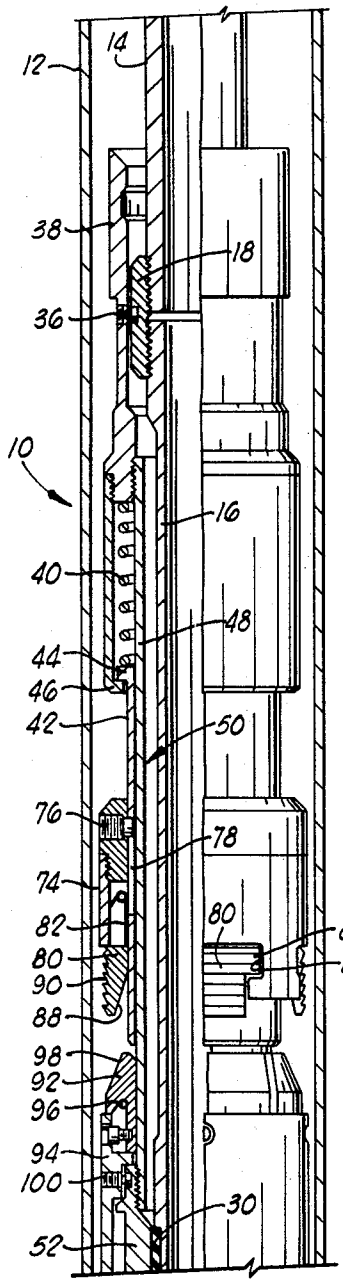
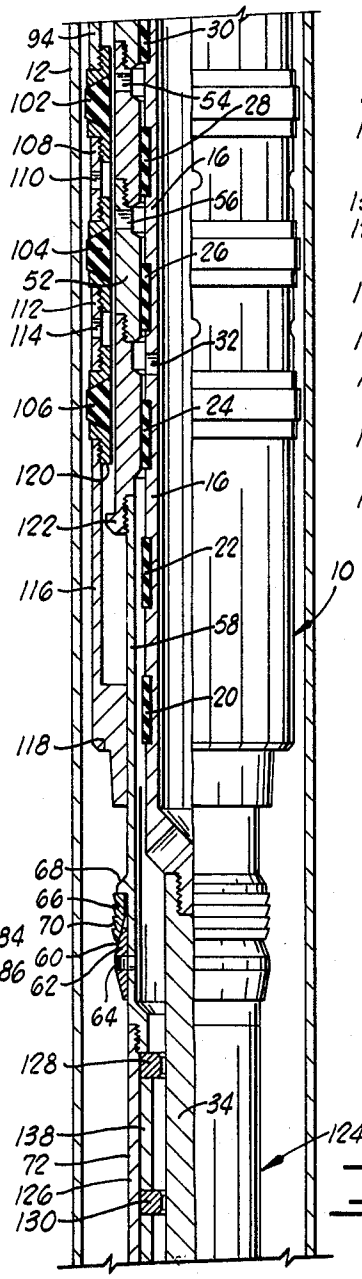
June 30, 1970 R. C. PUMPELLY ET AL 3,517,743

SELECTIVE INTERVAL PACKER

Filed Dec. 13, 1968 4 Sheets-Sheet 1



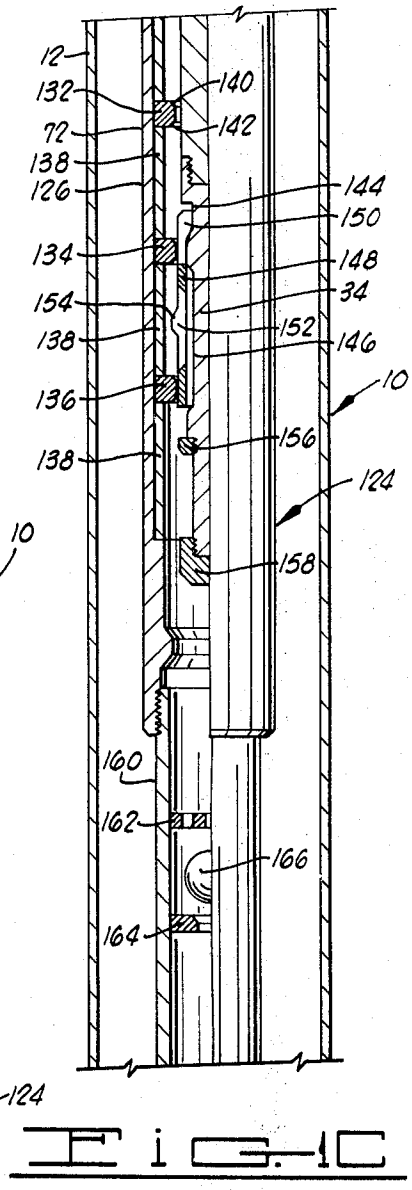




FIG-1A FIG-1B FIG-1C

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SELECTIVE INTERVAL PACKER

Filed Dec. 13, 1968 4 Sheets-Sheet 2

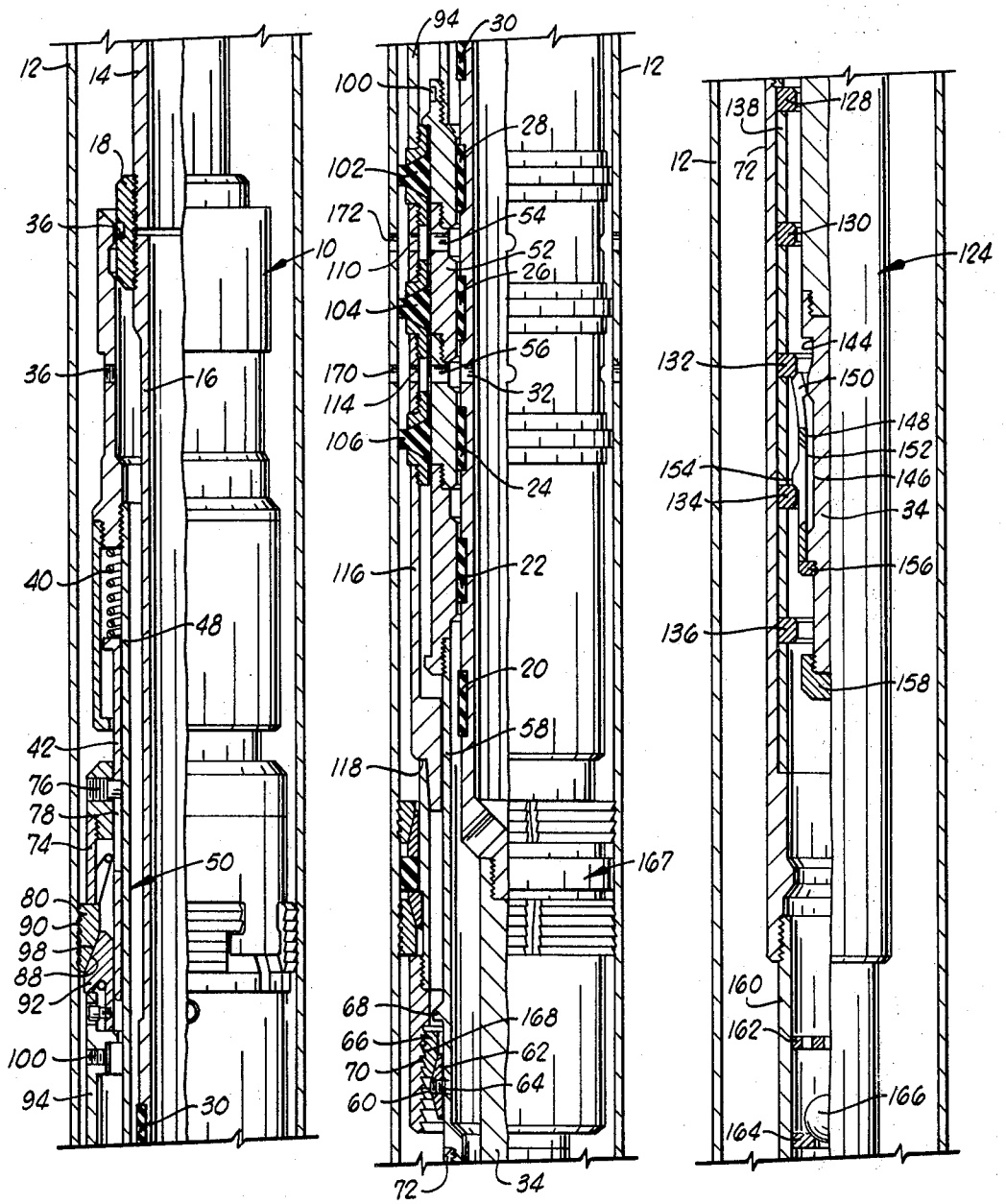



Fig. 2A Fig. 2B Fig. 2C

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SELECTIVE INTERVAL PACKER

Filed Dec. 13, 1968 4 Sheets-Sheet 3

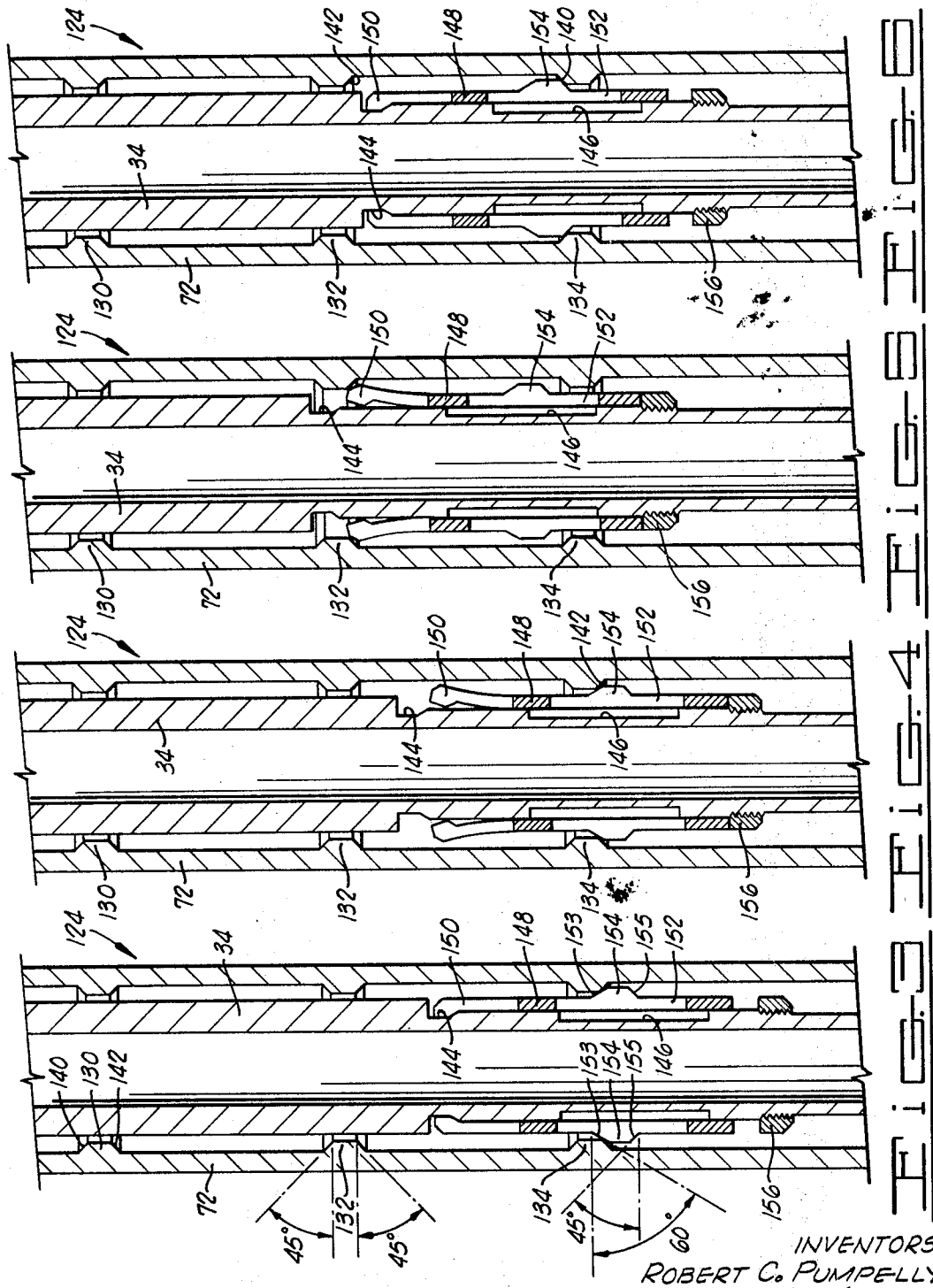



Fig. 3 Fig. 4 Fig. 5 Fig. 6

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SELECTIVE INTERVAL PACKER

Filed Dec. 13, 1968 4 Sheets-Sheet 4

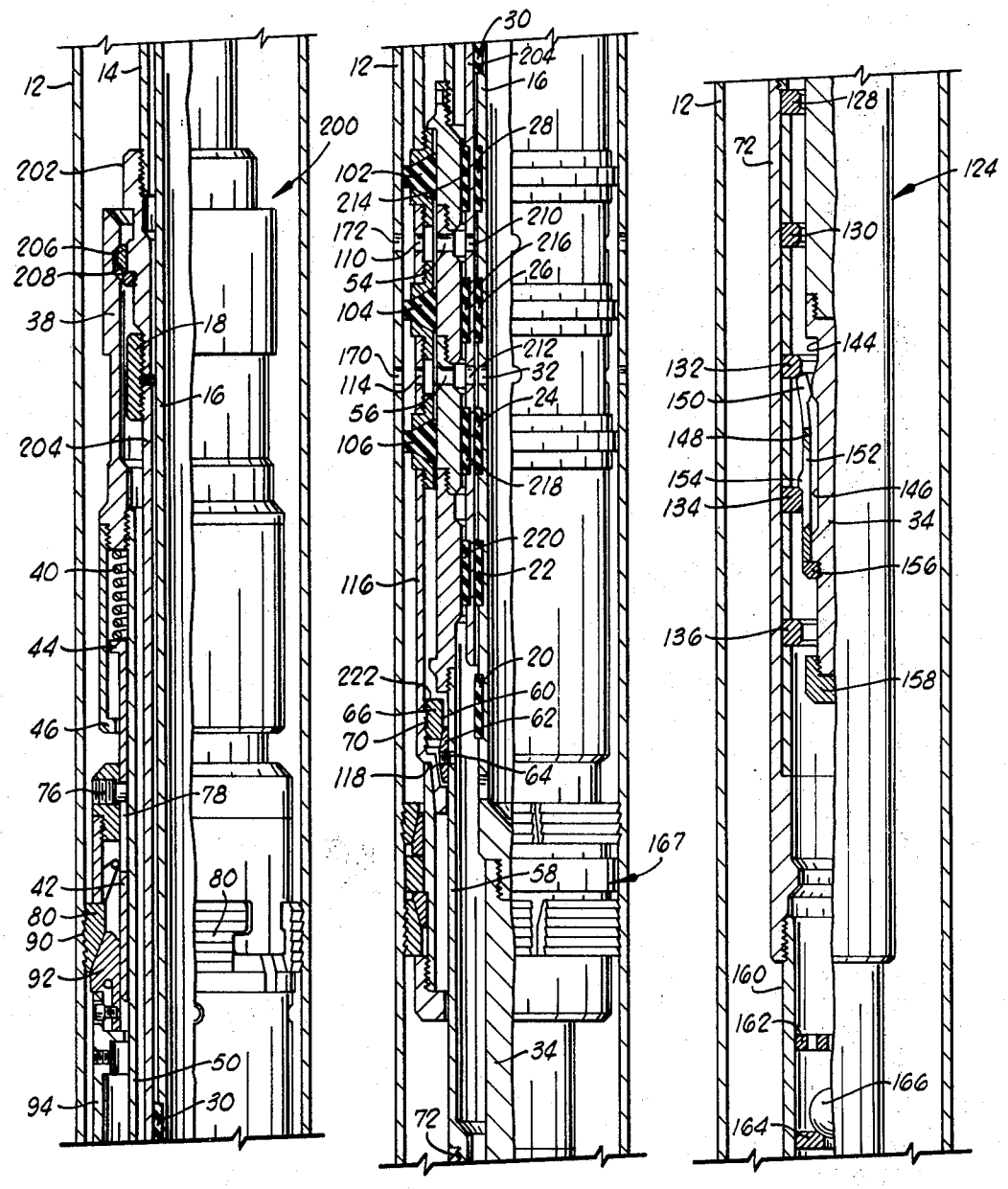



Fig. 7A Fig. 7B Fig. 7C

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3,517,743

# SELECTIVE INTERVAL PACKER

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Int. Cl. E21b 33/124
U.S. Cl. 166—127 21 Claims

## ABSTRACT OF THE DISCLOSURE

A selective interval packer for isolating a plurality of formations in a well bore or for isolating zones within a single formation and for selectively treating and/or producing the isolated formations or zones. The selective interval packer includes a plurality of spaced packing elements that are deformable into sealing engagement with a well bore wall to isolate the formations or zones, gripping means for retaining the packer in position when the packing elements are deformed, a tubular mandrel extending through the packer having a plurality of spaced seals thereon arranged to selectively isolate ports extending through the packer between the packing elements, and an indexing mechanism that permits a treating port located in the mandrel to be aligned with a selected one of the ports in the packer. The apparatus contemplates the use of a locating device such as a packer or anchor previously set in the well bore to which the selective interval packer can be releasably attached whereby the selective interval packer will be accurately positioned or located for treating the desired formations in the well bore.

## BACKGROUND OF THE INVENTION

The invention relates generally to packing apparatus for use in well bores. More particularly, but not by way of limitation, this invention relates to an improved packer apparatus for isolating selected formations or intervals within a formation in the well bore and testing, treating and/or producing the selected areas.

In the completion or servicing of an oil or gas well or the like, it is frequently desirable to be able to isolate selected areas therein and to treat the isolated areas with chemical additives or the like. For example, where a formation intersected by the well bore is made up of a loose or unconsolidated sand, it is highly desirable to be able to inject a sand consolidation material into the formation to consolidate the sand and thus prevent production of sand with the oil and/or gas into the well bore.

As is well known to those in the art of drilling wells, a well bore may penetrate a number of producing formations and each formation will have different characteristics. Thus, it is frequently desirable to be able to treat the formations individually. Also, it is well known that a single formation may have different characteristics, such as varying permeability and porosity. Therefore, it is desirable to be able to treat different portions of the same formation differently.

In the past, straddle packer type devices and other packers having a plurality of packing elements thereon have been utilized to isolate the various areas that are to be treated. While the isolation of the various formations or intervals has been successfully accomplished, the methods and apparatus for the selective treating of the formations has not been satisfactory.

In some of the previously utilized apparatus, flow control devices have been incorporated in each of the isolated zones whereby injected materials will be either more evenly distributed to all areas or else controlled whereby



they are distributed in greater quantity to one formation than the other, but all have had the common disadvantage of having the treating materials distributed to all the formations or zones isolated. None of the previously used apparatus, insofar as is known, has had the capability of treating a single one of the isolated formations and then being movable to selectively treat each of the remaining isolated formations.

## SUMMARY OF THE INVENTION

This invention provides improved well apparatus for isolating, treating and producing selected zones in a cased well bore, the apparatus includes: a hollow body member having a plurality of spaced ports therein; a plurality of spaced packing members carried by the body that are arranged to sealingly engage the casing to isolate the ports; a hollow treating member having a lateral opening therein and being movable through the hollow body member; a plurality of spaced seal members forming fluid tight seals between the treating member and the body to isolate the ports; and, an indexing device for locating the lateral opening in the treating member in communication with the ports in the body member selectively.

An object of this invention is to provide an improved selective interval packer that affectively isolates a plurality of formations or zones within a single formation in the well base whereby they can be individually treated.

Another object of the invention is to provide improved well apparatus wherein a packer having a plurality of packing elements thereon can be accurately loated within the well bore to isolate desired areas therein and latched in the well bore against movement whereby each of the isolated areas can be separately treated.

Still another object of the invention is to provide improved well apparatus that can be releasably latched to a locating member previously set in the well bore whereby the ports in the well apparatus will be aligned with the desired formations or zones in the well bore.

A further object of the invention is to provide an improved well apparatus wherein a single one of a plurailty of isolated areas can be individually treated and the particular area being treated can be identified as to its location by the indexing mechanism contained within the apparatus.

The foregoing and additional objects and advantages of the invention will become more apparent as the following detailed description is read in conjunction with the accompanying drawings.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A, 1B and 1C, taken together, comprise a view, partly in elevation and partly in cross-section, of a selective interval packer constructed in accordance with the invention.

FIGS. 2A, 2B and 2C, taken together, comprise a view partly in elevation and partly in cross-section, of the selective interval packer of FIGS. 1A, 1B and 1C, but showing the packer in the set position in the well bore.

FIGS. 3, 4, 5 and 6 are enlarged schematic cross-sectional views illustrating the operation of the indexing mechanism utilized in the selective interval packer.

FIGS. 7A, 7B and 7C, taken together, comprise a view, partly in cross-section and partly in elevation, of another embodiment of the selective interval packer also constructed in accordance with the invention.

## DESCRIPTION OF THE EMBODIMENT OF FIGS. 1A, 1B AND 1C

Referring to the drawings and to FIGS. 1A, 1B and 1C in particular, shown therein and generally designated by the reference character **10** is a selective interval packer

constructed in accordance with the invention. The packer **10** is shown positioned in a casing **12** located in a well bore (not shown).

The packer **10** is suspended on a tubing string **14** that is threadedly connected with a treating mandrel **16** by a threaded coupling **18**. As shown most clearly in FIG. 1B, the treating mandrel **16** has a plurality of spaced annular seals encircling the medial portion thereof. The seals are designated by reference characters **20**, **22**, **24**, **26**, **28** and **30** beginning with the lowermost of the seals.

A treating port **32** extends laterally through the treating mandrel **16** between the seals **24** and **26**. The lower end of the mandrel **16** is threadedly connected with an index mechanism body **34**.

Referring again to FIG. 1A, it can be seen that the collar **18** is connected by a shear pin **36** with a spring housing **38**. The spring housing **38** encircles the mandrel **16** and carries in its lower interior a coil spring **40**. The upper end of the coil spring **40** engages the spring housing **38** and the lower end thereof is in engagement with a slip sleeve **42**.

The slip sleeve **42** has a flange **44** on the upper end thereof that is engageable with an inner flange **46** on the lower end of the spring housing **38**. The spring **40** and the slip sleeve **42** encircle an upper portion **48** of a packer mandrel which is generally designated by the reference character **50**.

The upper portion **48** of the packer mandrel **50** is threadedly connected with the spring housing **38** and the lower end thereof is threadedly connected with a medial portion **52** of the packer mandrel **50**. The medial portion **52** includes an upper treating port **54** located between seals **28** and **30** and a lower treating port **56** located between seals **26** and **28**. As clearly illustrated, the seals **24**, **26**, **28** and **30**, with the packer **10** in the running-in condition as illustrated, are disposed in sealing engagement with the interior of the medial portion **52** of the packer mandrel **50**. It will also be noted that the port **32** in the treating mandrel **16** is blanked off due to its position between seals **24** and **26**.

The lower end of the medial portion **52** of the mandrel **50** is threadedly connected with a lower or latch portion **58**. The portion **58** carries a latching device **60** near its lower end.

The latching device **60** includes an expander **62** that is connected with the lower portion **58** by shear pin **64** and a split ring slip **66** that is retained thereon between an exterior flange **68** and the expander **62**. The split ring slip **66** is provided with external teeth **70** that are engageable with a locating mechanism that will be described more fully hereinafter for positioning the packer **10** at a preselected location in the well bore. As can be appreciated, the slip **66** need not be provided with the teeth **70**, but may be of any configuration that will latch into the locating mechanism. At its lower end, the lower portion **58** of the packer mandrel **50** is connected with a tubular shell **72** that forms a portion of the indexing mechanism.

Returning again to FIG. 1A, it can be seen therein that the slip sleeve **42** carries a slip housing **74** thereon. The connection between the slip housing **74** and the slip sleeve **42** is provided by a pin **76** that extends into and is movable in an elongated slot **78** formed in the slip sleeve **42**. A plurality of segmented slips **80** are carried by the slip housing **74**. The slips **80** are urged inwardly, that is, toward the slip sleeve **42** by a plurality of slip springs **82**.

The slips **80** are retained in the slip housing by T-shaped lugs **84** that fit into mating T-shaped slots **86** in the slip housing **74**. The T-lug and slot arrangement permits the slips to move radially with respect to the housing **74**, but prevent longitudinal movement therebetween. The slips **80** are provided with a tapered inner surface **88** and a toothed exterior surface **90**. The toothed exterior surface **90** is provided for holdingly engaging the interior wall of the casing **12** when the packer **10** is in the set position.



A plurality of the segmented expanders **92** are carried by an upper head **94**. As arranged, the segmented expanders **92** can move radially relative to the upper head **94**, but are prevented from moving longitudinally with respect to the longitudinal axis of the packer **10**. A garter spring **96** encircles the expanders **92** biasing them relatively inwardly toward the upper portion **48** of the packer mandrel **50**. Each of the expanders **92** is provided with a tapered surface **98** that is arranged to mate with the tapered surfaces **88** on the slips **80** as will be described hereinafter.

The upper head **94** is connected by a shear pin **100** with the medial portion **52** of the packer mandrel **50**. The lower end of the upper head **94** engages the uppermost of three spaced packing elements **102**, **104** and **106**. Disposed between the packing elements **102** and **104** is a spacer member **108** having a perforation **110** extending therethrough. A similar spacer **112** extends between the packing elements **104** and **106** and has a port **114** extending therethrough.

A lower sleeve **116** slidingly encircles the lowermost portion **58** of the packer mandrel **50**. The sleeve **116** has a downwardly facing shoulder **118** thereon that is arranged to engage a locating device which will be described hereinafter. The sleeve **116** has a downwardly facing shoulder **120** near the upper end thereof that is engageable with a flange **122** carried by the packer mandrel **50**.

As previously mentioned, the index mechanism body **34** is connected with the lower end of the treating mandrel **16** and the tubular shell **72** is connected with the lower end of the packer mandrel **50**. These parts, along with others to be described, comprise an indexing mechanism generally designated by the reference character **124**.

For convenience in manufacturing, the tubular shell **72** consists of an outer sleeve **126**, a plurality of spaced annular rings or abutments **128**, **130**, **132**, **134** and **136**. The abutments are retained in the spaced relationship by a plurality of spacers **138** located therebetween.

Preferably, and as may be seen more clearly in FIG. 3, each of the abutments has an upper annular surface **140** that is disposed at an angle of approximately 45° with the horizontal and a lower annular surface **142** that is disposed at an angle of approximately 45° to the horizontal. In FIG. 3, the abutments are shown as forming an integral portion of the shell **72**.

As shown in FIG. 1C, the index mechanism body **34** includes an upper annular recess **144** on the exterior thereof and a lower annular recess **146** on the exterior thereof spaced below the annular recess **144**. An indexing collet **148** encircles the body **34** and has a plurality of resilient fingers **150** formed on the upper end thereof that are located in the upper annular recess **144** when the packer **10** is being lowered into the well bore. If desired, the fingers **150** could be replaced by a suitable equivalent mechanism, such as spring-loaded dogs.

The medial portion of the collet **148** is provided with a plurality of elongated slots providing resilient portions **152**. Each of the resilient portions **152** is provided with an outwardly projecting lug **154**. An upper surface **153** on each lug **154** is preferably disposed at an angle of approximately 60° to the horizontal and a lower surface **155** on each lug **154** is preferably disposed at an angle of approximately 45° to the horizontal.

The downward travel of the collet **148** on the body **34** is limited by a shear ring **156** that is threadedly attached to the body **34**. The shear ring **156** is arranged to part upon the application of a predetermined load for reasons that will become more apparent hereinafter. In the event that the shear ring **156** parts, the collet **148** is retained on the body **34** by an enlargement **158** that is threadedly attached to the lower end of the body **34**.

Connected with the lower end of the sleeve **72** is a valve assembly **160**. The valve assembly **160** may be of any suitable type wherein the passageway through the packer **10** may be closed when desired.

As illustrated, the valve assembly **160** includes a ported retainer **162** and an annular valve seat **164** located in spaced relationship to the retainer **162**. A valve ball **166** is located in the assembly **160** between the retainer **162** and the seat **164**. As can be appreciated, downward movement of the packer **10** into the well bore moves the valve ball **166** upwardly up off of the seat **164**, permitting fluid to flow upwardly therethrough. However, when an attempt is made to pump fluid through the packer **10** in the downward direction, the valve ball **166** engages the seat **164**, preventing flow downwardly therethrough.

## OPERATION EMBODIMENT OF FIGS. 1A, 1B AND 1C

FIGS. 1A, 1B and 1C, taken together, illustrate the position of the various components of the packer **10** as the packer is being lowered through the casing **12** into the well bore. As illustrated therein, the shear pin **36** prevents relative movement between the treating mandrel **16** and the spring housing **38**.

The coil spring **40** exerts a downward force on the flange **44** on the upper end of the slip sleeve **42** maintaining the slip sleeve **42** in the position illustrated. The slip housing **74** will normally be in the position shown, that is, with the pin **76** located in the upper end of the slot **78** due to the resistance of liquid in the well bore as the packer **10** is lowered therethrough. However, the slot **78** is sized so that even though the slip housing **74** moves downwardly positioning the pin **76** in the lower end thereof, the slips **80** cannot engage the segmented expanders **92**. Thus, the slips **80** cannot become engaged with the casing **12** and prematurely set the packer **10** as the packer **10** is lowered.

As previously described, the upper head **94** and packer mandrel **50** are held together by the shear pin **100**. The pin **100** prevents relative movement between the packer mandrel **50** and the upper head **94** which relative movement would move the expanders **92** into engagement with the slips **80**.

It should also be pointed out that the indexing mechanism **124** is in the position illustrated in FIG. 1C, that is, with the lugs **154** on the collet **148** in engagement with the abutment **134** or **136**. Thus, the port **32** in the treating mandrel **16** is positioned and retained in the imperforate portion of the packer mandrel **50** while lowering the packer **10** into the well bore.

Also, the valve ball **166**, due to the presence of liquid in the well bore, rides upwardly off the seat **164**, permitting fluid flow upwardly through the packer **10**. Since the valve assembly **160** is open, the packer **10** and the tubing string **14** on which the packer **10** is being lowered, automatically fill with liquid as the packer **10** is lowered into the well bore.

The lowering of the packer **10** is continued until the downwardly facing shoulder **118** on the lower sleeve **116** engages the upper end of a locating device **167** that has been previously set in the casing **12**. In FIG. 2B, the locating device **167** is illustrated as being a relatively large bore packing device of conventional construction. The locating device **167** may be of any suitabe configuration such as an anchor or landing collar (not shown) having a bore therein and an upper end upon which the downwardly facing shoulder **118** can land.

In the locating device **167** illustrated in FIG. 2B, the lower end of the bore is provided with downwardly facing teeth **168** that are arranged to mate with the upwardly facing teeth **70** on the exterior of the latching device **60** carried by the packer **10**.

The teeth **70** and the teeth **168** are sized dimensionally so that as the latching device **60** enters the teeth **168** there is some interference therebetween. The arrangement of the teeth permits the split ring slip **66** to ratchet downwardly until the shoulder **118** lands on the upper end of the locating device **167**. When this occurs, it can be appreciated that a slight upward pull will move the expander **62** under the split ring slip **66** moving the slip **66** outwardly into firm holding engagement with the teeth **168** in the locating device **167**. When the teeth **70** and **168** are engaged, the packer **10** is positively retained in the locating device **167**.

It should also be pointed out that prior to running the packer **10** into the casing **12**, a conventional perforating apparatus has been run therein and landed on the locating device **167**. The perforating device is then actuated to form a plurality of vertically spaced perforations **170** and **172** in the casing **12**. The perforations **170** and **172** (and as many other perforations as desired) extend into the formations that are to be treated. Since the formations are perforated using the locating device **167** as a reference, their precise location as related to the locating device **167** is positively known. Thus, when the packer **10** is landed on the locating **167**, the packing elements **102**, **104** and **106** will be in the proper locations to isolate the formations and the perforations **170** and **172**.

When the shoulder **118** on the lower sleeve **116** engages the locating device **167**, continued downward movement of the tubing string **14** shears the shear pin **36**, moving the collar **18** downwardly until it engages the spring housing **38** which, as previously described, is threadedly connected with the packer mandrel **50**. Continued downward movement of the packer mandrel **10** and spring housing **38**, shears the shear pin **100** so that the packer mandrel **50** moves downwardly relative to the packing elements **102**, **104** and **106** and relative to the (upper head **94** and lower sleeve **116**) until the packer mandrel **50** engages the upper head **94** as shown in FIG. 2B. When this occurs, the packing elements **102** and **104** and the spacers therebetween, are moved downwardly deforming the packing elements outwardly into sealing engagement with the casing **12**. At this time, the packing elements **102**, **104** and **106** straddle and isolate the perforations **170** and **172** formed in the casing **12**.

Simultaneously, the slip sleeve **42** is moved downwardly carrying the slip housing **74** downwardly therewith. The slips **80**, which are mounted in the housing **74**, also move downwardly toward the segmented expanders **92**.

Prior to engagement of the slips **80** with the expanders **92**, the slip sleeve **42** moves between the expanders **92** and the packer mandrel **50**, forcing the segmented expanders **92** radially outwardly positioning the segmented expanders **92** for engagement with the slips **80**. When the tapered surfaces **88** on the slips **80** engage the mating tapered surfaces **98** on the expanders **92**, the slips **80** are moved radially outwardly forcing the teeth **90** thereon into holding engagement with the casing **12**. At this time, the packer **10** is set in the well bore with the perforations **170** and **172** isolated. It will also be noted that the ports **54** and **56** and the ports **110** and **114** in the packer **10** are in alignment with the perforations **170** and **172** in the casing **12**. The treating port **32** remains in the imperforate portion of the mandrel **50**.

After the packer **10** has been set, the tubing string **14** is raised, moving the upper surface **153** on the lugs **154** of the collet **148** into engagement with the lower surface **142** on the abutment **134** as shown in FIG. 3. As continued upward movement of the tubing string **14** and the indexing device body **34** continues, the shear ring **156** moves up into engagement with the lower end of the collet **148** as shown in FIG. 4. Also as shown therein, the collet fingers **150** on the collet **148** are moved out of the upper recess **144** and are deformed outwardly. In this position, the outside diameter of the collet fingers **150** is greater than the inner diameter of the abutments carried by the tubular shell **72**.

Continued upward movement of the tubing string **14** and body **34** forces the resilient portions **152**, carrying the lugs **154**, inwardly into the lower recess **146** in the body **34** so that the collet **148** snaps by the abutment **134**. When the collet **148** moves past the abutment **134**, the

collet fingers **150**, in their expanded position, engage the lower surface of the abutment **132**. Since the expanded collet fingers **150** have an outer diameter greater than the inner diameter of the abutment **132**, farther upward movement of the tubing string **14** and body **34** is prohibited. The treating mandrel **16** and the indexing mechanism **124** is now in the position illustrated in FIG. 2C and in FIG. 5.

As may be seen in FIG. 2B, the port **32** is now in alignment with the lower port **56** in the packer mandrel **50** and is in position to inject treating material through the aligned ports **32**, **56**, **114** and the perforations **170** into the formation isolated between the packing elements **104** and **106**.

When it is desired to bring the port **32** into alignment with the ports **54**, **110** and the perforations **172**, the tubing string **14** is lowered slightly, lowering the collet **148** moves the lower surfaces **155** of the lugs **154** into engagement with the upper surface **140** of the abutment **134** as illustrated in FIG. 6. Continued downward movement of the body **34** relative to the collet **148** moves the upper recess **144** on the body **34** under the collet fingers **150** thereby permitting the collet fingers **150** to move into the upper recess **144**. The collet **148** with the retracted fingers **150** will then pass the abutment **132** until the surfaces **153** on the lugs **154** engage the lower surface **142** of the abutment **132**. At this time, the indexing process is performed as previously described in connection with movement past the abutment **134** so that the collet fingers **150** will then engage the next abutment **130** bringing the treating port **32** into alignment with the ports **54**, **110** and with the perforation **172**. The foregoing procedure can be repeated until all of the desired formations have been treated.

The upper surfaces **153** on the lugs **154** have been provided with a greater angle relative to the horizontal than the lower surfaces **155** so that upward movement of the collet **148** past the abutments can be accomplished with less force and therefore with less chance of the collet **148** being jerked through or past more than one of the abutments at a time. The movement of the collet **148** upwardly and downwardly past the various abutments gives a positive indication at the surface of the well of the position of the indexing mechanism **124** and, thus, of the position of the treating port **32**. The various indexing movements can be counted so that the precise location of the treating port **32** can be ascertained readily. In the event that the location of the port **32** is questioned, the indexing mechanism **124** can be actuated in a downward direction until the lowermost abutment has been reached and then moved upwardly while counting the steps so that it is a relatively simple matter to determine the location of the port **32**.

Also, it is possible to treat any of the isolated formations when and as desired on an individual basis. While the abutments have been illustrated as being located in evenly spaced increments, the device could be provided with any desired length between abutments.

After the treating operation has been completed, the indexing mechanism **124** can be actuated to obtain a test of each of the intervals treated. For example, if the treatment performed was injecting a sand consolidation chemical, each of the intervals could be individually produced to determine whether or not sand is being produced with the oil and/or gas. Thus, the packer **10** can also be utilized in evaluating the results of the treatment performed therethrough.

After the treating operation has been performed and the intervals have been tested as desired, the tubing **14** and the treating mandrel **16** are raised upwardly until the collet **148** of the indexing mechanism **124** passes the uppermost abutment **128**. After passing the abutment **128**, the tubing string **14** and treating mandrel **16** can be removed from the packer **10** and pulled to the surface of the well. The remainder of the packer **10** can be left in the well bore to serve as a production packer.

If all of the formations treated are to be produced, the indexing mechanism body **34** and collet **148** are removed from the lower end of the treating mandrel **16**. The treating mandrel **16** is then drilled to provide ports corresponding to each of the producing zones. A latching mechanism (not illustrated in FIGS. 1A, 1B or 1C) is connected to the lower end tubing string **14** so that when the treating mandrel **16** is replaced in the bore of the packer **10**, the ports are aligned with the formations. Manifestly, if less than all of the treated formations are to be produced, the treating mandrel **16** is drilled to provide ports only in positions corresponding to the zones to be produced.

## DESCRIPTION OF THE EMBODIMENT OF FIGS. 7A, 7B AND 7C

FIGS. 7A, 7B and 7C, taken together, illustrate another embodiment of the selective interval packer that is generally designated by the reference character **200**. It will be appreciated from comparing FIGS. 7A, 7B and 7C with FIGS. 1A, 1B and 1C that the basic components of the packer **200** are identical to those previously described in connection with the packer **10**. For this reason, identical parts in the packer **200** have been designated by the same reference characters previously used in the description of the packer **10**.

One of the basic differences between the packers **10** and **200** is in the treating mandrel **16**. In the packer **200**, the treating mandrel **16** is connected to a second tubing string that is disposed concentrically within the tubing string **14**. It will be noted in FIG. 7B and in FIG. 7C that the shell **72** of the indexing mechanism **124** is connected to the lower portion **58** of the packer mandrel **50** in the packer **200**. Also, the index mechanism body **34** of the indexing mechanism **124** is connected with the lower end of the treating mandrel **16** as it was in the packer **10**.

In the embodiment of FIGS. 7A, 7B, and 7C, the lower end of the tubing string **14** is connected with a latching device **202** that is threadedly connected at its lower end to the collar **18**. The collar **18** is connected with the upper end of a production tube **204**. The production tube **204** extends into the packer **200** and is disposed concentrically between the packer mandrel **50** and the treating mandrel **16**.

The latching mechanism **202** includes a split ring latch member **206** that is disposed in an annular recess **208** formed in the spring housing **38**. With the latching mechanism **202** connected with the spring housing **38**, the production tube **204** is positioned in the packer **200** with ports **210** and **212** therein located in alignment with the ports **54** and **56**, respectively, in the packer mandrel **50**.

The port **210** is isolated by an annular seal **214** and an annular seal **216**. The seals **214** and **216** are located on each side of the port **210** in sealing relationship between the packer shell **50** and the production tube **204**. Similarly, the port **212** is isolated between the annular seal **216** and an annular seal **218**. The annular seal **218** is also disposed in sealing relationship between the packer shell **50** and the production tube **204**.

A fourth annular seal **220** is carried by the production tube **204** and is positioned in sealing engagement with the packer mandrel **50** relatively below the imperforate portion of the packer mandrel **50** to provide for sealing the treating port **32** in the treating mandrel **16** as the packer **200** is lowered into the well bore.

Another difference between the packer **200** and the packer **10** is in the position of the latching device **60**. In the embodiment of FIGS. 1A, 1B and 1C, the latching

device **60** is located on the lower portion of the packer mandrel **58** in a position wherein it engages the teeth **160** on the locating mechanism **167**. In the embodiment of FIGS. 7A, 7B and 7C the latching device **60** is located wholly within the lower sleeve **116** of the packer **200**. As shown therein, the latching device **60** is pinned to the lower portion **58** of the packer mandrel **50** by the shear pin **64**, but in a location within the lower sleeve **116**.

With the arrangement shown in FIGS. 7A, 7B and 7C, the entire setting operation of the packer **200** is self contained and does not depend upon a connection with the locating mechanism **167** to retain the packer mandrel **50** against upward movement. Also, it can be appreciated that if it is desired to retrieve the packer **200**, an upward pull exerted thereon sufficient to shear the pin **64** will not drop the latching device **60** into the well bore, as is true of the latching device **60** shown in the FIG. 2B location, but it will be retrieved with the lower sleeve **116**.

With regard to the operation of the packer **200**, the concentric tubing strings are run into the well bore with the packer **200** connected thereto until the shoulder **118** on the sleeve **116** engages the upper end of the locating device **167**. When this occurs, the packer **200** is set described in connection with the packer **10**. As can be appreciated by comparing FIG. 7C with FIGS. 1C and 2C, the indexing device **124** functions as previously described in connection with the packer **10**.

After the treating operation has been performed, the inner tubing string, which is connected to the treating mandrel **16**, is pulled upwardly from within the tubing string **14** removing the treating mandrel **16** from within the packer **200**. As will be noted, the production tubing **204** is left in the packer **200** is sealed relationship to the packer mandrel **50** as previously described and the packer **200** is in condition for the well to be put into production immediately.

By providing the production tubing **204** in the construction illustrated in FIGS. 7A, 7B and 7C, it is not necessary to return the modified treating mandrel **16** into the packer **200** to put the well on production as was true of the embodiment of FIGS. 1A, 1B and 1C. Thus, the packer **200** eliminates the necessity for rerunning the modified treating mandrel **16** which is a relatively expensive and time consuming process.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

**1.** Well apparatus for isolating, treating and producing selected zones in a cased well bore, said apparatus comprising:

hollow body means having a plurality of spaced ports therein;

packing means including a plurality of spaced packing members carried by said body means, said packing members being arranged to sealingly engage the casing to isolate said ports;

a hollow treating member having a lateral opening therein, said treating member being movable through said hollow body means;

a plurality of spaced seal members forming fluid-tight seals between said treating member and body means isolating said ports; and,

index means for locating said lateral opening in said treating member in communication with the ports in said body means selectively.

**2.** The well apparatus of claim **1** and also including:

an elongated, tubular member disposed between said hollow body means and said treating member, said tubular member having a plurality of spaced openings therein in communication with said ports;

spaced seal members forming fluid-tight seals between said tubular member and hollow body means to isolate said ports and openings; and,

latch means connecting said hollow body means and tubular member with said ports and openings in communication.

**3.** The well apparatus of claim **1** wherein:

said hollow body means has a plurality of spaced inwardly projecting abutments; and,

said index means includes

a body member connected with the lower end of said treating member and having an annular recess therein, and

a collet member slidingly encircling said body member, said collet member having resilient collet fingers movable into and out of said annular recess, said collet member engaging one of said abutments when out of said recess to position the lateral port in said treating member in communication with one of said ports.

**4.** The well apparatus of claim **3** wherein:

said body member has a second annular recess spaced from said first-mentioned annular recess; and,

said collet member has a resilient medial portion and at least one lug projecting outwardly from said medial portion engageable with said spaced abutments to move said fingers out of said first-mentioned recess for engagement with said another of said abutments upon upward movement of said treating member relative to said hollow body means.

**5.** The well apparatus of claim **1** and also including holding means carried by said hollow body means, said holding means being movable into holding engagement with the casing to prevent movement of said apparatus relative to the casing.

**6.** The well apparatus of claim **5** wherein said hollow body means includes:

a first member engageable with said holding means and with said packing means; and,

a second member engageable with said packing means and movable with respect to said first member to deform said packing members into sealing engagement with the casing.

**7.** The well apparatus of claim **6** and also including locating means positioned in the well casing, said locating means engaging the second member of said packing means to permit the relative movement between said first and second members.

**8.** The well apparatus of claim **7** and also including connecting means for operably connecting said first member to said locating means.

**9.** The well apparatus of claim **8** wherein said connecting means includes:

an expander member releasably connected to said first member; and,

gripping means carried by said first member and engageable with said expander member for radial movement into holding engagement with said locating means.

**10.** The well apparatus of claim **9** wherein:

a frangible member connects said expander member and first member, said frangible member being arranged to part when a predetermined force is exerted thereon releasing said expander member from said first member; and,

said gripping means is sized to frictionally engage said locating means prior to the radial expansion of said gripping means.

**11.** The well apparatus of claim **10** wherein:

said locating means has downwardly facing teeth therein; and

said gripping means has upwardly facing teeth adapted to mate with the teeth in said locating means to prevent upward movement of said first member relative to said locating means.

**12.** The well apparatus of claim **7** and also including connecting means for operably connecting said first and second member after deformation of said packing members.

13. The well apparatus of claim 12 wherein said connecting means includes:

an expander member releasably connected to said first member; and,

gripping means carried by said first member and engageable with said expander member for radial movement into holding engagement with said second member.

14. The well apparatus of claim 13 wherein:

a frangible member connects said expander member and first member, said frangible member being arranged to part when a predetermined force is exerted thereon releasing said expander from said first member; and,

said gripping means is sized to frictionally engage said second member prior to the radial expansion of said gripping means.

15. The well apparatus of claim 14 wherein:

said second member has downwardly facing teeth therein and an interior flange closely encircling said first member; and,

said first member has upwardly facing teeth adapted to mate with the teeth in said first member to prevent upward movement of said first member relative to said second member.

16. In well apparatus, indexing means comprising:

a tubular member having a plurality of spaced inwardly projecting abutments;

a body member movable through said tubular member and having a recess in the exterior thereof; and

a collet member carried by said body member, said collet member including at least one resilient collet finger movable into and out of said recess, said finger engaging one of said abutments when out of said recess, and said collet member including at least one lug engageable with another of said abutments to move said finger into and out of said recess.

17. The indexing means of claim 16 wherein:

said body member has a second recess in the exterior thereof; and,

said collet member includes a resilient portion carrying said lug and positioned adjacent said second recess to permit said lug and resilient portion to move into said second recess when said finger is in said first-mentioned recess whereby said collet member can move past said first-mentioned abutment for engagement with another of said abutments.

18. The indexing means of claim 16 wherein:

said recess is of annular configuration and said body member has a second annular recess on the exterior thereof spaced from said first-mentioned annular recess; and, wherein

said collet member encircles said body member and includes a plurality of said collet fingers, each having a radially thickened end portion, said collet member also including a resilient medial portion disposed adjacent said second annular recess and having a plurality of outwardly projecting lug portions thereon arranged to sequentially engage said abutments to move said collet fingers into and out of said first-mentioned annular recess.

19. The indexing means of claim 18 wherein said resilient medial portion is provided by a plurality of circumferentially spaced longitudinal slots in said collet member.

20. The indexing means of claim 18 wherein:

each said abutment has an upwardly and outwardly tapering surface and a downwardly and outwardly tapering surface; and,

each said lug portion has a downwardly and outwardly tapering surface mating with said downwardly and outwardly tapering surface on said abutments to move said collet fingers out of said first-mentioned annular recess, and an upwardly and outwardly tapering surface mating with said upwardly and outwardly tapering surface on said abutments to move said collet member to a position wherein said fingers are disposed in said first-mentioned annular recess.

21. The indexing mechanism of claim 20 wherein said upwardly and outwardly tapering surfaces on said abutments and lug portions are at an angle relative to the longitudinal axis of said tubular member greater than the angle of said downwardly and outwardly tapering surfaces, whereby a greater force is required to move said lug portions past said abutments in a downward direction than in an upward direction.


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