

July 8, 1969

C. C. BROWN

3,454,089

BRIDGING PLUG WITH PRESSURE RELIEF MEANS AND MANDREL LATCH

Filed Feb. 2, 1968

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Fig. 1

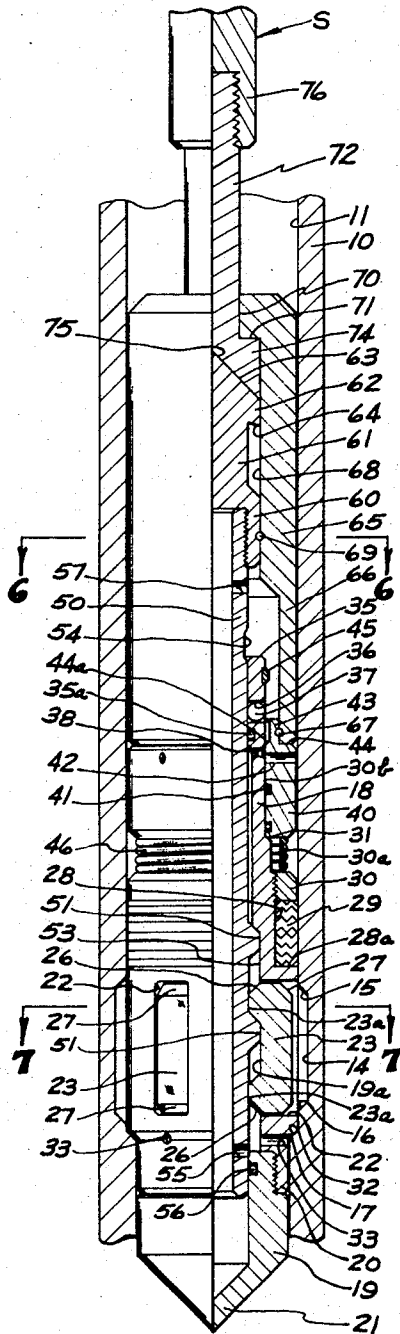
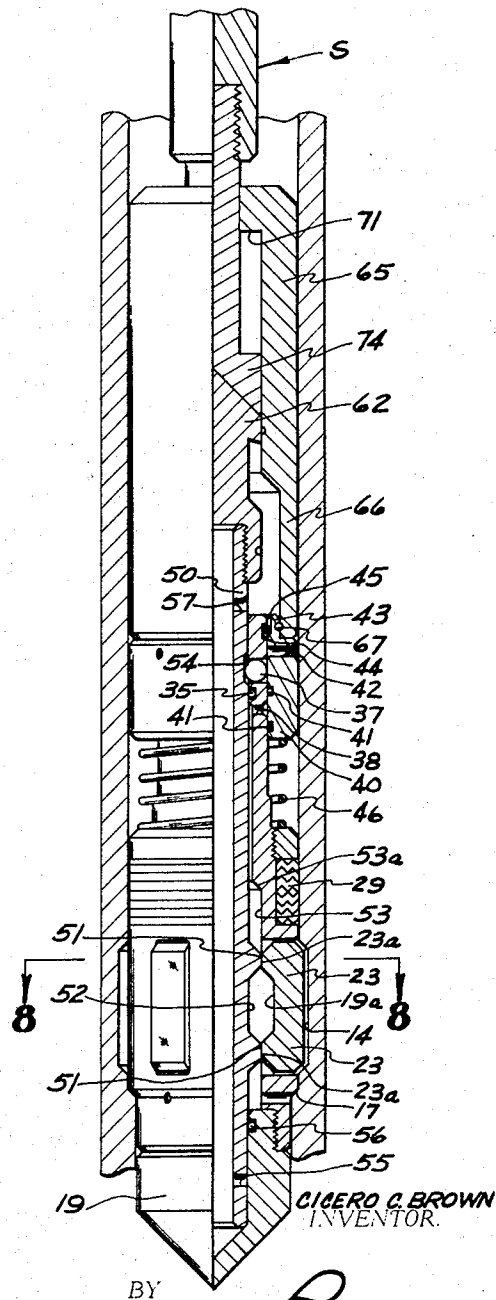


Fig. 2



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Fig. 3

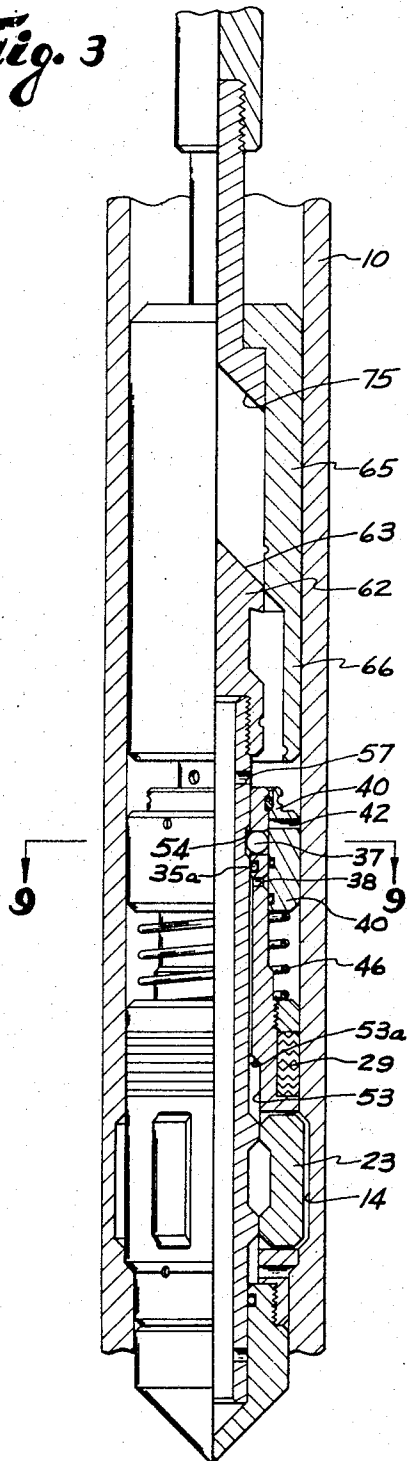
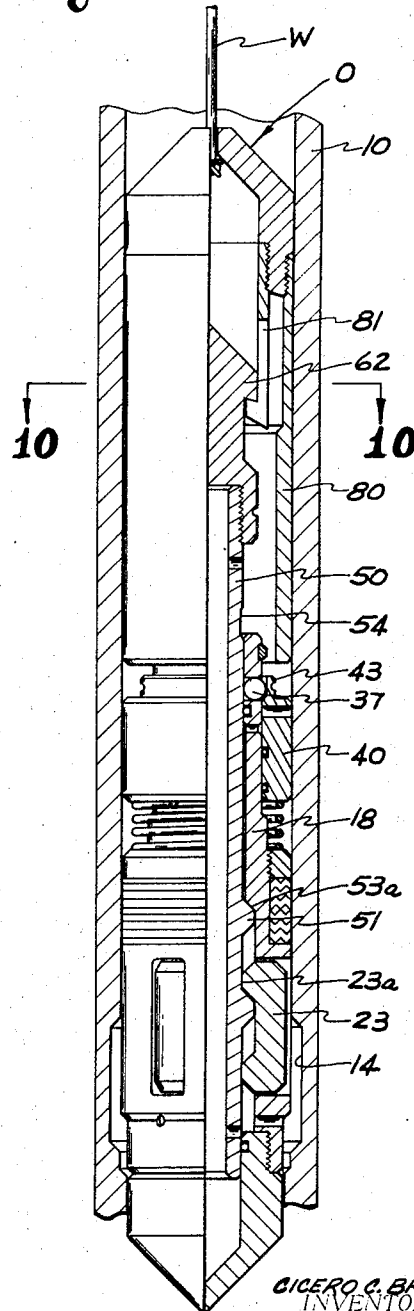


Fig. 5



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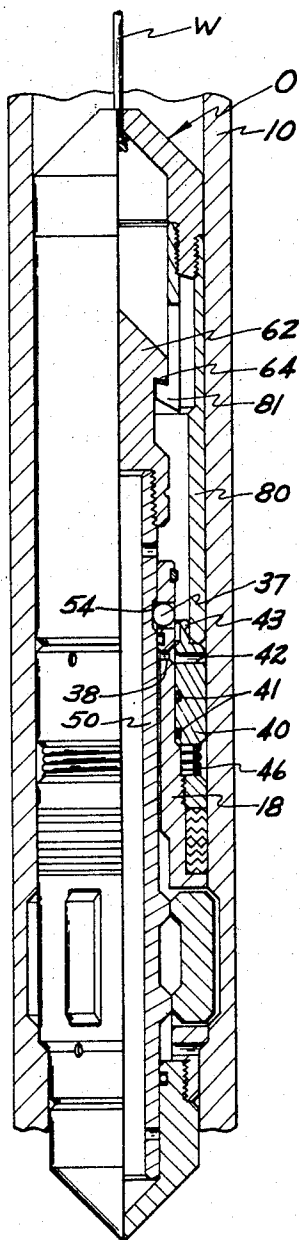
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Fig. 4



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Fig. 6

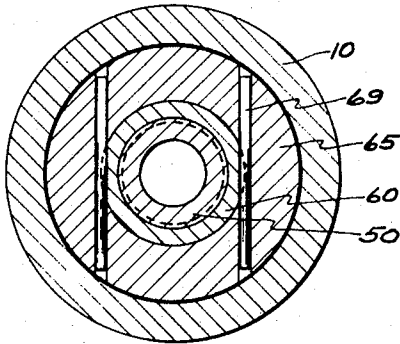


Fig. 9

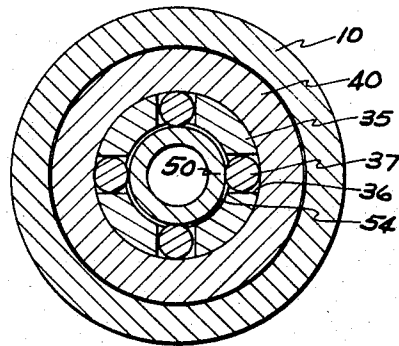


Fig. 7

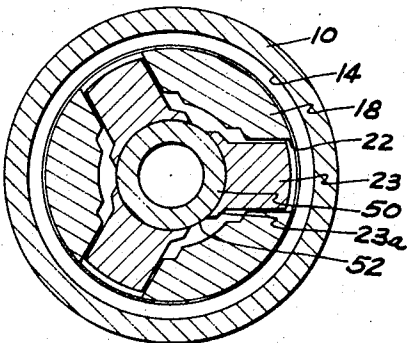


Fig. 10

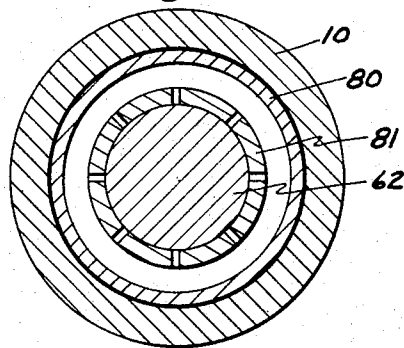
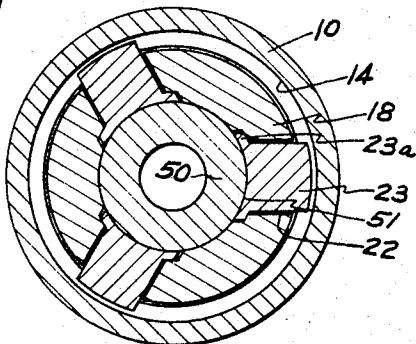


Fig. 8



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3,454,089
**BRIDGING PLUG WITH PRESSURE RELIEF
MEANS AND MANDREL LATCH**

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U.S. Cl. 166—128

7 Claims

ABSTRACT OF THE DISCLOSURE

A bridging plug for well pipes employing a hollow plug body carrying radially movable dogs for anchoring the plug in a well pipe, a mandrel axially movable in the body for actuating and releasing the anchor dogs, pressure relief valve means for balancing pressure across the device prior to release, and latch means operable by cooperating movements of the mandrel and the valve means to releasably lock the mandrel in the dog-actuating position.

Bridging plugs are commonly employed in the petroleum industry for plugging off the bore of well pipes, usually the production tubing string, for various purposes generally connected with repair or work-over operations. Some plugs are designed to be permanently installed, but usually they are of the type which are designed to be retrieved when the purpose for which the plug has been installed has been accomplished.

Retrievable type plugs generally employ some form of releasable anchoring device by which the plug may be secured to the well pipe and which may then be released to enable the plug to be withdrawn. One of the problems encountered with plugs heretofore employed is in holding the anchor elements in anchored position under pressure surges and vibrations commonly encountered in operations with which the plugs are employed. Such surges and vibrations tend to cause release of the anchor-holding elements, causing premature release of the plug with attendant difficulties. Also, it is necessary to relieve the fluid pressure usually trapped in the plug in order to balance the pressures across the plug to enable the anchor elements to be released, so that the plug may be retrieved.

The present invention is directed to improvements in bridging plugs of the general type disclosed in my prior Patent No. 2,953,206.

The present invention has for its principal objects the provision of a bridging plug design which is compact, relatively simple in construction and operation; obviates the difficulties encountered with more conventional designs; and is especially adapted to be run and retrieved with wire line strings of tools.

A suitable and useful form of bridging plug in accordance with one embodiment of this invention contemplates a tubular plug body closed at its lower end, and carrying a plurality of radially movable anchor dogs for anchoring the body to the well pipe in which it is run. Seal means is mounted about the body above the anchor dogs for sealing between the plug body and the well pipe. A tubular mandrel is slidably disposed in the plug body for limited reciprocating movements to actuate and release the anchor dogs. Fluid circulation passages are provided in the body above and below the seal means, a sleeve valve means is slidably disposed about the body above the seal means for opening and closing the upper circulation passage to block or permit bypassing of fluid around the seal means. A latch means, operated by cooperating axial movements of the mandrel and sleeve valve means, is provided to secure the mandrel in the down or inward

position in the body to hold the anchor elements in anchoring position and to thereafter release the same. The mandrel sleeve valve means are actuated in effecting the plug setting and releasing movements by means of wire line suspended tools.

Various other objects and advantages of this invention will become more readily apparent from the following detailed description when read in conjunction with the accompanying drawing which illustrates one useful embodiment in accordance with this invention.

In the drawing:

FIG. 1 is a longitudinal, partly sectional view of the bridging plug showing the parts in the positions occupied when being run into pipe string, the plug being shown carried in on a setting tool;

FIG. 2 is a view similar to FIG. 1 showing the parts in anchored or set position;

FIG. 3 is a view similar to FIG. 2, showing the setting tool being withdrawn after release from the plug;

FIG. 4 is a view similar to FIG. 2 showing a wire line-operated overshot connected to the plug preparatory to effecting its release;

FIG. 5 is a view similar to FIG. 4, showing the plug in released condition, the parts thereof being returned to the positions initially occupied in FIG. 1;

FIGS. 6 and 7 are cross-sectional views taken, respectively, along lines 6—6 and 7—7 of FIG. 1;

FIG. 8 is a cross-sectional view taken along line 8—8 of FIG. 2;

FIG. 9 is a cross-sectional view taken along line 9—9 of FIG. 3; and

FIG. 10 is a cross-sectional view taken along line 10—10 of FIG. 5.

A setting nipple 10 having a central bore 11 is adapted to be installed in and to form a part of a tubing string (not shown) into which the bridging plug is to be run. The nipple is provided at a point intermediate its ends with an annular recess 14 having upwardly and downwardly bevelled upper and lower end walls 15 and 16, respectively, defining longitudinally spaced, inclined shoulders. The bore wall of nipple 10 is also provided with an internal shoulder 17 spaced slightly below the lower end of recess 14.

The plugging device proper comprises the generally tubular body 18 closed at its lower end by a cap 19 threadably secured at 20 to the lower end of body 18 and provided with a conical guide nose 21. Intermediate its ends, body 18 is provided with a plurality of angularly spaced radial openings 22, in each of which is mounted a radially movable anchor slip or dog 23, each having a pair of longitudinally spaced, inwardly projecting lugs 23a—23a which define between them a recess 19a. The inner and outer edges at the upper and lower ends of the dogs are bevelled at 26 and 27, respectively. The portion of body 18 just above openings 22 is reduced in external diameter at 28 to provide the upwardly facing shoulder 28a. A series of ring packings 29, preferably of the chevron or other pressure sealing type, are positioned about reduced portion 28 and are compressed against shoulder 28a by means of a sleeve nut 30 which is threaded onto the reduced diameter portion 28. The portion of body 18 above sleeve nut 30 is further reduced in two steps at 30a and 30b, the juncture of which is defined by an upwardly facing external shoulder 31. The portion of body 18 below openings 22 is reduced slightly in diameter to form a downwardly facing, inclined shoulder 32 adapted to abut shoulder 17 and to thereby position dogs 23 opposite recess 14 when the plug body is fully inserted into the seating nipple. A plurality of radial ports 33 are provided through the wall of body 18 between shoulder 32 and the lower end of the body to provide communication between the interior of body 18 and the exterior there-

of through the space between the wall of nipple 10 and the exterior of cap 19. The upper end portion of body 18 has its bore somewhat reduced in diameter thereby thickening the wall thereof to form a latching head 35 having a plurality of radial openings 36 therein, in which are mounted detents or ball latches 37 for movement radially inwardly and outwardly of openings 36 in a manner and for purposes to be described more fully hereinafter. Ball latches 37 will have a diameter somewhat greater than the thickness of latching head 35. Immediately below the enlargement forming latching head 35, body section 30b is provided with a plurality of radial by-pass ports 38 which communicate the bore of body 18 with the exterior thereof.

Slidably disposed about body portion 30b is a sleeve valve 40 carrying on its inner wall a pair of longitudinally spaced annular seals 41 which are positioned to be below ports 38 when the sleeve valve is in its lowermost position abutting shoulder 31, and when moved to an upper position, as will be described subsequently, will be disposed above and below ports 38 to effectively close off fluid communication through the latter. Above seals 41, sleeve valve 40 is provided with a plurality of radial ports 42 which are positioned to be in substantial register with ports 38 when the valve is in the down or open position, as seen in FIG. 1. The internal diameter of sleeve valve 40 is such that when moved to its upper position it will urge ball latches 37 inwardly and function as a keeper for the latter, as will appear subsequently. Above ports 42 sleeve valve 40 is reduced in internal and external diameter to provide the annular neck 43 which defines an upwardly facing shoulder 44 about the exterior of the neck and an upwardly facing internal shoulder 44a interiorly of the neck. An abutment ring 45 is seated in the exterior of latch head 35 above openings 36 and is adapted to engage shoulder 44a in response to longitudinal movement of sleeve valve 40 upwardly relative to latch head 35, to thereby limit the upward movement of valve 40 to a position closing off by-pass ports 38 and thrusting ball latches 37 inwardly.

A coil spring 46 surrounds body section 30a in compression between sleeve nut 30 and the lower end of sleeve valve 40 tending to resiliently bias the latter upwardly relative to body 18, for purposes which will appear subsequently.

Coaxially disposed for sliding movement in the bore of body 18 is a generally tubular mandrel 50 which extends upwardly out of the upper end of body 18. Adjacent its lower portion mandrel 50 has formed thereon a pair of longitudinally spaced, radially enlarged expander lugs 51—51, the space 52 between the lugs being such that the lugs will be in registration with lugs 23a when mandrel 50 has been moved downwardly relative to body 18, as will appear subsequently. The bore of body 18, just above openings 22, is radially enlarged to form the recess 53 to receive the upper one of the lugs 51 in the course of operation of the device, as will be described hereinafter.

At a point spaced a short distance below its upper end mandrel 50 is provided with an annular latching recess 54 positioned to be moved into and out of registration with openings 36 in the plug body in the course of operation of the device. Adjacent its lower end mandrel 50 is provided with a plurality of radial ports 55 which, in the unset position of the plug as shown in FIG. 1, will be located at a point above seal packing 56 mounted in the wall of cap 19, and in the set position of the plug will be below packing 56, as seen in FIG. 2. In the position shown in FIG. 1, port 55 will be in communication with ports 33 in the plug body and thereby communicate the bore of the mandrel with the exterior of the plug and when below seal packing 56 will close off this communication. At a point above recess 54, the mandrel is also provided with a plurality of radial ports 57 which communicate the bore of the mandrel with the exterior of the plug structure above the upper end of body 18. Ports 55 and 57, as well

as ports 33 and 38 in the plug body, function as circulation ports through which fluids will be displaced when the plug is being lowered into a well pipe. The upper end of mandrel 50 is externally threaded for insertion into the externally threaded socket 60 of a fishing head 61 which carries at its upper end an enlargement 62 having its upper end face formed as an upwardly tapering conical surface 63 and defining an undercut annular shoulder 64.

The plug structure is run, or carried, into setting nipple 10 on a setting sleeve 65 having an annular skirt 66 at its lower end, the wall thickness of which is such that it fits snugly about neck 43 of the sleeve valve and seats against shoulder 44. A shear pin 67 is disposed between the exterior of neck 43 and skirt 66 to initially secure the setting sleeve to sleeve valve 40. The intermediate portion of setting sleeve 65, above skirt 66, is reduced in internal diameter to define the bore 68 which is adapted to have a close sliding fit over socket 60 and enlargement 62 of the fishing head. A second shear pin 69 is mounted between the exterior of socket 60 and the wall of bore 68 of the setting sleeve to thereby secure the setting sleeve to the mandrel. The longitudinal spacing between shear pins 67 and 69 is selected to be such that when the setting sleeve is secured to the mandrel through shear pin 69, the lower end of skirt 66 of the setting sleeve will have pushed sleeve valve 40 to its lower or open position, compressing spring 46, as best seen in FIG. 1. The upper end of setting sleeve 65 is formed with an axial opening 70 which is smaller in diameter than bore 68 of the setting sleeve and thereby defines the downwardly facing internal shoulder 71. A hanger member comprises a shank 72 which extends slidably through opening 70 and carries an enlarged head 74 on its lower end to bear against shoulder 71. The hanger member forms the means by which the plug and setting sleeve are carried into the well and operated therein. The lower face of head 74 has a conical reentrant surface 75 complementing the upper surface 63 of fishing head 62. The upper end of shank 72 is threadedly secured to the lower end 76 of a conventional string of wire line tools, indicated at S, generally including a set of conventional wire line jars (not shown), by which not only may the plug be run into pipe string 10 but by means of which upwardly and downwardly directed jarring blows may be applied to these several parts of the plug structure, as will be described hereinafter.

In operation, the plug, connected to setting sleeve 65 and the wire line tool string S with the parts in the relative positions shown in FIG. 1, will be run through the pipe string into setting nipple 10. As shown in FIG. 1, the connections formed by shear pins 67 and 69 between the setting sleeve and the plug body and mandrel, respectively, will position mandrel lugs 51—51 in interspersed relation with upper lugs 23a of the anchor dogs. In this position, it will be seen that dogs 23 are free to move inwardly of openings 22, so as to allow the plug to move freely through bore 11 of the pipe string until shoulder 32, on the lower end of body 18, engages shoulder 17 of the setting nipple, stopping the plug with dogs 23 opposite recess 14 in the setting nipple. When this position has been attained a downward jar is applied through tool string S against the upper end of fishing head 62, sufficient force being applied to break shear pin 69 and drive mandrel 50 downwardly in the bore of plug body 18. This downward movement will cause the bevelled faces of mandrel lugs 51 to engage the corresponding faces on lugs 23a of the anchor dogs, causing the latter to be pushed outwardly into recess 14 and allowing the mandrel lugs to move downwardly into registration with lugs 23a, as shown in FIG. 2. Movement to this registering position will be timed by the engagement of the lower end of mandrel 50 with the shoulder formed by the angular shape defining the inner wall of nose 21.

It will be understood that before the mandrel is moved downwardly and while the tool string is moving downwardly through setting nipple 10, any fluid in the pipe string

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will be free to move through ports 33 and 55 and thence through the bore of mandrel 50 out of ports 57, and thence between mandrel 50 and skirt 66, passing out of the plug body through ports 42. Also, fluid entering ports 33 will be displaced upwardly through the annular space between mandrel 50 and body 18, bypassing seal packing 29, and will exit out of bypass ports 38 and thence through ports 42 to the exterior of the plug, being so-directed by the seal formed by packing 35a which seals between latching head 35 and mandrel 50 at a point above ports 38. In this way, the plug structure may move freely through the bore of the pipe string and setting nipple 10 to its setting position.

When the mandrel has been driven downwardly to the position moving dogs 23 into anchoring position in recess 14, as previously described, latching recess 54 in the exterior of the mandrel will have moved opposite openings 36, thereby allowing ball latches 37 to move inwardly into recess 54. At the same time, by reason of the release of shear pin 69, the tool string may be picked up, raising setting sleeve 65 together with sleeve valve 40 which remains secured thereto, carrying the sleeve valve to its upper position shown in FIG. 2, at which not only is circulation cut off through bypass ports 38 and 42, but also moving the sleeve valve to a position behind ball latches 37, so as to effectively hold the latter in latching engagement in recess 54 and thereby effectively lock mandrel 50 in its downward position holding anchor dogs 23 locked into recess 14.

With anchor dogs 23 thus locked into anchor recess 14, an upward pull may now be applied through tool string S which will first lift head 74 of the hanger into engagement with shoulder 71 of the setting sleeve and thereafter will apply upwardly directed force sufficient to break shear pin 67, and thereby release the setting sleeve from sleeve valve 40 and thus from the plug structure as a whole, as best seen in FIG. 3. The setting sleeve and tool spring may now be withdrawn from the well, leaving the plug in locked position in seating nipple 10, as shown in FIG. 3, with packing 29 sealing off between the plug and the wall of nipple 10 at a point above the anchor dogs, which will also serve to protect the latter from any scale or detritus which might otherwise settle downwardly and interfere with the radial movements of the anchor dogs, particularly when it is desired to release the plug member for retrieval from the well. It will be noted that when the setting sleeve is released from sleeve valve 40, as shown in FIG. 3, spring 46 will expand and will have sufficient strength to hold the sleeve valve in the upper position closing bypass passageways 38. At the same time, by locking ball latches 37 into latching position in latching recess 54, the plug will be protected against release by reasons of upward surges from below or by vibrations occurring in the course of operation, since the latch formed by ball latches 37 and recess 54 can only be released by physically pushing sleeve valve 40 downwardly to its lowermost position and out of engagement with the ball latches.

Reference may now be had to FIGS. 4 and 5 which illustrate the operations employed in retrieving the plug from the setting nipple and the pipe string into which it is inserted. To accomplish the retrieval, an overshot tool, designated generally by the letter O, carried on a wire line W, will be run through the bore of the pipe string and will comprise a tubular skirt 80 having internal and external diameters generally similar to that of skirt 66 of the setting sleeve, so that it will pass over neck 43 of the sleeve valve and bear against shoulder 44. The overshot will be manipulated to apply downward pressure against the sleeve valve to move the latter downwardly against the resistance of spring 46 with sufficient force to move packings 41 below bypass ports 38. This will open communication between the interior of plug body 18 and the exterior of the tool, whereby any pressure trapped within the plug body will be relieved to thereby balance any well pressure across the tool so as not to interfere with release of the latter. The overshot carries in its bore spaced inwardly from skirt 80,

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a plurality of resilient catcher fingers 81 which are adapted to be forced outwardly over catcher head 62, and then spring back to engage beneath shoulder 64.

With the overshot in place, as illustrated in FIG. 4, it will be seen that the downward displacement of sleeve valve 40 will release ball latches 37 and thereby free mandrel 50 for upward movement under tension applied through fingers 81 by pull on wire line W. The upward movement resulting from this operation is illustrated in FIG. 5, wherein it will be seen that the resulting upward movement of the mandrel has moved mandrel lugs 51 out of engagement with lugs 23a of the anchor dogs, releasing the latter for inward movement out of anchor recess 14. The lugs 51 will then move upwardly to engage the shoulders 53a which will then permit the continued upward pull on wire line W to apply upwardly directed force to the plug body, enabling the whole structure to be withdrawn and retrieved from the well pipe.

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

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

1. A bridging plug for closing the bore of a well pipe comprising:

- (a) a hollow generally tubular plug body closed at its lower end insertible in the bore of a well pipe,
- (b) radially movable anchor elements mounted in said body projectible therefrom into anchoring engagement with the wall of the well pipe,
- (c) seal means mounted about the body to seal with the pipe wall above said anchor elements,
- (d) upper and lower ports in the wall of said body for bypassing fluid around said seal means,
- (e) mandrel means longitudinally movable in the bore of the plug body into and out of projecting engagement with said anchor elements,
- (f) cooperating latch elements carried by the body and said mandrel lockingly engageable upon movement of the mandrel into projecting engagement with said anchor elements, and
- (g) sleeve valve means movably mounted on the body above the seal means for movement between positions opening and closing said upper ports, said sleeve valve means being operable when in said port-closing position to hold said latch elements engaged with said mandrel.

2. A bridging plug according to claim 1 wherein said latch elements include:

- (a) an annular recess in the exterior of said mandrel, and
- (b) a plurality of angularly spaced ball latches mounted for radial movement through the wall of said body into and out of said recess.

3. A bridging plug according to claim 1 including abutable stop elements carried on the body and sleeve valve means for limiting relative upward movement of the valve means on said body to said port-closing position.

4. A bridging plug according to claim 1 including seal packing mounted in the bore of said body to seal between the mandrel and the body at a point above said upper ports.

5. A bridging plug according to claim 1 including resilient means mounted about the body to bias said sleeve valve means toward said port-closing position.

6. A bridging plug according to claim 1 including setting tool means initially positioning said sleeve valve means on the body in the port-opening position and releasable after actuation of said anchor elements by said mandrel to free said valve means for movement to said port-closing position.

7. A bridging plug according to claim 6 wherein said setting tool means has frangible connections both to said mandrel and to said sleeve valve means, said connections being spaced to initially hold said mandrel upwardly out of projecting engagement with said anchor elements while

holding said sleeve valve means in said port-opening position, said connections being sequentially releasable first from said mandrel and second from said sleeve valve means by manipulation of said setting tool.

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5 JAMES A. LEPPINK, *Primary Examiner*.

U.S. Cl. X.R.

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