June 7, 1966 H. B. SCHRAMM 3,254,723

LOCKING MECHANISM FOR WELL DEVICES

Original Filed Nov. 19, 1962

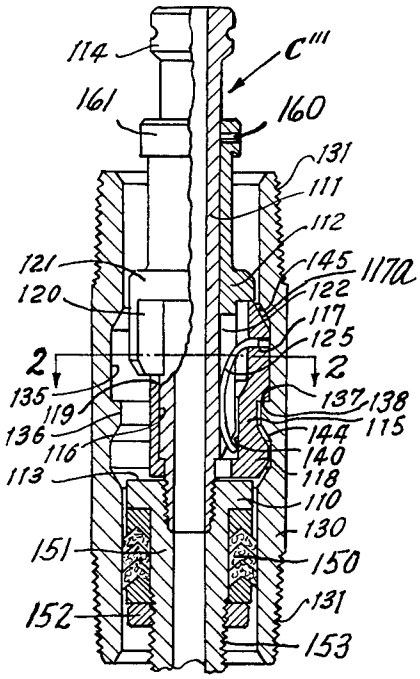


Fig. 1

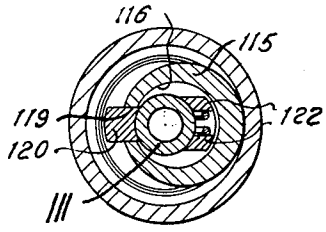


Fig. 2

INVENTOR.

Harry B. Schramm

BY Hastings Ackley and Walter J. Jay

ATTORNEY

United States Patent Office 3,254,723 Patented June 7, 1966

3,254,723

LOCKING MECHANISM FOR WELL DEVICES

Harry B. Schramm, deceased, late of Dallas, Tex., by Josephine Schramm, independent executrix, Dallas, Tex., assignor, by mesne assignments, to Otis Engineering Corporation, Dallas County, Tex., a corporation of Delaware

Original application Nov. 19, 1962, Ser. No. 243,694, now Patent No. 3,207,224. Divided and this application Oct. 23, 1964, Ser. No. 406,201

12 Claims. (Cl. 166—217)

This invention relates to new and useful improvements in locking mechanisms for well devices. This application is a division of applicant's co-pending application, Serial 243,694, filed November 19, 1962, now patent No. 3,207,224.

Various types of removable sub-surface carrier and locking devices have been used for supporting and removably positioning sub-surface flow control and safety devices in deep, high-pressure oil and gas wells. These devices are adapted to be lowered into and removed from the well pipe or flow conductor, and positioned therein by means of a suitable running and pulling mechanism lowerable in the well on a small flexible steel measuring line or the like. It has commonly been the practice, in the past, to use as anchoring elements or locking elements on such devices a plurality of separated and separately movable expansible members, such as dogs, keys or the like, which are suspended from a common carrier or project outwardly through apertures in a carrier sleeve or the like, and which are moved into locking position by a wedge or other locking member inserted between the movable elements to spread the same and provide a plurality of shoulders having a combined diameter greater than that of the downwardly facing locking shoulder against which they engage to hold the well device in place in the well pipe. In many cases, the expander member must be moved downwardly with respect to the expansible anchoring elements or dogs before the dogs can be moved to a retracted position permitting them to be withdrawn from the landing nipple. Sometimes, accumulations of sand, corrosion or other extraneous matter cause the anchoring elements to become stuck in expanded position and result in an extremely difficult job of removing the well device from a position in the well. Furthermore, the manufacture of the separate anchoring elements and the carrier therefor requires greater expense, since a longer time is required to machine the separate elements. Also, the elements are sometimes subjected to strain which they are not capable of withstanding, or corrosion or erosion will wear off the supporting member connecting the element to the carrier or retaining it in place on the carrier so that the element cannot be moved from expanded to retracted position and the well device is so locked in place in the well that it is necessary to remove the tubing from its position in the well in order to remove the well device from the flow conductor.

It is, therefore, one object of this invention to provide an improved removable carrier and locking device adapted to be lowered into a well flow conductor and locked in place therein for supporting a well flow control or safety device in the well, or for use in performing other well operations.

A particular object of the invention is to provide an improved and simplified locking mechanism for locking and unlocking a carrier in place in a well flow conductor, whereby positioning and releasing of the well device in the conductor is simplified and positive operation assured.

A still further object of the invention is to provide an improved locking mechanism of the character described wherein the locking mechanism is releasable from locking position by a straight upward pull on the device to assure removal thereof; such structure providing for use of retrieving devices which are operated in response to fluid pressure from within the well and therefore move upwardly out of the well.

A particular object of the invention is to provide an improved carrier and locking mechanism wherein the locking element may be positively freed from locking position for movement to releasing position to permit the mechanism to be withdrawn from within a well flow conductor.

Another object of the invention is to provide a locking mechanism of the character described which is extremely simple in structure and operation, which has few parts which are positive in operation and which may be positively removed to freed position.

Additional objects and advantages of the invention will be readily apparent from the reading of the following description of a device constructed in accordance with the invention, and reference to the accompanying drawings thereof, wherein:

FIGURE 1 is a view partly in elevation and partly in section, of a carrier and locking mechanism, and showing the same locked in place in a landing nipple; and,

FIGURE 2 is a horizontal cross-sectional view taken on the line 2—2 of FIGURE 1.

In the drawings, the letter C''' illustrates a carrier and locking device constructed in accordance with the invention wherein the body **110** has an elongate neck or inner mandrel **111** axially aligned with and extending upwardly from the upper end of the body, both body and mandrel being provided with aligned axially extending bores providing a flow passage through the carrier and locking device. An elongate locking sleeve **112** is slidable longitudinally on the mandrel **111**, and is confined thereon between the upwardly facing shoulder **113** at the upper end of the body **110** and an external annular flange or head **114** at the upper end of the mandrel. The length of the mandrel is such that the locking sleeve **112** may undergo a limited longitudinal movement thereon for the purpose of moving into and out of locking position with respect to an elongate locking key ring **115**, also slidably mounted on the mandrel **111** and having an eccentrically positioned bore **116** into which the lower end of the locking sleeve **112** is slidable. The locking key ring is formed with a pair of longitudinally spaced bosses **117** and **118** on one portion of its periphery and a longitudinally extending slot **119** in its wall diametrically opposed to the bosses. A guide rib **120** is formed on the exterior of the locking sleeve **112** projection downwardly from an external annular flange **121** at the lower end of said sleeve. A pair of locking prongs **122** depend from the under side of the flange **121** at a point diametrically opposed to the key **120**, and these ribs are adapted to engage the inner bore wall of the locking key ring **115** behind the bosses **117** to hold the locking key ring in a laterally displaced position with the bosses projecting. A spring **125**, formed of a wire bent upon itself at its mid-point to form a pair of substantially C-shaped runs, has its free ends mounted in suitable apertures in the inner wall of the locking key ring **115** and engages the outer periphery of the mandrel **111** to bias the key ring to a position in which the bosses are projecting laterally. This spring is adapted to ride in the space between the bifurcated prongs **122**, as clearly shown in FIGURE 2. The spring may be omitted, if desired.

The body member **110** may be provided with an external annular sealing or packing assembly **150** comprising, for example, a plurality of substantially V-shaped inverted sealing rings held in place on the reduced lower

sealing portion **151** of the body member by means of a packing lock nut **152** threaded onto the externally screw threaded lower end **153** of said body. Obviously, if desired, any suitable well flow control or safety device, or any other suitable well tool, may be threaded on to the lower end of the body member below the packing lock nut **152**, whereby the carrier and locking assembly C''' will support such tool or device in the well conductor or tubing or the like at the position determined by the location of the landing nipple **130** in said flow conductor or the like.

The carrier and locking device is adapted to seat and lock in sealing position in a landing and sealing nipple **130**, having means such as the external screw threads **131** at its opposite ends for connecting it in a well flow conductor. An internal locking and positioning groove **135** is formed in the bore wall of the nipple, and has intermediate its ends an inwardly projecting annular stop flange **136**, the upper face of which is substantially horizontal to provide an abrupt upwardly facing stop shoulder **137** against which the downwardly facing substantially horizontal stop shoulder **138** at the lower end of the upper boss **117** of the locking key ring is adapted to engage to limit downward movement of the carrier and locking device in the well flow conductor. The configuration of the locking groove **135** and flange **136** therein correspond substantially to the configuration of the bosses **117** and **118** formed on the locking key ring **115**. Thus, when the bosses on said locking key ring are engaged in said groove in the manner shown in FIGURE 1, the engagement of the shoulder **138** on the locking key ring with the stop shoulder **137** in the groove prevents further downward movement of the carrier and locking device, while the engagement of the beveled shoulder at the upper end of each of the bosses **117** and **118** with the corresponding beveled shoulders in the groove **135** prevents upward movement of the carrier and locking device out of the landing nipple when the bifurcated locking prongs **122** are positioned to engage the reduced lower portion **140** of the bore of the locking key ring in the manner shown in FIGURE 1. However, when the locking sleeve **112** is moved upwardly on the mandrel **111**, the bifurcated locking legs or prongs **122** will be moved upwardly in the bore of the locking key ring to a position above the reduced bore **140**, and the locking key ring may move laterally with respect to the mandrel and body to permit the beveled shoulders at the upper ends of the bosses to cam said locking key ring inwardly and permit the bosses to pass the locking shoulders **144** and **145** in the locking groove of the landing nipple. Furthermore, the beveled surfaces at the upper end of the bosses will likewise cam the bosses toward a retracted position as the carrier and locking device is lifted through the well bore to permit the bosses to pass other obstructions encountered in such movement. The boss **118** at the lower end of the locking key ring is positioned to prevent engagement of the shoulder **138** with any other obstruction in the well pipe or flow conductor until a locking groove **135** having a configuration conforming to the configuration of the bosses is encountered, whereupon the shoulder **138** on the locking key ring will engage the stop shoulder **137** in the groove to limit further downward movement of the device in the well.

The carrier and locking device C''' may be simply dropped through the tubing string into place in the nipple **130**, or it may be inserted into and locked in the landing nipple by means of a suitable running tool (not shown) such as is shown in the patent to H. C. Otis, Re. 20,546, having shear pins extending through the running tool and into apertures **160** formed in the under-cut retrieving flange **161** at the upper end of the lock sleeve. When the downwardly facing stop shoulder **138** on the lower end of the upper boss **117** of the locking key ring engages the upwardly facing stop shoulder **137** in the locking groove **135** in the landing nipple, further downward movement of the carrier is prevented and the locking key ring is moved outwardly relative to the mandrel by the spring **125**, whereby the engagement of the shoulders holds the ring against further downward movement in the locking nipple. The bifurcated prongs **122** on the lower end of the locking sleeve **112** then engage within the reduced lower portion of the bore **116** of the locking key ring to positively lock the key in the expanded position holding the tool against movement in either direction longitudinally out of the landing nipple. It will be apparent that the carrier and locking device is provided with the stop shoulder for limiting downward movement of the device formed on the locking key ring, whereby the bore of the well flow conductor may be without restrictions formed therein throughout its length. The locking recess **135** having a configuration conforming to that of the bosses of the locking sleeve is of greater longitudinal dimension than that of any recess likely to be encountered in the flow conductor thereabove, so that the device will not be stopped until the bosses on the locking key ring have entered the groove **135**. Obviously, the length of the upper boss **117** may be increased or diminished to provide for stopping the device at other positions in the well, in the manner described in the patent to I. A. Miller, 2,673,-614, issued March 30, 1954.

To remove the carrier and locking mechanism from its anchored position in the landing nipple, a suitable retrieving tool (not shown) such as that also shown in the patent to H. C. Otis, Re. 20,546, having a plurality of resilient hook members depending therefrom is lowered into the well flow conductor or tubing until the hook members engage under the undercut retrieving flange **161** at the upper end of the locking sleeve **112**. With the retrieving tool so engaged with the locking sleeve, upward force applied to the retrieving tool will lift the locking sleeve to retract the bifurcated locking prongs **122** from engagement in the reduced lower portion **116** of the bore of the locking key ring and move the sleeve upwardly until the upper end thereof engages the lower end of the head **114** at the upper end of the mandrel, whereupon further upward force applied to the retrieving tool will lift the mandrel upwardly out of the nipple, the beveled upper surface **117***a* at the upper end of the upper boss **117** of the locking key ring engaging the downwardly beveled surface **145** at the upper end of the locking recess or groove in the landing nipple to cam the bosses **117** and **118** of the locking key ring inwardly of the mandrel out of the locking groove and permit the carrier and locking device to be lifted upwardly out of the landing nipple and out of the tubing or other well flow conductor. The camming action provided by the engagement of the beveled surface **117***a* at the upper end of the upper boss of the locking key ring with the lock shoulders in the landing nipple assures lateral inward displacement of the locking ring to the freed to releasing position. There is adequate space provided in the bore of the ring for such lateral movement to permit the ring to move to releasing position, whereby the device may readily be removed from the well bore.

From the foregoing, it will be seen that an improved locking mechanism has been disclosed which is adapted to be lowered into a well flow conductor and locked in place therein for supporting a well device in the well. The locking mechanism is simple instructure and positive in actuation and may be released from locking position by a straight upward pull on the device, whereby retrieving devices operated in response to fluid pressure from within the well may be connected to the device by means of a suitable retrieving tool and pressure applied to the retrieving device to flow the same upwardly out of the well without the necessity of using a flexible line or cable or other mechanical means operable from the well surface, though such means may be used.

It will particularly be noted that the locking structure is simple and positive in operation, formed of few parts,

economical to manufacture and simple to install and remove.

The foregoing description of the invention is explanatory only, and changes in the details of the construction illustrated may be made by those skilled in the art, within the scope of the appended claims, without departing from the spirit of the invention.

What is claimed and desired to be secured by Letters Patent is:

1. A well tool including: an elongate mandrel; a lock sleeve mounted on said mandrel and slidable longitudinally thereon; said lock sleeve having an external lock surface formed thereon; and a locking member movably mounted on said mandrel and having a bore and a locking surface in its bore engageable by the lock surface of said sleeve, whereby said locking member is displaced laterally with respect to said mandrel to projecting locking position; said lock sleeve being slidable on said mandrel to a position disengaging the lock surface thereon from the locking surface in the bore of the locking member, whereby said locking member may move laterally with respect to the mandrel to a retracted position, said locking member having means thereon providing an abrupt laterally extending projecting stop shoulder intermediate its ends and an oppositely facing projecting lock shoulder spaced longitudinally from said stop shoulder.

2. A well tool of the character set forth in claim 1 and including: coengageable means on said lock sleeve and said locking member limiting relative rotative movement between said lock sleeve and said locking member for assuring engagement of the lock surface of said sleeve with the locking surface in the locking member.

3. A well tool including: an elongate mandrel; a lock sleeve mounted on said mandrel and slidable longitudinally thereon; said lock sleeve having an external lock surface formed thereon; a locking member laterally slidable on said mandrel and having a bore and a locking surface in its bore engaged by the lock surface of said sleeve, whereby said locking member is displaced laterally with respect to said mandrel to laterally projecting locking position; and coengageable means on said manrel and on said locking member limiting longitudinal movement of said locking member relative to said mandrel; said lock sleeve being slidable longitudinally on said mandrel to a position wherein the lock surface on said sleeve is out of engagement with the locking surface in the bore of said locking member, whereby said locking member may move laterally on said mandrel to a retracted position, said locking member having means thereon providing an abrupt laterally extending downwardly facing projecting stop shoulder and an upwardly facing beveled projecting lock shoulder spaced longitudinally from said stop shoulder.

4. A well tool including: an elongate mandrel; a lock sleeve mounted on said mandrel and slidable longitudinally thereon; said lock sleeve having an external lock surface formed thereon; an annular locking member laterally slidable on said mandrel and having an internal lock surface engageable by the lock surface of said sleeve, whereby said locking member is displaced laterally with respect to said mandrel to a laterally projecting locking position; first coengageable means on said mandrel and on said locking member limiting longitudinal movement of said locking member relative to said manrel; second coengageable means on said mandrel and said sleeve and on said locking member and said sleeve limiting longitudinal movement of said sleeve relative to said mandrel; said lock sleeve being slidable longitudinally on said mandrel to a position wherein the lock surface on said sleeve is out of engagement with the locking surface of said annular locking member, whereby said locking member may move laterally on said mandrel to a retracted position; and means on said locking member forming an abrupt laterally extending projecting stop shoulder and an oppositely facing projecting lock shoulder spaced longitudinally from said stop shoulder.

5. A well tool including: an elongate mandrel; a lock sleeve mounted on said mandrel and slidable longitudinally thereon, said lock sleeve having an external lock surface on its lower end portion; locking means laterally movable on said mandrel and having a longitudinal lock bore therethrough of a size to receive and be engaged by the lock surface of said lock sleeve; an upwardly facing shoulder on said mandrel having an external cylindrical surface concentric with the longitudinal axis of said mandrel; said lock sleeve having an external downwardly facing stop shoulder above said lock surface on said lock sleeve; longitudinal movement of said lock sleeve relative to said locking means and said mandrel being limited by engagement of said shoulders with said locking means and said lock sleeve, said locking means being movable laterally of said mandrel and sleeve when said lock surface of said sleeve is not engaged in said lock bore of said locking means; an abrupt external laterally projecting downwardly facing stop shoulder on said locking means intermediate its ends; and an external upwardly facing beveled lock shoulder on said locking means spaced longitudinally thereof from said stop shoulder; said lock sleeve being movable longitudinally relative to said locking means to position said lock surface of said lock sleeve in said lock bore of said locking means; said locking means when so engaged with said lock surface being disposed eccentrically with respect to the longitudinal axis of the mandrel so as to project the stop and lock shoulder of said locking means laterally beyond the cylindrical external surface of the mandrel stop shoulder in locking position; said lock sleeve being movable longitudinally upwardly on said mandrel to disengage said lock surface from within said lock bore of said locking means to permit said locking means to move laterally out of its eccentrically disposed locking position.

6. A well tool of the character set forth in claim 5 and including: coengageable means on said lock sleeve and said locking means limiting relative rotative movement therebetween on said mandrel.

7. A well tool including: an elongate tubular mandrel having an external annular flange intermediate its ends providing an upwardly facing supporting shoulder, the external diameter of the mandrel above said shoulder being reduced to form an elongate cylindrical stem portion having an enlarged head at its upper end; a lock sleeve slidable on said mandrel between said head and said upwardly facing shoulder, said lock sleeve having an external lock surface formed thereon and an enlarged external annular flange above said lock surface; annular locking means slidable laterally of said mandrel between said external annular flange of said lock sleeve and the upwardly facing supporting shoulder of said mandrel, said annular locking means having formed on its external periphery a pair of longitudinally spaced bosses, the upper one of said bosses having a downwardly and outwardly inclined beveled upper end and an abrupt laterally extending stop shoulder at its lower end; the lower of said bosses having outwardly convergent beveled shoulders at its upper and lower ends; said external lock surface of said lock sleeve being receivable in the bore of said annular locking means, one of the bore of said annular locking means and said external lock surface of said lock sleeve being disposed eccentrically with respect to the longitudinal axis thereof, whereby when said lock sleeve is positioned with the lock surface disposed in the bore of said annular locking means said locking means is held displaced laterally with the portion of the external periphery thereof having the bosses thereon in a laterally projecting position; means between said annular locking means and said mandrel normally biasing said locking means outwardly to said laterally projecting position; and means on said lock sleeve engageable with said annular locking means for positive displacement of said annular lock means to said laterally projecting position upon longitudinal downward movement of said lock sleeve on said mandrel.

8. A well tool of the character described in claim 7, wherein resilient means is disposed within said annular locking means and engageable with said mandrel for biasing said annular locking means outwardly toward projecting locking position.

9. A well tool of the character set forth in claim 7 and including: coengageable means on said lock sleeve and said locking means limiting relative rotative movement therebetween on said mandrel.

10. A well tool including: a tubular landing nipple having a bore provided with an internal annular recess having an internal annular flange formed therein, said flange provided with an abrupt upwardly facing stop shoulder at its upper end and a beveled shoulder at its lower end, the extreme ends of said recess being divergently inwardly beveled; an elongate tubular mandrel having an external annular flange intermediate its ends providing an upwardly facing supporting shoulder, the external diameter of the mandrel above said shoulder being reduced to form an elongate cylindrical stem portion having an enlarged head at its upper end; a lock sleeve slidable on said mandrel between said head and said upwardly facing shoulder, said lock sleeve having an external lock surface formed thereon and an enlarged external annular flange above said lock surface; annular locking means slidable laterally of said mandrel between said external annular flange of said lock sleeve and the upwardly facing supporting shoulder of said mandrel, said annular locking means having formed on its external periphery a pair of longitudinally spaced bosses, the upper one of said bosses having a downwardly and outwardly inclined beveled upper end and an abrupt laterally extending stop shoulder at its lower end; the lower of said bosses having outwardly convergent beveled shoulders at its upper and lower ends, said abrupt shoulder of said upper boss being engageable with said upwardly facing abrupt shoulder in said landing nipple to limit downward movement of said annular locking means in said landing nipple when the shoulders are so engaged; said external lock surface of said lock sleeve being receivable in the bore of said annular locking means, one of the bore of said annular locking means and said external lock surface of said lock sleeve being disposed eccentrically with respect to the longitudinal axis thereof, whereby when said lock sleeve is positioned with the lock surface disposed in the bore of said annular locking means, said locking means is held displaced laterally with the portion of the external periphery thereof having the bosses thereon in a laterally projecting position; means between said annular locking means and said mandrel normally biasing said locking means outwardly to said laterally projecting position; and means on said lock sleeve engageable with said annular locking means for positive displacement of said annular lock means to said laterally projecting position upon longitudinal downward movement of said lock sleeve on said mandrel.

11. A well tool including: an elongate tubular mandrel having an external annular flange intermediate its ends providing a downwardly facing shoulder, the external diameter of the mandrel above said shoulder being reduced to form an upwardly facing shoulder and an elongate cylindrical stem portion thereabove having an enlarged head at its upper end; a lock sleeve slidable on said mandrel between said head and said upwardly facing shoulder, said lock sleeve having an external lock surface formed thereon and an enlarged external annular flange above said lock surface; annular locking means slidable laterally of said mandrel between said external annular flange of said lock sleeve and the upwardly facing shoulder of said mandrel, said external lock surface of said lock sleeve being receivable within the bore of said annular locking means, one of the external periphery of said annular locking means and said external lock surface of said lock sleeve being disposed eccentrically with respect to the axis of said mandrel when said lock sleeve is positioned with the lock surface disposed in the bore of said annular locking means, whereby the locking means is held displaced laterally with a portion of the external periphery thereof in a laterally projecting position, said lock sleeve having means thereon engageable with the annular locking means for positive displacement of said annular locking means to said laterally projecting position upon longitudinal downward movement of said lock sleeve on said mandrel, said annular locking means being slidable laterally of said mandrel on the upwardly facing shoulder thereon at the lower end of said stem; and biasing means between said mandrel and said annular locking means biasing said locking means toward laterally projecting position; the external periphery of the laterally projecting portion of said annular locking means having formed thereon a pair of longitudinally spaced bosses, the upper one of said bosses having an abrupt laterally extending stop shoulder formed by its lower end, the other shoulders of said bosses being beveled.

12. A well tool of the character set forth in claim 11 and including: coengageable means on said lock sleeve and said locking means limiting relative rotative movement therebetween on said mandrel.

References Cited by the Examiner

UNITED STATES PATENTS

2,506,680	5/1950	Otis	166—217
2,920,704	1/1960	Fredd	166—206
3,074,485	1/1963	McGowen	166—217

CHARLES E. O'CONNELL, *Primary Examiner.*

BENJAMIN HERSH, *Examiner.*

J. A. LEPPINK, *Assistant Examiner.*