Aug. 15, 1939. J. J. SANTIAGO 2,169,502

WELL BORE ENLARGING TOOL

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Fig. 1.

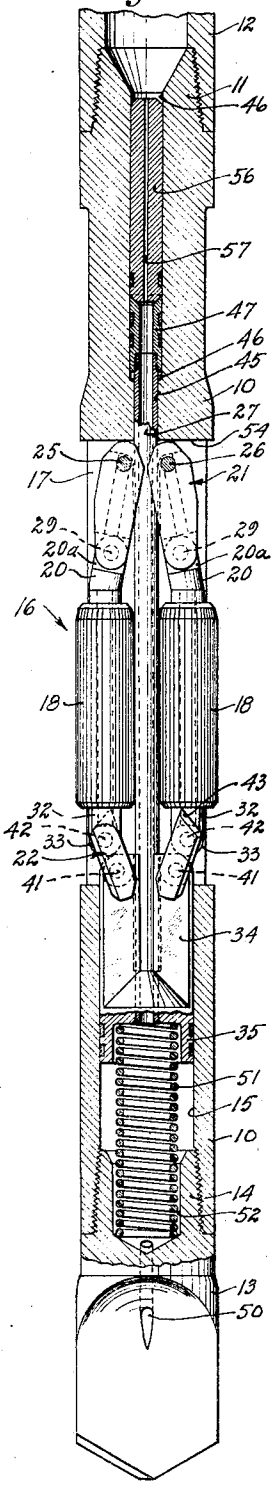

Fig. 2.

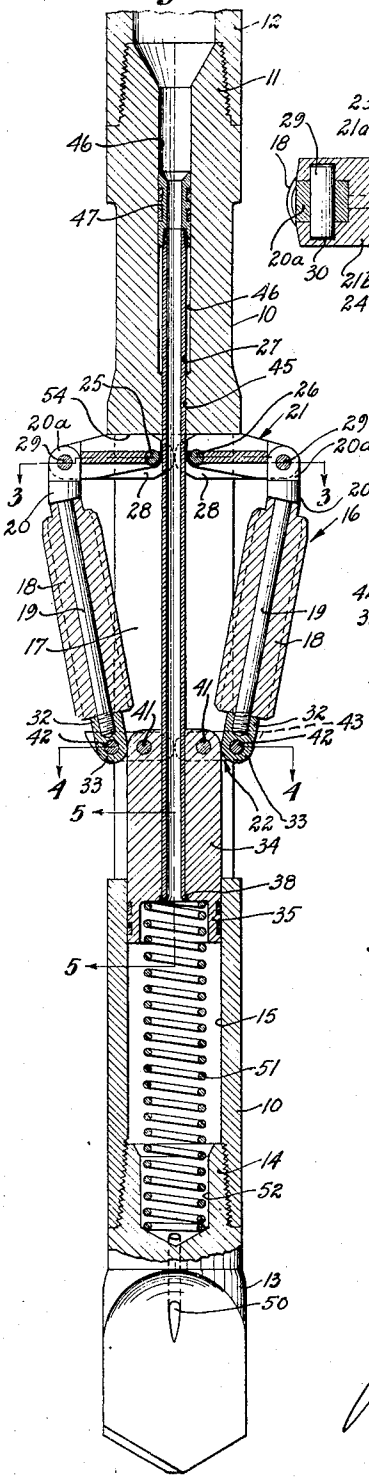

Fig. 3.

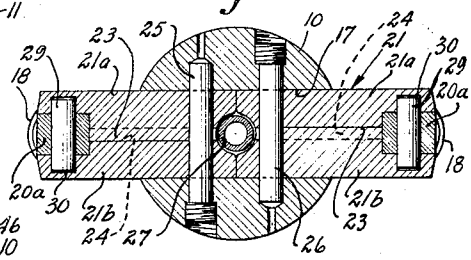

Fig. 4.

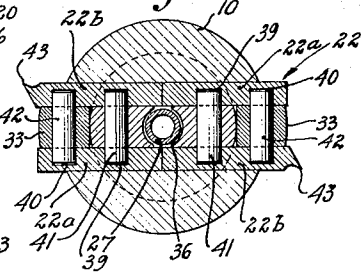

Fig. 5.

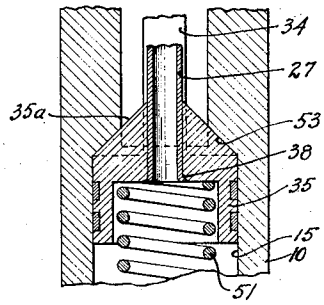

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Fig. 6.

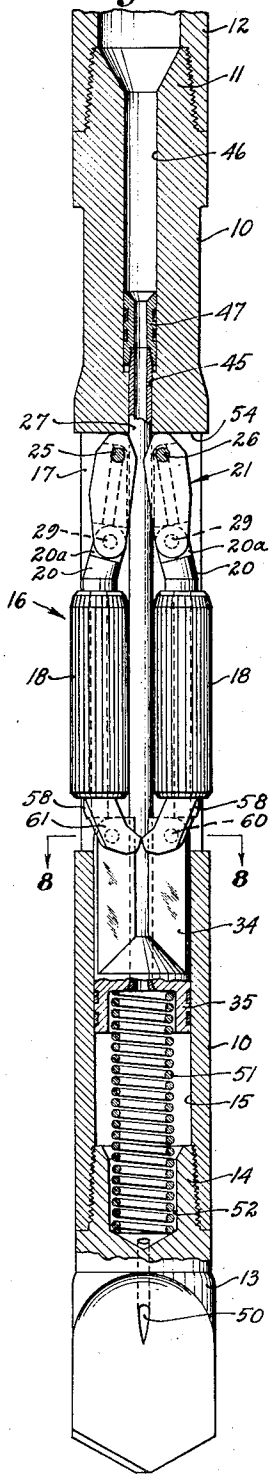


Fig. 7.

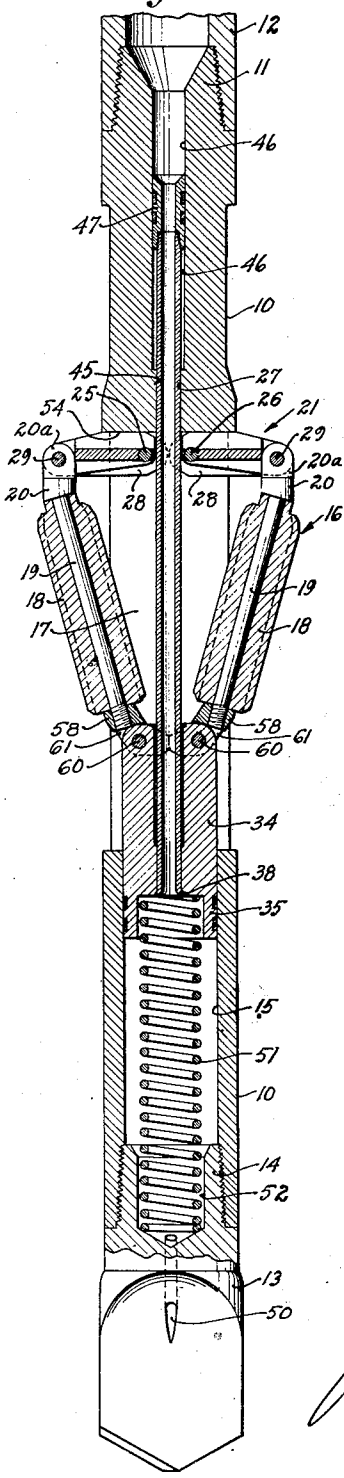


Fig. 8.

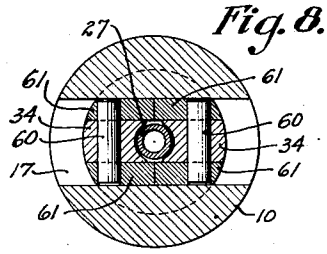


Fig. 10.

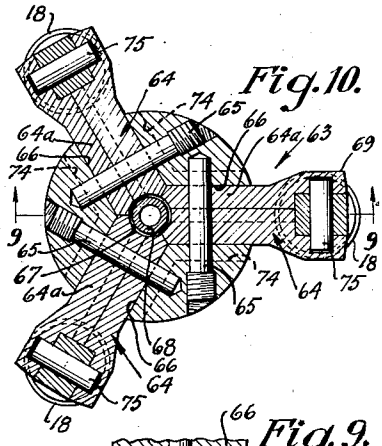
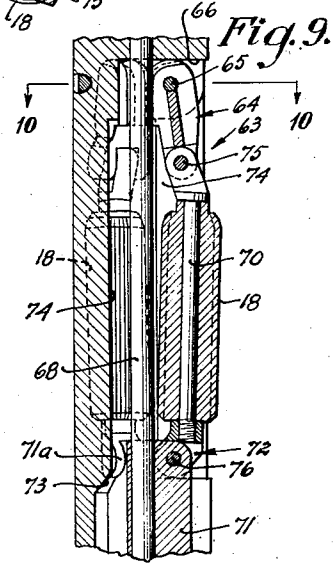


Fig. 9.



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UNITED STATES PATENT OFFICE

2,169,502

WELL BORE ENLARGING TOOL

James J. Santiago, Los Angeles, Calif., assignor to John Grant, Los Angeles, Calif.

Application February 28, 1938, Serial No. 193,056

2 Claims. (Cl. 255—76)

This invention relates generally to expansive well bore enlarging tools, particularly of the type designed to cut or ream the well bore to a substantially larger diameter than the ordinary expansive tools used in bore enlarging operations. In certain of its aspects the invention deals with improvements in swinging cutter reamers of the type described in U. S. Letters Patent No. 1,885,550, issued November 1, 1932, to me on Swinging cutter expanding reamer.

In this type of tool, the cutters are connected to the body by vertically swinging links which permit the cutters to have a comparatively large expansive range. One of my principal objects is to improve the cutter actuating means by providing within the body a single piston associated with the cutters so that the latter are expanded and contracted by the piston movement. The piston may be operated by spring or fluid pressure, or both. Preferably I utilize both spring and fluid pressure to actuate the piston in its cutter expanding movement, and provide means whereby circulating fluid is conducted downwardly within the body to exert upwardly applied pressure against the piston. In view of other functions performed by the circulating fluid pressure, I preferably conduct the fluid to the piston chamber through a tubular member carried by the piston, and through the piston itself.

Another feature of the invention is the provision of means whereby the expansible cutters of a reaming tool, and particularly of the present swinging cutter type, may be collapsed toward or into the body by the circulating fluid pressure. For this purpose I may utilize a suitable object or go-devil that is dropped through the drill string to close or restrict the fluid passage through the cutter actuating parts, and thereby render such parts responsive to fluid pressure to collapse the cutters against an expanding force, such as that exerted by a spring. Specifically the go-devil acts to restrict the normally open passage through the piston carried tubular member referred to above, so that while normally the piston is operable by fluid pressure to expand the cutters, when the go-devil is seated within the tool, the piston then becomes operable by the fluid pressure to contract the cutters.

The invention also embodies an important feature applicable to the present tool, as well as to other well tools having link connected parts, having for its object to prevent disconnection of the parts by the loss of pivot pins during operation. In accordance with the invention, the links are sectionally formed and the pins are wholly contained within the links in a manner precluding the possibility of their removal from the joints.

The invention has a number of additional characteristics and objects, but all these, as well as the features mentioned above, will be understood to better advantage from the following detailed description of certain typical and illustrative forms of the invention. Throughout the description reference is had to the accompanying drawings, in which:

Fig. 1 is a longitudinal section showing one form of the invention with the cutters in collapsed positions;

Fig. 2 is a view similar to Fig. 1 in which the cutter assemblies are shown in section and in expanded positions;

Figs. 3 and 4 are enlarged cross sections on lines 3—3 and 4—4 of Fig. 2;

Fig. 5 is a fragmentary enlarged section on line 5—5 of Fig. 2;

Figs. 6 and 7 are views similar to Figs. 1 and 2, showing a variational form of the invention;

Fig. 8 is an enlarged cross section on line 8—8 of Fig. 6;

Fig. 9 is a fragmentary longitudinal section on line 9—9 of Fig. 10, showing a further variational form of the invention comprisng a three cutter assembly with the cutters collapsed; and

Fig. 10 is an enlarged scale cross section on line 10—10 of Fig. 9, but showing the cutters in expanded position.

Referring first to Figs. 1 and 2, the tool comprises an elongated body 10 suitably attached to the drill pipe, as by threading the upper pin end 11 of the body into the lower end 12 of the drill pipe. The lower end of the body may be attached to a suitable tool, for example drill bit 13 having its upper pin end 14 threaded into the enlarged diameter body bore 15. The body is slotted or recessed to accommodate the cutter assemblies generally indicated at 16, any suitable number of which may be provided, although I prefer to use a single pair of oppositely positioned cutters collapsible into a centrally transverse and continuous body slot 17. Each of the cutter assemblies 16 comprises a rotating cutter 18 that may be of any suitable particular form and design, mounted on a pin 19 having at its upper end an integral enlargement 20 and pivot lug 20a. The cutter assemblies are carried by upper and lower vertically swinging links 21 and 22, the lower links being shorter in length so that when expanded, the cutters assume the inclined position shown in Fig. 2.

As best illustrated in Fig. 3, each of the upper

links 21 comprises a pair of longitudinal sections 21a and 21b having an interfitting tongue 23 and groove 24. The inner ends of the links 21 are received within the body slot 17 and are pivotally connected to the body by threaded head pins 25 and 26 inserted from opposite sides of the body. A tubular rod 27, the purpose of which will later appear, extends longitudinally through slot 17 and between the pairs of links. As best illustrated in Fig. 2, the inner and bottom surfaces of links 21 are recessed at 28 to clear the rod 27 in both the expanded and collapsed positions of the links. The outer ends of the links are pivotally connected to the cutter pin lugs 20a by pins 29 which terminate within closed end bores 30 so that the pins are entirely contained within the links. This feature is of importance in that by no possibility can the cutters become disconnected from the links by loss or dislocation of the pins 29.

Nuts 32 carrying hinge lugs 33 are pivotally connected by links 22 with upwardly extending projections or fingers 34 on a cutter actuating piston 35 that operates in the lower body bore 15. As best illustrated in Fig. 5, the inner surfaces of the piston extensions 34 are recessed at 36 to accommodate rod 27, the latter being suitably attached to the piston, as by a welded joint at 38 (see Fig. 2) so that the rod travels vertically with the piston. Each of the link assemblies 22 comprises sections 22a and 22b having bores 39 and 40 which receive pins 41 and 42 pivotally connecting the links to the piston extensions 34 and lugs 33. Each link sections 22b is shaped or built up to provide cutting edges 43, so that should the expanded cutters be lowered against a shoulder of smaller internal diameter than the effective cutting diameter of the lower ends of the cutter 18, the outer ends of link sections 22b (the tool being rotated clockwise) will cut or ream away the shoulder ahead of the roller cutters. As in the case of the pivotal connections of the links with the upper ends of the cutter assemblies, both sets of the lower link pivot pins are confined within the link sections, preventing their removal during operation of the tool.

In assembling the tool, and before bit 13 is attached, links 22 are connected to the piston extensions 34 and to lugs 33 before the piston 35 is inserted within the body, and before the cutters 18 and their pins 19 are attached to nuts 32. The piston 35, rod 27 and links 22 swung inwardly above the piston, are then inserted upwardly through the bore 15. The cutter and pin assemblies then are threaded into nuts 32, and finally the upper links 21 are assembled about pins 29 and then pivoted within the body slot by inserting pins 25.

Tubular rod 27, extending upwardly from the body slot 17 with slight clearance through a reduced diameter bore 45 into counterbore 46, carries a piston head 47 having a sliding fit with the counterbore wall. Fluid circulation normally is maintained to the bit through the bore of rod 27, piston cylinder 15 and the bit fluid passage 50. The cutter actuating piston 35 may be spring operated, as by means of coil spring 51 seated within bore 52 of the bit and bearing upwardly against the piston, or by fluid pressure communicated to bore 15, or by both spring action and fluid pressure. Provision preferably is made for utilizing both spring pressure and fluid pressure for expanding the cutters, spring 51 constantly tending to raise the piston to cutter expanding position, and rod 27 serving to communicate fluid through and beneath the piston to supplement the spring pressure. The size (cross sectional area) of the bit fluid passage 50 is such that it restricts the circulating fluid flow to a greater degree than the maximum fluid restriction offered by the rod assembly 27, so that increased rate of circulating fluid flow to the tool will result in increased fluid pressure within chamber 15 that is itself sufficient to actuate the cutters. As best illustrated in Fig. 5, upward travel of the piston 35 is limited by engagement of inclined piston surfaces 35a between the extensions 34, with correspondingly inclined body shoulders 53. In the full expanded positions of the cutters, links 21 may be brought to engage the upper end 54 of the body slot so that during reaming operations, the links are supported by the body against upward thrust communicated from the cutters.

In operation, the tool is inserted within the well casing, not shown, with the cutters confined against expansion under the influence of spring 51, by engagement with the casing wall. When lowered beyond the casing shoe, the cutters are released for expansion to the degree permitted by the bore diameter below the casing. During reaming operations, and as previously mentioned, fluid pressure may be communicated to the piston chamber to increase the expansive pressure on the piston, by increasing the rate of fluid circulation to the tool. With the upper and lower ends of the cutter assemblies carried by the vertically swinging links as in the described form of the invention, the cutters are not collapsible by engagement of links 21 with the casing shoe, and hence provision is required for collapsing the cutters independently of such engagement. In accordance with the invention, piston 35 is movable downwardly to cutter collapsing position by fluid pressure communicated to the upper end of rod 27. To collapse the cutters, a go-devil 56 is dropped through the drill pipe 12 into bore 46 to seat against the upper end of the rod head 47. The go-devil 56 sufficiently restricts the fluid passage above the rod that fluid pressure applied to the go-devil will force the latter, together with rod 27 and the piston 35, to the cutter collapsing positions shown in Fig. 1. It is desirable that it be possible to maintain some fluid circulation past the go-devil, and for this purpose the latter may be provided with a relatively restricted fluid course 57 of smaller cross sectional area than the smallest portion of the fluid passage therebelow, i. e., the bit passage 50. Thus the point of maximum pressure differential is at the go-devil, resulting in downward movement of the cutter actuating assembly and contraction of the cutters.

In Figs. 6 to 8 I show a variational form of the invention generally similar to the first described form, but differing structurally in that the lower ends of the cutter assemblies, instead of being connected by links to the actuating piston, are directly connected thereto. Otherwise corresponding parts in the two forms are designated by the same reference characters. Nuts 58 on the cutter pins are directly pivoted to the piston by pins 60 passing through the piston extensions 34 and terminating within the spaced lugs 61 carried by the nuts. The pins are confined against end movement out of the joints, by the walls of body slot 17. As in the first described form of the invention, the cutters are expansible by the action of spring 51, and also by fluid pressure communicated to the piston chamber

through the rod 27. Here however the cutters may, if desired, be collapsed by engagement of links 21 with the casing shoe as the tool is being pulled up into the casing, the cutters thus being contractible by reason of the fact that the lower ends of the cutters are directly connected to the piston so that downward swinging movement of links 21 is transmitted through the cutters to depress the piston. While, as before, the cutters may be collapsed by fluid pressure through the use of the go-devil, ordinarily in the operation of this form of the invention, the cutters will be collapsed by engagement with the casing shoe.

Figs. 9 and 10 illustrate a further variational form of the invention whose construction and operation is similar in all respects to the preceding forms, except with respect to the cutter arrangement and the cutter receiving body slots. Here the tool has three cutter assemblies, generally indicated at 63, each comprising upper link assemblies 64 having inner reduced width portions 64*a* pivoted on pins 65 within intersecting body slots 66 of corresponding width. The inner ends of the link assemblies are recessed at 67 to clear the piston carried tubular rod 68. The outer ends of the links are pivoted at 69 to the cutter pins 70, as before, and the lower ends of the cutter pins may be connected to the upper end of the piston 71 either by links as in Figs. 1 and 2, or directly to the piston as I have illustrated at 72 in Fig. 9. The piston stop is formed by body shoulders 73 between upwardly projecting portions 71*a* of the piston arranged 120° apart in accordance with the cutter arrangement. In their contracted positions, see Fig. 9, the cutters are received within intersecting body slots 74 of greater width, sufficient to accommodate the cutters, than the link receiving slots 66. As will be understood, pivot pin 75 is sufficiently offset outwardly with relation to pins 65 and 76 that vertical movement of the piston 71 will cause expansion and contraction of the cutters, all in the manner previously explained with reference to the first described forms.

I claim:

1. A well reaming tool comprising an elongated body adapted to be attached to a drill stem, said body containing a transverse longitudinal slot, a pair of cutters radially contractible within said slot, a pair of cutter carrying arms pivotally connected to the upper ends of said cutters and mounted on the body to swing vertically, a chamber and cutter operating piston within the body below said slot, a tube connected to said piston and extending longitudinally through said slot into a body bore thereabove, said piston being movable upwardly by fluid pressure communicated through said tube to said chamber, and means adapted to be dropped through the drill stem into engagement with said tube whereby fluid pressure applied to said means causes the tube and piston to move downwardly within the body, said means being apertured to pass fluid into said tube and restricting fluid flow to a greater degree than the fluid restriction offered by the tube bore.

2. A well reaming tool comprising an elongated body adapted to be attached to a drill stem, a cutter expansively and contractively movable on said body, said body having a longitudinal cylinder bore in its lower portion and a longitudinal plunger bore in its upper portion, said plunger bore being substantially smaller than said piston bore, an apertured cutter operating piston in the cylinder bore, a longitudinal tube connected to the piston and extending upwardly therefrom into the plunger bore to pass fluid pressure from the plunger bore to the cylinder bore below the piston thereby to move the cutter operating piston upwardly to operate the cutter, said tube forming in the plunger bore a relatively small tubular plunger, and means adapted to be applied to the upper end of said tubular plunger to restrict its tubular passage whereby fluid pressure applied to said means causes the tube and piston to move downwardly within the body, said means being apertured to pass fluid into said tube and restricting fluid flow to a greater degree than the fluid restriction offered by the tube bore.

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