

June 10, 1969

C. C. BROWN

3,448,805

HYDROSTATIC ANCHOR AND DRAIN DEVICE FOR WELL PIPE STRINGS

Filed Sept. 28, 1967

Sheet 1 of 4

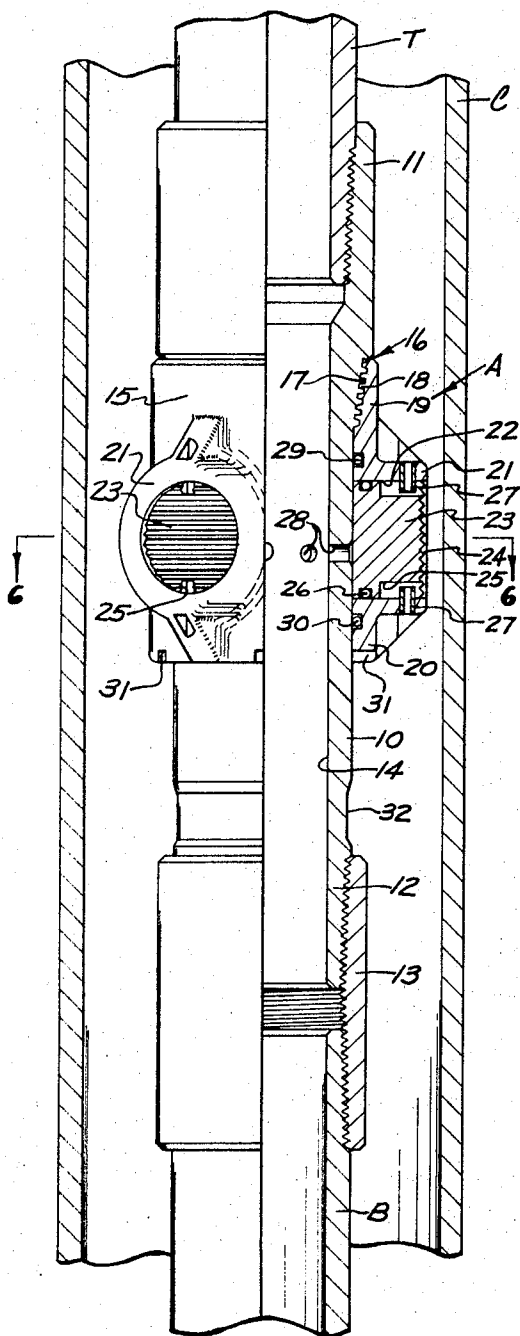


Fig. 1

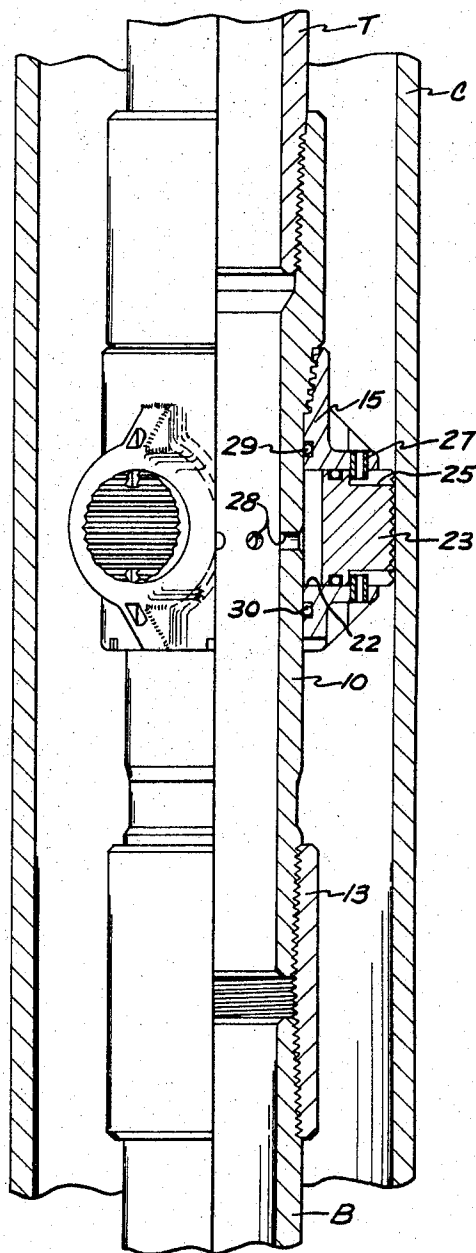


Fig. 2

CICERO C. BROWN  
INVENTOR.

BY

*Lawrence*

ATTORNEY

June 10, 1969

C. C. BROWN

3,448,805

HYDROSTATIC ANCHOR AND DRAIN DEVICE FOR WELL PIPE STRINGS

Filed Sept. 28, 1967

Sheet 2 of 4

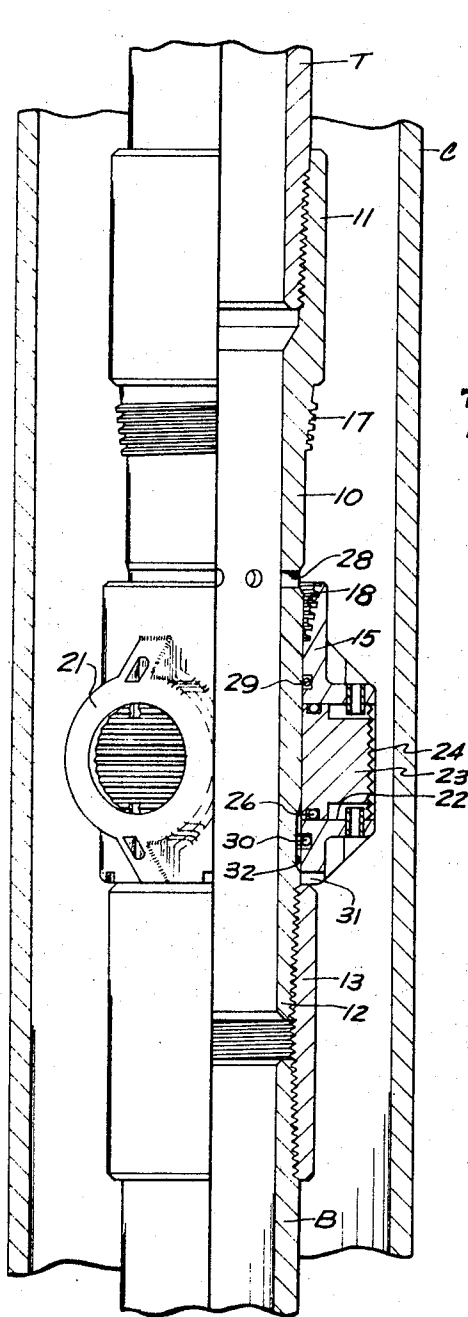


Fig. 3

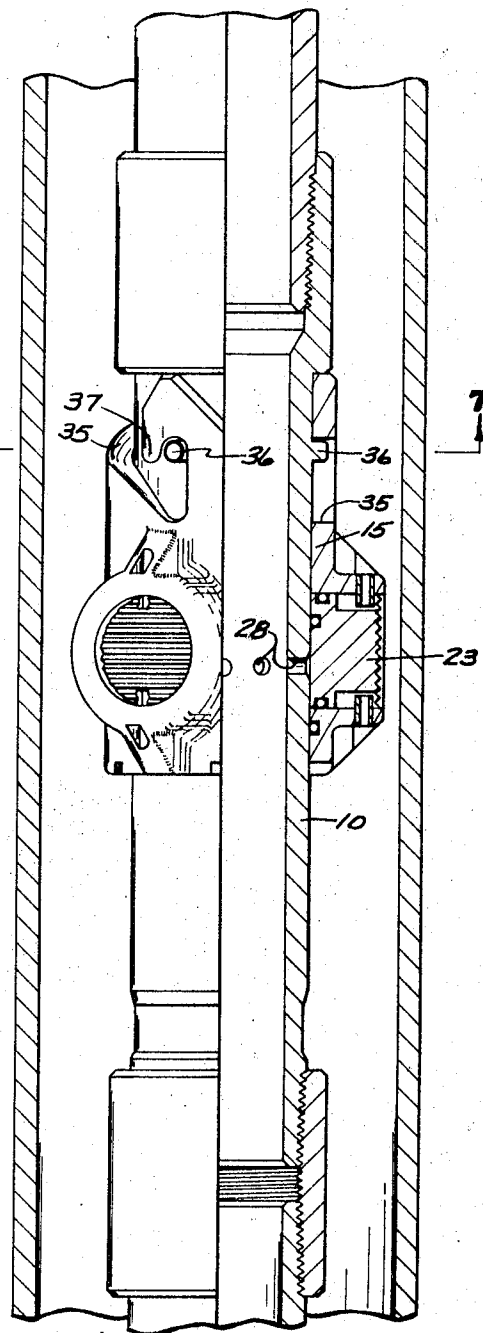


Fig. 5

CICERO C. BROWN  
INVENTOR.

BY

*Rever*  
ATTORNEY

June 10, 1969

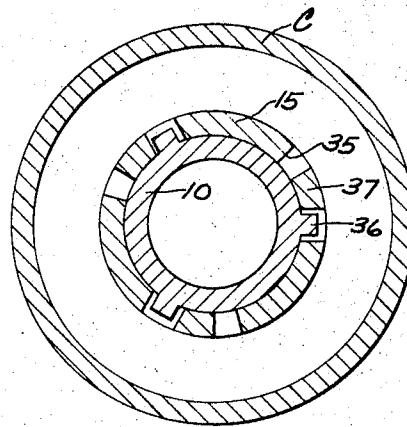
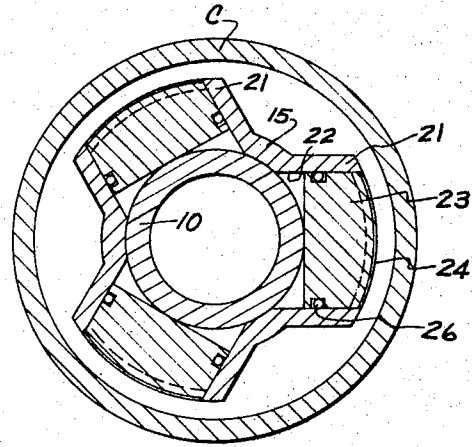
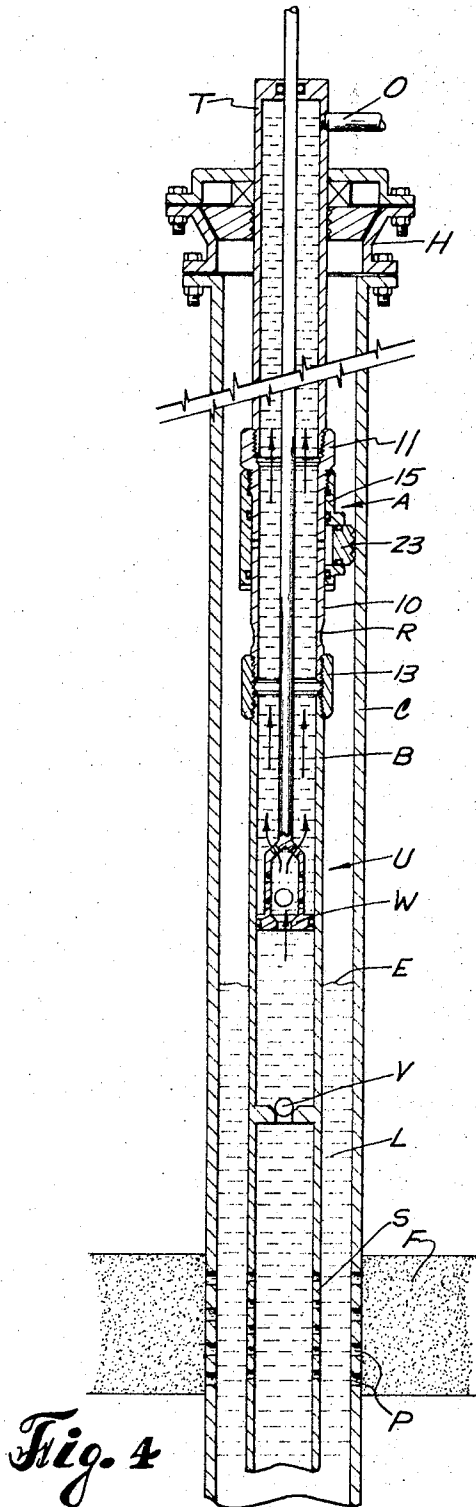
C. C. BROWN

3,448,805

HYDROSTATIC ANCHOR AND DRAIN DEVICE FOR WELL PIPE STRINGS

Filed Sept. 28, 1967

Sheet 3 of 4



CICERO C. BROWN  
INVENTOR.

BY

*Attorney*

ATTORNEY

June 10, 1969

C. C. BROWN

3,448,805

HYDROSTATIC ANCHOR AND DRAIN DEVICE FOR WELL PIPE STRINGS

Filed Sept. 28, 1967

Sheet 4 of 4

Fig. 10

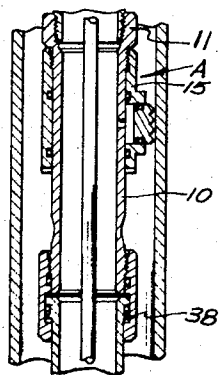


Fig. 9

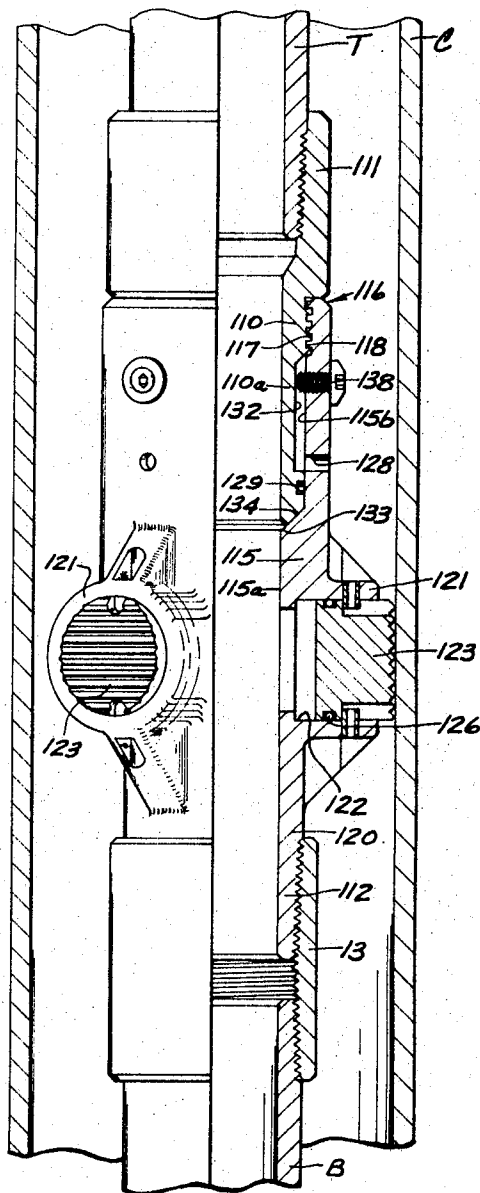
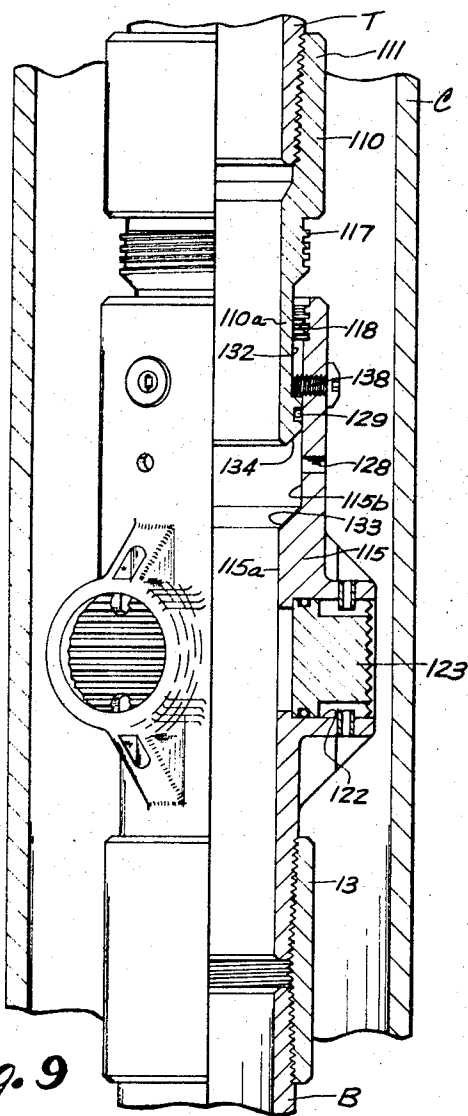


Fig. 8

CICERO C. BROWN  
INVENTOR.

BY

*R. W. Miller*  
ATTORNEY

1

2

3,448,805

## HYDROSTATIC ANCHOR AND DRAIN DEVICE FOR WELL PIPE STRINGS

Cicero C. Brown, Houston, Tex., assignor to Brown Oil

Tools, Inc., a corporation of Texas

Filed Sept. 28, 1967, Ser. No. 671,318

Int. Cl. E21b 23/00; F04b 21/00

U.S. Cl. 166—212

2 Claims

### ABSTRACT OF THE DISCLOSURE

A device adapted for insertion into a well pipe string, such as a pump tubing string, including means functioning in response to hydrostatic pressure in the pipe string to anchor the string to a surrounding well casing and including valve means operable to drain the column of fluid from the pipe string upon release of the anchor means.

In oil wells which employ reciprocating pumps operating inside of a string of tubing, it is necessary to anchor the tubing string against movement which usually results from the frictional forces produced by the pump plunger in its reciprocating movements inside the pump barrel which forms a part of the pipe string. This movement inside the surrounding well casing, if uncontrolled, may damage both the tubing and casing, as well as the sucker rod string.

Conventional tubing anchors employ various types of mechanical connectors or gripping devices which are of comparatively complicated construction, require special fittings to be preinstalled in the well casings for engagement by the anchors, and are subject to various difficulties in installation and release.

The present invention is directed to an improvement in such tubing anchors, by providing a tubular sub adapted for insertion into the tubing string at a point above the pump barrel and equipped with anchor means actuable by the hydrostatic head of fluid in the tubing string to grip a surrounding casing, and including valve means controlling passages operable to be opened to drain the fluid column from the tubing string simultaneously with release of the anchor means.

A primary object of the present invention is to provide a hydrostatically actuated tubing anchor.

An important object is the provision of a hydrostatically actuated tubing anchor in combination with a drain valve means.

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

In the drawing:

FIG. 1 is a longitudinal quarter-sectional view of an anchor device in accordance with one embodiment of this invention, showing the same installed in a tubing string and positioned inside a well casing before actuation of the anchor elements;

FIG. 2 is a view similar to FIG. 1 showing the anchor elements actuated into casing-gripping position;

FIG. 3 is a view similar to FIGS. 1 and 2, showing the positions of the parts of the device upon release of the anchor elements;

FIG. 4 is a longitudinal sectional view of a well showing the device installed in a pumping string;

FIG. 5 is a longitudinal quarter-sectional view illustrating a modification of the device illustrated in FIGS. 1 to 4;

FIG. 6 is a cross-sectional view taken on line 6—6 of FIG. 1;

FIG. 7 is a cross-sectional view taken on line 7—7 of FIG. 5;

FIG. 8 is a longitudinal sectional view illustrating another modification of the invention, showing the anchor elements in actuated casing-gripping position;

FIG. 9 is a view similar to FIG. 8, showing the parts in positions occupied upon release of the anchor elements; and

FIG. 10 is a fragmentary view of a well installation illustrating a further modification of the device of this invention.

Referring first to FIGS. 1 to 4 and 6, and more particularly to FIG. 4, there is shown in assemblage of apparatus for equipping a pumping well which includes the device in accordance with one embodiment of this invention.

As seen in FIG. 4, a well casing C extends through an oil producing earth formation F with which the casing is in communication by means of perforations P, through which production fluids L, particularly oil, water or both, enter casing C and rise therein to a level indicated at E. The top of the casing is equipped with the usual casing-head H through which extends a string of production tubing T, having a side outlet O.

The lower end of tubing T has connected thereto an anchor device, designated generally by the letter A, and the lower end of the latter is connected to a pumping unit, designated generally by the letter U, of any suitable and generally conventional design. For illustrative purposes, the pumping unit comprises a tubular barrel B, the lower end of which defines a perforate screen S which extends into the body of fluid L. A conventional standing valve V is positioned in the bore of barrel B above screen S. A working valve or plunger W is mounted in barrel B above the standing valve for reciprocation by means of a string of sucker rods R which extends through the upper end of the tubing string for connection to the usual walking beam or other conventional power-operated reciprocating device (not shown).

The details of anchor device A, best seen in FIGS. 1 to 3 and 6, comprise a tubular sub or mandrel 10 having an internally threaded box 11 for connecting it to the adjacent section of tubing T, and a threaded pin 12 to be received in a collar 13 for connection to the upper end of barrel B or to an intervening section of tubing T, if desired. Mandrel 10 has a bore 14 which is dimensioned to be substantially flush with the bores of tubing T and barrel B so that the mandrel effectively forms a part of tubing string T.

A tubular cage 15 is mounted about an intermediate portion of mandrel 10 for relative movement thereon. A releasable connection means, designated generally by the numeral 16, releasably connects cage 15 to mandrel 10. In the present embodiment connection means 16 comprises a downwardly tapered section of left-hand threads 17 carried on the exterior of mandrel 10 below box 11 and a mating section of internal threads 18 carried by the upper end 19 of cage 15. It will be understood that by using left-hand threads for connection means 16, the latter will be released by right-hand rotation of mandrel 10 relative to cage 15. Upon release of connection means 16, mandrel 10 will be freed for limited longitudinal movement relative to cage 15, the relative longitudinal movement in one direction being limited by engagement of the lower end 20 of cage 15 with a stop 21 defined by the upper end of collar 13 and in the other direction by engagement of threads 17 and 18.

Cage 15 carries a plurality (three in the illustrative embodiment) of angularly spaced, radially extending, tubular bosses 21 having cylindrical bores or cylinders 22 in each of which is radially slidably mounted a button-type, generally cylindrical pipe-gripping slip 23 having a

toothed outer end face 24 for grippingly engaging the surrounding casing C when urged outwardly of cylinders 22 against the casing. The inner ends of slips 23 carry seal rings 26 in their outer peripheries for slidable sealing engagement with the walls of cylinders 22, allowing the slips to function as pistons in the latter. Pairs of stop lugs 27 project through opposite points of the walls of bosses 21 into longitudinal slots 25 provided in the periphery of slips 23 for engagement by the inner end walls of the slots to prevent expulsion of the slips from the cylinders.

Mandrel 10 is provided with a plurality of angularly spaced radial passages 28 through the wall thereof located so as to be in communication with the inner ends of cylinders 22 when cage 15 is secured to mandrel 10 by connection means 16. Longitudinally spaced upper and lower seal elements 29 and 30, respectively, are disposed in the bore wall of cage 15 at points above and below cylinders 22 in slidable sealing engagement with the exterior of mandrel 10. Cage 15, together with seal elements 29 and 30, thus will function as a sleeve valve for ports 28, confining the latter to communication with cylinders 22 when the cage is secured to the mandrel (FIGS. 1 and 2) and opening the ports to communication with the exterior of the anchor device when connection means 16 has been released and mandrel 10 drawn upwardly relative to cage 15 a sufficient distance to raise ports 28 above upper seal element 29 (FIG. 3).

Lower end 20 of cage 15 is provided with a number of angularly spaced notches or slots 31 which may be placed in communication with the several cylinders 22, by-passing lower seal element 30, by means of annular groove 32 formed in the exterior of mandrel 10 at a point above pin 12. Groove 32 is of sufficient width and suitably located so that when mandrel 10 has been released from cage 15 and drawn upwardly a sufficient distance to open ports 28, as described above, groove 32 will extend around seal element 30, with one end in communication with cylinders 22 and the other end with slots 31 (FIG. 3), thereby providing venting or relief for any fluid trapped between the exterior of mandrel 10 and the inner end of slips 23 which might otherwise prevent retraction of slips 23 when released by retraction of the mandrel.

In operation, the string of tubing T, carrying the pumping unit U and anchor device A, will be run into the well to the desired level at which the suction portion of the pumping unit is submerged in the body of production fluid L accumulated in casing C. The parts of anchor device A will be generally in the positions shown in FIG. 1, namely, thread sections 17 and 18 engaged to secure cage 15 to mandrel 10 and placing ports 28 in registration with the inner ends of cylinders 22 and between seal elements 29 and 30. Slips 23 will be retracted.

When the tubing string has been lowered to the desired depth in the well, the tubing will be filled with a column of liquid to a height sufficient to exert, through ports 28, at least the amount of hydrostatic pressure required to urge slips 23 into strong anchoring engagement with casing C. As will be evident to those skilled in the art, the anchoring force will be determined by the cross-sectional areas of the slips at the seals 26 and the height of the liquid column in the tubing, and the dimensions of the slips will be selected accordingly to assure the anchoring forces under all conditions anticipated in the well.

The liquid column in the tubing sufficient to actuate slips 23 may be supplied initially by filling the tubing through outlet fitting O to the required height. However, if desired, the pump may be operated for a short period sufficient to raise a column of liquid from the liquid in the well to a height at which the hydrostatic head will exert effective setting forces on slips 23. When the slips have been thus actuated, as best seen in FIGS. 2 and 4, pumping of the well fluids may be conducted while the

tubing string remains firmly anchored to the surrounding casing.

When it is desired to release the anchor, pipe string T will be rotated in the right-hand or clockwise direction, which by reason of the left-hand thread arrangement provided in connection means 16 by thread sections 17 and 18, will cause the latter to be unscrewed, releasing mandrel 10 from cage 15 (FIG. 3). An upward pull applied to the tubing string will raise ports 28 above upper seal element 29 and into communication with the interior of casing C, thereby allowing the column of liquid in the tubing string to drain rapidly through ports 28 into the casing and relieving the hydrostatic head on slips 23. The upward movement of the tubing string will bring the upper end of collar 13 into engagement with lower end 20 of the cage, at which point groove 32 will place the inner ends of cylinders 22 in communication through slots 31 with the exterior of the device and thus provide a vent passage for fluids trapped between the exterior of the mandrel and the inner ends of slips 23. The latter will now easily retract when continued upward pull is applied through the tubing string against the lower end of cage 15 by its abutment with the upper end of collar 13.

From the foregoing, it will be evident that the described device not only prevents release of the anchor but also provides simultaneous draining of the fluid column from the tubing, thereby permitting the latter to be withdrawn from the well in empty condition, which is greatly to be desired.

FIGS. 5 and 7 illustrate a slight modification of the structure previously described, the difference being in the releasable connection means between the mandrel and the cage, all other parts being identical with those of the previously described embodiment. In this modification, the thread sections 17 and 18 are replaced by a bayonet-type connection comprising a plurality of J-slots 35 (three shown) provided in the upper end portion of cage 15 and cooperating J-pins 36 mounted on the mandrel, these connection elements being positioned so that when engaged, ports 28 will be in registration with cylinders 22, and when released, permitting upward movement of the mandrel relative to the cage to position the parts exactly as previously described.

In the latched position, pins 36 are engaged behind the downwardly turned lips 37 at the inner ends of the J-slots.

To release this bayonet-type connection, the tubing string will be lowered slightly but sufficiently to allow pins 36 to clear the lower ends of lips 37, whereupon turning the tubing string to the right will carry pins 36 into the open portion of slots 35 and permit the requisite upward movement of the mandrel relative to the cage to open ports 28 to the exterior of the device and permit retraction of the slips as previously described.

FIG. 10 illustrates another modification of the invention, the modification being in the provision of a swivel-type connection 38 between the lower end of mandrel 10 and the upper end of barrel B of the pump unit. This swivel arrangement may be employed in cases where the pump unit itself may be anchored or held against rotation in the casing. In such cases, the swivel connection will permit the rotation of mandrel 10 relative to cage 15 required to effect release of the anchor device.

FIGS. 8 and 9 illustrate still another modification of this invention, wherein the elements comprising the drain valve component of the device are of a modified form and arrangement.

In this embodiment, a tubular cage 115 having an axial bore 115a has a lower end portion 120 which is externally threaded at 112 for connection to collar 13 secured to the upper end of barrel B. Cage 115, like the previous embodiments, has a plurality of angularly spaced, radially extending tubular bosses 121 having cylindrical bores defining cylinders 122 communicating at their

5

inner ends with bore 115a. Cylindrical slips 123, fitted with annular seals 126 and otherwise substantially identical in form and arrangement with slips 23, are slidably mounted in cylinders 122 for radial movement into gripping engagement with casing C in response to hydrostatic pressure in bore 115a.

The upper portion of the cage above bosses 121 is counterbored from its upper end to form the enlarged diameter bore portion 115b which terminates at a point above cylinders 122 in a downwardly sloping annular shoulder or seat 133.

A tubular mandrel 110 has an internally threaded box 111 at its upper end for connection to the end of an adjacent section of pipe string T. From a point just below box 111 the external diameter of mandrel 110 is reduced to provide the stem 110a having a diameter to have a sliding fit in counterbore 115b. The inner end of stem 110a is bevelled at 134 to engage seat 133 and thereby limit the extent to which mandrel 110 may be inserted into the bore of cage 115.

A releasable connection means, designated generally by the numeral 116, initially connects the mandrel to the cage and, as illustrated, comprises a section of left-hand threads 117 on the exterior of stem 110a adjacent its upper end, and a section of mating internal threads 118 at the upper end of counterbore 115b. Between threads 117 and the inner end of stem 110a, the exterior of the latter is provided with an annular recess 132 of substantial length which is positioned, when thread sections 117 and 118 are engaged, to communicate with a plurality of radial angularly spaced, ports 128 extending through the wall of cage 115 at a level above seat 133. An annular seal ring 129 is mounted in the exterior of stem 110a at a point between the inner end of the stem and the inner end of recess 132, being located to seal off between stem 110a and counterbore 115b at a point below ports 128 when thread sections 117 and 118 are engaged. A plurality of stop screws 138 extend through the wall of cage 115 just below thread section 118 and project into recess 132, serving in cooperation with the lower end of the recess to limit outward movement of the mandrel relative to the cage.

In FIG. 9 the parts are shown in the positions occupied when slips 123 have been actuated by hydrostatic pressure applied from the bore of pipe string.

FIG. 10 shows the positions of the parts upon release of the anchor device. To effect such release, pipe string T is rotated in the right-hand or clockwise direction, thereby unscrewing left-hand threads 117 from threads 118 and releasing the mandrel from the cage, after which upward movement of the pipe string will pull mandrel stem 110a upwardly sufficiently to move seal 129 above ports 128 and place the bore of the mandrel in communication with ports 128. The extent of this upward movement of the mandrel will be limited by engagement of screws 138 with the lower end wall of recess 132. Thus, the lower end of stem 110a and seal 129 function as a sleeve valve for opening ports 128 to permit the column of fluid in the pipe string to drain out into the casing simultaneously releasing the hydrostatic pressure on slips 123. Since mandrel 110 will remain connected to cage 115 by reason of engagement of the lower end wall of recess 132 with

6

the inner ends of stop screws 138, the cage and the pump unit suspended therefrom may be pulled out of the well on an empty tubing string.

It will be understood that various other modifications and changes may be made in the details of the illustrative embodiments within the scope of the appended claims but without departing from the spirit of this invention.

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

1. An anchor and drain device for well pipe strings, comprising:

- (a) a tubular cage;
- (b) connector means on the lower end of the cage for connecting it into a pipe string to form a part thereof;
- (c) a plurality of angularly spaced radial cylinders opening through the wall of the cage to the exterior thereof;
- (d) pipe-gripping elements mounted in the cylinders for movement outwardly thereof into gripping engagement with a surrounding well casing in response to hydrostatic pressure in said well pipe string;
- (e) radial passage means through the wall of said cage above said cylinders;
- (f) a tubular mandrel axially insertible into the upper end of the cage;
- (g) left-hand thread means releasably connecting said mandrel to the cage at a point above said passage means;
- (h) connector means on the upper end of the mandrel for connecting it to the pipe string to form a part thereof;
- (i) cooperating stop means on the mandrel and cage permitting limited upward movement of the mandrel relative to the cage after release of said thread means;
- (j) internal shoulder means in the bore of the cage engageable by the lower end of the mandrel to limit inward movement thereof to a point above said cylinders; and
- (k) seal means disposed on the mandrel to seal off between the mandrel and the cage at a point below said passage means when the mandrel is secured to the cage by said thread means, said seal means being movable to a point above said passage means when said thread means is disconnected to thereby communicate the bore of the cage with the exterior thereof.

2. An anchor and drain device according to claim 1, wherein the lower one of said connector means comprises a swivel-type connector.

#### References Cited

##### UNITED STATES PATENTS

|           |         |        |         |
|-----------|---------|--------|---------|
| 2,603,163 | 7/1952  | Nixon  | 166—212 |
| 2,785,758 | 3/1957  | Baker  | 166—212 |
| 3,020,959 | 2/1962  | Nutter | 166—212 |
| 3,112,796 | 12/1963 | Myers  | 166—212 |

JAMES A. LEPPINK, *Primary Examiner*.

U.S. Cl. X.R.

103—218