Sept. 20, 1960 C. C. BROWN 2,953,206

BRIDGING PLUG

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Fig. 1

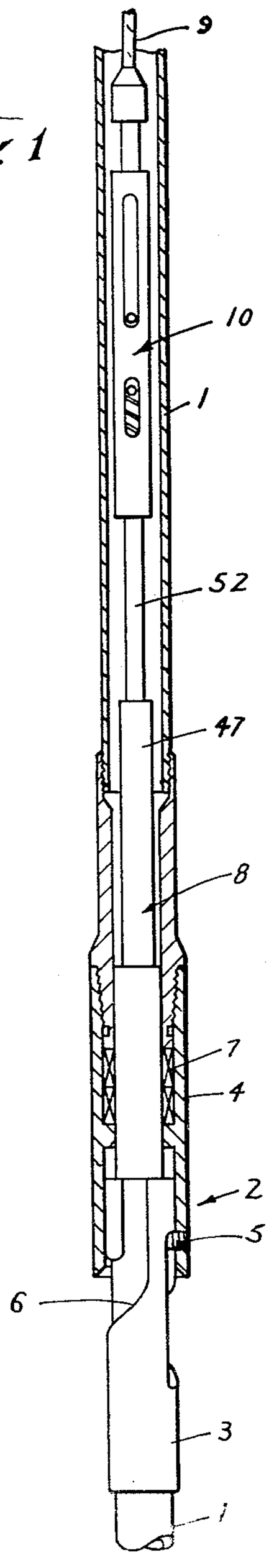
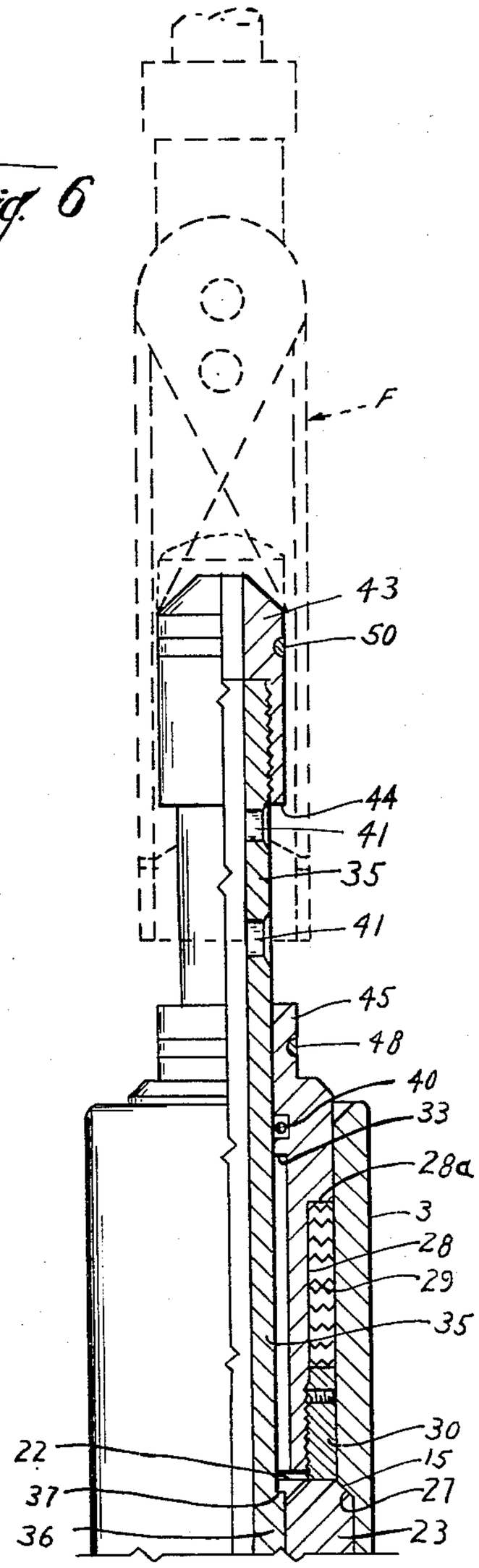


Fig. 6



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BRIDGING PLUG

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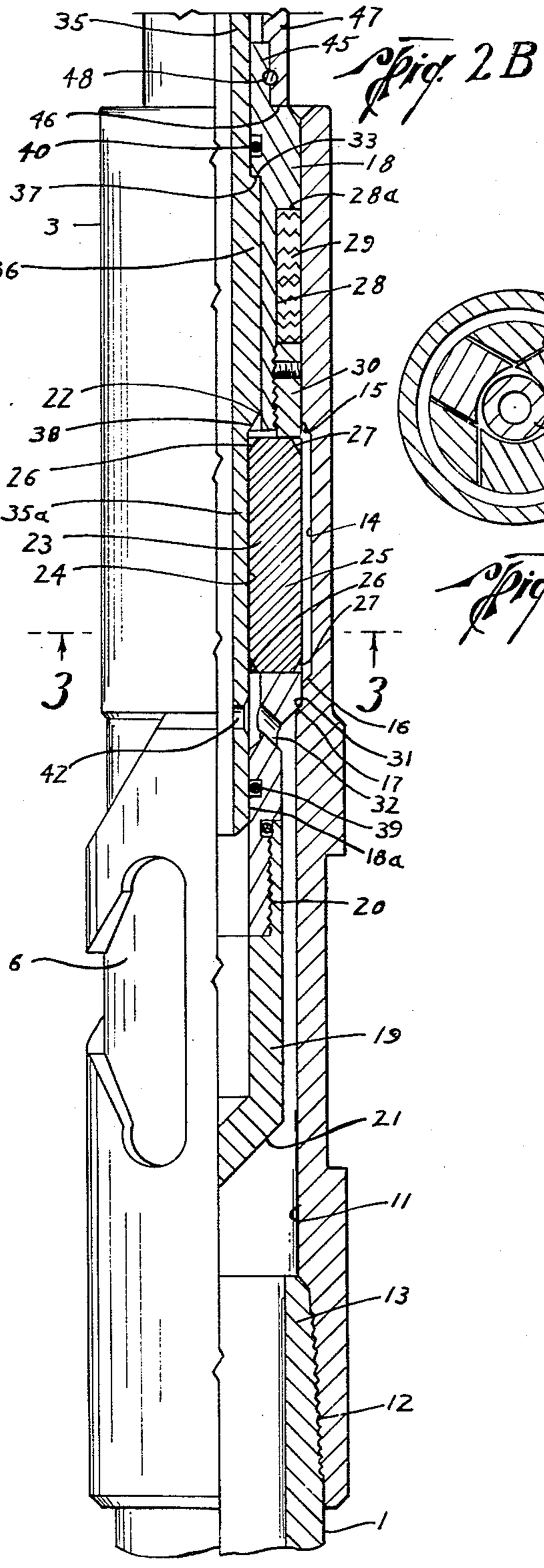

Fig. 2B

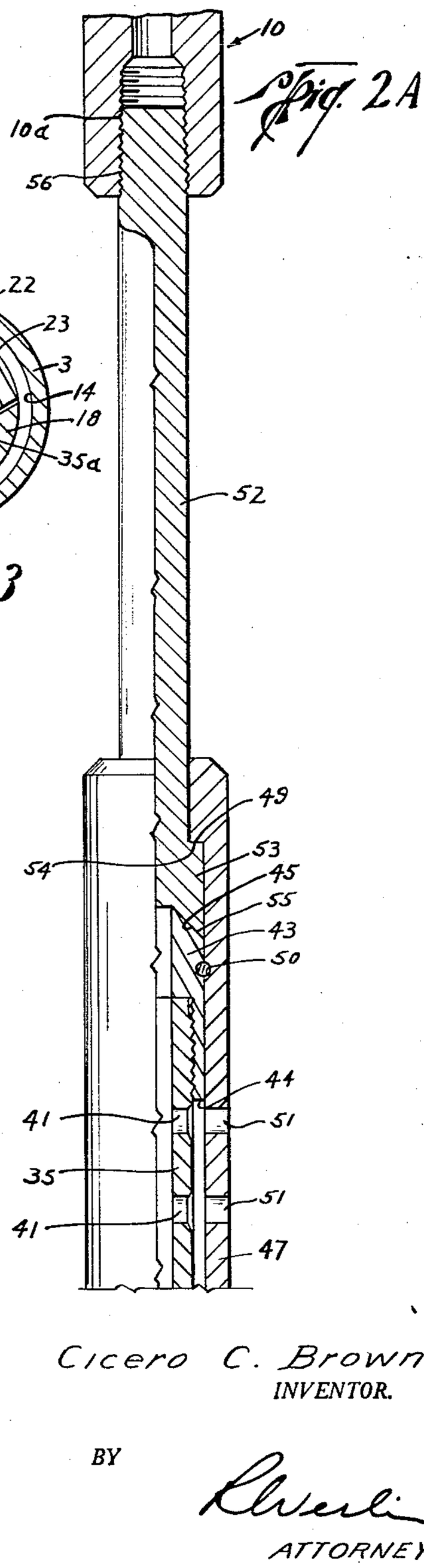

Fig. 2A

Fig. 3

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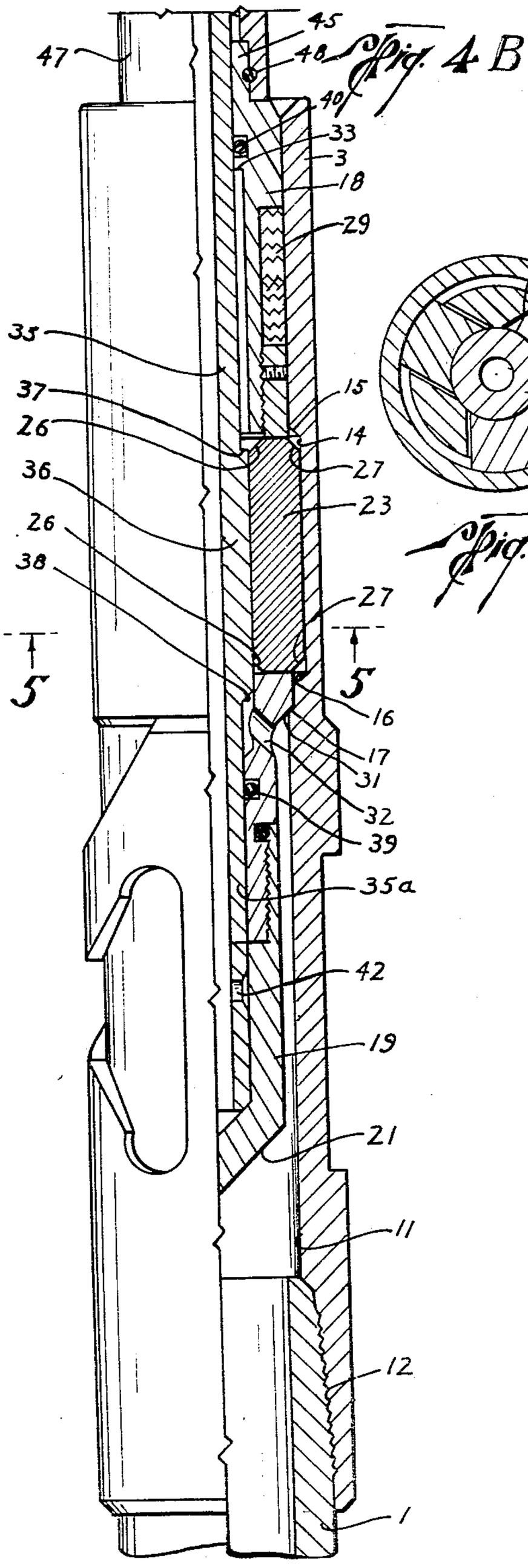

Fig. 4B

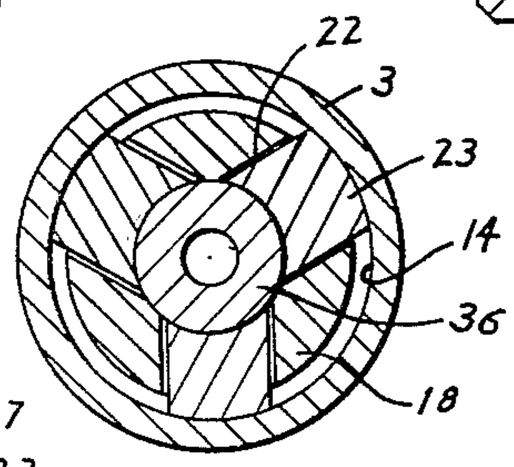

Fig. 5

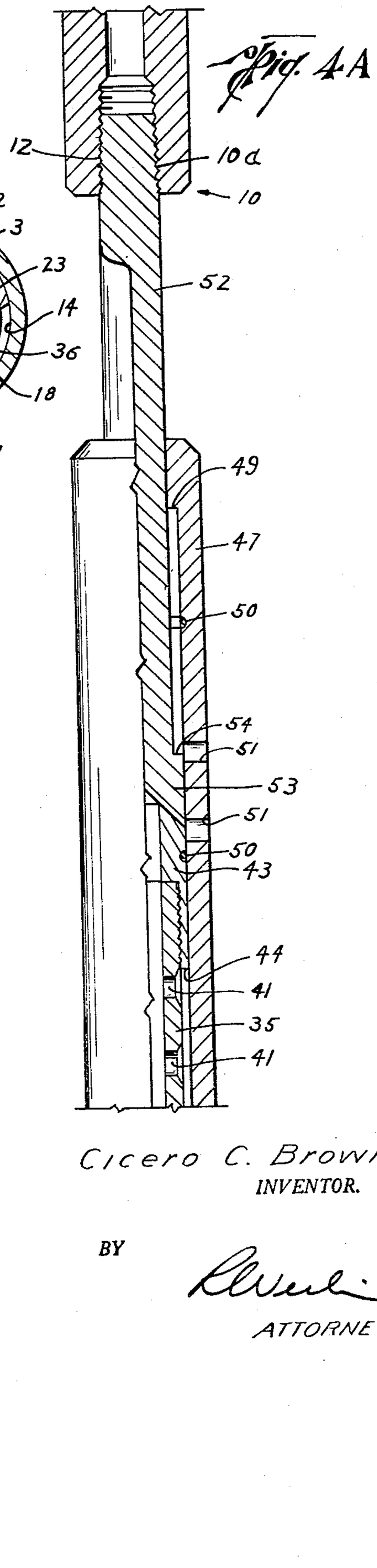

Fig. 4A

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BRIDGING PLUG

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Filed Aug. 8, 1955, Ser. No. 526,994

9 Claims. (Cl. 166—125)

This invention relates to a plugging device commonly termed "bridging plug" for plugging well pipes in a well bore, and particularly to a form of bridging plug adapted to be run on a wire line.

In oil and gas wells, it is often necessary to conduct repair or treating operations within the well bore at locations and under conditions which make it desirable or necessary to remove the tubing string, that is, the inner or production string of pipe, to some point at or below the point at which the operation is to be conducted. Ordinarily, this would require "killing" the well in some suitable manner, as by pumping mud into the well, in order to cut-off the flow of well fluid through the production pipe or tubing while the repair or treating operations are being conducted within the well bore. Killing the well in this manner may result in permanent damage to the well, and other means of stopping the flow are to be preferred.

Accordingly, it is a primary object of the present invention to provide an improved form of bridging plug which may be removably inserted at any desired point in a well pipe to effectively close the bore thereof, and which may be run on a wire line.

Another object is to provide a bridging plug for use particularly in comparatively small diameter well tubing.

A more specific object is to provide a bridging plug, including, anchor means for securing the plug body in the bore of a well pipe, and seal means positioned above the anchor means for forming a fluid-tight seal between the plug body and the well pipe, the positioning of the seal means above the anchor means serving the additional function of preventing detritus or foreign matter from the well above the plug from fouling the anchor means.

A further object is to provide a plugging device for well tubing which includes a seating nipple adapted to be installed in the tubing string for receiving the plug member and having means co-operating with the inserted plug member to anchor the latter in the seating nipple.

Still another object of this invention is to provide a plugging device for well tubing which includes a releasable coupling adapted to form a connection between sections of a well pipe string, one member of said coupling forming a seating nipple to receive and anchor the plug member of the device.

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

In the drawing:

Fig. 1 is a longitudinal view, partly in section, of a portion of a well pipe string, such as a tubing string, showing the manner in which the plugging device in accordance with this invention is installed therein;

Figs. 2A and 2B, together, comprise a longitudinal, partly sectional view of the plugging device in accordance with this invention, the parts thereof being shown in the positions occupied when being run into the pipe string;

Fig. 3 is a cross-section along line 3—3 of Fig. 2B;

Figs. 4A and 4B, together, constitute a view similar to Figs. 2A and 2B, showing the parts of the device in anchored position in the pipe string;

Fig. 5 is a cross-section view along line 5—5 of Fig. 4B; and

Fig. 6 is an enlarged view of the upper end of the plugging device, showing, in broken lines, the outline of a conventional fishing tool secured thereto for removing the device from the well.

Referring first to Fig. 1, there is shown a pipe string, such as a tubing string **1**, in which is interposed a coupling member, designated generally by the numeral **2**, comprising a seating nipple **3** and a coupling sleeve **4** which is releasably connected to seating nipple **3** by means of an inwardly projecting lug **5** which is engaged in a bayonet or J-type slot **6** formed on the exterior of seating nipple **3**. Coupling sleeve **4** is provided with internal packing **7** to form a fluid-tight seal about the exterior of nipple **3** when the coupling members are connected together in order to prevent leakage of fluid to the exterior of the tubing string. Releasable coupling member **2** will ordinarily be installed as a permanent part of the pipe string when the latter is first installed in the well in order to be available for use with the plugging device when the latter is required at a subsequent time during the life of the well. A plugging device, designated generally by the numeral **8**, is run into tubing string **1** on a wire line **9**, a set of wire line jars of any conventional form, designated generally by the numeral **10**, being interposed between wire line **9** and plugging device **8**.

Referring now to Figs. 2A, 2B and 3, the seating nipple **3** is shown in greater detail, having a central bore **11** internally threaded at its lower end at **12** to receive the externally threaded pin **13** forming the end of a section of pipe string **1** into which the seating nipple is connected. Intermediate its ends, the bore wall of nipple **3** is provided with an annular recess **14** having upwardly and downwardly tapered upper and lower end walls **15** and **16**, respectively, defining longitudinally spaced tapered shoulders. The bore wall of seating nipple **3** is also provided with an internal shoulder **17** spaced downwardly slightly from lower end wall **16**.

The plugging device, proper, comprises the generally tubular body **18** closed at its lower end by a cap **19** threadedly secured at **20** to the lower end of body **18**, cap **19** preferably having 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 arcuate slip member **23** having relatively smooth inner and outer arcuate surfaces **24** and **25**, respectively. The inner and outer edges at the upper and lower ends of the slip members, are chamfered at **26** and **27**, respectively. The portion of body **18** above openings **22**, is reduced somewhat in external diameter at **28** to provide the downwardly facing shoulder **28***a*. A series of packing rings **29**, preferably of the chevron or other pressure sealing type, are positioned about the reduced portion **28** of body **18** and are compressed against shoulder **28***a* by means of a sleeve nut **30** which is threaded on to the reduced diameter portion **28**. The portion of body **18** below openings **22** is reduced in diameter to form the downwardly facing tapered shoulder **31**, which is adapted to abut against shoulder **17** in the seating nipple in order to limit the inward movement of the plugging device in the bore of seating nipple **3** to a position adapted to dispose slips **23** opposite recess **14**. One or more ports **32** positioned in the wall of body **18** below shoulder **31** provide communication between the interior and the exterior of the body.

The bore of body **18** is enlarged somewhat in diameter from a point near its upper end, defining the downwardly facing annular shoulder **33**, to a point slightly below

ports **32**. Coaxially disposed to have a close sliding fit in the bore of body **18** is a generally tubular mandrel **35** which extends upwardly above the upper end of body **18**. Mandrel **35** is formed intermediate its ends to provide a radially enlarged expander portion **36**, the upper end of the latter defining the upwardly facing annular shoulder **37** adapted to abut shoulder **33** when the mandrel is in the inactive or retracted position. The lower end of enlarged portion **36** is downwardly and inwardly tapered to form the sloping annular shoulder **38**. The length of enlarged portion **36** is made such that when shoulder **37** is in engagement with shoulder **33**, the enlarged portion will be above and out of engagement with slips **23**. The portion **35***a* of the mandrel which extends below expander portion **36** has a length such that when the mandrel is in the retracted position (Fig. 2B), portion **35***a* will extend from a point above openings **22** to a point below ports **32** and into sliding engagement with the portion **18***a* of the bore wall of body **18** which is below ports **32**. The external diameter of mandrel portion **35***a* is made such that when the mandrel is in the retracted position, sufficient radial space will be provided behind slips **23** that the latter may move radially inwardly a sufficient distance to permit outer faces **25** of the slips to be substantially flush with, or radially inwardly of, the outer perimeter of body **18**. An annular seal packing **39** is positioned between the lower end portion of mandrel portion **35***a* and the adjacent portion of the bore wall of body **18** to form a fluid-tight slidable seal between these members at a point below ports **32**. A similar seal **40** is provided between mandrel **35** and body **18** at a point above shoulder **33**. Upper circulation ports **41—41** (Fig. 2A) are provided through the wall of the portion of mandrel **35** which extends out of the upper end of body **18** to provide communication between the interior and the exterior of the mandrel, and lower circulation ports **42** are provided through the wall of mandrel portion **35***a* above the lower end thereof to provide fluid communication between the interior of the mandrel and the bore of body **18** when the mandrel is in its retracted position. The upper end of mandrel **35** (Fig. 2A) is externally threaded to receive a tubular cap **43**, the lower end of which defines a downwardly facing annular shoulder **44** and the upper end **45** has a frusto-conical shape.

The upper end of body **18** is formed with a short upwardly extending neck **45** slidably surrounding mandrel **35** and having a lesser external diameter than body **18** to define the upwardly facing annular shoulder **46**. A tubular connector sleeve **47** has its lower end extending about the exterior of neck **45** and resting on shoulder **46** and is releasably secured to neck **45** by means of a suitable releasable connection, such as a breakable shear pin **48** which is inserted between the engaged surfaces of neck **45** and sleeve **47**. Connector sleeve **47** encloses the portion of mandrel **35** which extends above the upper end of plug body **18** and the sleeve extends somewhat above the upper end of cap **43**, being provided near its upper end with a downwardly facing internal annular shoulder **49** spaced above cap **43**. The bore of connector sleeve **47** is dimensioned to have a close sliding fit with the exterior of cap **43** and is releasably secured to mandrel **35** by a suitable releasable connection, such as a conventional breakable shear pin **50**, inserted between the adjacent surfaces of cap **43** and the bore wall of sleeve **47**. Circulation passages **51—51** are provided in the wall of sleeve **47** to provide fluid communication between the exterior thereof and the portion of the interior thereof between the lower end of cap **43** and neck **45**.

A cylindrical stem **52** extends into the upper end of connector sleeve **47** and is provided at its lower end with a cylindrical enlargement or head **53** defining an upwardly facing annular shoulder **54** adapted to abut shoulder **49**. The lower end of head **53** is provided with frusto-conical socket **55** adapted to snugly receive the similarly shaped

upper end **45** of cap **43**. When mandrel **35** is in its inactive position and secured to connector sleeve **47**, as seen in Fig. 2A, it will be understood that head **53** is held snugly between shoulder **49** and cap **43**. The upper end of stem **52** is threaded at **56** to be received in a threaded socket **10***a* provided in the lower end of jars **10**.

The plugging device is operated in the following manner: Bridging plug **8** is assembled with the parts thereof in the relative position shown particularly in Figs. 2A and 2B. In this position it will be seen that mandrel **35** is locked in the retracted position relative to plug body **18** by means of shear pin **50** which secures the mandrel to connector sleeve **47**. In this position expander **36** will be elevated above slips **23** so that the latter are free to move inwardly of the plug body so that the plug body may be freely inserted in the setting nipple. In the retracted or inactive position of the mandrel it will be seen that circulation ports **42** will be above seal **39**, hence there will be open fluid communication between ports **32** and **42**, and between ports **41** and **51** to permit passage of fluid through the bore of mandrel **35** when the device is lowered through tubing string and thereby equalize pressures across the device. Bridging plug **8** is then secured to a wire line **9**, as shown in Fig. 1, the string of tools having the wire line jars **10** inserted therein for use in connection with the operation. The string of tools, so assembled, is then lowered through tubing **1** from the surface until plug body **18** enters seating nipple **3** and shoulder **31** come into engagement with shoulder **17** in the seating nipple (Fig. 2B), which will stop further movement of the plug body and position slips **23** opposite recess **14** in the seating nipple. In this position, being that illustrated particularly in Figs. 2A and 2B, packing **29** will be placed in sealing engagement with the bore wall of seating nipple **3** above recess **14**. With further inward movement of the plugging device thus stopped, downward jarring by means of jars **10** will be applied through stem **52** against cap **43** in order to break shear pin **50** to thereby release the mandrel from its engagement with plug body **18**. Breaking of the releasable connection between the mandrel **35** and plug body **18** will allow the mandrel to be lowered relative to the plug body whereby expander **36** will be caused to descend relative to the plug body until tapered shoulder **38** engages tapered shoulder **26** on the slips, urging the latter radially outwardly into recess **14** and allowing the expander to move downwardly inside the slips. The inner end wall of nose **21** of the plug body serves as a limit stop for the lower end of mandrel **35** (Fig. 4B) to position expander **36** in back of slips **23**, so that as long as expander **36** is in the extended position, as described, slips **23** will be maintained in the radially expanded position engaged within recess **14**. Projection of slips **23** into recess **14** serves to anchor the plug body to the seating nipple and so long as expander **36** remains in its position in back of slips **23**, the latter cannot be retracted from recess **14** and the anchored engagement is thereby maintained.

When mandrel **35** is moved to the active or extended position, as described, it will be seen (Fig. 4B) that circulation port **42** will have been moved below seal **39**, thereby closing-off fluid communication between the interior of tubing string **1** and the bore of mandrel **35**. Seals **39** and **40** prevent leakage of fluid between mandrel **35** and plug body **18**, while packing **29** forms an effective fluid-tight seal between the plug body and the seating nipple, which, of course, constitutes a portion of the tubing string.

With the plug member thus effectively lodged in the seating nipple, the lowering cable or wire line and its attached tools may be released from the plug member by jarring upwardly through jars **10** against stem **52**. This upward jarring action will produce jarring blows between shoulder **54** carried by the stem and shoulder **49** in the upper end of connector sleeve **47**. This jarring action will break shear pin **48**, which secures the

connector sleeve 47 to the plug body. When shear pin 48 is thus broken, the string of tools may be withdrawn from the well, leaving the plug device anchored inside the seating nipple (Fig. 6).

The portion of the tubing string above the seating nipple and carrying coupling sleeve 4 may now be disconnected from the lower portion of the tubing string in which the plugging device is lodged by appropriate rotation of the tubing string from the surface to cause release of the bayonet-type connection between the seating nipple and the coupling sleeve. When the upper portion of the tubing string is thus released, it may be withdrawn from the well and operations of any desired character may be conducted within the well bore without danger to the formations which are in communication with the tubing string below the plug.

When it is desired to remove the plugging device from the tubing, the upper tubing section, including coupling sleeve 4, is run back into the well and re-connected to the seating nipple to restore the original continuity of the tubing string. Thereupon a suitable wire line fishing tool of any conventional construction such as is illustrated in broken lines in Fig. 6 and designated generally by the letter F, is run through the bore of the tubing to grasp the upper end of mandrel 35. Cap 43 with its downwardly facing shoulder 44 will provide a suitable fishing head adapted to co-operate with conventional fishing tools, so that the latter may effectively grasp the mandrel. An upward pull applied to mandrel 35 by means of the fishing tools, will draw the mandrel upwardly through the bore of body 18 until shoulder 37 again abuts shoulder 33, whereupon expander 36 will be retracted from engagement with slips 23, the parts being thus returned to their original inactive position illustrated in Figs. 2A and 2B. Continued upward pull applied to the mandrel will pull body 18 and slips 23 upwardly. Engagement of the tapered shoulder 27 on the slips with the tapered upper end wall 15 of recess 14 will urge the slips radially inwardly of plug body 18 and out of recess 14, thereby releasing the anchor means from the seating nipple and allowing the plug body to be withdrawn from the well through the tubing string.

The retraction of mandrel 35 to the position last described will re-open communication between circulation passages 32 and 42, and thence through the bore of mandrel 35 through circulation passages 41 and 51, to thereby permit the plug body to be withdrawn without difficulty.

By positioning the seal packing 29 above the anchor means, it will be seen that a fluid-tight seal may be effected between the upper portion of the plug body and the seating nipple which will effectively prevent movement of any well liquid through the upper end of the seating nipple and will also prevent the movement downwardly into the seating nipple of any sediment, scale, or other detritus which might result from the jarring action conducted above the upper end of the seating nipple during manipulation of the tool in seating and releasing the plugging device, and will thereby prevent fouling of the anchoring elements, which might otherwise prevent effective operation of the anchoring elements.

The described structure provides particular important advantages over more conventional plugging devices in connection with the removal of the plug in that reopening of the circulation ports to equalize pressures across the plug, and release of the anchoring elements are both effected by a simple upward pull applied through the operating string to the mandrel, thereby avoiding the more complex rotational and other movements ordinarily required in more conventional devices which are a frequent source of difficulty and hazard in operating tools of the kind here involved.

Ports 42 and seal 39 form a sleeve valve for controlling fluid communication through the passage formed by these ports, the bore of the mandrel and ports 41 and 51. When the mandrel is in the raised or inactive position, the valve is open and when the mandrel is in the lowered or active position, the valve is closed.

It will be evident that forms of anchor elements may be employed other than those illustrated by the specific embodiment hereinabove described. It will also be evident that seating nipple 3 may form part of a releasable connection in the pipe string different in form than that illustrated, as for example, a more conventional safety joint commonly used in pipe strings.

It will be understood that various other alterations, modifications and changes 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 hollow generally tubular plug body insertible in the bore of a well pipe, radially movable anchor elements mounted in the wall of said body projectible therefrom into anchoring engagement with the wall of the well pipe, tubular mandrel means longitudinally movable in the bore of the plug body into and out of projecting engagement with said anchor elements, a fluid passageway through said body including port means opening to the exterior of the body, valve means carried by the mandrel means operative by the longitudinal movements of the mandrel means relative to said port means to open and close said passageway, and circumferential seal means mounted on the plug body to seal with the pipe wall above said anchor elements.

2. In combination with a well pipe, a tubular coupling forming a connection between upper and lower sections of said pipe, said coupling comprising upper and lower members and a bayonet-type connector separably connecting said members, and plug means removably insertible in the bore of the lower coupling member to plug the bore of the pipe therebelow, said plug means including radially movable latch elements cooperable with the lower coupling member for releasably anchoring the plug means in the lower coupling member.

3. In combination with a well pipe, a tubular coupling forming a connection between upper and lower sections of said pipe, said coupling comprising upper and lower telescoping members and a bayonet-type connector separably connecting said members, a plug body insertible in the bore of the lower coupling member, means including radially movable latch elements mounted on the body for releasably anchoring the same in the lower coupling member, and circumferential seal means disposed about the plug body to seal with the bore wall of the lower coupling member above the anchor means.

4. In combination with a well pipe, a tubular coupling forming a connection between upper and lower sections of said pipe, said coupling comprising upper and lower telescoping members and a bayonet-type connector separably connecting said members, a hollow generally tubular plug body insertible in the bore of the lower coupling member, radially movable anchor elements mounted in said body projectible therefrom into anchoring engagement with the wall of the lower coupling member, mandrel means longitudinally movable in the bore of the plug body into and out of projecting engagement with said anchor elements, and circumferential seal means disposed about the plug body to seal with the bore wall of the lower coupling member above said anchor elements.

5. In combination with a well pipe extending into a well, a tubular coupling forming a connection between upper and lower sections of said pipe, said coupling comprising upper and lower members, plug means removably insertible in the bore of the lower coupling member to plug the bore of the pipe therebelow, said plug means including radially movable latch elements operable to releasably anchor the plug means in the lower coupling

member, and a readily releasable bayonet-type connector means separably connecting the coupling members whereby the upper section of said pipe may be released from the coupling and withdrawn from the well after said plug means is in place in the lower coupling member.

6. A bridging plug for closing the bore of a well pipe, comprising, a plug body having a fluid passageway therethrough insertable in the bore of a well pipe, closure means movable longitudinally in said passageway between a first position opening said passageway to the passage of fluid therethrough and a second position closing said passageway to the flow of fluid therethrough in either direction, anchor means mounted on the body, means connected to the closure means and operable by movement of said closure means to said second position to move said anchor means to anchor the body to the pipe wall, and circumferential seal means mounted on the plug body to seal with the pipe wall above said anchor means.

7. A bridging plug for closing the bore of a well pipe, comprising, a hollow generally tubular plug body having a fluid passageway therethrough insertable in the bore of a well pipe, radially movable anchor elements mounted in said body projectible therefrom into anchoring engagement with the wall of the well pipe, mandrel means longitudinally movable in the bore of the plug body into and out of projecting engagement with the anchor elements to project the latter into anchoring engagement with the wall of the well pipe, means carried by the mandrel operable by said longitudinal movements of the mandrel to also open and close said passageway, and circumferential seal means mounted on the plug body to seal with the pipe wall above said anchor elements.

8. A bridging plug for closing the bore of a well pipe, comprising, a hollow generally tubular plug body having a fluid passageway therethrough insertable in the bore of a well pipe, radially movable anchor elements mounted in the wall of said body projectible therefrom into anchoring engagement with the wall of the well pipe, mandrel means longitudinally movable in the bore of the plug body into and out of projecting engagement with said anchor elements to project the latter into anchoring engagement with the wall of the well pipe, means carried by the mandrel operable by said longitudinal movements of the mandrel to also open and close said passageway, securing means releasably connecting said mandrel means to said body in inactive non-projecting position with respect to said anchor elements and releasable for movement to active projecting position relative to said anchor elements, and circumferential seal means mounted on the exterior of the plug body positioned thereon to seal with the wall of the pipe portion above said anchor elements.

9. A bridging plug as defined by claim 8 wherein said mandrel means comprises a tubular member slidably fitted in the bore of said plug body, and wherein annular seal means are positioned between the mandrel means and the bore wall of the plug body on opposite sides of said anchor elements.

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