Jan. 28, 1969 W. D. MYERS 3,424,246

RETRIEVABLE WELL BORE INDEXING APPARATUS

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FIG. 1.

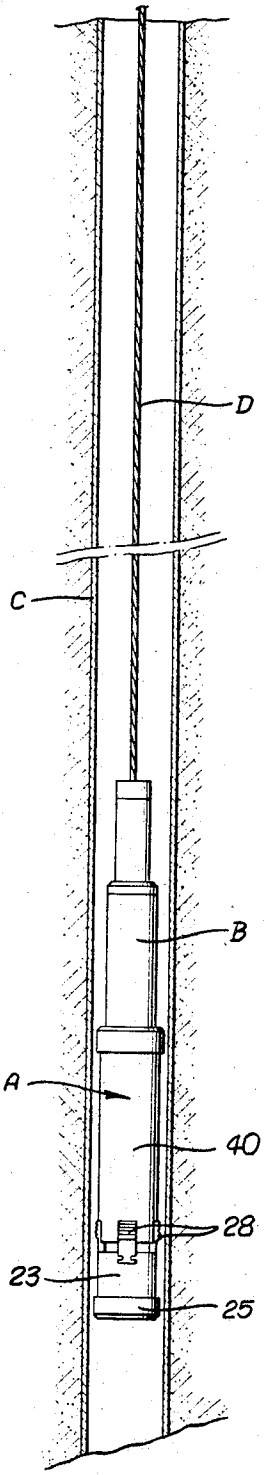



FIG. 2.

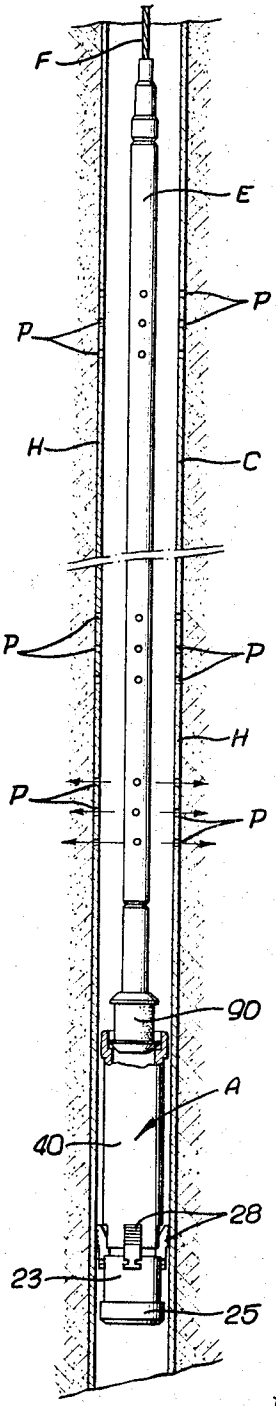
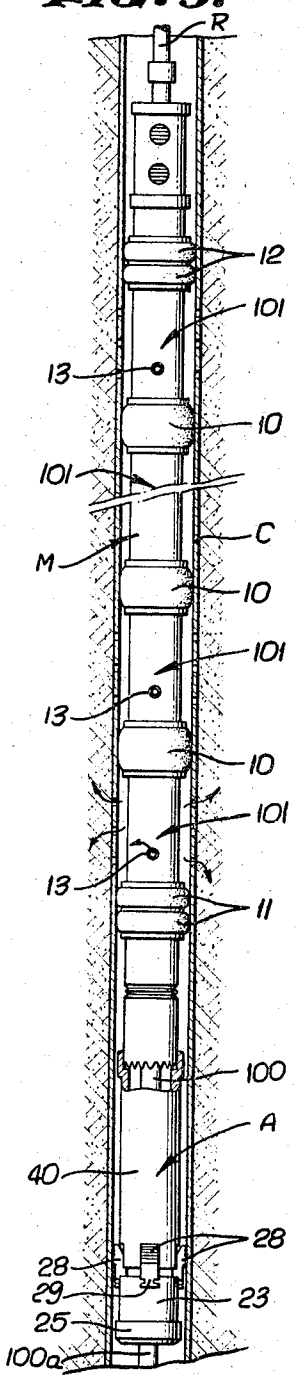



FIG. 3.




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FIG. 4.

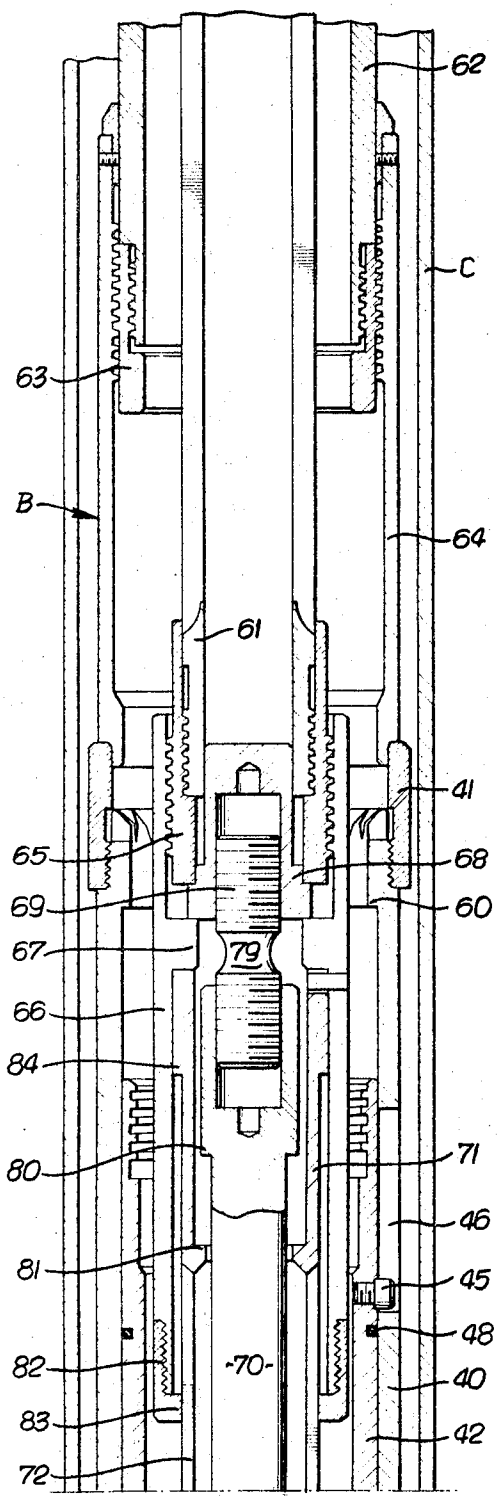
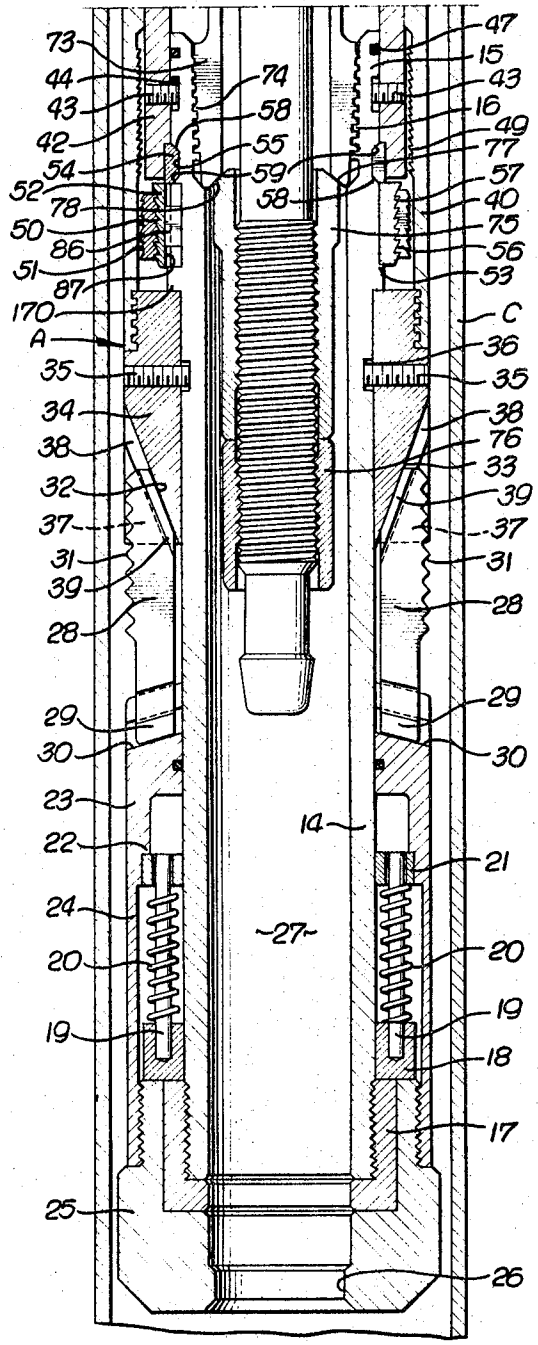



FIG. 4a.




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FIG. 5.

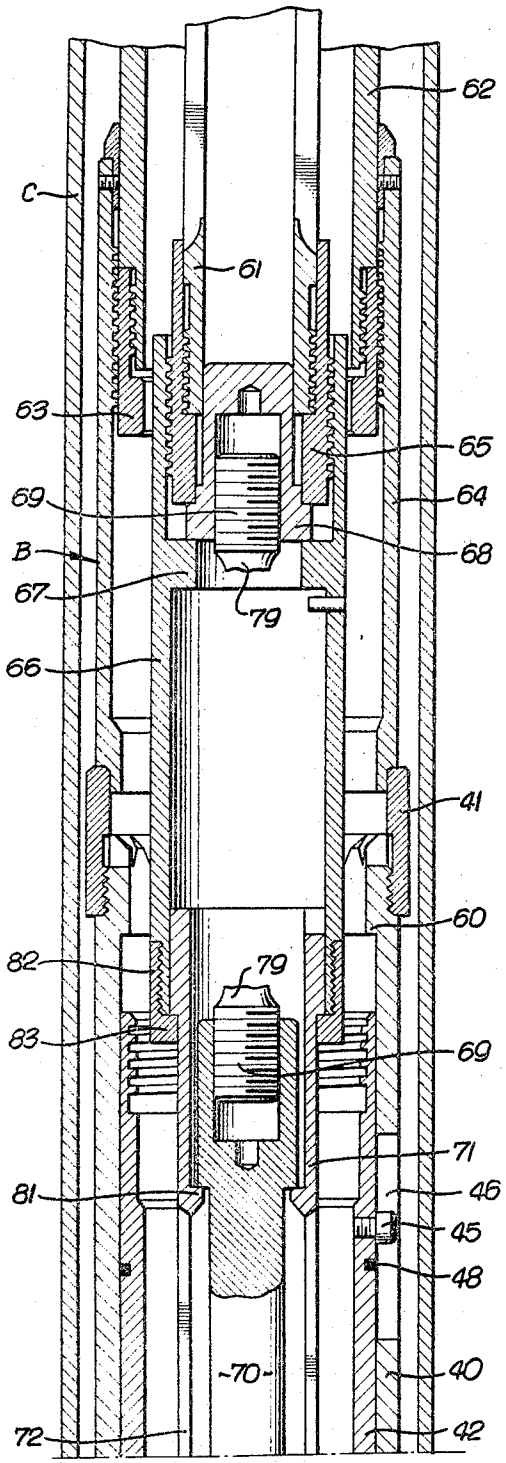
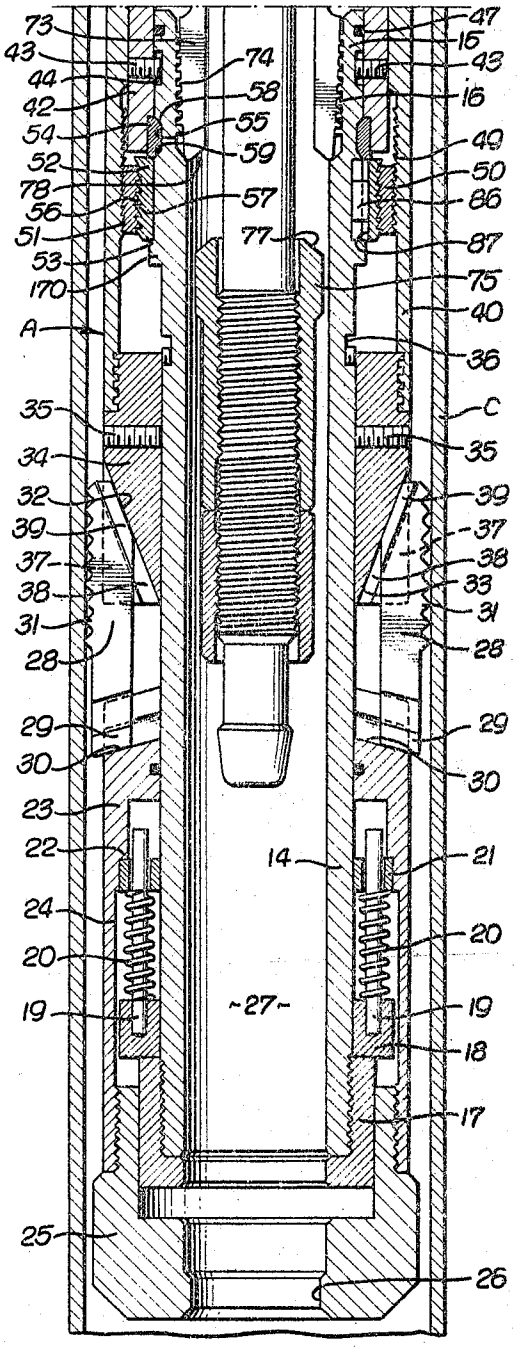



FIG. 5a.




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RETRIEVABLE WELL BORE INDEXING APPARATUS



FIG. 6.

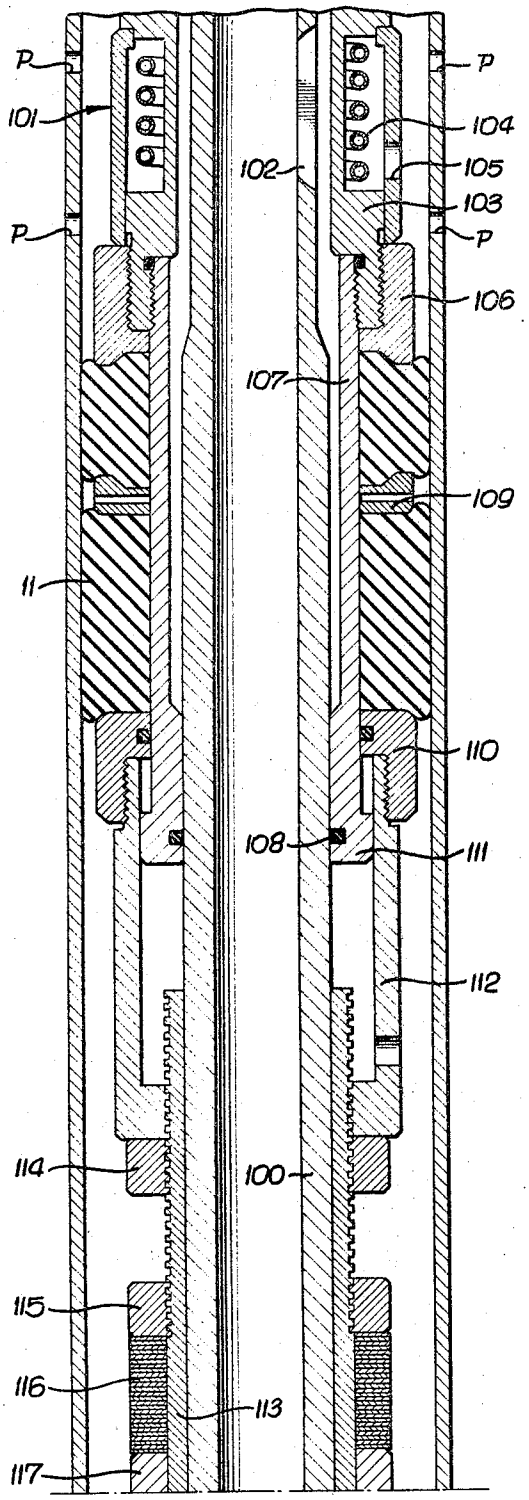
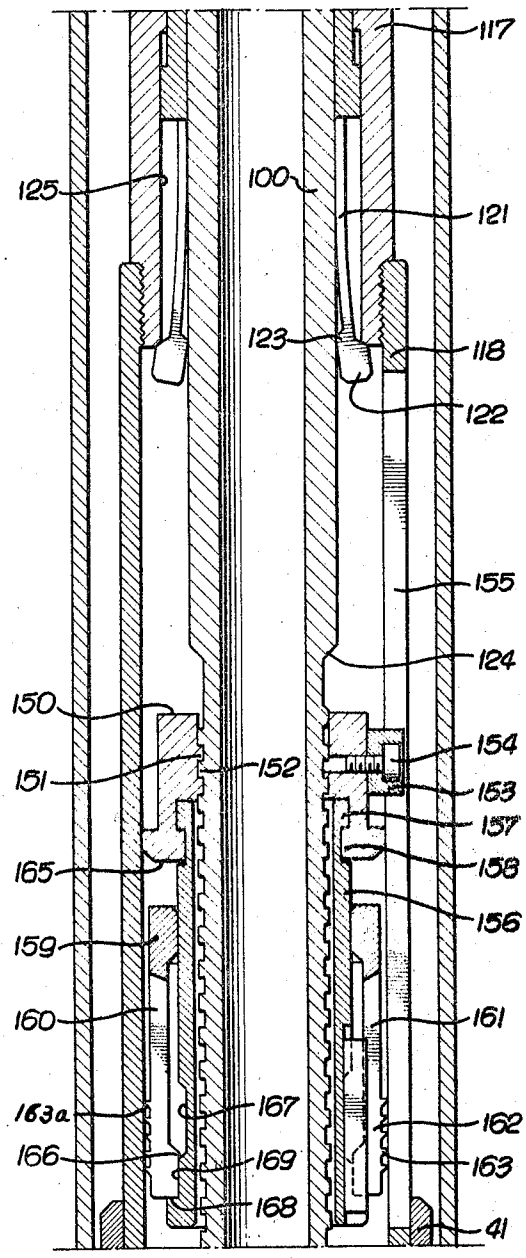



FIG. 6a.




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FIG. 6b.

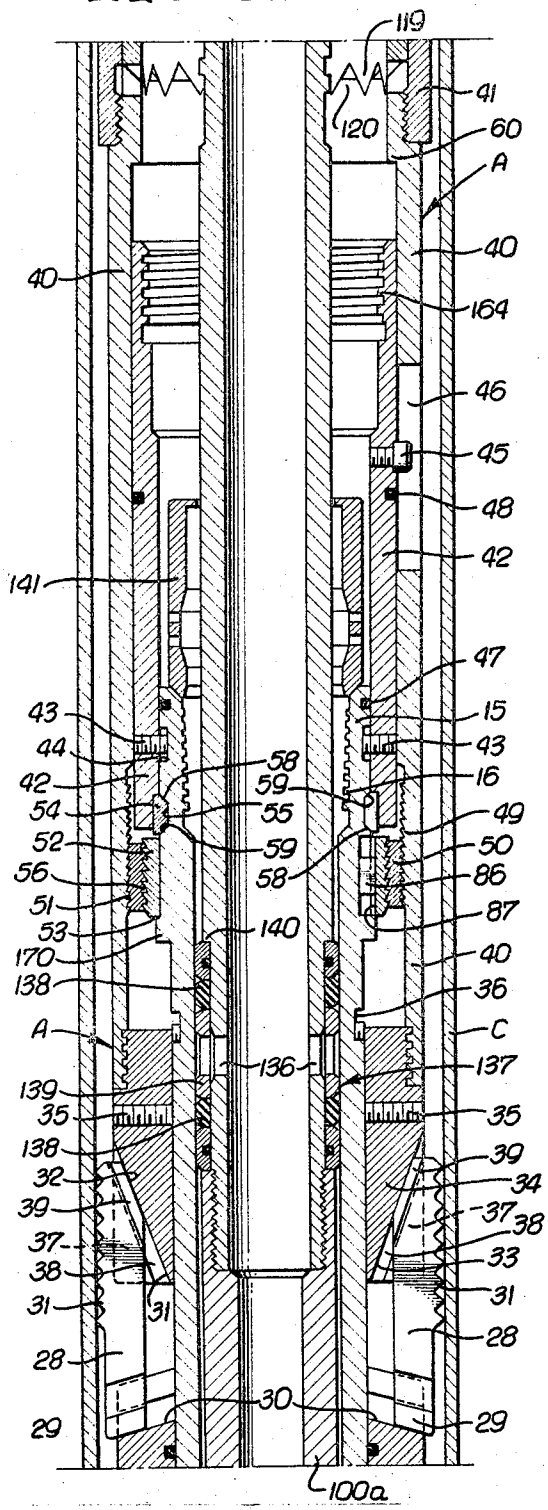
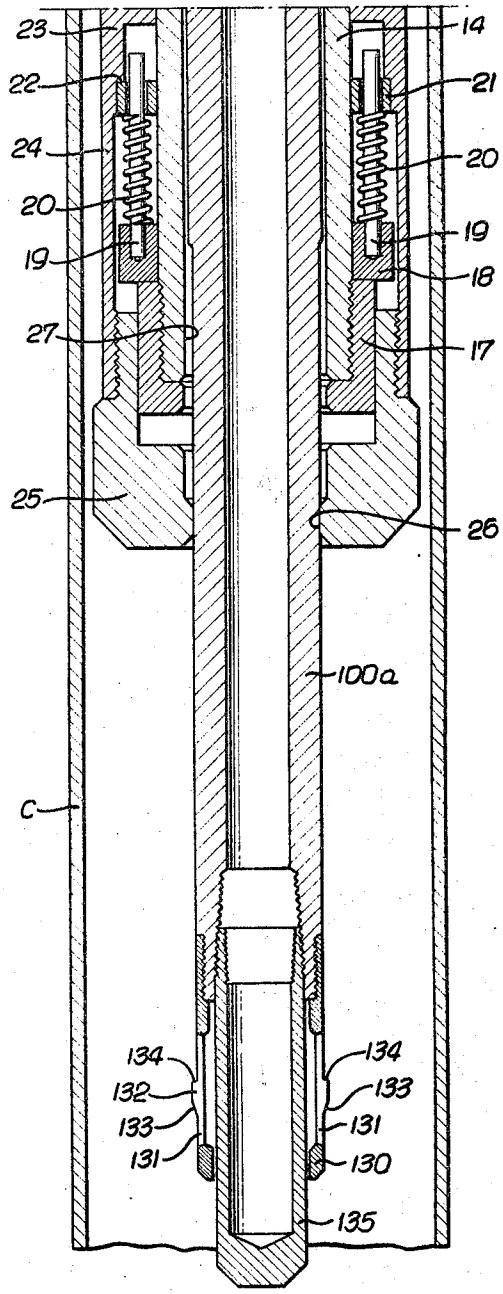



FIG. 6c.




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FIG. 7.

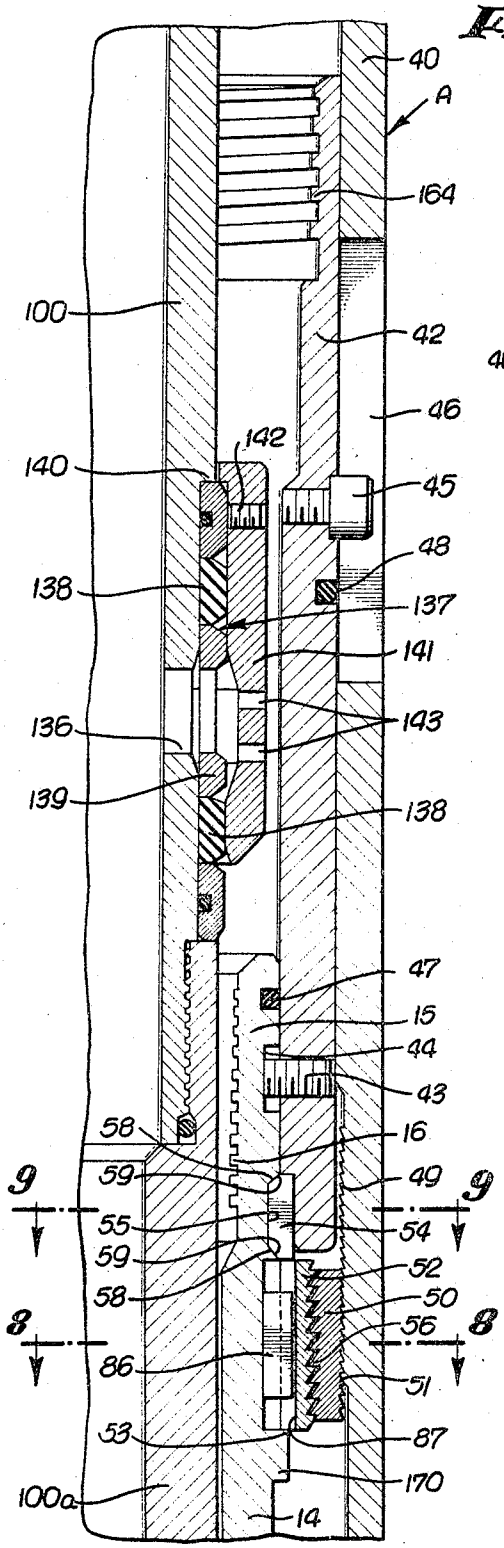



FIG. 8.

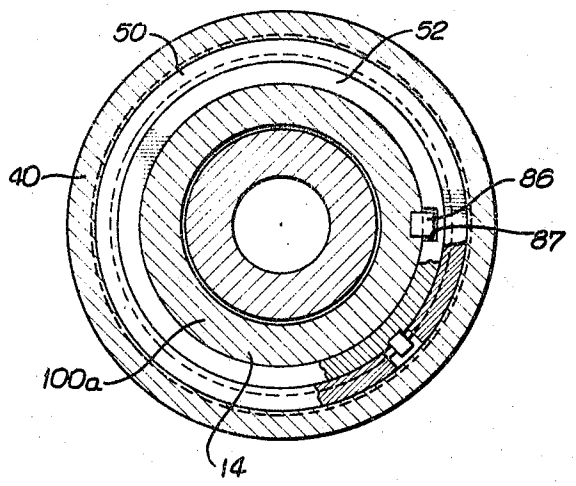
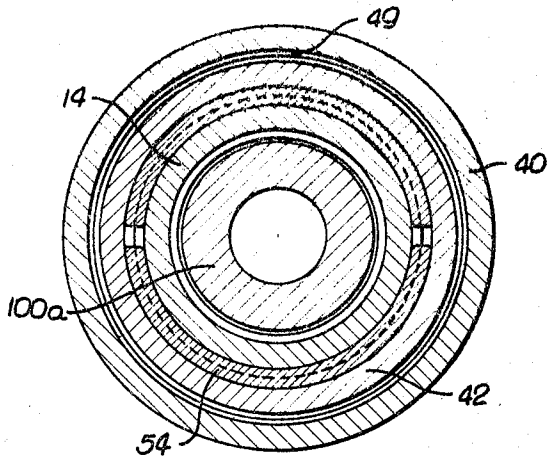



FIG. 9.




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FIG. 10.

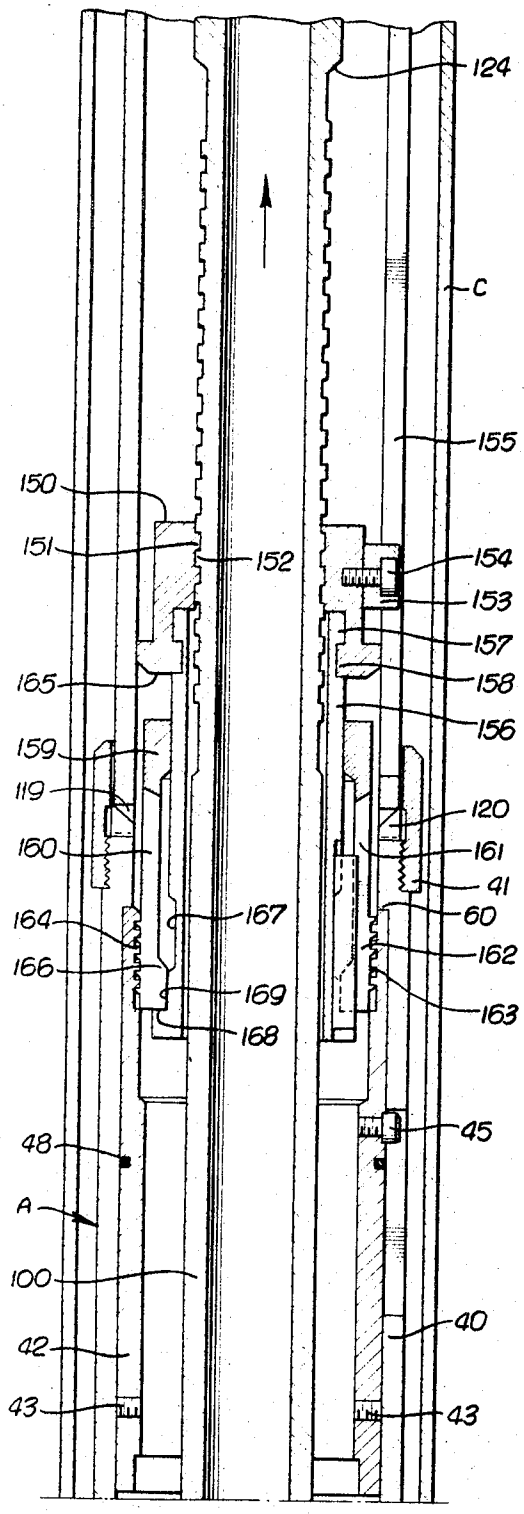
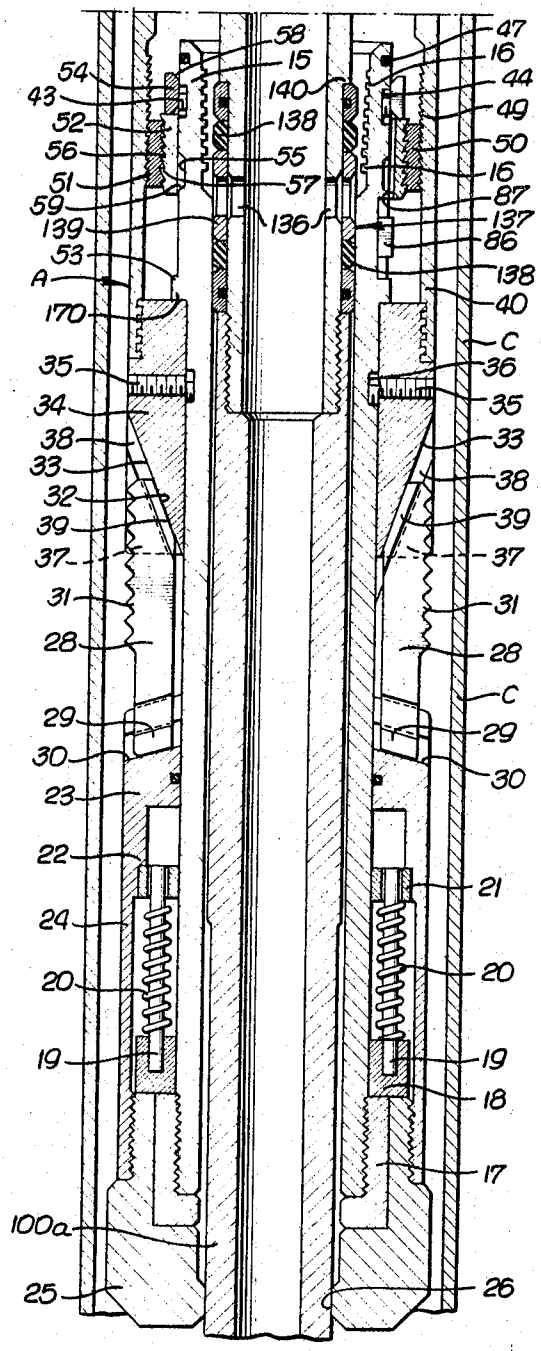



FIG. 10a.




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United States Patent Office 3,424,246 Patented Jan. 28, 1969



3,424,246

# RETRIEVABLE WELL BORE INDEXING APPARATUS

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Filed Aug. 15, 1966, Ser. No. 572,364
U.S. Cl. 166—127 28 Claims
Int. Cl. E21b 23/00, 33/12

## ABSTRACT OF THE DISCLOSURE

Apparatus adapted to be lowered in a well bore for facilitating perforating the well casing at vertically spaced intervals and the subsequent fluid treatment of the earth zones through the perforated intervals.

Such apparatus including an indexer having anchor means for releasably anchoring the indexer at a selected location in the well casing, the indexer being releasably connectible to a wire line running tool for setting the indexer in the well casing.

Such apparatus including packer means releasably engageable with the indexer and having vertically spaced packing elements for sealing engagement with the well casing between the perforated intervals.

Such apparatus in which the indexer has releasable lock means for preventing release of the anchor means, and the packer means is connectible to the lock means to release the same.

The present invention relates to subsurface well bore apparatus, and more particularly to retrievable apparatus adapted to be set in a well bore for the purpose of providing a fixed reference point from which other equipment can be located accurately in the well bore for the performance of desired operations therewithin.

In the United States patent application of Hiram H. Fisher, Jr., William D. Myers, and David V. Chenoweth, Ser. No. 510,001, filed Nov. 26, 1965, for "Multiple Injection Well Packer Apparatus," a packer apparatus is disclosed for injecting fluids into a desired length of a formation zone through a plurality of longitudinally spaced casing perforations located at predetermined points in the casing string. The packer apparatus has a multiplicity of packing elements capable of being sealed against blank portions of the casing, the packing elements being spaced apart by required distances so that the casing perforations at each point are disposed between a pair of packing elements. Typically, the packing elements are spaced from each other by relatively short distances, which, for example, may be two feet, the perforations at each injection point being located within this two feet interval. Following setting of the packer at the required location in the casing, fluids are pumped into the packer, discharging therefrom between each pair of packing elements for passage through the spaced perforations and into the formation surrounding the casing. By discharging the fluids from the packer apparatus between adjacent packing elements of each pair, and through the separated perforations, a substantially uniform injection of the fluid along the desired length of formation zone can be obtained.

The casing perforations are produced by a perforating gun having shots spaced from one another the desired distance to provide the required perforation pattern in the well casing upon firing of the gun. The gun is then retrieved and the multiple injection packer run in the well bore and set therewithin so that its packing elements straddle the perforations at each of the predetermined spaced points, in order to isolate the perforations at such points from each other. The present invention is directed



to and has for an object the provision of an improved indexer or locator capable of being set in the well casing preparatory to use of the perforating gun and multiple injection packer, so as to function as a fixed reference point against which the gun and packer can bear, thereby insuring the production of casing perforations at required locations and pattern in the casing, and the setting of the multiple injection packer with its adjacent packing elements straddling the perforation or perforations at each location.

Another object of the invention is to provide an indexer or locator capable of being anchored at the desired location in the well bore so that casing perforations can be produced in the casing by a proper gun assembly at precise points, the indexer or locator being readily retrievable from the well casing after the required operations in the well bore have been performed, such operations including the use of a multiple injection packer, for example, and the pumping of fluids through the packer and through the casing perforations into the formation.

A further object of the invention is to provide an indexer adapted to be anchored in the well casing to serve as a fixed reference point for accurate locating of a multiple injection packer in the casing with respect to casing perforations through which fluids are to be injected into the formation, the multiple injection packer and indexer being simultaneously retrievable from the casing. If desired, the multiple injection packer can be removed from the indexer at any time without disturbing the set condition of the latter in the casing, the indexer being releasable and retrievable subsequently.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a somewhat diagrammatic view illustrating the lowering of a retrievable indexer and a setting tool on a wire line in a casing to a desired reference point at which the indexer is to be set in the casing;

FIG. 2 is a diagrammatic view illustrating the indexer anchored in the well casing and a perforating gun lowered thereagainst for shooting perforations in the well casing at required points or locations;

FIG. 3 is a diagrammatic view illustrating a multiple injection packer associated with the set indexer so that fluids can be pumped through the packer and through the individual perforations previously formed in the casing by the gun;

FIGS. 4 and 4*a* together constitute a longitudinal section through the indexer and lower portion of the setting tool, with the indexer parts in their initial retracted positions for lowering of the apparatus in the well casing, FIG. 4*a* being a lower continuation of FIG. 4;

FIGS. 5 and 5*a* are views corresponding to FIGS. 4 and 4*a*, illustrating the indexer having been anchored against the wall of the well casing and with the setting tool in a released condition with respect to the indexer, for removal from the well casing, FIG. 5*a* being a lower continuation of FIG. 5;

FIGS. 6, 6*a*, 6*b* and 6*c* together constitute a longitudinal section through the lower portion of the multiple injection packer in association with the set indexer, FIGS. 6*a*, 6*b* and 6*c* being lower constinuations of FIGS. 6, 6*a* and 6*b*, respectively;

FIG. 7 is an enlarged partial longitudinal section

through a portion of the indexer and a portion of the multiple injection packer while the latter is being inserted in the indexer;

FIG. 8 is a cross-section, on a reduced scale, taken along the line 8—8 on FIG. 7;

FIG. 9 is a cross-section, on a reduced scale, taken along the line 9—9 on FIG. 7;

FIGS. 10 and 10*a* together constitute a longitudinal section through the indexer and lower portion of the multiple injection packer, illustrating the indexer in its released condition from the well casing, permitting its elevation, together with the packer, in the well casing, and withdrawal therefrom at the top of the well bore.

The apparatus illustrated in the drawings is intended for use to perform the multiple injection of fluids through spaced perforations P that are to be provided in a well casing C and into the surrounding formation. As disclosed in FIG. 1, a retrievable indexer or locating tool A is releasably connected to a setting tool B and is lowered on a wire line D, which has an electric conductive core therein, through the casing to a desired location therewithin at which the retrievable indexer is to be anchored. Following setting or anchoring of the indexer in the casing, the setting tool B is released therefrom and the setting tool and wire line D are then elevated in and removed from the well casing.

A perforation gun E, which is preferably of the simultaneously firing or salvo type, is then lowered on a suitable wire line F in the casing and will come to rest on the retrievable indexer. The shots in the perforating gun are spaced along its length in accordance with the spacing of perforations P desired in the casing. As disclosed in FIG. 2, the gun charges are spaced from one another by predetermined amounts so as to leave blank casing intervals H against which the packing elements **10**, **11**, **12** of the multiple injection packer can seal after the latter is run in the well casing. The gun E is fired to produce the desired pattern of perforations P in the casing, which, for example, may be three sets of perforations as disclosed in FIG. 2. Of course, the number of perforations at each point in the well casing and the number of sets of perforations can be varied depending upon the desired operation to be performed, as well as the spacing between sets of perforations.

After the casing has been perforated, the gun E is removed therefrom and the multiple injection packer M of the type specifically illustrated in the above-identified United States patent application, Ser. No. 510,001, is run in the casing on tubing R and will come to rest upon and in association with the retrievable indexer A, which remains anchored at its set location. This multiple injecton packer has the packing elements **10**, **11**, **12** along its length, which are spaced from one another by preselected distances, such that upon being set or expanded against the well casing, they will seal against blank casing on opposite sides of the sets of perforations P, as disclosed in FIG. 3. In the above referred to patent application, the uppermost and lowermost packing elements **12**, **11** are of the mechanically set type; whereas, the intervening packing elements **10** are of the inflatable or balloon type, being expanded outwardly in response to the pressure of fluid being pumped down through the tubing string R and through the well packer for discharge from outlets **13** in the packer between each pair of expanded packing elements. The desired fluids, such as described in the above-identified patent application, are pumped through the tubing string and packer for discharge through its outlets **13** and for passage through the respective casing perforations P into the surrounding formation after the packing elements are sealed against the casing. After the fluid injecting operation has been performed, the packing elements **10**, **11**, **12** are retracted. The multiple injection packer can then be removed from its relation to the indexer A and elevated to the top of the well bore, leaving the indexer in place, if desired. However, the present invention also contemplates the use of the multiple injection packer M for releasing the indexer or locator A from its anchored position in the casing and for elevating it therewith to the top of the well bore.

The indexer A includes a central tubular body **14** having an upper box box **15** provided with a female left-hand thread **16**, its lower end being threadedly connected to a body nut **17** that is engaged by a spring seat **18** carrying a plurality of circumferentially spaced, longitudinally extending centering pins **19** surrounded by helical compression springs **20**. The lower ends of the springs bear against the upper end of the spring seat **18**, the upper ends of the srings bearing against an alignment plate **21** through which the centering pins are slidable. This alignment plate engages a downwardly facing shoulder **22** on a slip ring **23** that has a skirt **24** enclosing the springs **20** and spring seat **18**, the lower end of the skirt being threadedly secured to a guide **25** surrounding the nut **17**, this guide extending under the latter but having a full opening **26** therethrough in alignment with the central opening or passage **27** through the body.

A plurality of circumferentially spaced slips **28** are coupled to the upper portion of the slip ring **23** so that the slips move jointly in longitudinal directions. However, the slips can shift radially inwardly and outwardly of the slip ring, as by forming the lower portions of the slips as T-shaped heads **29** slidably received in companion transversely extending T-shaped slots **30** in the upper portion of the slip ring. The slips **28** have external teeth **31** adapted to embed themselves in the wall of the well casing C and inner surfaces **32** tapering in a downward direction and slidable along companion external tapered surfaces **33** on an expander **34** initially secured to the body **14** by one or a plurality of shear screws **35** received within a circumferential groove **36** in the body.

Relative downward movement of the expander **34** along the body **14** and the slips **28** will shift the slips radially outwardly into anchoring engagement with the well casing C; whereas, relative upward movement of the expander with respect to the slips will retract the latter from the casing, by virtue of a tongue and groove interconnection between the expander and slips. Thus, the slips **28** are received in longitudinal slots **37** in the expander, the base of each slot constituting the external expander surface **33**, each of these slots having side grooves **38** adjacent to its base **33**, and inclined in the same direction and to the same extent as the base, and receiving companion tongues **39** extending outwardly from opposite sides of the slips **28**. Accordingly, a positive slidable connection is provided between the expander **34** and slips **28**, such that their relative longitudinal separation will effect radial inward retraction of the slips **28** from the casing C.

The upper portion of the expander **34** is threadedly, or otherwise suitably, secured to a housing **40** extending upwardly along the body **14** and thereabove to a substantial extent, an upper guide **41** being threadedly secured to the upper portion of the housing. A retrieving sleeve **42** is slidably mounted within the housing **40**, being secured initially to the upper portion of the body **14** by one or a plurality of shear screws **43** received within a circumferential body groove **44**, this retrieving sleeve having a cap screw or key **45** extending therefrom and receivable within a companion longitudinal slot **46** in the housing to prevent relative longitudinal rotation therebetween while permitting their relative longitudinal movement. Fluid leakage between the retrieving sleeve and body is prevented by a suitable side seal ring **47** on the body engaging the sleeve; whereas, leakage between the retrieving sleeve and housing is prevented by a suitable side seal ring **48** on the sleeve engaging the inner surface of the housing below the key **45**.

Assuming the slips **28** have been expanded outwardly, as described hereinbelow, they are locked in their expanded and anchored condition by a lock device acting

between the expander **34** and the body **14**. As disclosed, the housing has inwardly directed internal ratchet teeth **49**, which can be formed as an internal ratchet or buttress thread, facing in an upward direction and extending along its length, which is initially disposed above a split lock ring **50** having external ratchet teeth or a buttress thread **51** companion to the housing teeth **49** but facing in the opposite or downward direction. This lock ring encompasses a support ring **52**, the lower end of which bears against an upwardly facing shoulder **53** on the body **14**, and the upper end of which bears against an abutment ring **54**, which is split or made in two circumferential pieces, disposed within an external groove **55** in the indexer body. The inner surface of the lock ring **50** has internal tapered cam teeth **56** engageable with companion external tapered cam teeth **57** on the lock ring support.

As described hereinbelow, upon relative downward shifting of the housing **40** and expander **34** along the body **14**, for the purpose of expanding the slips **28** outwardly, the housing ratchet teeth **49** will ratchet downwardly freely over the lock ring teeth **51**, the lock ring **50** being contractible to the required extent about the support ring **52** because of the clearance provided between the cam teeth **56**, **57** on the lock ring and support ring (FIG. 7). However, any tendency of the housing **40** and expander **34** to move upwardly is resisted by the coengagement between the ratchet teeth **49**, **51** which tends to shift the lock ring **50** upwardly along the support ring **52**, the cam teeth **56**, which taper in a downward direction, urging the lock ring laterally outwardly and retaining its ratchet teeth **51** fully meshed with the housing teeth **49**, and in this manner precluding upward or return movement of the housing **40** and expander **34** along the body **14**. The support ring **52** engages the abutment ring **54**, and is prevented from moving upwardly along the body thereby. It is to be noted that the abutment ring **54** has beveled upper and lower inner corners **58** and is received within the body groove **55** that has companion tapered upper and lower sides **59**. The upward force imposed on the support ring **52** would tend to cam the abutment ring **54** out of its groove **55**. However, such removal from the groove is prevented since the retrieving sleeve **42**, at first, encompasses the abutment ring **54**, as disclosed in FIG. *4a*, for example, being held in such position by the shear screws **43**. It is only after an upward pull is taken on the retrieving sleeve **42** to shear the screws **43** that it can be elevated along the body **14** from the ring **54** to permit expansion of the latter from the body groove **55** and release of the support ring **52** for slidable upward movement along the body **14**. The retrieving sleeve is movable upwardly into engagement with a housing shoulder **60** to carry the housing **40** and expander **34** upwardly with it and effect retraction of the slips **28**.

The indexer has its parts in their initial retracted conditions disclosed in FIGS. 4 and *4a*, with all shear screws intact. It is attached to a setting tool B of a known type, such as illustrated in United States Patent Nos. 2,640,546 and 2,713,910, the setting tool being connected to the lower end of the wire line D, which, preferably, is of the electrically conductive type. Since the setting tool is known and is described in the above patents, and per se forms no part of the present invention, only its lower portion has been disclosed in the drawings. As shown, such lower portion includes an elongate mandrel **61** surrounded by a setting sleeve **62**, this setting sleeve having a nut **63** threaded thereto, which, in turn, is threadedly secured to the upper portion of an adjustable setting sleeve **64**, the lower end of which bears upon the upper housing guide **41**. The lower end of the mandrel **61** is threadedly connected to a nut **65**, which is, in turn, threadedly attached to a retrieving sleeve **66** having an inwardly directed flange **67** that clamps a coupling adapter **68** between it and the lower end of the nut. The upper portion of a release stud **69** is threadedly secured to the coupling adapter **68**, the lower end of the stud being threadedly attached to the upper portion of a tension rod **70** extending downwardly in the apparatus and within a latching sleeve **71** that has circumferentially spaced spring-like legs **72** depending from the upper portion of the latching sleeve and terminating in threaded latch feet **73** that have external threads **74** meshing with the internal threads **16** of the body **14**. The upper faces of the external threads **74** are tapered in an upward direction.

The threaded latch feet **73** are positively held in mesh with the body box threads **16** by a cam or expander member **75** threadedly secured to the tension rod **70** and locked thereon by a suitable lock nut **76**. This cam has a tapered upper surface **77** engaging companion surfaces **78** on the latch feet, such that any upward force transmitted to the tension rod **70** will be exerted through the cam **75** onto the latch feet **73**, which are thereby held in threaded mesh with the body box threads **16**, so that the upward force is, in turn, transmitted to the indexer body **14**.

The release stud **69** has an intermediate reduced diameter or weakened portion **79** at which the stud will pull apart when subjected to a predetermined tensile force. When the stud disrupts at its weakened section, the tension rod **70** can drop down, the cam **75** dropping away from the latch feet **73** and removing the holding force from the latter. The rod drops down until a shoulder **80** on its upper portion engages an inwardly directed shoulder **81** on the latch sleeve **71**. A nut **82** is threaded on the lower portion of the retrieving sleeve **66**, which has an inwardly directed flange **83** adapted to engage an upper shoulder **84** on the latch sleeve when the entire setting tool B is to be removed from the indexer A, as described hereinbelow.

The setting tool B is connected to the indexer A, as shown in FIGS. 4 and *4a*, and the apparatus is lowered in the well casing on the wire line D to the predetermined point at which the indexer is to be anchored against the casing C. When this point is reached, the setting tool B is actuated, as described in the above United States patents, producing a setting force pulling the mandrel **61** upwardly and pushing the setting sleeve **62** and adjustable setting sleeve **64** in a downward direction. The upward force and movement of the mandrel **61** is transmitted through the stud **69**, tension rod **70** and cam **75** to the latch feet **73**, which are threadedly connected to the body **14** of the tool, exerting an upward force on the body **14** which is transmitted through the spring seat **18**, springs **20**, alignment plate **21**, and slip ring **23** to the slips **28**. At the same time, the downward force on the setting sleeves **62**, **64** is being transmitted to the housing **40** and the expander **34**. When the upward and downward forces exceed the shear strength of the screws **35** releasably and initially securing the expander **34** to the body **14**, they are disrupted and the expander **34** is shifted downwardly along the body **14**, while the body and the slips **28** are being shifted upwardly along the expander, the movement of the expander and slips toward each other expanding the slips **28** outwardly against the wall of the well casing C.

The force in the setting tool B increases to exert an increasing force on the mandrel **61**, release stud **69**, tension rod **70**, and body **14**, this force being transmitted through the springs **20**, which preferably are heavy springs and which are eventually compressed to their solid height. The setting force continues to increase in magnitude, resulting in an increasing wedging of the expander **34** behind the slips **28** to embed and anchor their teeth **31** more firmly into the wall of the well casing C. During the downward movement of the expander and the housing **40** along the body **14**, the housing ratchet teeth **49** ratchet downwardly over the lock ring teeth **51**, such teeth **49**, **51** permitting downward movement of the housing along the lock ring and body, but precluding return or upward movement. Accordingly, when the expander **34** has finally

been wedged relatively downwardly behind the slips **28** to a maximum extent, the expander will be prevented from shifting upwardly relative to the body **14** and slips by virtue of the locking action of the lock ring **50** and the support ring **52** therebehind, which cannot move upwardly because of its engagement with the abutment ring **54** that is retained in the body groove **55** by the retrieving sleeve **42**.

The setting force in the setting tool B continues to increase, and when the upward pull on the setting mandrel **61** and release stud **69** exceeds the strength of the latter at its weakened section **79**, it will pull apart at the point, permitting the tension rod **70** to drop downwardly and removing the cam **75** from its holding location behind the threaded latch feet **73**. The tension rod will drop downwardly until its shoulder **80** engages the latch sleeve shoulder **81**, whereupon elevation of the wire line D and setting tool B will shift the mandrel **61** upwardly to pull the retrieving sleeve **66** upwardly until the flange **83** of the nut **82** engages the shoulder **84** on the retrieving sleeve **71**. An upward pull taken thereon will then cause the upper inclined faces of the latch feet threads **74** to engage the body box threads **16** and shift inwardly to a released condition with respect to the threads **16**, in effect, ratcheting upwardly along the latter until the feet are fully removed from the body box **15**. At the same time, the elevation of the setting tool elevates its adjustable setting sleeve **64** from the guide **41**, the setting tool B then being elevated on the wire line D to the top of the hole, leaving the indexer A fully anchored against the well casing and locked in such anchored condition by the ratchet lock device **42**, **49–59**. It is to be noted that rotation of the support ring **52** with respect to the body **14** is prevented by a key **86** secured to the body and slidable in a keyway **87** in the support ring.

Although the lock device will maintain the expander **34** firmly wedged behind the slips **28** to hold them anchored against the wall of the well casing, the springs **20**, which, as indicated above, are heavy and exert a large compressive force, and which are actually compressed to solid height, exert a continuing force urging the slip ring **23** and the slips **28** in an upward direction and acting through the body **14** and the ratchet lock device to urge and retain the expander **34** in a downward position. These springs **20** insure the anchored condition of the slips **28** against the well casing and permit other mechanisms, such as the lower portion of the multiple injection packer M, to move and be snapped through the indexer A without effecting its release.

After removal of the setting tool B from the well casing, the perforator E is run therein on the wire line F, this perforator having its shots spaced at the preselected points along its length so that the lowermost set of shots will be spaced the appropriate distance above the anchored indexer A when the gun perforator rests thereupon. Preferably, the lower portion of the perforator has a shock absorber or shock isolator **90**, which may be made of rubber or rubber-like material, formed thereon so that any shock incident to firing of the gun will be cushioned to some extent with respect to the imposition of a downward force on the retrievable indexer, A and will not inadvertently shift or release the latter in the casing.

Following the firing of the gun to produce the perforations P at the required predetermined points and in the appropriate pattern in the well casing C, the gun E is elevated from the well casing on the wire line F and removed therefrom. Thereafter, the multiple injection packer M is lowered on the tubing string R in the well casing. As stated above, an example of such packer is disclosed in United States patent application Ser. No. 510,001, and is adapted to be lowered into engagement and in operative association with the indexer A, at which time the lowermost packing element or elements **11** will be disposed below the lowermost set of perforations P, the uppermost packing element or elements **12** being disposed above the uppermost perforations P. The uppermost inflatable packing element **10** is disposed immediately below the uppermost set of perforations, the lowermost inflatable packing element **10** being disposed immediately above the lowermost set of perforations, with the intervening inflatable packing element **10** being disposed immediately above and below each set of perforations. Although only three sets of perforations P are illustrated in the drawings, they can be provided in any required number, such as six, seven, ten, fifteen, twenty, etc. By way of example, the packing elements, when expanded against the well casing, may be spaced from each other on opposite sides of each set of perforations by about two feet, although longer and even somewhat shorter intervals can be used, if desired.

Only the lower portion of the multiple injection packer is shown in the drawings in detail, since the remainder of the tool can be the same as disclosed in the above-identified United States patent application. As illustrated, the multiple injection packer includes a central tubular body **100** extending completely therethrough, there being a plurality of modules **101** secured to each other and surrounding the body, there being one module for each set of casing perforations P. The body **100** has side ports **102** along its length opening to the interior of the modules through which fluid will discharge, then passing through a suitable valve mechanism (not shown) in each module body **103** into a helical ratio tube **104**, discharging from the tube and through a port **105** to the exterior of the module between a pair of spaced packing elements **10**, **10**, or **10**, **11**, or **10**, **12**, which straddle the perforations P, the fluid then passing through the perforations into the surrounding formation. The lowermost module body **103** has an upper gauge ring **106** threadedly secured thereto, and also the upper portion of a connector sleeve **107** slidable along the packer body **100**. A seal ring **108** on the sleeve seals against the periphery of the body. A pair of initially retracted packing elements **11** of rubber or rubber-like material surround the connector sleeve **107**, being separated by a spacer ring **109**, the upper packing element **11** engaging the gauge ring **106** and the spacer **109**, and the lower packing element **11** engaging the spacer **109** and a guide ring **110** slidable along the connector sleeve. This guide ring overlies an external lower flange **111** on the connector sleeve **107**, and is also threadedly secured to the upper portion of a tie sleeve **112** threaded onto a control latch sleeve **113**, being held in appropriate connected position therewith by an adjuster nut **114**. A second adjuster nut **115** is threaded onto the control latch sleeve **113**, there being a conical spring assembly **116** bearing thereagainst, such as Belleville springs, the lower end of which bears against a connector sleeve **117** threadedly secured to the upper end of a lower housing **118** that can fit within the upper guide **41** of the indexer housing **40**, and which has lower tapered clutch teeth **119** adapted to mesh with companion upwardly projecting clutch teeth **120** on the upper end of the indexer housing **40**, for the purpose of preventing rotation of the housing **118** of the multiple injection packer M. The control latch sleeve **113** has depending spring-like latch legs **121** terminating in latch feet **122** that have inner portions **123** initially fitting under a downwardly facing shoulder **124** on the packer body **100**, for the purpose of preventing relative longitudinal movement between the body **100** and the control latch sleeve **113** and tie sleeve **112** during longitudinal movement of the packer in the well casing, thereby insuring the retention of the packing elements **11**, **12** in their retracted position.

In FIGS. 6 and 6*a*, the latch feet **122** are shown after having been released from the shoulder **124**, since the packing elements **11**, **12** have been expanded outwardly against the well casing C. However, the latch feet **122** are initially disposed under the shoulder **124**, as described above, being held in such position by the inner wall **125**

of the connector **117**. It is only after the lower housing **118** of the packer has come to rest upon the housing **40** of the indexer A that the packer body **100** and its control latch sleeve **113** can be shifted downwardly to a position in which the latch feet **122** are disposed below the connector **117** and can be shifted outwardly by the tapered body shoulder **124**, which then permits the body **100** to move downwardly to a further extent. The lower housing **118** and connector **117** cannot shift downwardly, the downward movement of the body **100** moving the entire packer mechanism downwardly with it, as described in the above-identified United States patent application, to shift the gauge ring **106** and connector sleeve **107** downwardly with respect to the guide ring **110** and tie sleeve **112**, compressing the packing elements **11**. In shifting the latch feet **122** downwardly of the connector **117** to their released position, the Belleville springs **116** are compressed substantially to a solid height and will remain in that condition until the packer M is released from the casing.

The body **100** of the multiple injection packer M is adapted to extend downwardly into the body **14** of the indexer A, being threadedly secured to a body extension **100***a* which is adapted to extend completely through the indexer body **14** and its guide **25**. An indicator sleeve **130** is threadedly secured to the body extension **100***a*, having a plurality of spring-like members **131** formed by a plurality of circumferentially spaced longitudinal slots in the sleeve between its ends. The intermediate portions **132** of the spring-like members or beams **131** are enlarged and have downwardly tapering surfaces **133** and upwardly tapering surfaces **134**, the unrestricted diameter of these intermediate portions being greater than the diameter of the passage **26** through the indexer guide **25**, being required to snap therethrough. The lower taper **133** is greater or steeper than the upper taper **134**, so that the sleeve **130** can snap through the guide **25** with lesser force when moving in a downward direction therethrough, and with greater force when moving in an upward direction therethrough, thereby giving an indication to the operator at the top of the well bore of the indicator **130** moving through the guide, and of the condition of the multiple injection packer M with respect to the indexer A. A bull plug **135** is threadedly secured to the lower end of the body extension **100***a* and extends through the indicator sleeve **130**, as disclosed in FIG. 6*c*.

In order to permit fluid to flow into the body **100** of the packer during its lowering in the well casing C, it is provided with side ports **136** adjacent to its extension **100**a, this region being surrounded by a seal device **137** including seal rings **138** above and below the ports **136** spaced apart by a ported separator **139**, the entire seal device being confined between a body shoulder **140** and the upper end of the body extension **100**a. Initially, a valve sleeve **141** surrounds the seal device, as disclosed in FIG. 7, being in sealed engagement with the upper and lower seal rings **138**, and being held initially in such position by a screw **142** bearing against the upper portion of the seal device **137**. The screw **142**, however, only releasably holds the valve sleeve frictionally in the position disclosed in FIG. 7. The valve sleeve has a plurality of small ports or choke orifices **143** so as to reduce the rate of flow of well casing fluid into the packer body **100**, and thereby minimize the build-up of pressure in the body that might, perhaps, tend to expand the inflatable packing elements **10** during longitudinal movement of the packer M in the well casing. However, when the lower portion of the multiple injection tool M is lowered into the anchored indexer A, the lower end of the valve sleeve **141** engages the upper end of the indexer body **14**, the packer body then continuing moving downwardly within the latter to result in the removal of the seal rings **138** from the valve sleeve **141** and their location within and in sealed relation to the indexer body, effecting a closing and sealing of the body ports **136**, as disclosed in FIG. 6*b*.

The multiple injection packer M embodies a mechanism for releasing and retrieving the indexer A, enabling the latter to be removed from the well casing simultaneously with removal of the packer therefrom. As specifically disclosed, the releasing and retrieving mechanism includes a split sleeve **150** which has an internal left-hand thread **151** meshing with a companion left-hand thread **152** on the exterior of the packer body **100** and extending a substantial distance along its length. The sleeve **150** is slidably splined to the packer housing **118** by a key **153** fixed to the sleeve, as by means of a screw **154**, and slidable in a longitudinal housing slot **155**. Secured to the sleeve is a latch support **156**, by virtue of the overlapping support and sleeve flanges **157**, **158**, this latch support depending therefrom and having a retrieving latch sleeve **159** slidably mounted thereon. This sleeve **159** has circumferentially spaced slots **160** providing flexible latch legs **161** terminating in threaded foot portions **162** having left-hand threads **163** thereon adapted to snap into and mesh with left-hand threads **164** in the upper portion of the retrieving sleeve **42** of the indexer.

The latch sleeve **159** is shiftable longitudinally to a limited extent along the latch support **156**. When in its upper position therealong in engagement with the lower end **165** of the split sleeve **150**, inward projections **166** on the latch feet **162** are disposed opposite a circumferential recess **167** in the latch support, permitting inward deflection of the latch feet, the teeth of which have lower faces **163**a tapering in a downward direction so that upon entering the threaded box **164** of the retrieving sleeve **42**, they can ratchet thereby. When the latch support **156** is shifted upwardly of the retrieving sleeve, after its threads **163** have meshed with the retrieving sleeve or box threads **164**, the lower ends of the feet **162** engage a latch support shoulder **168** and contact the periphery **169** of the latch support, which prevents the feet from shifting inwardly and retains their threads **163** fully meshed with the threads **164** of the retrieving sleeve.

Initially, the retrieving latch sleeve **159** is disposed in the position illustrated in FIG. 6*a*, with the split sleeve **150** in its uppermost threaded position along the packer body **100**. If retrieving is desired, the packer body is rotated, the split sleeve **150** being prevented from rotating because of its key connection **153**, **155** in the lower housing **118** which is clutched to the housing **40** of the indexer A, that is anchored to the casing by the expander **34** and slips **28**. Accordingly, right-hand rotation of the tubing string R and of the packer body **100** will cause the split sleeve **150** to thread downwardly along the body **100**, the retrieving latch **159** moving downwardly with it until the threaded latch feet **162** are forced downwardly into the retrieving sleeve box **164**, ratcheting over the threads **164** and coming into full threaded mesh therewith. At this time, an upward pull taken on the packer body **100** will be transmitted through the split sleeve **150**, latch support **156**, latch feet **162** and their threads **163** to the retrieving sleeve threads **164**, exerting an upward pull on the retrieving sleeve **42**. When such upward pull is sufficient to shear the screws **43** holding the retrieving sleeve to the indexer body **14**, the screws are disrupted, the retrieving sleeve **42** shifting upwardly until its upper end engages the downwardly facing shoulder **60** on the housing **40**, the retrieving sleeve being elevated from the abutment ring **54** and allowing it to expand out of its groove **55**, thereby removing restraint to upward shifting of the lock ring support **52** along the body **14**. Upward movement of the packer body **100** will then result in elevation of the retrieving sleeve **42** and housing **40**, and upward shifting of the expander **34** along the slips **28**, effecting a retraction of the latter from the casing C, because of their tongue and groove interconnections **39**, **38**. The indexer A can now be elevated with the multiple injection packer M within and from the well casing Actually, the upward elevation of the packer body **100** to unset the indexer A will occur after fluid pressure

therewithin has been relieved and after the packing elements **10, 11, 12** have all returned to their initial retracted positions. Thereafter, the body **100** will be rotated for the purpose of threading the retrieving latch **159** downwardly into engagement with the threaded box **164** of the retrieving sleeve **42**, whereupon the release of the indexer A in the manner described above can occur, and the multiple injection packer and indexer removed as a unit from the well casing.

In the use of the multiple injection packer M in connection with the indexer or locator A, previously anchored in the well casing to provide a reference point therewithin, the packer is lowered on the tubing string R in the well casing C after the casing has been perforted with the perforating gun E. The packing elements **10, 11, 12** of the packer are in retracted position, and, as has been stated above, they are spaced from one another appropriately so that the lowermost packing elements **11** will be disposed below the lowermost set of perforations P, the uppermost packing elements **12** above the uppermost set of perforations, and the intervening packing elements **10** between adjacent sets of perforations. At this time, the valve sleeve **141** of the packer is located in the position illustrated in FIG. 7 so as to throttle the flow of fluid from the well casing to the interior of the body **100** and thence upwardly therethrough into the tubing string R, in order to guard against build-up of pressure in the packer body which might inadvertently expand the inflatable packing elements **10** out against the casing. All of the packing elements, including the lowermost packing elements **11** disclosed in FIG. 6, are in their retracted position, the packer body shoulder **124** being disposed above the inner projections **123** of the latch feet **122**, being held thereagainst by the inner wall **125** of the connector **117** encompassing the latch feet, which are then disposed within the connector, rather than in the released position illustrated in FIG. 6*a*.

Upon reaching the anchored indexer A, the indicator portion **130** of the packer will enter the body **14** of the indexer, and when the indicator projections **132** engage the guide **25** of the indexer, a substantial force will be required to force the flexible beam members **131** of the indicator or snap sleeve through the guide, which force, for example, may be about 3,000 lbs. set-down weight. As a result, an indication is given to the operator at the top of the well bore that the indicator **130** is being pushed through the guide and that the lower portion of the packer housing **118** is near the upper end of the indexer housing **40**. The tubing string R and packer M are then lowered an additional short distance to move the lower housing **118** into the indexer guide **41** and to mesh the clutch teeth **119, 120** with one another, the lower indicator **130** merely shifting down below the lower indexer guide **25**. During such additional lowering movement of the packer body **100**, its valve sleeve **141** engages the upper end of the indexer body **14**, whereupon it will come to rest in the position disclosed in FIG. 6*b*, the packer body **100** moving downwardly an additional short distance to place the seal rings **138** within the seal bore of the indexer body to fully close the body ports **136**. Additional set-down weight, which, for example, might be at least 10,000 lbs., is then imposed on the multiple injection packer M, effecting a compression or flattening of the conical or Belleville springs **116** to shift the latch feet **122** to the released position from the shoulder **124**, whereupon the body **100** can continue to move down to effect compression of the lower packing elements **11**, as well as the upper packing elements **12** of the packer, and their outward expansion into sealing engagement with the wall of the well casing, as disclosed in FIG. 3, the expanded condition of the lower packing elements **11** also being shown in FIG. 6. More specifically describing the above operations, the Belleville springs retain the control latch sleeve **113** upwardly with respect to the connector **117** so that the latch feet **122** are encompassed by the latter, and are held under the packer body shoulder **124**. However, after the packer housing **118** has engaged the indexer housing **40**, the first set-down weight taken upon the upper packer M will result in compression of the Belleville springs to a sufficient extent as to shift the latch feet **122** down below the lower end of the restraining connector (initially the latch feet are disposed at the lowermost portion of the connector), allowing the latch feet to snap outwardly and free from engagement with the tapered body shoulder, whereupon the body is movable downwardly to effect the compression of the uppermost and lowermost packing elements **12, 11**.

Fluid under pressure is then pumped down through the tubing string R and into the packer body **100**, discharging through the body ports **102** (a multiplicity of which are disposed along the length of the packer body) and then through the control valve mechanisms (not shown) illustrated in the above-identified United States patent application, and through the helical ratio tubes **104** and the ports **105** for discharge through the sets of casing perforations P into the surrounding formation. Preparatory to opening of the control or limit valves (not shown), the inflatable packing elements **10** would have been expanded outwardly into sealing engagement with the well casing C between the sets of perforations P, thereby isolating the sets of perforations from one another.

Different types of fluids can be injected from the apparatus through the casing perforations P and into the surrounding formation as required by the operation being performed, which, for example, may be a sand consolidation method or process described in the above-identified patent application.

Following completion of the injection of the fluid into the formation, the pressure in the tubing string R and packer body **100** is relieved, allowing the inflatable packing elements **10** to contract inherently. The upward shifting of the tubing string and body will then permit the uppermost and lowermost packing elements **12, 11** to retract inherently to their initial position, whereupon a continuation of the upward movement of the tubing string and body will shift the packer M upwardly of the unit. The enlargements **132** of the lower indicator **130** will engage the lower end of the indexer guide **25**, requiring a substantial force to contract the spring-like beam members **131** inwardly for passage through the guide, which will give an indication to the operator at the top of the well bore that the well packer is in condition for retrieval from the well casing, if desired. As an example, the force required to pull the indicator members **131** through the guide could be of the order of about 6,000 lbs. The tubing string R and the packer M can then be elevated in the well casing C and removed therefrom, leaving the indexer A in its anchored condition in the well casing. The slips **28** will remain in their anchored condition despite the force imposed on the indexer in shifting the packer indicator **130** downwardly and upwardly through the guide **25**, such holding action being insured by the substantial force imposed by the compressed helical springs **20**, as well as by the action of the lock mechanism **49–59** in securing the expander **34** and its housing **40** to the indexer body **14** against upward movement with respect thereto.

Ordinarily, the indexer A will be released through appropriate manipulation of the multiple injection packer M, being coupled thereto for retrieval from the well casing simultaneously with the multiple injection packer. After the multiple injection packer M has been manipulated in the manner described above to enable its packing elements **10, 11, 12** to retract from the well casing, the tubing string R and the packer body **100** are rotated to the right. Since the packer housing **118** is prevented from rotating by reason of its being clutched to the indexer housing **40**, such right-hand rotation will effect a downward feeding of the split sleeve **150**, latch support **156** and retrieving latch **159** along the body **100** of the

tool M and within its lower housing **118**, as described above. When the lowermost thread **163** of the latch feet **162** engages the uppermost thread **164** of the retrieving sleeve box, the retrieving latch **159** will be prevented from moving downwardly at that time, whereupon the continued rotation of the body **100** will cause the split sleeve **150** and latch support **156** to shift downwardly until the circumferential groove **167** of the latch support is disposed opposite the lower portions **166** of the latch members **162**. Continued rotation of the body **100**, or for that matter, its straight-line downward movement at this time, will cause the lower end **165** of the split sleeve to engage the upper end of the retrieving latch **159** and force its threads **163** downwardly along the threads **164** of the retrieving sleeve box, the threaded feet **162** being able to ratchet past the box threads by virtue of their ability to spring inwardly into the latch support groove **167**.

After the latch threads **163** are disposed within the retrieving sleeve box **164**, the taking of an upward pull on the tubing string R and the packer body **100** will move the lower portion **169** of the latch support behind the lower portion of the threaded latch legs, as determined by engagement of the lower end of the latch sleeve with the latch support shoulder **168**, positively locking the latch threads **163** to the retrieving sleeve threads **164**, as illustrated in FIG. 6*a*. Accordingly, the taking of a straight-line upward pull on the tubing string R and packer body **100** with a sufficient force will shear the screws **43** releasably securing the retrieving sleeve **42** to the indexer body **14**, which upward strain or pull might, for example, be about 10,000 lbs., the retrieving sleeve then being pulled upwardly along the body **14** and within the lower housing **40** to a position elevated above the abutment ring **54**, the retrieving sleeve **42** moving upwardly until its upper end engages the housing shoulder **60**, as disclosed in FIG. 10. When such engagement occurs, the continued upward movement on the retrieving sleeve **42** is then transmitted to the housing **40**. Although the housing ratchet teeth **49** are still engaged with the lock ring teeth **51**, the lock support **52** will engage the abutment **54** and shift it upwardly, camming it out of its groove **55**, because of the tapered upper coengaging surfaces **58**, **59** between the abutment ring and the upper side of the body groove. Accordingly, the indexer housing **40** and the expander **34** can shift upwardly along the body **14** and relative to the slips **28**, the slips being pulled inwardly from the casing, due to the tongue and groove interconnections **39**, **38** between the parts, the expander **34** being shifted upwardly until it engages the downwardly facing body shoulder **170** thereabove, the parts then being in the relative positions illustrated in FIGS. 10 and 10*a*. The packer M and the indexer A can then be elevated as a unit in the well casing C to the top of the well bore.

If desired, as indicated above, the multiple injection packer M is removable from the indexer without releasing the latter, and elevated to the top of the well bore. Thereafter, a suitable retrieving tool (not shown) can be lowered on a running-in string (not shown) in the well casing for latching into the threaded box **164** of the retrieving sleeve **42**, an upward pull being taken thereon sufficient to shear the screws **43** and elevate it above the abutment ring **54**, the retrieving sleeve being brought into engagement with the housing shoulder **60** for the purpose of effecting elevation of the expander **34** along the body **14** and with respect to the slips **28**, in order to retract the latter from the well casing. The released indexer A can then be removed from the well casing by elevating the running-in string.

I claim:

**1.** In apparatus adapted to be lowered in a well casing disposed in a well bore: a retrievable indexer adapted to be lowered in the well casing, said indexer including initially retracted anchoring means expandable outwardly against the casing to anchor the indexer thereto, and lock means for locking said anchoring means in its expanded condition anchored to the casing; a well packer adapted to be lowered in the well casing from the top thereof, after said indexer has been anchored in the well casing, into engagement with said indexer; said well packer comprising packing means for sealing against the well casing, said packer further comprising means connectible to said lock means for releasing said lock means and for releasing said anchoring means from the well casing to allow simultaneous withdrawal of said packer and indexer from the well casing.

**2.** In apparatus as defined in claim **1**; wherein said indexer comprises a body, said anchoring means including expander means slidable along said body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and body to prevent relative movement of said expander means away from said slip means after expansion of said slip means, said lock means including a member retaining said lock means in locked condition; said releasing means of said packer being connectible to said retaining member to shift said retaining member to a position releasing said lock means and into engagement with said expander means to move said expander means in a direction away from said slip means to effect retraction of said slip means from the casing.

**3.** In apparatus as defined in claim **1**; wherein said indexer comprises a body, said anchoring means including expander means slidable along said body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and body to prevent relative movement of said expander means away from said slip means after expansion of said slip means, said lock means including a member retaining said lock means locked to said body, said releasing means of said packer being connectible to said retaining member to shift said retaining member to a position unlocking said lock means from said body and into engagement with said expander means to move said expander means in a direction away from said slip means to effect retraction of said slip means from the casing.

**4.** In apparatus as defined in claim **1**; wherein said indexer comprises a body, said anchoring means including expander means slidable along said body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and body to prevent relative movement of said expander means away from said slip means after expansion of said slip means, said lock means including a sleeve encompassing a portion of said lock means to retain said lock means locked to said body, said releasing means of said packer comprising latch means connectible to said sleeve to elevate said sleeve above said portion of said lock means to unlock said lock means from said body and to engage said sleeve with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing.

**5.** In apparatus as defined in claim **1**; wherein said indexer comprises a body, said packing means including expander means slidable on said body and slip means engaging said expander means to be expanded thereby against the casing upon relative downward movement of said expander means with respect to said body and slip means; said lock means being connected between said expander means and body to prevent relative upward movement of said expander means with respect to said slip means after expansion of said slip means, said lock means including a member retaining said lock means in locked condition; said releasing means of said packer being con-

nectible to said retaining member to shift said retaining member upwardly to a position releasing said lock means and into engagement with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing.

6. In apparatus as defined in claim 1; wherein said indexer comprises a body, said packing means including expander means slidable on said body and slip means engaging said expander means to be expanded thereby against the casing upon relative downward movement of said expander means with respect to said body and slip means; said lock means being connected between said expander means and body to prevent relative upward movement of said expander means with respect to said slip means after expansion of said slip means, said lock means including a sleeve encompassing a portion of said lock means to retain said lock means locked to said body, said releasing means of said packer comprising latch means connectible to said sleeve to elevate said sleeve above said portion of said lock means to unlock said lock means from said body and to engage said sleeve with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing.

7. In apparatus as defined in claim 1; said releasing means of said packer being movable downwardly into connected relation with said lock means in response to rotation of at least a portion of said packer.

8. In apparatus as defined in claim 1; said packer further comprising a body connectible to a running-in string for moving the packer in the casing; said indexer having a passage; said packer body being movable through said passage; and indicator means on said packer body engageable with said indexer to indicate the position of said packer with respect to said indexer.

9. In apparatus as defined in claim 1; said packer further including a tubular body connectible to a tubular running-in string for moving the packer in the casing, said tubular body having a port establishing communication between its interior and exterior; said indexer having a passage; said body being movable into said passage and coacting with said indexer to close said port.

10. In apparatus as defined in claim 1; said packer further including a tubular body connectible to a tubular running-in string for moving the packer in the casing, said tubular body having a port establishing communication between its interior and exterior; said indexer having a passage; said body being movable into said passage and coacting with said indexer to close said port; and indicator means on said body engageable with said indexer to indicate the position of said packer with respect to said indexer.

11. In apparatus as defined in claim 1; said packer further including a tubular body connectible to a tubular running-in string for moving the packer in the casing, said tubular body having a port establishing communication between its interior and exterior; said indexer comprising a body having a passage, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion of said slip means; said lock means including a member retaining said lock means in locked condition; said releasing means of said packer being mounted on said packer body and being connectible to said retaining member to shift said retaining member to a position releasing said lock means and into engagement with said expander means to move said expander means in a direction away from said slip means to effect retraction of said slip means from the casing; said packer body being movable into said passage of said indexer body and coacting with said indexer body to close said port.

12. In apparatus as defined in claim 1; said packer further including a tubular body connectible to a tubular running-in string for moving the packer in the casing, said tubular body having a port establishing communication between its interior and exterior; said indexer comprising a body having a passage, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expander thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means including a member retaining said lock means locked to said indexer body, said releasing means of said packer being connectible to said retaining member to shift said retaining member to a position unlocking said lock means from said indexer body and into engagement with said expander means to move said expander means in a direction away from said slip means to effect retraction of said slip means from the casing; said packer body being movable into said passage of said indexer body and coacting with said indexer body to close said port.

13. In apparatus as defined in claim 1; said packer further including a tubular body connectible to a tubular running-in string for moving the packer in the casing, said tubular body having a port establishing communication between its interior and exterior; said indexer comprising a body having a passage, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion of said slip means; said lock means including a sleeve encompassing a portion of said lock means to retain said lock means locked to said indexer body, said releasing means of said packer comprising latch means connectible to said sleeve to elevate said sleeve above said portion of said lock means to unlock said lock means from said indexer body and to engage said sleeve with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing; said packer body being movable into said passage of said indexer body and coacting with said indexer body to close said port.

14. In apparatus as defined in claim 1; said packer further including a tubular body connectible to a tubular running-in string for moving the packer in the casing, said tubular body having a port establishing communication between its interior and exterior; said indexer comprising a body having a passage, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion of said slip means; said lock means including a sleeve encompassing a portion of said lock means to retain said lock means locked to said indexer body; said releasing means of said packer comprising latch means threadedly connected to said packer body and connectible to said sleeve in response to rotation of said packer body to enable elevation of said packer body to elevate said sleeve above said portion of said lock means to unlock said lock means from said body, said sleeve being movable upwardly into engagement with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing.

15. In apparatus adapted to be lowered in a well casing

disposed in a well bore: a retrievable indexer adapted to be lowered in the well casing, said indexer including initially retracted anchoring means expandable outwardly against the casing to anchor the indexer thereto, lock means for locking said anchoring means in its expanded condition anchored to the casing; a well packer adapted to be lowered in the well casing from the top thereof on a tubular running-in string, after the indexer has been anchored in the well casing, into engagement with said indexer; said well packer comprising a plurality of spaced packing means adapted to seal against the well casing on opposite sides of each of the plurality of perforated regions in the casing above the anchored location of the indexer therein; said well packer further comprising a tubular body and passage means for conducting fluids from said body to the exterior of said packer between said plurality of packing means; said packer also comprising means connectible to said lock means for releasing said lock means and for releasing said anchoring means from the well casing to allow simultaneous withdrawal of said packer and indexer from the well casing.

**16.** In apparatus as defined in claim **15**; wherein said indexer comprises a body, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion of said slip means, said lock means including a member retaining said lock means in locked condition; said releasing means of said packer being connectible to said retaining member to shift said retaining member to a position releasing said lock means and into engagement with said expander means to move said expander means in a direction away from said slip means to effect retraction of said slip means from the casing.

**17.** In apparatus as defined in claim **15**; wherein said indexer comprises a body, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion of said slip means, said lock means including a member retaining said lock means locked to said indexer body, said releasing means of said packer being connectible to said retaining member to shift said retaining member to a position unlocking said lock means from said body and into engagement with said expander means to move said expander means in a direction away from said slip means to effect retraction of said slip means from the casing.

**18.** In apparatus as defined in claim **15**; wherein said indexer comprises a body, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion of said slip means, said lock means including a sleeve encompassing a portion of said lock means to retain said lock means locked to said indexer body, said releasing means of said packer comprising latch means connectible to said sleeve to elevate said sleeve above said portion of said lock means to unlock said lock means from said indexer body and to engage said sleeve with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing.

**19.** In apparatus as defined in claim **15**; wherein said indexer comprises a body, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion means of said slip means, said lock means including a sleeve encompassing a portion of said lock means to retain said lock means locked to said indexer body, said releasing means of said packer comprising latch means threadedly connected to said packer body and shiftable downwardly into connected relation to said sleeve in response to rotation of said packer body to permit said packer body to elevate said sleeve above said portion of said lock means to unlock said lock means from said indexer body and to engage said sleeve with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing.

**20.** In apparatus as defined in claim **15**; said indexer comprising a body having a passage, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; said lock means being connected between said expander means and indexer body to prevent relative movement of said expander means away from said slip means after expansion of said slip means; said lock means including a member retaining said lock means in locked condition; said releasing means of said packer being mounted on said packer body and being connectible to said retaining member to shift said retaining member to a position releasing said lock means and into engagement with said expander means to move said expander means in a direction away from said slip means and thereby effect retraction of said slip means from the casing, said packer body having a port below its lowermost packing means and being movable into said passage of said indexer body and coacting with said indexer body to close said port.

**21.** In apparatus as defined in claim **15**; said packer body further having a port below its lowermost packing means establishing communication between the interior and exterior of said packer body; said indexer comprising a body having a passage, said anchoring means including expander means slidable on said indexer body and slip means engaging said expander means to be expanded thereby against the casing upon relative downward movement of said expander means with respect to said slip means; said lock means being connected between said expander means and indexer body to prevent upward movement of said expander means with respect to said slip means after expansion of said slip means; said lock means including a sleeve encompassing a portion of said lock means to retain said lock means locked to said indexer body; said releasing means of said packer being threadedly mounted on said packer body and being shiftable downwardly into connected relation to said sleeve in response to rotation of said packer body to enable said packer body to move upwardly and elevate said sleeve above said portion of said lock means to unlock said lock means from said body and to engage said sleeve with said expander means to elevate said expander means with respect to said slip means and effect retraction of said slip means from the casing; said packer body being movable into said passage of said indexer body and coacting with said indexer body to close said port.

**22.** In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; expander means slidable on said body; slip means engaging said expander means to be expanded thereby against the casing upon

relative longitudinal movement of said expander means and slip means toward each other; lock means connected between said body and one of said means for preventing relative longitudinal movement of said expander means and slip means away from each other after expansion of said slip means, said lock means including a member retaining said lock means in locked condition, said member being shiftable to a position releasing said lock means to enable said slip means and expander means to move relatively longitudinally away from each other to effect retraction of said slip means from the casing, said lock means being normally engaged with said body to prevent relative longitudinal movement of said lock means and said body, said lock means further comprising releasable abutment means carried by said body and engaged with said lock means, said abutment means being released from said body upon shifting of said retaining member to said position.

23. In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; expander means slidable on said body; slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; lock means connected between said body and one of said means for preventing relative longitudinal movement of said expander means and slip means away from each other after expansion of said slip means, said lock means including a member retaining said lock means in locked condition, said member being shiftable to a position releasing said lock means to enable said slip means and expander means to move relatively longitudinally away from each other to effect retraction of said slip means from the casing, said lock means comprising coengageable ratchet means on said body and said one of said means, said lock means further comprising releasable abutment means secured to said body and engaged by said ratchet means, said retaining member encompassing said abutment means to hold said abutment means secured to said body, said abutment means being released from said body upon shifting of said retaining member from its position encompassing said abutment means to release said ratchet means from said body.

24. In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; expander means slidable on said body; slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; lock means connected between said body and one of said means for preventing relative longitudinal movement of said expander means and slip means away from each other after expansion of said slip means, said lock means including a member retaining said lock means in locked condition, said member being shiftable to a position releasing said lock means to enable said slip means and expander means to move relatively longitudinally away from each other to effect retraction of said slip means from the casing, said lock means comprising a support ring on said body having external cam means, an expansible and contractible lock ring surrounding said support ring and engaging said cam means, said lock ring having external ratchet teeth, said one of said means having internal ratchet teeth meshing with said external teeth, said body having a groove, a laterally shiftable abutment ring in said groove engaged by said support ring to prevent longitudinal movement of said support ring on said body; said retaining member encompassing said abutment ring to retain said abutment ring in said groove, removal of said retaining member from encompassing relation to said abutment ring releasing said lock means from said body.

25. In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; expander means slidable on said body; slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; lock means connected between said body and one of said means for preventing relative longitudinal movement of said expander means and slip means away from each other after expansion of said slip means, said lock means including a member retaining said lock means in locked condition, said member being shiftable to a position releasing said lock means to enable said slip means and expander means to move relatively longitudinally away from each other to effect retraction of said slip means from the casing, said lock means being connected between said body and said expander means; said lock means comprising coengageable ratchet means on said body and expander means, said lock means further comprising releasable abutment means secured to said body and bearing against said ratchet means, said retaining member encompassing said abutment means to hold said abutment means secured to said body, said abutment means being released from said body upon shifting of said retaining means from its position encompassing said abutment means to release said ratchet means from said body; said member being shiftable into engagement with said expander means to shift said expander means longitudinally away from said slip means and effect retraction of said slip means from the casing.

26. In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; expander means slidable on said body; slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; lock means connected between said body and one of said means for preventing relative longitudinal movement of said expander means and slip means away from each other after expansion of said slip means, said lock means including a member retaining said lock means in locked condition, said member being shiftable to a position releasing said lock means to enable said slip means and expander means to move relatively longitudinally away from each other to effect retraction of said slip means from the casing, said lock means being connected between said body and said expander means; said lock means comprising a support ring on said body having external cam means, an expansible and contractible lock ring surrounding said support ring and engaging said cam means, said lock ring having external ratchet teeth, said expander means having internal ratchet teeth meshing with said external teeth, said body having a groove, a laterally shiftable abutment ring in said groove engaged by said support ring to prevent longitudinal movement of said support ring on said body; said retaining member encompassing said abutment ring to retain said abutment ring in said groove, said member being shiftable from encompassing relation to said abutment ring to release said lock means from said body, said member being shiftable into engagement with said expander means to shift said expander means longitudinally away from said slip means and effect retraction of said slip means from the casing.

27. In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; expander means slidable on said body; slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; lock means connected between said body and one of said means for preventing relative longitudinal movement of said expander means and slip means away from each other after expansion of said slip means, said lock means including a member retaining said lock means in locked condition, said member being shiftable to a position releasing said lock means to enable said slip means and expander means to move relatively longitudinally away from each other to effect retraction of said slip means from the casing, and spring means engaging said slip means and body to urge said

slip means toward said expander means to retain said slip means expanded against the casing.

28. In apparatus adapted to be anchored in a well casing disposed in a well bore: a body; expander means slidable on said body; slip means engaging said expander means to be expanded thereby against the casing upon relative longitudinal movement of said expander means and slip means toward each other; lock means connected between said body and one of said means for preventing relative longitudinal movement of said expander means and slip means away from each other after expansion of said slip means, said lock means including a member retaining said lock means in locked condition, said member being shiftable to a position releasing said lock means to enable said slip means and expander means to move relatively longitudinally away from each other to effect retraction of said slip means from the casing, said lock means being connected between said body and said expander means; said lock means comprising a support ring on said body having external cam means, an expansible and contractible lock ring surrounding said support ring and engaging said cam means, said lock ring having external ratchet teeth, said expander means having internal ratchet teeth meshing with said external



teeth, said body having a groove, a laterally shiftable abutment ring in said groove engaged by said support ring to prevent longitudinal movement of said support ring on said body; said retaining member encompassing said abutment ring to retain said abutment ring in said groove, said member being shiftable from encompassing relation to said abutment ring to release said lock means from said body, said member being shiftable into engagement with said expander means to shift said expander means longitudinally away from said slip means and effect retraction of said slip means from the casing; and spring means engaging said slip means and body to urge said slip means toward said expander means to retain said slip means expanded against the casing.

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