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RETRIEVABLE BRIDGING PLUG FOR WELL CASINGS

Filed Feb. 11, 1963

2 Sheets-Sheet 1

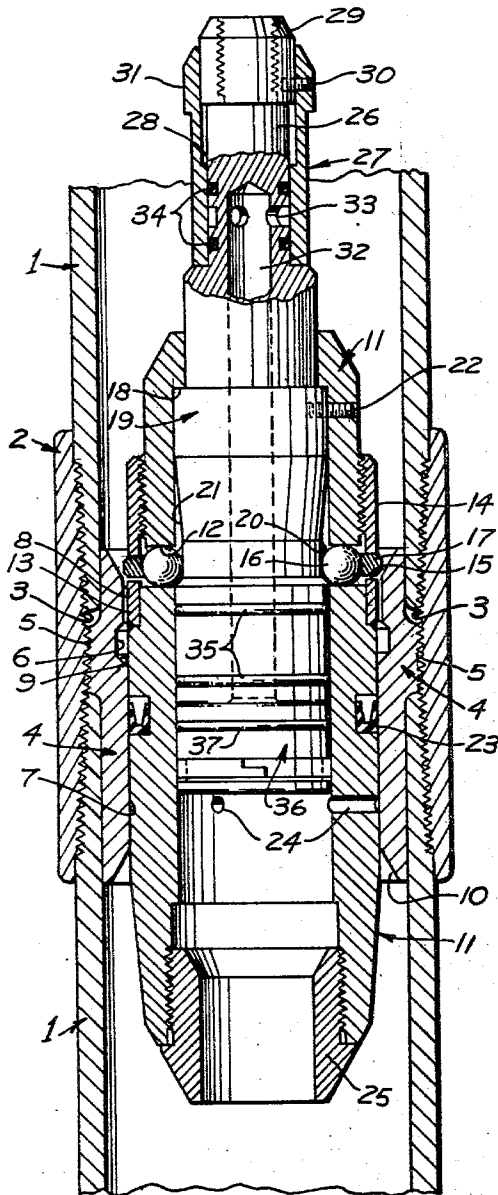


Fig. 1

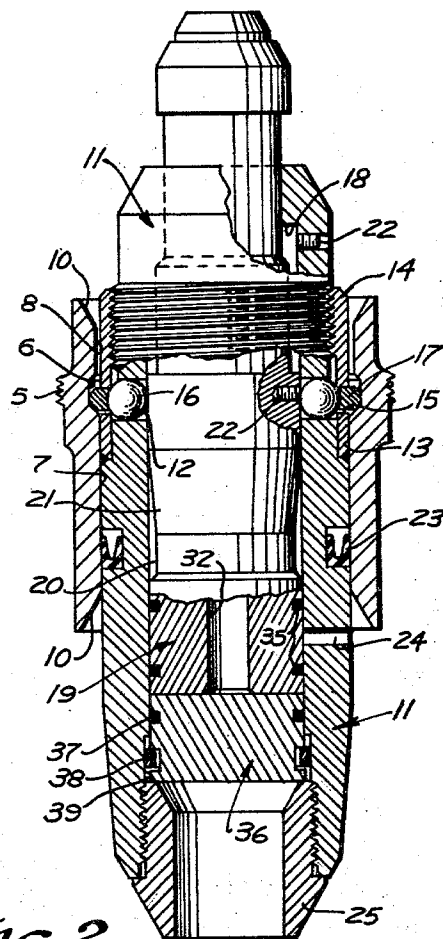


Fig. 2

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2 Sheets-Sheet 2

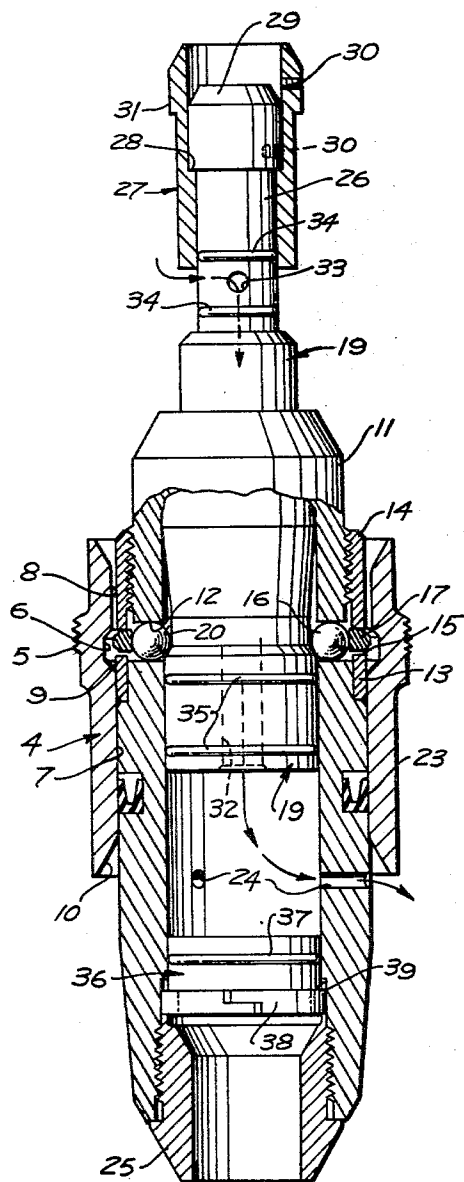


Fig. 3

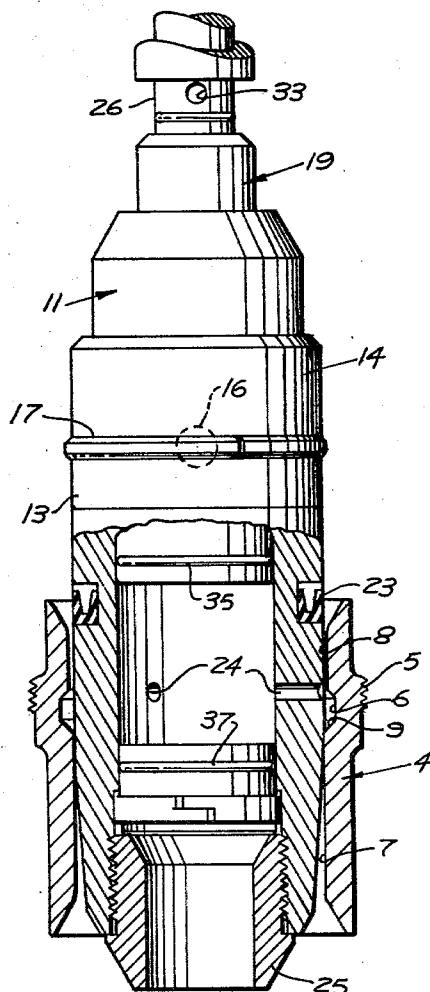


Fig. 4

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3,180,420 RETRIEVABLE BRIDGING PLUG FOR WELL CASINGS

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This invention relates to retrievable bridging plugs for well casings, and included in the objects of this invention are:

First, to provide a retrievable bridging plug which may be dropped or pumped downwardly into a casing for engagement with a landing collar, previously fixed within the casing; whereupon, the bridging plug interlocks therewith to resist thrust in either direction as well as to form a seal against flow from above or below the bridging plug.

Second, to provide a retrievable bridging plug which, after being set, is readily engaged and manipulated to disengage the landing collar, and simultaneously therewith establish flow passages through the bridging plug to facilitate withdrawal of the bridging plug through well fluid.

Third, to provide a retrievable bridging plug, the parts of which may be formed of drillable material so that in the event the bridging plug malfunctions it may be drilled out.

With the above and other objects in view, as may appear hereinafter, reference is directed to the accompanying drawings in which:

FIGURE 1 is a fragmentary, longitudinal, sectional view of a well casing string showing the retrievable bridging plug, partially in longitudinal section and partially in elevation, as it appears when it is ready to be received in its landing collar;

FIGURE 2 is a similar longitudinal, sectional view of the bridging plug and its landing collar, showing the bridging plug locked therein;

FIGURE 3 is a similar view of the bridging plug and its landing collar, showing the initial step to effect retrieval of the bridging plug;

FIGURE 4 is a similar view showing the bridging plug partially removed from the landing collar.

The casing string in which the bridging plug is adapted to be set includes a series of casing sections 1 having screw-threaded ends which fit into internally screw-threaded couplings 2. Within the casing string, between the casing sections 1, there are formed internal channels 3 having internally exposed screw threads. A landing collar 4 is installed within the casing string opposite a selected coupling.

The landing collar 4 includes an external annular flange 5 which is screw-threaded to fit the internal screw threads of the coupling 2 exposed at the internal channel 3. The landing collar 4 extends axially in both directions from the flange 5 and fits snugly within the adjacent ends of the casing sections 1.

Formed within the landing collar 4 is a key-receiving internal, annular groove or channel 6. The channel 6 divides the landing collar 4 into a lower cylindrical portion 7 and an upper cylindrical portion 8. The lower cylindrical portion 7 has an internal diameter slightly smaller than the upper portion 8 so that the channel 6 forms at its lower margin a stop shoulder 9. The axial extremities of the landing collar 4 are internally beveled as indicated by 10.

The landing collar is adapted to receive a tubular body 11. The upper portion of the body 11 is reduced slightly in diameter and provided with a ring of radiating keyway openings 12. The outer ends of the openings are partially covered by a ring 13 welded to the body 11. Above

the openings, the body 11 is externally screw-threaded to receive a screwthread collar 14 which is axially adjustable relative to the ring 13 to define therewith an annular keyway groove 15. The openings 12 receive key ball members 16, whereas the groove 15 receives a split key ring 17 of spring material which normally occupies a retracted position. The upper end of the tubular body 11 is provided with an internal flange forming a shoulder 18.

The tubular body 11 receives a mandrel 19. The mandrel is provided with a key ball groove 20, the upper margin of which is tapered as indicated by 21. Initially, the mandrel 19 is held in an upper position with respect to the body structure, in bearing engagement with the shoulder 18, by means of one or more shear screws 22 extending radially through the body structure 11 into the mandrel 19.

The body 11 is provided below the connecting ring 13 with an external annular groove which receives a seal ring 23. Below the seal ring 23 the body 11 is provided with lateral ports 24. The lower portion of the body 11 is externally tapered so as to be guided readily into the landing collar. Its lower extremity is internally threaded and receives a shoulder ring 25.

The upper end of the mandrel 19 is reduced in diameter to form a stem 26 which projects upwardly through the upper end of the body 11. The upper end of the stem 26 is further reduced to receive a sleeve 27, the lower portion of which fits slidably on the stem 26. The upper portion of the sleeve 27 is counterbored to clear the stem 26 and form a shoulder 28.

The upper end of the stem 26 is provided with a collar 29 which is engaged by the shoulder 28 to limit upward movement of the sleeve 27. The sleeve is initially held in its lower position relative to the stem 26 by means of one or more shear screws 30. The upper end of the sleeve 27 is enlarged to form a head 31 which may be engaged by a conventional overshot tool, not shown.

The mandrel 19 is provided with a longitudinal bore or passageway 32 which extends into the stem 26, and is provided with side ports 33 which are initially closed by the sleeve 27 when the sleeve is in its lower position. Seal rings 34 bracket the side ports 33.

The lower end of the mandrel 19 below the key ball groove 20 is provided with a pair of spaced seal rings 35 which, when the mandrel 19 is in its lower position relative to the body 11, straddles the side ports 24, as shown in FIGURE 2.

Slidably mounted within the body 11 below the mandrel 19 is a plug 36 having a seal ring 37 and a split locking ring 38. The split locking ring 38 is capable of radial expansion. A locking groove 39 is formed in the body 11 immediately above the shoulder ring 25.

Operation of the retrievable bridging plug is as follows: The movable portion of the bridging plug, including the body structure and mandrel 19, is dropped or pumped downward within the casing string until the body 11 enters the landing collar 4, as shown in FIGURE 1. Initially, the mandrel 19 is secured in its upper position relative to the body structure by the shear screws 22, also shown in FIGURE 1, so that the key ball members 16 fit within the key ball groove 20. The split key ring 17, however, projects slightly beyond the body 11 so that it may enter the larger upper cylindrical portion 8 of the landing collar 4 but engage the stop shoulder 9.

When the key 17 engages the stop shoulder 9, further hydraulic or mechanical force downwardly causes the mandrel 19 to shear the screws 22 and move downward to cause the balls 16 to expand the key 17, as shown in FIGURE 2, into the channel 6. When this is accomplished, the bridging plug is locked against movement in either direction.

The seal ring 23 carried by the body 11 sealingly en-

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gages the walls of the lower cylindrical portion 7. The mandrel 19, on moving downward, positions the seal rings 35 so as to close the lateral ports 24. Also the plug 36 seals the lower end of the body 11 and is retained against subsequent upward displacement by the locking ring 38. Under the conditions shown in FIGURE 2, the bridging plug is not only locked in place but forms an effective seal.

When it is desired to retrieve the bridging plug, a conventional overshot tool is lowered so as to grasp the head 31 of the sleeve 27. Upward movement of the sleeve 27 shears the screws 30, permitting the sleeve to move relative to the stem 26 until stopped by the collar 29, as shown in FIGURE 3. This initial movement opens the central passageway 32.

Continued upward force on the sleeve 27 causes the sleeve to lift the stem 26 and mandrel 19 to bring the key ball groove 20 into registry with the balls 16, so that the upper beveled side of the key-receiving channel 6 deflects the split ring key 17 inwardly and frees the movable portions of the bridging plug for withdrawal, as shown in FIGURE 4.

While a particular embodiment of this invention has been shown and described, it is not intended to limit the same to the exact details of the construction set forth, and it embraces such changes, modifications, and equivalents of the parts and their formation and arrangement as come within the purview of the appended claims.

What is claimed is:

1. A bridging plug adapted for location within a casing string having casing sections connected by internally screw-threaded collars, said bridging plug comprising: a fixed landing collar having a portion adapted for reception within a casing collar and retained between the confronting ends of a pair of casing sections, said landing collar having an internal, annular, key-receiving channel and a stop shoulder below said channel; a tubular body structure slidable into said landing collar and provided with a lateral flow passage; a radially expansible key element carried by said body structure, said key element being initially engageable with said shoulder and radially movable into said channel; a mandrel having a longitudinal bore and being axially movable in said body structure between an upper and a lower position; means operatively connecting said mandrel and said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar, and means carried by said mandrel for closing said lateral flow passage when said mandrel is in its lower position.

2. A bridging plug adapted for location within a casing string having casing sections connected by internally screw-threaded collars, said bridging plug comprising: a fixed landing collar having a portion adapted for reception within a casing collar and retained between the confronting ends of a pair of casing sections, said landing collar having an internal, annular, key-receiving channel and a stop shoulder below said channel; a tubular body structure slidable into said landing collar and provided with a lateral flow passage; a radially expansible key element carried by said body structure; said key element being initially engageable with said shoulder and radially movable into said channel; a mandrel having a longitudinal bore and being axially movable in said body structure between an upper and a lower position; means operatively connecting said mandrel and said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar; seal means between said body structure and landing collar; means for sealing said mandrel with respect to said body structure, means carried by said mandrel for closing said lateral flow passage when said mandrel is in its lower position, and movable closure means on the man-

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drel for opening said longitudinal bore for flow therethrough.

3. A bridging plug adapted for location within a casing string having casing sections connected by internally screw-threaded collars, said bridging plug comprising: a fixed landing collar having a portion adapted for reception within a casing collar and retained between the confronting ends of a pair of casing sections, said landing collar having an internal, annular, key-receiving channel and a stop shoulder below said channel; a tubular body structure slidable into said landing collar and provided with a lateral flow passage; a radially expansible key element carried by said body structure, said key element being initially engageable with said shoulder and radially movable into said channel; a mandrel having a longitudinal bore and being axially movable in said body structure between an upper and a lower position; means operatively connecting said mandrel and said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar; shearable means initially holding said mandrel in a raised position relative to said body structure thereby to dispose said key element in a retracted position, means carried by said mandrel for closing said lateral flow passage when said mandrel is in its lower position, and movable closure means on the mandrel for opening said longitudinal bore for flow therethrough.

4. A bridging plug adapted for location within a casing string having casing sections connected by internally screw-threaded collars, said bridging plug comprising: a fixed landing collar screw-threaded within a casing collar and retained between the confronting ends of a pair of casing sections, said landing collar having an internal, annular, key-receiving channel and a stop shoulder below said channel; a tubular body structure slidable into said landing collar; a radially expansible key element carried by said body structure, said key element being initially engageable with said shoulder and radially movable into said channel; a mandrel axially movable in said body structure between an upper and a lower position; means operatively connecting said mandrel and said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar; seal means between said body structure and landing collar; said body structure having lateral flow passages, said mandrel having a longitudinal bore; means carried by said mandrel for closing said lateral flow passages when said mandrel is in its lower position; and closure means for said longitudinal bore operable on upward movement of said mandrel to open said longitudinal bore for flow therethrough.

5. A bridging plug adapted for location within a casing string, comprising: a landing collar adapted to be fixed within said casing string, said landing collar having an internal, annular, key channel; a tubular body structure slidable into said landing collar and provided with a lateral flow passage; a radially expansible key element carried by said body structure, said key element being radially movable into said channel; a mandrel having a longitudinal bore and being axially movable in said body structure between an upper and a lower position; means operatively connecting said mandrel and said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar, means carried by said mandrel for closing said lateral flow passage when said mandrel is in its lower position, and movable closure means on the mandrel for opening said longitudinal bore for flow therethrough.

6. A bridging plug adapted for location within a casing string, comprising: a landing collar adapted to be fixed within said casing string, said landing collar having

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an internal, annular, key channel; a tubular body structure slidable into said landing collar and provided with a lateral flow passage; a radially expansible key element carried by said body structure, said key element being radially movable into said channel; a mandrel having a longitudinal bore and being axially movable in said body structure between an upper and a lower position; means operatively connecting said mandrel and said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar; seal means between said body structure and landing collar; means for sealing said mandrel with respect to said body structure, means carried by said mandrel for closing said lateral flow passage when said mandrel is in its lower position, and movable closure means on the mandrel for opening said longitudinal bore for flow therethrough.

7. A bridging plug adapted for location within a casing string, comprising: a landing collar adapted to be fixed within said casing string, said landing collar having an internal, annular, key channel; a tubular body structure slidable into said landing collar and provided with a lateral flow passage; a radially expansible key element carried by said body structure, said key element being radially movable into said channel; a mandrel having a longitudinal bore and being axially movable in said body structure between an upper and a lower position, and engageable with said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar; shearable means initially holding said mandrel in a raised position relative to said body structure thereby to dispose

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said key element in a retracted position, means carried by said mandrel for closing said lateral flow passage when said mandrel is in its lower position, and movable closure means on the mandrel for opening said longitudinal bore for flow therethrough.

8. A bridging plug adapted for location within a casing string, comprising: a landing collar fixed within said casing string, said landing collar having an internal, annular, key channel; a tubular body structure slidable into said landing collar; a radially expansible key element carried by said body structure, said key element being radially movable into said channel; a mandrel axially movable in said body structure between an upper and a lower position, and engageable with said key element to lock said key element in said channel, when said mandrel is in its lower position, thereby to lock said body structure against axial movement in either direction with respect to said landing collar; seal means between said body structure and landing collar; said body structure having lateral flow passages, said mandrel having a longitudinal bore; means carried by said mandrel for closing said lateral flow passages when said mandrel is in its lower position; and closure means for said longitudinal bore operable on upward movement of said mandrel to open said longitudinal bore for flow therethrough.

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