June 28, 1960 E. BURNS ET AL 2,942,670

CIRCULATING SHOE

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Fig. 1.

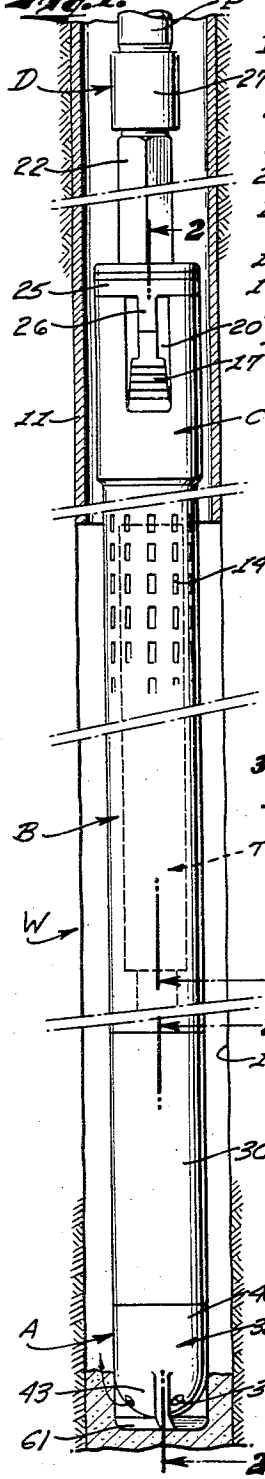



Fig. 2.

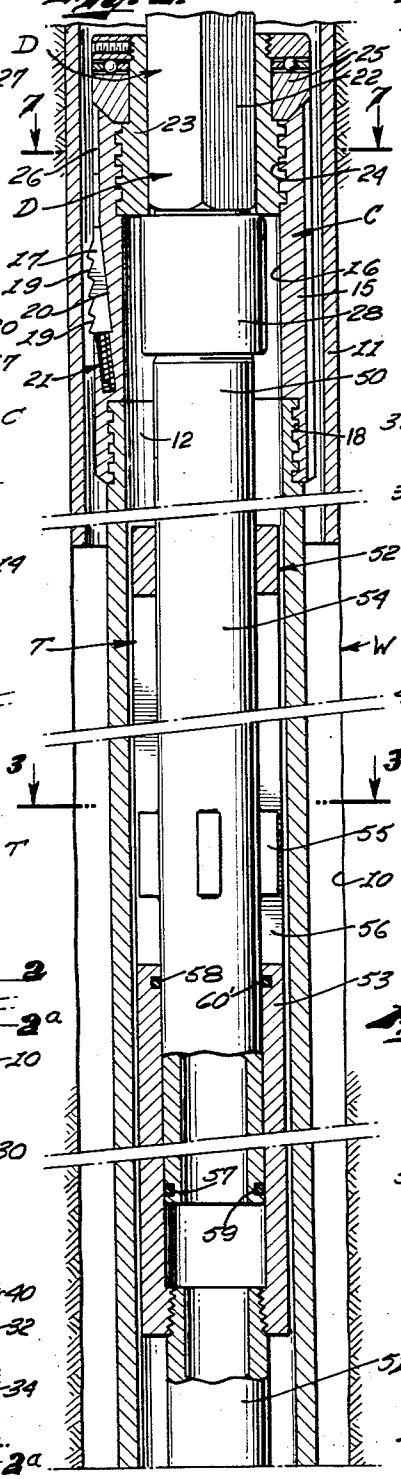



Fig. 2a.

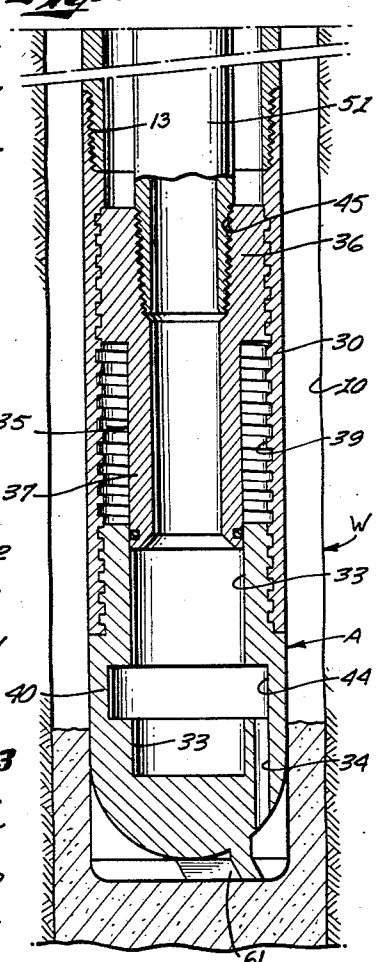
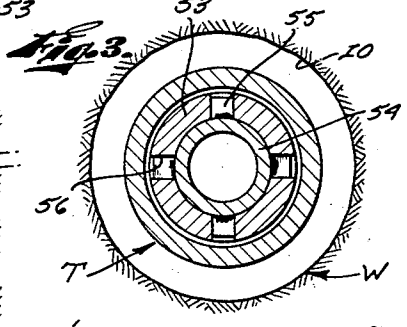



Fig. 3.



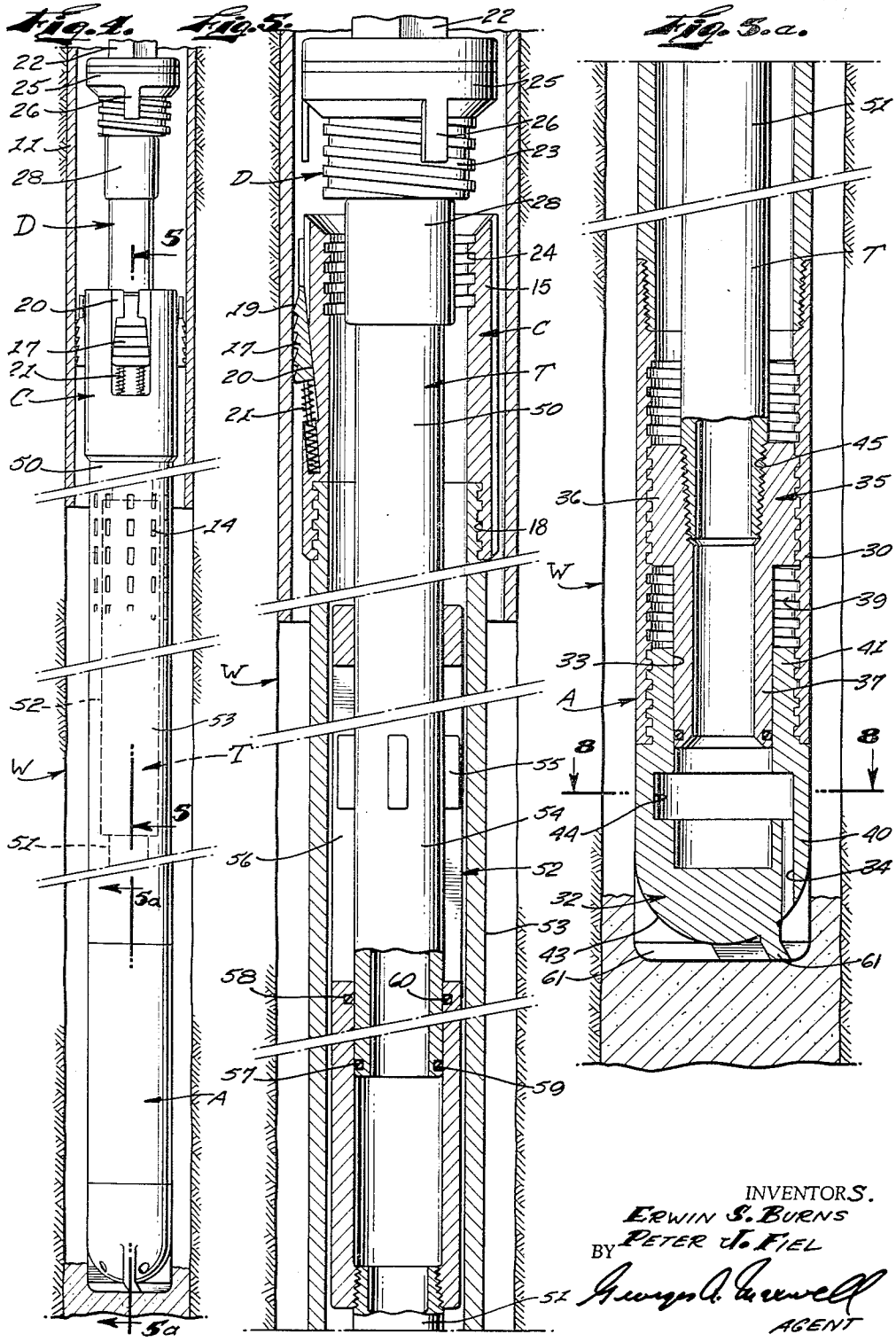

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Fig. 4. Fig. 5. Fig. 5a.




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CIRCULATING SHOE

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Fig. 6.

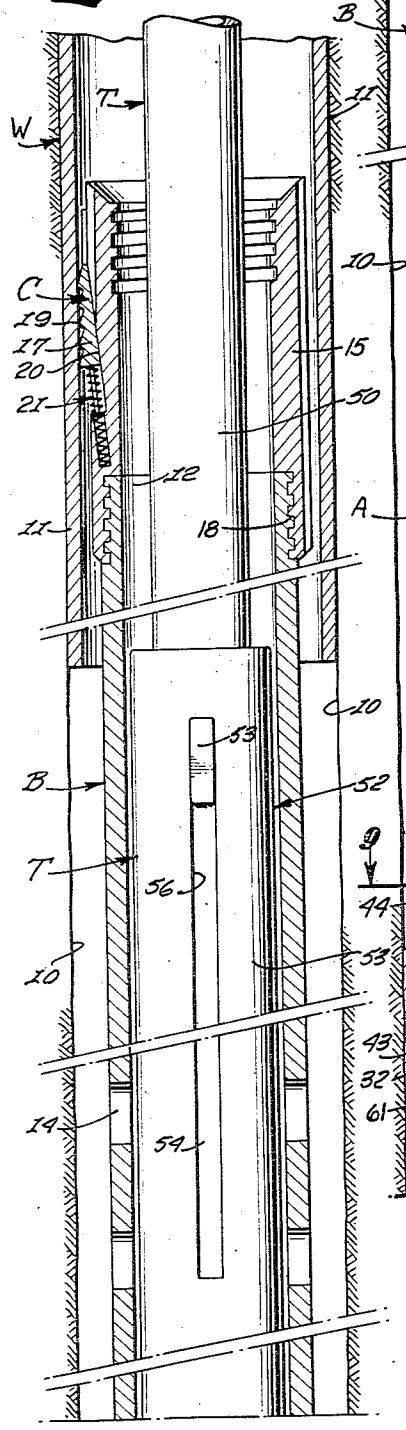



Fig. 6a.

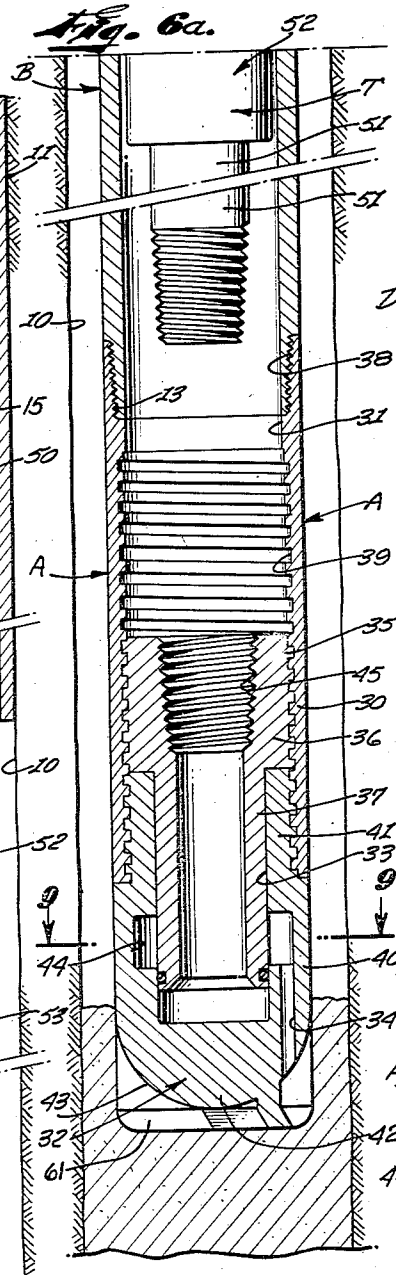



Fig. 7.

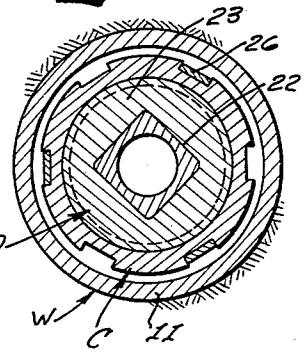



Fig. 8.

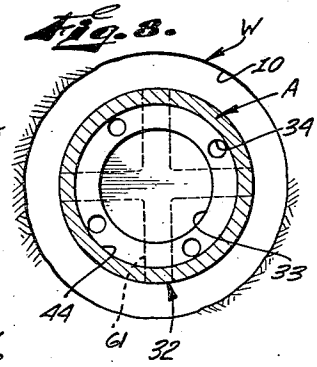
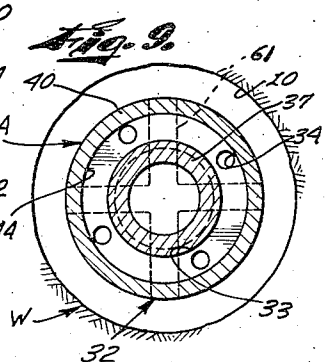



Fig. 9.




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2,942,670

# CIRCULATING SHOE

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Filed May 26, 1958, Ser. No. 737,695

11 Claims. (Cl. 166—205)

This invention relates to an oil tool and is more particularly concerned with an improved circulating shoe.

Upon the completion of drilling an oil well, it is common practice to insert a liner into the well to depend from and occur below the lower end of a well casing previously set in the well and adapted to support the surrounding production formation above the production formation. The ordinary liner is generally closed at its lower end by a plug-like member, commonly referred to as a shoe, and is provided at one or more points along its longitudinal extent with a plurality of perforations to permit the flow of well fluid into the interior thereof.

It frequently happens that after the drilling bit has been removed from the well bore and before the liner can be inserted and set in place, sand and other like loose formation plugs the well and prevents insertion of the liner. When this happens, it is necessary to provide a circulating shoe at the lower end of the liner hanger, that is, a shoe having ports therein and adapted to circulate fluid flowing down through the string of drill pipe, employed to lower the liner into the well, through the liner and the ported shoe, in order to flush and wash the sand out of the well in advance of the liner as it is being lowered therein. Due to the perforations in the liner it is necessary that a suitable removable fluid conducting member or wash pipe be provided to extend from the lower end of the drill string through the liner and to the circulating shoe in order to insure the flow of fluid downwardly through the perforated liner and into the shoe. In the ordinary set-up, the fluid conducting member is connected with a setting tool at the lower end of the drill pipe string and which is provided to actuate a suitable liner hanger provided at the upper end of the liner for supporting the liner in the lower end of the well casing.

A serious disadvantage of the ordinay circulating shoe is that after the liner is set and the fluid conducting member is removed, the ports in the shoe remain open and establish open communication between the well and the interior of the liner at the lower end thereof. In many oil wells, due to the location, character and extent of the oil bearing formation and the manner in which the liner extends therethrough, proper positioning of the perforations in the liner is critical and any flow of fluid into the liner at the bottom or lower end thereof through the circulating shoe would create serious adverse effects.

An object of the present invention is to provide an improved fluid circulating shoe applicable to the lower end of a liner and having valve means related thereto to shut off the flow of fluid therethrough as desired.

Another object of the present invention is to provide a novel apparatus for setting a liner in a well, for delivering circulating fluid to a circulating shoe at the lower end of the liner and for actuating the circulating shoe to shut off the flow of fluid therein.

A further object of the present invention is to provide a novel circulating shoe of the character referred to which involves a minimum number of parts, each of which is



easy and economical of manufacture and a shoe which is both highly effective and dependable in operation.

It is an object of the present invention to provide a novel apparatus for hanging a liner from the lower end of a well casing and for delivering fluid to and for actuating a valve controlled actuating shoe at the lower end of the liner, which apparatus is simple, practical and involves a minimum number of easy and economical to manufacture parts and an apparatus which is highly effective and dependable in operation.

An object of the present invention is to provide a ported circulating shoe applicable to the lower end of a liner having a tubular body and having a screw actuated valving element threadedly engaged therein and adapted to be actuated to shut off circulating of fluid therethrough.

A further object of our invention is to provide a threaded connection between the fluid conducting and setting apparatus that we provide and the screw actuated valving element of our new circulating shoe, having dissimilar threads from those between the valve element and the shoe body whereby rotation of the apparatus initially actuates the valve element and subsequently disconnects the apparatus from the valve element.

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

Fig. 1 is an elevational view of the shoe that we provide, showing it related with a liner and with the apparatus provided to set the liner and actuate the shoe. Fig. 1 shows the above structure positioned in a well structure in an unactuated position.

Fig. 2 is a longitudinal sectional view of the upper portion of the structure illustrated in Fig. 1 and taken as indicated by line 2—2 on Fig. 1.

Fig. 2ª is a longitudinal sectional view of the lower portion of the structure illustrated in Fig. 1 and taken as indicated by line 2ª—2ª on Fig. 1.

Fig. 3 is a tranverse sectional view taken as indicated by line 3—3 on Fig. 2.

Fig. 4 is a view similar to Fig. 1 and showing the construction partially actuated.

Fig. 5 is a longitudinal sectional view taken substantially as indicated by line 5—5 on Fig. 4.

Fig. 5ª is a longitudinal sectional view taken as indicated by line 5ª—5ª on Fig. 4.

Fig. 6 is a longitudinal sectional view similar to Fig. 5 and showing that portion of the construction fully actuated.

Fig. 6ª is a longitudinal sectional view similar to Fig. 5ª and showing that portion of the construction fully actuated.

Fig. 7 is a transverse sectional view taken as indicated by line 7—7 on Fig. 2.

Fig. 8 is a transverse sectional view taken as indicated by line 8—8 on Fig. 5ª.

Fig. 9 is a transverse sectional view taken as indicated by line 9—9 on Fig. 6ª.

The fluid circulating shoe A that we provide is adapted to be engaged in the lower end of a liner B related to a typical liner hanger C and setting tool D therefor.

Throughout the drawings, we have shown the shoe A, liner B and liner hanger C and setting tool D therefor engaged in the lower end of a typical well structure W including a well bore 10 and a casing 11 within the well bore and terminating short of the bottom thereof.

The liner B is a simple length of pipe having open top and bottom ends 12 and 13 and a plurality of perforations 14 at one or more points along its longitudinal extent and provided to establish open communication be-

tween the interior and the exterior thereof. The liner B is adapted to be positioned within the well structure W to occur in the bore 10 below the lower end of the casing 11 and extend into or through the production formation.

The hanger C for the liner B is secured to the upper end of the liner B to occur within the lower end of the casing 11 and is shown as including a tubular body 15 having a central longitudinal passage 16 extending therethrough and a plurality of upwardly and radially outwardly shiftable wickered casing engaging slips 17 spaced circumferentially about its exterior.

The lower end of the hanger body 15 is internally threaded as at 18 and threadedly receives the upper terminal end of the liner B.

The slips 17 of the hanger C are upwardly convergent wedge-shaped members having curved wickered outer faces 19 adapted to cooperatively engage the interior of the casing 11 and are slidably engaged in upwardly and radially outwardly inclined recesses 20 provided in the outer surface of the hanger body 15.

Suitable spring means 21 are provided in the body 15 of the hanger C at the bottom of the slip 17 receiving recesses 20 therein, which means are adapted to normally yieldingly urge the slips upwardly in the recesses and into tight wedging engagement between the hanger body and the well casing 11.

The setting tool D for the hanger C is adapted to releasably secure the hanger and liner to the lower end of a string of drill pipe P and to releasably hold the slips 17 downwardly in the recesses 20 and against the resistance of the spring means 21.

The setting tool D is shown as including an elongate, vertically disposed, tubular, fluid conducting kelly 22, fixed to the lower end of the string of drill pipe P to depend into and through the passage 16 in the hanger body 15, a lock nut 23 slidably engaged on the kelly to establish rotary driving engagement therewith and is threadedly engaged in the upper end of the hanger body 15 as at 24. A retainer ring 25 is rotatably carried by the lock nut 23 and normally overlies the upper end of the hanger body 15 and is provided with circumferentially spaced depending fingers 26 which fingers are adapted to normally engage the tops of the wickered slips 17 and hold them down in their unactuated position. The upper and lower ends of the kelly 22 are provided with suitable stop nuts 27 and 28 threadedly engaged thereon.

The stop nuts 27 and 28 are in the nature of pipe nipples or subs and serve to maintain the lock nut 23 engaged on the kelly and also facilitate connecting the string of drill pipe P to the upper end thereof and a suitable actuating tool T for the shoe A, at the lower end thereof, which actuating tool will hereinafter be described.

With the hanger C and setting tool D set forth above, it will be apparent that when the hanger and liner are lowered into proper position in the well W, as by means of the string of drill pipe P and the mandrel 22 of the setting tool is rotated, as a result of rotation of the drill pipe P, the lock nut 23 of the setting tool is turned out of engagement with the liner hanger 15 and the fingers 26 on the retaining ring 25 carried by the lock nut, are elevated out of engagement with the slips 17, allowing the slips to shift upwardly and outwardly and establish tight wedging and gripping engagement with the well casing 11.

When the slips 17 of the hanger C are thus set and the setting tool is disengaged from the hanger, it will be apparent that the liner B is suitably suspended from the lower end of the casing 11 as clearly illustrated in Figs. 4, 5 and 6 of the drawings.

It is to be understood that the particular liner hanger C and setting tool D therefor, illustrated in the drawings and briefly described above, is only typical of one preferred form of liner hanger and setting tool that can be advantageously employed in connection with our new circulating shoe and that, in practice, other suitable and similar hanger constructions and setting tools therefor can be employed without adverse effects and without affecting the novelty of the present invention.

The fluid circulating shoe A that we provide is adapted to be engaged in the lower end of the liner B and releasably connected with the string of drill pipe P and the liner hanger setting tool D by means of the actuating tool T. The shoe A is shown as including an elongate, vertically disposed tubular body 30 having a central, longitudinal bore 31, a cylindrical head 32 engaged in the lower end of the body and having an upwardly opening central socket 33 communicating with the bore 31 in the body and a plurality of downwardly opening ports 34 communicating with the socket, and an elongate, vertically disposed tubular valve member 35 having an internally and externally threaded upper portion 36 threadedly engaged in the body 30 and with the lower end of the actuating tool T and a straight, cylindrical lower portion 37 slidably engaged in the socket 33 of the head and adapted to control the flow of fluid through the ports 34 communicating therewith.

The bore 31 in the body 30 of the shoe is provided with standard, tapered pipe threads 38 at its upper end portion to threadedly receive the lower end of the liner B and to threadedly secure the shoe to the liner. The remainder of the bore, that is, the central and lower portions thereof, is provided with left hand threads 39. The threads 39 are preferably square threads and are of large pitch or lead.

The exterior of the body 30 preferably corresponds in outside diameter with the liner B and is plain and unobstructed.

The head 32 of the shoe A has a straight, cylindrical central portion 40 corresponding in outside diameter with the body 30, an upper portion 41 of reduced diameter projecting upwardly from the central portion and a lower portion 42 continuing downwardly from the central portion and provided with a rounded lower end 43. The upper portion 41 of the head is externally threaded and is cooperatively engaged with the threads 39 in the lower end portion of the body 30.

The upwardly opening, central socket 33 in the head 32 terminates at a flat bottom in the lower end portion 42 of the head. The central portion 40 of the head is provided with an annular, radially inwardly opening recess 44, which recess opens into the socket 33 intermediate the upper and lower ends thereof.

The ports 34 adapted to communicate with the socket 33 and contact fluid from within the head from the exterior of the shoe are shown as simple, straight, longitudinally disposed ports entering the rounded lower end 43 of the head at points spaced about its outer peripheral portion and continuing upwardly to communicate with the recess 44, as clearly illustrated throughout the drawings.

With the structure set forth above, it will be apparent that fluid flowing downwardly through the construction and into the socket in the head of the shoe enters the recess 44 therein and is then free to flow through the ports 34 and into the well bore below and in advance of the liner.

It is to be understood that, in practice, the ports 34 need not be parallel with the longitudinal axis of the shoe as shown, but could, if desired, be pitched or inclined in a manner to intersect and communicate with the socket in the head at a point intermediate its ends, in which case the recess 44 referred to above, could be eliminated.

The valve member 35 is an elongate tubular member and, as pointed out above, has upper and lower portions 36 and 37. The upper portion 36 of the member 35 is provided with square threads 45 about its exterior and

is threadedly engaged with the threads 39 in the body 30 of the shoe to occur above the upper portion 31 of the head engaged therein. The lower portion 37 of the member 35 is a simple, straight, tubular extension of reduced diameter depending from the upper portion 36 and slidably entered in the socket 33 of the head 32.

The valve member 35 is adapted to be advanced downwardly in the body and in the head of the shoe from an unactuated position as illustrated in Fig. 2[a] of the drawings, where the upper portion 36 occurs at the upper end of the threads 39 and where the lower end of the lower portion terminates above the recess 34 in the head, to an actuated position as illustrated in Fig. 6 of the drawings, where the upper portion 36 bottoms and seats on the top of the upper portion 41 of the head and the lower portion 37 terminates in the socket 33 below the recess 44 in the head.

With the above relationship of parts, it will be apparent that when the valve member 35 is in the up or unactuated position, fluid is free to flow downwardly therethrough and into the socket 33 and recess 44 and then through the ports 34. It will be further apparent that when the member is in the down or actuated position, the lower portion 37 thereof overlies the recess 44 and shuts off the flow of fluid into the recess and through the ports 34.

The upper portion 36 of the valve member is provided with internal right hand, tapered pipe threads 45 adapted to threadedly receive the lower end of the actuating tool T. The threads 45 have less lead or pitch than the threads 39 in the body 30. The preferred differential in lead or pitch between the threads 45 and 39 is about two to one.

The actuating tool T for the shoe A is an elongate, fluid conducting structure fixed to and extending between the lower end of the mandrel 22 of the hanger setting tool D and the top portion of the valve member 35 of the shoe A.

The tool T involves generally, an upper pipe section 50, a lower pipe section 51 and a bumper sub 52 engaged between the upper and lower sections.

The upper section 50 is a simple, vertically disposed length of pipe having its upper end threadedly engaged in the lower stop nut 28 on the setting tool mandrel 22 and depends therefrom into the liner B.

The lower section 51 of the actuating tool T is a simple, vertically disposed length of pipe having its lower end threadedly engaged in the threads 45 in the upper section 36 of the valve member 35 to project upwardly therefrom and into the liner and to terminate at a point spaced below the lower end of the upper section 50.

The bumper sub 52 of the setting tool A includes an elongate, vertically disposed, upper tube section 53 threadedly engaged on the lower end of the upper pipe section 50 to depend therefrom, an elongate, vertically disposed lower tube section 54 threadedly engaged on the upper end of the lower pipe section 51 to project upwardly therefrom and telescopically receive the upper tube section 53. The upper tube section 54 is provided with a plurality of circumferentially spaced, radially outwardly projecting lugs 55 at its upper end portion and slidably engaged in circumferentially spaced, longitudinally disposed slots 56 provided in the lower tube section 53.

The bumper sub 52 is further provided with suitable sealing means to prevent the escape of fluid outwardly between the upper and lower telescopically related sections. In the case illustrated, the sealing means is shown as including an annular, radially outwardly opening groove 57 in the lower end of the upper tube, a radially inwardly upwardly opening groove 58, in the lower tube adjacent the lower end of the slots 56 therein and O-ring seals 59 and 60 in the grooves 57 and 58 and sealing with the opposing walls of the tubes 53 and 54.

It will be apparent that the actuating tool T is such that it freely conducts fluid downwardly from the mandrel of the setting tool D through the liner B and into the shoe A. It will be further apparent that the tool T is such as to allow for free vertical shifting and disengagement of the setting tool D, while it is still engaged in or with the shoe A. It will also be apparent that the tool T establishes and maintains rotary driving engagement with the valve member 35 of the shoe A after the liner hanger C is set and the setting tool D therefor is elevated out of engagement therewith.

In operation, as when the liner B is being lowered into the well structure W, the various elements and parts of the construction that we provide are assembled in the manner illustrated in Figs. 1, 2 and 2[a] of the drawings. When the liner is entered into well bore 10 below the lower end of the well casing 11, circulating fluid flowing downwardly through the construction and out through the ports 34 in the lower end of the shoe A flushes and washes the well bore clean of sand and the like, in advance of the liner, thereby permitting the liner to be advanced freely into the well.

When the liner B is properly positioned in the well bore 10, the string of drill pipe P is rotated in a clockwise direction. The rotation of the drill pipe P operates the setting tool D fixed thereto, releasing and setting the slips 17 of the liner hanger C and disconnecting the nut 23 of the setting tool from the hanger as clearly illustrated in Figs. 4, 5, and 5[a] of the drawings.

It will be apparent that when the setting tool D is rotated to set the slips and liner, the valve member 35 in the shoe is screwed or advanced downwardly a short distance in the shoe, but not so far as to interrupt the free flow of fluid therethrough.

After the liner B and hanger C are fully set in the well W and the setting tool D is disengaged from the hanger, further rotation of the drill string S, setting tool D and actuating tool T causes the valve member 35 to advance to the bottom of the shoe and to shut off the flow of fluid therethrough.

It will be apparent that when the valve member 35 is shifted downwardly in the manner set forth above, the drill string P need not be shifted vertically to compensate for the vertical travel of the valve member 35 and that the bumper sub 52 of the actuating tool T allows for relative vertical shifting between the said string and the valve member.

When the valve member 35 is fully actuated and is bottomed or against the upper portion 41 of the head engaged in the body 30, continued and further counterclockwise rotation of the drill string and the actuating tool T coupled thereto, backs the lower pipe section 51 of the tool out of threaded engagement in the valve member 35, leaving the valve member down and disconnecting the tool T from the shoe, whereupon it can be pulled from the well with the string P and setting tool D, as clearly illustrated in Figs. 6 and 6[a] of the drawings.

In the preferred carrying out of the invention, the lower end portion of the lower portion 37 of the valve member 35 is provided with a radially outwardly opening, annular channel in which an O-ring seal is engaged. The O-ring seal is adapted to engage and seal with the wall of the socket 33 in the head of the shoe and to prevent passage and escape of fluid between the valve member and the head.

In the case illustrated, the lower end of the head of the shoe is provided with a plurality of circumferentially spaced, radially disposed webs 61, which webs serve as cutters to free certain of the matter plugging the well as the structure is lowered into engagement therein.

The webs 61 preferably occur adjacent the lower open ends of the ports 34 in the head and one or more is inclined so as to intersect the flow stream issuing from the port related thereto and serves to deflect or fan the stream of fluid out and in such a manner as to enhance the washing and flushing action thereof.

Having described only a typical preferred form and

application 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 or variations that may appear to those skilled in the art and fall within the scope of the following claims.

Having described our invention, we claim:

1. A circulating shoe of the character referred to including, an elongate, vertically disposed, tubular body engageable on the lower end of a well liner to depend therefrom and having an internally threaded bore, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a substantially downwardly opening port establishing communication between the exterior of the head and the socket intermediate the ends thereof, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof and spaced above the head, a lower cylindrical portion of reduced diameter slidably engaged in the socket in the head to normally terminate above the port in the head and a central, longitudinal flow passage extending through the valve member and having threads at its upper end to threadedly receive a fluid conducting actuating tool depending through the liner.

2. A circulating shoe of the character referred to including, an elongate, vertically disposed, tubular body engageable on the lower end of a well liner to depend therefrom and having an internally threaded bore, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a substantially downwardly opening port establishing communication between the exterior of the head and the socket intermediate the ends thereof, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof and spaced above the head and a lower cylindrical portion slidably engaged in the socket to normally terminate above the port, a central, longitudinal flow passage extending therethrough and having threads at its upper end to threadedly receive a fluid conducting rotary actuating tool depending through the liner, said threads in the body being left hand threads, said threads in the upper end of the valve member being right hand threads and of less pitch than the threads in the body.

3. A circulating shoe of the character referred to including, an elongate, vertically disposed, tubular body engageable on the lower end of a well liner to depend therefrom and having a bore with left hand threads therein, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a radially inwardly opening annular recess establishing communication with the socket intermediate its ends and a plurality of substantially downwardly opening ports establishing communication between the exterior of the head and the recess, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof and spaced above the head and, a lower cylindrical portion slidably engaged in the socket to normally terminate above the recess therein and having a central bore with right hand threads at its upper end of less pitch than the threads in the body and adapted to threadedly receive the lower end of a fluid conducting rotary actuating tool depending through the liner.

4. A circulating shoe of the character referred to including, an elongate, vertically disposed, tubular body adapted to be threadedly engaged on the lower end of a well liner to depend therefrom and having a bore with left hand square threads therein, a head having an upper portion threadedly engaged in and closing the lower end of the body, a central portion continuing downwardly from the body, a lower rounded nose portion, said head having a central upwardly opening cylindrical socket of reduced diameter extending through the upper and central portion thereof and communicating with the bore in the body, a radially inwardly opening annular recess in the central portion communicating with the socket at a point spaced above the bottom thereof and a plurality of substantially downwardly opening ports extending through the central and lower portions of the head and establishing communication between the exterior of the head and the recess, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof and spaced above the head and a lower cylindrical portion of reduced diameter slidably engaged in the socket to normally terminate above the recess therein and a central, longitudinal flow passage with tapered right hand threads in its upper end to threadedly receive a fluid conducting rotary actuating tool depending through the liner.

5. A circulating shoe of the character referred to including, an elongate, vertically disposed, tubular body adapted to be threadedly engaged on the lower end of a well liner to depend therefrom and having a bore with left hand square threads therein, a head having an upper portion threadedly engaged in and closing the lower end of the body, a central portion continuing downwardly from the body, a lower rounded nose portion, said head having an upwardly opening cylindrical socket of reduced diameter extending through the upper and central portions and communicating with the bore in the body, a radially inwardly opening annular recess in the central portion communicating with the socket at a point spaced above the bottom thereof and a plurality of substantially downwardly opening ports extending through the central and lower portions and establishing communication between the exterior of the head and the recess, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof and spaced above the head and a lower cylindrical portion of reduced diameter slidably engaged in the socket to normally terminate above the recess therein and a central, and a longitudinal flow passage with tapered right hand threads in its upper end to threadedly receive a fluid conducting rotary actuating tool depending through the liner, said lower nose portion of the head having downwardly projecting radially disposed blades adjacent the lower opening ends of the ports, certain of said blades being inclined to overlie the ports related thereto to deflect circulating fluid issuing therefrom.

6. A circulating shoe of the character referred to including, an elongate, vertically disposed, tubular body engageable on the lower end of a well liner to depend therefrom and having an internally threaded bore, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a substantially downwardly opening port establishing communication between the exterior of the head and the socket intermediate the ends thereof, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof and spaced above the head and a lower cylindrical portion slidably engaged in the socket to normally terminate above the port, a central, longitudinal flow passage extending longitudinally therethrough and having threads at its upper end to threadedly receive a fluid conducting rotary actuating tool depending through the liner, said threads in the body being left hand threads, said threads in the upper end of the valve member being right hand threads and of less pitch than the threads in the body, the lower end of said lower portion of the valve member carrying a sealing ring to engage and seal with the wall of the socket.

7. In combination, a liner hanger having radially outward shiftable casing engaging slips to engage a well casing, an elongate, perforated liner fixed to and depending from the hanger, a circulating shoe engaged in and clos-

ing the lower end of the line, a setting tool fixed to the lower end of a drill pipe and releasably engaged with the hanger to normally maintain the slips thereof in and an actuating tool fixed to and depending from the setting tool to releasably engage the circulating shoe, said circulating shoe including, an elongate vertically disposed tubular body engageable on the lower end of the liner to establish communication therewith and having an internally threaded bore, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a substantially downwardly opening port establishing communication between the exterior of the head and the socket intermediate the ends thereof, a tubular valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof, spaced above the head and a lower cylindrical portion slidably engaged in the socket to normally terminate above the port, said actuating tool including pipe sections connected with the setting tool and threadedly engaged in the upper portion of the valve member, said actuating tool serving to initially screw the valve member downwardly in the body and head to a position where the lower portion overlies the port in the head and shuts off flow of fluid through the port and upon continued rotation to back the lower pipe section out of threaded engagement in the valve member.

8. In combination, a liner hanger having radially shiftable casing engaging slips operable to engage a well casing, an elongate perforated liner fixed to and depending from the hanger, a circulating shoe engaged in and closing the lower end of the liner, a setting tool fixed to the lower end of a rotary drill pipe and releasably engaged with the hanger and operable upon rotation of the drill pipe to actuate the hanger to shift the slips thereof into engagement with a casing and an actuating tool fixed to and depending from the setting tool to releasably engage the circulating shoe and operable upon rotation of the drill pipe to actuate the shoe to shut off the flow of fluid therethrough, said circulating shoe including, an elongate, vertically disposed tubular body engageable on the lower end of the liner to establish communication therewith and having an internally threaded bore, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body, an annular, radially inwardly opening recess communicating with the socket intermediate its ends and a substantially downwardly opening port establishing communication between the exterior of the head and the recess, a tubular valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof, spaced above the head, and a lower cylindrical portion slidably engaged in the socket to normally terminate above the recess, said actuating tool including an upper pipe section connected with the setting tool to depend into the liner, a lower pipe section threadedly engaged in the upper portion of the valve member to project upwardly into the liner and a fluid conducting bumper sub between and connecting said pipe sections, said actuating tool, upon rotation, initially screws the valve member down to a position where it overlies the recess and shuts off flow of fluid through the port in the head and upon continued rotation backs the lower pipe section out of threaded engagement in the valve member, said drill pipe setting tool and actuating tool being removable from the well upon disengagement from the hanger and the shoe.

9. In combination, a liner hanger having radially shiftable casing engaging slips operable to engage a well casing, an elongate, perforated liner fixed to and depending from the hanger, a circulating shoe engaged in and closing the lower end of the liner, a setting tool fixed to the lower end of a rotary drill pipe and releasably engaged with the hanger and operable upon rotation of the drill pipe to set the hanger slips in engagement with the casing and an actuating tool fixed to and depending from the setting tool to engage the circulating shoe and to operate said shoe to shut off the flow of fluid therethrough, said circulating shoe including, an elongate, vertically disposed tubular body engageable on the lower end of the liner to establish communication therewith and having a bore with left hand threads therein, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a substantially downwardly opening port establishing communication between the exterior of the head and with the socket intermediate the ends thereof, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof, a lower cylindrical portion slidably engaged in the socket to normally terminate above the port, and a central longitudinal flow passage extending through the valve member and provided with right hand threads of less pitch than the threads in the body in its upper end, said actuating tool including an upper pipe section connected with the setting tool to depend into the liner, a lower pipe section threadedly engaged in the upper threaded portion of the valve member to project upwardly into the liner and a fluid conducting bumper sub between and connecting said pipe sections, said actuating tool upon clock-wise rotation, initially screwing the valve member down to a position where the lower portion overlies and shuts off flow of fluid through the port in the head and upon continued rotation backs the lower pipe section out of threaded engagement in the valve member, said drill pipe setting tool and actuating tool being removable from the well upon disengagement of the actuating tool from the shoe.

10. In combination, a liner hanger operable to engage a well casing, an elongate, perforated liner fixed to and depending from the hanger, a circulating shoe engaged in and closing the lower end of a drill pipe and engageable with and adapted to actuate the hanger and an actuating tool fixed to and depending from the setting tool to engage the circulating shoe and adapted to actuate and shut off the flow of fluid therethrough, said anchor including an elongate, vertically disposed, tubular body having a plurality of circumferentially spaced upwardly and radially outwardly shiftable casing engaging shoes, said circulating shoe including, an elongate, vertically disposed tubular body engageable on the lower end of the liner to establish open communication therewith and having and internally threaded bore, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a substantially downwardly opening port establishing communication between the exterior of the head and the socket intermediate the ends thereof, a tubular valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof, above the head, and a lower cylindrical portion slidably engaged in the socket to normally terminate above the port, said setting tool including an elongate, vertically disposed fluid conducting kelly depending from the lower end of the drill pipe and through the hanger body, a lock nut slidably engaged on the kelly to have rotary driving engagement therewith and threadedly engaged in the hanger body and a retainer ring carried by the lock nut and normally holding the hanger slips down and in, said setting tool operable to set the slips with the casing and to disconnect from the hanger body upon rotation of the drill pipe and kelly, said actuating tool including an upper pipe section connected with the kelly to depend into the liner, a lower pipe section threadedly engaged in the upper portion of the valve member to project upwardly into the liner and a fluid conducting bumper sub between and connecting said pipe sections, said actuating tool operable upon rotation, to initially screw the valve member down to a position where the lower portion overlies the port and shuts off flow of

fluid outwardly through the port and upon continued rotation to back the lower pipe section out of threaded engagement in the valve member, said drill pipe setting tool and actuating tool being removable from the well upon disengagement with the hanger and the shoe.

11. In combination, a liner hanger operable to engage a well casing, an elongate, perforated liner fixed to and depending from the hanger, a circulating shoe engaged in and closing the lower end of the liner a rotary setting tool fixed to the lower end of a rotary drill pipe and engageable with and adapted to actuate the hanger and a rotary actuating tool fixed to and depending from the setting tool to engage the circulating shoe and adapted to actuate and shut off the flow of fluid therethrough, said anchor including an elongate, vertically disposed tubular body having a plurality of circumferentially spaced upwardly and radially outwardly shiftable casing engaging shoes, said circulating shoe including, an elongate, vertically disposed tubular body engageable on the lower end of the liner to establish communication therewith and having a bore with left hand threads therein, a head closing the lower end of the body and having an upwardly opening cylindrical socket communicating with the bore in the body and a substantially downwardly opening port establishing communication between the exterior of the head and the socket intermediate the ends thereof, a valve member having an upper portion threadedly engaged in the body to normally be positioned in the upper portion thereof, a lower cylindrical portion slidably engaged in the socket to normally terminate above the port and a central longitudinal flow passage extending therethrough and provided with right hand threads of less pitch than the threads in the body in the upper end, said setting tool including an elongate, vertically disposed fluid



conducting kelly depending from the lower end of the drill pipe and through the hanger body, a lock nut being slidably engaged on the kelly to have rotary driving engagement therewith and threadedly engaged in the hanger body and a retainer ring carried by the lock nut and normally holding the hanger slips down and in, said setting tool operable to set the slips with the casing and to disconnect from the hanger body upon rotation of the drill pipe and kelly, said actuating tool including an upper pipe section connected with the kelly to depend into the liner, a lower pipe section threadedly engaged in the upper threaded portion of the flow passage in the valve member to project upwardly into the liner and a fluid conducting bumper sub between and connecting said pipe sections, said actuating tool operable, upon rotation of the drill pipe and kelly of the setting tool, to initially screw the valve member down to a position where the lower portion overlies and shuts off flow of fluid outwardly through the port in the head and upon continued operation backs the lower pipe section out of threaded engagement in the valve member, said drill pipe setting tool and actuating tool being removable from the well upon disengagement with the hanger and the shoe.

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