April 22, 1958 J. LYNES ET AL 2,831,542

LOCKING ASSEMBLY FOR TREATING AND TESTING TOOLS

Original Filed Aug. 28, 1948 6 Sheets-Sheet 1

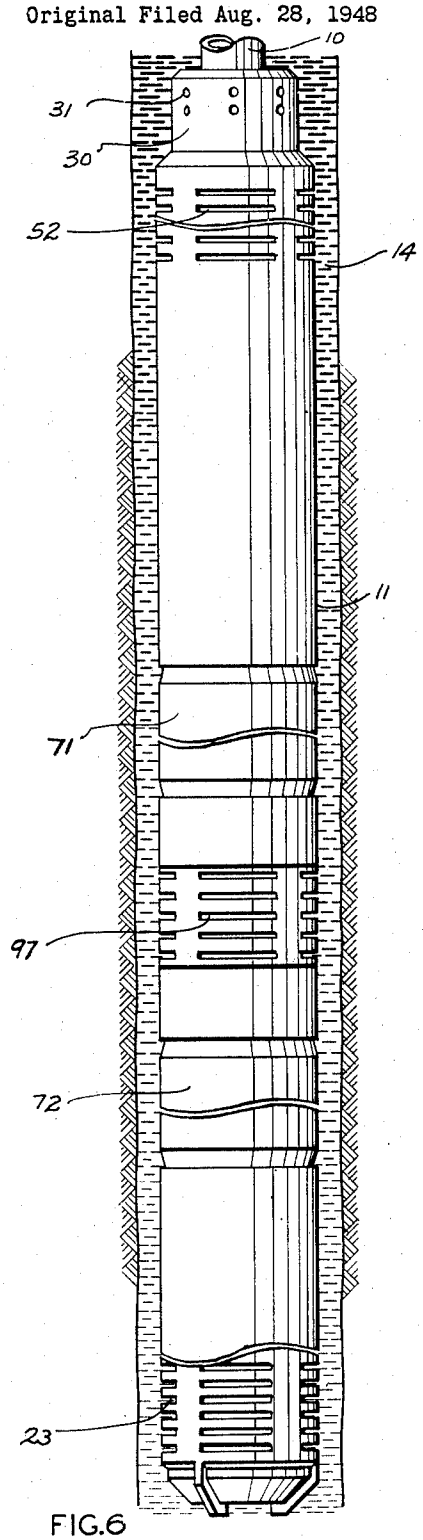


FIG.6

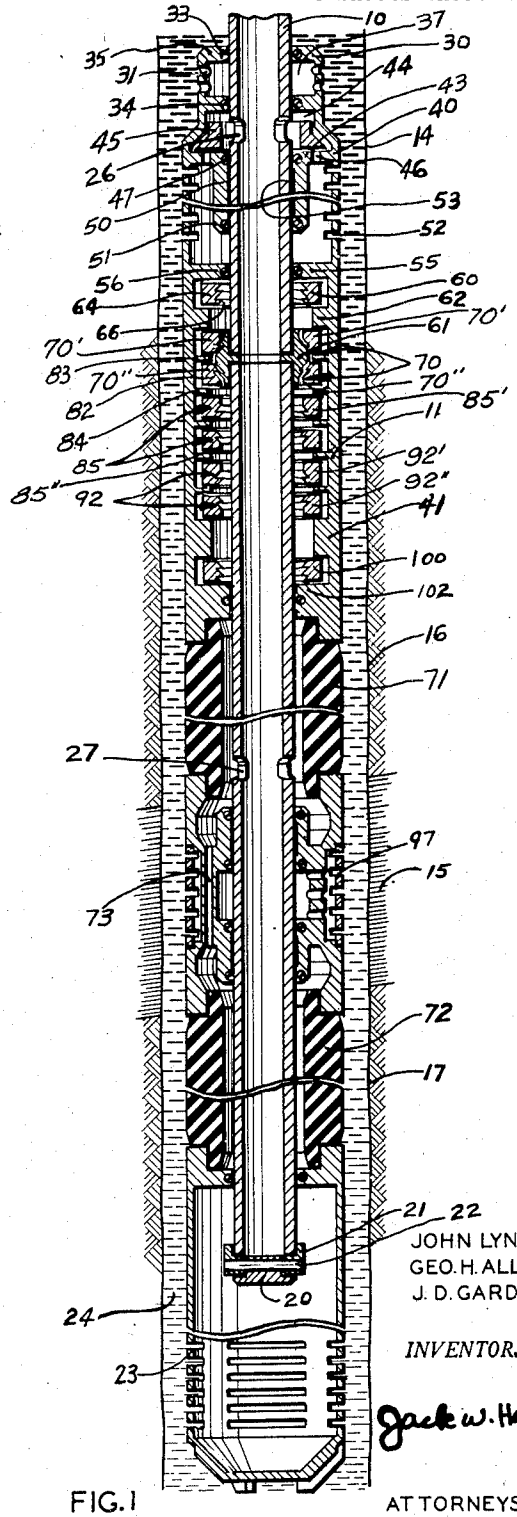


FIG.1

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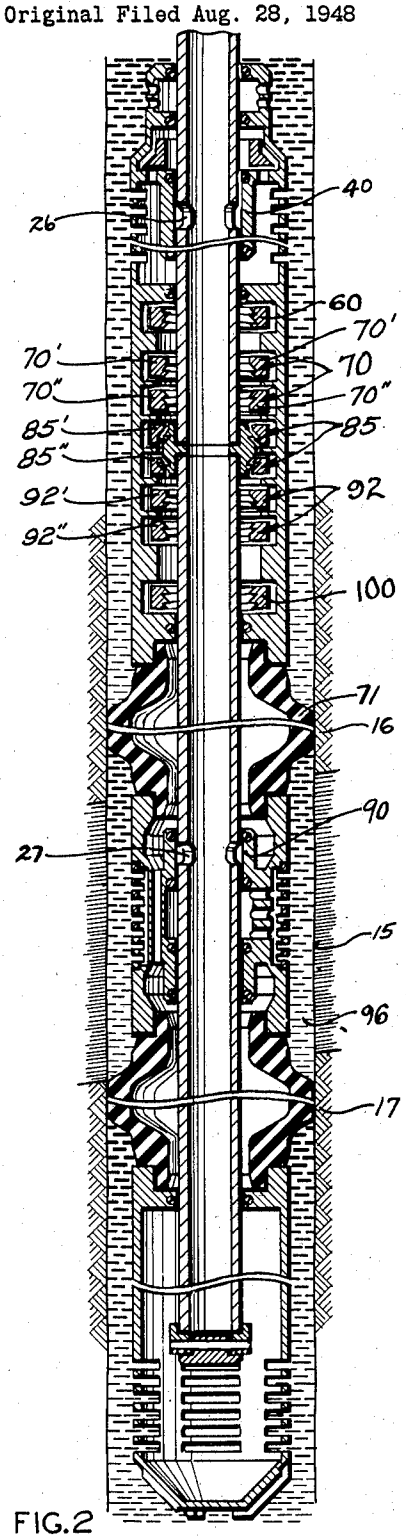


FIG. 2

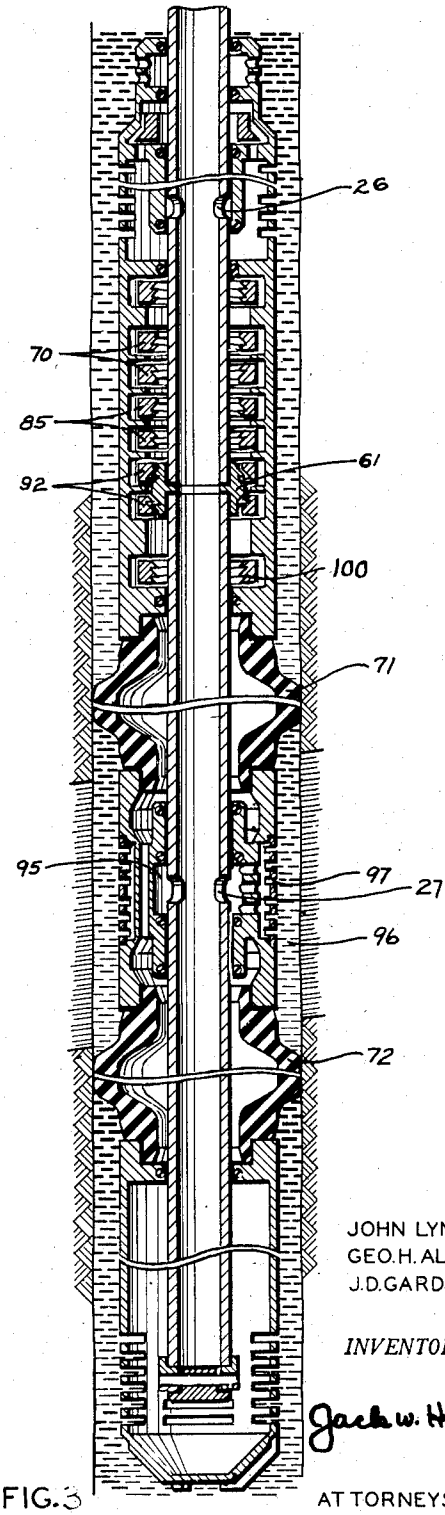


FIG. 3

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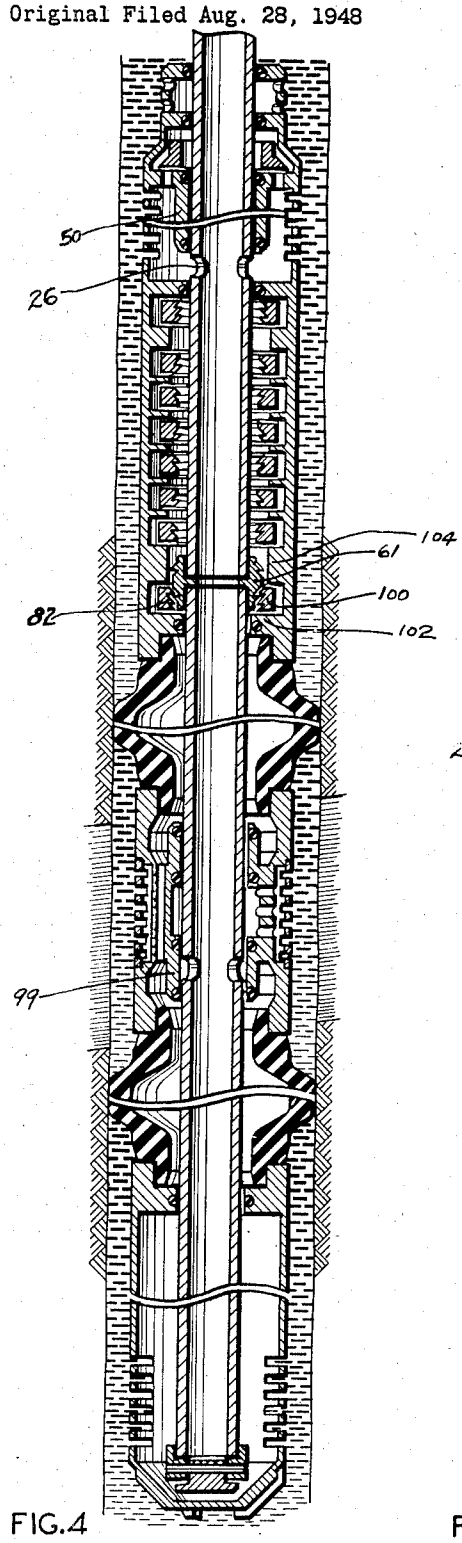


FIG. 4

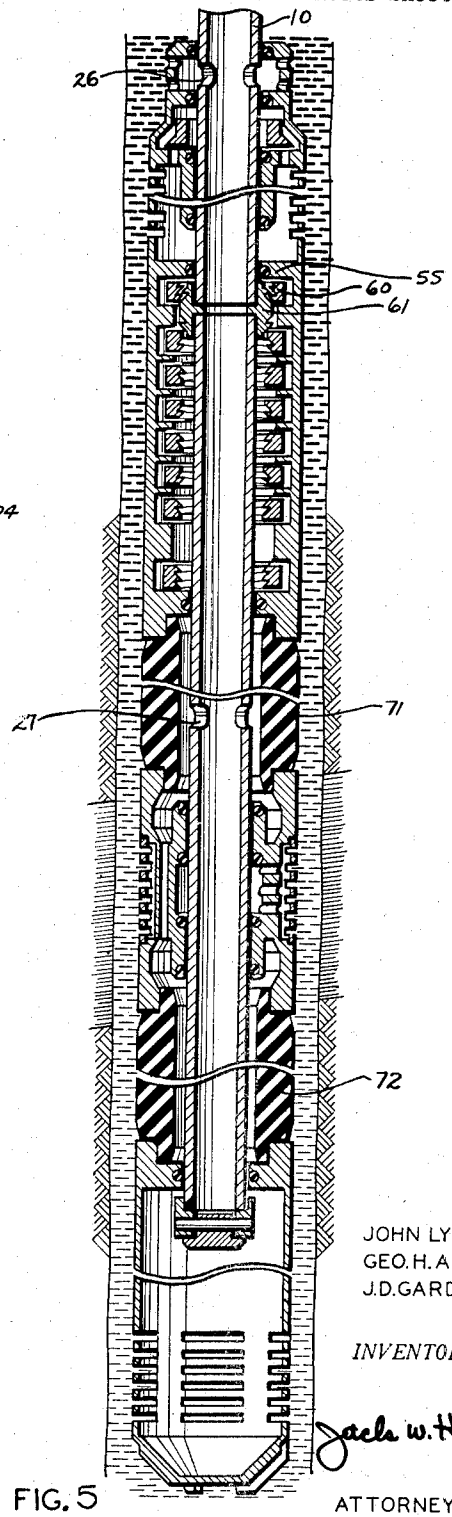


FIG. 5

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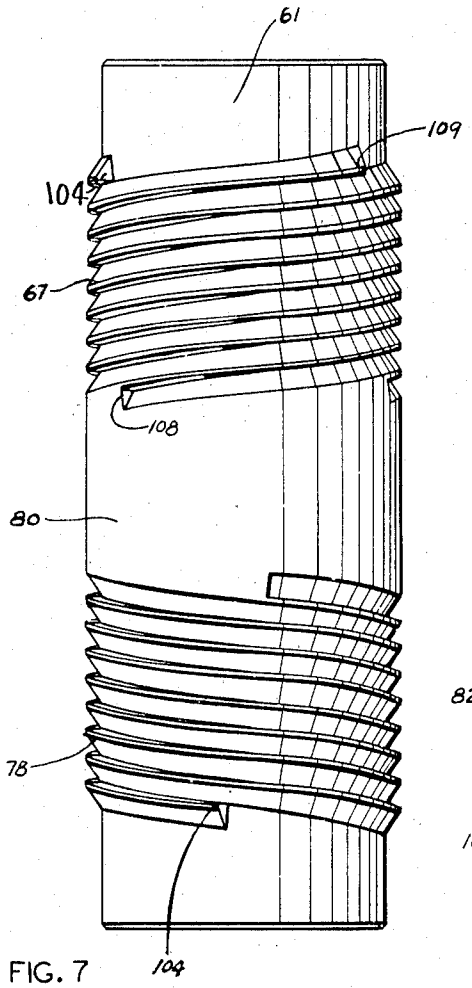


FIG. 7

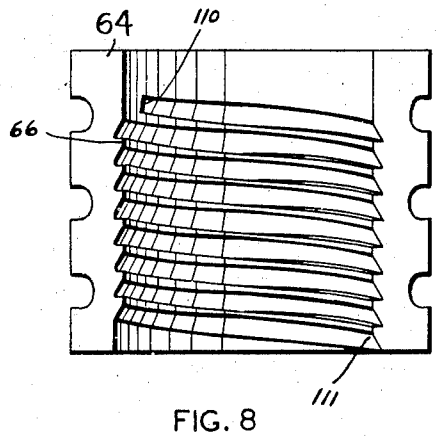


FIG. 8

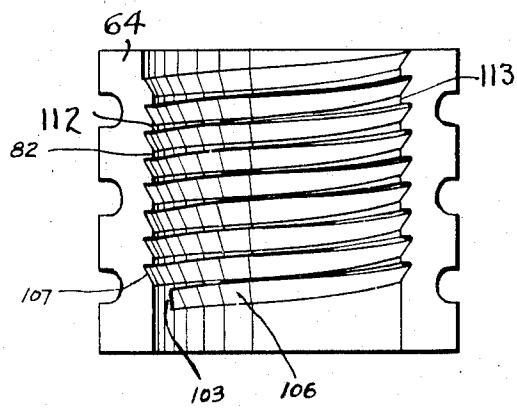


FIG. 9

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LOCKING ASSEMBLY FOR TREATING AND TESTING TOOLS

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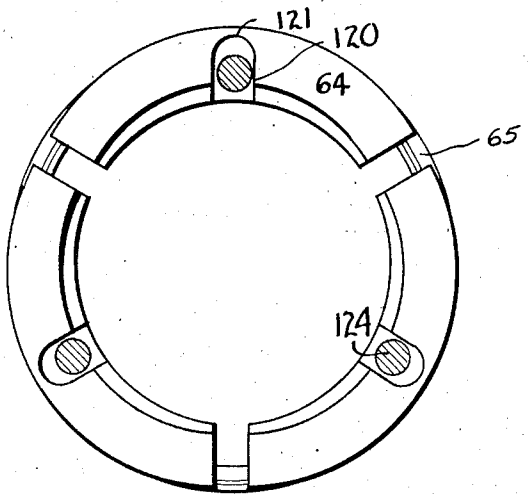


FIG. 10

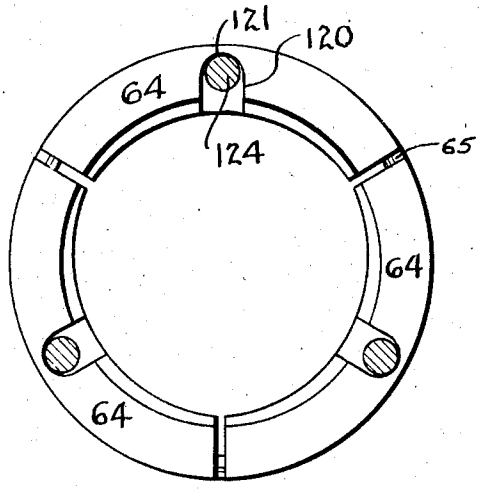


FIG. 11

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LOCKING ASSEMBLY FOR TREATING AND TESTING TOOLS

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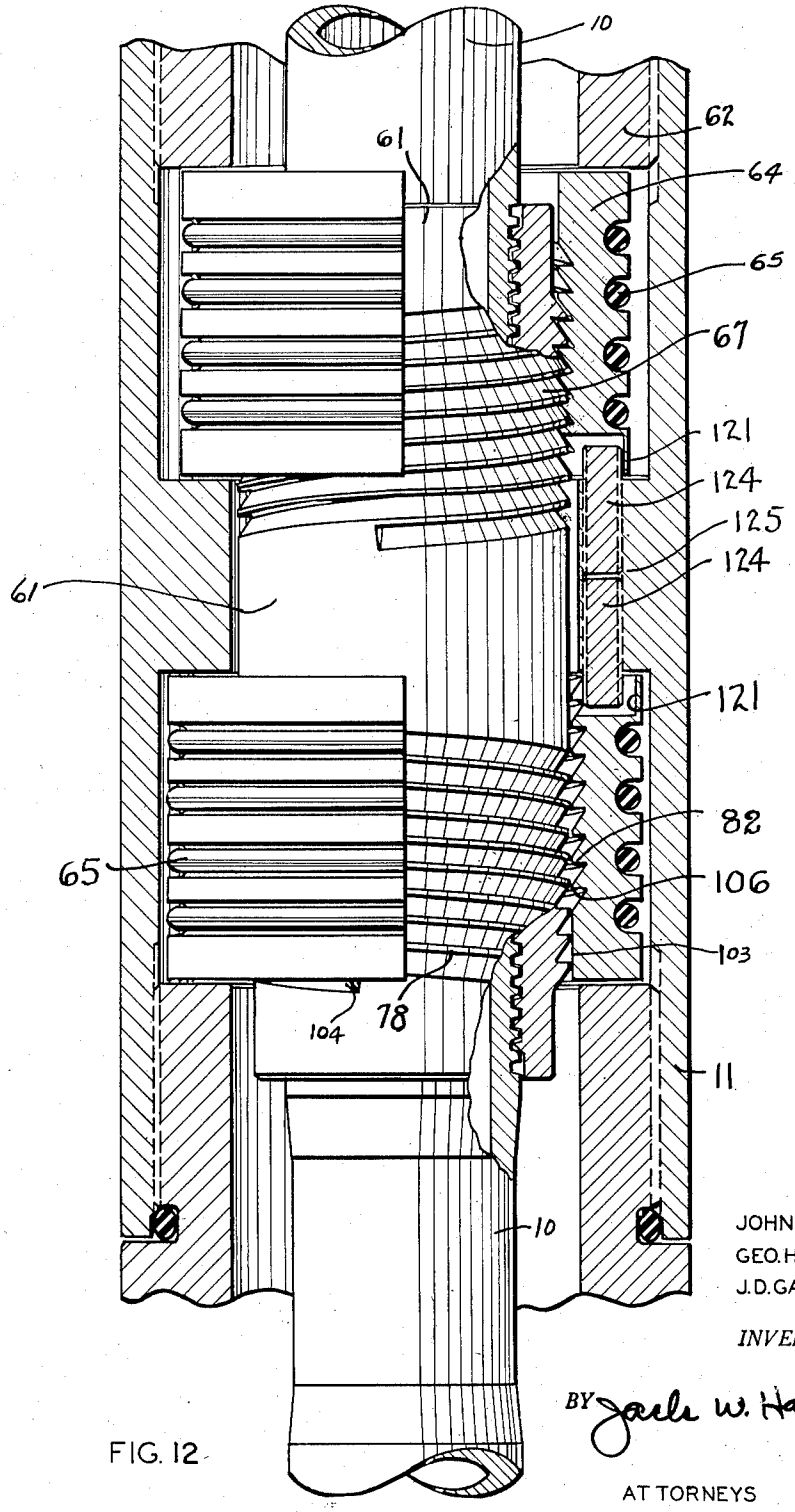


FIG. 12

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United States Patent Office 2,831,542 Patented Apr. 22, 1958

2,831,542

LOCKING ASSEMBLY FOR TREATING AND TESTING TOOLS

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Continuation of abandoned application Serial No. 46,564, August 28, 1948. This application January 19, 1953, Serial No. 332,128

15 Claims. (Cl. 166—221)

The invention relates to a latching or locking mechanism whereby two concentric members, such as an operating pipe and a control assembly, may be moved relative to each other and locked and released in a plurality of different positions solely by the manipulation of one of the members.

In conducting operations where one of two concentric members is to be manipulated it is often necessary to temporarily latch the two concentric members together and then to effect release of one with respect to the other and movement thereof to a different relative position.

It is contemplated, as an illustration of the construction and operation of the invention, that it may be applied to an operating or control pipe in a well bore so as to position the pipe at different elevations for the purpose of performing different pumping or circulating operations with respect to other equipment such as packers, valves, and pipes.

To be more specific, the invention will be described as applied to treating and testing tools being utilized in a well bore.

Tools of the type mentioned above often employ one or more spaced, expansible packers to form a seal or seals with the wall of the well bore so as to shut off a flow of fluid to or from an increment of the well bore.

In treating operations liquids may be forced through the tool and into the formation or withdrawn from the formation into the tool, whereas in testing, a sample of the formation liquid is taken into the tool for investigative purposes.

In the manipulation of such a tool, it is desirable to have the operating pipe or mandrel and the packer assembly and housing latched together in a predetermined position relative to each other when the tool is being lowered into the well bore. When the desired elevation in the well bore has been reached the packers are first inflated by applying pressure through the operating pipe. It is then desirable to release the operating pipe from its initial position in the outer member or housing for longitudinal movement to any one of a plurality of other positions in the housing in each of which positions the pipe may be locked or latched and thereafter released. In the drawings herewith, three intermediate positions along with upper and lower terminal positions have been shown.

With this construction of the tool it is one of the objects of the invention to provide a locking mechanism whereby the operating pipe may be latched in either an upper or a lower position with respect to the packer assembly, and may be latched in any one of a plurality of intermediate positions, so that, solely by manipulation of the operating pipe, it is possible to lock the pipe in either upper position, lower position or any one of the intermediate positions.

It is therefore one of the objects of the invention to provide a releasable locking and latching mechanism for two concentric members whereby the inner and outer members may be locked against relative axial movement

in a plurality of predetermined positions and thereafter released from such positions.

A still further but specific object of the invention as here disclosed is to provide a locking and latching mechanism for two concentric members whereby one member may be manipulated solely by right-hand rotation and axial movement into either an upper or lower locked position and at least three intermediate locked positions in the other concentric member.

Other and further objects of the invention will be readily apparent when the following description is considered in connection with the accompanying drawings, wherein:

Fig. 1 is a vertical sectional view of a packer tool with the present invention shown in detail and with the operating pipe and outer member in their initial relative position in the packer tool as it is lowered into the well bore and with the inner and outer members locked in such initial position, which for purposes of explanation will be identified as position No. 1. This is the position in which the hydraulically inflatable packers carried by the housing portion of the tool are deflated, and the operating pipe is locked in position to discharge liquid therefrom so as to effect inflation of such packers to seal an increment of the well bore.

Fig. 2 is a vertical sectional view similar to Fig. 1 and illustrates the packers in No. 2 inflated position with the operating pipe moved and locked so as to confine the inflating liquid within the packers. In this position, all of the ports in the operating pipe are covered by a blank area on the housing so the tool is thus set and sealed at that position.

Fig. 3 is a vertical section similar to Fig. 1 but showing the operating pipe and parts in the No. 3 position, which is designated as the working position with the packers still in sealed position and the operating pipe having been moved and locked to open the tool to the isolated section between the upper and lower packers so that the tool is now in position to either treat or test the isolated increment of the well bore or earth formation.

Fig. 4 is a vertical sectional view like Fig. 1, but showing the pipe locked in the No. 4 position, which will be designated as the circulating position because the tool has been closed to the isolated section between the upper and lower packers and opened to the well bore above the tool.

Fig. 5 is a vertical sectional view similar to Fig. 1 illustrating the inner operating pipe in locked position No. 5.

Fig. 6 is a side elevation of a tool which incorporates the inventive construction and shows the tool lowered in a well bore prior to being set in the well.

Fig. 7 shows a side elevation of the mandrel coupling showing the right and left male threads which cooperate with the locking ring segments.

Figs. 8 and 9 are inside elevations of right and left hand threaded locking ring segments respectively.

Fig. 10 is a plan view looking down on one of the locking rings with the segments in expanded position.

Fig. 11 is a plan view of one of the locking rings with the segments contracted.

Fig. 12 is a side elevation of the locking joint showing the outer member and the segmental rings in section, with the upper ring locked and the lower ring ratcheting downward.

It is believed that by reference to the drawings showing Figs. 1, 2, 3, 4 and 5 it will be appreciated that the inner operating pipe or mandrel **10**, best seen in Fig. 1 can be moved and locked in five different positions with respect to the housing **11** which will be designated as the outer of the two concentric members **10** and **11**, but these five positions will be designated as positions No. 1

through No. 5 inclusive, to correspond with the drawing figure numbers.

While the locking mechanism is being illustrated and described as applied to a formation testing and treating tool for wells, it appears very obvious that there may be many and varied applications of a locking or latching mechanism for two relatively movable members which are to be latched in a releasable position for different types of operation. It is therefore intended that this invention shall not be limited in its interpretation, operation or scope to the treating and testing tool to which this illustration is applied.

In Fig. 1 the parts are assembled and arranged in the No. 1 position and the tool is then lowered into the well bore **14** by adding sections or lengths of pipe to the upper end of the operating pipe **10**. When the tool arrives at the desired elevation, that is, with the tool openings **97** opposite a formation **15** which is to be investigated then the packers will be inflated to contact the well wall and anchor the tool.

Obviously the operating pipe **10** may now be moved to any one of the possible positions depending on the operation to be conducted.

The operating pipe **10** may be designated as the inner member or mandrel and has a plug **20** affixed to the lower collar **21** thereof by means of a shear pin **22**. In this manner if sufficient pressure is applied within the mandrel **10**, the pin **22** may be sheared to release the plug **20** so as to open the lower end of the pipe **10** to the portion **24** of the well bore below the tool. The lower end of the pipe **10** is enclosed in the lower end of the housing **11** with a strainer section **23** thereon.

The mandrel **10** is shown as having a set of circulating ports **26** and with a set of working ports **27**. These ports are located in accordance with the construction of the outer concentric member or housing **11** in order to accomplish the desired opening and closing of the ports to circulate above the tool, inflate the packers, open between the packers and deflate the packers. Each of the foregoing steps, of course, embodies additional detailed steps which will be described hereinafter.

The outer concentric member **11** is provided with a closure cap **30** having passages **31** through the periphery thereof and having the upper seal rings **33** and the lower seal rings **34** disposed in the inwardly directed upper and lower flanges **35** so that such seal rings **33** and **34** will maintain a seal with the periphery of the mandrel or inner member **10**. Fig. 5, for instance, shows the openings **26** disposed within the chamber **37** in the cap member **30**, so that circulation either from the inside of the mandrel **10** into the well bore **14** or through the well bore **14** back into the mandrel **10** may be accomplished.

When the operating pipe is positioned as shown in Fig. 1, position No. 1, the openings **26**, however, will be disposed within the cage **40**, which cage is on the upper end of the cylindrical housing **41** which is a portion of the outer concentric member **11**. The ports **27** will be disposed in the packers to effect inflating thereof.

The cage **40** is formed with a partition **43** which creates a valve chamber **44** in the upper portion of the cage, and the valve **45** rests on the partition and covers the flow openings **46** formed in the partition **43**. When the operating pipe is in position No. 1, the openings **46** will permit a flow of fluid from the well bore upwardly into the valve chamber **44** and thence into the mandrel through openings **26**. This allows the well liquid to flow into the mandrel **10** when lowering the tool in the well to equalize the pressure in the tool and the well. The seal rings **47** seal the partition **43** about the periphery of the pipe or mandrel **10**.

A skirt **50** depends from the partition **43** and surrounds mandrel **10**. A seal ring **51** adjacent the lower end of skirt **50** and the seal ring **47** adjacent the upper end of the skirt **50** are disposed about the mandrel **10** so as to provide a dead space **53** into which the opening **26** of the mandrel may be positioned when desired, as seen in Figs. 2 and 3, positions No. 2 and 3 respectively. The cage **40** has a plurality of apertures **52** therein so that the well liquid may pass into and out of the cage.

The cage **40** is separated from the remainder of the housing **41** by a stop partition **55**, which is sealed about the periphery of the mandrel **10** with the seal ring **56**. This partition not only separates the cage **40** from the balance of the housing, but it serves as the upper limit or stop for the top locking ring **60**. This same partition also serves as an upper stop for the control coupling **61**, which is incorporated on the inner member or mandrel **10**. Fig. 5, position No. 5, shows the coupling in its uppermost position engaging the partition **55**.

The top locking ring **60** is confined with very little movement between the stop partition **55** and the support partition **62**. This top locking ring **60** is made up of a plurality of segments **64**, three of which have been employed, and the segments are held together with a resilient ring **65**, not shown in the diagrammatic view of Fig. 1, but a form of which is shown in Figs. 10 and 11. As seen in Fig. 1 and Fig. 8, each of the segments **64** of this top locking ring is provided with inwardly, upwardly facing right-hand female buttress threads **66**.

This same type of resilient retainer ring **65** is utilized on all of the segmented locking rings to be hereinafter described. These locking rings may be of any desired axial length and may have more than one retainer ring to hold the parts in proper alignment.

The upper end of the coupling **61**, as best seen in Fig. 7, is provided with a series of outwardly facing right-hand male buttress threads **67** which are complementary with the threads **66**. When the coupling **61**, therefore, is raised upwardly and moves into engagement with the top locking ring **60**, as seen in Fig. 5, position No. 5, the segments **64** will be forced radially outward against the tension applied by the resilient ring **65**, and when each of the male threads **67** ratchets upwardly past a female thread **66** the segments will snap back into latching position because the oppositely facing buttress threads **66** and **67** will interfit each other, thread by thread, as the mandrel **10** is raised. The only manner in which this upper latch in position No. 5 can be released is to rotate the mandrel in a right-hand direction while lowering the mandrel somewhat so as to unscrew the threads **67** from the threads **66**, both of which are right-hand threads, the thread **66** being the female thread while the thread **67** is the male thread.

When the mandrel is latched into the top locking ring **60** against downward movement except on rotation, any upward pull on the mandrel **10** can be employed to raise the tool in the well bore because the top of the coupling **61** abuts the stop partition **55**. As a matter of fact, the Fig. 5, No. 5 position, is or may be considered to some extent as an emergency position, whereupon a very strong pull upwardly on the mandrel **10** may be performed in order to pull the tool loose if the tool should be lodged in the well bore. It will be noted that the top stop partition **55** is a relatively heavy partition to withstand the stresses of a strong upward pull.

The No. 1 position of Fig. 1 illustrates the upper intermediate set of locking rings **70** which includes an upper right hand threaded ring **70'** and a lower left hand threaded segmental ring **70''** which are complementary to the corresponding right and left hand male threads **67** and **78** respectively on the coupling **61**. The threads **67** and **78** are oppositely facing as shown in an enlarged section in Fig. 12.

In the No. 1 position the opening **27** is disposed within the confines of the upper packer **71** so that the pressure will be equalized on the inside and the outside of the packer due to the position of the opening **26**. The lower packer **72** is connected by a bore **73** with the upper packer so that the pressure will also be equalized in the lower packer.

When it has been determined that the entire tool is at the desired elevation with the entrance openings **97** of the tool opposite the formation **15** which is to be treated or tested, then pressure can be applied from the surface through the pipe **10**. This pressure closes the valve **45** and will cause the inflation of the packers **71** and **72** and the peripheries of the packers will engage the formation at **16** and **17** as seen in Fig. 2 so as to form spaced seals above and below the formation **15**.

While the operating pipe **10** is in position 1, and so long as the pressure in the mandrel **10** is maintained above bottom hole pressure, the packers will remain inflated. The operating pipe **10** is then moved to position 2, as shown in Figure 2, to confine the inflating liquid within the packers, as previously mentioned herein.

To move the mandrel **10** from the position No. 1, Fig. 1, to position No. 2, Fig. 2, it is only necessary to rotate the mandrel **10** from the surface and to lower it. This combination lowering and rotational movement causes the coupling **61** to thread downwardly in the upper locking ring **70'** of the set **70** as the threads **67** unscrew from the threads **66** in the segmental locking ring. This unthreading accompanied by the downward movement causes the lower left-hand male threads **78** to move downwardly in the female left-hand threads **82** in the lower segmental ring **70''** of the set **70**. In this manner the mandrel **10** moves downwardly from position 1, Fig. 1, until the coupling **61** has passed through both of the locking rings of the set **70** by unthreading from the upper ring **70'** and moving through the lower ring **70''**. These rings are, of course, held in position by the intermediate partition **83** between the upper and lower rings and the lower partition **84** below the lower ring **70''**.

The surface **80** maintains the lower locking ring segments of the set **70** in their expanded position as such control surface **80** moves through them.

As the lower left-hand threads **78** on the coupling **61** move into the upper ring **85'** of the second intermediate set of locking rings **85** of position No. 2 seen in Fig. 2, these threads continue to slip through the upper locking ring **85'** as the mandrel continues to move downwardly. The downwardly facing right-hand threads **67** move into the upper right-hand segmental locking ring **85'** of the pair **85** while the lower left-hand threads **78** slip into the lower left-hand segmental ring **85''** of the set **85**.

The coupling **61** at the surface **80** thereon has a diameter that is at least equal to the crest diameter of the threads **67** and **78**. As the coupling **61** moves downwardly into the upper right-hand threaded segments of the upper ring **85'** it seems obvious that the surface **80** holds the segments in radially extended position to permit the entrance of the threads **67** into the segmental nut. It is, of course, impossible for the segmental locking ring or the nut to slip into engagement with the thread **67** unless and until the coupling **61** has moved down far enough so that all of the threads **67** have moved into the threads **66** in the upper locking segmental ring **85'** of the second set **85**.

In view of the definite spacing between the upper and lower rings or members of each intermediate set such as each of the sets **70**, **85**, and **92**, it should be apparent that when the upper and lower segments both snap into the male threads **67** and **78** respectively, so that the mandrel **10** cannot then be moved longitudinally, either upwardly or downwardly with respect to the sets of rings **70**, **85**, or **92**, because both the upper and lower segments of each set will have snapped into their respective buttress threads on the coupling **61**. If the mandrel is to be moved downwardly to the next position it may, of course, be rotated to the right so that the operation above described will be repeated.

Fig. 2 illustrates the parts as being fully locked in the No. 2 position with the coupling **61** in the intermediate locking ring set **85**.

This position No. 2 places the upper openings **26** adjacent the dead space **53** formed by skirt **50** on the cage **40** as seen in Fig. 2 and the upper and lower seal rings on the skirt isolate such openings and close the mandrel to prevent any outlet or inlet of fluids through the openings **26**.

In this position the lower openings **27** are disposed in a cage **90** at the lower end of the upper packer **71** so that the ports **27** are also closed.

When the liquid is locked in the packers, of course, the packers are maintained in such inflated position so as to maintain the seal above and below the formation **15** being tested or treated. The position No. 2 will be known as the dead position because the fluid in the packers, tubing, and the upper, central and lower portions of the well bore are isolated each from the other.

The next position, No. 3, Fig. 3, is attained by rotating the mandrel **10** to the right and continuing the lowering movement thereof the same as moving from the No. 1 to the No. 2 position. Fig. 3 of the drawing shows the coupling **61** as having been moved into the third intermediate set **92** of the locking segmental rings and the parts are the same as described in connection with the intermediate position No. 2, Fig. 2. In No. 3 position the upper openings **26** are still disposed within the dead space **53** so as to prevent either entrance or exit of liquid above the upper packer. The bottom set of outlets **27**, however, have moved downwardly out of the cage **90** into the position shown in Fig. 3 where these openings **27** are disposed in control section **95** adjacent the tool openings **97** between the upper and lower packers. This opens the tool to the isolated formation being treated or tested so that the tool is now available either to inject material into the formation or to withdraw material from the formation. This position maintains all of the liquid locked in the packers so that they will remain inflated and sealed against the formation as illustrated at **16** and **17**.

The No. 4 position is the next operational step wherein the coupling **61** is shown as having been rotated and lowered out of the intermediate locking ring set **92**. This movement is effected by the lowering of the coupling **61** out of the locking rings **92'** and **92''** of the set **92** and into the lower locking ring **100** in the same manner as described heretofore.

Fig. 4 shows the bottom openings **27** as having been moved into the lower cage **99** so as to shut off these openings **27**. Since the openings **26** have moved downwardly out of the skirt **50** to the position shown in Fig. 4 where such openings are in the open cage of the tool, circulation above the packers, between the operating pipe **10** and well bore may be accomplished.

Fig. 4 shows the coupling **61** as having been latched into the lower left-hand locking segments because the male threads **78** will have ratcheted into the threads **82**. The lower end of the coupling **61** will abut the lower stop partition **102** as best seen in Fig. 4, and the lower latching ring **100** is thus snapped onto the lower left-hand threads.

If it is now desired to execute an upward pull on the tool an upward lift on the mandrel **10** would raise the lower locking ring **100** against the base partition **104**.

When it is desired to retrace all of the operations and return the tool to its No. 1 position or to the No. 5 position, such retracing may be accomplished by a combination of right-hand rotation and upward pull on the mandrel.

The continued right-hand rotation unscrews the left-hand male threads **78** out of the left-hand female threads **82** while the male threads **67** ratchet upwardly through the female threads **66**.

When the operating pipe **10** is returned to the No. 5 position, Fig. 5, the openings **27** are moved into the confines of the upper packer **71** so as to unlock the packers by opening the inside of the mandrel to the inside of the packer. The upper openings **26** are now moved into the

top of the cage as seen in Fig. 5 so that the pressure in the operating pipe and well bore will equalize.

From the foregoing explanation it should appear that a complete locking and releasing of the mandrel with respect to the housing can be accomplished in accordance with the number of sets of locking rings provided. Generally speaking, this might be described as the locking and releasing of two concentric members, one relative to the other.

There remains to be explained the detailed construction and operation of the coupling **61** upon which the right and left hand male threads **67** and **73** respectively are provided so as to understand the threading, ratcheting, expanding, and contracting of the female segments.

The thought held to in designing this locking mechanism was to develop a mechanism in which all segments and the threads thereof might be engaged so as to develop the full strength of the threads. To accomplish this, it is necessary that the buttress threads be of the multiple type and that the number of segments of the locking ring be equal to the number of threads of which the multiple thread is composed. As an example, if a thread with a lead three times the pitch is employed, then the locking ring will be segmented into three equal parts.

This is necessary so that each segment of the locking ring will have on thread terminating in it so as to establish the portion of the control surface designated as **103**, Fig. 9, which may or may not, depending on orientation of the locking coupling within the segmented ring, be in contact with the terminal points **104** of the control surface of the locking coupling. If the orientation is such that the portions of the control surface **103** do not slide longitudinally over the terminal control points **104**, the segments of the locking ring will engage so that the terminal female thread **106** of the segment falls into engagement with the terminal male threads **104** of the locking coupling. On the other hand, if the portion of the control surface **103** of the segments of the locking ring do slide longitudinally in contact with the terminal point **104** of the control surface of the locking coupling, longitudinal movement will continue until the first full female thread **107** of the locking ring segments falls into place with the terminal threads **104** of the locking coupling.

The segmented rings are bored so as to have an inside radius of curvature equal to the outside radius of the locking coupling. Thus, when the segmented rings are placed around the locking coupling theoretically all points in the bored surface of the locking rings that remain after threading would contact all points of the outside surface of the locking coupling (that remain after threading) when disposed over them.

Furthermore, the locking coupling and the segmented rings are threaded so that the length of the arc between points **108** and **109**, Fig. 7, on the control surface of the locking coupling is exactly equal to the length of arc between points **110** and **111** of the bored control surface of the locking ring segments, Fig. 8. Also, the number of raised threads on the locking coupling between points **108** and **109** are equal to the grooves or female threads in the locking ring segment between points **110** and **111**.

Thus, it is apparent that if the locking coupling moves through the segmented locking rings in a direction so that the flats of the buttress threads are approaching each other that as long as any portion of the unthreaded control surface of the segment is in contact with any portion of the outside diameter control surface of the locking coupling that also some portion of the threaded control bore of the segment will be in contact with the unthreaded portion of the locking coupling. Consequently, only when no portion of the bored control surface of the locking ring is in contact with no portion of the outer control surface of the locking coupling can the locking ring segment move radially inward to engage the threads of the respective parts.

The terminal ends, female and male, of the threads in both the locking coupling and the segmented rings are terminated so that no interference is offered to the radially inward movement of the respective segments once the control surfaces of the locking coupling and segmented rings are no longer in contact.

The drawings illustrate a triple thread where the lead is triple the pitch.

The factor which determines the direction in which the coupling is released from the intermediate locking rings is the axial direction in which a force is applied to the mandrel during the rotation of the mandrel to free the coupling from the locking rings.

It seems obvious that if the mandrel is to move longitudinally of the locking rings that any pair of oppositely facing buttress threads on the mandrel in a pair of locking rings will prevent longitudinal movement of the mandrel in either direction.

The flats **112** and **113** at the ends of the threads **66** and **82** at the edges of the locking ring segments **64** of Figs. 8 and 9 respectively are obtained by making the minor diameter of the female thread in the locking rings equal to the major diameter of the male threads on the locking coupling. In order that ratcheting of the female threads on the male threads may occur to permit relative longitudinal movement of the mandrel with respect to the locking ring segments, it is necessary that the locking ring segments be moved radially outward so that the crest of the male and female threads may slide one with respect to the other.

If the inner diameter of the locking ring segments were not made equal to the outer diameter of the locking coupling, but were true minor diameters of the thread of the locking coupling, the locking ring segments would be balanced and held from engaging with the locking coupling by the ends of the threads in each of the segments. This manner of forming the segments of the locking rings would give a satisfactorily operating mechanism under practically all positions of orientation of the locking ring segments in respect to the locking coupling. Only at such times that the major diameter terminal point of the locking coupling threads travel across the area of surface **103**, Fig. 9 between the terminal point of the female thread in the locking ring and the line of segmentation would interference result from such construction.

In the arrangement being described where the ends of the threads, Fig. 9 of the segmented locking ring are the only points of contact with the control surfaces of the locking coupling, all other points of the inside diameter of the locking ring segments are radially disposed farther from the axial center of the locking coupling than are these points of contact. Thus, if the male major diameter terminal point **104** of the locking coupling is in contact with the surface **103** which is a part of the surface that is greater distance radially from the longitudinal axis of the locking coupling than the ends of threads, then the ends of the threads must necessarily interfere with the crests of the locking coupling threads. The result is that the minor diameter points of the locking ring threads will partially engage with the locking coupling threads and longitudinal movement of the locking coupling will be terminated prior to full engagement of the locking ring segment threads with the threads of the locking coupling.

The detailed arrangement of the locking coupling as seen in Figs. 10, 11 and 12, illustrates the structure for accommodating radial movement of the segments **64**. Each segment has a radial slot **120** which has an outer wall **121** for abutting a drive pin **124** carried by the stop partition **125**. These pins engage all of the segments and serve to hold the segments in the outer member or housing against rotation.

In view of the detailed explanation of the construction and operation of the parts it is not believed necessary to repeat a full scale operational or procedural explanation.

It may be noted however that the several positions explained may be concisely described as:

Fig. 1, No. 1 position, as the going-in and inflate position.

Fig. 2, No. 2 position, is the inflated and isolated or dead position where the packers are locked inflated.

Fig. 3, No. 3 position, is the working position where the tool is opened to perform its intended operation such as treating or testing.

Fig. 4, No. 4, is the circulating position where the tool is closed and the well may be circulated above the packers.

Fig. 5, No. 5 position, is the position where the packers are deflated and released, and the tubing opened to the annulus so that the pipe may be pulled dry.

Fig. 12 shows the mandrel being moved out of an intermediate position. It shows the mandrel and a set of intermediate locking collars where the upper locking collar is engaged and holding the mandrel against downward movement except upon rotation, while the lower locking collar is shown as sliding over its complementary threads due to the fact that some of the segmental threads are disposed on the control surface and therefore held outwardly so that the mandrel may be moved therethrough.

While the description has been directed to a mechanism employing right-hand rotation, optionally, a mechanism could be constructed in which left-hand rotation could be employed.

The relative position of the male and female portions on the operating pipe **10** and outer housing **11** could be reversed.

Broadly the invention contemplates a control and latching mechanism for two concentric members, whereby such members may be repeatedly latched together and released even though one of such members may be disposed at an inaccessible position with all of the control effected by manipulating the other of the members by rotation and longitudinal thrust in either direction.

This application is a continuation application of our prior co-pending application Serial 46,564, filed August 28, 1948, now abandoned, for the same invention and is entitled to the benefit of the filing date of such application.

What is claimed is:

1. A locking and releasing mechanism for inner and outer concentric members comprising, an inner member, oppositely facing right and left hand buttress threaded areas on said inner member, an unthreaded major diameter surface between said areas on the inner member, an outer member, a set of threaded, radially expansible segmental nuts retained in said outer member against axial and rotational movement relative to said outer member and spaced to interfit thread for thread on said threaded areas of said inner member thereby locking said inner and outer members together, said inner member being releasable relative to said outer member in either axial direction by rotating said inner member and simultaneously moving it in the desired axial direction of release, said rearwardmost of said segmental nuts relative to the direction of movement of said inner member unthreading from said interfitting threads on said inner member, and said forwardmost of said segmental nuts relative to the direction of movement of said inner member expanding to accommodate movement of said major diameter surface therethrough as said inner and outer member release relative to each other.

2. A mechanism for locking inner and outer members together wherein the members may be moved axially from either direction into the mechanism to lock the members together comprising, an outer member, an inner member, a set of threaded, radially expansible locking collars carried in said outer member against axial and rotational movement relative to said outer member, oppositely facing threaded areas on said inner member to interfit thread for thread with said locking collars, and resilient means engaging each of said collars to accommodate radial expansion thereof whereby said inner and outer members may be moved axially from either direction to interfit said threads on said inner member with said threaded locking collars to lock said inner and outer member together.

3. A mechanism which locks two concentric members in position against relative axial movement but which is operable to release the members for relative axial movement in either direction from the locked position comprising, concentric members, spaced oppositely facing right and left hand buttress threaded areas on one of said concentric members, a set of corresponding threaded, radially movable segmental nuts retained by the other of said concentric members against axial and rotational movement relative to said other member and spaced to fit on said threaded areas of said one member thereby locking said concentric members together, and resilient means engaging each of said nuts for accommodating radial movement thereof whereby the concentric members may be moved relatively axially in either direction from the locked position.

4. A mechanism which locks inner and outer members in position against relative axial movement but which is operable to release the members for relative longitudinal movement in either direction from the locked position comprising, an inner member, oppositely facing right and left hand buttress threaded areas on said inner member, an outer member, a right hand buttress threaded and a left hand buttress threaded radially expansible segmental nut retained by said outer member against axial and rotational movement relative to said outer member and spaced to fit on said threaded areas of said inner member, resilient means yieldingly urging the segments of each of said segmental nuts toward each other and accommodating radial expansion thereof whereby right hand rotation and a longitudinal thrust on said inner member effects release of said threaded nuts in said outer member from said threaded areas on said inner member by expanding said threaded nut in said outer member whose threads face opposite to the direction of thrust while unthreading said threaded nut in said outer member whose threads face in the same direction as the direction of thrust.

5. A mechanism which locks two concentric members in position against relative axial movement but which is operable to release the members for relative longitudinal movement in either direction from the locked position comprising, two concentric members, spaced oppositely facing right and left hand buttress threaded areas on one of said members, a right hand buttress threaded and a left hand buttress threaded radially movable segmental nut retained by the other of said members against axial and rotational movement relative to said other member and spaced to fit on said threaded areas of said one member, resilient means yieldingly urging the segments of each of said segmental nuts toward each other and accommodating radial movement thereof whereby right hand rotation and a longitudinal thrust on said one member effects release of said threaded nuts in said other member from said threaded areas on said one member by radially moving said threaded nut in said other member whose threads face opposite to the direction of thrust while unthreading said threaded nut in said other member whose threads face in the same direction as the direction of thrust.

6. A mechanism which locks two tubular members in position against relative movement in either axial direction which is operable upon relative rotation of the members to release the members for relative longitudinal movement in either axial direction from the locked position comprising, two tubular members, interfitting right hand buttress threads carried by each of said two tubular members, interfitting left hand buttress threads carried by each of said two tubular members, and means holding

said threads of at least one of said tubular members to accommodate radial movement thereof whereby relative longitudinal movement of said members interfits said right hand buttress threads and left hand buttress threads carried by each of said members to lock said members against relative movement in either axial direction, said right and left hand buttress threads, upon rotational and longitudinal movement of said members, disengaging for relative movement of said members in either axial direction from the locked position.

7. A mechanism for locking inner and outer tubular members in position against relative movement in either axial direction which is operable upon relative rotation to release the members for relative movement in either axial direction from the locked position comprising, an inner member, an outer member, means on each said inner member and said outer member cooperable upon relative longitudinal movement of said members to lock said inner and outer members together against relative movement in either axial direction, and yieldable means cooperating with said first mentioned means whereby relative longitudinal movement without relative rotation of said members locks said means on said inner and outer members to prevent relative movement of said members in either axial direction, said means, upon relative rotation of said inner and outer members, releasing whereby said members may be moved relatively in either axial direction from the locked position.

8. A mechanism for locking inner and outer tubular members in position against relative axial movement which is operable to release the members for relative movement in either axial direction from the locked position comprising, an inner member, an outer member, a plurality of segments on said outer member retained against rotational and axial movement relative to said outer member, oppositely facing surfaces on said segments, means holding said segments to accommodate radial movement thereof, oppositely facing surfaces on said inner member opposed to said surfaces on said segments and engageable therewith upon relative axial movement of said members to lock said inner and outer members together against relative axial movement, said surfaces on said inner member and said surfaces on said segments disengageable by relative rotation of said members to release said inner and outer members for relative movement in either axial direction from the locked position.

9. A mechanism for locking inner and outer tubular members in position against relative axial movement in either direction which is operable upon relative rotation of the members to release the members for relative movement in either axial direction from the locked position comprising, an inner member, an outer member, a plurality of spaced sets of segments on said outer member retained against rotational and axial movement relative to said outer member, surface means in each set of segments which are faced so that said surface means on one set is facing opposite to the surface means of an adjacent, spaced set, means holding said segments to accommodate radial movement thereof, surface means on said inner member facing to engage with said surface means on said spaced sets of radially movable segments upon relative axial movement of said members to lock said inner and outer members together against relative axial movement, said surfaces on said inner member and said surfaces on said sets of segments disengageable by rotating said inner member to release said inner and outer members for relative movement in either axial direction from the locked position.

10. A mechanism for locking inner and outer tubular members in position against relative axial movement which is operable to release the members for relative movement in either axial direction from the locked position comprising, an inner member, an outer member, a plurality of segments on said outer member retained against rotational and axial movement relative to said outer member, oppositely facing surfaces on said segments, resilient means holding said segments to accommodate radial movement thereof, oppositely facing surfaces on said inner member opposed to said surfaces on said segments and engageable therewith upon relative axial movement of said members to lock said inner and outer members together against relative axial movement, said surfaces on said inner member and said surfaces on said segments disengageable by relative rotation of said members to release said inner and outer members for relative movement in either axial direction from the locked position.

11. A mechanism for locking two tubular members in a predetermined position against relative axial movement which is operable to release the members for relative movement in either axial direction from the locked position comprising, one member, another member, a plurality of segments on said one member retained against rotational and axial movement relative to said other member, oppositely facing surfaces on said segments, means holding said segments to accommodate radial movement thereof, oppositely facing surfaces on said other member opposed to said surfaces on said segments and engageable therewith upon relative axial movement of said members to lock said members together against relative axial movement, said surfaces on said other member and said surfaces on said segments disengageable by relative rotation of said members to release said one and other members for relative movement in either axial direction from the locked position.

12. A mechanism for locking an inner tubular member in position in an outer tubular member against movement in either axial direction which is operable to release the inner member for movement in either axial direction from the locked position upon rotation of the inner member relative to the outer member comprising, an inner member, an outer member about said inner member, cooperating surfaces on each said inner member and said outer member engageable for locking said inner member in position in said outer member against axial movement in one direction, other cooperating surfaces on each said inner and outer member co-engageable for locking said inner member in position in said outer member against axial movement in the other direction, both of said surfaces engaging upon longitudinal movement of said inner member relative to said outer member, and said surfaces releasing upon rotation of said inner member relative to the outer member for movement of said inner member in either axial direction to and from the locked position.

13. A mechanism for locking an inner tubular member in position in an outer tubular member against movement in either axial direction which is operable to release the inner member for movement in either axial direction from the locked position upon rotation of the inner member relative to the outer member comprising, an inner member, an outer member about said inner member, cooperating means on each said inner and outer member for locking said inner member in position in said outer member against axial movement in one direction, other cooperating means on said each said inner and outer member for locking said inner member in position in said outer member against axial movement in the other direction, both of said means locking upon longitudinal movement of said inner member relative to said outer member, and releasing upon rotation of said inner member relative to said outer member for movement of said inner member in either axial direction to and from the locked position.

14. A mechanism for locking inner and outer tubular members in position against relative movement in either axial direction which is operable upon relative rotation between the members to release the members for relative movement in either axial direction from the locked posi-

tion comprising, an inner member, an outer member, means on each said inner and outer member locking said members upon relative longitudinal movement between said inner and outer members to position said members against relative movement in either axial direction, said means releasing upon relative rotation between said members for relative movement of said members in either axial direction from the locked position.

15. A mechanism for locking inner and outer tubular members in position against relative axial movement in either axial direction which is operable to release the members for relative movement in either axial direction from the locked position comprising, an inner member, an outer member, means carried by said inner member, additional means carried by said outer member, and cooperating means carried by each said inner and outer member cooperating upon relative longitudinal movement of said inner and outer members for locking said inner and outer members together in position against relative movement in either axial direction, said means releasing upon relative rotation of said members for free relative axial

movement of said members in either direction from the locked position.

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