

Sept. 7, 1943.

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2,328,840

LINER HANGER

Filed June 3, 1940

2 Sheets-Sheet 1

Fig. 1.

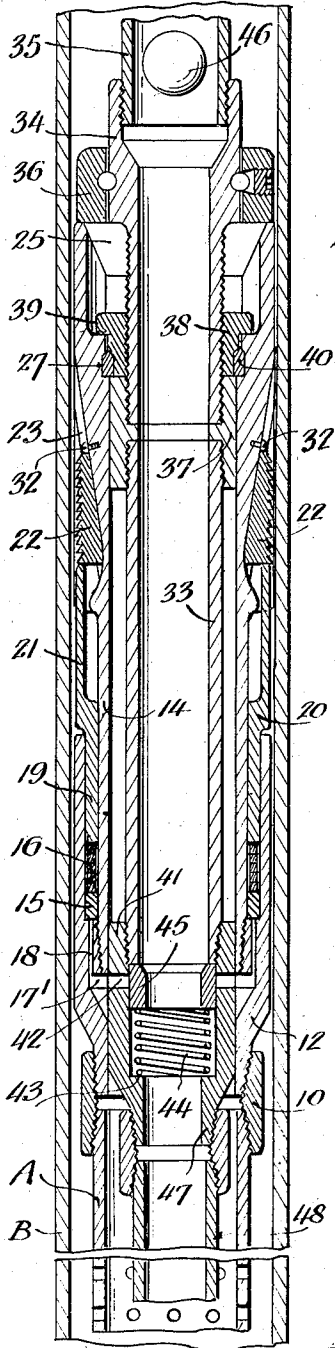


Fig. 2.

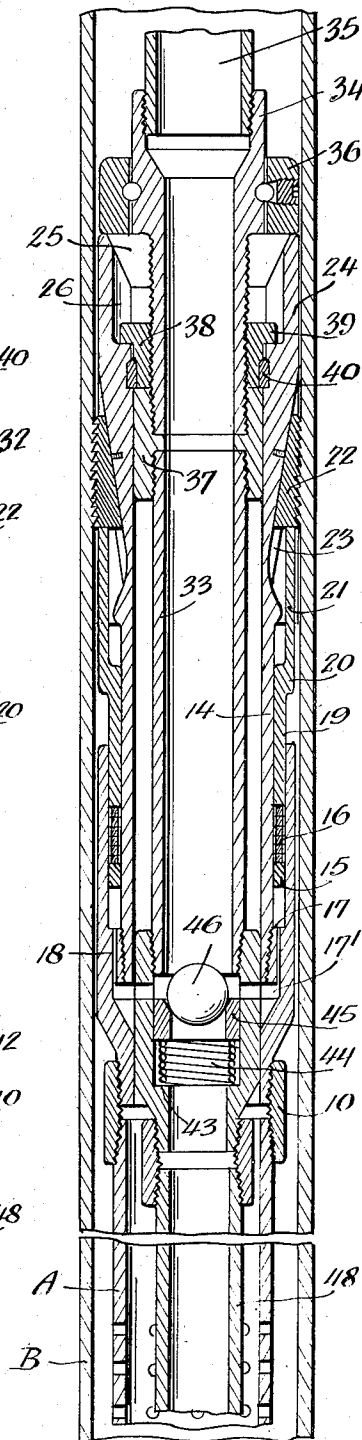
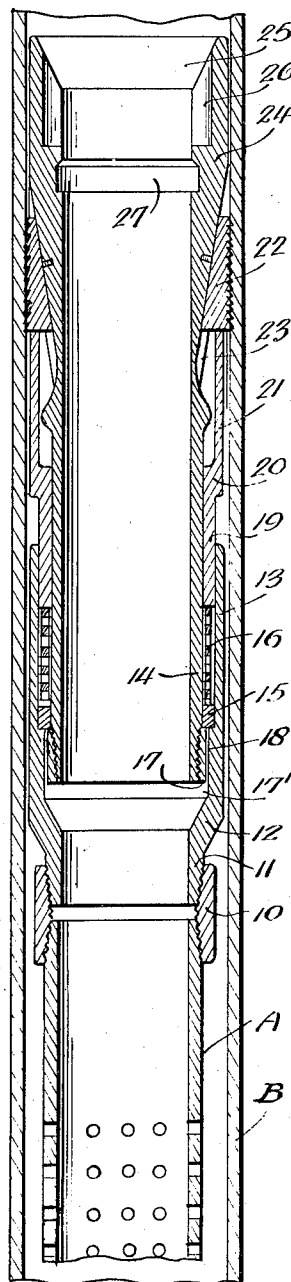


Fig. 4.



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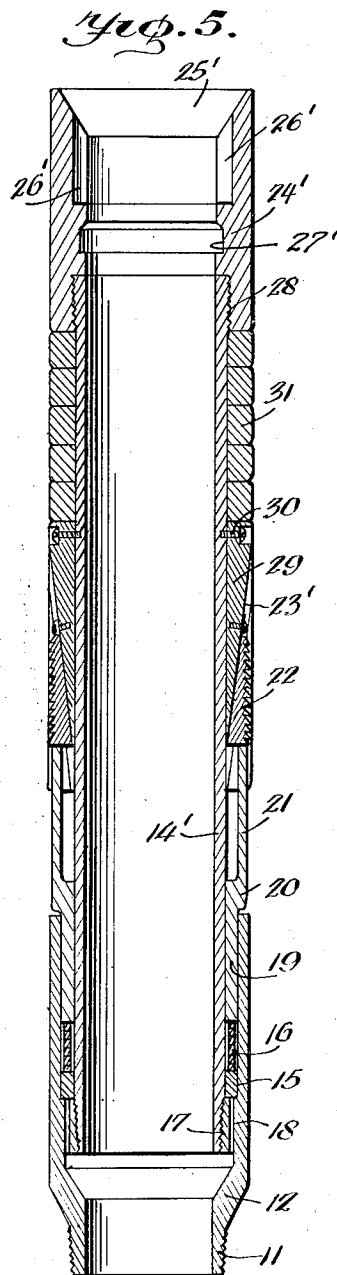
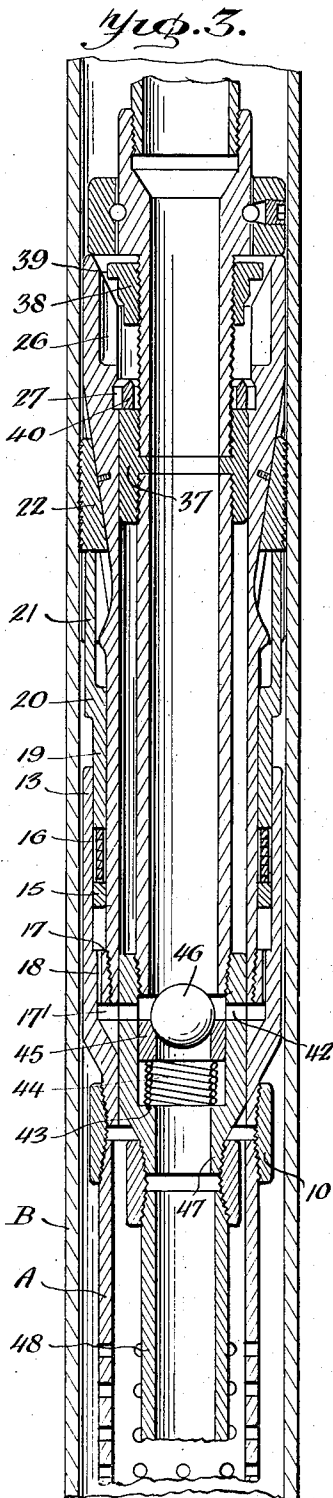
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2,328,840

LINER HANGER

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Application June 3, 1940, Serial No. 338,501

12 Claims. (Cl. 166—1)

The present invention relates generally to oil well equipment and more particularly to casing liners, and has for its primary object the provision of means for hanging a liner in a casing in a direct, positive manner insuring its effective retention, and at the same time providing for its retrieval or removal at any time adjustment thereof is desired, or repair or replacement thereof becomes necessary.

Another object of the invention is the provision of a liner hanger and means for setting the same, which are of simple, economical construction both as to first cost and upkeep and are singularly free from the complications of those devices now in use such as interengaging threaded and milled connections between the hanger and the setting tool or means.

A further object has to do, therefore, with the manner and means of engagement or connection between the hanger and the setting tool providing in a practical inexpensive construction for the speedy effective setting of the hanger as well as the disengagement and removal of the setting tool after setting of the hanger.

It is generally conceded that the practice of hanging or suspending the liner in a well pipe insures that the liner will not collapse of its own weight, become buckled, or shift position in the hole, and is the best practice in view of the further fact that the liner is thereby prevented from sinking into soft formation at the bottom of the hole and cannot fall into cavities or otherwise lose alignment with the hole above. Since, however, as commonly used in two types, one known as the pack off type with rubber or other packing means, and the other known as a plain type without packing means, such liner hangers invariably depend upon the engagement of slips with the well pipes from which they are suspended, the manner and means of bringing about such engagement become highly important.

Another object of the invention has to do, therefore, with the slips and the means whereby they are normally held inactive during run in and may be released and positively set while the hanger is stationary in the pipe to thus insure its setting at precisely the desired point.

Another object of the invention is to provide a liner hanger which can be set at any point in a well casing without imparting torsional or compressive strains to the liner or liner hanger.

Another object of the invention is to provide a liner hanger in which the holding slips are forcefully and equally expanded in a manner to

locate the liner in a position concentric with the well casing.

Another object of the invention is to provide a liner hanger offering high frictional resistance to disengagement of the setting tool during the run in period and which offers a minimum frictional resistance to disengagement of the setting tool after the liner has been anchored.

Another object of the invention is to provide a setting tool that is fool-proof in construction to an extent making it impossible for an inexperienced operator to damage either the liner hanger or setting tool during the releasing operation either by carrying an excessive amount of the setting string weight upon the tool, or by rotating the setting string more than the necessary number of times to effect a release from the liner hanger.

A still further object of the invention is the provision of a hanger which includes a setting and releasing tool of a nature adaptable to the use of a wash pipe therewith so that in one trip the hole may be circulated clean and the liner subsequently set before release and withdrawal of the setting tool.

With the above general objects in mind, other and further objects as well as the resulting advantages of the invention will clearly appear in the course of the following detailed description of the best mode so far devised for carrying the invention into practice, and may be better understood and more thoroughly appreciated by reference to the accompanying drawings, forming a part of this specification, and wherein,

Figure 1 is a vertical longitudinal sectional view through a well casing and a portion of a liner, as well as the plain type of hanger of the present invention and its setting tool, showing these latter parts after run in and prior to actual setting.

Figure 2 is a similar view showing the parts in position after positive setting of the slips and prior to any withdrawal movement of the setting tool.

Figure 3 is another similar view showing the parts in position ready for withdrawal of the setting tool.

Figure 4 is still another similar view showing the liner and its hanger after withdrawal of the setting tool, and,

Figure 5 is a detail vertical longitudinal sectional view through a liner hanger of the packed off type.

Referring to the above described drawings and particularly to Figures 4 and 5 and a comparison thereof, it will be noted that in each instance the

liner indicated at A, of somewhat smaller diameter than the well pipe or casing B, and of any desirable apertured or slotted perforation, may be made up on the lower end of either the plain or packed off type of hanger and that the latter are in all essential respects the same as far as the present invention is concerned, differing only as to slight modification permitting the use of packing in connection therewith in the case of the packed off hanger of Figure 5 where no packing is used with the plain hanger of Figure 4 which is also shown in Figures 1 to 3 inclusive.

In each instance the liner A is threaded at its upper end into a coupling 10 which is threaded onto the lower reduced end 11 of a collar 12 which has an upstanding sleeve portion 13 surrounding the lower portion of the body or barrel 14 of the hanger of Figures 1 to 4 inclusive in spaced relation thereto for the reception in this space of an annular packing ring 15 below a helical spring 16 preferably square spring steel.

The collar 12 has therein, immediately above its reduced lower portion 11, an internal annular rib 17 forming an annular space 17' in collar 12 below the rib 17, and presenting a threaded internal surface for the secure connection of the externally threaded lower end of barrel 14 of Figures 1 to 4 inclusive. The rib 17 is also provided with a series of vertical ports 18, spaced therearound, communicating at their lower ends with the annular space 17' and communicating at their upper ends with the above mentioned annular space between barrel 14 and sleeve 13. The lower ends of these ports 18 open, as before stated, into the interior of collar 12 below its said rib 17.

Extending downwardly into the above mentioned space between barrel 14 of Figures 1 to 4 inclusive and sleeve 13 is the lower cylindrical guide portion 19 of a slip setting plunger 20 having upstanding arms 21 engaging at their upper free ends the larger lower ends or bases of the slips 22. It will be understood that these slips are movable lengthwise of the barrel 14 exteriorly thereof and are disposed in an annular series of dove-tail grooves therearound, each slip being engaged by one of the said upstanding arms 21 of the slip setting plunger 20.

The lower edge of the lower cylindrical guide portion 19 of the plunger 20 is seated on the spring 16 and thus when the parts are otherwise free, as when the slips are set in engagement with the internal surface of the casing or pipe B to prevent downward movement of the hanger and the liner suspended therefrom, the spring exerts a constant tension to hold the plunger upwardly against the slips 22. All of the parts thus far described in connection with the barrel 14 of Figures 1 to 4 inclusive are precisely the same as those in connection with the barrel 14', shown in Figure 5, and it is only when we proceed above the slips 22 that there are differences between the two constructions.

In the case of the plain hanger of Figures 1 to 4 inclusive, the slips 22 are disposed in lengthwise dove-tail grooves grouped around the upper portion of the external surface of barrel 14. The dove-tail grooves just mentioned have downwardly tapering bases 23 on which the slips are slidably seated, and are located immediately below the integral adaptor head 24 at the upper end of the barrel 14, which receives, and cooperates with, the setting tool to be presently described.

For the above purpose the head 24 has a conically counterbored end as seen at 25 and is provided below said counterbore with diametrically

opposed longitudinal grooves 26 in its inner surface, and with an internal annular groove 27 below the said longitudinal grooves 26. The manner in which these parts coact with the setting tool will presently be made plain.

In the case of the packed off type of hanger, as shown in Figure 5, the adaptor head 24' is precisely the same as in the plain type in so far as its means of engagement with the setting tool are concerned. In other words it is provided with a conically counterbored upper end 25', has diametrically opposed longitudinal grooves 26' therebelow and an internal annular groove 27' below grooves 26'. It is, however, formed as a separate part from the barrel 14' and is threaded onto the upper end of the latter at 28. Moreover, in this packed off type of hanger, the slip expander, indicated in this instance at 29 with slip grooves 23', is initially fixed on the barrel 14', by shear screws 30, at a point spaced below the adaptor head 24', and the space between the lower edge of the adaptor head 24' and the upper edge of expander 29 receives packing 31 which is longitudinally compressed and in this way laterally expanded into sealing engagement with the well pipe or casing B, by downward movement of the adaptor head 24' and barrel 14' with respect to the expander 29 after the slips 22 have been set.

In both the plain and packed off types of hangers as above described, the slips 22 are, in the initial lowering or running in of the hanger, held in the lower deeper portions of the expander slip grooves by means of shear screws 32 set into the tapering bases of the slip grooves at the upper smaller ends of the slips as plainly seen in Figures 1 and 5. These screws are sheared off when the slips 22 are forced upwardly in the setting of the hanger as presently described and when so sheared, the slips are free to move to set position as seen in Figures 2, 3 and 4.

The setting tool of the present invention, as shown within the hanger in Figures 1 to 3 inclusive, is equally applicable to the plain and packed off types of hangers, and its description of application with reference to the above figures will be understood to apply equally to the hanger of Figure 5. This tool has its body formed by a hollow cylindrical mandrel 33 provided with an upper enlarged head 34. The head 34 is internally threaded for secure connection to the lower end of a run in string 35, which may be tubing, drill pipe and the like, so that the bore of the string becomes alined with the bore of the mandrel 33. The head 34 also supports therearound, preferably in an anti-frictional manner, a seating ring 36 arranged to seat on the upper end of the adaptor head 24.

Below the head 34, that portion of the mandrel 33 lying between said head and a collar 37 around the mandrel, is externally threaded for the reception thereon of an internally threaded clutch control and expanding sleeve 38 whose upper portion has diametrically outstanding trunnions 39 for slidable disposition in the adaptor head longitudinal grooves 26 to thus prevent rotation of sleeve 38 and force the same to shift upwardly on the upper part of the mandrel 33 when the latter is rotated to the right.

The mandrel collar 37, which may, as shown, join two sections of the mandrel 33 for convenience in assembly of the parts, serves at its upper edge as a seat for a split spring clutch ring 40 having an upper beveled edge and whose normal external diameter is somewhat less than the internal diameter of barrel 14. This ring is of an

internal diameter less than the reduced lower end of the control and expander sleeve 38 and is such that when the latter is in assembly forced downwardly into the ring from the position of these parts shown in the released position of Figure 3 to the clutched position shown in Figure 1, the ring will be expanded into locking position within the annular groove 27 of the adaptor head 24.

It will be understood that for the above purposes, it is presupposed the mandrel 33 of the setting tool has been positioned within the barrel 14 of the hanger as shown in Figures 1 to 3 inclusive and it will be noted that in the initial assembly of the parts, the seating of the head ring 36 on the upper end of barrel 14 positions the clutch ring 40 in horizontal alinement with barrel groove 27 so that the clutch ring may be expanded therein as above described and the setting tool thus effectively connected to the hanger whereby the latter may be run into the casing with its pendant liner A to the position at which the latter is to be set in the well pipe or casing B.

When the setting tool is within the barrel 14 of the hanger as above, the lower end of its mandrel 33 depends to approximately the lower end of said barrel and it will be noted that at its said lower end, the mandrel threads securely within the upper end of a collar 41 in the barrel, the lower portion of which collar snugly and slidably interfits the bore of the lower reduced portion of barrel collar 12. The wall of mandrel collar 41 has radially extending openings 42 which communicate between its bore and the annular space 17' in the collar 12 below rib 17, which space is substantially sealed off when the upper portion of mandrel collar 41 is in the lower end of the barrel and the lower portion of said collar is in the lower portion of the barrel collar 12.

In the bore of mandrel collar 41 is an annular upwardly facing shoulder 43 forming a seat for the lower end of a coil spring 44 whose upper end engages a relatively thick walled, ring shaped valve member 45 to normally hold said member in its upper position against the lower end of mandrel 33, in which position it extends across and closes the several wall openings 42. The upper end of valve 45 has a seat for a setting ball 46 which is dropped through the run in string and falls through mandrel 33, the ball being of such diameter that it closes the bore of the valve 45, whereby pump pressure can be applied within the mandrel above said valve, to force the latter downwardly to a position in the bore of mandrel collar 41 where the openings 42 are uncovered as in Figure 2.

The mandrel collar 41 is also preferably provided with a reduced lower extremity 47 to which may be attached, as shown in Figures 1 to 3, the upper end of a wash pipe 48. Thus when the setting tool, with the liner hanger and liner carried thereby, are initially run in the casing B as the parts are shown in Figure 1, and before the setting ball 46 is dropped, the bottom of the well bore or hole may be thoroughly washed, as circulation is established through the run in string and wash pipe 48, around the hanger before it is set.

When the bore has been washed or circulated clean, the setting ball 46 is dropped in the run in string and comes to rest on the upper end of valve ring 45 which presents a somewhat smaller internal diameter than the mandrel 33. Thus upon the application of fluid pressure the valve

ring 45 will be depressed as above described and openings 42 uncovered so that fluid under pressure may be pumped into the internal annular groove 17' of the collar 12 below the hanger barrel with the parts in the position shown in Figure 2, to thus force the packing 15 upwardly. At this time, the spring 16 is in tightly compressed condition so that it forms in effect a solid body between the packing 15 and the lower guide portion 19 of the slip setting plunger 20.

Plainly the fluid pressure actuated upward movement of packing 15, acting through plunger 20, will force the slips 22 upwardly, shearing the screws 32, and spreading the same on the expander to the engaged position shown in Figure 2. The liner A and its hanger as previously described, are now in set position.

In the next operation, therefore, the run in string 35 is lowered so that its weight is carried on ring 36 and it is rotated to the right and clutch ring expander 38 is thus shifted upwardly from its active position of Figures 1 and 2 to its inactive position of Figure 3 substantially above the clutch ring 40 whereby the latter may retract and recede from the barrel groove 27 to free the setting tool for bodily withdrawal upwardly out of, and free from, the liner hanger, leaving the latter anchored in the casing or well pipe B in the position shown in Figure 4.

The above sequence of operations for the plain type of liner hanger also suffices for the packed off hanger as shown in Figure 5, after slips 22 have been set as described, the run in string is lowered to apply downward pressure on the setting tool before its release, to thus force the hanger barrel 14' downwardly, shearing screws 30 and thus forcing the barrel through the slip expander 29, since the latter cannot move downwardly with the slips 22 set in connection with the casing B. The result is that packing 31 is longitudinally compressed and laterally expanded into sealing engagement with the casing B. In all other respects the before described setting and setting tool releasing operations applies to the packed off hanger as well as the plain hanger.

It is to be particularly noted that during run in, the clutch connection between the hanger and the setting tool imposes a maximum frictional resistance to rotational movement of either with respect to the other, since the weight of the liner and liner hanger bears on clutch ring 40 and tends to cause the latter to tightly grip the ring expander 38. This situation changes immediately upon the setting of the hanger in the casing and the slight lowering of the run in string so that its anti-friction seating ring 36 rests on the upper end of the barrel 14, so that the run in string now rests on the set hanger and relieves the clutch parts of the tension previously imposed by the weight of the liner and liner hanger. Hence, with the heavy friction relieved and an anti-friction engagement of the run in string with the hanger, it becomes an easy operation to release the setting tool by rotation thereof as previously described.

It also is to be noted that in the rotational release of the setting tool, upward shifting movement of the clutch ring expander 38 ceases when its trunnions 39 move beyond the upper ends of the vertical grooves 26. It is apparent from this that the expander 38 cannot be run upwardly against the seating ring to impair the function of the latter which avoids the otherwise probable disadvantage of great friction if

too much weight of the run in string is lowered on the hanger. To the above extent the apparatus of this invention is fool-proof and provides for maximum frictional engagement of tool and hanger going in, and minimum frictional engagement thereof after the liner hanger has been set. Furthermore it permits unlimited rotational releasing movements of the run in string and setting tool in respect to the liner hanger without damage to these parts.

Attention is particularly called to the fact that by setting the slips by fluid pressure, uniform operation thereof to set the hanger in coaxial relation to the casing is assured, and that this advantage is obtained by an arrangement including means closing the pressure ports during run in and cleaning operations before setting. Furthermore the arrangement for this purpose provides a considerable pressure force for initially setting the slips and a relatively small spring force for holding them in set position, thus bringing about positive setting of the slips and at the same time eliminating excessive friction thereof against the casing when the liner is retrieved.

It is obvious the liner hanger as thus fully set forth and described, while capable of changes and modifications in many respects, presents on the whole a strong, effective and durable device of this class of well equipment, which is singularly free of time wasting complications in setting and release of the setting tool, which is of such positive action as to preclude any possibility of failure of proper support of the liner, and may be economically made and assembled in a manner admitting of ready easy replacement of its parts.

Having thus fully described the invention, what is claimed is:

1. A liner hanger having a passage therethrough, pipe gripping means externally thereof, fluid pressure-actuated means for setting said gripping means, and spring means forming a part of said setting means for holding said gripping means in set position after release of fluid pressure thereagainst.

2. A liner hanger having a bore, and an internal annular shoulder in said bore, a setting tool extendible into said bore and to rest on the hanger, a split spring clutch ring around, and seated on, portions of said tool for positioning opposite said shoulder and of a diameter, when contracted, less than the diameter of the hanger bore, a portion of said tool adjacent said ring being threaded, a ring expander having threads internally thereof and disposed on the threaded portion of the tool and having one end thereof extendible into the ring to expand the latter into engagement with said shoulder of the hanger, and cooperating means carried by said expander and the hanger constraining the former to movement lengthwise of the tool when the latter is rotated in the hanger.

3. A liner hanger having a passage therethrough, pipe gripping means externally thereof, and fluid pressure-actuated means for shifting said gripping means including a pressure actuated plunger member and spring means engaging said plunger member to hold the gripping means lightly in engaged position after release of fluid under pressure against said plunger member.

4. A liner setting tool having an anti-frictional setting ring rotatably around its upper portion,

and a clutch control member threaded thereon below said ring.

5. A liner hanger having a bore and vertical grooves in its internal surface, opening at their upper ends into the bore below the upper end of the latter, an expansible clutch ring for engaging the internal surface of the hanger below said grooves, and a setting tool having a support for said ring, a ring expander threaded on said tool above the clutch ring and having means extending into said grooves to constrain the same to movement lengthwise of the tool for the lengths of the grooves, and a seating ring in anti-frictional connection with the setting tool for engagement with the upper end of the hanger.

6. A liner hanger having a bore, and a setting tool for disposition in said bore, a clutch ring supported around said tool for gripping the hanger in expanded position, a ring expander threaded on the tool and actuated by rotation thereof, and cooperating means on said expander and the hanger for constraining the expander to limited movement lengthwise of the tool into and out of the ring, during rotation of the tool.

7. A liner hanger, a setting tool therefor, clutch means therebetween releasable by rotation of the tool and held in substantial frictional resistance to such rotation, by the weight of the hanger during run in of the latter, and a member in anti-frictionally rotatable connection with the tool for engagement with the hanger to support the weight of the tool and its run in string after the setting of the hanger and to thus relieve the frictional resistance of said clutch means to rotational release.

8. In a liner hanger, a barrel having a passage therethrough, pipe gripping means externally thereof, means having a sleeve around and spaced from the barrel and also having openings communicating between the barrel passage and the lower portion of the space within the sleeve, and a plunger actuated by fluid pressure from the barrel for setting the pipe gripping means, said plunger having a portion normally engaging the gripping means and another portion slidable in the space within the sleeve.

9. In a liner hanger, a barrel having a passage therethrough, pipe gripping means externally of the barrel, an external plunger movable lengthwise of the barrel against said gripping means, a sleeve forming an annular space around the barrel, receiving a portion of said plunger, and in communication at one end with the barrel passage, and a spring under tension between said last mentioned end of the said space and the adjacent portion of the plunger.

10. In combination with a well liner and run in string for setting said liner, means including an expanding clutch ring for releasably connecting the liner and run in string and a nut for disengaging said ring operable by rotation of the run in string, and an anti-friction member between the run in string and the liner to relieve frictional resistance to relative rotation between the run in string and liner as they are disconnected.

11. In combination with a liner hanger and run in string for setting said hanger, said hanger having means forming an internal annular shoulder and lengthwise grooves adjacent to said shoulder, a clutch ring expansible in opposing relation to said shoulder for releasably connecting the liner and run in string, a nut shiftable by rotation of the said string within said grooves

for disconnecting said clutch ring, and an anti-friction member between the run in string and the liner hanger to relieve frictional resistance to relative rotation between the run in string and hanger as they are disconnected.

12. In a liner hanger, a barrel having a passage therethrough, pipe gripping means externally of the barrel, an external sleeve forming a space around the barrel and in communication at one end with the barrel passage, a

plunger around the barrel in contact at one end with said gripping means and having its other end slidable in said space, a tension spring in said space with one end engaging the last mentioned end of the plunger, and a movable packing member between the other end of the spring and the passage communicating end of the space within the sleeve.

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