

[54] HANGER AND PACKER WELL TOOL

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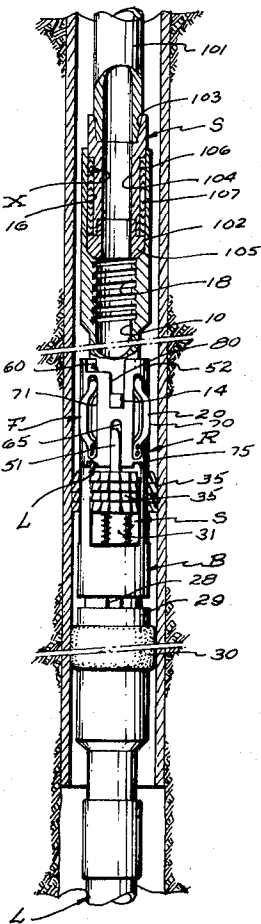
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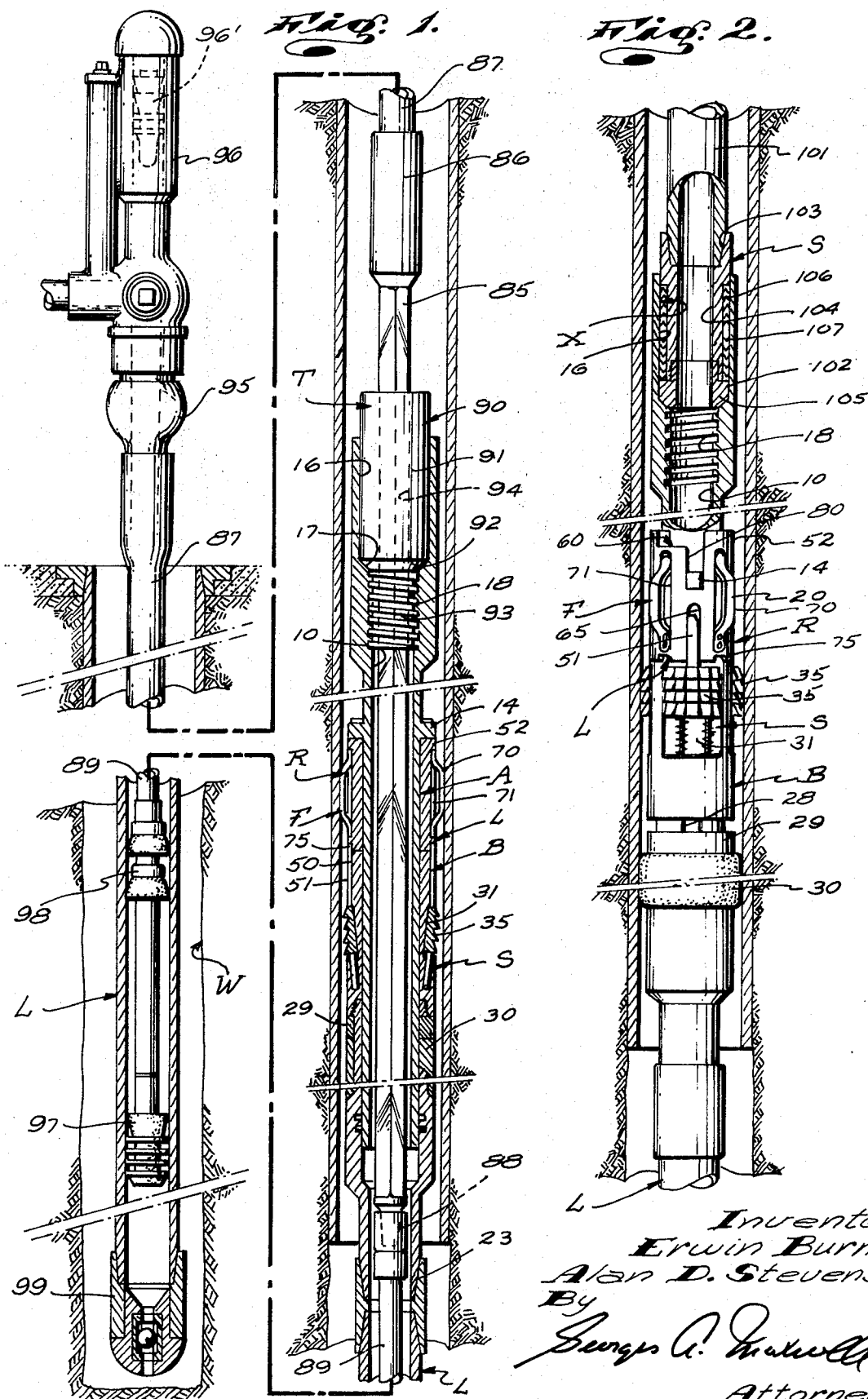
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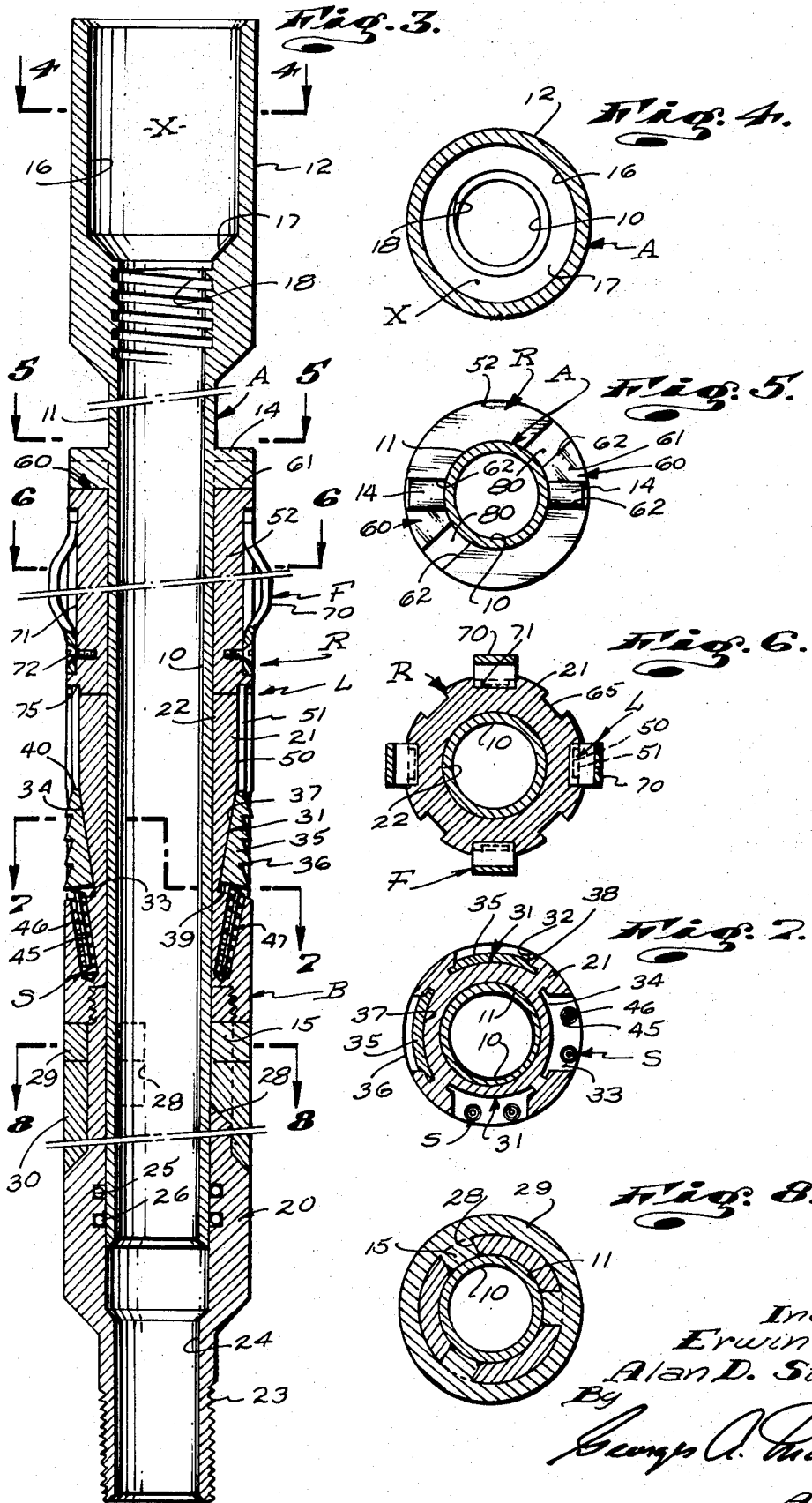
[57] ABSTRACT

A combination oil well liner hanger and packer with a related setting tool which is such that the packer can not be actuated to seal between the tool and a surrounding casing until after the casing engaging slips have been set in engagement with and between the tool and said casing. The tool including novel latch means to releasably hold relatively rotatable parts in their normal unactuated position and utilizing elements and parts of the liner hanger means and the actuating means for said liner hanger means and the packer means; and further including novel means for cooperatively receiving and establishing quick and easy fluid tight connection with a sealing tool on the lower end of a fluid conducting tubing string, above the tool, after it has been set in the casing.

11 Claims, 8 Drawing Figures







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HANGER AND PACKER WELL TOOL

This invention has to do with a well tool and is more particularly concerned with an improved combination hanger and packer tool to hang a tubular liner within a tubular casing and to seal the annulus therebetween.

The prior art is highly developed and has provided numerous casing and liner hangers, numerous packer tools and a number of special combination hanger and packer tools

Where individual liner hangers and packer tools are used, each must be operated independently of the other as by means of special setting or operating tools run into the wells on special run-in strings of tubing and/or by special and careful manipulation of the tubing string which carries them. Whichever the case might be, the use of separate tools, for hanging a liner in a casing and for sealing the annulus between the liner and casing, is extremely unsatisfactory in carrying out many operations which may have to be performed in the course of bringing in a well and in certain cases prevents the satisfactory carrying out of vital operations.

Special, combination liner hanger and packer tools provided by the prior art make possible the effective and efficient carrying out of certain of those operations in a well which could not be effectively or efficiently performed by separate hangers and packers, but are themselves limited in use and are not suitable for affecting certain operations.

Those combination liner, hanger and packer tools provided by the prior art are, as a general rule, such that the hangers and the packers are actuated and set simultaneously, that is, as the hanger is actuated or released to set, the packer is, in the course of action thus initiated, actuated and set. As a result of the above, the liners can not be set prior to and independently of the packers and certain necessary or desired operations which require the passage of fluids through the annulus between the casing and set liner can not be performed. For example, if the casing is previously cemented and sealed in the well bore and the liner is then hung and set, and it is then desired to cement or gravel pack the liner in the bore below the casing, the fluids in the well which must be displaced by the cement or gravel introduced therein is trapped and can not escape, making the gravel packing or cementing operation impossible without the use of still other and special gravel packing and/or cementing tools with special bypass means, packing cups and the like and which are such that the displaced fluids are conducted out of the well through the liner.

It is an object of our invention to provide a combination liner hanger and packer tool which is such that the hanger section of the tool can be initially actuated and set and such that actuation and setting of the packer section of the tool can be effected at the same time the hanger portion is actuated or at any later time as is desired or as circumstances require.

It is another object and feature of this invention to provide a tool of the character referred to which is such that actuation of the hanger section thereof is effected by rotation of the run-in string of tubing and actuation of the packer portion is effected by axial shifting of the run-in string after the hanger is set. Accordingly, by rotating the run-in string at one time the hanger section of the tool can be set, subsequent downward axial shifting of the run-in string at another and subsequent time sets the packer section of the tool or simultaneous rotation and downward shifting of the run-in string effects, sequentially, without pause or interruption, actuating of the hanger section and immediate actuation of the packer section.

In liner hanger structures provided by the prior art wherein actuation thereof, from a pre-set to a set condition, is effected by rotation of the run-in string and parts of the tool relative to the casing in the well, extreme care must be taken that rotation of the run-in string and/or tool parts, in that direction which effects actuation of the liner, not take place or occur prematurely. To assure the above, it is common practice to slowly rotate the string in the opposite direction until it is desired to set the hanger, whereupon such reverse rotation is terminated and the string is then turned in the other or actuating direction to set the hanger.

The necessity to continuously rotate a hanger structure contra to the rotative direction which effects its actuation, to prevent premature actuation thereof, is troublesome, inconvenient and often times not practical or even possible.

An object of this invention is to provide an improved structure of the character referred to wherein a releasable latch means is provided to normally yieldingly hold and prevent premature setting rotation of parts whereby contra rotation of the run-in string, to prevent premature setting of the tool, is not required.

Liner hangers are characterized by a fluid conducting body secured to the upper end of a tubular liner and releasably engaged on the lower end of a string of run-in tubing; a plurality of circumferentially spaced, axially and radially outwardly shiftable wedge-like slips carried by the body and actuating means normally holding the slips down relative to the body and operable to allow for upward and outward shifting of the slips into wedging gripping engagement between the body and the bore of a casing about the body and from which the liner is to be hanged. The casing engaging surfaces of the slips are serrated so as to bite into the casing and assure the establishment of a secure grip therewith.

The actuating means in hanger structures such as referred to above are, as a general rule, such that they slowly urge or permit slow upward and outward shifting of the slips relative to the hanger bodies.

Slow movement of the slips frequently prevents the immediate and positive biting and wedging relationship of the slip with the casing.

An object of our invention is to provide a tool of the character referred to in the foregoing wherein the slips are spring loaded and the actuating means is such that when the tool is actuated the slips are released and are urged rapidly upwardly and outwardly by spring pressure to engage the casing with sufficient impact force to assist and assure desired biting engagement of the serrations thereon with the bore of the casing and the establishment of tight wedging relationship between said casing and the hanger body.

In the ordinary linear hanger and/or packing tool, once the sections of the tool are set and the run-in string therefor is separated therefrom and pulled from the well, no suitable means is provided for establishing a sealed fluid connection between the tool and another string of circulating tubing, as might be employed to circulate high pressure fluid into the liner, below the packing, for the purpose of fracturing the formation or the like.

An object and feature of our invention is to provide a tool of the character referred to having an elongate, cylindrical, upwardly opening chamber to cooperatively receive and seal with a tubular sealing tool or stringer on the lower end of a string of tubing lowered into the well, whereby a fluid tight connection can be easily, conveniently and economically re-established within the tool, as desired or as circumstances require.

It is an object and feature of this invention to provide a liner hanger and packing tool of the character referred to which is simple, rugged and durable, a tool which involves a small number of easy and economical to make and assemble parts and a tool which is highly effective and dependable in operation.

The foregoing and other objects and features of our invention will be apparent and will be fully understood from the following detailed description of a typical preferred form and carrying out of the invention, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is a view showing our new tool engaged in a well structure and related to other tools and means therein, said tool and certain of the structure being in sections to better illustrate the invention;

FIG. 2 is similar to a portion of the structure shown in FIG. 1, showing the tool in another position and showing another well tool engaged therewith;

FIG. 3 is an enlarged detailed sectional view of the tool that we provide;

FIG. 4 is a sectional view taken as indicated by line 4—4 in FIG. 3;

FIG. 5 is a sectional view taken as indicated by line 5—5 in FIG. 3;

FIG. 6 is a sectional view taken as indicated by line 6—6 in FIG. 3;

FIG. 7 is a sectional view taken as indicated by line 7—7 in FIG. 3;

FIG. 8 is a sectional view taken as indicated by line 8—8 in FIG. 3.

The tool that we provide is an elongate, vertically extending structure and includes an elongate upper mandrel A and an elongate lower barrel B in which the mandrel is telescopically engaged.

The mandrel A is an elongate unitary part with a central longitudinal flow passage 10 extending therethrough and is characterized by a small diameter lower portion 11 of substantial longitudinal extent and a large diameter, upper portion or head 12 of limited longitudinal extent.

The lower portion 11 is straight and unobstructed except for a pair of circumferentially spaced, diametrically opposite, radially outwardly projecting lugs 14 on its upper quarter portion and a plurality (three) of circumferentially spaced, radially outwardly projecting blocks 15 on its lower quarter portion.

The upper, head portion 12 is characterized by an upwardly opening large diameter cylindrical bore 16 with a downwardly convergent conical bottom, which bottom intersects the flow passage 10 and establishes an annular radially inwardly and downwardly included seat 17 about the upper open end of the flow passage 10. The bore 16 is of substantial vertical vertical extent, is smooth and unobstructed and defines a chamber X which is adopted to selectively cooperatively receive a setting tool T as shown in FIG. 1 of the drawings, or a sealing tool S, as shown in FIG. 2 of the drawings.

The upper end portion of the flow passage 10 is threaded, as indicated at 18, to cooperatively receive a part of the tool T, as shown in FIG. 1.

The lower barrel B of our tool is a sectional structure comprising a lower section 20 and upper section 21. The sections are screw-threaded together to establish a unitary assembly.

The barrel B has an elongate, upwardly opening central bore 22 corresponding in diameter with the outside diameter of the lower portion 11 of the mandrel and slidably receives the mandrel for free axial shifting therein. The lower end of the barrel is threaded at 23 to cooperatively engage and connect with the upper end of a liner L and has a central longitudinal flow passage 24 corresponding in diameter with the flow passage 10 in the mandrel and serving to establish communication between the liner, interior of the barrel and the mandrel.

In practice, suitable sealing means is provided between the mandrel and the barrel which means is shown as including a pair of axially spaced annular grooves 25 in the lower portion of the bore 22 and O-ring seals 26 in the grooves and engaging the exterior of the mandrel.

The lower section 20 of the barrel has an upper portion 27 of reduced diameter, the upper end of which is threadedly engaged into and with the lower end of the upper section 21. The reduced upper portion 27 of the lower section cooperates with the lower end of the upper section to define an elongate, radially outwardly opening annular packing recess. The portion 27 is provided with a plurality (three) of circumferentially spaced, vertically extending, radial slots 28 into and through which the blocks 15 on the lower portion of the mandrel A slidably project.

An annular actuating ring 29 of limited axial extent is engaged in the recess and about the portion 27 and is suitably fixed to the blocks 15, by screw fasteners or by welding, as desired or as circumstances require.

The actuating ring 29 normally occurs in and about the upper end of the recess and stopped against the bottom of the upper section 21.

The recess and the slots 28, below the ring 29 and blocks 15 are occupied by and carry an expansible packer sleeve 30. The sleeve 30 is preferably established of soft, malleable lead, poured into the recess and slots and has a cylindrical exterior surface which, normally, is equal to the outside diameter of the barrel sections 20 and 21.

In practice, materials other than lead can be employed to establish the sleeve 30.

The noted recess, slots, blocks, ring and sleeve define the packer section P of our invention. The section P is such that when the mandrel A is shifted downwardly in the barrel, the ring 29 and the blocks 15 are urged downwardly, displacing the packing sleeve 30 and causing it to flow radially outwardly and into sealing engagement with a structure surrounding the tool, such as the interior of a well casing C.

The upper section 21 of the barrel B is provided with a plurality (four) of circumferentially spaced, radially outwardly opening hanger slip receiving recesses 31. Each of the recesses 31 has vertical side edges 32, a horizontal, substantial upwardly disposed lower edge 33 and a radially outwardly and upwardly inclined, radially outwardly and downwardly disposed bottom 34. Arranged in each recess 31 is a wedge-shaped casing engaging slip 35 having an outer, vertical, semi-cylindrical or radiused, serrated casing engaging face 36, an upwardly and radially outwardly inclined inner surface 37 which slidably engages the bottom 34 of the recess 31, vertical sides 38 opposing the side edges 32 of the recess, a bottom edge 39 opposing the bottom 33 of the recess and an upper edge 40.

The slips 35 normally occur down and fully engaged within the recesses 31 and are adapted to be shifted upwardly therein to move radially upwardly and outwardly relative to the barrel and into tight wedging engagement with and between the barrel and the casing C.

In practice, the side edges of the slips and their related recesses are provided with tongue and groove type retaining means, such as is clearly illustrated in FIG. 7 of the drawings, to prevent radial displacement of the slips.

In addition to the foregoing, the tool is provided with spring means S which normally yieldingly urge the slips upwardly relative to the barrel and releasing means R to normally releasably hold the slips 35 down in their normal or unactuated position.

The spring means S includes one or more upwardly and radially outwardly inclined spring receiving opening 45 entering the bottom 33 of each slip recess, a pin-like spring guide 46 for each opening 45, carried by the slips and projecting downwardly therefrom and into its related opening 45 and helical compress springs 47 in the openings 45, about the guides 46 and acting on and between the bottoms of the openings 45 and the bottoms 39 of the slips to urge the slips upwardly.

The springs 47 are sufficient in strength and number to exert considerable force on the slips and so that when the slips are released and free to move, they are driven upwardly and outwardly at a considerable rate of speed and with great force.

The releasing means R that we provide includes an elongate, vertical, radially outwardly opening channel 50 extending from the upper edge of each slip recess 31 to the upper end of the upper section 21 of the barrel, an elongate, vertical retainer finger 51 on and projecting upwardly from each slip 35 and slidably engaged in the channel 50 related thereto and an actuating sleeve 52 carried by the mandrel to occur adjacent to and slidably engage the upper end of the barrel and engaging the upper ends of the fingers to hold the fingers and slips down.

The actuating sleeve 52 of the releasing means R is an elongate tubular part rotatably engaged about the portion 11 of the mandrel A and is provided with a pair of upwardly and radially inwardly and outwardly opening circumferentially extending lug receiving notches 60 at its upper end. The notches 60 have flat upwardly disposed bottoms 61 and vertical ends defining first and second stop shoulders 62 and 63. The

notches 60 cooperatively receive the lugs 14 on the mandrel, which lugs slidably engage the bottoms 61, normally engaged with the first stop shoulders 62 and are engageable with the second stop shoulders 63 upon rotation of the sleeve relative to the barrel and mandrel.

It will be apparent that the mandrel is held against vertical displacement from the barrel by the blocks 15 which are normally in stopped engagement in the upper ends of the slots 28 in the barrel and that the sleeve 52 is thereby held captive between the lugs 14 on the mandrel and the upper end of the barrel, with which it establishes sliding engagement.

The sleeve 52 is next provided with a plurality of circumferentially spaced, longitudinally extending, radially outwardly and axially downwardly opening finger receiving grooves 65, which grooves are normally circumferentially spaced from and out of register with channels 50 in the barrel and the fingers 51 and are, upon rotation of the sleeve, shiftable into axial alignment with said channels and fingers and are such that they will freely receive said fingers and allow for free upward and resulting outward shifting of the slips.

In the case illustrated, there are four circumferentially spaced slips, accordingly, the sleeve is provided with four grooves 65 which grooves are, when in their normal position, spaced 45° circumferentially of the channels 50 and finger 51 related thereto. The lugs 14 engage the first stop shoulders 62 of the related notches when the structure is in the noted normal position and engage and stop against the second stop shoulders 63 when the sleeve is rotated to align the channels and the slots for actuation of the construction.

In accordance with the above, the notches 60 are of sufficient circumferential extent and the second stop shoulders 63 thereof are positioned so as to permit or allow for turning the sleeve 45° and to stop the sleeve with its grooves 65 in alignment with the channels 50 and fingers 51 carried by the barrel.

The sleeve 52 is next provided with casing engaging friction means F which means includes a plurality (four) of elongate, axially extending and radially outwardly projecting casing engaging belly springs 70. The ends of the springs 70 seat in recesses 71 provided in the barrel and have curved radially outwardly projecting central portions which are adapted to establish pressure friction engagement with the interior of the casing C. One end of each spring is fixed in its recess by screw fastening means 72 or the like.

It will be apparent that upon rotation of the mandrel, as by means of the setting tool T, the frictional drag afforded by the belly springs holds the sleeve stationary and effects shifting of the sleeve from its normal to its actuated position and resulting upward shifting of the slips.

The slips 35 and the means S and R described above establish the basic casing engaging liner hanger section of our invention and is not totally distinct from certain other liner hanger structures provided by the prior art.

The hanger structure thus far described is such that slight, unintentional rotation of the tool or rotation of the sleeve as a result of the springs 70 engaging grooves or other obstructions in the casing C will actuate the structure prematurely. So as to prevent premature actuation of the structure in the manner set forth above, we provide novel releasable latch means L. The means L includes downwardly opening latch notches 75 in the lower end of the sleeve 52, which notches normally occur in vertical alignment with the fingers 51 on the slips 35 and in which the upper ends of the fingers or bolt extensions on the fingers normally project. The upper corners of the fingers or the bolt-extensions and the opposing sides or corners of the notches 75, which oppose the direction of relative rotation of the sleeve and barrel when the tool is actuated from its normal to its actuated position, are inclined at about 45° defining cam surfaces which are such that applied forces, tending to rotate the sleeve from its normal position drive the fingers axially downwardly and out of engagement in their related notches 75.

The means L, in addition to the foregoing, requires that the slips 35 normally occur in their related recesses 34 with their

bottom edges 39 spaced above the lower edges 33 of the recesses a distance equal to or greater than the bolt-extensions of the fingers, or the distance the fingers and slips must move, downwardly to effect disengagement of the latch means. In light of the above, it will be apparent that the means L is a spring loaded latch means and utilizes the basic components of the hanger means, imparting new and secondary functions thereto.

The holding force of the latch means L is a function of the force of the spring means S and the angle at which the opposing, inclined, cam surfaces of the notches 75 and fingers. By varying the angle of the cam surfaces and/or by varying the forces of the springs 47 of the means S, the force required to release the latch means L can be advantageously varied and controlled.

In practice, if the force required to release the latch is approximately two-thirds the frictional resistance to relative rotation afforded by and between the belly springs 70 and the casing C, release of the latch means can only be effected by intentional rotation of the tool in and relative to the casing.

Finally, the actuating sleeve 52 is provided with a pair of vertical, longitudinally extending lug receiving slots 80 extending downwardly from the ends of the notches 60, adjacent the second stop shoulders 63. The lug receiving slots 80 are provided to permit the lugs 14 on the mandrel A to move downwardly whereby the mandrel can move downwardly in the barrel and effect actuation and setting of the packer means or section, as set forth above.

It is important to note that the packer can not be actuated until the hanger has been actuated and set.

The setting tool T that we provide includes an elongate polygonal kelly 85 with a central longitudinal flow passage (not shown), a tool joint box 86 at its upper end threadedly connected with the lower end of a fluid conducting run-in tubing string 87 and a tool joint pin 88 at its lower end and connected with the upper end of an elongate fluid circulating pipe or stringer 89. The tool T next includes a releasing nut 90 threadedly engaged in and with the mandrel A and slidably engaged on the kelly. The nut 90 has an upper cylindrical body portion 91 with a tapered lower end 92 normally slidably engaged in the bore 16 and seated on the seat 17 in the mandrel and a threaded lower portion 93 releasably engaged in the threads 18 in the mandrel. The nut 90 has a polygonal central opening 94 in which the kelly is engaged for free relative axial shifting and for rotary driving engagement between the nut and kelly.

In FIG. 1 of the drawings the run-in tubing string 87 is shown extending to the top of the well and has a swivel 95 and valve operated cementing head 96 connected with its upper end. The cementing head 96 is adapted to direct a slurry of cement into the string 87 for conduction downwardly therethrough and carries a tubing wiper plug 96'. The wiper plug is adapted to be selectively introduced into and circulated downwardly through the well structure, between the cement slurry and a following mass of circulating fluid.

The circulating pipe 89 depending from the tool T extends longitudinally through the liner L to terminate above the lower end thereof. The pipe 89 is provided with a casing wiper plug 97 at its lower end which plug seals with the interior of the liner, normally allows for the free flow of fluid from the pipe into the liner and is adapted to be selectively sealed or plugged by the drill pipe wiper plug 96' and to thereafter be urged out of engagement with the pipe 89 and advanced downwardly in the liner by fluid pressure within the run-in string.

The pipe 89 is further provided with a cementing packer 98 above the plug 97 to seal with the interior of the liner and to stop the flow of cement back and up through the liner L, through our new tool and into the casing.

The lower end of the liner L is provided with a casing shoe 99. The shoe 99 has a check valve means to permit the flow of cement and the like downwardly therethrough and into the well bore and about the exterior of the liner and which

prevents the reverse flow of cement and fluids back up into the liner.

The shoe 99 is adapted to be plugged by the liner wiper plug 97 when said plug is stopped by the plug 97', is urged from engagement with the pipe 89 and is moved downwardly in the liner, as noted above.

The above described well cementing apparatus and means with which our new tool is related is intended to illustrate one, substantially complete, operable, set-up and/or environment in which our new tool can be used to advantage. Since the details of design, construction and mode of operation of the several cementing tools and means shown and briefly described in the foregoing can vary widely without in any way effecting the novelty of the tool that we provide, further detailed description and/or illustration thereof can and will be dispensed with.

In operation and when it is desired to hang the liner L in the well W; cement the liner in place and pack off or seal the annulus between the casing C and the liner, the tool that we provide is made up with the liner L, the setting tool T, circulating pipe 89 and run-in string 87 substantially as shown in FIG. 1 of the drawings. The string 87, liner L and circulating pipe 89 have the various aforementioned cementing tools and means related thereto, as shown.

The assembly of tools and means carried by the run-in string is lowered in the well casing C to a desired point where the liner hanger and packer tool occurs within the lower end portion of the casing and the liner L depends from the casing and freely into the well bore, below the casing.

When the liner, liner hanger and packer are thus arranged in the well, the hanger can be actuated and set by rotating the run-in string in a counter clockwise direction, which rotation turns the kelly 85 of the tool T in the same direction and effects similar rotation of the mandrel A and the barrel B. The actuating sleeve 52 of the means R, by virtue of the frictional engagement of the belly springs 70 of the means F on and with the casing C is frictionally held stationary, relative to the mandrel and barrel, with the result that the lugs 14 on the barrel move from their normal to their actuated positions in the notches in the sleeve, the latch means L release and the slip 35 are actuated and set, as previously described and as shown in FIG. 2 of the drawings.

When the slips are thus set, a slurry of cement can be circulated downwardly through the well structure, outward through the casing shoe at the lower end of the liner and thence upward in the well bore, about the liner. Circulating fluid in the well bore, displaced by the cement is free to flow upwardly into the casing, about the liner hanger and the unactuated and yet to be actuated packer.

When the liner is cemented, as desired or at any desired time during the introduction of cement into the well bore, the packer of the new tool can be actuated to seal the annulus between the liner and casing by simply lowering the run-in string setting tool and mandrel, thereby effectively downward shifting of the actuating ring 29 and distending of the packing 30 into sealing engagement in and with the casing C.

When the packing means is thus set, the run-in string 87 is rotated clockwise, backing the releasing nut 90 of the tool T out of engagement with the mandrel A. When the nut 90 is thus released, the string 87 and tool T, with the circulating pipe and cementing packer 98 related thereto, are pulled from the well structure.

After the liner hanger and packer that we provide is set and left in the well, as set forth above, the liner L and the cement thereabout is perforated by any one of the several well known and widely used liner perforating tools.

After the well is completed in the above manner it may be necessary or desired that fluid, under high pressure, be introduced into the well structure, below the liner hanger and packer for the purpose of fracturing the cement and the production formation or for some other special purpose.

To make possible and effect the introduction of fluid, under high pressure, into the well structure below the set liner

hanger and packer, we provide a novel fluid conducting sealing tool S, which tool is engagable on the lower end of a string of circulating tubing 101 and is adapted to be lowered into the well and into sealed, fluid conducting engagement in the sealing chamber X in the upper end of the mandrel A.

The tool S is an elongate unit with a cylindrical exterior 102 corresponding in diameter with the bore 16 in the mandrel and slidably engagable therein. The tool S has a central upwardly opening threaded box 103 in which the lower end of the tubing string 101 is engaged, a central flow passage 104 extending downwardly from the box 103 and adapted to communicate with the flow passage 10 of the mandrel; a downwardly and radially inclined annular shoulder 105 about its lower end to engage on and with the seat 17 in the mandrel; an axially extending, radially outwardly opening annular recesses 106 in its exterior 102 and chevron packing 107 in the recess 106 and adapted to seal with the bore of the chamber X.

With the tool S illustrated and described above, it will be apparent that when the tool S is lowered into engagement in the socket X of the mandrel, open communication is established between the mandrel A and the tubing string 101 and that the connection established by and between the tool S and mandrel A is fluid tight and such that it will not permit the escape of fluid from within the tubing 101 and mandrel A, outwardly into the casing, above the liner hanger and packer.

It is to be noted that the connection between the tool S and mandrel A is established by axial sliding engagement of the tool S into the socket X of the mandrel and that the tool S and its related tubing string 101 need not be rotated or otherwise turned and manipulated in any special manner to make up or break the connection.

In practice, if necessary or desired, the packer section of our liner hanger and packer can be left unactuated until such time as the tool S is lowered into engagement with the mandrel, whereupon the weight of the tubing string 101 can be applied to the mandrel to effect actuation of the packer section. Such a procedure would not be carried out when the tool we provide is related to the cementing apparatus shown in FIG. 1 of the drawings, but can be carried out when our tool is utilized in completing a well in some other and distinct fashion or manner.

In the drawings, we have shown the hanger portion or section of our tool as including 4 circumferentially spaced slips, the means F including 4 circumferentially spaced springs, the packer portion or section utilizing 3 blocks and the means R including but two lugs. It is to be understood and it will be readily apparent that the number and circumferential spacing of such elements, parts and portions can be and is subject to variation, depending upon the major diameter of the tool, which dimension is determined and controlled by the diameter of the casing and liner with which the tool is to be related.

Having described only typical preferred forms and applications of our invention, we do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to ourselves any modifications and/or variations that may appear to those skilled in the art to which this invention pertains.

Having described our invention, we claim:

1. A well tool engagable with and between an elongate, vertical, tubular well casing and an elongate, vertical, tubular well liner engaged within and depending from the casing and comprising an elongate, vertical, tubular barrel fixed on the upper end of the liner and arranged in the casing in spaced relationship therewith, an elongate, tubular mandrel slidably engaged in the barrel and projecting from the upper end thereof; the barrel having a plurality of circumferentially spaced radially outwardly opening slip recesses with upwardly and outwardly inclined bottom surfaces, a wedge-shaped casing engaging slip engaged in each slip recess and having an elongate, vertical finger projecting upwardly therefrom, spring means carried by and between the barrel and the slip and normally yieldingly urging the slips upwardly and outwardly in the slip recesses

and relative to the barrel and the casing; an elongate, vertical, annular actuating sleeve adjacent the upper end of the barrel and rotatably carried by and about the mandrel, said sleeve having downwardly opening finger receiving notches normally receiving the upper ends of the fingers and normally holding the slip down in the slip recesses, said sleeve having elongate, vertical finger receiving channels spaced circumferentially from said finger receiving notches and shiftable into alignment with said fingers upon rotation of the sleeve relative to the barrel whereupon the fingers are urged out of engagement in the finger receiving notches and shift upwardly in the finger receiving channels.

2. A structure as set forth in claim 1 wherein the upper ends of the fingers and the finger receiving notches have normally opposing, upwardly and circumferentially inclined cam faces and said slips have bottom edges which are normally spaced above opposing bottom edges of their related slip recesses a distance at least equal to the distance the upper ends of the fingers enter the finger receiving notches.

3. A structure as set forth in claim 1 wherein the actuating sleeve has circumferentially extending lug receiving notches with horizontal upwardly disposed bottom edges and circumferentially spaced, circumferentially disposed first and second stop shoulders, said mandrel has radially outwardly projecting lugs projecting into said lug receiving notches to slidably engage the bottom edges thereof and normally engaging the first stop shoulders and engagable with the second stop shoulders when the actuating sleeve is rotated relative to the mandrel and the barrel and the fingers are aligned with the channels.

4. A structure as set forth in claim 1 wherein the upper ends of the fingers and the finger receiving notches have normally opposing, upwardly and circumferentially inclined cam faces and said slips have bottom edges which are normally spaced above opposing bottom edges of their related slip recesses a distance at least equal to the distance the upper ends of the fingers enter the finger receiving notches, said actuating sleeve has circumferentially extending lug receiving notches with horizontal upwardly disposed bottom edges and circumferentially spaced, circumferentially disposed first and second stop shoulders, said mandrel has radially outwardly projecting lugs projecting into said lug receiving notches to slidably engage the bottom edges thereof and normally engaging the first stop shoulders and engagable with the second stop shoulders when the actuating sleeve is rotated relative to the mandrel and the barrel and the fingers are aligned with the channels.

5. A structure as set forth in claim 1 including means releasably coupling the upper end of the mandrel with the lower end of a fluid conducting tubing extending through the casing, said actuating sleeve has means frictionally engaging the casing to yieldingly hold said sleeve against rotation upon rotation of said tubing string, mandrel and barrel.

6. A structure as set forth in claim 1 wherein the upper ends of the fingers and the finger receiving notches have normally opposing, upwardly and circumferentially inclined cam faces and said slips have bottom edges which are normally spaced above opposing bottom edges of their related slip recesses a distance at least equal to the distance the upper ends of the fingers enter the finger receiving notches, means releasably coupling the upper end of the mandrel with the lower end of a fluid conducting tubing extending through the casing, said actuating sleeve has means frictionally engaging the casing to yieldingly hold said sleeve against rotation upon rotation of said tubing string, mandrel and barrel.

7. A structure as set forth in claim 1 wherein the actuating sleeve has circumferentially extending lug receiving notches with horizontal upwardly disposed bottom edges and circumferentially spaced, circumferentially disposed first and second stop shoulders, said mandrel has radially outwardly projecting lugs projecting into said lug receiving notches to slidably en-

gage the bottom edges thereof and normally engaging the first stop shoulders and engagable with the second stop shoulders when the actuating sleeve is rotated relative to the mandrel and the barrel and the fingers are aligned with the channels, means releasably coupling the upper end of the mandrel to the lower end of a fluid conducting tubing extending through the casing, said actuating sleeve has means frictionally engaging the casing to yieldingly hold said sleeve against rotation upon rotation of said tubing string, mandrel and barrel.

8. A structure as set forth in claim 1 wherein the upper ends of the fingers and the finger receiving notches have normally opposing, upwardly and circumferentially inclined cam faces and said slips have bottom edges which are normally spaced above opposing bottom edges of their related slip recesses a distance at least equal to the distance the upper ends of the fingers enter the finger receiving notches, said actuating sleeve has circumferentially extending lug receiving notches with horizontal upwardly disposed bottom edges and circumferentially spaced, circumferentially disposed first and second stop shoulders, said mandrel has radially outwardly projecting lugs projecting into said lug receiving notches to slidably engage the bottom edges thereof and normally engaging the first stop shoulders and engagable with the second stop shoulders when the actuating sleeve is rotated relative to the mandrel and the barrel and the fingers are aligned with the channels, means releasably coupling the upper end of the mandrel with the lower end of a fluid conducting tubing extending through the casing, said actuating sleeve has means frictionally engaging the casing to yieldingly hold said sleeve against rotation upon rotation of said tubing string, mandrel and barrel.

9. A structure as set forth in claim 1 wherein the actuating sleeve has circumferentially extending lug receiving notches with horizontal upwardly disposed bottom edges and circumferentially spaced, circumferentially disposed first and second stop shoulders, said mandrel has radially outwardly projecting lugs projecting into said lug receiving notches to slidably engage the bottom edges thereof and normally engaging the first stop shoulders and engagable with the second stop shoulders when the actuating sleeve is rotated relative to the mandrel and the barrel and the fingers are aligned with the channels, said barrel has an elongate, annular, radially outwardly opening packer recess below the slip recesses, radial opening longitudinal block slots communicating with the packer recess, an annular actuating ring normally in and about the upper end of the packer recess, blocks slidably engaged in the block slots and extending between and fixed to the mandrel and the actuating ring and a sleeve-like body of deformable expansible packing material in the packer recess and in the block slots below said ring and the blocks, said blocks and ring adapted to displace said packing material downwardly and radially outwardly in and relative to the packer recess to seal with said casing upon downward shifting of the mandrel in the barrel, said actuating sleeve having vertical lug receiving slots extending downwardly from the ends of the lug receiving notches adjacent the second stop shoulders thereof to accommodate the lugs upon downward shifting of the mandrel in the barrel.

10. A structure as set forth in claim 9 wherein means releasably coupling the upper end of the mandrel with the lower end of a fluid conducting tubing extending through the casing, said actuating sleeve has means frictionally engaging the casing to yieldingly hold said sleeve against rotation upon rotation of said tubing string, mandrel and barrel.

11. A structure as set forth in claim 10 wherein said setting means includes a releasing nut with a central polygonal opening thread into the upper end of the mandrel and an elongate polygonal fluid conducting kelly fixed to the lower end of the tubing string and slidably engaged through and establishing rotary driving engagement with the releasing nut.

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