

June 23, 1942.

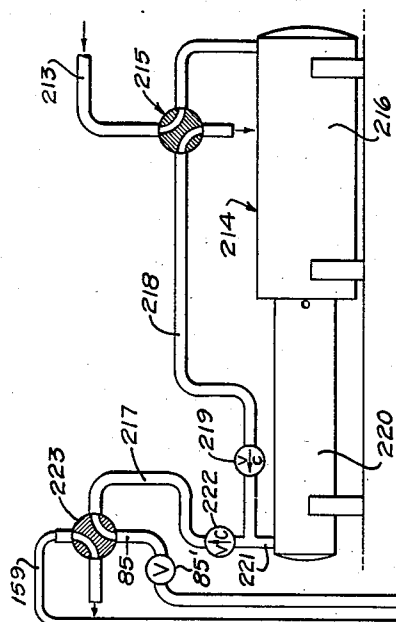
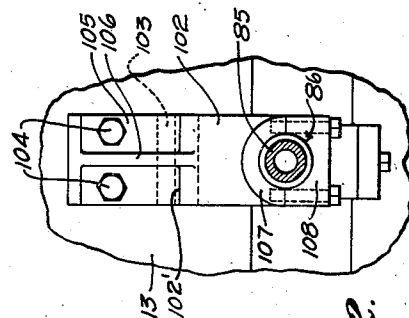
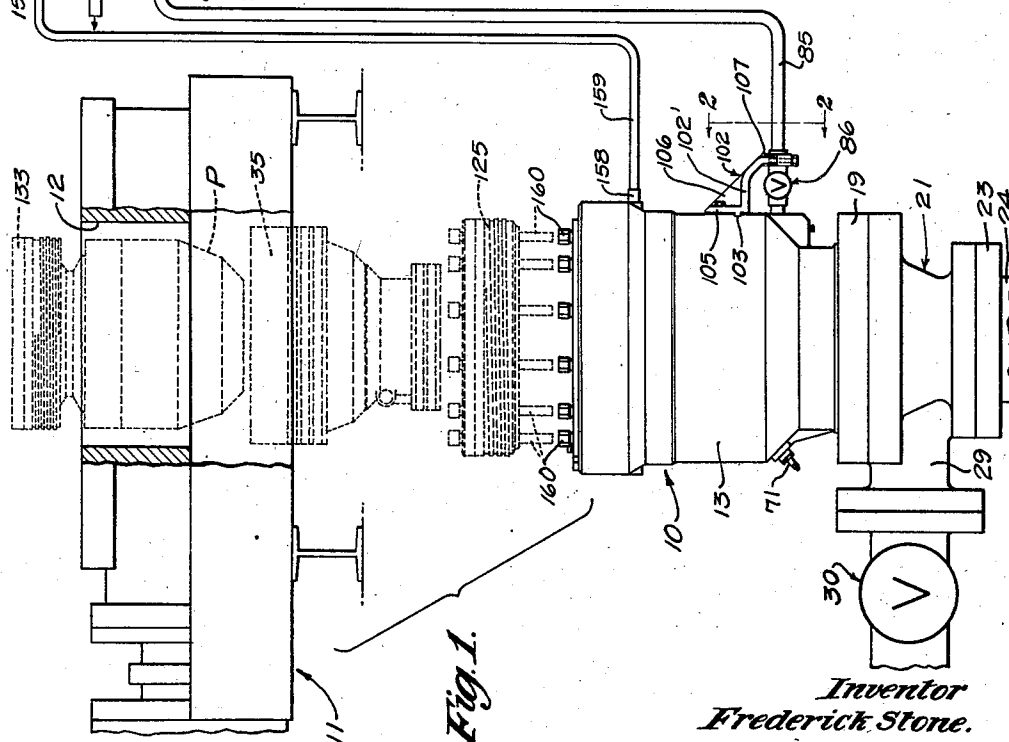
F. STONE

2,287,205

PACKING HEAD

Filed Jan. 27, 1939

9 Sheets-Sheet 1



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June 23, 1942.

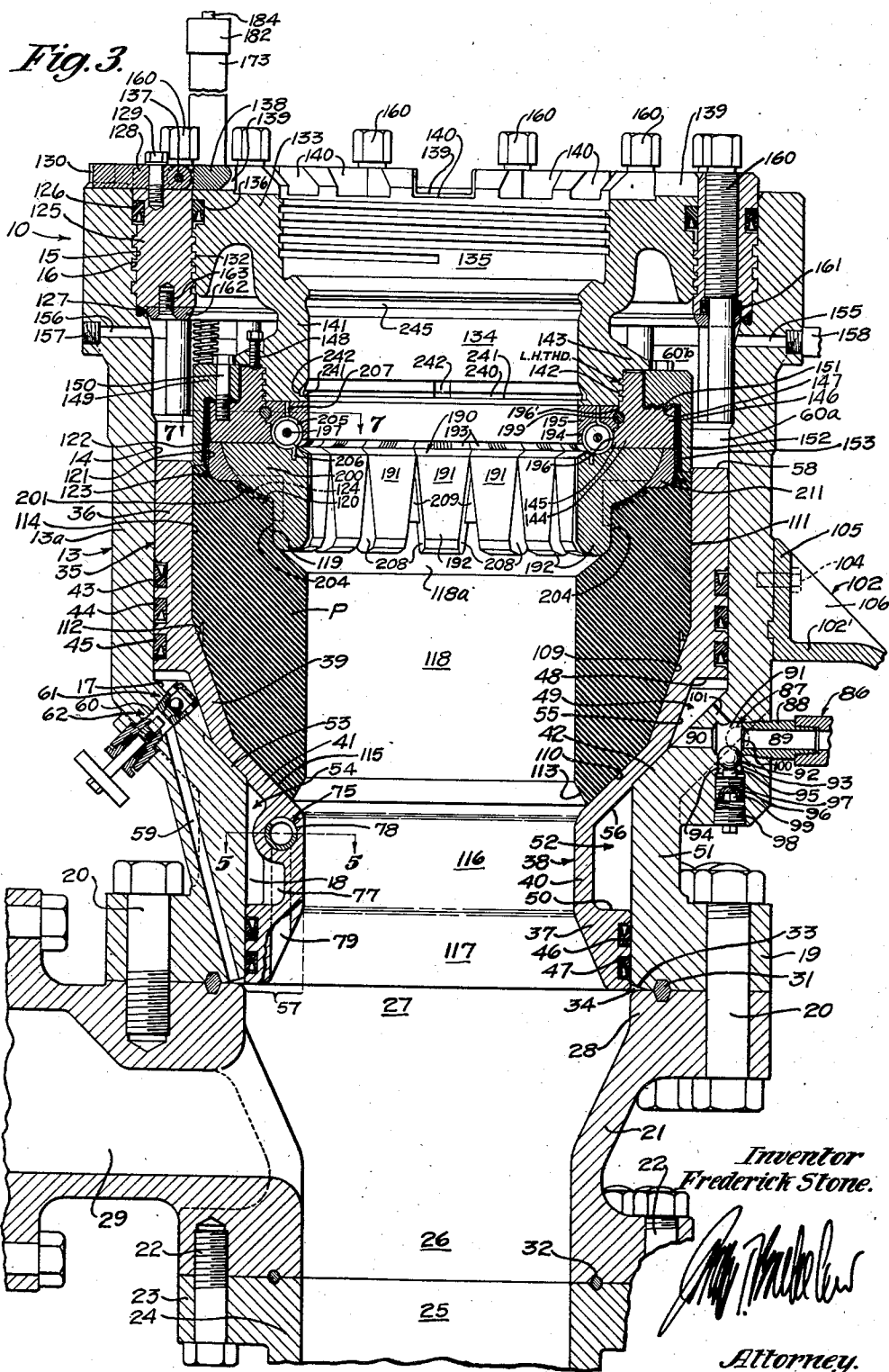
F. STONE

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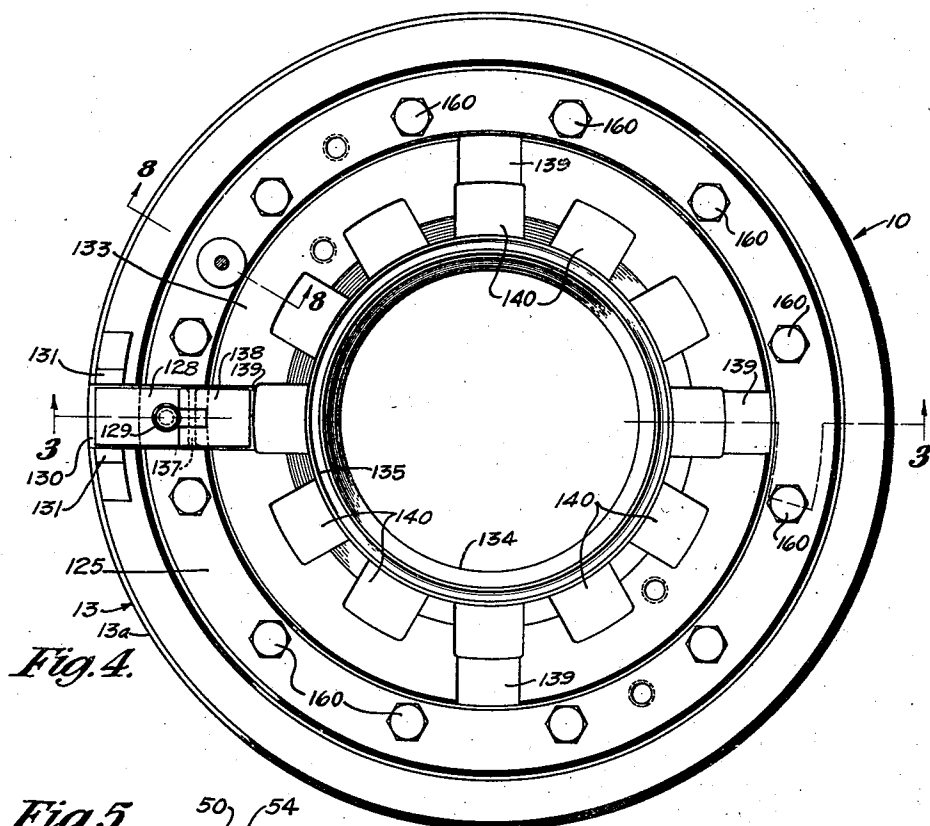


Fig. 4.

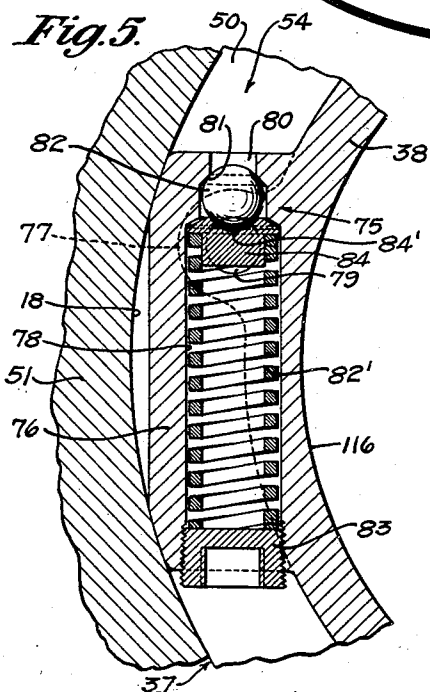


Fig.5.

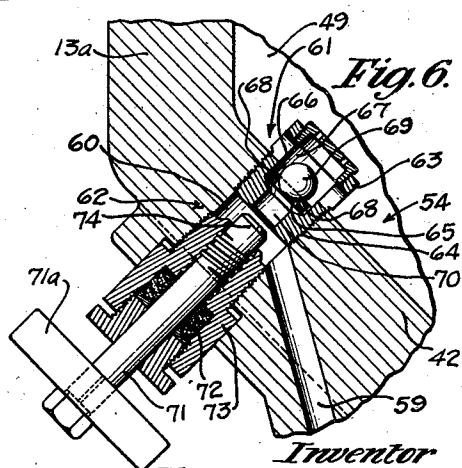


Fig. 6.

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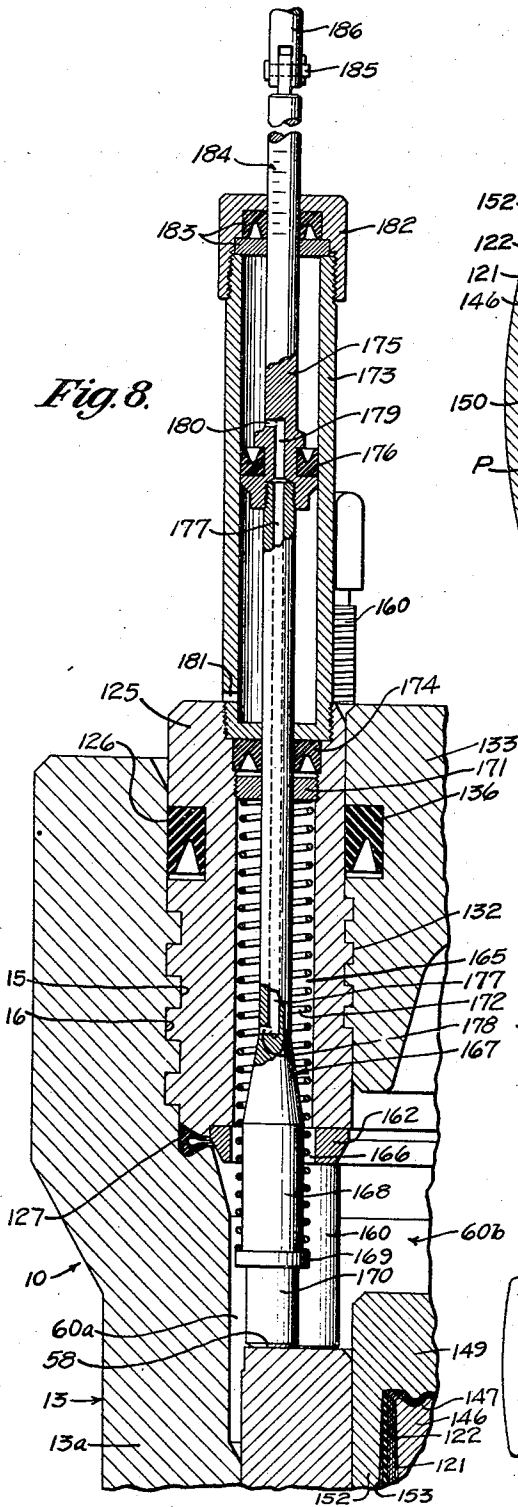
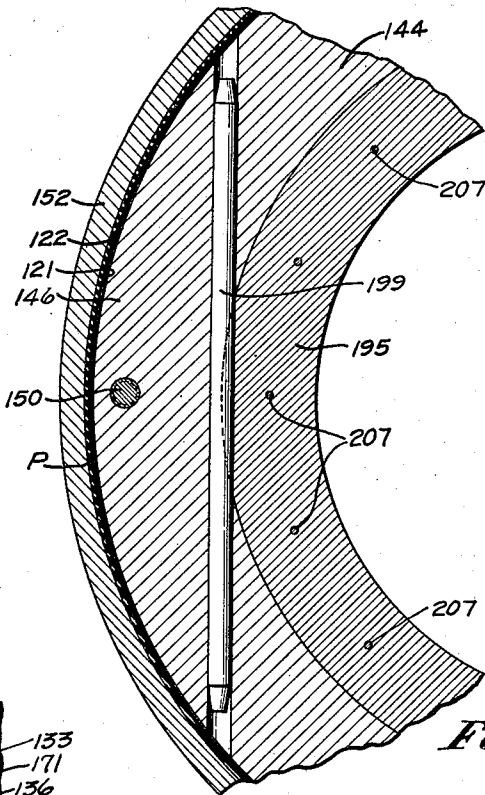
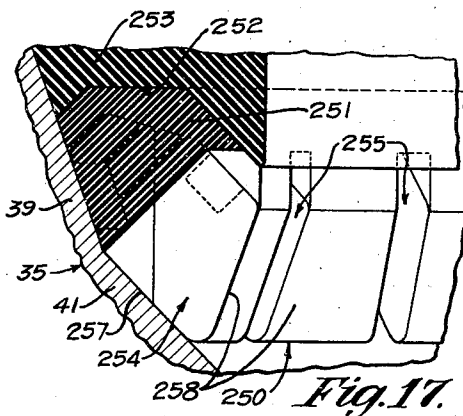
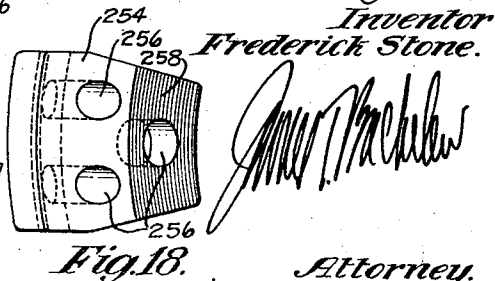
F. STONE

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PACKING HEAD

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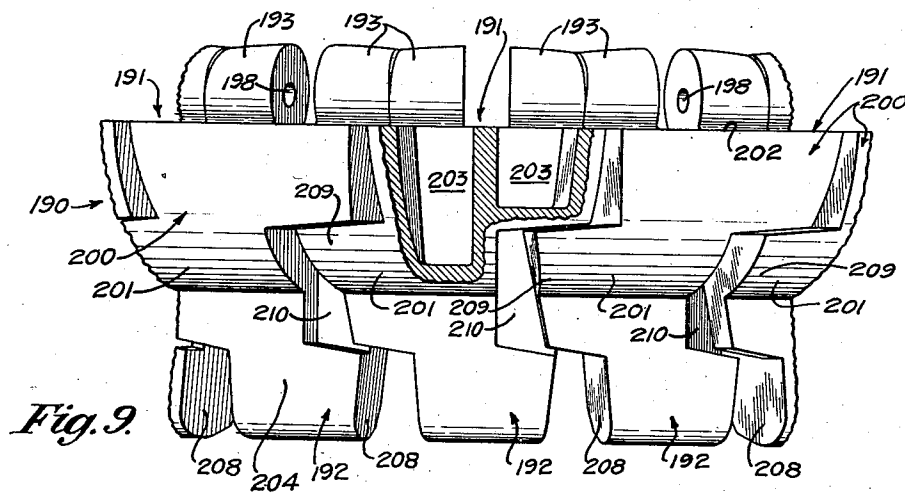
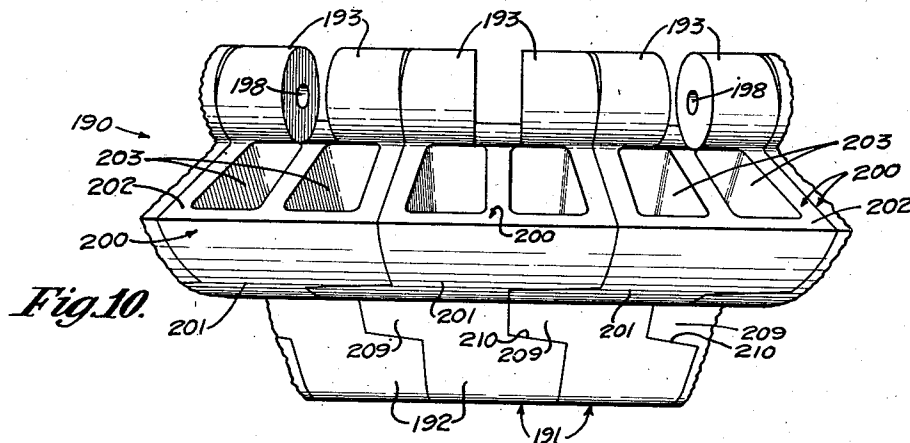
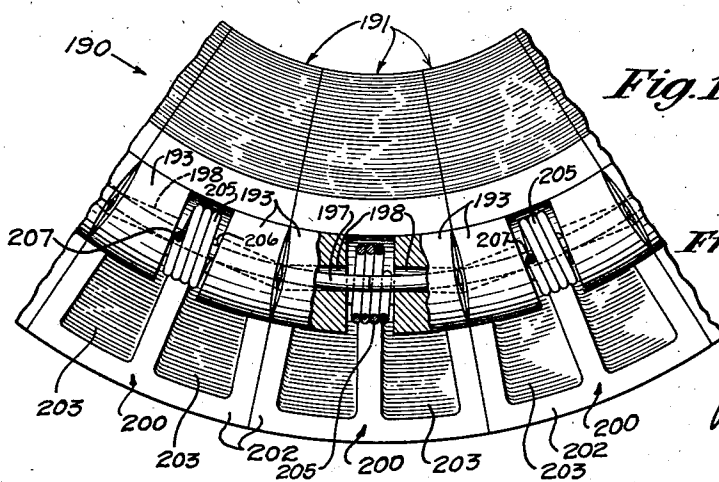
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PACKING HEAD

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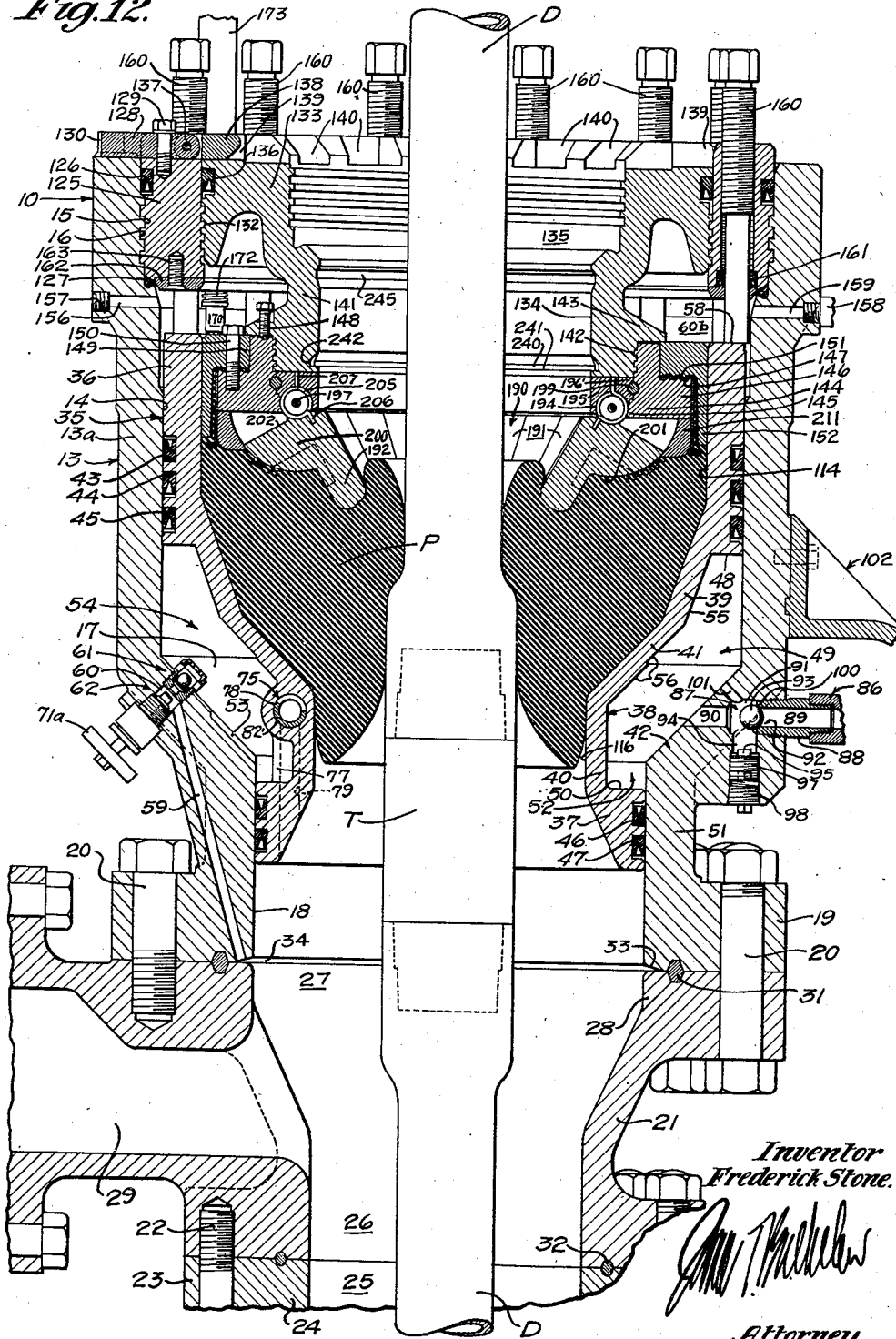
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Fig. 12.



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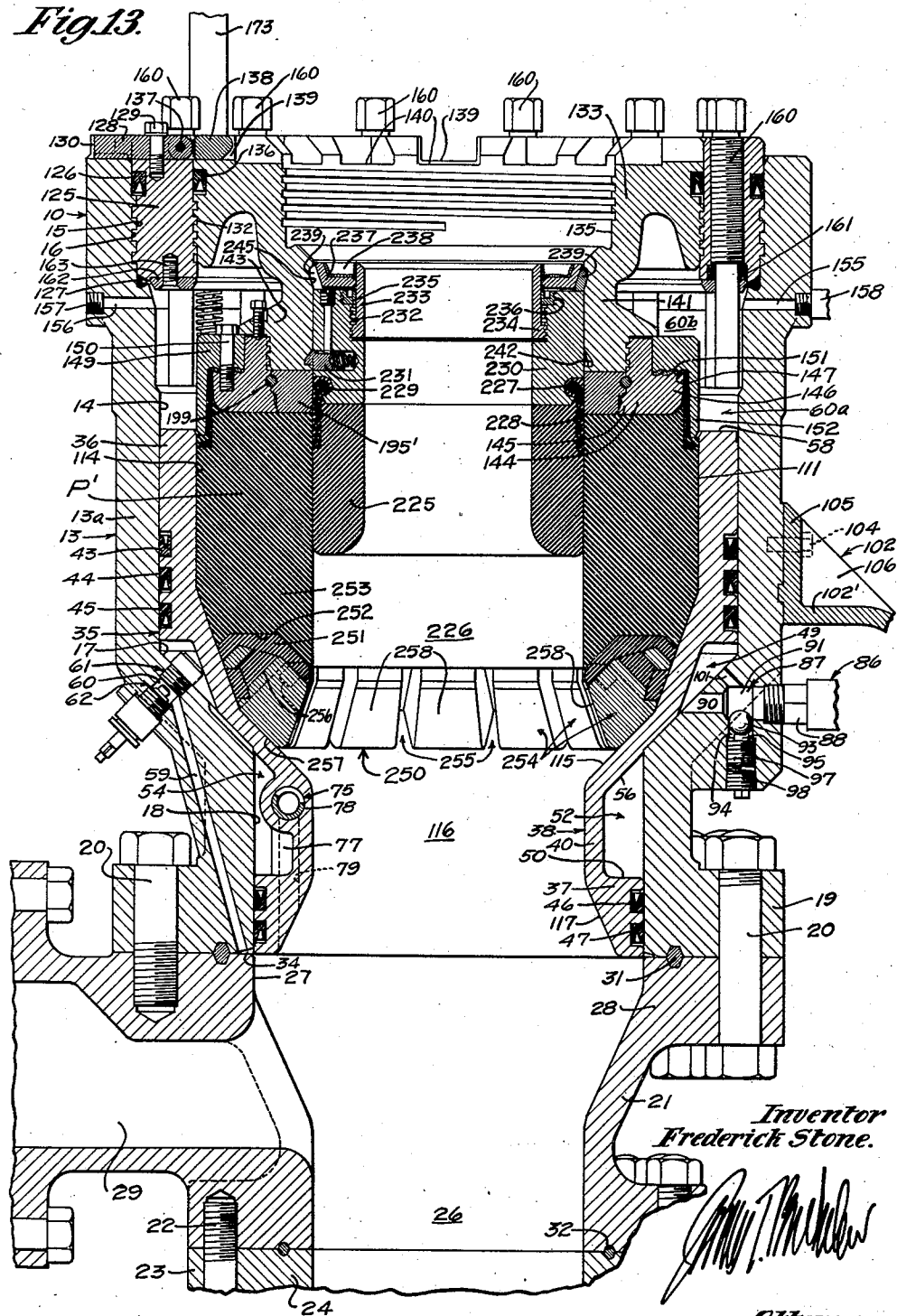
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Fig 13.



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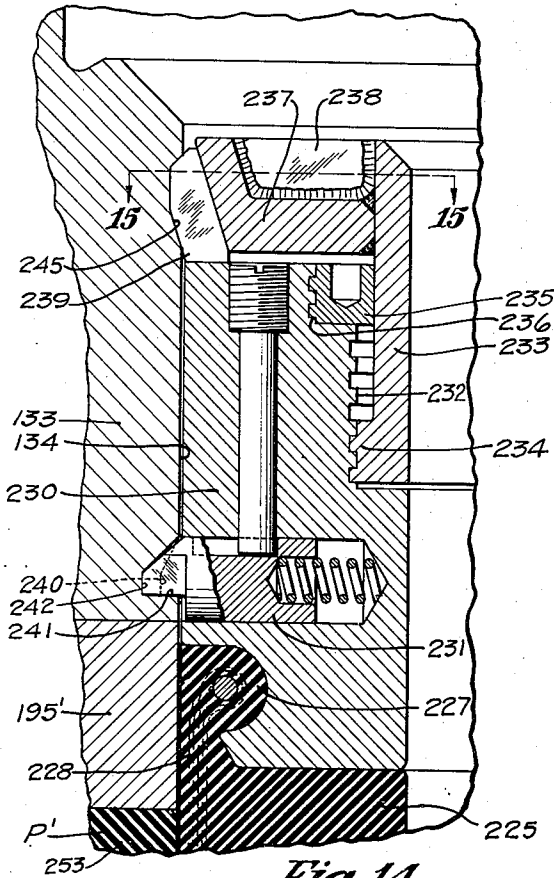


Fig. 14.

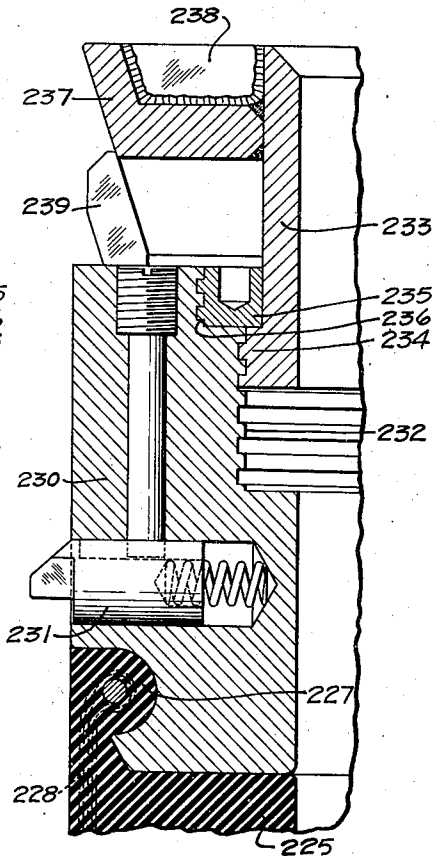


Fig. 16.

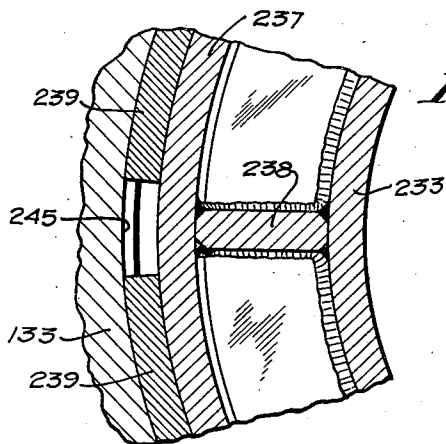


Fig. 15.

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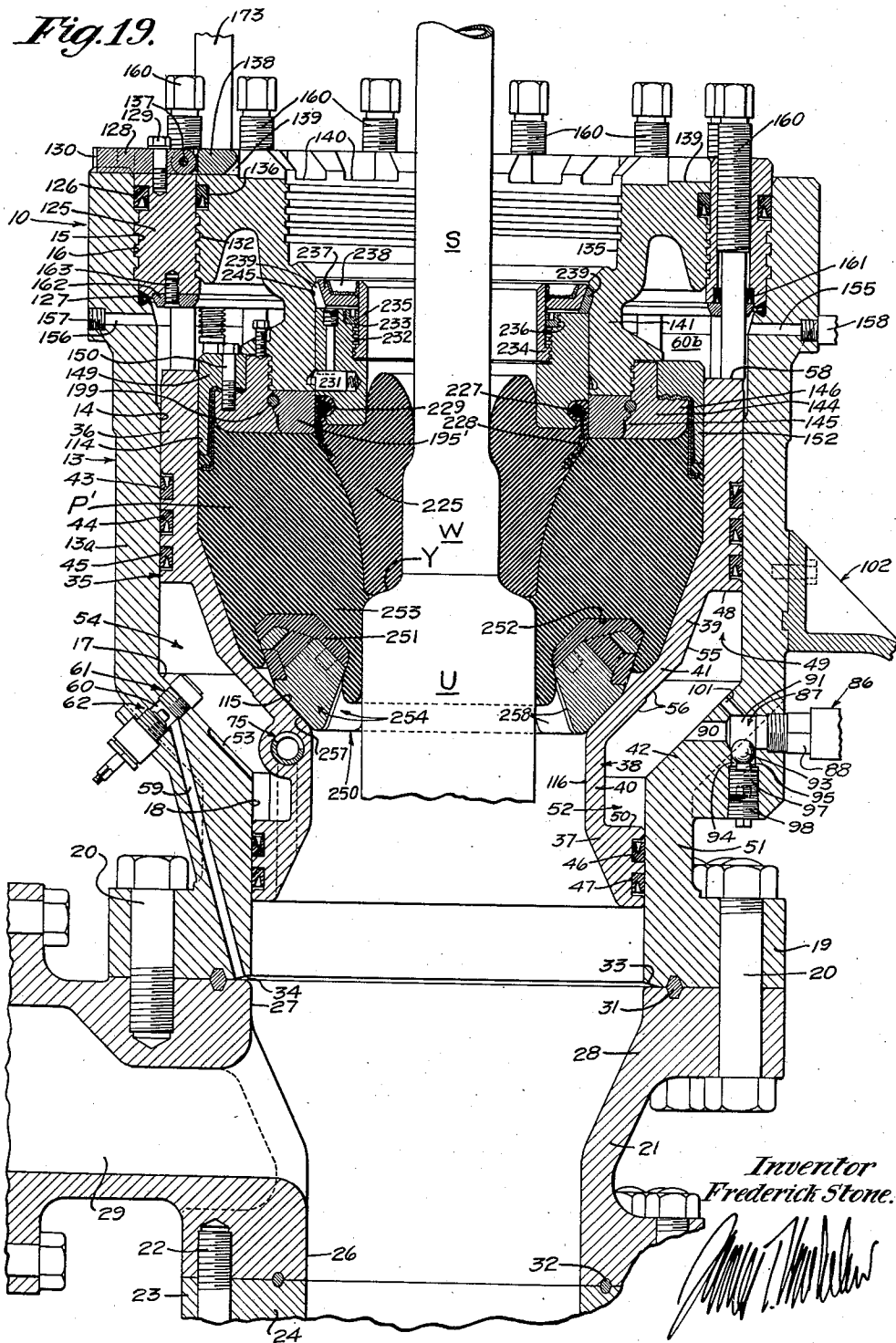
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PACKING HEAD

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UNITED STATES PATENT OFFICE

2,287,205

PACKING HEAD

Frederick Stone, Redondo Beach, Calif., assignor
to Hydril Company of California, Los Angeles,
Calif., a corporation of California

Application January 27, 1939, Serial No. 253,102

21 Claims. (Cl. 286—16)

This invention has to do generally with oil well packing heads used for such purposes as sealing around drill pipe or other work extending from the well into the head. It may be used for maintaining constantly a seal about drill pipe as it is being rotated or moved vertically through the head during "pressure drilling," or may be utilized as a blow-out preventer, in which latter case it normally stands in idle condition but is effective to be brought into play, either automatically or by manually controlled actuating forces, to effect a seal about the work and thus prevent the well from blowing out. It will be seen that irrespective of its particular use, whether that use be one of those mentioned above or any other use to which it is suited, the device may be characterized generally as a "packing head."

In certain aspects, the invention may be considered as an improvement over the devices shown in the following patents: Patents No. 2,038,140 issued to Frederick Stone April 21, 1936; No. 2,124,015 issued to Frederick Stone et al. on July 19, 1938, both on Packing heads; No. 2,163,813 issued to Frederick Stone et al. June 27, 1939, for a Well packing head; and No. 2,148,844 issued Feb. 28, 1939 to Albert L. Stone et al. on Packing heads for oil wells.

It is among the objects of the invention to provide a packing head which, in spite of the fact that it has sufficient diametrical capacity to take work of relatively great diameter, is likewise effective to seal off work of relatively small diameter, it following that the single head is, within reasonable limits; adapted to accommodate all the elements of a given string of drilling tools from the relatively small-diameter drill pipe, proper, through the various collars and upsets and through the relatively large drill collar and, in certain cases, the tool at the lower end of the string. The advantage of such capacity is obvious.

The head is also of such character that it gives the operator ready access to the various internal parts for inspection, repair, or replacement, it being possible to remove relatively rapidly wearing parts as the packer, proper, without disassembling the rest of the head and by working entirely through the bore of the rotary table overlying the head. The importance of this feature is readily recognizable by those working in the art.

It is also an important object of the invention to provide means whereby the operation of the head is safe, sure and rapid, for it will be recognized that very severe service strains are im-

posed on and very serious duties are intended to be performed by a device of this type and when the time comes for it to go into operation, failure or delay may easily result in loss of life and property, or cause such damage that a well may have to be abandoned or made subject to costly repair operations.

The various means employed for giving the device great working range and rendering it swift, sure, and durable in operation, may be discussed to better advantage in connection with the following detailed description, wherein reference is made to the accompanying drawings, in which:

Fig. 1 is a side elevation of a head embodying my invention, showing it in association with a conventionally illustrated rotary table and an external source of operating fluid;

Fig. 2 is an enlarged, fragmentary section taken on line 2—2 of Fig. 1;

Fig. 3 is a longitudinal section taken on line 3—3 of Fig. 4;

Fig. 4 is a top plan view of Fig. 3;

Fig. 5 is an enlarged section on line 5—5 of Fig. 3;

Fig. 6 is an enlarged, fragmentary section taken through the well-pressure inlet valve shown in Fig. 3;

Fig. 7 is an enlarged fragmentary section on line 7—7 of Fig. 3;

Fig. 8 is an enlarged section on line 8—8 of Fig. 4;

Fig. 9 is a detached, fragmentary assembly of the segmental bushing, showing the individual segments or leaves in inoperative positions;

Fig. 10 is a view similar to Fig. 9 but showing the individual segments in operative positions;

Fig. 11 is a top plan view of Fig. 10, but showing additionally the spring means tending normally to hold the segments yieldably in inoperative positions;

Fig. 12 is a view similar to Fig. 3 but showing the packer in contracted condition, and showing the safety check valve in closed condition;

Fig. 13 is a view similar to Fig. 3 but showing a different type of packer and packer bushing in place;

Fig. 14 is an enlarged fragmentary section showing the bushing mounting of Fig. 13;

Fig. 15 is a fragmentary section on line 15—15 of Fig. 14;

Fig. 16 is a view similar to Fig. 14 but showing the parts in different positions;

Fig. 17 is an enlarged fragmentary section of the reinforced packer section shown in Fig. 13;

Fig. 18 is a detached view of one of the reinforcing inserts; and

Fig. 19 is a view similar to Fig. 13, but showing the packer in contracted condition.

In Fig. 1 I have illustrated the packing head, generally indicated at 10, as being disposed beneath the rotary table, conventionally illustrated at 11, and in axial alignment with bore 12 of that table. The head is usually disposed in the "cellar" just below the table, it following that its internal parts are relatively inaccessible for inspection or replacement except through the table bore. This fact has been taken into account in fashioning certain of the parts, as will later appear.

The body member or housing 13 of head 10 includes a barrel portion 13a having a major bore 14, a counterbore 15 internally threaded at 16, and a conical bore 17 which inclines inwardly and downwardly to the lower and relatively reduced bore 18. The lower end of the housing is flanged at 19 for connection at 20 with the upper flange of side-outlet spool 21, or any other suitable fitting; the spool, in turn, being secured at 22 to flange 23 of coupling 24, the latter being adapted to be connected directly or indirectly to the upper end of the well casing (not shown). The bore 25 of coupling 24 and the lower portion 26 of the spool bore are substantially the same size as the bore of the casing to which a given head is to be applied, and it may therefore be considered broadly that the coupling member and spool make up the upper end of the string of casing. The upper portion 27 of the spool bore flares sufficiently to bring bore-defining wall 28 substantially flush with the defining wall of housing bore 18, while side outlet port 29 opens outwardly from the spool bore to flow control valve 30 (Fig. 1).

The joints between spool 21 and flanges 19 and 23 are packed off as at 31 and 32, respectively. The lower end of housing flange 19 is chamfered about bore 18 as at 33 to define, with the upper face of the spool, an annular groove 34 which opens, in effect, to the bores of the housing and spool.

Vertically slidable within housing barrel 13a is the tubular piston or packer-contractor generally indicated at 35, this member having a main piston portion or head 36 which has sliding fit within major bore 14, a reduced diameter piston portion or head 37 having sliding fit within bore 18, and a connecting neck 38 extending between the piston heads and comprising an upper conical portion 39, a lower cylindrical portion 40, and an intermediate conical portion 41, which latter has the same inclination as the face of body-wall 42 which defines body bore 17. The seating of portion 41 on the inner face of wall 42 limits the downward movement of the piston or contractor.

Though it will later be described in detail, it will suffice here to state that packer P is in the nature of a resilient, radially contractible sleeve of rubber or the like extending within the contractor bore and so shaped that upward movement of the contractor radially moves it into sealing engagement with work extending through the bore thereof (Fig. 20).

Piston head 36 of contractor 35 is packed off by annular rings 43, 44 and 45, these rings being preferably of rubber or the like and having V-shaped cross-section, the V's of rings 44 and 45 opening downwardly and the V of ring 43 opening upwardly. Piston head 37 is packed off by

rings 46 and 47 which are of the same character as the upper rings, the V's of rings 43 and 47 opening upwardly and downwardly, respectively. Both heads are thus packed off against fluid pressure directed either upwardly or downwardly between the peripheries of the heads and the bore-walls along which they are adapted to reciprocate.

Defined between the lower end 48 of piston head 36 and neck portion 39 on the one hand and the defining wall of bore 17 on the other hand, is an annular chamber 49; while defined between the upper end 50 of head 37 and piston-portions 40, 41 on the one hand and body-wall portion 51 on the other hand, is an annular chamber 52. However, wall portion 42 is preferably routed as at 53 to interconnect chambers 49 and 52 when the contractor is in its lowermost position (Fig. 3) and, when the contractor is elevated (Fig. 12) chambers 49 and 52 are in full communication, so it may be considered that, in effect, chambers 49 and 52 make up a single chamber 54 for the reception of packer-setting fluid pressure, said single chamber being located between piston heads 36 and 37.

Contractor 35 thus presents within chamber 54 the downwardly exposed pressure-taking faces 48, 55 and 56, and upwardly presented pressure-taking face 50. The lower end of the contractor presents a downward face 57 to fluid under pressure within the spool and piston bores, while the upper end of piston head 36 presents an upwardly facing shoulder 58 to chamber 60a defined within the upper end of housing 13, as will later be described. A passageway 59, which may be considered broadly as being within the packing head, extends through housing wall portions 42 and 51 from recess or groove 34, thus being constantly in communication with the bore of spool 21, or, generally, with the bore of the housing or casing at a point below packer P. Passageway 59 opens to the transverse body-passage 60 which is normally in communication with chamber 49, or more broadly, chamber 54. Disposed in passageway 60 are the valves generally indicated at 61 and 62 (Fig. 6). A cage 63 is threaded at 64 into passage 60, having a major orifice 65 defined by the bore of seat ring 66 which is press-fitted in cage-bore 67, the ring being peripherally notched as at 68 to provide bleed ports or minor orifices. The check valve ball or stopper 69 is loosely confined within cage 63, permitting the flow of fluid through passageways 59 and 60 into chamber 54 through major orifice 65, but preventing substantial reverse flow.

Valve 62 comprises a shut-off means for the bore 70 of cage 63 and, comprises a stem 71 suitably packed off at 72 and threaded through the bore of bushing 73, which latter is held within bore 60 in the manner clearly shown. It will be seen that the stopper end 74 of stem 71 may be adjusted either to allow free passage of fluid between passageway 59 and cage-bore 70 or to close off communication between said bores, in which latter case there may be no fluid flow through either the major or minor orifices of valve 61.

The function and operation of valves 61 and 62, as well as of the unloading valve now to be described, will be made apparent during the subsequent description of the operation of the head.

A safety or unloading valve is indicated generally at 75 (Figs. 3 and 5), it being adapted to relieve excess pressure within chamber 54. Neck 38 is provided with a horizontal boss 76 and a vertical boss 77, the latter extending from boss

76 to piston head 37. A bore 78 in boss 76 communicates with the upper end of vertical passage 79 in boss 77, the lower end of passage 79 opening to the bore of the contractor below the packer. Bore 78 has an inlet 80 opening to chamber 54, this inlet being bounded by an internal seat 81 against which is yieldably pressed a ball stopper 82, the valve-closing pressure being exerted by compression spring 82' interposed between adjustable bore-plug 83 and the sliding plunger or follower 84 which is concaved at 84' to take ball 82. When the pressure within chamber 54 reaches a predetermined value, ball 82 will be unseated against the pressure of spring 82' and the excess pressure will be relieved through inlet 80, passageway 78 and bore 79.

In addition to the previously described passageways and valves for admitting fluid under pressure to chamber 54 from the bore of the housing or casing at a point below packer P, I provide means for introducing fluid under pressure to that chamber from an external source. Such means is shown as including a pipe 85 and valve 86 (Fig. 1) the latter being put in communication with inlet passageway 87 by nipple 88, though broadly, the bore 89 of the nipple may be considered as a part of the inlet. Portion 90 of inlet 87 is in the form of a bore through the housing wall and opening to chamber 49 (or, more broadly, to chamber 54) bore 90 being of substantially the same diameter as the nipple bore, while between the inner end of the nipple and the opposing end of bore portion 90 is an enlarged valve chamber 91. Now it will later be made apparent that inlet 87 is adapted to serve alternately to introduce fluid under pressure to chamber 54 for moving the contractor upwardly in order to radially contract packer P, and for exhausting that chamber in order that the contractor may move downwardly. It follows that the inlet must normally be in a condition to allow fluid flow therethrough in either direction. However, assuming that the contractor is being held upwardly in packer-contracting position (Fig. 12) by pressure admitted to space 54 from an external source, if pipe 85, valve 86 or any other part of the inlet line were accidentally broken, the contractor would, in the absence of preventative means, drop by reason of the relief of pressure from chamber 54, and the packer would thus be allowed to expand, resulting in the loss of the seal about the work, an occurrence which might easily be disastrous or, at least, would create an extremely hazardous condition. It might be assumed that an ordinary check valve to prevent this reverse flow could be utilized for safe-guarding against an occurrence, but that would not suffice, for it must be remembered that reverse flow is essential when it is desired wilfully to exhaust space 54 when the time comes for moving the packer downwardly, and an ordinary check valve would prevent such normal reverse flow. Accordingly, I have devised a valve which permits normal flow of fluid in either direction through the inlet but, upon sudden reduction of the inlet pressure (as by breaking the inlet line) responds in a manner to check reverse or exhaust flow through the inlet.

The automatically selective check valve devised for the above purpose is indicated generally at 92 and comprises a stopper 93, preferably, though not necessarily, spherical in form and mounted in a vertically extending bore 94 opening at its upper end to valve chamber 91. The stopper is supported on extension 95 of plug or ball sup-

port 96 which is screwed at 97 into bore 94 and is thus vertically adjustable. The lower end of bore 94 is closed by a removable plug 98 which, when removed, gives access to the bore so a suitable tool may be inserted in the polygonal socket 99 of ball support 96 for adjusting said member and hence stopper 93 vertically. Member 96 is adjusted in a manner to support a ball in the position where it has the requisite sensitivity for a given condition. An average position is indicated in Fig. 3 where the top of the ball barely extends above the lower defining walls of bores 89 and 90. Then, during normal flow through these bores, in either direction, ball 93 remains at rest in bore 94. If, however, the inlet pressure is suddenly reduced, there is a rapid flow of fluid from chamber 54 outwardly through the inlet, the stopper being "sucked" upwardly from bore 94 and into a position where it closes bore 89 by seating against the conical seat 100 formed at the inner end of the nipple, thus preventing further escape of fluid from chamber 54 and holding the contractor upwardly in packer-contracting position, the response of the ball being so rapid that practically no pressure is lost from space 54 before the ball is seated. Due to the spherical characteristics of stopper 93, its movement into seated position is aided by the fact that the outwardly rushing fluid tends to rotate it in a clockwise direction (Fig. 3) and thus tends to roll it up along the right-hand defining wall of bore 94.

It will be seen that by adjusting member 96 vertically and thus raising or lowering the ball with relation to inlet 87 and chamber 91, the sensitivity of the valve may be varied at will. By removing plug 98, it will be seen that the valve may be adjusted from the exterior of the housing even though the interior of that housing be under pressure, for member 96 has such fit within bore 94 that there will be no appreciable loss by leakage even though plug 98 be removed.

Ball 93 is, of course, too large to permit its bodily movement through either bore 89 or 90, but to prevent the ball from ever reaching a position where it might check flow of fluid from bore 89 into chamber 54, I have provided a by-pass 101 extending from chamber 91 into chamber 54, it being impossible for the ball to close off both bore 90 and by-pass 101 at the same time.

It will later be made apparent that valve 62 is normally open but, when fluid from an external source is admitted through inlet 87 to chamber 54, valve 61 will act as a check valve to prevent the fluid so introduced from escaping through passageway 59 to the housing bore below the packer, although bleed ports 68 allow a very slow escape from the chamber through passage 59 but not in sufficient volume to affect the operation so long as the input does not drop below a certain value.

Under the conditions outlined above, that is, when valve 92 closes the inlet by reason of a break in the inlet line, and with check valve 61 closed by reason of the high pressure within chamber 54, were it not for bleed ports 68 or some equivalent provision, it would be practically impossible under certain conditions and even after the repair to the inlet lines were made, to unseat ball 93 in a manner to relieve the pressure in chamber 54 when occasion arose for wilfully lowering the contractor. However, bleed ports 68 prevent the existence of such a pressure lock, for the pressure within chamber 54 will gradually be reduced by the outward flow through

the bleed ports and passageway 59, though not with a speed sufficient to destroy the safety effect of valve 92. Of course, if, after valve 92 automatically closes, it be desired temporarily to prevent escape through the bleed ports so that full pressure may be held in chamber 54 until repairs have been made, it is merely necessary manually to close valve 62. Then, when it is desired subsequently to lower the contractor, it is merely necessary to open valve 62 and the pressure will gradually bleed out through ports 68 into the housing or casing bore below the packer, being thus disposed of controllably and safely.

Another situation wherein manually controlled valve 62 is closed, is when well pressure is insufficient to actuate the packer contractor and "bottled" gas is admitted for this purpose through inlet 87. Since this gas is relatively expensive and the capacity of the "bottles" is relatively limited, it becomes a matter of economy to close valve 62 and thereby prevent the gas from escaping.

While it will be seen that by incorporating valve 92 within the body structure of the head, it is assured that the valve is so protected that it will always be in a condition to automatically shut off the inlet if breakage occurs in the inlet line where it extends outwardly beyond the housing, I prefer to take additional precaution to protect valve 86 against dropping or swinging extraneous objects. For this purpose I have provided a bracket 102 (Figs. 1 and 2) keyed into the housing at 103 and bolted thereto at 104. The horizontal portion 102' of the bracket overlies valve 86 and is connected to the upper, vertical portion 105 by rib 106. Depending bracket-leg 107 carries a detachable cap 108 whereby the outer end of the valve is clamped and supported. The horizontal portion 102' of the bracket is sufficiently wide to extend outwardly over the valve and thus serve as an effective protector.

Valve 86 is normally left open throughout operation of the packer, being provided as an auxiliary, manually controlled means for closing off inlet 87 under certain circumstances.

Packer P has what may be termed generally as a downwardly pointing conical end, said end having two angles of taper, namely an upper taper 109 of relatively slow angle and a lower taper 110 of relatively abrupt angle, this combination giving the combined beneficial result of reducing the extreme end of the packer in a manner to allow it to be readily deformable in the manner best adapted to take a proper shape under radial contracting pressures, and of providing sufficient radially extending bulk above that extreme end to give the packer relatively long life under conditions of severe internal wear and to give sufficient radial extent to enable it to adjust itself to work varying in diameter between relatively wide limits.

At the junction of angle 109 and the upper cylindrical portion 111 of the packer, is an annular, downwardly pointing lip 112 which is adapted to be spread radially outward to effect a seal with the wall of the contractor in the event there is leakage between the contractor and the lower end of the packer. The tip of the packer preferably has a downwardly opening, conical counterbore 113.

The upper portion 114 of the contractor bore is complementary to the external configuration of the packer, the lower, tapering portion 115 of

said bore opening into neck bore 116 which flares at its lower end 117.

The major bore 118 of the packer is cylindrical, the packer being further provided with conical counterbore 118a, a cylindrical counterbore 119, a larger, arcuate counterbore 120, and a still larger terminal counterbore 121. An annular, flexible hanger 122 of fabric or the like, has its lower end 123 embedded or molded in the upper end of preformed packer P and, preferably, the packer is internally reenforced at 124 beneath counterbore 120.

I will now describe the means for suspending the packer within body or housing 13 and for supporting the upper end of the packer in such a manner that said upper end is held against vertical bodily movement with respect to the housing. Threaded into housing counterbore 15 is a cap ring 125 whose internal diameter is at least as great as the inside diameter of piston bore 114 and, by the same token, as the overall outside diameter of packer P. The ring is packed off at its upper and lower ends 126 and 127 as clearly illustrated, and, after proper vertical adjustment, is releasably held from rotation and hence from vertical movement with relation to housing body 13 by a locking bar 128 which is detachably held to the ring by bolt 129 and extends into slot 130 defined between lugs 131 on the top of the housing barrel (Figs. 3 and 4).

Threaded at 132 into the bore of ring 125 is an annular packer-supporting member or ring 133 whose major bore is indicated at 134, an internally threaded counterbore being indicated at 135. Counterbore 135 is adapted to take any suitable connection or adapter for supporting whatever apparatus may be desirable in a given installation; for instance, a tandem drilling-packer head (not shown) such as is disclosed in certain of the aforementioned patents and applications.

Annular packing 136 provides a seal between rings 125 and 133. Hingedly connected at 137 to bar 128, is a locking bolt 138 adapted to drop into a selected notch 139 provided on the upper end of ring 133 to releasably hold ring 133 from rotating with relation to ring 125, and thus releasably locking ring 133 in its position of vertical adjustment. The upper end of ring 133 is also provided with tool-taking formations 140 whereby the cap may be threaded into or out of its position of assembly with the rest of the packing head. Rings 125 and 133 may be considered as making up an annular, two-part cap for housing-barrel 13a.

Ring 133 has a depending neck 141 with external, left-hand threads 142 and an external, overhanging flange 143. Threadably connected to neck 141 is a clamping ring 144 having an internal flange 145 and an external flange 146, the upper face of the latter preferably having annular clamping grooves 147. Ring 144 is releasably held by set-screw 148 against rotation with relation to ring 133. Clamping ring 149 is bolted at 150 to flange 146, said ring 149 preferably having clamping grooves 151. The upper end of hanger 122 is extended horizontally between flange 146 and ring 149, being clamped tightly in a manner to prevent longitudinal separative movement between ring 133 and the packer. Clamping ring 149 has a depending, annular skirt 152 which surrounds the hanger, but there is sufficient annular clearance 153 between the outer peripheral face of flange 146 and the inner peripheral face of skirt 152 to allow limited lat-

eral movement to the vertically extending portion of the hanger.

Skirt 152 defines, with the inner peripheral wall of barrel 13a, an annular chamber 60a, the effective cross-sectional area of which is substantially equal to the area of piston face 58, though the chamber is enlarged at 60b where it overlies the stationary ring 149 and flange 143. Diametrically opposite passageways 155 and 156 open through the housing wall to chamber 60a, one of the passageways being closed as by a removable plug 157 and the other having a fitting 158 for connection with a fluid pressure line 159 (Fig. 1). Should it be desired to flush out chamber 60a, the fitting and plug are removed and flushing fluid is admitted through one passageway 156 or 157, being thence circulated through the chamber and then out through the opposite passageway.

Extended through cap ring 125 and projecting into chamber 60a, are adjusting screws 160 which provide adjustable, positive stops for limiting the upward movement of contracter 35, the lower ends of said screws being opposed to end 58 of the contracter. As has been described in detail in connection with the showing of certain of the aforementioned patents and applications, screws 160 provide means for positively limiting the contracting movement of contracter 35 irrespective of the pressure exerted thereupon by the actuating fluid, all to the advantageous ends spoken of in said prior disclosures.

In order to prevent leakage from chamber 60a around the threads of the adjusting screws, the lower ends of said screws are packed off as clearly shown at 161, the packings of all the screws being held from downward bodily displacement by retainer ring 162 bolted at 163 to the underside of cap-ring 125.

As pointed out in my Patent No. 2,124,015, it is of advantage for the operator to have constant knowledge of the relative position of the contracter within the housing and from this be able to ascertain the instant condition of the packer as regards the extent of its radial contraction (which, of course, depends directly upon the extent to which the contracter has been raised.) In that patent, there is disclosed an indicating rod which is secured to and movable with a part of the piston assembly. In the present device I have shown an indicator which is not secured to the contracter and therefore which enables easier assembling of certain internal parts of the packing head. However, the fact that there is no positive connection between the indicator and the piston creates other problems for which I have provided the solution, as will be demonstrated.

Referring to Fig. 8, it will be seen that a vertical bore 165 in cap-ring 125 registers with bore 166 in retainer ring 162. Extending through these bores is an indicator rod 167 having an enlarged head 168, an external flange 169 and a tip 170 which is of somewhat reduced diameter with respect to head 168.

An abutment ring 171 forms a stop for the end of compression spring 172 which acts against flange 169 in a manner tending to hold tip 170 on end face 58 of contracter 35. Upon upward movement of contracter 35, rod 167 is pushed upwardly, and since it extends to the exterior of the housing, may be utilized either directly or indirectly to indicate the extent to which the contracter has been raised and therefore the relative condition of the packer.

Assuming there be no appreciable pressure within chamber 60a, if the contracter now descends, spring 172 exerts its pressure against flange 169 in a manner to cause rod 167 to follow the contracter downwardly and thus exteriorly to indicate the new position of the contracter. However, if there be appreciable pressure within chamber 60a it is necessary to counteract the pressural effect of the fluid on the downwardly exposed faces of the rod, since all upwardly facing shoulders on the rod exteriorly of the housing are exposed only to atmospheric pressure, and the consequent differential in effective pressures would cause the rod always to remain at the top of its stroke irrespective of the position of the contracter.

To overcome this effect, I provide an externally arranged cylinder 173, screwed into the upper end of bore 165, packing 174 being interposed between the closed, lower end of the cylinder and stop ring 171 to prevent leakage of fluid past either the rod or the exterior of the cylinder where it is threaded into the cap-ring. An extension 175 of indicator rod 167 carries piston head 176 disposed within cylinder 173, and the rod below the piston has a central bore 177 opening at its lower end through port 178 to bore 165 and therefore to chamber 60a. Bore 177 opens at its upper end to a short, central bore 179 in extension 175, which bore 179 communicates through port 180 with the interior of cylinder 173 above head 176. Vent 181 opens to the atmosphere from the cylinder at a point below the lowest stroke limit of head 176, while the upper end of the cylinder is closed by cap 182 and the packing rings 183. Indicator extension 175 extends through cap 182 and may either directly carry indicia 184 or it may be connected as at 185 to a member 186 adapted, in turn, to actuate a remotely positioned indicator (not shown) of any suitable type.

Upon the upstroke of contracter 35, rod 167 is pushed upwardly by end shoulder 58, and pressure built up in the cylinder above piston 176 is relieved by passing into chamber 60a through port 180, passages 179—177 and port 178. On the other hand, upon descension of the contracter, fluid from within chamber 60a is transmitted through the rod-passageways and ports to the cylinder above piston 176 and, since the effective area of the piston is greater than the effective cross-sectional area of the rod where it is exposed within chamber 60a, and since the cylinder below the piston is vented to the atmosphere, the indicator rod will be moved downwardly by the force of spring 172 and whatever overbalancing fluid pressure advantage is given by reason of the differential effective areas mentioned. Of course, this differential need only be enough to have a balancing effect, disregarding the effect of the spring, in which case the actual downward movement is imparted to the indicator rod solely by the spring.

By reference to Figs. 1 and 3, it will be noted that should occasion arise for removing or replacing packer P, it is only necessary to swing bolt 138 clear of slot 139 and unscrew supporting ring 133 from the bore of cap-ring 125, whereupon the supporting ring and all the parts suspended therefrom, including packer P, may be lifted, as one, clear of the packer head and withdrawn vertically through table bore 12. Such removal or subsequent replacement of the packer and its supporting structure may be accomplished

without disturbing contracter 35 or cap ring 125 in any way.

The outside diameter of contracter 35 is such that it will also pass through table bore 12, but the outside diameter of cap ring 125 is usually such that it may not be passed through the table bore. Accordingly, when occasion arises for removing or replacing contracter 35, locking bolt 128 is released, ring 125 is unscrewed from counterbore 15, raised to the position approximately represented in dotted lines in Fig. 1 and then shifted sidewise clear of head 13, whereupon contracter 35 may be withdrawn vertically through table bore 12.

Thus, while the contracter and piston are capable of ready removal from a position above the table, (a feature of decided advantage as is well recognized by those working in the art) the outside diameter of the packer may be relatively very large, giving the packer ample radially extending mass even though its bore is sufficiently large to take work of relatively large diameter.

It will be noted that packer bore 118, as well as bores 134 and 116 of necks 141 and 38, respectively, is of substantially the same diameter as bore 26 of spool 21, it following that the packer and the packer-actuating means are adapted to take and pack-off work up to and including anything that may be passed through the spool and the casing therebelow. However, when the work is of relatively small diameter (and in this connection it will be recognized that a single string of drilling tools may have portions which vary between relatively wide limits in diameter) it becomes desirable to provide a bushing for the bore of the packer, which bushing is radially contractible, in itself, and will more or less establish the shape assumed by the main packer when the latter is radially contracted, so it may continue to function properly in spite of the relatively extreme condition of its inwardly radial spread.

I have shown means for interchangeably supporting two different types of such bushings, both types being radially and resiliently contractible. The type shown in Figs. 3 and 12 is made up of rigid units, to form, in their contracted condition, a rigid, conical bushing, while the type shown in Figs. 13 and 19 is made of substantially the same material as the main packer. As a further difference, the bushing shown in Fig. 3 has a normal internal diameter substantially the same as that of the normal internal diameter of the main packer, being, in effect, set in a counterbore at the upper end of said packer; while in Fig. 13, the bushing extends into the main bore of the packer and, in effect, normally reduces the effective, inside diameter of the main packer throughout a portion of its extent.

Referring particularly to Figs. 3, 7 and 9 to 11, inclusive, it will be seen that bushing 190 is made up of a ring of segments 191, each segment consisting of a finger 192 having a pair of spaced, centrally pierced and substantially cylindrical hubs 193 at its upper end. These hubs are mounted for oscillation between the arcuate face 194 of ring 195 and an arcuate face 196 of clamping-ring-flange 145, these arcuate faces extending angularly a sufficient distance about the hubs to hold them against bodily displacement from ring 144. Holding bushing 190 (when detached from supporting ring 133) in loose assembly, is a split ring 197 extended through hub-bores 193.

Ring 195 has a flange 196' clamped between the underface of ring-neck 141 and flange 145,

rings 195 and 144 being held against relative rotation by dowels 199 (Fig. 7) which are removable only when the packer is disconnected from supporting member 133. It will be seen that, with supporting ring 133 detached from the packing head, bushing 190 may be freed bodily from that ring by removing clamping-ring 149, unscrewing ring 144 from neck 141, and removing dowels 199.

On the outer side of each segment is a lug 200 having an arcuate face 201 which is substantially concentric with the associated hubs 193, the upper face 202 of the lugs, which may be recessed for purposes of weight-reduction as at 203, being adapted normally to extend horizontally. The lugs stop short of the lower end of fingers 192, thus leaving exposed an outer, vertically extending pressure-taking face 204 at the end of each finger.

Between each pair of hubs on each segment, is a torsion spring 205 threaded on split ring 197 and having one end 206 anchored in the segment and the opposite end 207 anchored in ring 195. These springs act yieldingly to hold the fingers normally in vertical position (Figs. 3 and 9) the faces 202 engaging the underside of ring 144 to limit their outward swinging movement. When the segments hang in this position their side edges 208 are angularly spaced, but the segments have overlapping formations such as side lugs 209 fitting within recesses 210 of adjacent segments, so that as one segment is swung in or out, its side lug imparts like movement to the adjacent segment, it following that the segmental ring symmetrically expands or contracts as a whole when oppositely directed radial forces are applied laterally against one or more fingers. When the segments are swung inwardly sufficiently to bring their side edges 208 together, they form a closed, exteriorly flush ring as shown in Figs. 10 and 11.

Bushing 190 is so disposed that, in normal condition (Fig. 3) fingers 192 fit within packer-counterbore 119 with their inner faces substantially flush with or a little below the defining wall of packer bore 118, with the lower portions of arcuate lugs 200 fitting within the complementary counterbore 120 of the packer, and the upper portion of the lugs fitting in the complementary, arcuate bore of rigid ring 211, the latter being seated in packer counterbore 121 and engaging the underside of clamping ring 144. It will be seen that the upper end of packer P is thus rigidly backed up by the lower end of skirt 152, ring 211, and bushing 190.

Before proceeding to the description of operation, I will describe the conventionally illustrated system for supplying actuating fluid to the packing head, though it is to be understood this showing is not at all to be considered as limitative either as to fluid source, piping connections of the control system, or valve members of the control system. It may be assumed that the actuating fluid is steam, the supply line from the boiler (not shown) being indicated at 213. In some instances, the boiler pressure may be insufficient for the purpose, so it is preferable to provide a "pressure booster" 214. Line 213 leads to valve 215 which is here shown in position to introduce line-steam to the low pressure side 216 of booster 214. However, valve 215 may be adjusted to by-pass the booster and thus put line 213 into direct communication with feed line 217 through line 218, the latter being provided with a check valve 219.

The high pressure side 220 of the booster is connected by line 221 and through check valve 222 to line 217, the latter leading to valve 223 which is here shown in a position to put lines 217 and 85 into communication and as opening line 159 from chamber 60a to the atmosphere. A shut-off valve 85' is provided in pipe 85. When operating conditions demand, valve 223 may be reversed to put lines 217 and 159 into communication and to exhaust line 85 to the atmosphere.

In the following description of operation, certain typical situations, relative pressures and responsive actions of the packer head elements will be set forth, but it is to be understood that the discussion is intended only as illustrative and not as limitative or as inferring that the apparatus may not respond differently under different given conditions, or that the given situations are the only ones in which the apparatus may be used to advantage.

It will first be assumed that the apparatus is in the condition of Fig. 3 but with work, such as drill pipe D having enlarged tool joints T (Fig. 12) extending through its bore. It will also be assumed that the well pressure is of such relatively low value that it is unnecessary for the packer to be set.

Under such conditions, valve 86 is open, valve 85' is closed and valve 223 is in such condition that chamber 60a is vented to the atmosphere. Valve 62 will be open, and since it is highly desirable that it be closed only under the unusual circumstances mentioned above, so that chamber 54 may normally be constantly in communication with the well bore at a point below the packer, I prefer to provide valve stem 71 with a removable control handle 71a which will be left in the custody of some one authorized person and thus prevent the inadvertent closing of the valve by an unauthorized person who may not understand the importance of leaving it open under all normal circumstances.

Though the lower end of the contractor is exposed to the pressure within the well, the pressure effect against this lower end is balanced off by reason of the well pressure communicated to chamber 54 and exerted downwardly against face 50, as well as the well pressure directed against the upwardly presented face of the contractor at a point just below the lower end of the packer. The well pressure directed against downwardly presented contractor faces 55 and 56 which define a portion of the top of chamber 54, is substantially balanced off by the inherent resistance of packer P to deformation from its normal condition (Fig. 3) and such well pressure as is directed against the bore defining wall thereof. The pressure within chamber 54 acts against downwardly presented face 48 in a manner tending to raise the contractor, since chamber 60a above the piston is vented to the atmosphere, but under the conditions given, the weight of the contractor and the frictional resistance opposing its upward movement are sufficient to hold the contractor down in the position of Fig. 3.

Now assume that the well pressure suddenly increases. Remembering that the work somewhat restricts the packer bore and, in some instances such as spoken of in the aforementioned patents and applications, that there may be provided above the packing head a second member tending to close off the space around the work, there is sufficient restriction against

the free upward flow of the well fluid about the pipe under conditions of suddenly increased volume to build up sufficient pressure within chamber 54 (via passageways 59, 60 and check valve 61) to move the contractor upwardly and thus, due to the inward wedging effect on the conical end of the packer to radially contract said packer about the work. The action is not ordinarily one of extreme suddenness but it will be seen that, as the packer starts to contract, it gradually further chokes down the free flow of fluid around the work and thus directs more and more of the fluid into chamber 54 and finally becomes effective to move the contractor to its limit, as determined by stops 160 and thus to effect the shut-off desired. This relatively gradual shut-off is preferable to the sudden shut-off accomplished in certain types of apparatus where the shock incident to sudden closures against high pressures may result disastrously to the shut-off mechanism.

It will thus be seen that the packing head is constantly in condition to function as an automatically operated blow-out preventer in the event of a sudden increase in well pressure. Since the line leading from the bore below the packer to the contractor actuating chamber is constantly open under all normal conditions and since this line is "self-contained" within the head so it is not exposed to external damaging forces, it will be seen that there is practically no chance for it to fail in operation when the emergency arises.

Fig. 12 illustrates a typical condition of complete shut-off about work of relatively reduced diameter, showing also how the packer adapts itself to work of varying diameter. Here the drill stem is indicated as being of quite small diameter, and it will be seen that as the packer has been pressed radially inward it has acted against pressure faces 204 of the fingers in a manner to swing the segments inwardly to a position where the bushing is in the form of a rigid, closed, conical ring, thus forming a backing for the upper and inward portion of the packer so that it does not "flow" excessively upwardly about the pipe and has a rigid backing of relatively small diameter so that the sealing effect of the packer about the relatively small work is just as effective as it is about the larger diameter of the work where there is need of much less radial displacement of the packer material.

With the packer thus set, there sometimes arises a need for moving the work vertically and as larger portions of the work, such as tool joint T, pass through the packer, it is essential that the bushing yield outwardly to prevent damage to the packer or to the bushing segments. Were the fingers to be of rectilinear formation throughout, as distinguished from the partial arcuate formation given to them by lugs 200, the pressure tending to hold them inwardly would be so great that they would tend to remain in the positions of Fig. 12 and thus sever the upper end of the packer which extends between the fingers and the work. However, the arcuate lugs act, in effect, as at least partial counterbalancing means, for the pressures directed against the arcuate faces by the packer all resolve themselves into forces directed radially with respect to the axis of hubs 193 and thus the only forces resisting movement of the segments to their expanded positions are those directed by the packer against pressure faces 204. Thus, in spite of the

fact that the fingers are sufficiently long to cause a material reduction in the bore of the bushing when they are swung inwardly, their resistance to return movement is not represented by a pressure face equal to the overall length of said fingers, the reduction being sufficient to insure that the fingers may be swung to expanded position by the passage of relatively large work therethrough without causing damage.

With the packer in the condition of Fig. 12, and the work is being moved vertically therethrough, whenever a relative enlargement in the work reaches the packer there is a tendency to forcibly depress both the packer and the piston. This may result in the building up of excessive pressures within chamber 54, particularly if that chamber contains an accumulation of liquid from the well or feed lines. In the event such excess pressures are created, which obviously might result in bursting the head or the connecting pressure lines, unloading valve 15 acts to relieve the pressure within chamber 54 in the manner previously described. The effective strength of the unloading valve spring may be varied by adjustment of plug 83 to set the valve so that it will yield under any chosen pressure.

When it is desired to release the packer, valve 85' is opened and valve 223 is adjusted to vent line 85 and hence chamber 54 to the atmosphere. Then, if chamber 60a, above the piston be vented to the atmosphere or if pressure be applied thereto through line 217, the contractor will descend and all parts will return to the positions shown in Fig. 3. In order to release the packer, ordinarily it is only necessary to vent both chambers 60a and 54 to the atmosphere, as the contractor will then ordinarily drop by gravity. However, if the contractor sticks, fluid pressure may be admitted to chamber 60a through line 159 to drive it downwardly.

If it be desired to hasten the upward movement of the piston once it has been started up by fluid pressure introduced through passageway 59, or if it be desired to elevate the packer entirely independently of the well pressure, fluid pressure may be admitted to chamber 54 from line 217 through valves 223, 85', and 86, chamber 60a being vented, as before.

In Figs. 13, 14, 15, 16 and 19, I have shown a different type of packer bushing. Here, the bushing is made up of a radially contractible, resilient sleeve 225 of rubber or the like, which is adapted to fit within the upper end of bore 226 of packer P'. Ring 195 is here replaced by a filler ring 195', and ring 211 is omitted. The upper end of bushing 225 has a bead 227 into which projects the internal reinforcement 228. Bead 227 is taken between the inner peripheral face of ring 195' and the defining wall of annular recess 229 provided at the lower end of suspension ring 230. Ring 230 has a spring-pressed latch 231 projecting to the outer peripheral surface thereof, while it also has an internally threaded counterbore 232. Lock-actuating sleeve 233 has a head 234 adapted to be threadably adjusted through counterbore 232, the upward movement of the sleeve with respect to the ring being limited by a collar 235 threaded into ring 230 at 236. A spreading ring or cone 237 is welded about the upper end of sleeve 233 and is provided with tool-taking formations 238. Split locking ring 239 has an inherent tendency to spring radially inward to release position, such inward movement being allowable when sleeve 233 is screwed to its upper limit, as indicated

in Fig. 16. This will be the condition of the bushing-supporting assembly before it has been applied to the supporting ring 133.

Neck 141 of ring 133 has an internal annular groove 240 presenting an upward face 241, and at intervals about this groove there are provided recesses 242, the inner walls of both the groove and recesses inclining inwardly and upwardly from shoulder 241. With the bushing assembly in the condition of Fig. 16, it is dropped into the bore of neck 141 until groove 240 is reached by latch 231 which thereupon springs outwardly over shoulder 241 to prevent further downward movement of the assembly. The assembly is then rotated until latch 231 springs into one of the recesses 242, the latch thereafter holding ring 230 against rotation with relation to ring 133. At this time, locking ring 239 is opposite annular recess 245 in neck 141. Sleeve 233 is then threaded downwardly which causes wedging or spreading cone 237 to spread lock ring 239 into recess 245, thus tightly locking the bushing and its supporting assembly against longitudinal movement with relation to ring 133.

When the bushing is to be removed, ring 233 is unscrewed until the locking ring 245 is free to spring back to the position of Fig. 16 and clear of groove 245. The bushing may then be lifted clear, since the inclined walls of recess 242 will cam latch 231 back to retracted position.

Fig. 19 illustrates the condition of bushing 225 when it is contracted about the work, which is here shown as consisting of drill stem S, drill collar U and intermediate enlargement W. Packer P' is shown as contracted about collar U, while bushing 225 is shown as adapting itself to pack off both stem S and enlargement W. If it be desired to pull the work clear of the packing, as soon as the work-shoulder Y strikes the lower end of bushing 225, locking ring 239 is released as described above and, as the work is elevated, shoulder Y pushes the bushing ahead of it and clear of the bore of packer P', but it will be observed that the packer P' will still continue to hold its seal about collar U in spite of the fact that the bushing has been removed.

In Figs. 13, 17, 18 and 19, packer P' is indicated as being more in the nature of a drilling packer than of a blow-out preventer, although it will be understood that it may function exactly as described in connection with the other figures of the drawings. As an added feature, however, I have provided means for preventing undue deformation of the lower end of packer P'. This means is indicated generally at 250 but while it is here shown as being separable from the packer proper, as a matter of fact it may be considered as a part of that packer. It is here shown as consisting of a ring 251 made up of material similar to that of the main portion of the packer and extending upwardly into an annular groove 252 provided in the lower end of main packer portion 253.

Moulded into ring 251 are segmental, rigid inserts 254 which are angularly spaced apart to provide slots 255. The inserts have cavities or bores 256 into which the ring material is moulded to act as retaining keys. The inserts have outer conical faces 257 which are adapted to slide on the opposed conical face of the contractor, while they have conical faces 258 presented toward the work. The spacing between the rigid inserts allows limited radial contraction of ring 251, as a whole, but never to a point where it is

of sufficiently reduced diameter to be movable into neck-bore 116.

The relatively resilient ring 251 with its relatively rigid inserts is thus adapted to serve as a radially contractible bushing for the lower end of the packer, preventing that lower end from "flowing" downwardly under extreme pressural conditions, to an undesirable extent. Yet it radially "backs up" the reduced-diameter tip of the packer so as to insure effective sealing engagement with the work as clearly illustrated in Fig. 19.

It will be understood that while I have shown and described preferred embodiments of my invention in detail, various changes in design, structure and arrangement may be made without departing from the spirit and scope of the appended claims.

I claim:

1. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, there being a space within the housing and an inlet for introducing fluid under pressure to said space, an increase in the fluid pressure within the space being effective to contract the packer radially about the work, and a safety valve adapted normally to permit flow of fluid through the valve and inlet to and from said space, said valve being adapted to close the inlet by virtue of a sudden reduction of inlet pressure to prevent continued flow of fluid from said space through the inlet.

2. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, there being a space within the housing and an inlet for introducing fluid under pressure to said space, an increase in the fluid pressure within the space being effective to contract the packer radially about the work, a safety valve adapted normally to permit flow of fluid through the valve and inlet to and from said space, said valve being adapted to close the inlet by virtue of a sudden reduction of inlet pressure to prevent continued flow of fluid from said space through the inlet, and means for adjusting the sensitivity of said valve.

3. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, there being a space within the housing and an inlet for introducing fluid under pressure to said space, an increase in the fluid pressure within the space being effective to contract the packer radially about the work, and a safety valve adapted normally to permit flow of fluid through the inlet passageway to and from said space, said valve being adapted to close the inlet by virtue of a sudden reduction of inlet pressure to prevent continued flow of fluid from said space through the inlet, said valve embodying a seat in the passageway and facing the space, and a stopper normally loosely supported at one side of the passageway and between the space and the seat, said stopper being free for bodily movement from its position of normal support onto said seat to close the passageway by virtue of an outrush of fluid from the space through the passageway.

4. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, a

packer contracter movable upwardly within said housing to contract the packer radially about such work, there being a substantially horizontal inlet passageway for introducing fluid under pressure to a space within the housing and against the contracter in a manner to move it upwardly, an annular seat about the inlet passageway intermediate its ends and facing towards said space, a vertically extending recess opening at its upper end to said passageway between said space and the seat, and a ball stopper normally loosely mounted in said recess.

5. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, there being a space within the housing and an inlet for introducing fluid under pressure to said space, an increase in the fluid pressure within the space being effective to contract the packer radially about the work, and safety valve means adapted normally to permit flow of fluid through the inlet passageway to and from the space, said valve means being adapted to close the passageway by virtue of a sudden reduction of inlet pressure to prevent continued flow of fluid from the space through the inlet, said valve means embodying a seat in the passageway and facing the space, and a stopper normally loosely supported at one side of the passageway and between the space and seat, said stopper being free for bodily movement from its position of normal support onto said seat to close the passageway by virtue of an outrush of fluid from the space through the passageway, and means insuring free flow of fluid between the seat and the space should the valve stopper become lodged in the inlet passageway at a point removed from said seat.

6. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, there being a space within the housing and an inlet for introducing fluid under pressure to said space, an increase in the fluid pressure within the space being effective to contract the packer radially about the work, and a safety valve adapted normally to permit flow of fluid through the valve and inlet to and from said space, said valve being adapted to close and thereby shut off the inlet by virtue of a sudden reduction of inlet pressure to prevent continued flow of fluid from said space through the inlet, there being a port leading from said space for bleeding fluid therefrom to provide for subsequently opening the valve.

7. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, there being a space within the housing, a radially contractible packer in the space and adapted to encircle the work, there being a passageway extending upwardly through the wall of the housing from the bore of the housing below the packer to said space for introducing well fluid from beneath the packer to said space in a manner to contract the packer radially about the work, valve means for controlling fluid flow through said passageway, there being an inlet for introducing fluid under pressure to said space from an external source, and a safety valve adapted normally to permit flow of fluid through the safety valve and inlet to and from said space, said safety valve being adapted to close the inlet by virtue of a sudden reduction of inlet pressure

through said inlet to prevent continued flow of fluid flow from the space through said inlet.

8. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, a packer contractor movable upwardly within said housing to contract the packer radially about such work, means for introducing fluid under pressure to a space within the housing and against the contractor in a manner to move it upwardly, means for moving the contractor downwardly, there being a passageway in the contractor opening downwardly from said space to the housing bore below the packer, and a spring-loaded valve in said contractor-passageway adapted to open automatically when the pressure in the space exceeds a given value.

9. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, a packer contractor movable upwardly within said housing to contract the packer radially about such work, means for introducing fluid under pressure to a space within the housing and against the contractor in a manner to move it upwardly, means for moving the contractor downwardly, and an unloading valve acting automatically to open said space to the housing bore below the packer when the pressure in the space exceeds a given value.

10. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a tubular packer-contractor slidable vertically through the housing bore, the upper end of the housing bore being of a diameter to allow the contractor to be moved vertically therethrough during assembly and disassembly, a cap ring detachably secured in the housing bore at the upper end thereof and directly overlying the contractor, the inside diameter of the ring being at least as large as the maximum effective diameter of the upper end of the contractor bore, and the lower face of the ring being spaced above the upper end of the contractor whereby a chamber is vertically defined between that lower face and the upper end of the contractor, a packer mounting ring detachably secured to the cap ring, and a radially contractible packer suspended from said mounting ring and adapted to be taken in the bore of the contractor, said packer being movable vertically through the bore of the cap-ring into or out of the contractor-bore without detaching said cap or ring from the housing, during assembly or disassembly.

11. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a tubular packer-contractor slidable vertically through the housing bore, the upper end of the housing bore being of a diameter to allow the contractor to be moved vertically therethrough during assembly and disassembly, a cap ring detachably secured in the housing bore at the upper end thereof and directly overlying the contractor, the inside maximum effective diameter of the ring being at least as large as the diameter of the upper end of the contractor bore, and the lower face of the ring being spaced above the upper end of the contractor whereby a chamber is vertically defined above the contractor, a vertically adjustable stop carried by the cap ring and extending downwardly into said chamber to limit the upward movement of said

contractor, a packer mounting ring detachably secured to the cap ring, and a radially contractible packer suspended from said mounting ring and adapted to be taken in the bore of the contractor, said packer being movable vertically through the bore of the cap-ring into or out of the contractor-bore without detaching said cap ring from the housing, during assembly or disassembly.

12. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a packer-supporting member supported within the housing, a tubular radially contractible packer supported by said member, a bushing for the packer bore and supported by said member, and a packer contractor movable vertically through the housing bore, said bushing being characterized as a plurality of relatively rigid segments pivotally supported at their upper ends by said member, said segments embodying fingers adapted normally to hang vertically with their side edges in angularly spaced relation and being pivotally movable toward the housing-bore axis until their side edges engage one another to present, as an assembly, a closed ring, the outer faces of said fingers having projecting counterbalancing formations.

13. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a packer-supporting member supported within the housing, a tubular radially contractible packer supported by said member, a bushing for the packer bore and supported by said member, and a packer contractor movable vertically through the housing bore, said bushing being characterized as a plurality of relatively rigid segments pivotally supported at their upper ends by said member, said segments embodying fingers adapted normally to hang vertically with their side edges in angularly spaced relation and being pivotally movable toward the housing-bore axis until their side edges engage one another to present, as an assembly, a closed ring, and arcuate, convex formations on the outer faces of the fingers concentric with the pivotal axis of the segments and extending from a point near their upper ends to a point spaced above their lower ends.

14. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a packer-supporting member supported within the housing, a tubular radially contractible packer supported by said member, a bushing for the packer bore and supported by said member, and a packer contractor movable vertically through the housing bore, said bushing being characterized as a plurality of relatively rigid segments pivotally supported at their upper ends by said member, said segments embodying fingers adapted normally to hang vertically with their side edges in angularly spaced relation and being pivotally movable toward the housing-bore axis until their side edges engage one another to present, as an assembly, a closed ring, arcuate, convex formations on the outer faces of the fingers concentric with the pivotal axis of the segments and extending from a point near their upper ends to a point spaced above their lower ends, and a relatively rigid ring at the upper end of the packer having a concave arcuate face concentric with said pivotal axis and over which said convex formations are adapted to pass during pivotal movement of the fingers.

15. In a packing head for well pipe, a vertically arranged tubular housing adapted to take

elongated work through its bore, an annular packer-supporting member coaxial with and supported within the housing, a tubular radially contractible packer coaxial with and supported by said member, a bushing for the packer bore and supported by said member, and a packer contractor movable vertically through the housing bore, said bushing being characterized as a radially contractible sleeve of resilient material having its lower end-face exposed; a relatively rigid ring secured to the upper end of the sleeve, said ring being mountable in the bore of the annular member, and releasable means for holding the ring against longitudinal displacement through the bore of the annular member.

16. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer sleeve in the housing and adapted to encircle the work, means supporting the upper end of the packer sleeve from the housing, angularly spaced, relatively rigid inserts carried at the lower end of the packer sleeve and having surfaces exteriorly exposed, each of said inserts having two such exposed surfaces, one facing toward the bore of the sleeve and the other facing toward the outer periphery of the sleeve, and a packer contractor movable upwardly within the housing against the lower end of the packer sleeve and against the inserts to contract said packer sleeve radially.

17. In a packing head for well pipe, a vertically arranged tubular housing adapted to take elongated work through its bore, a tubular, radially contractible packer coaxial with and within the housing, an annular supporting member supported within the housing, a radially contractible bushing, of resilient material, for the packer bore, and means releasably holding the bushing against longitudinal displacement through the packer bore, said means embodying a relatively rigid ring secured to the bushing at its upper end, the downward face of its lower end being exposed, and a releasable lock between said supporting member and ring.

18. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, a radially contractible packer in the housing and adapted to encircle the work, there being a space within the housing and an inlet for introducing fluid under pressure to said space, an increase in the fluid pressure within the space being effective to contract the packer radially about the work, a safety valve adapted normally to permit flow of fluid through the valve and inlet to and from said space, said valve being adapted to close and thereby shut off the inlet by virtue of a sudden reduction of inlet pressure to prevent continued flow of fluid from said space through the inlet, there being a port leading from said space for bleeding fluid therefrom to provide for subsequently opening the valve, and manually controlled valve means for controlling fluid flow through said port.

19. In a packing head for well pipe, a tubular housing adapted to take elongated work through its bore, there being a space within the

housing, a radially contractible packer in the space and adapted to encircle the work, there being a passageway extending from the bore of the housing below the packer to said space for introducing well fluid from beneath the packer to said space in a manner to contract the packer radially about the work, a check valve in said passageway for checking reverse flow there-through, there being an inlet for introducing fluid under pressure to said space from an external source, and a safety valve adapted normally to permit flow of fluid through the safety valve and inlet to and from said space, said safety valve being adapted to close the inlet by virtue of a sudden reduction of inlet pressure through said inlet to prevent continued flow of fluid flow from the space through said inlet.

20. In a packing head for well pipe, a vertically arranged tubular housing adapted to take elongated work through its bore, a tubular packer coaxial with and within the housing, an annular supporting member supported by the housing, a bushing for the packer bore and having a rigid ring-portion at its upper end, said portion being adapted to be taken within the bore of the annular supporting member, there being an annular recess in the bore-wall of the supporting member, a resilient, split locking ring carried by the ring portion and having an inherent spring tendency to contract radially toward release position, said locking ring lying in the plane of and being adapted to be radially expanded into the recess and thus into locking position when the bushing is in operative position within the packer bore, and an actuating member carried by the ring-portion and coacting with the locking ring, said actuating member being movable to radially expand the locking ring into said recess.

21. In a packing head for well pipe, a vertically arranged tubular housing adapted to take elongated work through its bore, a tubular packer coaxial with and within the housing, an annular supporting member supported by the housing, a bushing for the packer bore and having a rigid ring-portion at its upper end, said portion being adapted to be taken within the bore of the annular supporting member, there being an annular recess in the bore-wall of the supporting member, a resilient, split locking ring carried by the ring portion and having an inherent spring tendency to contract radially toward release position, said locking ring lying in the plane of and being adapted to be radially expanded into the recess and thus into locking position when the bushing is in operative position within the packer bore, the bore of the locking ring tapering inwardly and downwardly, a downwardly and inwardly inclining cone carried by the ring-portion and threadably movable axially thereof and through the bore of the locking ring, said cone member being of a diameter to spread the locking ring radially into said recess when the cone is moved axially to a given position within the locking ring bore while the bushing is in operative position.

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