

Jan. 22, 1957

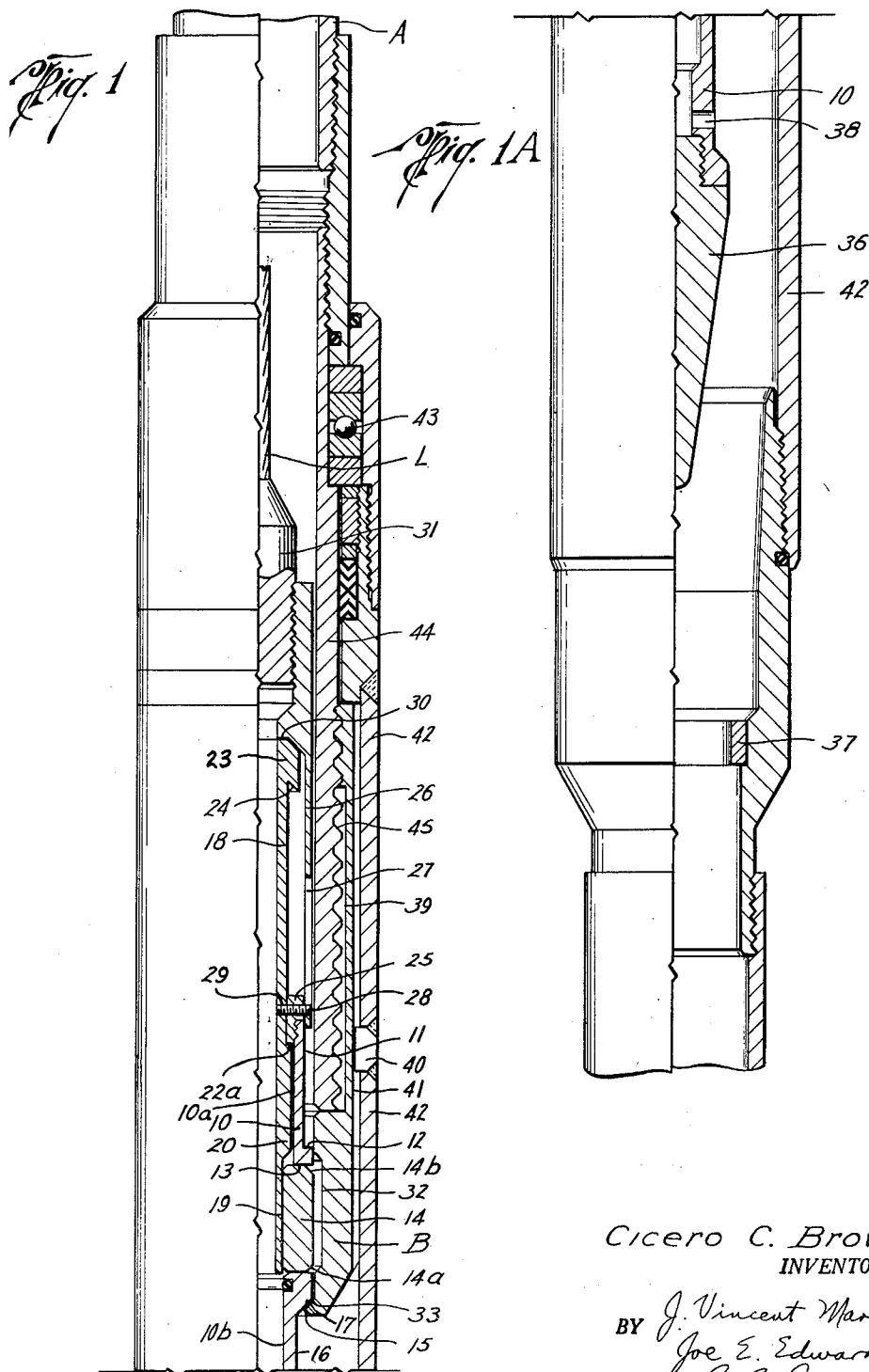
C. C. BROWN

2,778,433

WELL TOOLS

Filed Aug. 10, 1953

3 Sheets-Sheet 1



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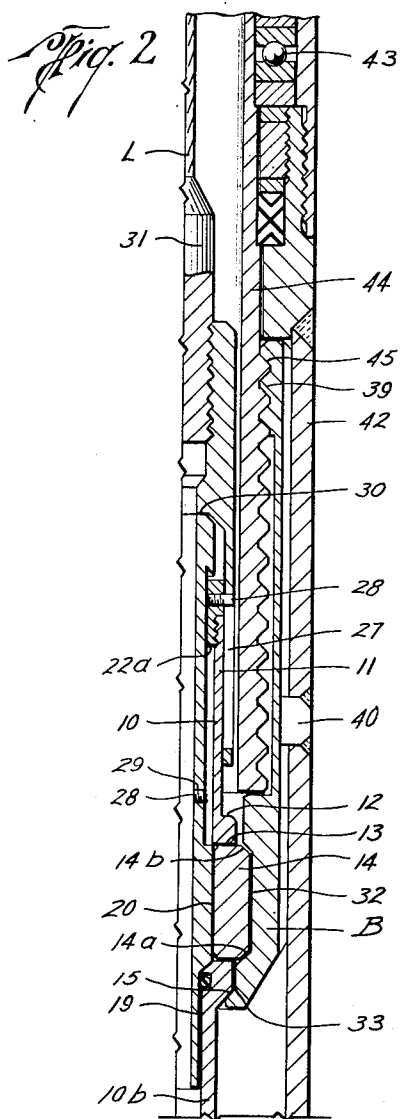
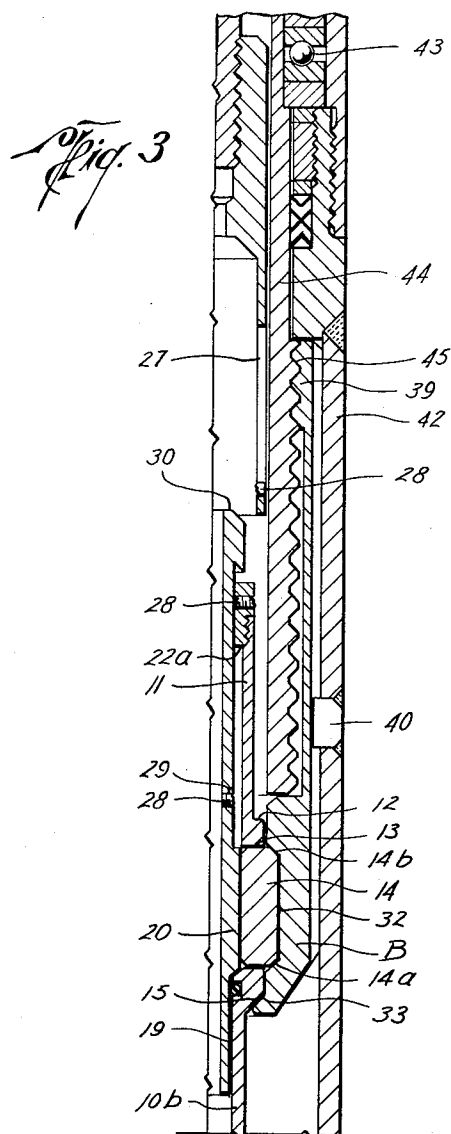
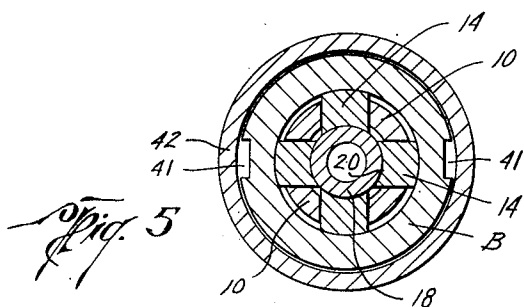
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3 Sheets-Sheet 2



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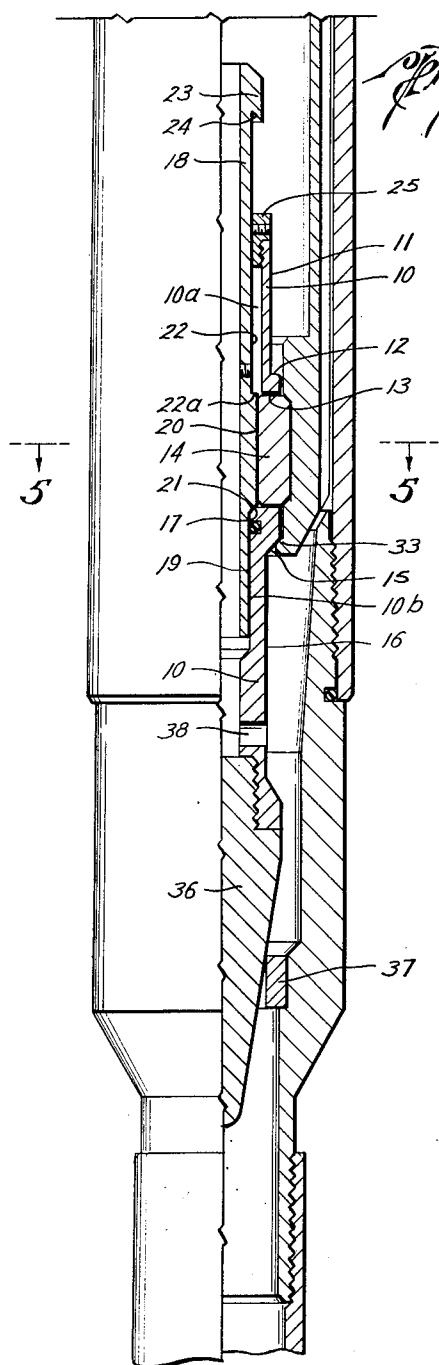
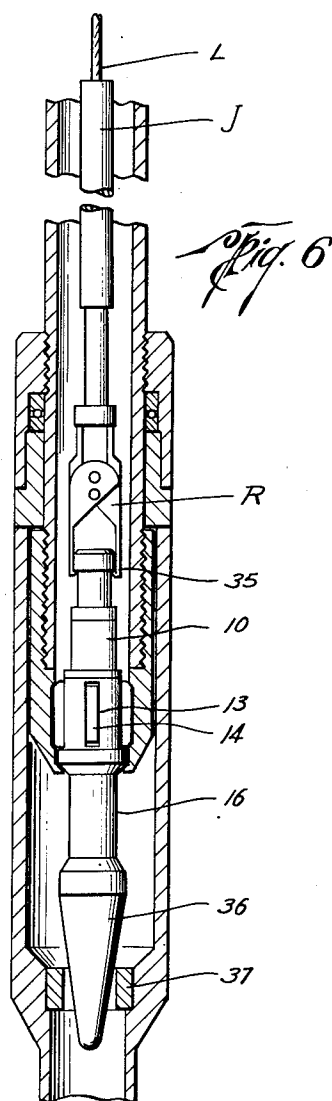
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3 Sheets-Sheet 3



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WELL TOOLS

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Application August 10, 1953, Serial No. 373,261

6 Claims. (Cl. 166—226)

This invention relates to new and useful improvements in well tools.

Various operations which are carried out within the usual well tubing or pipe string extending through a well bore make it desirable that the particular apparatus or device employed in such operation be capable of being lowered or removed from the well pipe without requiring the removal of the pipe string. In such instances the apparatus or device being operated, may be run into position within the pipe string or removed therefrom by means of a flexible or wire line. It is further desirable that the well tool which locates and locks the device within the pipe string be so arranged that upon its removal the pipe string bore is substantially fully opened or unrestricted so that any desired normal operation may be carried out through said string.

It is one object of the present invention to provide an improved well tool which may be utilized to locate and lock an apparatus or device within a well pipe string, said tool being adapted to be lowered into position or removed therefrom by means of a flexible line or cable, whereby removal of the pipe string is not necessary each time the tool is to be run or removed from the well bore.

Another object is to provide a well tool for locating and mounting any desired apparatus or device within a well tubing or similar pipe string, which makes the tool adaptable for use with choke devices, valves, or other control members, plugs or the like.

An important object of the invention is to provide an improved well tool of the character described wherein a single axially movable mandrel is employed for controlling the expansion and retraction of the locking elements of the tool, whereby movement of the mandrel in one direction expands the locking elements and movement of the mandrel in the opposite direction retracts said elements so that a simplified construction is obtained, and any standard retrieving tool may be employed in removing the tool from its position within the well pipe.

Another object is to provide in combination with a well tool of the character described an improved lowering assembly which facilitates lowering of the tool and proper setting thereof within the well pipe.

Another object is to provide a well tool which may be run into and removed from the well pipe by means of a flexible line and which may be readily combined with an actuating device, whereby the apparatus connected with the tool may be actuated by a rotation of the well tubing string; such arrangement making the tool particularly adapted for use with adjustable apparatus, such as bottom hole chokes, control valves or similar elements.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

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Figure 1 is a view partly in section and partly in elevation of the upper portion of a well tool constructed in accordance with the invention and illustrating the tool lowered into position within a pipe string;

5 Figure 1A is a continuation of Figure 1 illustrating a choke member secured to the lower end of the tool so as to be actuated thereby;

Figure 2 is a partial vertical sectional view illustrating the locking elements of the tool in an expanded position;

10 Figure 3 is a view similar to Figure 2 showing the release of the lowering assembly from the well tool;

Figure 4 is a view partly in section and partly in elevation showing the well tool in locked position and also illustrating the choke which is actuated thereby in a substantially closed position;

Figure 5 is a horizontal cross-sectional view taken on the line 5—5 of Figure 4; and

Figure 6 is a transverse vertical sectional view of a retrieving device connected with the mandrel of the well tool to illustrate the manner of removal of said tool from the pipe.

The well tool comprising the present invention will be described herein as controlling the operation of an adjustable choke within a well pipe, but it is to be understood that said tool may be employed for controlling the operation of a valve or similar member or may be utilized for locating and locking a plug or similar device within the well pipe.

As shown in the drawing the well tool comprising the present invention includes a tubular housing 10 (Figures 1, 4 and 6) having a cylindrical portion 11 at its upper end. An external annular shoulder 12 is formed at the lower end of the cylindrical portion and below the shoulder are a plurality of radial slots or openings 13 within which radially movable locking elements or blocks 14 are mounted. The number and size of the openings or slots 13 are subject to variation, and said slots are spaced circumferentially around the housing. At a point spaced below the slots 13, the housing is formed with an external annular inclined shoulder 15 and extending downwardly from the shoulder is a reduced cylindrical section 16. That portion 10a of the bore of the housing which is within the upper cylindrical portion 11 is of a larger diameter than the portion 10b of the bore of said housing which is within the lower cylindrical section 16 so that an internal annular inclined shoulder 17 is formed within the bore of the housing. This shoulder is located at the lower end of the radial slots 13.

The locking elements or blocks 14 are movable radially within their respective slots 13 and for controlling the radial expansion or retraction of said blocks a tubular mandrel 18 is provided. The mandrel extends axially within the upper portion of the housing 10, and said mandrel has its lower portion reduced in external diameter as indicated at 19. Above the reduced lower portion 19 the mandrel is enlarged as indicated at 20 whereby an external beveled shoulder 21 is formed on the mandrel. Above the enlarged section the external diameter of the mandrel is again reduced as indicated at 22. At its extreme upper end the mandrel is formed with an integral enlargement 23 which is formed with an undercut shoulder 24, whereby a suitable retrieving tool may be engaged therewith, as will be hereinafter explained. The upper portion of the housing 10 surrounds the mandrel and its bore 10a is of greater diameter than the external diameter of the upper portion 22 of the mandrel. A collar 25 is threaded into the upper end of the housing and has the wall of its bore slidably engaging the external surface 22. Downward movement of the collar on the mandrel is limited by the shoulder 22a which is formed between the upper portion 22 of the mandrel and the enlarged intermediate portion 20,

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Normally the housing 10 which carries the locking elements or blocks 14 is in a lowered position with respect to the housing and in such position the lower end of the collar 25 of the housing is engaged with the external shoulder 22a of the mandrel so that the housing is in effect suspended from the mandrel. This position of the parts is shown in Figure 1 and in such position the lower reduced end 19 of the mandrel is in alignment with or behind the locking elements or blocks. Each locking block has its lower outer edge 14a beveled while its upper outer edge 14b is also beveled or inclined, and these beveled edges will assist in effecting a retraction of the blocks while the tool is being lowered and removed from the well.

For lowering the tool into position within a well pipe a lowering assembly is employed which includes a lowering sleeve 26. The sleeve is engageable over the upper end of the mandrel and also over the upper end of the collar 25 of the housing 10 (Figure 1). The sleeve is formed with a longitudinal slot 27 and a shear pin 28 projects through the slot and also through the collar 25, as well as through an opening 29 in the mandrel. The shear pin functions to lock the housing 10 in its lowered position on the mandrel and also functions to connect the housing 10 with the sleeve 26, this latter connection being effected by reason of the pin projecting into the slot 27. When the shear pin 28 is in the lower end of the longitudinal slot 27 of the sleeve, an internal shoulder 30 within the sleeve 26 is engaged within the upper end of the mandrel 18. The upper end of the sleeve has connection through the usual socket 31 with a flexible line or cable L.

The well pipe is generally indicated at A and this may be the well tubing or other pipe string which extends within the well. The pipe string has connected therein an element B which has a plurality of locking recesses 32 therein. These recesses are adapted to be engaged by the locking elements or blocks when the latter are expanded. As will hereinafter appear the element B may take any desired form, it being only necessary that said element have the locking recesses therein and that a stop shoulder 33 be provided within its bore below said recesses.

In running the improved tool within the well, the parts of said tool are in the position shown in Figure 1 with the lowering sleeve 26 connected to the housing 10 and mandrel 18 by means of the shear pin 28. Lowering of the tool continues until the external shoulder 15 on the housing engages the stop shoulder 33 of the element B and at such time further downward movement of the housing is arrested. Thereafter the lowering sleeve 26 is urged downwardly by means of suitable jars (not shown) which are normally connected in the flexible line L and such downward movement fractures the inner end of the shear pin 29. The downward jarring on the mandrel is directly through the shoulder 30 of the sleeve 26 against the upper end of the mandrel 18 and the slot 27 in the sleeve 26 permits this jarring to be accomplished without imparting any downward jar on the housing 10.

As the inner end of the shear pin 28 is fractured the mandrel 18 may move downwardly with respect to the housing 10 in the manner illustrated in Figure 2. Since the housing 10 is supported upon the stop shoulder 33 downward movement of the mandrel moves the enlarged portion 20 of the mandrel behind the locking elements or blocks 14. Positioning of the housing by engagement of the shoulder 15 with the stop shoulder 33 previously located the locking elements or blocks 14 opposite the locking recesses 32 of the element B whereby the movement of the enlarged portion 20 of the mandrel into alignment with the locking blocks causes said locking blocks to engage their respective locking recesses.

After the blocks have engaged the recesses the housing 10 is locked to the element B and thereafter the flexible

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line is pulled upwardly in the manner illustrated in Figure 3. The upward movement of the line results in an upward movement of the lowering sleeve 26 and as the outer end of the shear pin engages the lower edge of the slot 27 this outer end is fractured so that the lowering sleeve is disconnected from the housing. The lowering sleeve is then removed and the tool is located and locked within the well pipe.

When it is desired to remove the tool it is only necessary to lower a suitable retrieving device, such as is indicated at R in Figure 6, by means of a suitable flexible line L. The usual jars indicated at J may be connected between the line L and the device R so as to permit upward jarring. The retrieving device has latching fingers 35 which are engageable with the undercut shoulder 24 of the mandrel. By an upward jarring action or a straight upward pull if no jarring is necessary, the mandrel is pulled upwardly relative to the housing so that the enlarged portion 20 is moved from behind the locking blocks and the parts are returned to the position shown in Figure 1. Thereafter a straight upward pull on the retrieving device will remove the tool from its locked position, retraction of the locking blocks being assisted by the coaction between the upper beveled edges B of said blocks with the beveled upper ends of the locking recesses.

From the foregoing it will be seen that the tool is relatively simple in construction and employs only the single mandrel which controls the operation of the locking blocks. By a downward movement of the mandrel the blocks are expanded and by an upward movement of the mandrel the blocks may be retracted. Since the tool has a diameter substantially equal to the diameter of the pipe through which it is lowered, it has not been found necessary to provide any retaining means for the locking blocks since said blocks cannot move outwardly out of their respective slots 13 during movement through the pipe.

As has been noted, the well tool hereinbefore described may be employed for locating any desired apparatus or device within the well pipe, and in the drawings it is illustrated as combined with a bottom hole choke. The choke element 36 is connected to the lower end of the housing 10 and is adapted to move with respect to a seat 37 which is provided within the well pipe string. In this use the housing 10 would be provided with a flow port 38 in its lower end. Also in this application of the tool the element B which has the locking recesses 32 disposed therein is formed with a tubular extension 39 which is slidably keyed by means of a key 40 and groove 41 to an outer conductor 42. This outer conductor is rotatably suspended on a suitable bearing 43 on the well tubing or pipe string A so that the tubing may be rotated with respect to the outer conductor. The tubing has an actuator sleeve 44 connected therewith, and this sleeve extends downwardly into the tubular extension 39 and has a coarse threaded connection 45 therewith. The outer conductor 42 may have friction springs or similar means (not shown) mounted thereon to prevent rotation thereof.

In employing the well tool to control the choke 36, it is evident that after the tool is in locked position the housing 10 of said tool which carries the choke 36 has been latched to the element B which, as noted, is secured to the non-rotatable extension 39. When the tubing or pipe string A is rotated with respect to the extension and with respect to the housing 10 which is locked thereto, the actuating sleeve 44 through its threaded connection with the extension will move the extension and the element B longitudinally within the conductor 42. Because the housing is locked to the element B through the locking blocks a similar longitudinal movement is imparted to the choke 36. Thus the choke 36 may be adjusted with respect to the seat 37 to control the flow, and such adjustment is effected by a rotation of the pipe string.

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It is evident that the tool is readily removable so as to permit the pipe to be substantially unrestricted.

The invention resides primarily in the well tool which may be run into the well pipe and locked in position therein and may be removed from the well pipe by means of a flexible line. The locking blocks are so arranged that so long as the mandrel is in a lowered position with respect to the housing, said blocks cannot be disengaged so that the tool is firmly held against movement. Due to the arrangement of the mandrel it is only necessary to impart an upward pull on the mandrel to effect a release. Because of its construction the tool requires only a minimum projection into the bore by the stop shoulder 33, and thus when the tool is removed from the well string the bore of said string is substantially full opening to permit any desired operation to be carried on therethrough.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

Having described the invention, I claim:

1. A well tool which is adapted to be lowered within a well pipe and including a tubular housing, a locking element mounted in said housing for radial movement with respect thereto, an actuating mandrel extending axially within the housing and movable to different longitudinal positions with respect thereto, means on the actuating mandrel for coacting with the locking element upon longitudinal movement of the mandrel with respect to the housing to move the locking element to radially expanded position, a lowering sleeve adapted to encompass the upper end of the mandrel and the housing, frangible means connecting the lowering sleeve to the housing and to the mandrel with said mandrel in such position relative to the housing that the locking element is in a retracted position, and an annular member mounted in the well pipe within which the tool is lowered having a locking recess therein, said recess being adapted to receive the locking element when the same is in radially expanded position to lock the housing against displacement within the well pipe.

2. A well tool which is adapted to be lowered within a well pipe and including a tubular housing, a locking element mounted in said housing for radial movement with respect thereto, an actuating mandrel extending through the housing and movable axially with respect thereto, said mandrel having a reduced cylindrical portion and an enlarged cylindrical portion, which portions are adapted to coact with the locking element, positioning of the reduced portion in alignment with the locking element permitting a radial retraction of the element and alignment of the enlarged portion with the element effecting a radial expansion of said element, a lowering sleeve adapted to encompass the upper end of the mandrel and the housing, frangible means connecting the lowering sleeve to the housing and to the mandrel with said mandrel in such position relative to the housing that the locking element is in a retracted position, and an annular member connected in the well pipe within which the tool is lowered and having a locking recess for receiving the locking element when the latter is in radially expanded position whereby the housing is locked against displacement within the well pipe.

3. A well tool adapted to be lowered within a well pipe including a tubular housing having a radial slot formed therein with an external shoulder on said housing below said slot for positioning said housing within the well pipe, an internal shoulder formed within the upper portion of said housing, a radially movable locking block mounted within the slot of said housing, an actuating mandrel extending through the housing and having an external shoulder which is engageable by the in-

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ternal shoulder of said housing, whereby said housing may be suspended from said mandrel, said mandrel having a portion of its external surface of reduced diameter, which portion is aligned with the locking block when the housing is suspended from the mandrel, whereby the locking block may move inwardly against said reduced portion and into a radially retracted position, the mandrel also having a portion of increased external diameter which is disposed above the reduced diameter portion whereby when the mandrel is moved downwardly relative to the housing, the enlarged diameter portion engages and coacts with the locking block to move the same into a radially expanded position, an annular member connected in the well pipe in which the tool is lowered and having a locking recess which is adapted to receive the locking block when the latter is moved to a radially expanded position, and an internal stop shoulder within the bore of the annular member engageable by the external shoulder on the housing for positioning the housing within the annular member so that the locking block is aligned with the locking recess of said annular member.

4. A well tool adapted to be lowered within a well pipe including a tubular housing having a radial slot formed therein with an external shoulder on said housing below said slot for positioning said housing within the well pipe, an internal shoulder formed within the upper portion of said housing, a radially movable locking block mounted within the slot of said housing, an actuating mandrel extending through the housing and having an external shoulder which is engageable by the internal shoulder of said housing, whereby said housing may be suspended from said mandrel, said mandrel having a portion of its external surface of reduced diameter, which portion is aligned with the locking block when the housing is suspended from the mandrel, whereby the locking block may move inwardly against said reduced portion and into a radially retracted position, the mandrel also having a portion of increased external diameter which is disposed above the reduced diameter portion whereby when the mandrel is moved downwardly relative to the housing, the enlarged diameter portion engages and coacts with the locking block to move the same into a radially expanded position, a lowering sleeve adapted to encompass the upper end of the mandrel and the upper end of the housing, and frangible means for connecting the lowering sleeve to the housing and to the mandrel, such connection being made when the housing is suspended from the external shoulder of the mandrel, whereby the lowering sleeve may be utilized to lower the tool within a well bore, after which the frangible means may be fractured to disconnect the mandrel from the housing and to disconnect the lowering sleeve from the tool.

5. A well tool adapted to be lowered within a well pipe including a tubular housing having a radial slot formed therein with an external shoulder on said housing below said slot for positioning said housing within the well pipe, an internal shoulder formed within the upper portion of said housing, a radially movable locking block mounted within the slot of said housing, an actuating mandrel extending through the housing and having an external shoulder which is engageable by the internal shoulder of said housing, whereby said housing may be suspended from said mandrel, said mandrel having a portion of its external surface of reduced diameter, which portion is aligned with the locking block when the housing is suspended from the mandrel, whereby the locking block may move inwardly against said reduced portion and into a radially retracted position, the mandrel also having a portion of increased external diameter which is disposed above the reduced diameter portion whereby when the mandrel is moved downwardly relative to the housing, the enlarged diameter portion engages and coacts with the locking block to move the same into a radially expanded position, a lowering sleeve adapted to encompass the upper end of the mandrel and

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the upper end of the housing, and frangible means for connecting the lowering sleeve to the housing and to the mandrel, such connection being made when the housing is suspended from the external shoulder of the mandrel, whereby the lowering sleeve may be utilized to lower the tool within a well bore, after which the frangible means may be fractured to disconnect the mandrel from the housing and to disconnect the lowering sleeve from the tool, said frangible means connecting the housing to the mandrel against relative movement and connecting the housing to the lowering sleeve by means of a longitudinal slot in said lowering sleeve, whereby the lowering sleeve may undergo a limited movement with respect to the housing when in connected position.

6. A well tool adapted to be lowered within a well pipe including a tubular housing having a radial slot formed therein with an external shoulder on said housing below said slot for positioning said housing within the well pipe, an internal shoulder formed within the upper portion of said housing, a radially movable locking block mounted within the slot of said housing, an actuating mandrel extending through the housing and having an external shoulder which is engageable by the internal shoulder of said housing, whereby said housing may be suspended from said mandrel, said mandrel having a portion of its external surface of reduced diameter, which portion is aligned with the locking block when the housing is suspended from the mandrel, whereby the locking block may move inwardly against said reduced portion and into a radially retracted position, the man-

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drel also having a portion of increased external diameter which is disposed above the reduced diameter portion whereby when the mandrel is moved downwardly relative to the housing, the enlarged diameter portion engages and coacts with the locking block to move the same into a radially expanded position, a lowering sleeve adapted to encompass the upper end of the mandrel and the upper end of the housing, frangible means for connecting the lowering sleeve to the housing and to the mandrel, such connection being made when the housing is suspended from the external shoulder of the mandrel, whereby the lowering sleeve may be utilized to lower the tool within a well bore, after which the frangible means may be fractured to disconnect the mandrel from the housing and to disconnect the lowering sleeve from the tool, and means on the upper end of the mandrel for engagement by a retrieving tool, whereby the mandrel may be moved upwardly with respect to the housing to retract the locking block and thereafter may be utilized to remove the tool from the well bore.

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