This invention relates generally to well devices of the character commonly known as cement retai-
ners by reason of their predominant use in the cementing of oil wells but which are also utilized
as well packers for various other purposes.

Various specific forms of cement retainers or
packers have heretofore been employed to pack
off selected elevations between a run-in string
of tubing and a well casing to confine the flow of
cement, fluid or gas pumped down the run-in
string and through the retainer or packer. It
has been a general practice to incorporate in such
devices a back-pressure valve normally restrained
in an open position by a trip means and to employ
a trip ball sent down the run-in string to block
the flow passage of the device for the purpose of
building up a pressure therein sufficient to set
the device and effect a release of the back-pressure
ball which thereafter prevents a return flow of
cement, fluid or gas into the set device.

To extend the range of uses of a device of this
general character, it is very desirable that up-
ward flow through the device be permitted after
it is set in position in the well casing and before
the back-pressure valve is rendered effective to
arrest such upward flow, and to subsequently re-
lease said valve at will, thus it becomes the prin-
cipal object of the present invention to provide
a device of the general character referred to in
which provisions are made for setting the device
in a desired position in a well casing, without
releasing the open back-pressure valve, so as to
permit circulation through the set device in either
direction, and in which a separate means is pro-
vided for subsequently releasing said valve.

In general, the device is tubular in character
and is adapted to be run-in a well casing at the
lower end of a string of tubing by which it may
be manipulated by an operator at the derrick
floor, and it includes in its structure operable
slips for anchoring the device firmly in the sur-
rounding casing at a desired location, an expan-
sible packing means or sealing element for seal-
ign off the annular space between the exterior of
the device and the wall of the casing, the slips
and the packing means being operated by fluid
pressure and by manipulation of the run-in
string, and a back-pressure valve normally held
in open position and releasable at will by an in-
dependent means sent down the run-in string
by the operator.

One form of embodiment of the invention is
exemplified in the following description and illus-
trated by way of example in the accompanying
drawing, in which:

Fig. 1 is a longitudinal section through a por-
tion of a well casing and through the device of
the present invention with the parts in the posi-
tions they assume when the device is being run
in the casing.

Fig. 2 is a view similar to the lower portion
of Fig. 1, but showing the device anchored in the
casing, and illustrating the discharge of the trip-
ing means from the set device.

Fig. 3 is an elevation of the device as con-
structed to include a tail pipe.

The device shown in the drawing is, insofar
as the body and its run-in string, the packing
and slip mechanisms, and the restraining and re-
lease means for the back-pressure valve are con-
cerned, of the type disclosed in United States
Letters Patent No. 2,121,051, issued June 21, 1936,
to Clarence E. Burt and Thomas M. Ragan, to
which Letters Patent reference may be had for
a more complete description of these portions of
the present device.

The device A, in the condition shown in Fig. 1,
will be lowered into the well casing B by a run-in
string C having a screw-threaded lower end which
engages in the upper screw-threaded end of the
axial flow passage of the tubular body member 16,
said screw-threads being preferably left-hand
threads of square form. The body member 10
has an upper abutment collar 11, and an en-
larged lower end providing a lower annular abut-
ment shoulder 12 and having secured thereto a
body member 13 providing a valve chamber 14.

A sleeve packing 15, formed of rubber or other
suitable pliable material, surrounds the medial
portion of the body member 10 and is connected
at its lower end to a lower cone 16 which slide-
ably fits said body, while its upper end is connected
to an upper cone 17 likewise slideably fitting said
body. Normally these cones 16 and 17 are con-
ected to the body 10 by shear pins 18 and 19,
respectively, the pins 18 of the lower cone having
a greater shear value than the pins 19 of the
upper cone so that a lesser pressure is required to
release the upper cone than that required to re-
lease the lower cone. One or more lateral ports
20 direct fluid under pressure from the bore of
the body 10 to in back of the packing sleeve 15 to ex-
pand the same.

"Up-pressure" slips 21 are normally connected
to the body 10 by shear pins 22 and "down-
pressure" slips 23 are normally connected to the
body by shear pins 24 and to the lower cone 16
by shear pins 25.

It will be noted that the interior bore of the
upper cone 17 has formed therein an annular
groove 26 which receives a ratchet latch 27 in the form of a split contractile ring, tooth-shape in cross-section and adapted to engage annular serrations forming the exterior of the body 10. A series of ratchet teeth 28, said teeth and latch forming a one-way ratchet means which will retain the upper cone latched to the body in operational position.

At the lower end of the bore of the body member 10 is an annular valve seat 30 disposed in the valve chamber 14 is a buoyant back-pressure valve ball 31 adapted to cooperate with said seat when released, but normally held to one side of said chamber in open position, as shown in the drawing, by an upwardly extending arm 32 of a tubular valve restraining means comprising a sleeve 33 which is slidable mounted in the lower end of the bore of the body member 10 but normally held stationary by a shear pin 34, and which is formed to provide an internal annular valve seat 35. By thus holding the back-pressure valve open, the device may be run-in the casing and moved up or down therein without causing a swabbing action.

On the lower end of the body member 10a is attached, preferably by screw-thread, a body member 10b having an axial bore of an internal diameter larger than the exterior diameter of the valve restraining sleeve 33, and slidably fitting is said axial bore is a sleeve member 36 which is normally held stationary therein by a shear pin 37 and which is formed to provide an annular seat 38 which is somewhat smaller in diameter than is the similar seat 35 of the sleeve 33.

In practice, the packing device is conditioned as shown in Fig. 1 and is lowered into the well casing to a position of use. A trip ball 39 is then inserted in the run-in string C to travel downwardly through said string and the fluid passage of the device, past the retracted back-pressure valve 31 and through the bore of the restraining sleeve 33, to engage the seat 35 of the trip sleeve 35 and thus close the lower end of the fluid passage, it being preferable to establish the circulation immediately after inserting the trip ball in the run-in string so that said ball will more quickly reach its seat.

As soon as the trip ball 39 seats to close the fluid passage, fluid pressure will be built up in the run-in string and in said fluid passage and becomes effective through the lateral ports 20, to expand and engage the packing sleeve 15 and shear the pins 19 of the upper cone 17, moving said cone upwardly with sufficient force to shear the pins 22 of the upper slips 21. With the shearing of the slip pins 22 said upper slips will engage the abutment collar 14 and, by reason of the co-engaging angled surfaces of the cone and sleeve lower slips and the lower end of the packing sleeve relative to the now stationary upper end of the packing sleeve, so as to compress said packing sleeve 15 into sealing condition against the casing wall until it will compress no further, whereupon continued relative movement, will shear the pins 18 of the lower cone 16, causing the abutment shoulder 12 to engage the lower slips 23, and then shear the pins 24 and 25 and move said lower slips upwardly and outwardly into gripping engagement with the casing wall.

The device being thus properly set in the well casing, the fluid pressure will be built up to a degree sufficient to shear the pin 22 and eject the sleeve 36 and trip ball 39 from the device (as illustrated in Fig. 2). This condition the device in such a position to permit flow through its fluid passage in either direction and to permit its employment in various situations where such open flow passage in a set packer is desirable or necessary.

When it is desired to release the normally restrained back-pressure ball 31, a valve-release ball 40 (indicated in dotted lines in Fig. 2) is inserted in the run-in string C and pumped down to engage the seat 35 of the restraining sleeve 33 to close the fluid passage at this point, with the result that a build-up of pressure above this closure will shear the pin 34 and eject from the set device said restraining sleeve 33 and the ball 40, thus removing the ball restraining arm 32 and releasing the back-pressure valve 31 for cooperation with its seat 38.

The device is thus provided with a primary trip means for effecting a setting of the packer and a secondary trip means for effecting a release of the normally restrained back-pressure valve.

In instances where it may be desired to convert the set device into a bridge plug, this may be done at any time by inserting into the run-in string a bridging ball 41 which will travel downwardly to engage an internal annular seat 42 formed in the fluid passage of the device above the lateral ports 20 (as indicated in dotted lines in Fig. 2), and thus effectively bridge said fluid passage.

For some uses it may be desirable to provide the packer with a tail pipe for the purpose of insuring a fluid discharge at an appreciable distance below the set packer and for such purpose the body member 10b together with its contained trip sleeve 36 and shear pin 37 will be attached to the lower end of a tail pipe 43, instead of directly to the body member 10a as previously described, and the upper end of said tail pipe will be connected to the lower end of the body member 10a by a pipe coupling 44, as shown in Fig. 3.

In its use as a cement retainer, the device will be run-in the well casing to the desired point, drilling fluid present in the well passing into the normally open fluid passage and the run-in string. If the operator is of the opinion that the well is in condition for cementing, he may proceed to set the retainer by first inserting the trip ball 39 in the cementing string and establish the circulation, the resulting increase of pressure within the closed fluid passage expanding the packing and setting the upper slips, and then stopping the circulating pumps and manipulating the run-in string to compress the packing and set the lower slips, in the manner previously described. However, it is often considered better practice to circulate for a time before the trip ball is inserted, to render it more certain that the well is reasonably clear of drilling detritus, settled mud or other undesirable substances, such clear condition being indicated by the character of the return circulation.

With the retainer or packer properly set in the well casing, the circulation will be re-established to build up a pressure sufficient to shear the pin 34 and eject the trip sleeve 36 and trip ball 39 from the set device, leaving it in the condition shown in Fig. 2.

In this set condition of the device, its flow passage is again open to permit flow of fluid there-through in either direction, this offering the valuable opportunity of swabbing through the run-
in string for the purpose of removing the mud sheath off the face of the formation to be cemented.

After such swabbing operation, or after the setting of the retainer, if such swabbing is considered undesirable or unnecessary, the valve-release ball 40 will be inserted into the run-in string and pumped down to engage its seat 35 in the valve-release sleeve 33 and again cause a pressure build-up in the fluid passage such as will shear the pin 24 and eject said sleeve and ball from the retainer through the larger bores of the lower end of the body member 102, and thus release the back-pressure ball 31 from the restraint of the upright arm 32 of the sleeve 33.

Cement slurry may then be pumped down the run-in or cementing string and through the flow passage past the released back-pressure valve to discharge in the well casing below the set retainer, the back-pressure valve functioning to prevent a reverse flow of the cement.

Off the interests of it is desired to conduct a second cementing operation above the set retainer, in the accomplishment of what is sometimes referred to as stage or series cementing, the retainer may be converted into a bridge plug by inserting into the cementing string the bridging ball 41 which will engage the seat 42 in the flow passage of the set retainer which then establishes a complete seal in the casing. A cementing operation above this bridge plug will be conducted by first disconnecting the cementing string from the set device and elevating it from engagement therewith, after which a batch of cement slurry will be pumped down the disconnected cementing string or down the casing itself to discharge through perforations or ports formed in the casing wall above the bridge plug.

Since the device may be set in a well casing at any desired elevation, in the condition shown in Fig. 2 and with the back-pressure ball restrained in inactive position, it may be effectively employed as a production packer, in which use production from an oil sand below the set packer 24 will flow up the run-in string. As a production packer, this arrangement swabbing through the run-in string and the set packer whenever such swabbing is necessary or desirable.

An advantage of the method described is that the use of an oil sand, an exhausted well, which taps said sand is selected and the packer set therein just above the perforated section of the well casing. Pumping of gas into the casing below the set packer will force the gas into the oil sand and create therein a gas pressure sufficient to drive additional oil into adjacent wells from which it may be pumped to the surface.

As the device may, with the use of the bridging ball 41, be used purely as a bridge packing to seal heretofore, the well casing at any point above bottom, it may be employed to effect a complete shut off of high pressure gas below a producing oil sand.

While I have disclosed a preferred form of my invention, it is to be understood that various changes may be made therein by those skilled in the art without departing from the spirit of the invention as defined in the appended claims.

Having thus described my invention, what I claim is:

1. A well packing device comprising a packer body having a longitudinal flow passage, normally ineffective anchoring means for said body, packing means for said body capable of being expanded by fluid pressure built up in said passage to actuate said anchoring means, a primary trip valve means for closing said flow passage to enable a pressure rise therein to actuate said packing means and render said anchoring means effective to anchor said device in a well casing, said trip valve means capable of being thereby actuated to reopen said fluid passage and permit fluid flow therethrough in either direction, a back-pressure valve, retaining means for maintaining said back pressure valve in ineffective position, and a secondary trip valve means for closing said fluid passage to enable a pressure rise therein to actuate said packing means and render said anchoring means effective to anchor said device in a well casing, said trip valve means capable of being subsequently actuated to permit downward discharge of fluid from said fluid passage.

2. A well packing device comprising a packer body having a longitudinal flow passage, normally ineffective anchoring means for said body, packing means for said body capable of being expanded by fluid pressure built up in said passage to actuate said anchoring means, a primary trip valve means for closing said flow passage to enable a pressure rise therein to actuate said packing means and render said anchoring means effective to anchor said device in a well casing, said trip valve means capable of being thereafter actuated to reopen said fluid passage and permit fluid flow therethrough in either direction, a back-pressure valve, retaining means for maintaining said back pressure valve in ineffective position, and a secondary trip valve means for again closing said fluid passage to enable a pressure rise therein to actuate said retaining means and release said back pressure valve and permit it to function to prevent upward flow of fluid through said fluid passage, said secondary trip valve means capable of being subsequently hydraulically ejected from the fluid passage to permit downward discharge of fluid from said fluid passage.

3. An apparatus of the character described comprising a member having a longitudinal fluid passage and adapted to be secured to the lower end of a string of tubing and lowered into a well casing, slips mounted on said member, means capable of being released connecting said slips to said member and maintaining them in an ineffective position, a packing mounted on said member capable of being hydraulically actuated to release said means and thereby release said slips so that they may move to an effective position, a primary trip valve means for closing said fluid passage to enable a pressure rise therein to actuate said packing, said trip valve means capable of being thereafter actuated to reopen said fluid passage and permit fluid flow therethrough in either direction, a back-pressure valve, retaining means for maintaining said back-pressure valve in ineffective position, and a secondary trip valve means for again closing said fluid passage to enable a pressure rise therein to actuate said retaining means and release said back-pressure valve and permit it to function to prevent upward flow of fluid through said fluid passage, said secondary trip valve means capable of being subsequently actuated to permit downward discharge of fluid from said fluid passage.

4. A well packing device comprising a packer body adapted to be connected to a tubing string and lowered into a well, said body having a longitudinal flow passage formed to provide a back-
pressure valve seat, packing means capable of being expanded by fluid pressure built up in said passage, a primary valve seat member slidably fitting in said passage and disposed below said back-pressure valve seat, a first securing means capable of being disabled normally maintaining said seat member fixed in said passage, a back-pressure valve adapted to engage said back-pressure valve seat, retaining means normally maintaining said back-pressure in ineffective position and including a secondary valve seat member slidably fitting in said passage between said primary seat member and said back-pressure valve, a second securing means capable of being disabled normally maintaining said secondary seat member and retaining means fixed in said passage, a primary trip valve adapted to be sent down said tubing string and capable of traveling past the retained back pressure valve and through said secondary seat member to engage said primary seat member and close said flow passage to enable a pressure rise therein sufficient to disable said second securing means and eject from said passage the secondary trip valve and the secondary seat member and its back-pressure retaining means to release said back-pressure valve and permit it to function to prevent upward flow of fluid through said flow passage.

5. A well packing device comprising a packer body having a flow passage, normally ineffective means carried by said body for engagement with a well casing, fluid operated means for moving said means into engagement with said casing, means for restricting fluid flow through said passage to cause a rise in the pressure of the fluid therein and its actuation of said fluid operated means, means for supporting said restricting means with respect to said body in a manner permitting its subsequent actuation to produce opening of said passage and allow free flow of fluid therethrough in either direction, a one-way valve for preventing fluid flow through said passage in one direction, means in said passage for retaining said valve in ineffective position, including instrumentalities adapted to restrict fluid flow through said passage to cause a rise of pressure therein, and means supporting said retainer means in a manner permitting its actuation to release said one-way valve.

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