July 14, 1953 R. BASSINGER 2,645,207

PERCUSSION DRILLING TOOL

Filed April 12, 1948 2 Sheets-Sheet 1

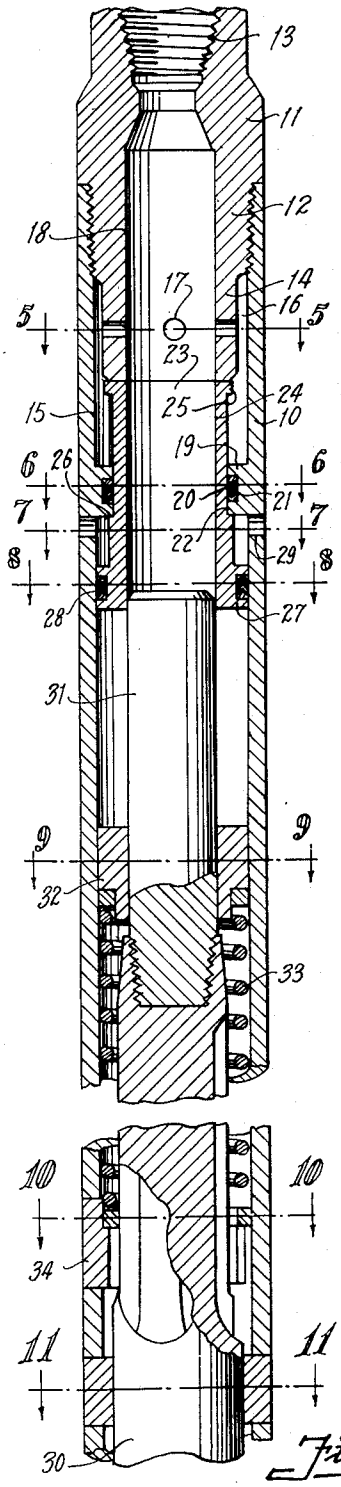


Fig. 1

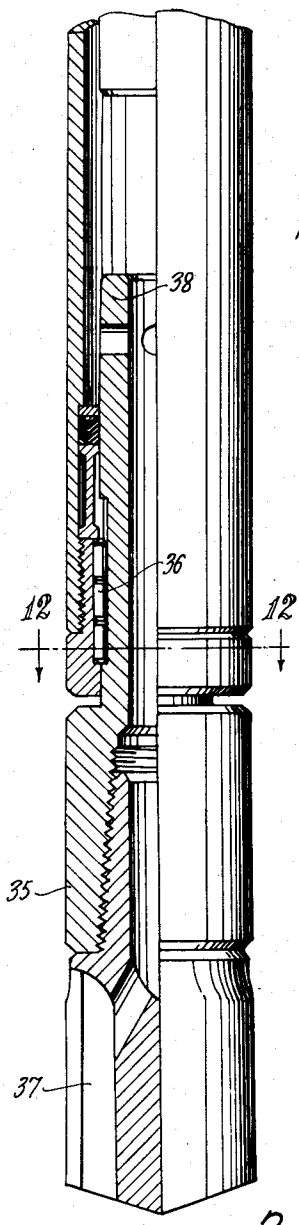


Fig. 2

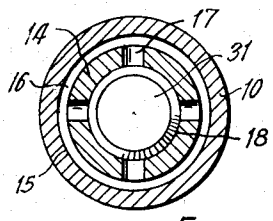


Fig. 5

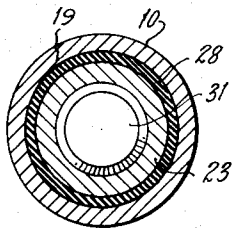


Fig. 8

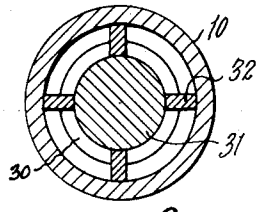


Fig. 9

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PERCUSSION DRILLING TOOL

Filed April 12, 1948 2 Sheets-Sheet 2

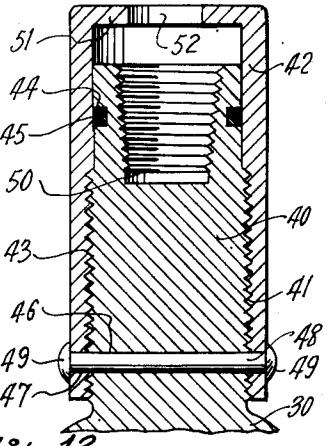
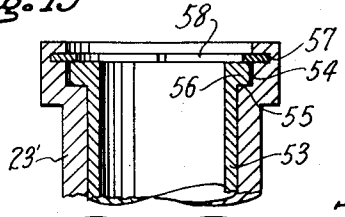


Fig. 13



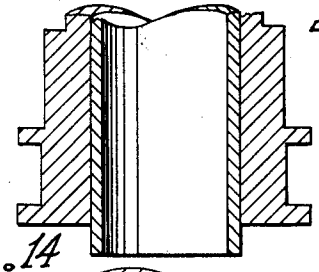


Fig. 14

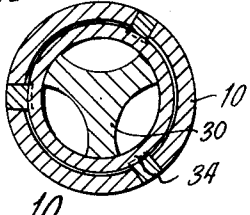


Fig. 10

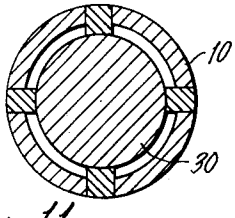


Fig. 11

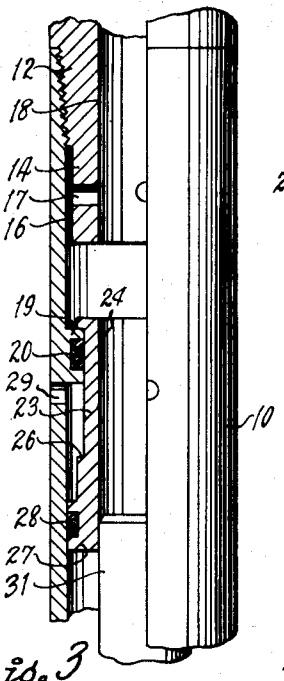


Fig. 3

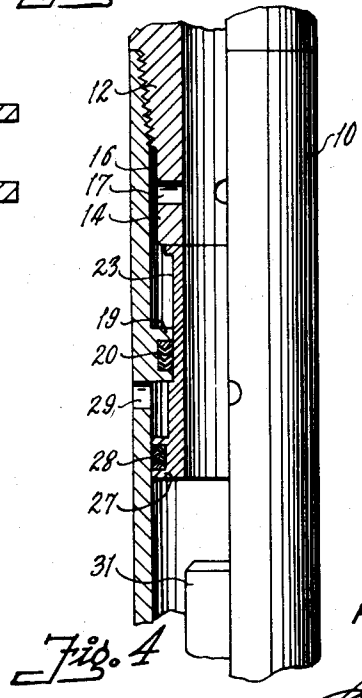


Fig. 4

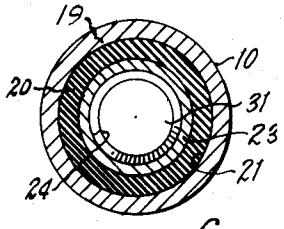


Fig. 6

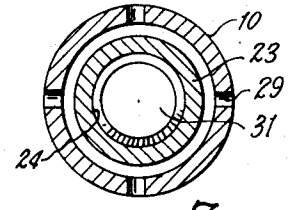


Fig. 7

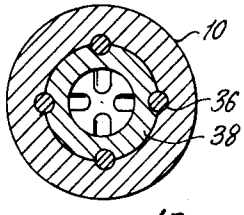


Fig. 12

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UNITED STATES PATENT OFFICE

2,645,207

PERCUSSION DRILLING TOOL

Ross Bassinger, Houston, Tex.

Application April 12, 1948, Serial No. 20,470

4 Claims. (Cl. 121—17)

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This invention relates to new and useful improvements in percussion drilling tools.

This invention is concerned with percussion tools of the type disclosed in my co-pending application, Serial 686,497, filed July 26, 1946, now Patent 2,507,585, issued May 16, 1950.

In my previous application was disclosed a percussion tool for wells in which a reciprocating hammer was alternately subjected to the pressure of the drilling fluid and acted upon by the force of a coiled spring to cause said hammer to undergo longitudinal movement within the tool and deliver a series of impact blows to a suitable element also within said tool. The portion of the hammer acted upon by the pressure of the drilling fluid is, in some instances, a piston adapted to telescope a tubular element which has been termed a control sleeve. The control sleeve also is alternately acted upon by the pressure of the drilling fluid and the compressive force of a coiled spring, to cause the sleeve to reciprocate with respect to the piston and alternately engage and disengage the same.

The principal object of the present invention is to provide an improved percussion tool in which a springless control sleeve is employed, the elimination of control sleeve springs increasing the economy of manufacture and operation of the tool and reducing to a considerable extent the likelihood of mechanical failure or difficulties occurring in connection with said control sleeve and its immediately allied structural elements.

Another object of the invention is to provide a wear sleeve for the control piston carried by the hammer.

A still further object of the invention is to provide a wear sleeve for the interior bore of the control sleeve, the former being applicable regardless of mechanical elements associated with the control sleeve.

A particular object of the invention is to provide a control sleeve of the character described having differential areas exposed to the pressure of the drilling fluid at various times so that the pressure of such fluid causes the sleeve to undergo reciprocal movement.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein an example of the invention is shown, and wherein:

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Fig. 1 is a longitudinal, sectional view, with some parts shown in elevation, of the upper portion a percussion tool constructed in accordance with this invention,

Fig. 2 is a longitudinal view, partly in elevation and partly in section, of the lower portion of the percussion tool,

Fig. 3 is a fragmentary, longitudinal view, partly in elevation and partly in section, of the control sleeve section of the tool, showing the sleeve in its lowermost position,

Fig. 4 is a view similar to Fig. 3 showing the sleeve in its upper position,

Figs. 5 through 12 are horizontal, cross-sectional views taken upon the respective lines appearing in Figs. 1 and 2,

Fig. 13 is an enlarged, sectional view of the wear sleeve for the hammer piston, and

Fig. 14 is an enlarged, vertical, sectional view of the wear sleeve for the control sleeve.

In the drawings, the numeral 10 designates an elongate tubular body forming the housing of the percussion tool contemplated by this invention. While the housing 10 is shown as one continuous element, it is to be understood that suitable screw-threaded joints may be provided at any desired point therein to facilitate assembly or repair of the tool, or the removal and replacement of any of the elements thereof. A collar 11 carries a reduced screw-threaded pin 12 which engages within the upper end of the housing 10, said collar being provided with a screw-threaded box 13 at its upper end for receiving the lower extremity of a suitable drilling spring (not shown). An annular skirt 14 depends from the lower end of the pin 12 so as to project into the bore 15 of the housing 10. The outside diameter of the skirt 14 is less than the diameter of the bore 15, so that an annular space 16 is provided between said skirt and the side wall of the housing. A plurality of radial ports 17 communicate between the bore 18 of the collar 11 and said annular space.

An internal, annular flange 19 is formed upon the inner wall of the housing 10 at a point spaced below the lower end of the skirt 13. The flange 19 is of considerable thickness whereby a set of suitable pressure-responsive, packing rings 20 may be positioned within an annular recess 21 cut in the inner periphery or face 22 of said flange. The face 22 defines a bore extending longitudinally within the housing 10, and a control sleeve 23 has a snug sliding fit within said bore. The control sleeve has an axial bore 24 through which drilling fluid flows from the bore

18, and carries an external, annular lip 25 at its upper extremity, said lip serving to engage the upper surface of the flange 19 and thereby limit the downward travel of the control sleeve. Upward movement of the sleeve is limited by its engagement with the lower edge of the skirt 14 and also by the engagement with the underside of the flange 19 of an annular shoulder 26 formed externally upon the lower portion of said sleeve. An external, annular flange 27 is provided at the extreme lower end of the control sleeve, said flange being of such diameter as to have a snug sliding fit within the bore 15 of the housing 10. Similarly to the flange 19, the flange 27 is of such thickness as to permit the recessing in its outer periphery of a set of annular, pressure-responsive, packing rings 28. The rings 28 seal off the space between the control sleeve and that portion of the bore 15 below the flange 19, while the packing rings 20 seal off the space between the latter flange and the medial portion of the sleeve. A plurality of radial ports 29 are cut in the wall of the housing 10 immediately below the flange 19 so as to prevent the occurrence of a fluid lock between the underside of said flange and the upper side of the flange 27. With this structure, the control sleeve is free to undergo longitudinal reciprocation within the housing 10, but at the same time, communication between those portions of the housing above and below the flange 19 is limited to the bore 24 of said sleeve.

An impact hammer 30 is positioned within the housing below the control sleeve 23, said hammer carrying an upstanding piston 31 having a sliding fit within the bore 24 of said control sleeve. The hammer carries an annular guide spider 32 near its upper end, and a suitable helical spring 33 encircles the hammer below said spider, the spring being confined between the underside of the spider and an annular support 34 carried by the housing at a point spaced below the upper end of the hammer. The spring 33 thus constantly urges the hammer upwardly so as to telescope the piston 31 within the bore of the control sleeve. A bit carrier 35 is suitably splined to the lower end of the housing at 36 and carries a depending drill bit 37. The upper end of the bit carrier extends upwardly into the bore of the housing at its lower end and forms an anvil 38 upon which the hammer 30 is adapted to strike so as to impart impact blows to the bit carrier and therefore to the bit itself. The splined connection 36 between the housing and the bit carrier permits the bit to be rotated through the medium of the housing and the drilling string, but protects the housing and drilling string against the shock of the impact blows delivered to said bit carrier by the hammer.

In the operation of this tool, the pressure and momentum of the column of drilling fluid or mud within the tubing string is employed to reciprocate the hammer 30 and deliver impact blows of considerable magnitude to the bit 37 with great rapidity thereby increasing the drilling capacity or rate of the bit to a marked extent. When the tool has been lowered into position within the well bore and before the flow of drilling fluid has been commenced, the hammer will be in its upper position as illustrated in Figs. 1 and 2, while the control sleeve 23 may be at any point of its stroke since fluid pressure is relied upon for movement of the same. However, it is to be noted that even when the control sleeve is in its uppermost position as shown in Fig. 1, the piston 31 will be engaged in the lower portion of the bore 24 when the hammer is in its upper position. For the sake of convenience, it will be assumed that the control piston is in its uppermost position when the flow of drilling fluid is commenced.

In the afore-mentioned position, the first action achieved by the drilling fluid when its flow is started, is to drive the control sleeve downwardly over the piston 31 of the hammer. When this has occurred, the pressure of the drilling fluid is brought to bear upon the piston 31 and therefore the hammer 30 and moves the same downwardly when the control sleeve reaches the lower end of its stroke, as illustrated in Fig. 3. Upon engagement by the lip 25 with the upper surface of the flange 19, further downward movement of the control sleeve is prevented, and the hammer and piston commence to move downwardly under the force and impetus of the column of drilling fluid flowing downwardly through the bore of the drilling string.

It will be understood that the upper end surface of the sleeve 23 does not make a precision fit with the lower surface of the skirt 14. This will be apparent when it is borne in mind that the whole system operates with a coating of drilling mud thereon which mud contains particles of appreciable grain size. Consequently the upper portion of the sleeve 23 is, in operation, constantly exposed to the pressure fluid entering the upper end of the collar 11.

It will be noted that to this point the underside of the flange 27 has been shut off from exposure to the pressure of the drilling fluid by the engagement of the piston within the bore 24 of the control sleeve. The annular space below the flange 27 and between the hammer and the inner wall of the housing is under nothing more than the static pressure of the column of drilling fluid present in the well bore. This pressure is also exerted upon the upper end of the control sleeve, but in addition, the pressure of the mud pumps (not shown) which are driving the drilling fluid downwardly through the bore of the drilling string, is also applied to the upper end of the control sleeve. Thus, although the upper end of said sleeve is smaller in diameter than the lower end, the predominance of pressure upon the upper end forces the same to move downwardly in a rapid fashion. However, as soon as the hammer has moved downwardly a distance sufficient to withdraw the piston from the bore 24, the pressure being exerted by the drilling fluid immediately comes to bear upon the underside of the flange 27. Now, the predominant force created by the pressure of the drilling fluid tends to move the control sleeve upwardly. This is true because the pressure is acting downwardly on the sleeve only over an area equal to the cross-sectional area of the upper portion of the sleeve which is the cross-sectional area of the sleeve below the lip 25 less the cross-sectional area of the bore 24. On the other hand, the entire area of the flange 27 is exposed to this pressure, and since the latter area considerably exceeds the former area, the pressure of the drilling fluid immediately forces the control sleeve to move upwardly into its uppermost position, and the elements assume the position illustrated in Fig. 4.

The tool is so proportioned and the various elements so regulated that the separation of the piston and the control sleeve takes place immediately before the hammer strikes the upper end of the anvil 38. Thus, when the hammer strikes said anvil, it is still moving under the consider-

able momentum and velocity imparted thereto by the pressure of the column of drilling fluid, and very little of its energy has been lost in the very short interval occurring between the cessation of application of the pressure thereto and the moment of impact. Of course, in moving downwardly under the pressure of the drilling fluid, the hammer compresses the spring **33**. Therefore, when the hammer strikes the anvil and its energy is transferred thereto, the spring **33** functions to return the hammer to its upper position wherein it again moves the piston **31** into the bore **24** and causes the cycle to repeat. This entire operation requires only a fraction of a second for completion, and as many as 250 to 400 blows per minute may be obtained with this tool.

Once the operation is started by the admittance of the drilling fluid under pressure, the hammer assumes a vibratory action delivering impact blows of considerable magnitude to the upper end of the anvil **38** and thereby to the bit **37** while returning to its upper position between each blow. As before pointed out, immediately upon withdrawal of the piston from the bore **24**, the control sleeve is moved to its upper position. As the piston approaches the lower end of the control sleeve during the upward travel of the former, the flow of drilling fluid between the piston and the sleeve is gradually restricted so that a point is reached at which the pressure upon the flange **27** is insufficient to retain the sleeve in its upper position and the pressure upon the upper end of said sleeve becomes predominant. Thus, the sleeve may begin to move downwardly even before the piston has entered the bore **24**. As soon as the piston does so engage within the bore, the upward movement of the hammer is not immediately checked and it may continue its upward travel in opposition to the tremendous ram action of the moving column of fluid present within the bore of the drilling string. This action is possible due to the small established compressibility of drilling fluid (because of occluded air) and the elastic expansibility of the tubing string. The piston, in moving upwardly, compresses the drilling fluid to some extent and also expands the tubing radially. These represent stored energies which are returned to the hammer as it begins its downward travel.

It is pointed out that the flow of drilling fluid through the drilling bit is never shut off or interrupted for a period of time long enough to result in physical damage. As pointed out, the control sleeve begins to move downwardly even before the piston engages therewithin. Thus, the control sleeve is displacing fluid therebelow at the time the piston engages within the bore, and it is obvious that downward movement of the hammer will commence as soon as such engagement is completed. In this manner, although the piston shuts off communication momentarily through the bore **24**, the downward movement of the various elements continues to displace fluid downwardly through the water courses of the bit **37**, and flow therethrough is not seriously interrupted. Due to the relatively high frequency of impact blows delivered, there is only a slight pulsation of the drilling fluid being discharged through the bit. The fluid thus continues to flow downwardly around the outside of the hammer and into the bore of the anvil, and thence downwardly through the drilling bit to flush cuttings upwardly in the well bore around the exterior of the tool.

In Fig. 13 is illustrated a wear sleeve which may be incorporated into the structure of the hammer piston **31**. The modified form of piston **40** is provided with external screw-threads **41** extending from its lower end to a point spaced below its upper end. A tubular wear cap or sleeve **42** is provided with internal screw-threads **43** and is received upon the piston **40**. The screw-threads **43** stop short of the upper end of the sleeve **42**, the upper portion of said sleeve having a snug sliding fit over the upper portion of the piston **40**. An annular groove **44** is cut near the upper end of the piston **40** and receives a suitable packing ring **45**, circular in cross section and formed of a suitable resilient material such as synthetic rubber. The ring protrudes slightly from the recess **44** so as to bear against the inner surface of the sleeve **42** when the same is positioned upon the piston and to pack off the space between said sleeve and piston. At the lower end of the piston, a diametric bore **46** is provided, and the sleeve carries diametrically opposed radial openings **47** adapted to be alined with the bore **46** when the sleeve is positioned upon the piston. A transverse securing pin **48** extends through the bore **46** and the openings **47**, the outwardly projecting ends **49** of the pin being suitably peened or otherwise treated to secure the pin in position. The purpose of the pin **48** is not so much to prevent longitudinal movement of the sleeve **42** with respect to the piston **40**, but to prevent unscrewing of the sleeve from said piston, and any suitable means to prevent unscrewing may be used in its stead. A screw-threaded box **50** is formed in the upper end of the piston **40** for engagement by a suitable tool (not shown) when it is desired to lift and move the hammer.

The upper end **51** of the sleeve **42** is closed, but is provided with an axial opening **52** which permits equalization of fluid pressure upon either side of said upper end **51**. This arrangement prevents crushing of the upper end of the sleeve by the pressure of the drilling fluid, and in conjunction with the packing ring **45**, prevents the trapping of fluid under pressure beneath said closed upper end with the resultant stripping of the sleeve from engagement with the piston. Of course, the upper end of the sleeve may abut the upper end of the piston **40** so that the opening **52** may be eliminated.

In the operation, the wear sleeve **42** is of the proper outside diameter as to have a snug sliding fit within the bore **24** of the control sleeve **23** and permits this tool to operate in the fashion described. However, as wear occurs due to the reciprocation of the piston within the control sleeve, such wear is taken by the wear sleeve **42** which is made readily replaceable for this purpose. Thus, when wear does occur, the sleeve **42** is easily replaced with a new sleeve whereas to retain a sufficiently accurate fit within the bore of the control sleeve **23**. At the same time, the wear sleeve is so secured to the hammer as to form a rigid portion thereof and provision is made for preventing the stripping of the sleeve from the hammer through the action of fluid under pressure.

A similar wear sleeve for the control sleeve is illustrated in Fig. 14. In adapting the control sleeve **23** to this structure, the bore **24** is sufficiently enlarged as to permit the insertion of a tubular liner **53** equal in inside diameter to the outside diameter of the hammer piston which it is to receive. The liner **53** extends substantially

throughout the length of the control sleeve, which is designated by the numeral 23'. The upper portion of the sleeve 23' is counter-bored at 54 to provide an internal, upwardly directed shoulder 55, and an annular external flange 56 provided upon the upper end of the liner 53 seats upon said shoulder so as to anchor the liner against downward movement within the sleeve 23'. An internal, annular groove 57 is cut in the upper portion of the counter-bore 54 immediately above the upper end of the sleeve 53, and receives a suitable snap-type retaining ring 58 which overlies the upper end of the sleeve and prevents its upward displacement.

The provision of this liner or wear sleeve for the control sleeve achieves the same results as the wear sleeve for the hammer piston and limits the wear occurring by engagement of the piston within the sleeve, to an element which is readily replaceable and relatively inexpensive. Thus, as wear occurs during operation of the tool, the liner 53 may be replaced from time to time to retain full efficiency and maximum effectiveness of the tool while at the same time avoiding heavy expense due to replacement of entire structural elements.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A well percussion tool comprising a tubular housing, sliding sleeve and piston elements arranged to mutually telescope and in telescoping position to divide the housing into a high pressure zone and a low pressure zone, means defining a drilling mud inlet to the high pressure zone, means defining a drilling mud outlet from the low pressure zone, resilient means biasing one of said elements toward said drilling mud inlet, a hammer connected to that one of said elements on which the resilient-biasing means acts, an anvil, means to stop the sliding stroke of the other of said elements in a direction toward said low pressure chamber before the hammer has struck the anvil so that the element to which the hammer is connected moves beyond telescoping relation with the other element in completing its stroke, that end surface of said other element which faces the high pressure chamber being of smaller area than the end surface thereof which faces the low pressure chamber.

2. A well percussion tool comprising a tubular housing, sliding sleeve and piston elements mounted in said housing to mutually telescope and in telescoping position to divide the housing into a high pressure zone and a low pressure zone, means defining a drilling mud inlet to the high pressure zone, means defining a drilling mud outlet from the low pressure zone, a hammer connected to said piston, resilient means biasing said piston toward the drilling mud inlet, an anvil, means to stop the sliding stroke of the sleeve toward the low pressure chamber before the hammer strikes the anvil so that the piston moves beyond telescoping relation with the sleeve in completing its stroke, the end surface of said sleeve which faces the high pressure chamber being of smaller area than the end surface thereof which faces the lower pressure chamber.

3. A well percussion tool comprising a housing, sliding sleeve and piston elements mounted in said housing to mutually telescope and in telescoping position to divide the housing into first and second zones having fluid inlets and outlets, a hammer having a power transmitting connection with said piston, an anvil, means biasing said piston away from said anvil, means to stop the sliding stroke of the sleeve toward said anvil before the hammer strikes the latter so that the piston moves beyond telescoping relation with the sleeve in completing its stroke, said sleeve having a first endwise surface in communication with said first zone and an oppositely facing second endwise surface in communication with said second zone, the effective area of said first endwise surface being smaller than the effective area of said second endwise surface.

4. The tool of claim 3 wherein said housing includes an inturned annular shoulder forming a sliding seal with said sleeve, said sleeve having an outturned shoulder forming a sliding seal with said housing, said outturned and inturned shoulders together with said sleeve and housing forming a variable capacity chamber, and a passage placing said chamber in communication with the exterior of said housing.

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