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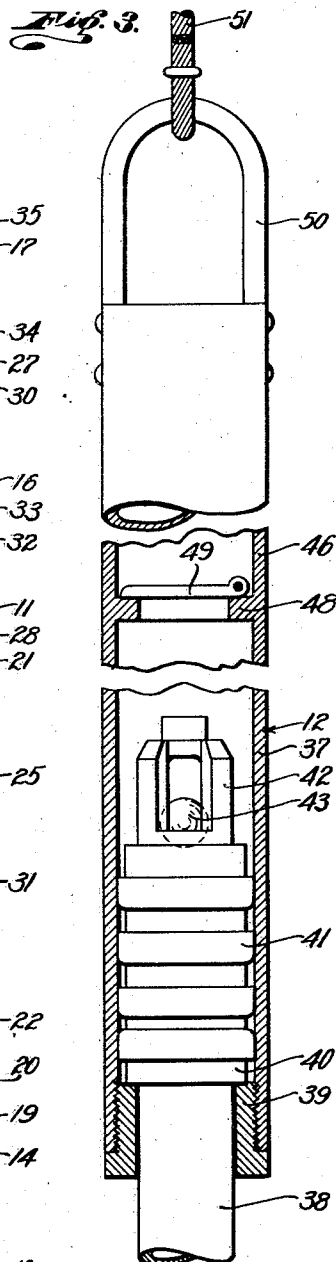
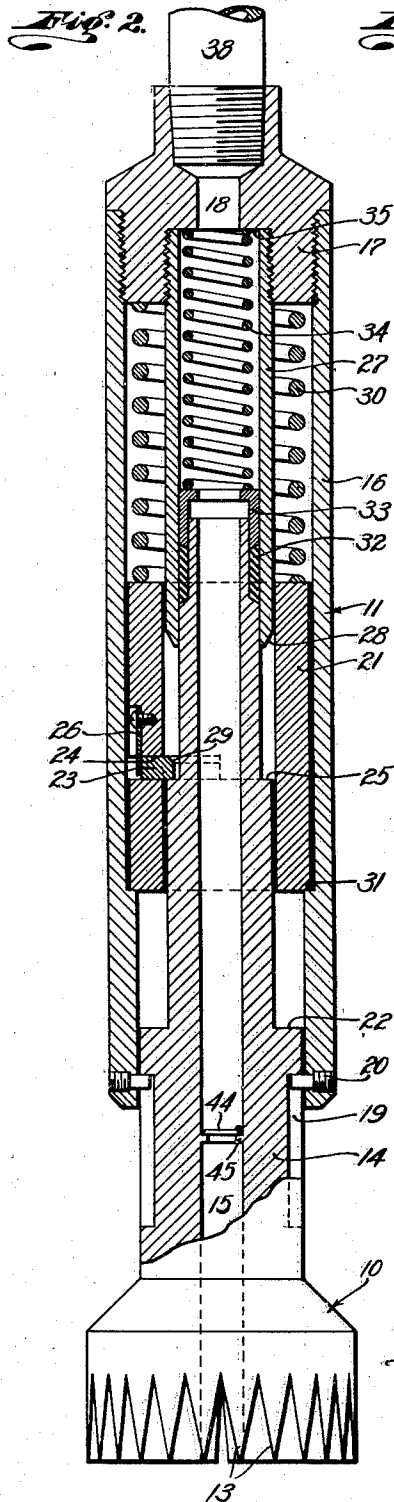
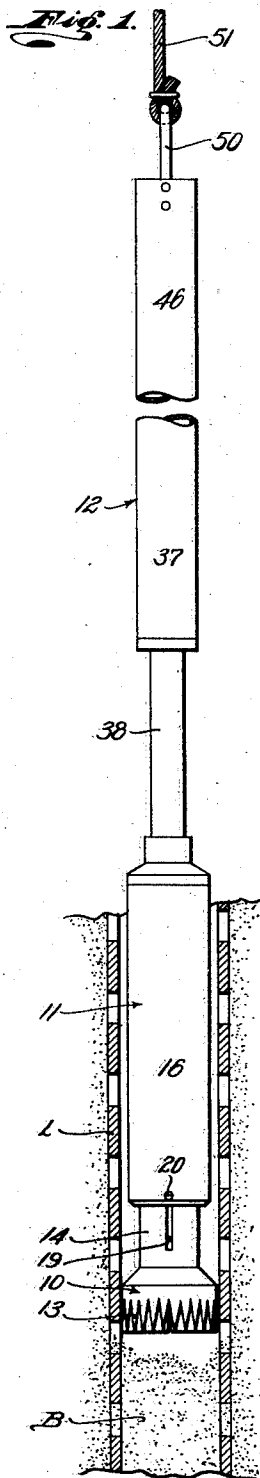
A. L. ARMENTROUT

2,252,912

WELL TOOL

Filed March 6, 1939

2 Sheets-Sheet 1



Inventor
ARTHUR L. ARMENTROUT
By
W. H. H. H. H. H.
His Attorney

Aug. 19, 1941.

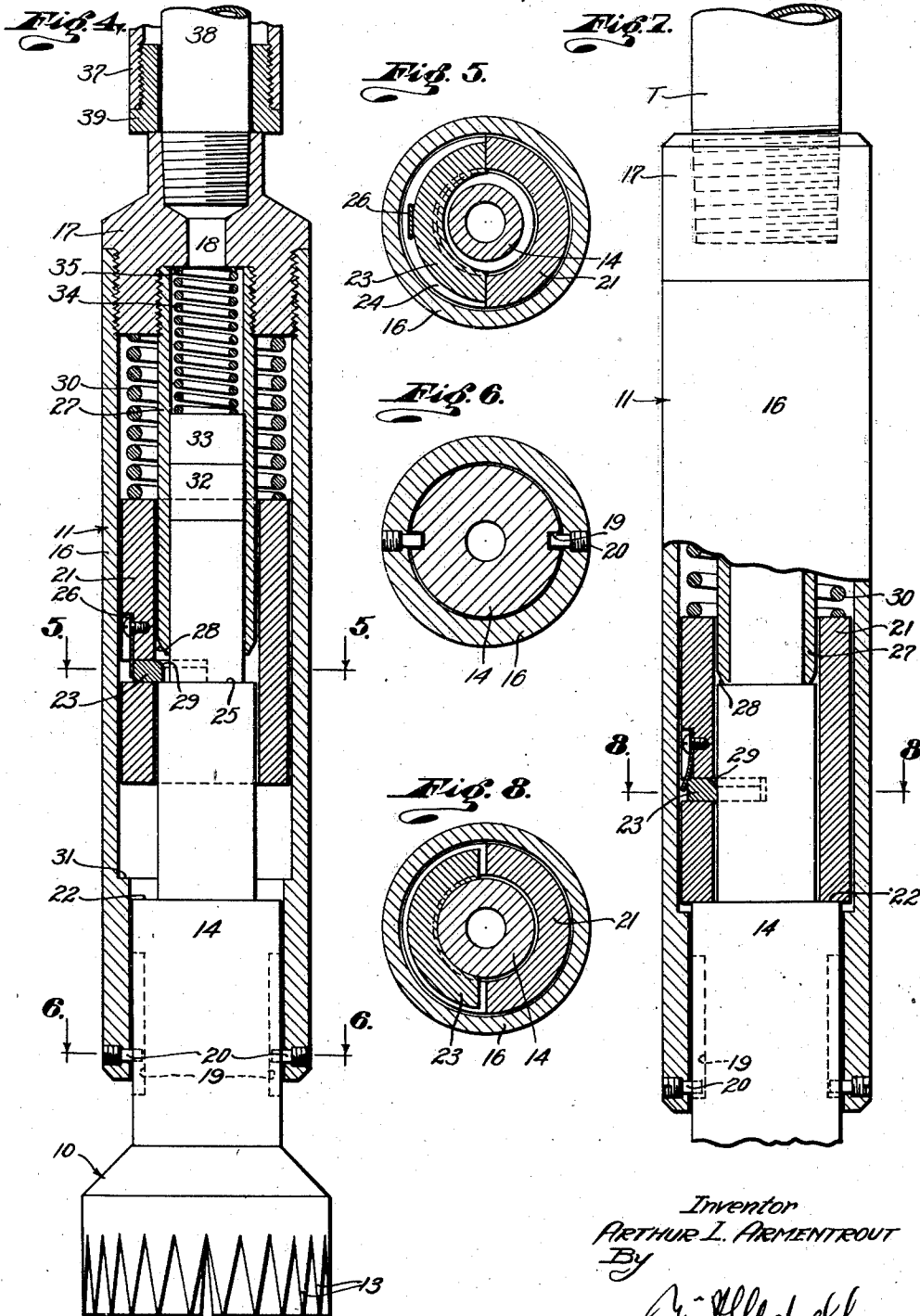
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WELL TOOL

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2 Sheets-Sheet 2



Inventor
ARTHUR L. ARMENTROUT
By
R. H. H. H. H. H.
His Attorney

UNITED STATES PATENT OFFICE

2,252,912

WELL TOOL

Arthur L. Armentrout, Los Angeles, Calif., assign-
or of one-third to Elwin B. Hall and one-third
to Virgil P. Baker

Application March 6, 1939, Serial No. 260,025

11 Claims. (Cl. 255—61)

This invention relates to a well tool and relates more particularly to a tool useful in removing sand bridges and accumulations of sand, shale, etc., from wells.

In producing oil wells, and the like, sand and other solid matter accumulates in the well bores and forms what are known as sand bridges. These sand bridges interfere with the flow of the fluid being produced and often completely close off the bores to stop production.

A general object of this invention is to provide a simple, practical and effective tool for breaking down, drilling through, and removing sand bridges in wells.

Another object of this invention is to provide a tool of the character mentioned that is operable to effectively and quickly drill through and break down a sand bridge in a well.

Another object of this invention is to provide a tool of the character mentioned that is operable to carry away or to provide for the washing away of the loosened solid matter of the sand bridges.

Another object of this invention is to provide a tool of the character mentioned that may be operated either on a cable or a string of pipe and that is operable to drill through and break down the sand bridges by a reciprocatory motion of the cable or pipe.

Another object of this invention is to provide a tool of the character mentioned embodying novel means for imparting an impact or blow to the drilling element or cutting head to quickly drill away or break down the sand bridge.

Another object of this invention is to provide a tool of the character mentioned that embodies a pump means operable to draw or pump the freed sand, etc., into a tubular string, container or bailer body for removal from the well.

Another object of this invention is to provide a tool of the character mentioned in which the pump means is operated simultaneously with the cutter head, that is, the reciprocation of the operating string or line actuates the pump means as well as the means for imparting the drilling blows to the cutting head.

A further object of this invention is to provide a tool of the character mentioned that is simple to operate and that is positive and dependable in operation.

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

Fig. 1 is a side elevation of one form of tool of the present invention showing the cutter head and adjacent parts in position in a well liner. Fig. 2 is an enlarged central longitudinal detailed sectional view of the lower portion of the tool illustrated in Fig. 1 with the cutter head in elevation, showing the parts in their normal or initial positions. Fig. 3 is an enlarged central longitudinal detailed sectional view of the upper portion of the tool illustrated in Fig. 1 with certain parts in elevation. Fig. 4 is a view similar to Fig. 2 with the cutter head and stem in elevation showing the parts being actuated to provide an impact. Figs. 5 and 6 are transverse detailed sectional views taken as indicated by lines 5—5 and 6—6, respectively, on Fig. 4. Fig. 7 is a side elevation of another form or application of the invention with certain parts in longitudinal cross section and illustrating the impact means in an actuated condition, and Fig. 8 is a transverse detailed sectional view taken as indicated by line 8—8 on Fig. 7.

The form of the present invention illustrated in Figs. 1 to 6, inclusive, of the drawings may be said to comprise, generally, a cutter head 10, means 11 operable to impart an impact action to the head 10, and pump means 12 for handling the material loosened by the cutter head 10.

The cutter head 10 is provided to cut free and drill through a sand bridge or accumulation of sand, shale, or the like, that may be present in a well bore or a well liner. Thus, as illustrated in Fig. 1 of the drawings, the head 10 is operable to break away and drill through the sand bridge B within the well liner L. The head 10 is proportioned to operate freely in the well bore or the well liner L and is designed to drill by a percussive action. In the structure illustrated the cutting head 10 is a generally cylindrical member provided on its lower end with cutting teeth 13. The teeth 13 may be varied considerably in form. In the construction illustrated the teeth 13 are generally V-shaped in side elevation and are arranged in an annular row or series. The cutting head 10 is provided with an upwardly projecting stem 14. The stem 14 may be formed integral with the head 10 and is of less diameter than the head. The cutting head structure is tubular, there being a central vertical opening 15 extending from the lower end of the head 10 to the upper end of the stem 14.

The means 11 for imparting an impact action to the cutting head 10 is a feature of the invention. The means 11 is operable by reciprocation of a well string such as a string of pipe or

tubing, or a cable, to impart downward blows to the cutting head 10 so that the latter loosens, breaks down and drills through the sand bridge B in the liner L. In the preferred construction illustrated the means 11 includes a shell or body 16 shiftable or reciprocable relative to the stem 14 of the head 10. The body 16 is a tubular member and telescopes downwardly over the stem 14 with suitable clearance. The major portion of the stem 14 that is received in the body 16 is reduced in diameter to leave an annular space in the body. An adapter 17 is threaded in the upper end of the tubular body 16. The adapter 17 is provided to connect the pump means 12 with the means 11 and has a central vertical opening 18 for handling the pumped material. The body 16 is connected or associated with the stem 14 for limited longitudinal movement. Spaced vertical grooves 19 may be provided in the lower portion of the stem 14 and set screws 20 may be threaded through openings in the wall of the body 16 to cooperate with the grooves 19 to connect the body 10 and the stem 14 for relative longitudinal movement.

The means 11 further includes a weight element or hammer element 21 in the body 16. The hammer element 21 is a tubular part shiftable surrounding the reduced portion of the stem 14 with suitable clearance. In practice the element 21 is of substantial length and of substantial wall thickness to have considerable weight. The hammer element 21 is adapted to jar or hammer downwardly against an impact shoulder or anvil shoulder 22 on the stem 14. The shoulder 22 is annular and is spaced above the grooves 19 to be within the body 16 when the parts are in their initial positions.

A novel latch means or releasable holding means is provided to initially hold the hammer element 21 against downward movement in a position some distance above the anvil shoulder 22. This releasable holding means comprises a latch block 23 arranged in an opening or window 24 in the wall of the tubular hammer element 21. The latch block 23 is curved or partially circular and is shiftable radially in the window 24. The block 23 shiftable engages against the upper and lower walls of the window 24 and may engage against the vertical end walls of the window. In practice the latch block 23 may be of approximately 180° in extent. An upwardly facing annular shoulder 25 is provided on the stem 14 and is engageable by the lower side of the latch block 23. The engagement of the latch block 23 with the shoulder 25 releasably holds the hammer element 21 against downward travel relative to the stem. A leaf spring 26 is secured in a recess in the hammer element 21 and projects downwardly into the window 24 to bear inwardly against the latch block 23. The spring 26 is operable to yieldingly hold the block 23 in the position where it cooperates with the shoulder 25.

The means for releasing the block 23 from the shoulder 25 comprises a tube 27 threaded in the lower end of the adapter 17 and projecting downwardly in the body 16. The lower portion of the tube 27 initially or normally enters the tubular weight element 21 and the lower end of the tube has a tapered face 28 cooperable with the latch block 23. The upper inner part of the latch block 23 has a tapered surface 29 engageable by the surface 28. It will be seen how engagement of the surface 28 with the surface 29 operates to disengage the latch block 23 from the shoulder 25. The spring 26 operates to normally hold

the latch block 23 in a position where it projects from the inner surface of the tubular hammer element 21 so that its surface 29 is engageable by the surface 28 of the tube 27.

Spring means is provided to drive the hammer element 21 downwardly against the anvil shoulder 22 when the latch block 23 is released from the shoulder 25. The spring means for actuating the hammer element 21 is such that it stores energy, resulting from downward movement of the body 10 with respect to the stem 14, and operates to drive the element 21 against the anvil shoulder 22 with substantial force. The means for actuating the hammer element 21 comprises a helical spring 30 arranged under compression between the lower end of the adapter 17 and the upper end of the hammer element 21. The spring 30 has substantial strength and is adapted to drive the element 21 downwardly with great force. It will be observed that the spring 30 is enclosed in the body 16 and is protected by the tube 27 as well as the body. When the body 16 is moved downwardly relative to the stem 14 the spring 30 is put under increased compression and the energy thus stored in the spring 30 operates to drive the element 21 downwardly against the anvil shoulder 22 when the surface 28 cooperates with the surface 29 to release the latch block 23 from the shoulder 25.

Means is provided for resetting or restoring the hammer element 21 when the body 16 is raised at the completion of each operation of the means 11. An annular internal shoulder 31 is provided on the body 16 and is adapted to engage upwardly against the lower end of the hammer element 21. When the body 16 is raised after the means 11 has been operated the shoulder 31 picks up the element 21 and returns it to its initial position where the block 23 moves into cooperation with the shoulder 25 under the action of the spring 26. During downward movement of the body 16 relative to the stem 14 when the means 11 is being actuated the shoulder 31 moves downwardly away from the element 21 and passes below the impact shoulder 22 before the block 23 is released. Accordingly, the hammer element 21 strikes the impact or anvil shoulder 22 and does not strike the resetting shoulder 31.

The opening 15, the tube 27 and the opening 18 serve to conduct the mud, sand, fluid, etc., upwardly to the pump means 12 and the invention preferably provides means for sealing between the stem 14 and the tube 27. The upper reduced portion of the stem 14 enters the tube 27 and carries packing 32 which seals with the inner wall of the tube. A shiftable gland or follower 33 engages downwardly against the packing 32. Means may be provided to assist in returning the stem 14 and the body 16 to their initial or extended positions following the actuation of the means 11. A helical spring 34 may be arranged in the tube 27 to be under compression between the follower 33 and an internal shoulder 35 on the adapter 17. The spring 34 aids in restoring the stem 14 and the body 16 to their extended normal positions and urges the follower 33 against the packing 32 to hold the packing under compression.

The pump means 12 operates to remove or pump away the solid matter loosened or drilled free by the cutting head 10 during operation of the head and the means 11. The pump means 12 may be varied considerably without departing from the broader aspects of the invention. In the embodiment of the invention illustrated the

pump means 12 includes an elongate tubular barrel 37 and a plunger 38 received in the barrel 37. The pump means 12 is connected with the upper end of the impact means 11. In the case illustrated in the drawings the lower end of the pump plunger 38 is threaded in the upper end of the adapter 17. The plunger 38 is tubular to conduct the pumped material from the opening 18 to the interior of the barrel 37. A tubular plug or nut 39 is threaded in the lower end of the barrel 37 and receives or passes the plunger 38 with suitable clearance. A head 40 on the upper end of the plunger 38 has sealing cups 41 or other suitable sealing means cooperating with the inner surface of the barrel 37. The upper end of the plunger head 40 is provided with a valve to control the passage of fluid through the plunger. In the case illustrated this valve comprises a cage 42 on the head 40 and a ball 43 in the cage operable to prevent a downward flow or a return flow through the plunger 38. It may be desired to provide a valve 44 in the stem opening 15 to assist in preventing a return flow through the stem and to prevent the settlement of the solid matter being pumped. The valve 44 may be a simple pivoted valve adapted to seal downwardly against an annular seat 45 on the wall of the opening 15.

The barrel 37 of the pump means 12 may be carried by or may be connected with a container 46 for receiving and holding the pumped material. In the construction illustrated the container 46 is an elongate upwardly extending integral continuation of the pump barrel 37. Valve means is provided to control communication between the pump barrel 37 and the container 46. An annular internal flange or valve seat 48 is provided at the upper end of the barrel 37 and a pivoted valve 49 is adapted to seal downwardly against the seat 48 to prevent a return flow of the pumped material from the container 46 to the barrel 37. A ball 50 may be provided on the upper end of the container 46 and the operating cable or line 51 may be secured to the ball 50. The upper end of the nut 39 is engageable with the lower end of the plunger head 40 to limit upward travel of the barrel 37 relative to the plunger 38 so that upward movement may be transmitted from the line 51 to the body 16 to restore or reset the means 11 after each operation of the same. The lower end of the nut 39 may engage the upper end of the adapter 17 so that the weight of the barrel 37 and the associated parts may be transferred to the body 16.

In employing the tool of the present invention the tool may be lowered into the well on the line 51 to enter the liner L. With the parts in their initial or normal positions the block 23 cooperates with the shoulder 25 to hold the hammer element 21 in its raised position. When the tool has reached the position where the head 10 is in engagement with the sand bridge B the operating line 51 is lowered to cause actuation of the means 11 and actuation of the pump means 12. When the line 51 is lowered the pump barrel 37 moves downwardly on the plunger 38 and any fluid that may be in the barrel is displaced upwardly into the container 46. Downward movement of the line 51 is also accompanied by downward movement of the plunger 38 and the body 16. This may follow the downward movement of the barrel 37 just described. The spring 30 is compressed as the body 16 moves downwardly and downward movement of the body is, of course, accompanied by downward movement of

the tube 27. The body 16 moves downwardly to compress the spring 30 until the surface 28 of the tube 27 cooperates with the surface 29 to retract the block 23 from the shoulder 25. When this occurs the hammer element 21 is freed from the stem 14 and the spring 30 moves or drives the element 21 downwardly to strike the anvil shoulder 22 with substantial force. The blow thus imparted to the shoulder 22 drives the cutting head 10 downwardly against or into the sand bridge B. The teeth 13 of the head 10 cut free or drill into the bridge B.

The operating line 51 is raised immediately following actuation of the means 11 to reset the means 11 and to operate the pump means 12. Upward movement of the line 51 of course causes upward movement of the barrel 37 relative to the plunger 38. This upward stroke of the barrel 37 draws or pumps a charge of the fluid, sand, shale, etc., into the barrel 37. It will be observed that this pumping action takes place immediately following the actuation of the cutting head 10 so that the material loosened by the cutting head is immediately drawn or pumped into the barrel 37. The nut 39 engages the plunger head 40 at the upper end of the pumping stroke and transmits upward movement to the plunger 38. Upward movement of the plunger 38 is accompanied by upward movement of the body 16. As described above, the shoulder 31 engages and picks up the hammer element 21 to return the element to its initial position during the upward movement of the body 16. The spring 26 restores the block 23 to its active position in engagement with the shoulder 25 when the element 21 reaches its normal position.

The above operations may be repeated until the sand bridge B is completely broken down or drilled away. The means 11 and the pump means 12 are operated concurrently or simultaneously by a simple reciprocation of the operating line 51. The sand, shale, etc., loosened or drilled away by the tool is removed from the well in the container 46 when the tool is withdrawn from the well.

Figs. 7 and 8 of the drawings illustrate another form and application of the invention. In the tool illustrated in Figs. 7 and 8 of the drawings water or other fluid may be pumped down through the tool during its operation to carry away the material loosened or drilled out by the cutting head 10. A tubular well string such as a string of tubing T may be employed to operate the tool and to conduct the circulation fluid to the tool. The cutting head 10 and the means 11 may be the same as in the previously described form of the invention. The body 16 of the means 11 is provided at its upper end with an adapter 17^a corresponding generally to the adapter 17. The lower end of the operating and circulating string of tubing T may be threaded in the adapter 17^a to connect the tool with the tubing T.

In the operation of the tool illustrated in Figs. 7 and 8 of the drawings the tool may be run into the well to the sand bridge on the string of tubing T. Fluid may be circulated down through the tubing T to discharge at the cutting head 10 to flush or wash away the sand bridge. If it is found that the sand bridge is not removed in this manner the string of tubing T is reciprocated to actuate the means 11 as described above. The means 11 imparts downward impacts or blows to the cutting head 10 and the cutting head 10 operates to break free or drill

through the sand bridge. During this operation or following this operation, or both, fluid may be pumped down through the string of tubing T to discharge at the cutting head 10. This fluid returns through the well casing to the upper end of the well and carries away the solid matter freed or drilled out by the cutting head 10. The operations may continue until the sand bridge or accumulation of solid matter is completely removed from the well bore or the well liner.

Having described only typical preferred forms and applications of my invention, I do not wish to be limited or restricted to the specific details herein set forth, but wish to reserve to myself any variations or modifications that may appear to those skilled in the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A well tool for use on a well string comprising a cutting head, spring actuated means operable by reciprocation of the string for imparting actuating blows to the head, pump means operated by said reciprocation of the string for pumping away the material freed by the head, and a container for receiving and retaining the material pumped by the pump means.

2. Well apparatus of the character described comprising a cutting head for acting on material in a well, a body reciprocable relative to the head, a spring loaded hammer element, means operable upon movement of the body relative to the head to release the element to strike the head, and pump means operable upon reciprocation of the body for pumping away the material freed by the head.

3. A tool operable by a reciprocatory well string for removing solid material from a well comprising a cutting head for acting on the material in the well, a body associated with the string to be moved thereby and movable vertically relative to the head, a hammer element for driving the head against the solid material, spring means for actuating the hammer element, releasable means holding the hammer element against operation, means operable to release the releasable means upon downward movement of the string and body relative to the head, and pump means associated with the body operable upon upward movement of the string and body to pump upwardly the solid material freed by the head.

4. A tool for use on a reciprocatory well string comprising a cutting head for acting on material in a well, a body connected with the string to be movable vertically thereby relative to the head, an anvil part rigid with the head, a hammer element for hammering against the anvil part to drive the head against solid material in the well, a spring arranged under compression between the body and the hammer element for actuating the hammer element, releasable means holding the hammer element against downward movement relative to the head whereby downward movement of the body relative to the head compresses the spring, means for releasing said releasable means when the compression on the spring reaches a given value, and a shoulder on the body for restoring the hammer element to its initial position upon upward movement of the body following actuation of the hammer element.

5. A well tool of the character described comprising a cutting head for cutting away material in a well, a body shiftable relative to the head, a shiftable hammer element for striking the head to actuate the same, latch controlled spring

means actuated by downward movement of the body to drive the element against the head, means operated by upward movement of the body for resetting the said spring means, pump means associated with the body to be actuated by said upward and downward movement of the body and operable to pump away the material of the bridge freed by the cutting head.

6. A well tool of the character described comprising a cutting head for acting on solid material in a well, a well string, means operable by reciprocation of the well string for imparting a hammering action to the head so that the head frees the solid matter, the head and said means having a passage leading upwardly from the head, pump means for pumping material freed by the head upwardly from the head through the passage and actuated by said reciprocation of the string whereby the pump means is operated simultaneously with said hammering of the head, and a container for receiving and retaining said material thus pumped upwardly through the passage.

7. A tool for use on a well string comprising a cutting head for acting on solid material in the well, a stem on the cutting head, a body connected with the stem for relative vertical movement, an anvil part on the stem, a shiftable hammer element in the body for striking the anvil part, releasable means holding the hammer element against movement toward the anvil part, a releasing member on the body operable to release the releasable means when the body is moved downwardly a given distance relative to the stem, a spring in the body compressed against the hammer element during said downward movement of the body to drive the hammer element against the anvil part when the releasable means is released, and pump means connecting the body with the string actuated by upward and downward movement of the string to pump away the solid matter loosened by the cutting head.

8. A tool for use on a well string comprising a cutting head for acting on solid material in a well, a stem on the cutting head, a body connected with the stem for relative vertical movement, an anvil part on the stem, a shiftable hammer element in the body for striking the anvil part, releasable means holding the hammer element against movement toward the anvil part, a releasing member on the body operable to release the releasable means when the body is moved downwardly a given distance relative to the stem, the stem having a passage leading upwardly from the head, a tubular plunger connected to the body to receive material from the passage, and a barrel reciprocable on the plunger to pump material up through the passage from the head and cooperable with the plunger to transmit vertical movement to the body.

9. A tool for use on a well string comprising a cutting head for acting on solid material, a stem on the cutting head, a body connected with the stem for relative vertical movement, an anvil part on the stem, a shiftable hammer element in the body for striking the anvil part, releasable means holding the hammer element against movement toward the anvil part, a releasing member on the body operable to release the releasable means when the body is moved downwardly a given distance relative to the stem, the stem having a passage leading upwardly from the head, and pump means for pumping the drilled material upwardly through the passage

comprising two elements one a barrel, the other a plunger, and means connecting one pump element with the body to receive the fluid from the passage, the well string being connected with the other element for operating the pump means and for operating the body.

10. A tool for use on a well string comprising a cutting head, a stem rigid with the cutting head, a body connected with the stem for relative vertical movement, an anvil part on the stem, a shiftable hammer element in the body for striking the anvil part, releasable means holding the hammer element against movement toward the anvil part, a releasing member on the body operable to release the releasable means when the body is moved downwardly a given distance relative to the stem, the stem having a passage leading upwardly from the head and the body having an opening communicating with the passage, and pump means connecting the

well string with the body to operate the same and operable to circulate fluid upwardly through said opening and passage upon reciprocation of the string.

11. A tool of the character described comprising a reciprocable well string, a cutting head, a hollow body reciprocable relative to the head, a tubular stem carrying the head and received in the body, a hammer element in the body for striking the stem to actuate the head, latch controlled spring means in the body actuated by downward movement of the body to drive the hammer element against the stem, means operated by upward movement of the body for resetting the spring means, and pump means connecting the body with the string and communicating with the stem to pump the freed solid material upwardly upon said up and down movement of the body.

ARTHUR L. ARMENTROUT.