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RELIEF DEVICE FOR TUBING PRESSURE

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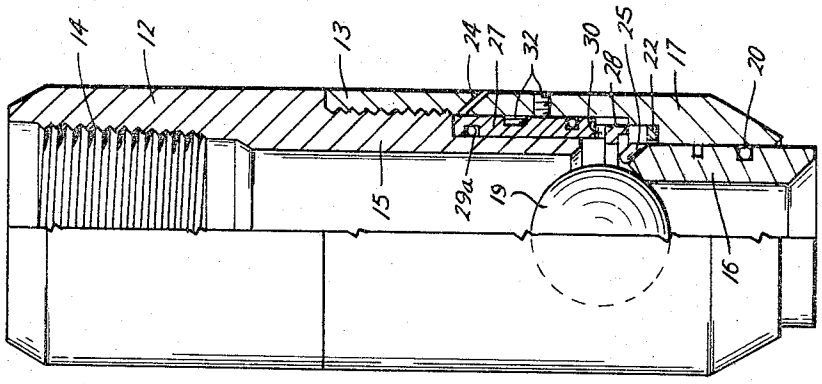

Fig. 3

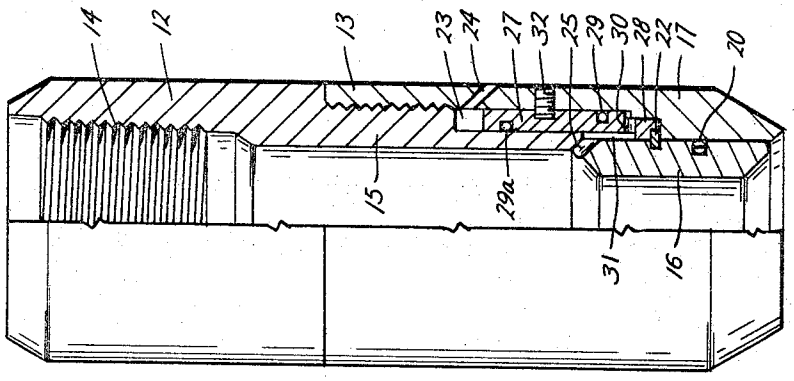

Fig. 2

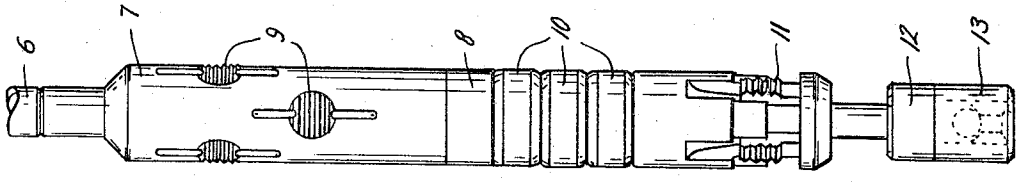

Fig. 1

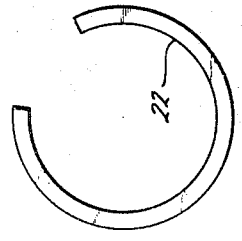

Fig. 4

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RELIEF DEVICE FOR TUBING PRESSURE

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This invention relates to tubing pressure retaining and relief devices for holding tubing pressure as in setting a hydraulic packer or for testing tubing in place, and then releasing the pressure to permit the tubing to function normally.

Where a tubing string is provided with a hydraulic packer or slip, it is conventional to releasably mount a valve seat in the tubing beneath the packer, as by means of a shear pin. When it is desired to set the packer, a check valve is dropped through the tubing and lodges against the seat as a closure. Pressure is then applied sufficiently to set the hydraulic packer or packers. The shear pin which holds the closure valve in position is adapted to shear at a predetermined pressure in excess of that required to set the hydraulic packer, creating a surge of pressure in the well fluid. This external surge may be sufficient to counteract the internal tubing pressure and unseat the hydraulic slips.

Consequently, an object of the present invention is to provide a closure device for tubing for temporarily subjecting the tubing to high internal pressure and which will avoid the application of a pressure surge to the ambient well fluid upon opening or removal of the closure device.

Another object is to provide a closure device for tubing which does not yield during an initial application of pressure thereto, for instance, sufficient to set a hydraulic packer, but which will yield or open easily after the internal pressure has been released.

In accordance with the present invention, there is provided a housing which may be incorporated axially in a tubing string and which has an annular valve seat received therein. The valve seat is normally held in fixed position within the housing by means of a resiliently expansible split locking ring which is held in its latching position by a keeper sleeve which, in turn, is secured in its latching position by a shear pin. The keeper sleeve is movably received in an annular chamber within the housing which is exposed to the internal tubing pressure upstream of the valve seat in such a way that when a valve is on the seat, tubing pressure will cause retraction of the keeper sleeve, breaking the shear pin. Thereafter, the valve seat will remain fixed in the housing as long as sufficient pressure is applied against the ball valve to prevent the locking ring from expanding. When this tubing pressure is released, the locking ring is permitted to expand and thereafter the seat and ball valve will simply drop out or may be dislodged by relatively slight pressure.

In the accompanying drawings which illustrate the invention:

FIG. 1 is an elevation of the novel closure device assembled with a mechanical packer and hydraulic and mechanical slips for oil well tubing;

FIG. 2 is an enlarged elevation and center longitudinal section showing the novel pressure retaining and relief device in its normal position with the valve seat locked;

FIG. 3 is a view similar to FIG. 2, but showing the valve seat unlocked; and

FIG. 4 is a top plan view of the lock ring employed in the closure device.

FIG. 1 shows the lower end of a tubing string **6** having a more or less conventional packer attached thereto, including an upper hydraulic slip portion **7** and a lower mechanical portion **8**. Upper portion **7** has a plurality

of radial plungers **9** which may be hydraulically impelled outwardly to grip the casing wall by means of hydraulic pressure within the tubing. Packer part **8** has a series of packer rings **10** of suitable resilient material which are caused to swell radially to grip the casing wall and seal off the well annulus upon the application of axial forces to the packer. At **11** are shown wedge actuated slips **11**.

Secured to the lower end of the packer assembly is the novel pressure retaining and relief device including upper and lower threadedly assembled housing parts **12** and **13**, upper part **12** having an internal thread **14** for attachment to a mating thread at the lower end of the packer assembly. Upper housing member **12** telescopes through lower housing part **13**, as at **15**, and at its lower end abuts the annular valve seat member **16** which is closely but slidably received in the thickened lower portion **17** of lower housing part **13**. The upper end of valve seat member **16** is tapered, as at **18**, for seating the ball check valve **19**, shown in FIG. 3. An O-ring seal **20** is provided between the valve seat member and the lower housing part **17**. An annular groove on the outer surface of member **16** serves to receive the split locking ring **22** in the locked position of the parts.

The lower portion of housing portion **15** and the intermediate portion of lower housing member **13** are, respectively, externally and internally recessed to form a continuous annular chamber **23** within the housing. The upper part of this chamber communicates through one or more relief ducts **24** with the well annulus outside of the device. The lower part of chamber **23** communicates with the interior of the housing above seat member **16** through one or more recesses **25** formed in the upper edge of seat member **16**.

A keeper sleeve **27** is slidably received within compartment **23** and capable of upward movement therein from the latching position shown in FIG. 2 to the unlatched position of FIG. 3. O-ring seals **29** and **29***a* are provided between the engaging surfaces of sleeve **27** and casing parts **12** and **13**. At the lower end of sleeve **27** is a counterbored part **28** which, in the latching position as in FIG. 2, fits over locking ring **22** and restrains the same in its locking position with respect to valve seat member **16**. Just above counterbored part **28**, the keeper sleeve is provided with one or more radial recesses **30** which, in the normal assembly, connect through an annular groove **31** between seat member **16** and the keeper sleeve and recesses **25** in the top of the seat member with the interior of the housing. Sleeve **27** is normally maintained in its restraining position with respect to locking ring **22** by a shear pin **32**.

In operation, the parts are normally assembled as shown in FIG. 2, with annular valve seat member **16** firmly locked in position by means of resilient ring **22** which is restrained in its locking position by keeper sleeve **27**, in turn maintained in its restraining position by shear pin **32**. If it is desired to apply hydraulic pressure to the interior of the tubing—for instance, to set hydraulic slips **9**—or to test the tubing, or for any other reason, a suitable check valve—for instance, the ball check **19**—is dropped through the tubing and rests against annular seat member **16** to close off the tubing at this point. Next, the fluid within the tubing and interior of the housing is subjected to the desired hydraulic pressure. The only limitation upon the pressure, which can be so applied, is the strength of the tubing and of locking ring **22**. The internal hydraulic pressure within the tubing is applied through recesses **25** and **31** to the downwardly facing surface of keeper sleeve **27** formed immediately above radial recess or recesses **30** therein. Since the space in chamber **23** above the keeper sleeve is exposed to ambient well pressure through ducts **24**, the differential applied to the keeper ultimately will break shear pin **32** and elevate the keeper sleeve clear of

locking ring **22**. However, the locking ring will not expand as long as pressure is applied to the closure valve, due to the frictional gripping of spring ring **22** by the valve seat member. As soon as the internal tubing pressure is bled off or otherwise relieved, locking ring **22** will spring outwardly due to its inherent resilience. Thereafter, valve seat member **16** and the valve will drop out of the housing or may be easily expressed so that the tubing may be used for its intended purpose.

Thus, the required hydraulic pressure may be applied internally of the tubing and then released without materially affecting the normal functioning of the tubing or the ambient pressure. Various details may be modified as will occur to those skilled in the art, and the exclusive use of all modifications as come within the scope of the appended claims is contemplated.

We claim:

1. A pressure retaining and relief device for tubing comprising a housing for incorporation in tubing in alignment therewith, closure means movably mounted inside said housing, said housing defining a chamber in fluid communication with fluid pressures on opposite sides of said closure means, a locking member movable between positions, respectively, for locking said closure means in its housing closing position and releasing said means, said member being normally biased toward its closure means releasing position and extending into said chamber, a control device movable in said chamber between positions, respectively, for holding said locking member in a closure means locking position and for releasing said locking member, and means releasably retaining said control device in its locking member holding position, said control device responding to pressure differential across said closure member above a predetermined minimum value to move to its locking member release position, said closure means responding to said pressure differential to hold said locking member in its closure means locking position and responding to substantial equalization of pressures across said closure means to release said locking member and thereby permit movement of said closure means to a housing opening position.

2. A pressure retaining and relief device as described in claim **1** in which said means for normally retaining said control device in its locking member holding position is a pressure sensitive shear pin.

3. A pressure retaining and relief device as described in claim **1** in which said closure means is comprised of an annular valve seat normally secured in said housing by said locking member and a check valve which may be applied against said seat for closing the same.

4. A pressure retaining and relief device for tubing as described in claim **1** in which said closure means includes an annular recess and said locking member is comprised of a split, resilient ring normally held in said recess by said control device and shiftable by its inherent resilience to release said closure means after movement of said control device to its locking member release position and substantial equalization of pressures across said closure means.

5. A pressure retaining and release device as described in claim **1** in which said chamber is formed in the wall of said housing and further including ports connecting portions of said chamber on opposite sides of said control device, respectively, with the interior and exterior of said housing.

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