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E. C. BRUMLEU ET AL

2,735,497

TUBING ANCHOR

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3 Sheets-Sheet 1

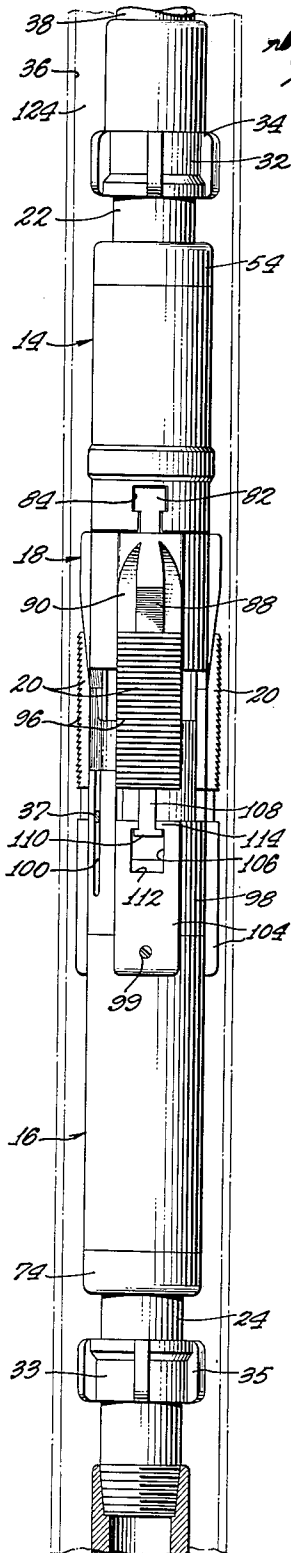


Fig. 1.

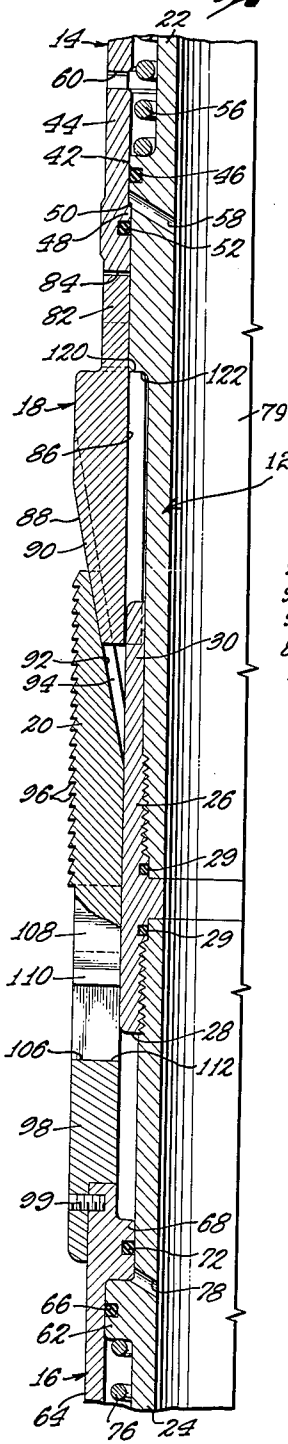


Fig. 2.

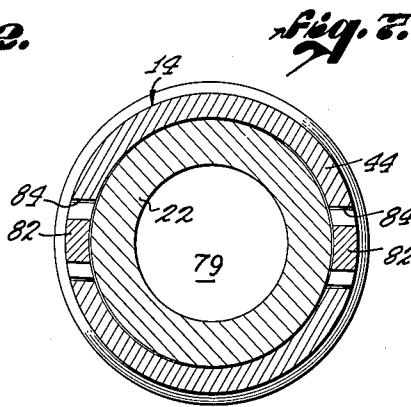


Fig. 3.

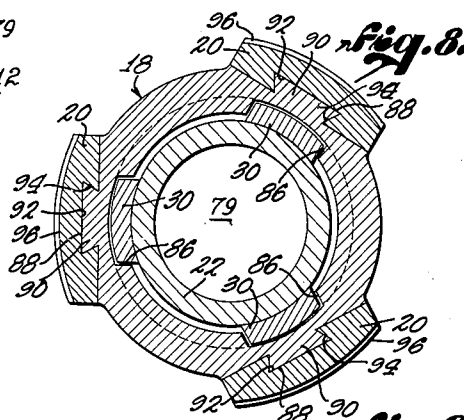


Fig. 4.

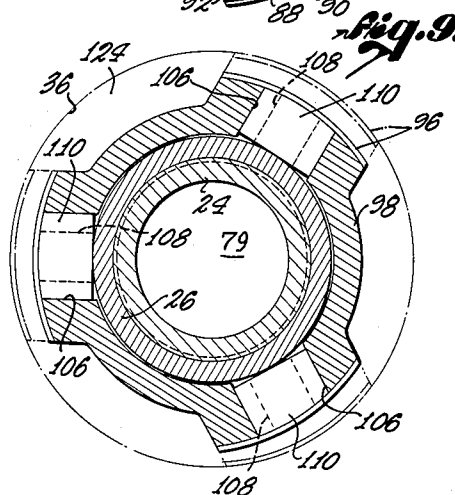


Fig. 5.

INVENTORS:
EDWARD C. BRUMLEU &
ROSS M. MEHL.
BY
Redd G. Lawlor
ATTORNEY.

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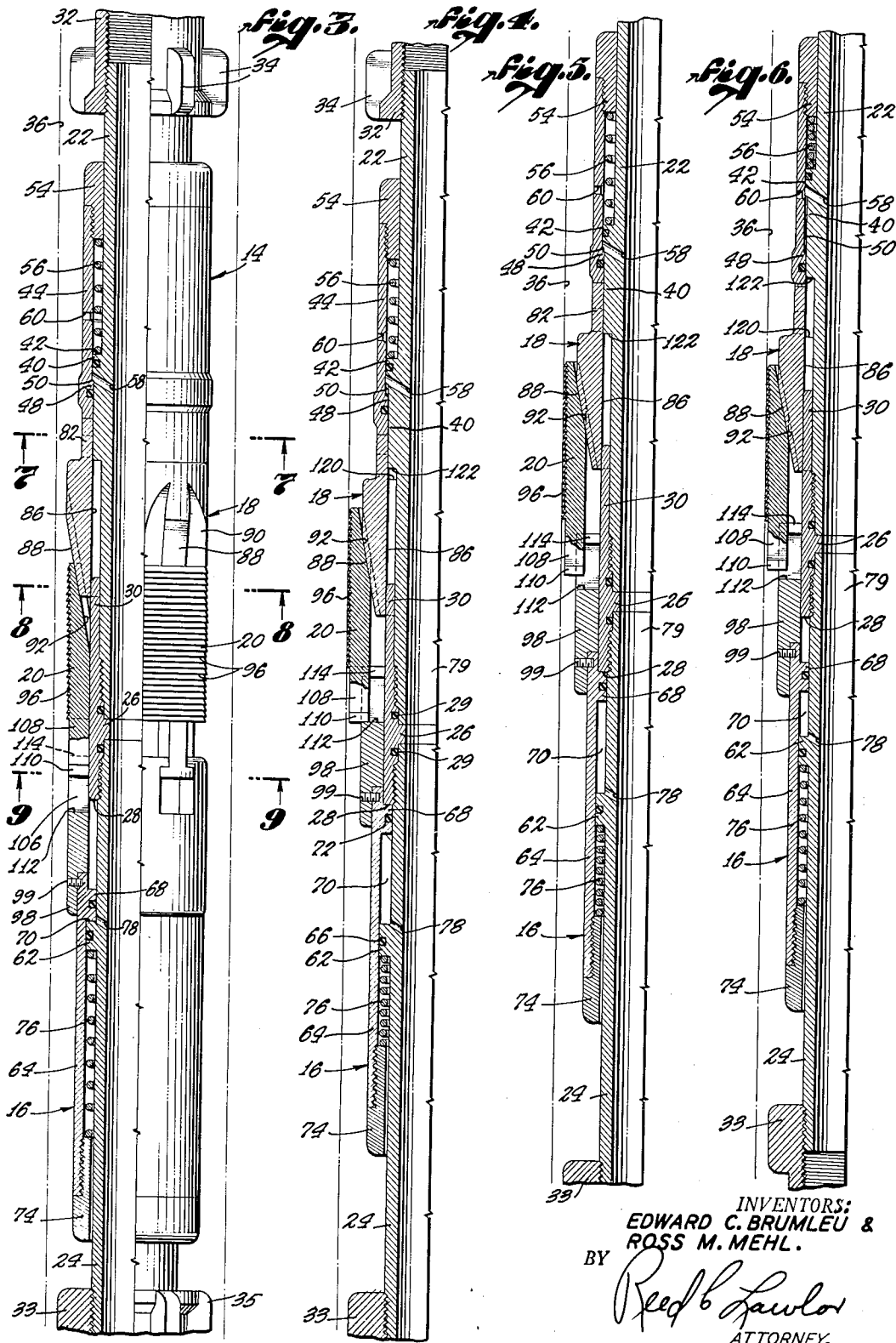
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Feb. 21, 1956

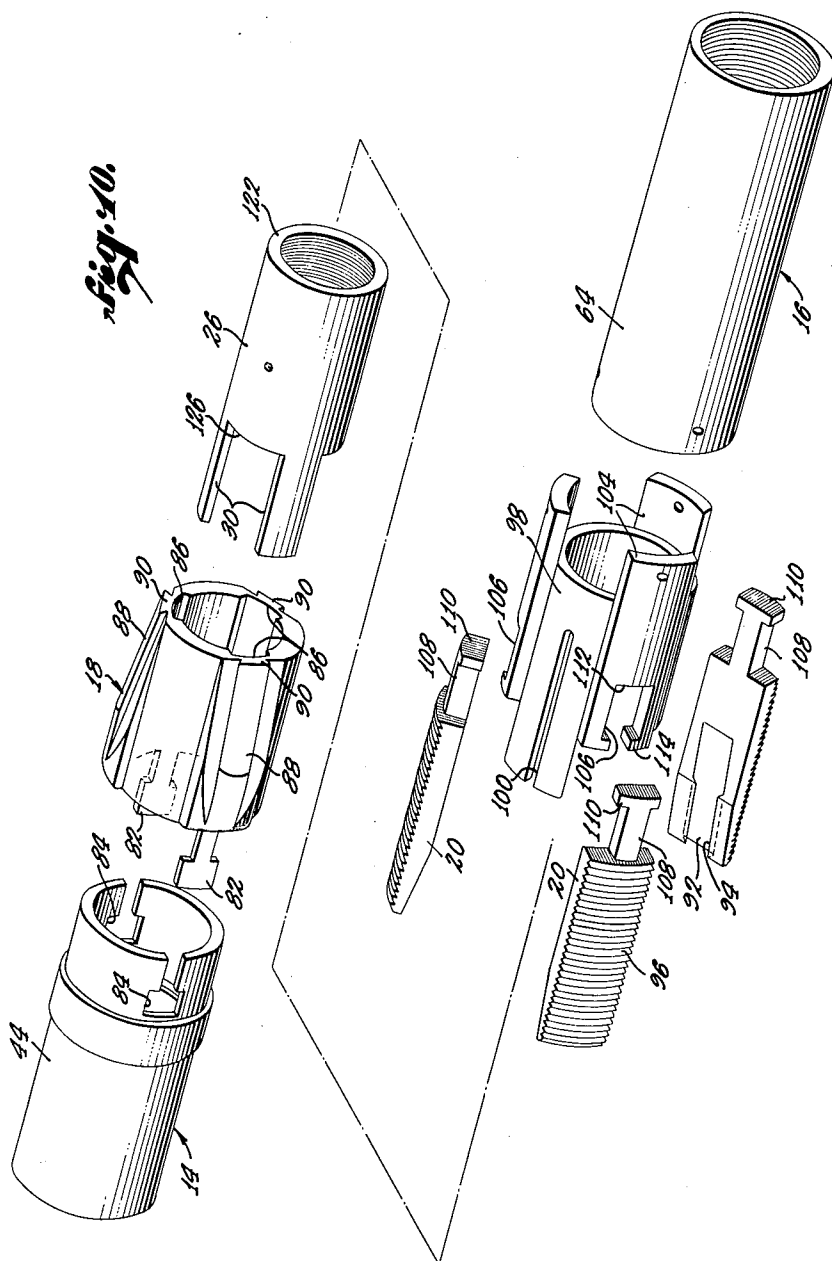
E. C. BRUMLEU ET AL

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3 Sheets-Sheet 3



INVENTORS:
EDWARD C. BRUMLEU &
ROSS M. MEHL.

BY

Reed & Lawlor
ATTORNEYS.

1

2,735,497

TUBING ANCHOR

Edward C. Brumlen, Los Angeles, and Ross M. Mehl, Lynwood, Calif., assignors to Western Pressure Control, Los Angeles, Calif., a limited partnership

Application August 17, 1951, Serial No. 242,358

10 Claims. (Cl. 166—212)

Our invention relates to improved apparatus for use in oil wells which are producing by means of rod actuated well pumps and pertains more particularly to improvements in apparatus for anchoring tubing or pipe strings in cased wells.

Generally, in producing from a well, the well is first lined with casing and then a string of tubing is lowered into the casing in order to raise oil from a point near the bottom of the casing to the well head. Usually a reciprocating pump located at the bottom end of the tubing is employed to pump the oil upwardly through the tubing. The pump itself is generally driven by means of a rod string reaching downwardly within the tubing from the surface to the pump.

In producing from such a well, the vertical load on the tubing is alternately increased and decreased as the pump reciprocates. If only the upper end of the tubing is secured to the earth at the well head, the alternating loads so created by the pumping action cause the tubing to stretch and contract alternately, thus oscillating vertically especially at the lower end. Such vertical oscillatory motion causes excessive wear between the tubing and the pump rod string and between the tubing and the casing and also results in a loss of pumping efficiency.

Such vertical oscillatory motion of the tubing is prevented by employing a tubing anchor to lock the bottom end of the tubing in fixed position relative to the casing. In many of these, the anchor is locked when the differential pressure between the liquid inside the tubing and that outside the tubing exceeds a predetermined amount and is released when the differential pressure falls below that predetermined amount.

Various means have been employed in the past to facilitate releasing the tubing anchor whenever it is desired to remove the tubing from the well. In particular, for this purpose various types of pressure operated means have been employed to effect the desired locking action, and the releasing action has been effected either by pulling or by rotating and pulling the tubing.

When a string of tubing is to be removed from a well, it is desirable to establish communication between the interior of the tubing and the annular space between the tubing and the casing in order that the fluid in the tubing may be drained into the well before raising the tubing or while the tubing is being raised. Usually this is accomplished by withdrawing the standing valve of the pump from the bottom of the tubing, thus establishing an open port at the bottom of the tubing out of which the liquid can drain. Sometimes, however, the pump becomes frozen in position or becomes so loaded with sand that the standing valve cannot be withdrawn. Under these circumstances the withdrawal of the tubing from the well causes the liquid contained therein to be raised to the surface, blowing or splashing over the equipment at the head of the well and over personnel working there. The "wet job" so performed is objectionable because of its effect on the personnel and also because of the extra

2

cost required for cleaning the equipment after the tubing has been removed.

Furthermore, when a hydraulically-operated tubing anchor is employed at the bottom of the tubing string, the failure to open the standing valve causes the tubing anchor to be retained in locked, or anchored, position. Under these circumstances, the lifting of the tubing in the well requires an unnecessarily strong force to overcome the drag between the tubing anchor and the casing. Also, of course, such dragging action causes undesirable and unnecessary wear on the tubing anchor, on the casing, and on the equipment being employed to remove the tubing.

It is therefore an object of our invention to provide an improved tubing anchor that is automatically anchored or locked when the differential pressure between the liquid inside the tubing and outside the tubing exceeds a predetermined amount.

Another object of our invention is to provide a hydraulically-actuated tubing anchor that is adapted for draining the tubing while the tubing is being raised even though the standing valve at the bottom end of the tubing remains closed.

Another object of our invention is to provide a hydraulically-actuated tubing anchor that is adapted for draining the tubing through the action of a straight upward pull on the tubing without the necessity of rotating the tubing and without the necessity of removing the standing valve.

Another object of my invention is to provide a pressure-actuated tubing anchor that will not become set accidentally while being raised or lowered in a well.

Another object of my invention is to provide an improved pressure-actuated tubing anchor that is readily released from its locked condition by an upward pull applied to the tubing at the head of the well.

Another object of my invention is to provide an improved pressure actuated tubing anchor that limits the elongation of the tubing caused by the fluid load there-within by transferring this load through the tubing anchor to the well casing.

Our invention possesses numerous objects and features of advantages some of which, together with the foregoing, will be set forth in the following description of specific apparatus embodying the principles of my invention. Though only one embodiment of the invention is illustrated and described herein in detail, it is to be understood that my invention is not limited thereto but is defined by the appended claims.

In the drawings wherein like reference characters indicate like elements throughout the several views:

Figure 1 is a side elevational view of the tubing anchor of the present invention;

Fig. 2 is an enlarged fragmentary view of the working parts of the tubing anchor;

Fig. 3 is a view, partly in elevation and partly in section, showing the tubing anchor in its normal condition when being lowered into a well;

Figs. 4 and 5 are fragmentary sectional views of the tubing anchor illustrating the action of the moving parts in the setting operation;

Fig. 6 is a fragmentary sectional view showing the relative position of the moving parts of the tubing anchor during draining;

Fig. 7 is a cross-sectional view taken on the plane 7—7 of Fig. 3;

Fig. 8 is a cross-sectional view taken on the plane 8—8 of Fig. 3;

Fig. 9 is a cross-sectional view taken on the plane 9—9 of Fig. 3; and

Fig. 10 is an exploded isometric view of a portion of the tubing anchor.

According to our invention, a tubing anchor is provided with gripping means in the form of slips that are movable between an inner, retracted position and an outer operative position and the movement is accomplished by means of a pressure-actuated mandrel that is arranged to move up and down relative to the body of the tubing anchor. In addition, according to our invention, a tubing anchor employs spring-actuated means for retaining the gripping means in their inner position to facilitate lowering and raising the tubing anchor. Furthermore, according to our invention, means are provided for lifting the mandrel by means of an upward pull on the tubing body to release the slips from the casing wall. In addition, means are provided to drain the tubing to which the tubing anchor is attached while the tubing is being withdrawn from the well if for any reason the bottom end of the tubing remains closed.

Referring particularly to Figs. 1, 2, 3 and 10 of the drawings, the tubing anchor there illustrated comprises a tubular body 12, upper and lower sleeve pistons 14 and 16 respectively, a mandrel 18, and a plurality of gripping elements or slips 20. The various parts are so arranged and interconnected that the pistons 14 and 16 operate between extended and retracted positions to force the slips between an outer position and an inner position. As the slips are forced to the outer position they are operated, or set, by biting into the casing 36 of the well and when they are forced to their inner position they are withdrawn into a retracted, or running, condition in which the tubing anchor can be run into or withdrawn from a well without danger of the slips becoming set.

The tubular body 12 comprises three main parts, namely, an upper member 22, a lower body member 24 and a center coupling 26 threadably interconnecting the two body members. The center coupling 26 is arranged externally of the two body members 22 and 24, forming a collar having a shoulder 28 at its lower end. The coupling 26 is also formed with three equally spaced vertical splines 30 at its upper end. Packing is employed in glands 29 to seal the surfaces between the body members 22 and 24 and the coupling 26.

Baffle couplings 32 and 33 threadably connected to the body members 22 and 24 at their outer ends are provided with a plurality of radially extending projections 34 and 35. These projections act as guides to prevent the pistons 14 and 16, the mandrel 18, and the slips 20 from rubbing against the casing 36 of a well unnecessarily as the string of tubing 38 to which the tubing anchor is connected is raised or lowered in the well.

An annular shoulder, or collar, 40 is formed externally of the upper body member 22 intermediate its ends. An upper body head 42 in the form of an enlarged, or upset ring, or auxiliary upper collar, or enlargement, is also formed in the upper body member 22 at the upper end of the main upper collar 40. The upper sleeve piston 14 comprises an upper sleeve, or cylinder, 44, that slidably engages the upper body head 42, the surfaces therebetween being sealed by means of packing in gland 46 arranged in the body head 42. The upper sleeve piston 14 also comprises an upper piston head 48 in the form of an inwardly projecting collar at the lower end of the cylinder 44. The upper piston head 48 slidably engages the collar 40 of the upper body member 22 below the upper body head 42 thereby forming an upper working chamber 50. The surfaces between the piston head 48 and the upper collar 40 are sealed by means of a packing in gland 52 arranged in the upper piston head. A retaining nut 54 is threadably secured to the upper end of the upper sleeve piston 14. There is sufficient clearance between the retaining nut 54 and the upper body member 22 to permit liquid to pass therebetween as the upper sleeve piston 14 moves up and down. An upper compression spring 56 is mounted concentrically with the upper body member 22 and is compressed between the upper body head 42 and the upper retaining nut 54. An upper port 58 extending through the upper body mem-

ber 22 at a point between the two packing glands 46 and 52 and just below the body head 42, establishes communication between the upper working chamber 50 and the interior of the body member.

A drain port 60 extending through the wall of the upper cylinder 44 serves to permit liquid contained within the string of tubing 38 to be drained outwardly therefrom when the packing gland 46 is moved upwardly past the drain port 60 as explained in more detail hereinbelow.

A lower body head 62 in the form of a collar is formed externally of the lower body member 24 intermediate its ends. The lower sleeve piston 16 comprises a lower sleeve, or cylinder, 64 that slidably engages the lower body head 62, the surfaces therebetween being sealed by means of a packing in gland 66 arranged in the lower body head. The lower sleeve piston 16 also comprises a lower piston head 68 in the form of an inwardly projecting collar at the upper end of the cylinder 64. The lower piston head 68 slidably engages the lower body member 24 above the lower body head 62 thereby forming a lower working chamber 70. The surfaces between the lower piston head 68 and the lower body member 24 are sealed by means of packing in gland 72 arranged in the lower piston head 68. A retaining nut 74 is threadably secured to the lower end of the lower sleeve piston 16. There is sufficient clearance between the retaining nut 74 and the lower body member 24 to permit liquid to pass therebetween as the lower sleeve piston moves up and down.

A lower compression spring 76 is mounted concentrically with the lower body member 24 and is compressed between the lower body head 62 and the lower retaining nut 74. A lower port 78 extending through the lower body member 24 at a point between the two packing glands 66 and 72 establishes communication between the lower working chamber 70 and the interior of the body member.

When the pressure of liquid in the space 79 within the tubing anchor exceeds that in the annular space 124 between the string of tubing and the casing, the pressure of the liquid in the lower working chamber 70 tends to force the lower sleeve piston 16 upwardly against the force exerted by the lower compression spring 76, this spring normally tending to urge the lower sleeve member 16 into its lowermost position. Similarly, when the pressure of liquid in the space 79 within the tubing anchor exceeds that in the annular space 124 between the string of tubing and the casing, the pressure of the liquid in the upper working chamber 50 tends to force the upper sleeve piston 14 downwardly against the force exerted by the upper compression spring 56, this spring normally tending to urge the upper sleeve member 14 into its uppermost position.

For reasons which will become apparent hereinafter, the strength of the springs 56 and 76 and the cross-sectional areas of the two working chambers 50 and 70 are so arranged that the lower sleeve piston 16 moves upwardly to its uppermost position before the upper sleeve member 14 is moved downwardly to its lowermost position. For example, this result may be accomplished by forming the lower working chamber with a working surface having a larger cross-sectional area than that of the working surface of the upper working chamber if the upward force acting on the upper sleeve piston 14 equals the downward force acting on the lower sleeve piston 16, taking due account of the weights of the sleeve pistons etc. as well as the forces exerted by the springs 56 and 58. In the present case the difference in working areas of the working chambers 50 and 70 is produced by utilizing cylinders 44 and 64 of the same internal diameter and by employing a collar 40 beneath the upper body head 42 but no such collar above the lower body head 62.

The mandrel 18 is connected to the lowermost end of the upper sleeve piston 14 below the upper piston head 48 by means of a pair of diametrically opposite T-

members 82 that interengage a complementary pair of T-shaped slots 84. This connecting arrangement has been adopted in order to facilitate assembly of the mandrel 18 and the upper sleeve piston 14. However, it is to be understood that the mandrel 18 and the upper sleeve piston 14 may be interconnected in any other convenient way and may even be formed, if desired, as a unitary structure. The mandrel 18 is provided with three vertical slots 86 on the inner side thereof which slots loosely fit the three splines 30 at the upper end of the center coupling 26 in order to prevent the mandrel from rotating. A plurality, for instance three, equally spaced downwardly converging tapered surfaces 88 are formed by three dovetail keys 90.

The three slips 20 are provided on their inner sides with surfaces 92 as the bases of dovetail keyways 94, the surfaces 92 and 88 being adapted to slide smoothly over each other when the dovetail keyways 94 mate with the keys 90. The slips 20 are provided on their outer surfaces with downwardly-biting teeth or serrations 96. The dovetail keyways 94 form an angle with the serrated surfaces in such a manner that the serrations may all contact the casing at the same time.

A slip holder 98 is secured to the upper end of the lower sleeve piston 16 by means of three screws 99. As indicated in Fig. 1, a slot 100 formed in the main body of the slip holder 98 is engaged by a screw or pin 37 secured to the center coupling 26 in order to prevent the slip holder 98 and the lower piston 16 from rotating. The slip holder 98 is provided with three vertically extending arms 104 that project outwardly from the main body of the slip holder.

The slips 20 are connected to the slip holder 98 by means of lost-motion connections in the form of T-shaped slots 106 formed in the upper ends of the arms 104 and T-shaped tongues 108 formed at the lower ends of the respective slips 20. The slips are adapted to move inwardly and outwardly with respect to the tubular body 12 as they slide along the dovetail keys 90. The cross-arm 110 of the tongues 108 have a vertical dimension substantially less than that of the main portion of the slot 106 so as to provide the desired lost-motion action. The range of vertical motion of the slips 20 is limited in a downward direction by the abutment of the cross-arms 110 with the shoulders 112 at the inner ends of the slots 106 and are limited upwardly by the abutment of the cross-arms 110 with the jaws 114 of the T-slot.

The manner in which our tubing anchor operates normally can best be understood by reference to Figs. 3, 4, 5 and 6. While a string of tubing 38 is being lowered into a well, normally the bottom end of the tubing beneath the tubing anchor is open. Under these circumstances, the pressure of liquid in the interior of the tubing anchor and externally thereof are substantially equal. In this case the upper and lower springs 56 and 76 extend the tubing anchor by urging the upper and lower sleeve pistons 14 and 16 respectively into their uppermost and lowermost positions. The upper position of the upper sleeve piston is established by the engagement of inner shoulders 120 on the mandrel with shoulders 122 at the lower end of the collar 40. The lower position of the lower sleeve piston 16 is established by engagement of the lower piston head 68 with the lower body head 62. In this extended condition, both of the working chambers 50 and 70 are contracted to their minimum volumes. The dimensions of the various parts of the tubing anchor are so arranged that when the tubing anchor is thus extended the jaws 114 of the slip holder 98 engage the cross-arms 110 of the slip tongues 108 drawing the slips to their lowermost and also to their innermost, or retracted, positions.

When the full length of tubing 38 has been installed in the well, pumping action is commenced raising the level of liquid within the tubing 38 above that in the annular space 124 between the string of tubing and the casing. 75

When the pressure within the tubing exceeds that outside the tubing by a predetermined amount sufficient to overcome the force of the lower spring 76, the lower working chamber 70 starts to expand. This expansion continues as the pressure inside the tubing 38 increases, causing the shoulders 112 on the slip holder 98 to engage the cross-arms 110 on the slips 20, forcing them upwardly and outwardly as illustrated in Fig. 4. Normally this upward and outward movement of the slips continues until the lower piston head 68 abuts the shoulder 28 on the lower end of the coupling 26. Thereafter as the pressure within the tubing 38 continues to rise the upper working chamber 50 expands forcing the slips 20 outwardly to the point where the serrations 96 engage the inner walls of the casing 36 as illustrated in Fig. 4.

As the fluid level within the tubing 38 is increased by continued pumping, the tubing stretches. Even after the slips 20 engage the casing 36, the stretching continues, causing the abutment 112 to recede downwardly from the cross-arms 110, and causing the shoulders 122 at the lower end of the collar 40 to engage the shoulders 120 of the mandrel as illustrated in Fig. 5. Thereafter, continued raising of the fluid level within the string of tubing 38 merely causes the force between the shoulders 120 and 122 to increase, this increasing load being utilized to further force the slips 20 to bite more and more firmly into the casing 36. Subsequently, when the well is producing, the fluctuations of load on the string of tubing 38 merely cause minor fluctuations in the force between the shoulders 120 and 122 without, however, permitting the shoulders 120 and 122 to become disengaged. Thus, as the load fluctuates, the tubing itself is not displaced to any extent that would cause the tubing to rub on the casing, the tubing not being subjected to any excessive vertical oscillation.

When the tubing 38 is to be withdrawn from the well two main possibilities arise. Either the port at the bottom of the tubing may be opened by removing the standing valve of the pump or the port may remain closed. Operation of our tubing anchor under both conditions is considered below.

If the standing valve is opened before the raising of the tubing is commenced and remains open, the liquid within the tubing flows out of the bottom of the tubing, permitting the liquid level in the tubing to fall, thus diminishing the differential pressure between the interior of the tubing and the annular space outside the tubing 124. As this differential pressure diminishes, the lower chamber 70 contracts under the influence of the lower spring 76, until such time as the jaws 114 of the slip holder 98 engage the cross-arms 110 of the slips. Thereafter the slips 20 are disengaged from the casing 36 by pulling or jarring the tubing upwardly to the point where the coupling 26 raises the mandrel 18, permitting the slips to disengage the casing 36. Once the slips 20 have become disengaged, the upper spring 56 raises the upper sleeve piston 14 to its uppermost position. At the same time, since the slips 20 have become disengaged, the lower spring 76 pulls the slips 20 to their lowermost, or retracted, position, all as illustrated in Fig. 3. In such condition, as the tubing is raised the slips 20 remain out of contact with the casing 36.

On the other hand, it sometimes happens that the tubing cannot be drained as by opening the standing valve of the pump, thus causing all the liquid within the tubing 38 to be raised to the surface unless special precautions are taken to drain the tubing. If the bottom end of the string or tubing 38 does remain closed, the upper body member 22 rises within the upper sleeve piston 14 as illustrated in Fig. 6 to the point where the gland 46 passes by the drain port 60 allowing the port 60 to register with the upper port 58, registration of the drain port 60 with the upper port 58 being assured by the abutment of the lower end of the mandrel 18 with the upper shoulder

126 of the coupling 26 at the base of the splines 30. Further upward pull on the string of tubing 38 raises the mandrel, forcing the slips 20 inwardly thereby disengaging the slips from the casing 36. Thereafter, as the raising of the string of tubing continues the drain port 60 and the upper port 58 register whenever a sufficient differential pressure exists to cause draining.

Although the present invention has been described in relation to a particular embodiment thereof, it will be readily apparent that various modifications and changes can be made in the structure of the present tubing anchor without departing from the scope of the invention as defined by the appended claims.

We claim:

1. A pressure actuated tubing anchor comprising: a tubular body having an annular shoulder thereon; a locking structure comprising a mandrel and a sleeve piston connected thereto, said locking structure being movable relative to said tubular body, said mandrel having a plurality of tapered surfaces, said surfaces converging downwardly; said sleeve piston comprising a cylinder slidably encircling said annular shoulder and an inwardly projecting piston head connected to said cylinder and slidably engaging said tubular body beneath said annular shoulder, thereby forming a working chamber; a port communicating between said working chamber and the interior of said tubular body whereby said chamber tends to expand when pressure inside said tubular body exceeds that outside; a plurality of slips adapted to move inwardly toward and outwardly away from said tubular body, said slips having tapered surfaces slidably engaging the respective tapered surfaces of said mandrel, said slips having serrated surfaces adapted to engage a well casing when said slips are forced outwardly and to lock said tubing anchor against downward movement; and means including a pair of relatively movable but interengageable surfaces located respectively on said structure and on said tubular body for jarring said mandrel to release said slips from the well casing when said tubular body is pulled upward.

2. A pressure actuated tubing anchor comprising: a tubular body having an annular shoulder thereon; a locking structure comprising a mandrel and a sleeve piston connected thereto, said locking structure being movable relative to said tubular body, said mandrel having a plurality of tapered surfaces, said surfaces converging downwardly, said sleeve piston comprising a cylinder slidably encircling said annular shoulder and an inwardly projecting piston head connected to said cylinder and slidably engaging said tubular body beneath said annular shoulder, thereby forming a working chamber; a port communicating between said working chamber and the interior of said tubular body whereby said chamber tends to expand when pressure inside said tubular body exceeds that outside; a plurality of slips adapted to move inwardly toward and outwardly away from said tubular body, said slips having tapered surfaces slidably engaging the respective tapered surfaces of said mandrel, said slips having serrated surfaces adapted to engage a well casing when said slips are forced outwardly and to lock said tubing anchor against downward movement; a drain port in said cylinder, said drain port normally standing above said annular shoulder; and a pair of relatively movable but engageable surfaces located respectively on said structure and on said tubular body for limiting the upward movement of said tubular body relative to said sleeve piston, said stops being so positioned as to maintain said shoulder above said drain port when said surfaces are engaged whereby fluid may flow from the interior of said tubular body through said chamber to the space exterior to said cylinder.

3. A pressure actuated tubing anchor comprising: a tubular body having an annular shoulder thereon; a structure comprising a mandrel and a sleeve piston con-

nected thereto, said structure being movable relative to said tubular body; said mandrel having a plurality of tapered surfaces, said surfaces converging downwardly, said sleeve piston comprising a cylinder slidably encircling said annular shoulder and an inwardly projecting piston head slidably engaging said tubular body beneath said body head thereby forming a working chamber; a port communicating between said working chamber and the interior of said tubular body whereby said chamber tends to expand when pressure inside said tubular body exceeds that outside; a plurality of slips adapted to move inwardly and outwardly of said tubular body, said slips having tapered surfaces slidably engaging the respective tapered surfaces of said mandrel, said slips having serrated surfaces adapted to engage a well casing when said slips are forced outwardly and to lock said tubing anchor against downward movement; a drain port in said cylinder; and resilient means acting between said structure and said tubular body for urging said drain port into its normal position above said shoulder, said drain port being movable to a position beneath said shoulder in response to an upward force applied to said tubular body while said slips engage a well casing, whereby fluid may flow from the interior of said tubular body through said chamber to the space exterior to said cylinder.

4. A pressure actuated tubing anchor comprising: a tubular body; upper and lower sleeve pistons mounted for sliding along said tubular body, said sleeve pistons forming upper and lower working chambers between the respective sleeve pistons and said tubular body; upper and lower ports respectively communicating between the upper and lower chambers and the interior of the tubular body, whereby said chambers tend to expand when pressure inside said tubular body exceeds that outside; a mandrel connected to one of said sleeve pistons, said mandrel having a tapered surface; a gripping element adapted to move slidably along said tapered surface between an inner position and an outer position; means including a pair of relatively movable but engageable stops located respectively on said lower sleeve piston and said gripping element for limiting the raising and lowering of said gripping element on said tubular body; resilient means acting on said sleeve pistons for urging said gripping element into its innermost position, said resilient means acting in opposition to pressure in the respective chambers; a drain port in one of said sleeve pistons; and means operative in response to an upward pull on said tubular body only while said gripping means is constrained externally against upward movement for establishing communication between said drain port and the interior of said tubular body.

5. A pressure actuated tubing anchor comprising: a tubular body; independently movable upper and lower sleeve pistons slidably encircling said tubular body and forming respectively the lower and upper ends of upper and lower working chambers between the respective sleeve pistons and said tubular body; upper and lower ports respectively communicating between the upper and lower chambers and the interior of the tubular body, whereby said chambers tend to expand when pressure inside said tubular body exceeds that outside, thereby urging said sleeve pistons toward each other; a mandrel connected to one of said sleeve pistons, said mandrel having a plurality of tapered surfaces, said surfaces converging downwardly; a plurality of gripping elements adapted to move slidably along the respective tapered surfaces between an inner, lower position and an outer, upper position; means interconnecting said lower sleeve piston and said gripping elements for limiting the raising and lowering of said gripping elements along said tubular body when slid along said tapered surfaces; and resilient means acting on said sleeve pistons in opposition to pressure in the respective chambers for urging said sleeve pistons apart whereby said gripping elements are urged into their innermost positions.

6. A pressure actuated tubing anchor comprising: a tubular body; independently movable upper and lower sleeve pistons slidably encircling said tubular body and forming respectively the lower and upper ends of upper and lower working chambers between the respective sleeve pistons and said tubular body; upper and lower ports respectively communicating between the upper and lower chambers and the interior of the tubular body, whereby said chambers tend to expand when pressure inside said tubular body exceeds that outside, thereby urging said sleeve pistons toward each other; a mandrel connected to one of said sleeve pistons, said mandrel having a plurality of tapered surfaces, said surfaces converging downwardly; a plurality of gripping elements adapted to move slidably along the respective tapered surfaces between an inner, lower position and an outer, upper position; and means including two pairs of interengageable surfaces, one member of each pair being arranged on said lower sleeve piston, the other member of each pair being arranged on said gripping element for limiting both the raising and the lowering of said gripping element along said tubular body when said gripping element is slid along said tapered surfaces.

7. A pressure actuated tubing anchor comprising: a tubular body having upper and lower shoulders thereon; upper and lower sleeve pistons, each piston comprising a cylinder associated with the respective shoulders and slidably encircling the associated shoulders, the upper piston comprising a first inwardly projecting head slidably engaging said tubular body beneath said upper shoulder, thereby forming an upper working chamber, the lower piston comprising a second inwardly projecting head slidably engaging said tubular body above said lower shoulder, thereby forming a lower working chamber; upper and lower ports communicating between the upper and lower chambers and the interior of the tubular body, said first port being located above said first piston head and said second port being located beneath said second piston head, whereby said chambers tend to expand when pressure inside said tubular body exceeds that outside; resilient means acting on said pistons for urging said upper piston into its uppermost position in opposition to pressure in the upper chamber and for urging said lower piston into its lowermost position in opposition to pressure in the lower chamber; a mandrel connected to the lower end of said upper sleeve piston, said mandrel having a plurality of downwardly converging tapered surfaces; a plurality of gripping elements adapted to move slidably along said tapered surfaces between an inner position and an outer position; and means interconnecting said lower sleeve piston and said gripping elements for limiting the raising and lowering of said gripping elements along said tubular body.

8. A pressure actuated tubing anchor as defined in claim 7 wherein the cross-sectional area of the working surface of said lower piston exceeds the cross-sectional area of the working surface of said upper piston.

9. A pressure actuated tubing anchor comprising: a tubular body having upper and lower shoulders thereon; upper and lower sleeve pistons, each piston comprising a cylinder associated with the respective shoulders and slidably encircling the associated shoulder, the upper piston comprising an inwardly projecting piston head slidably engaging said tubular body beneath said upper shoulder thereby forming an upper working chamber, the lower piston comprising an inwardly projecting piston head slidably engaging said tubular body above said lower

shoulder thereby forming a lower working chamber; upper and lower ports communicating between the upper and lower chambers and the interior of the tubular body, whereby said chambers tend to enlarge when pressure inside said tubular body exceeds that outside; an upper coil spring encircling said tubular body and compressed between said upper shoulder and said upper piston head, said upper spring acting in opposition to pressure in the upper chamber for urging the upper sleeve piston into its uppermost position; a lower coil spring encircling said tubular body and compressed between said lower shoulder and said lower piston head, said lower spring acting in opposition to pressure in the lower chamber for urging the lower sleeve piston into its lowermost position; a mandrel connected to the lower end of said upper sleeve piston, said mandrel having a plurality of downwardly converging tapered surfaces; a plurality of gripping elements adapted to move slidably along said tapered surfaces between an inner position and an outer position; and means interconnecting said lower sleeve piston and said gripping elements for limiting the raising and lowering of said gripping elements along said tubular body.

10. A pressure actuated tubing anchor comprising: a tubular body having upper and lower shoulders thereon, said tubular body comprising a collar between said shoulders; upper and lower sleeve pistons, each piston comprising a cylinder associated with the respective shoulder and slidably encircling the associated shoulder, the upper piston comprising an inwardly projecting piston head slidably engaging said tubular body above said collar and beneath said upper shoulder thereby forming an upper working chamber, the lower piston comprising an inwardly projecting piston head slidably engaging said tubular body beneath said collar and above said lower shoulder thereby forming a lower working chamber; upper and lower ports communicating between the upper and lower chambers and the interior of the tubular body, whereby said chambers tend to expand when pressure inside said tubular body exceeds that outside; resilient means acting on said pistons for urging said upper and lower pistons respectively in opposite directions into their uppermost and lowermost positions in opposition to pressure in the respective chambers; a mandrel connected to the lower end of said upper sleeve piston, said mandrel having a plurality of downwardly converging tapered surfaces; a plurality of gripping elements adapted to move slidably along said tapered surfaces between an inner position and an outer position; means interconnecting said lower sleeve piston and said gripping elements for limiting the raising and lowering of said gripping elements along said tubular body; and a drain port in said upper sleeve piston, said drain port normally standing above said upper shoulder but being positioned below said upper shoulder when said collar engages said upper piston head.

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2,532,418	Page	Dec. 5, 1950