Feb. 28, 1939. A. L. STONE ET AL 2,148,844

PACKING HEAD FOR OIL WELLS

Filed Oct. 2, 1936 3 Sheets-Sheet 1

Fig. 1.

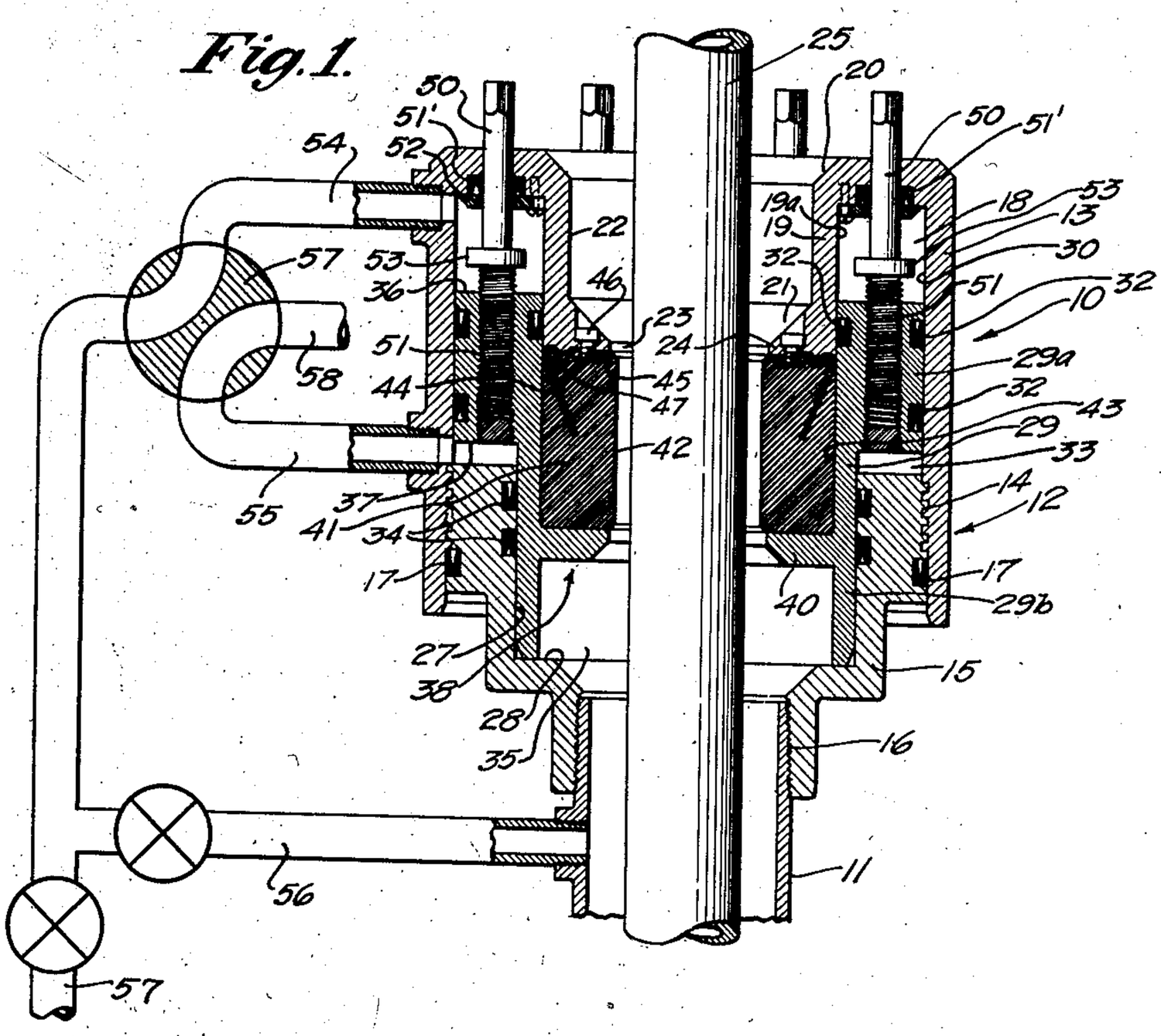
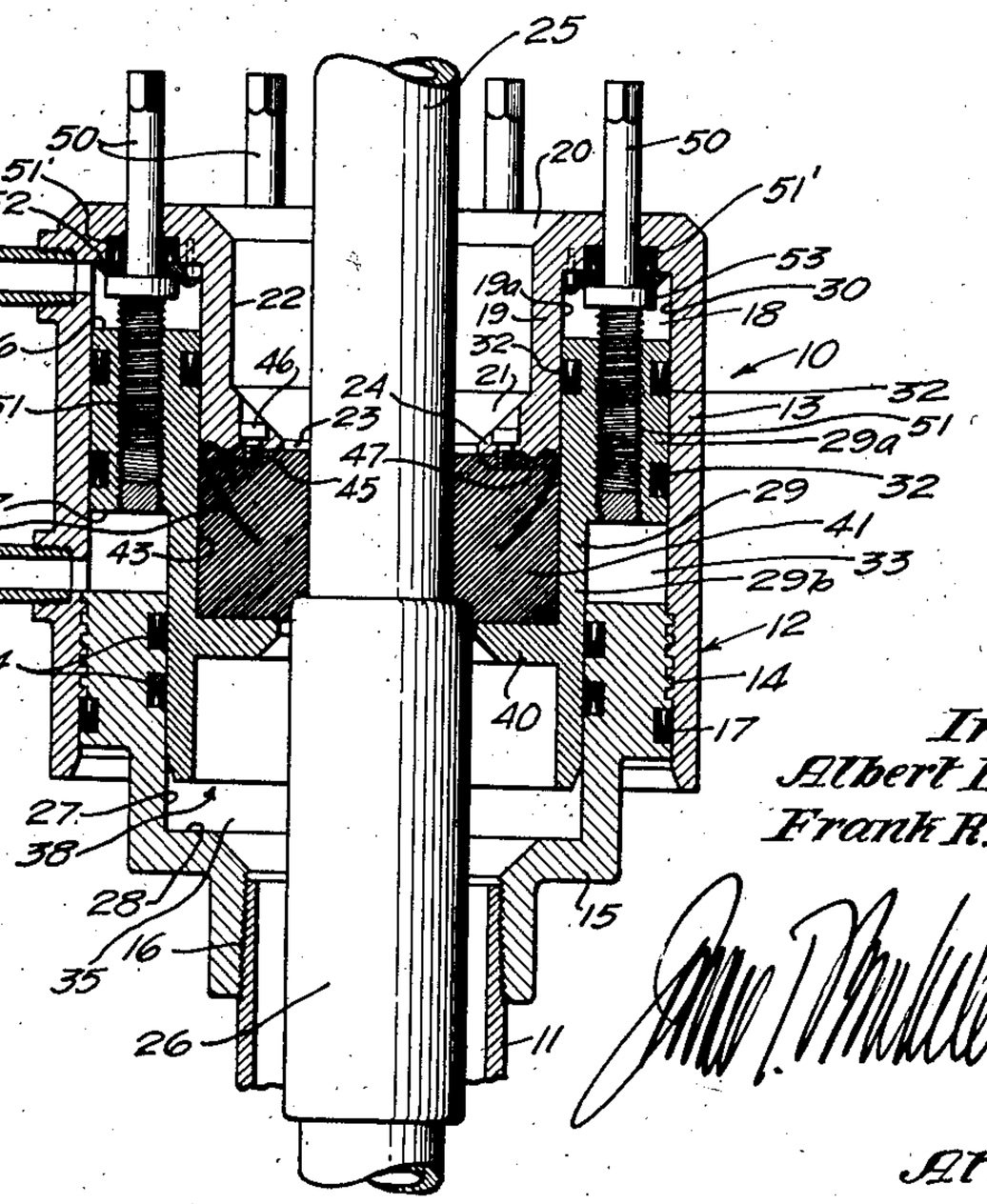


Fig. 2.



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Filed Oct. 2, 1936 3 Sheets-Sheet 2

Fig. 3.

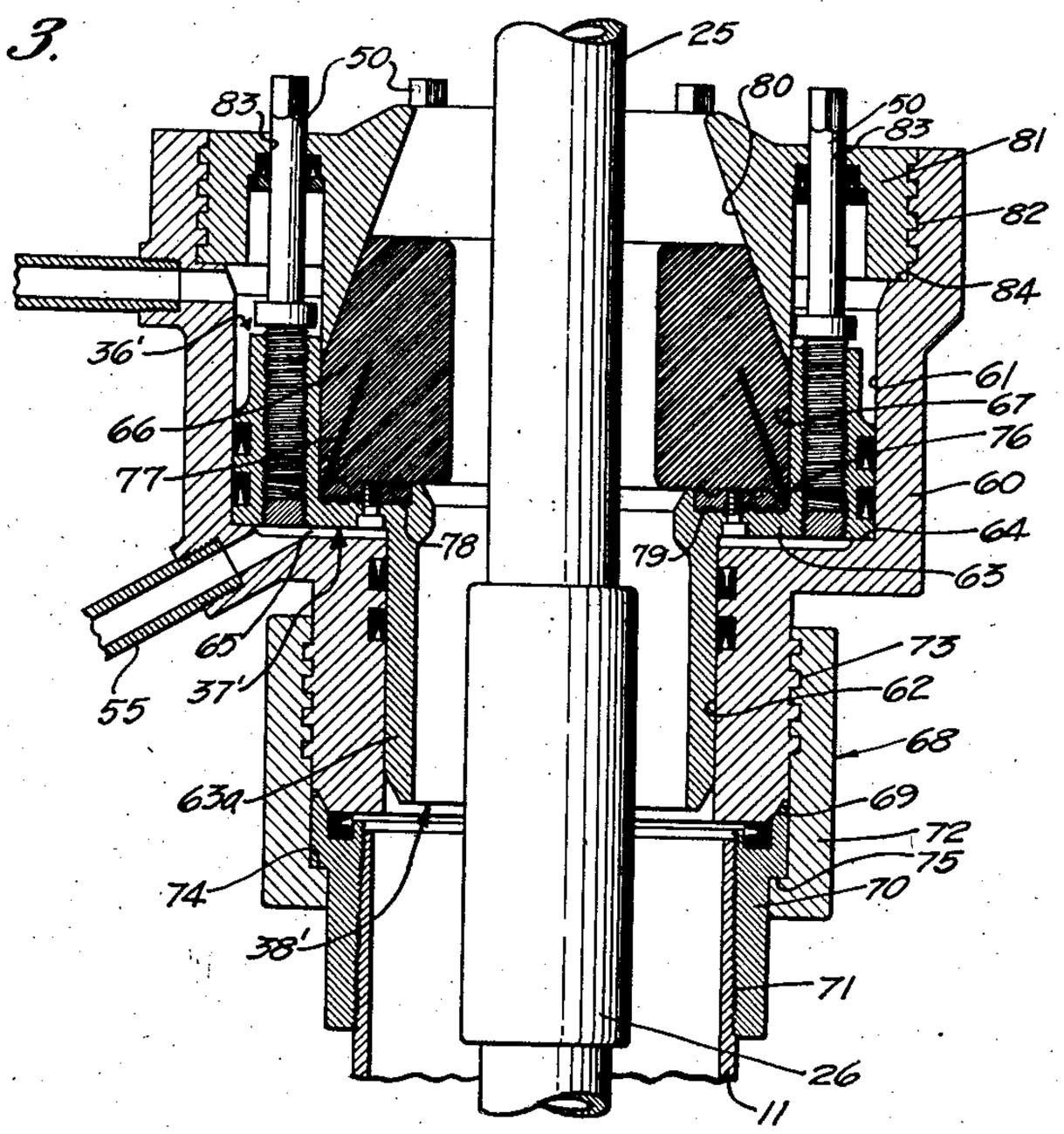
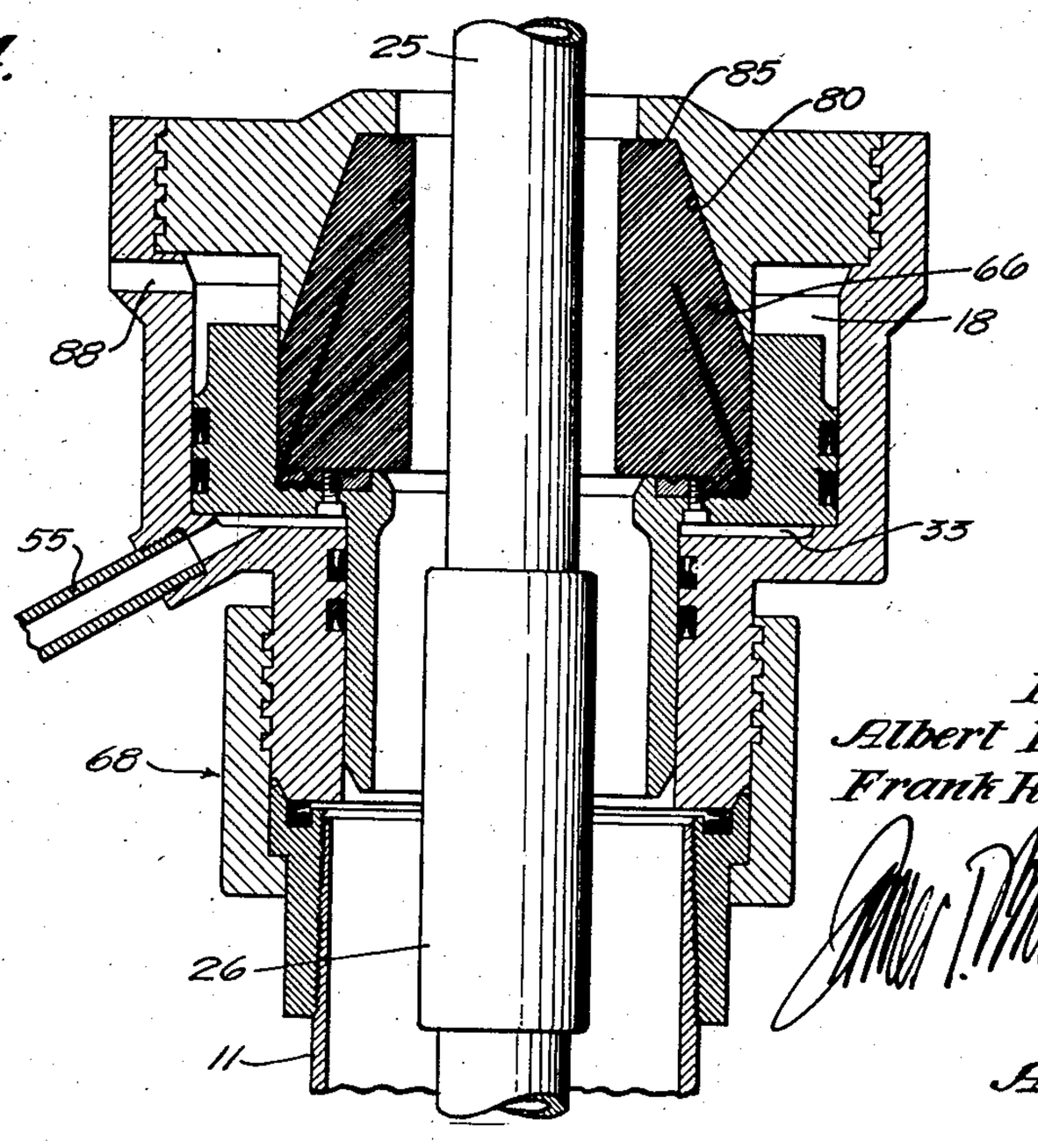


Fig. 4.



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Filed Oct. 2, 1936 3 Sheets-Sheet 3

Fig. 5

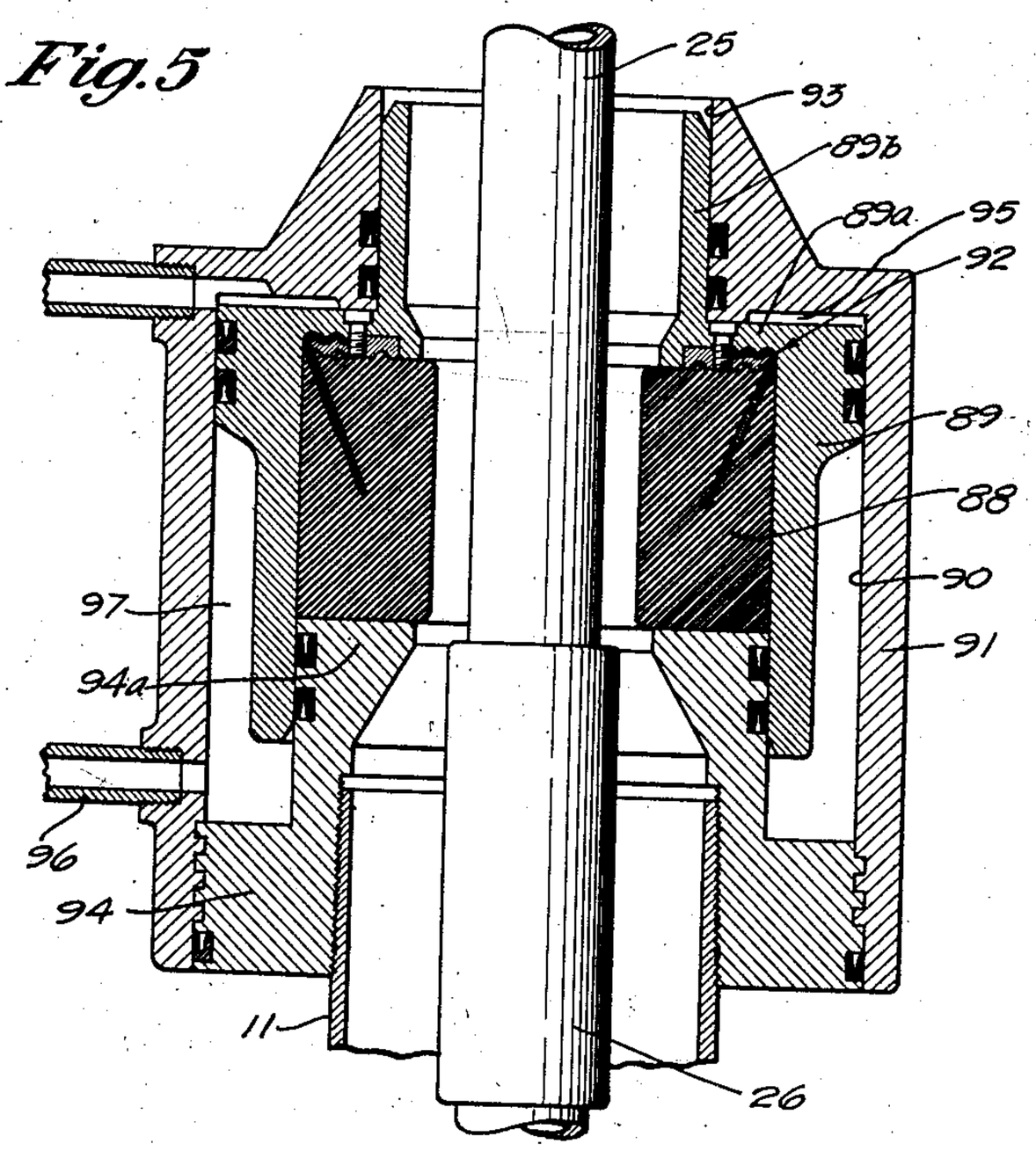
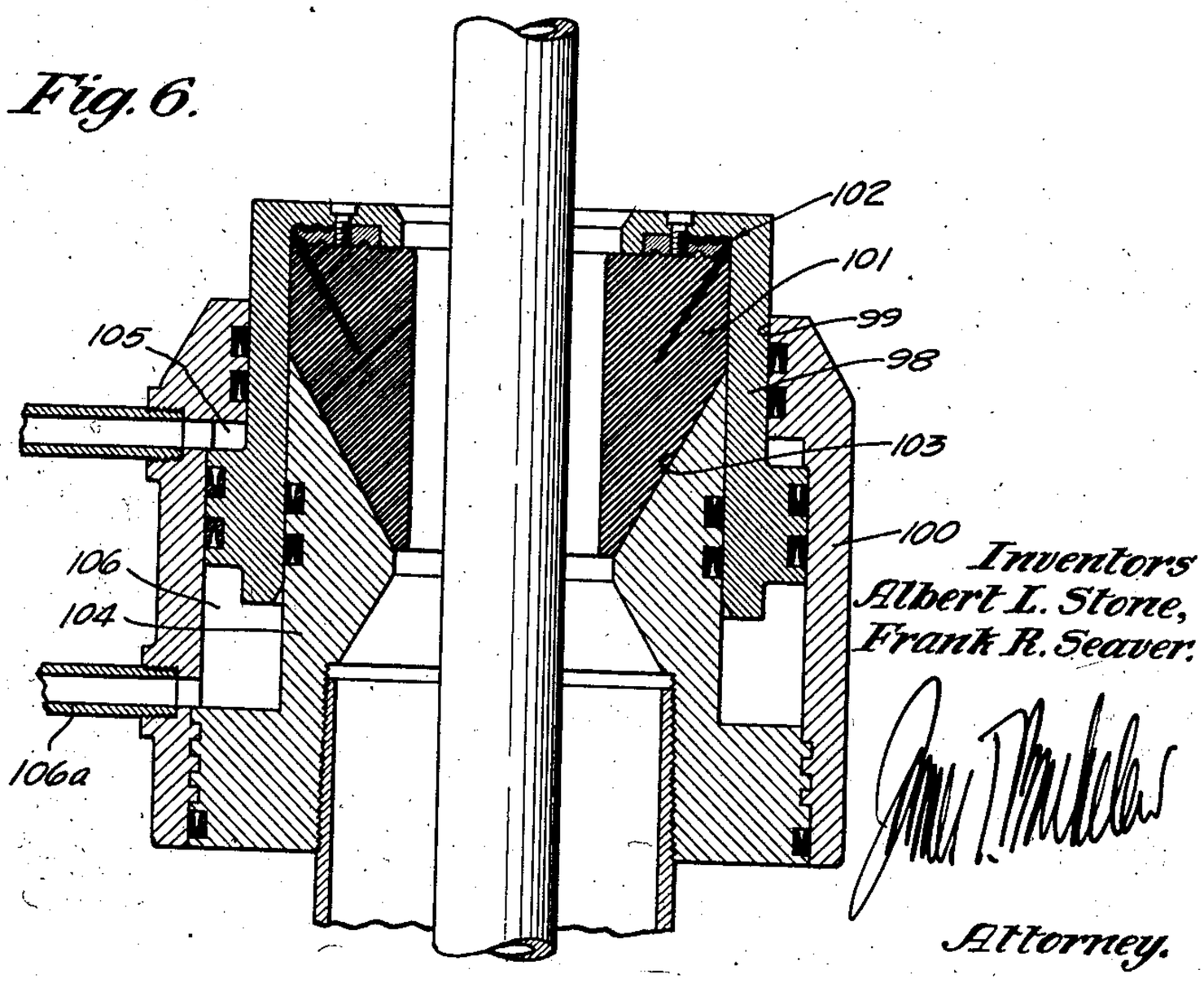


Fig. 6.



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UNITED STATES PATENT OFFICE

2,148,844

PACKING HEAD FOR OIL WELLS

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Application October 2, 1936, Serial No. 103,678

8 Claims. (Cl. 286—26)

This invention has to do generally with devices for sealing around work, e. g. drill pipe and the like, in oil well drilling operations. In certain of its aspects, the invention is directed to improvements in packing heads of the type disclosed in the copending applications of Frederick Stone et al., on Packing head, Serial Number 50,482, filed November 19, 1935, now Patent No. 2,124,015, issued July 19, 1938, and Oil well packing heads, Serial Number 97,632, filed August 24, 1936.

One of our principal objects is to alter and simplify the type of packing head constituting the subject-matter of the copending applications referred to, for the purpose of better adapting the head to simpler and more economical manufacture, and to certain uses where all the features of the earlier disclosed inventions may not be required. In accordance with the present invention, we have provided an improved form of packing head capable of general use for sealing around work of various types, shapes and sizes, and possessing, notwithstanding its simplicity, the capability of controllable positive action that insures dependable operation and prolonged service.

The invention also embodies another feature of outstanding importance, that distinguishes it from all prior packing heads or similar devices of which we are aware. We refer here to the utility of the invention as a stripper that may be used, for example, to maintain by means of a single packer, a fluid tight seal about elongated work having cross sectional enlargements, for example, collared pipe, as the work is being pulled from or lowered into the well. Although the packing heads disclosed in the above mentioned copending applications also have been found to be capable of such operation as strippers, as well as for sealing about work that remains without great variation in its cross sectional size or area, the present forms of packing heads are in general better adapted to that type of operation. Different forms of strippers have been proposed, and some are in common use, but our improved device differs from all these in that it involves a distinctly different structure and mode of operation, particularly as regards the provision for rendering the packer expansible to pass the pipe collar, and yet capable of maintaining at all times an effective seal about the pipe.

Referring particularly to its stripper aspect, the invention may be described briefly as comprising an expansive packer together with a movable packing contracter, preferably though not necessarily in the broader aspects of the invention, a fluid pressure actuated piston, that yieldably bears against the packer to maintain it in radially constricted condition about the work. The coaction between the packer and the contractor is reciprocal in that the packer is radially constricted by movement of the contractor, and the latter is in turn displaceable in response to expansion or movement of the packer. Advantage is taken of this condition to adapt the device for use as a stripper, the contractor serves to maintain the packer constricted about the smaller diameter pipe, but enables the packer to pass the pipe collar because when the packer is expanded by movement of a pipe collar into it, the contractor is accordingly displaced by the packer expansion, permitting the collar to pass through the packer. Thereafter, the contractor immediately closes the packer about the smaller diameter pipe.

All the various features and objects will be more fully explained and understood to better advantage in the following detailed description of the invention in certain of its typical and illustrative forms. Throughout the description reference is had to the accompanying drawings, in which:

Fig. 1 is a sectional view showing a typical form of invention, with the packer in expanded position;

Fig. 2 is a view similar to Fig. 1 showing the packer constricted about the work;

Fig. 3 is a sectional view illustrating a variational form of the invention;

Fig. 4 is a similar view showing a modification of the form of Fig. 3; and

Figs. 5 and 6 show additional variant forms in which the packer contractor moves downward against the direction of well flow.

Referring first to Fig. 1, the packing head generally indicated at 10 and mounted on the well casing 11, comprises a body 12 that may conveniently be made in two sections, the upper section 13 being threaded at 14 on the lower section 15, and the latter attached at 16 to the casing by a threaded connection or in any other suitable manner. Suitable packing 17 may be interposed between the body sections to prevent fluid leakage through the joint at 14. Upper body section 13 is shaped to provide an annular cylindric walled chamber 18 to receive the later described packer contracting piston, and has an inner tubular wall 19 with downwardly tapering surfaces 20 and 21 at the upper and lower ends of the counterbore 22. The opening or bore 23 through the bottom inwardly flanged end 24 of the tubular

wall 19 is of sufficient diameter to pass the maximum diameters of the work 25, for example, pipe couplings 26, the drill bit (not shown), or other tools that may be carried in the pipe string. The lower body section 15 has a cylindric bore 27 within which the contractor piston works, and an annular shoulder 28 at the bottom of the bore that serves as a stop to limit the downward travel of the piston.

The tubular packer contracting piston 29 comprises an upper enlarged diameter portion 29*a* having a substantially sliding fit with the body bore 30 and the outer cylindric surface 19*a* of wall 19, and a lower reduced diameter portion 29*b* slidably fitting the wall of counter-bore 27 in the lower body section 15. The piston carries packing rings 32 to prevent fluid leakage along the piston from either chamber 18 or space 33, the lower section also containing packing rings 34 that prevent fluid leakage along the piston from either space 33 or chamber 35 within the head below the packer. The piston may be regarded as having three pressure areas: the upwardly facing surface 36 on the top of the piston exposed to chamber 18, the downwardly facing surface 37 formed on the piston intermediate its ends and exposed to space 33, and a pressure area generally indicated at 38, on the lower end of the piston, the last mentioned area corresponding to the area between the work 25 and the lower body section counter-bore 27. For reasons that will later appear, it is desirable, as is the case, that pressure area 36 be greater than pressure area 38, in order that the piston may be caused to move downward by the application of the same fluid pressure per unit area to the two surfaces.

A suitable flexible packer 41, preferably in the form of a continuously annular (as distinguished from segmental annular) rubber sleeve, is confined between the inwardly projecting piston flange 40 and the lower end of the inner tubular portion 19 of the upper body section. As illustrated, the packer has a straight bore 42 with annular clearance in its expanded condition about the work 25, the outer diameter and shape of the packer being made to snugly fit the piston bore 43 and the top surface of flange 40. While either or both ends of the packer may be connected to the adjacent shouldered surfaces against which the packer ends bear, the packer is shown typically as being fastened to the bottom of the body flange 24. Our preferred form of packer connection comprises a fabric 44 embedded in the rubber at the upper and outer interior of the packer and clamped between flange 24 and a ring 45 held tightly to the flange by screws 46. The bottom surface of the ring may be provided with annular concentric ridges 47 which form grooves or recesses into which the rubber is forced upon longitudinal compression, and from which the air is thereby expelled, so that the pressure applied to the packer also serves as a means of securely holding it to its support. The fabric 44 provides an effective and durable connection for anchoring the packer to the support, in that it is adapted to withstand the strains and distortions to which the packer is subjected in being constricted about the work, and in being forced to some extent up through the flange bore 23, when the packer is holding extremely high well pressures.

As illustrated in Fig. 2, upon upward movement of the piston 29, packer 41 is constricted radially into sealing engagement with the work due to longitudinal compression between stationary supporting flange 24 and the interior piston flange 40. Where the apparatus is to be used for general purposes as a packing head or stripper it is desirable to limit the upward piston travel and therefore the extent of packer constriction about the work. For example, to reduce wear on the packer when employed to seal about a drill pipe or a polygonal cross sectional kelly during drilling operations, it is desired to limit the packer contraction to the point where a slight leakage of well fluid will be allowed through the packer to lubricate its engagement with the work. It is also desirable that piston limiting or stop means be adjustable and capable of regulation to compensate for wear on the packer tending to enlarge its normal bore diameter.

In accordance with the invention we have provided an improved type of piston stop means in the form of adjustable screws 50 threaded at 51 into the piston and extending through the top wall of the body, suitable packing 51′ held in place by retaining ring 52 being provided to prevent fluid leakage past the screws. Each of the stop screws has a flange 53 that comes into engagement with ring 52 to limit the upward travel of the piston as shown in Fig. 2, all the screws of course being correspondingly adjusted to give flanges 53 the same spacing from the piston.

The contactor piston is operated by fluid pressure, preferably gas or mixed gas and liquid, communicated selectively to chamber 18 and space 33 by way of pipes 54 and 55. The piston operating fluid may be derived from any suitable source, for example from the well casing via line 56, or from an independent source through line 57. The communication of the pressure fluid to lines 54 and 55 is controllable by a four-way valve diagrammatically shown at 57. With the valve positioned as shown in Fig. 1, the operating fluid pressure is communicated to chamber 18 and to the upper pressure area 36 of the piston to maintain the latter in its lower position and the packer 41 in radially expanded condition. The pressure in space 33 is released via pipe 55 communicating with the exhaust line 58. To constrict the packer about the work, the position of valve 57 is reversed, venting chamber 18 to the exhaust line, and communicating the pressure fluid to space 33, the application of the fluid pressure to piston surface 37 causing the piston to move upward and to constrict the packer, as shown in Fig. 2. To again open the packer, valve 57 is returned to the position illustrated, and although the pressures then applied to piston areas 36 and 38 may be the same when the well pressure is employed to operate the piston, the latter will move downward by reason of the differential in the areas as described above.

In normal drilling operations the packer may be maintained constricted about the work, the drill pipe or polygonal cross sectional kelly, where the well is under pressure. The head also may be used as a blow-out preventer to close about the work in the event of sudden development of high well pressures. Assuming the packer to be open, as in Fig. 1, and the well to suddenly develop high pressure, the packer may be immediately closed by communicating the pressure fluid to space 33 to raise the contractor piston.

We have previously referred to the particular advantage of the invention in being capable of operation as a stripper capable of passing and maintaining a fluid tight seal about successive lengths or stands of collared pipe being pulled from or lowered into the well. The adaptability of the head for use as a stripper results from

the displaceability of the piston as a result of packer expansion by the pipe collars, to permit the collars to pass through the packer. Assuming that the pipe string is being pulled from the well with the packer closed about the pipe and a collar **26** raised to the point where it has entered the lower end of the packer as shown in Fig. 2, continued upward movement of the collar tends to displace and to longitudinally expand the packer. The result is that the rubber tends to "flow" and the lifting force on the collar to be transmitted through the rubber to the piston flange **40**, causing the piston to be displaced downwardly a distance sufficient to accommodate the volume of rubber displaced by the collar as it enters and moves through the packer bore. Consequently, by reason of the displaceability of the piston by the packer, it has been found possible to pull the collar through the packer at any desired speed and without excessive wear on the rubber or damage to the packer. Displacement of the piston is yieldably resisted by the fluid contained in space **33**, the connecting lines and the chamber below the piston (valve **57** being reversed from the positions of Fig. 1) and as a result, the packer at all times during this operation tightly engages the surface of the collar and immediately constricts about the smaller diameter pipe as the collar moves out of the packer. As will be apparent, the same piston action in response to expansion of the packer occurs as the pipe string is being lowered into the well.

While generally similar to the described form of the invention shown in Figs. 1 to 2, the variational form of Fig. 3 differs mainly with respect to the body structure and its attachment to the casing, the packer mounting (the packer in this form being carried by the piston), and the provision of a tapered body shoulder or bore cooperating with the piston to radially constrict the packer. In Fig. 3 the body **60** has a counter-bore **61** and a lower reduced diameter bore **62** containing the piston **63**, the downward travel of the piston being limited by engagement with stop shoulder **64**, with clearance provided at **65** to receive the operating fluid introduced through line **55**. Here the packer **66** is seated within the comparatively large diameter piston counter-bore **67**, the lower portion **63***a* and body bore **62** being of reduced diameter so that the piston pressure area **37'** is somewhat larger than the corresponding area **37** in Fig. 1, and the bottom pressure area **38'** is comparatively smaller. Likewise, the differential between the top piston area **36'** and the bottom pressure area **38'**, is comparatively greater than in the first described form.

The body is attached to the casing by a type of joint **68** that may be broken without requiring rotation or substantial elevation of the head, and permitting the head to be shifted laterally to one side when the joint is disconnected. The lower end of the body has a tapered shoulder **69** that seats on the top correspondingly shaped surface of a sleeve **70** threaded at **71** on the casing. Sleeve **72**, threaded at **73** on the body and having a shoulder **74** bearing upwardly against shoulder **75** on sleeve **70**, provides an attachment between the last mentioned sleeve and head that may be disconnected simply by unscrewing and dropping sleeve **72**, permitting the head then to be raised off its seat and to be moved to one side to clear the casing.

In this form, the packer **66** is attached at **76** to the contractor piston **63** so that the packer is bodily movable with the piston in its vertical travel. The connection between the packer and the piston is similar to the previously described form, and comprises a fabric **77** embedded in the outer interior of the packer and clamped between the annularly grooved ring **78** and the upwardly facing piston surface **79**. As the piston is moved upwardly, the packer is radially constricted by movement along the tapered bore **80** of head **81** threaded at **82** into the upper end of the body. In assembling the apparatus, the piston first may be raised to insert the stop screws **50** through openings **83** in head **81**, and the latter then screwed down to seat on shoulder **84**, the piston and packer assembly rotating with the head as the latter is being threaded into the body.

The operation of the last described form of the invention is similar to the previously described form, as will be apparent without the necessity for repetitious description. It may be observed in passing, that the main difference in operation is the effect of the tapered bore **80** in causing radial contraction of the packer by inwardly displacing it as the piston moves upwardly. Also it may be observed that this form of head is capable of operation as a stripper in the manner previously described, since the piston and packer are reciprocally displaceable, i. e., each is displaced in response to movement of the other.

The second variational form of the invention shown in Fig. 4 differs from that of Fig. 3 in that it is designed to provide a somewhat simpler and less expensive head intended, though not necessarily limited, for use only as a blowout preventer. Here the piston stop screws are eliminated to simplify the construction and cheapen the cost of manufacture. This is permissible where the apparatus is to be used as a blow-out preventer (and the same applies to the previously described forms) since, although the provision of stop means for limiting the full contractive position of the piston may be desirable, such means may be dispensed with in favor of cheaper construction adapted to the specific purpose. It will be noted that in Fig. 4, the same type of connection at **68** is employed for attaching the body to the casing, a readily disconnectible joint of this type being desirable in order to enable the stripper head to be quickly applied to and removed from the casing. Fig. 4 illustrates an additional feature in the provision of an annular shoulder **85** at the upper end of the tapered bore **80**, and which is engaged by the upper end of the packer so that the latter is confined between shoulder **85** and the piston shoulder, and held against bodily upward movement as in the case of Fig. 3. As will be apparent, when the piston moves upward, the packer is radially constricted by longitudinal compression as in the form of Fig. 1, and is also subjected to inward displacement as the rubber is pressed against the tapered surface **80**.

To further simplify the construction in this form, the pressure fluid connection with chamber **13** above the piston may be omitted, and merely a vent opening provided at **88** or some other suitable location. In the absence of a pressure fluid connection for moving the piston downward to open the packer, the latter may be released from the work and the contractor returned to its lower position, by relieving the well pressure acting upwardly against the piston and packer. Thus, assuming a blow-out to have occurred and the packer to have been closed by fluid pressure communicated through line **55** to space **33**, circulating mud may be pumped into the well through

the drill string to "kill" the well, whereupon the pressure in space 33 may be released, permitting the packer to expand longitudinally and move the piston down.

Figs. 5 and 6 show additional variant forms of the invention similar in principle to the described embodiments, but differing primarily in the arrangement of the piston so that it moves downwardly in constricting the packer, in opposition to the direction of pressure communication from the well, instead of moving upwardly with the well pressure, as in the first described forms. In Fig. 5, the packer 88 is contained within the inverted cup-shaped piston 89 that slidably engages the bore 90 of body section 91, the packer being attached to the shouldered wall 89*a* by the previously described type of connection generally indicated at 92. The upper reduced diameter tubular portion 89*b* of the piston slidably fits bore 93 in the top wall of the body. The packer 88 is confined between the piston shoulder 89*a* and the stationary upper end 94*a* of the lower body section 94, so that as the piston is moved downwardly by pressure fluid communicated to chamber 95, the rubber is longitudinally compressed and radially contracted between the shoulders 89*a* and 94*a*. If desired, a pressure fluid connection 96 may be provided for delivering operating fluid to chamber 97 to raise the contractor and release the packer. The head is shown to be mounted on the casing by threading the lower body section 94 on the upper end of the casing.

In Fig. 6, the inverted piston 98 is extended upwardly through bore 99 in the top of the body 100, the top of the piston being exposed, with the packer 101 attached to its under surface at 102. Upon downward movement of the piston, the packer is pressed against the downwardly tapering stationary surface 103 of the lower body section 104, the piston being forced downwardly by fluid pressure communicated to chamber 105. As in Fig. 5, the piston may be raised to release the packer by pressure fluid introduced to chamber 106, or, in case the fluid connection 106*a* is not used, by relieving the well pressure in the manner previously explained and allowing the packer to expand to release itself from sealing engagement with the work.

We claim:

1. In a packing head applied to a well pipe, a tubular housing adapted to pass collared tubing through its bore, a packer in the housing and radially contractible about said tubing to prevent fluid escape from said pipe through the housing, a continuously annular packer contracter movable vertically within the housing and directly engaging the packer, one end of said packer being bodily and vertically movable with said contracter in its contracting movement, a packer support, flexible means embedded in the packer and attached to said support, and means for selectively introducing into fluid-tight spaces within said housing and substantially closed from communication with said well pipe through the housing bore, fluid under pressure to move the contracter in opposite directions and thereby to cause the packer to radially expand and contract.

2. In a packing head applied to a well pipe, a tubular housing adapted to pass collared tubing through its bore, a continuously annular packer in the housing and radially contractible about said tubing to prevent fluid escape from said pipe through the housing, said packer having a longitudinally tapered portion, a continuously annular packer contracter movable vertically within the housing and directly engaging the packer, one end of said packer being bodily movable with said contracter in its contracting movement, a packer support, flexible means embedded in the packer and attached to said support, wedge means engaging said tapered portion of the packer and acting to radially constrict the packer during packer contracting movement of said contracter, and means for selectively introducing into fluid-tight spaces within said housing and substantially closed from communication with said well pipe through the housing bore, fluid under pressure to actuate the contractor and thereby to cause the packer to radially expand and contract.

3. In a packing head applied to a well pipe, a tubular housing adapted to pass collared pipe through its bore, a packer in the housing and radially contractible about said tubing to prevent fluid escape from said pipe through the housing, a continuously annular packer contracter movable vertically within the housing and directly engaging and surrounding the outside of the packer, one end of said packer being bodily movable with said contractor in its contracting movement, flexible means connecting said end of the packer to the contracter, and means for introducing into a fluid-tight space within said housing and substantially closed from communication with said well pipe through the housing bore, fluid under pressure to actuate the contracter.

4. In a packing head applied to a well pipe, a tubular housing adapted to pass collared tubing through its bore, a packer in the housing and radially contractible about said tubing to prevent fluid escape from said pipe through the housing, a continuously annular packer contracter movable vertically within the housing and directly engaging the packer, an annular shoulder on said contracter supporting one end of said packer, said end of the packer being bodily movable with the contracter in its contracting movement, supporting means stationary with relation to the housing and supporting the opposite end of the packer, fabric embedded in the packer and projecting from the last mentioned end thereof, means connecting the fabric to said support, and means for selectively introducing into fluid-tight spaces within said housing and substantially closed from communication with said well pipe through the housing bore, fluid under pressure to move the contracter in opposite directions and thereby to cause the packer to radially expand and contract.

5. In a well pipe packing head, a tubular housing adapted to take an elongated member through its bore, a radially contractible packer in the housing and about said member, a packer contracting piston movable vertically within the housing, one end of said packer being suported directly by and movable vertically with said piston in its contracting movement, fabric embedded in said end of the packer and connected to the piston, and a clamp ring securing said fabric to the piston.

6. In a well pipe packing head, a tubular housing adapted to take an elongated member through its bore, a radially contractible packer in the housing and about said member, a packer contracting piston movable vertically within the housing, one end of said packer being supported directly by and movable vertically with said piston in its contracting movement, and fabric embedded in said end of the packer and connected to the piston.

7. In a packing head applied to a well pipe, a tubular housing adapted to pass collared tubing through its bore, a packer contracting piston movable vertically within the housing and having differential pressure areas, an annular shoulder formed on and within said piston, a stationary annular shoulder spaced axially of the housing from said piston shoulder, a packer between said shoulders and surrounding the housing bore, flexible means embedded within and extending beyond the end of the packer, means attaching said flexible means to said stationary shoulder, the end of the packer adjacent the first mentioned shoulder being bodily movable with the piston, valve means for selectively introducing into fluid-tight spaces within said housing and substantially closed from communication with said well pipe through the housing bore, fluid under pressure acting against said differential piston areas to move the piston in opposite directions.

8. In a packing head applied to a well pipe, a tubular housing adapted to pass collared pipe through its bore, a packer contracting piston movable vertically within the housing, an annular shoulder formed on and within said piston, a stationary shoulder spaced axially of the housing from said piston shoulder, a packer between said shoulders and surrounding the housing bore, fabric embedded within the packer, means attaching said fabric to said stationary shoulder, means forming on said contracter oppositely facing differential area pressure surfaces intermediate its ends, and means for selectively introducing into fluid-tight spaces within said housing and substantially closed from communication with said well pipe through the housing bore, fluid under pressure acting against said differential area surfaces to move the contracter in opposite directions and thereby to cause the packer to radially expand and contract, the end of the packer nearest said annular shoulder being bodily movable with the piston.

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