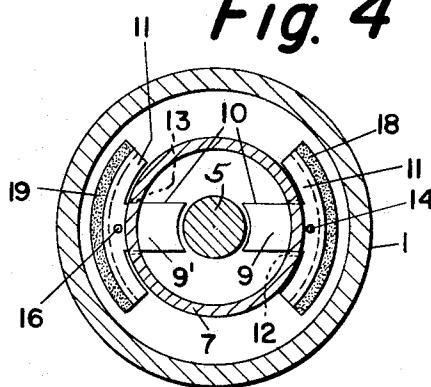
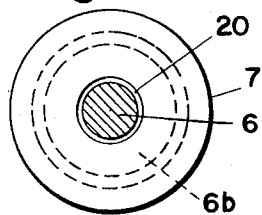


Fig. 3



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PULLING TOOL ASSEMBLY

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This invention relates to a pulling tool assembly, and more particularly to a wireline pulling tool assembly for pulling subsurface controls upwardly through a string of tubing in a borehole.

Subsurface controls, of the type designed to be removed through the tubing string by wireline tools, are usually locked in landing nipples in the tubing string. As a result of various factors, there is often a greater well pressure below the subsurface control than above it. This results in an unbalanced force across the control, in an upward direction; that is to say, there is a net upward force on the control. When the control is disengaged from the landing nipple by means of wireline tools, the upward force is often sufficient to blow the entire wireline assembly, including the pulling tools and the control, up the tubing. This usually results in sticking of the assembly, thereby causing an expensive fishing operation. Thus, a problem often occurs in wells, when attempts are made to remove subsurface controls by means of wireline tools.

Prior approaches to the solution of the aforementioned problem consist of various methods for equalizing the pressure across the subsurface control while it is still locked in the landing nipple, or elsewhere in the tubing. One method for effecting this equalization, with the pulling tool assembly, is to run a prong below it, in such a way that an equalizing valve, incorporated in the objective control, is opened by the prong.

Another method for equalizing the pressure across the control is to apply pressure to the tubing at the surface (thereby to build up the pressure above the control) with, for example, a pump truck.

The prior methods are expensive, and are not always dependable.

An object of this invention is to provide a novel pulling tool assembly.

Another object is to provide a pulling tool assembly which eliminates the need for equalizing the pressure across the control being pulled, yet which positively prevents the wireline assembly (pulling tools and control) from being "blown up" the tubing, as a result of unbalanced upwardly-acting force across the control.

A further object is to provide a pulling tool assembly which acts automatically to stop or slow down the motion of the subsurface control, whenever the latter tends to be "blown up" the tubing, ahead of the wireline.

A still further object is to provide a pulling tool assembly which, while accomplishing the foregoing objects, is cheap and dependable.

The objects of this invention are accomplished, briefly, in the following manner: The pulling tool assembly includes upper and lower jars which can move relative to each other, the lower jar being attached securely to the control which is to be pulled upwardly or removed, and the upper jar being attached to the wireline. When the lower jar starts to move upwardly with respect to the upper jar (as a result of an unbalanced upward force acting on the control), a brake member is moved outwardly to engage the tubing, thereby to arrest the further upward movement of the lower jar and of the subsurface control attached thereto.

A detailed description of the invention follows, taken in conjunction with the accompanying drawing, wherein:

FIG. 1 is a front elevation of a complete wireline pull-

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ing tool assembly incorporating the invention, in position in a tubing string;

FIG. 2 is a sectional view of a portion of the assembly of FIG. 1, drawn on an enlarged scale;

FIG. 3 is a horizontal cross-section taken on line 3-3 of FIG. 2; and

FIG. 4 is a horizontal cross-section taken on line 4-4 of FIG. 2.

Referring first to FIG. 1, the wireline pulling tool assembly incorporating the invention is illustrated as it would appear during use, positioned in a string of tubing which extends into a borehole. At the lower end of the assembly, there is a pulling tool 2 which is quite conventional and which during use is coupled to the pulling neck at the upper end of the subsurface control (not shown), which latter is to be pulled upwardly through the tubing. Above the pulling tool 2 proper, secured at its lower end to the upper end of such tool, and forming a part of the pulling tool assembly, is a knuckle joint 3 which is also conventional and which allows for angular movement between the jar subassembly 4 (to be described hereinafter) and the pulling tool 2. The pulling tool 2 and the knuckle joint 3 are secured together tightly, such that no appreciable relative movement can occur between them, in the longitudinal (or vertical) direction, that is, in the direction of the length of the tubing. Similarly, no appreciable relative movement can occur, in this direction, between pulling tool 2 and the subsurface control.

The jar subassembly 4 (see FIG. 2) includes a lower jar 5, an upper jar 6, and a housing 7. At its lower end, the lower jar 5 is rigidly secured (as by threads, for example) to the upper end of knuckle joint 3. Again, no appreciable relative movement can occur, in the longitudinal or vertical direction, between knuckle joint 3 and lower jar 5. Thus, when the subsurface control is subjected to an upward force and begins to move upwardly, this movement is transmitted through pulling tool 2 and knuckle joint 3 to lower jar 5.

Housing 7 is elongated, and has the form of a closed hollow cylinder. The shank portion 5a of lower jar 5 (which is secured at its lower end to knuckle joint 3) passes freely through a hole 8 in the lower end wall of housing 7, and the enlarged head portion 5b at the upper end of jar 5 is positioned within housing 7, the lower end of this head portion 5b being adapted to engage the inner face of the housing lower end wall. Thus, when housing 7 moves upwardly, the housing lower end wall can come into engagement with the jar head portion 5b, to thereby move jar 5 (and also knuckle joint 3, pulling tool 2, and the subsurface control carried thereby) upwardly. Above its lower end, head portion 5b of jar 5 has a frusto-conical or tapered section, the taper being to a smaller diameter upwardly. Above this tapered section, there is a section of uniform diameter, and then at the extreme upper end of head 5b, there is a percussive circular, horizontally-extending face of enlarged diameter, which face enables jar 5 to function as a jar. The O.D. of head portion 5b is less than the I.D. of housing 7, so that jar 5 is free to move vertically with respect to the housing.

A pair of oppositely-disposed brake members 9 and 9' are resiliently attached to housing 7 and are adapted to move in a radial direction with respect to the housing. Each of the members 9 and 9', which are diametrically-opposed with respect to the cylindrical housing 7, includes a radially-inner actuating portion 10 of limited arcuate length but of considerable vertical length, which portion extends through the wall of housing 7, and also a radially-outer gripping portion 11 of greater arcuate length than portion 10 but of the same vertical length, portion 11 being positioned outside of housing 7; these two said portions 10 and 11 are integrally joined together to make up the brake member 9 or the brake member 9', as the

case may be. The radially inner edge of each of the portions 10 has a taper which matches the taper of the jar head portion 5b, and these inner edges are positioned closely adjacent the jar head portion 5b, diametrically opposite each other.

Each actuating portion 10 passes through a respective vertically-elongated slot in the wall of housing 7, and merges into its respective gripping portion 11 outside of the housing. Thus, actuating portion 10 of brake member 9 passes through a slot 12 in housing 7; slot 12 is of such size as to provide both horizontal (arcuate) and vertical clearance for free movement of member 9, it being particularly important to provide a substantial amount of vertical clearance (i.e., clearance in a direction parallel to the length of tubing 1). Actuating portion 10 of brake member 9' passes through a slot 13 in housing 7; slot 13 is of such size as to provide both horizontal (arcuate) and vertical clearance for free movement of member 9', it being particularly important to provide a substantial amount of vertical clearance (i.e., clearance in a direction parallel to the length of tubing 1).

Member 9 is resiliently attached to housing 7 (so as to allow movement of such member with respect to the housing) by means of an upper spring 14 whose upper end is attached to the housing and whose lower end is attached to the upper face of member 9, and a lower spring 15 whose lower end is attached to housing 7 and whose upper end is attached to the lower face of member 9. In similar fashion, member 9' is attached to housing 7 by means of an upper spring 16 and a lower spring 17. The springs 14, 15, 16, and 17 all extend substantially vertically and are located outside the wall of housing 7; the housing wall is reduced in thickness in the region of slots 12 and 13 to accommodate these springs. The upper ends of springs 14 and 16 and the lower ends of springs 15 and 17 define the upper and lower limits of the reduced-thickness area of the housing wall. The various spring tensions are so adjusted that the brake members 9 and 9' are normally vertically centered in their respective slots 12 and 13.

It may be seen that, because of the tapers of jar head portion 5b and of the brake member actuating portions 10, when jar 5 moves upwardly with respect to housing 7 (and also with respect to brake members 9 and 9', attached to the housing), brake members 9 and 9' will be moved radially outwardly with respect to housing 7, i.e., in a direction perpendicular to the inner wall of the tubing 1. The spring mounting of members 9 and 9' in housing 7 allows this movement to take place freely.

In order to increase the frictional force resulting when the brake members 9 and 9' come into engagement with the inner wall of tubing 1, an insert (brake shoe) 18 of a material having a high coefficient of friction (such as synthetic rubber) is secured in a shallow groove provided in the outer periphery of gripping portion 11 of member 9. Brake shoe 18 has an arcuate length co-extensive with that of gripping portion 11, and its vertical dimension may be somewhat less than that of member 9; insert 18 may be serrated at its outer edge, as illustrated, to increase the gripping action. A similar insert or brake shoe 19 is secured in a shallow groove provided in the outer periphery of gripping portion 11 of member 9'. The inserts 18 and 19 should also be made of a non-metallic material (such as the material previously mentioned), to prevent damage to the tubing which they are adapted to contact.

The shank portion 6a of upper jar 6 passes freely through a hole 20 in the upper end wall of housing 7, and the enlarged base portion 6b at the lower end of the jar 6 is positioned within housing 7, the upper end of this base portion 6b being adapted to engage the inner face of the housing upper end wall. Thus, when jar 6 is pulled upwardly (by the reeling in at the surface of a wireline secured to this jar), the jar base portion 6b can come into engagement with the housing upper

end wall, to thereby move housing 7 (and the other elements moving therewith) upwardly. The lower end of base portion 6b provides a circular, horizontally-extending percussive face, which face enables jar 6 to function as a jar. The O.D. of base portion 6b is less than the I.D. of housing 7, so that jar 6 is free to move vertically with respect to the housing.

The upper end of upper jar 6 (that is to say, the upper end of its shank portion 6a) is rigidly secured (as by mating threads, for example) to the lower end of a conventional weight bar or stem 21, which is used as a weight to transmit either upward or downward impact to the tool assembly (and also to the control carried thereby) at subsurface levels.

The upper end of stem 21, in turn, is threadedly secured to the lower end of a wireline socket 22 which is of conventional construction and which provides a means of connecting the steel wireline 23 to the remainder of the pulling tool assembly. The wireline 23 extends to the surface, at which it is manipulatable. It is reeled in to pull the pulling tool assembly (together with the subsurface control, carried by such assembly) upwardly, and it is alternately pulled and released to jar up or down by means of the stem 21 and jar sub-assembly 4.

It may be seen that the upper jar 6 is attached to the wireline 23 through the stem 21 and the socket 22, and that the lower jar 5 is attached securely to the subsurface control to be pulled upwardly, through the knuckle joint 3 and the pulling tool 2.

As described hereinabove, a complete pulling tool assembly comprises the wireline socket 22, the stem 21, the jar subassembly 4, the knuckle joint 3, and the pulling tool 2. This assembly is run in the tubing 1 on the wireline 23 when it is necessary to remove some type of subsurface control, such as a tubing safety valve, a bottom hole choke, a bottom hole regulator, a multiple completion choke assembly, a side-door choke, etc. The removal of the subsurface control entails pulling the same upwardly through the tubing string 1.

When the subsurface control has been disengaged from its landing nipple by means of the pulling tool assembly described (through manipulation of the jars, etc.), the jars 5 and 6 are separated, or open, as illustrated in FIG. 1. If there is a pressure differential across the control which creates a net upward force thereon, the resulting movement of the control is immediately transmitted through pulling tool 2 and knuckle joint 3 to the lower jar 5. Therefore, the jars immediately begin to close, that is lower jar 5 immediately begins to move upward relative to upper jar 6, housing 7, and brake members 9 and 9'. When jar 5 thus moves upwardly, this tapered lower jar forces the brake members 9 and 9' to move in a direction radially outwardly with respect to housing 7, that is, in a direction perpendicular to the inner wall of the tubing 1. The rubber brake shoes or inserts 18 grip the tubing 1 and arrest (or at least slow down) the upward surge of the lower part of the assembly (to wit, lower jar 5, knuckle joint 3, pulling tool 2, and the subsurface control) long enough for the rapidly moving wireline 23 (which is moving upwardly at this time, being reeled in at the surface to move the subsurface control upwardly through tubing 1) to "stay ahead" of the pulling tool assembly plus subsurface control. It will be noted that the brake members 9 and 9' grip the tubing at one end of such members, and these members at their other ends grip the lower jar 5, thus preventing undesired upward movement of this lower jar and the elements attached thereto with respect to the fixed tubing 1.

If the upward surge of the lower part of the assembly were not arrested, the tool assembly plus control would move up faster than the wireline was being removed from the hole (that is, it would be "blown up" the tubing) and would thereby cause the wireline to become

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balled up and snarled in the tubing. This balling up or snarling of the wireline is of course undesirable.

When the pressure differential which created the net upward force on the control is dissipated (which happens almost immediately, once the control has left the landing nipple), the jar 5 no longer tends to move upward relative to housing 7. The release of the brake will then occur in the manner now to be described. Housing 7, moving upwardly with upper jar 6, pulls brake members 9 and 9' upwardly with it. Springs 14-17 couple together housing 7 and members 9 and 9' for this movement; these springs also urge brake members 9, 9' away from tubing 1. Once the upward force on the control is dissipated, there is almost no resistance to upward pull on the members 9 and 9'. These members move upwardly on the frusto-conical taper of jar head portion 5b, since lower jar 5 tends to remain in place and is not at this time moving upwardly. This causes brake members 9 and 9' to be drawn radially inwardly, away from tubing 1, releasing these brakes, and as housing 7 continues to move upwardly (being drawn upwardly by the wireline), it "picks up" the lower face of jar head portion 5b, causing the entire pulling tool assembly plus control to move upwardly.

The invention claimed is:

1. In a wireline pulling tool assembly for pulling subsurface controls upwardly through a string of tubing, a lower jar attached securely to the subsurface control to be pulled upwardly, an upper jar attached to a wireline manipulatable at the surface, means coupling together said lower jar and said upper jar so that they normally move upwardly together in response to reeling in of said wireline, said coupling means providing a degree of looseness whereby said jaws can move relative to each other in the direction of the length of said tubing; and means acting only in response to an upward movement of said lower jar relative to said upper jar for arresting the further upward movement of said lower jar and of the subsurface control carried thereby.

2. An assembly as set forth in claim 1, wherein the upward movement of said lower jar results from an ex-

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cessive upward force due to a pressure differential across said subsurface control.

3. An assembly as defined in claim 5, wherein said arresting means comprises a brake member arranged to be actuated, by relative movement of said lower jar, into frictional engagement with the inner wall of said tubing.

4. In a wireline pulling tool assembly for pulling subsurface controls upwardly through a string of tubing, a housing, a lower jar normally positioned in engagement with an inner lower wall of said housing but being free to move upwardly with respect thereto, a portion of said lower jar extending through said housing wall and being attached securely to the subsurface control to be pulled upwardly; an upper jar mechanically coupled to said housing and attached to a wireline manipulatable at the surface, and means acting in response to an upward movement of said lower jar with respect to said housing for arresting the further upward movement of said lower jar and of the subsurface control carried thereby.

5. An assembly as defined in claim 4, wherein said arresting means comprises a brake member resiliently attached to said housing, operatively associated with said lower jar, and frictionally engaging the inner wall of said tubing.

6. An assembly in accordance with claim 5, wherein said brake member is moved radially outwardly with respect to said housing, into frictional engagement with said tubing, only in response to movement of said lower jar with respect to said brake member and said housing.

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