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(54) **BREAKER FOR EXCAVATORS WITH OPTIMIZED HYDRAULIC CIRCUIT**

SCHALTER FÜR BAGGER MIT OPTIMIERTER HYDRAULIKSCHALTUNG

CONCASSEUR POUR EXCAVATRICES À CIRCUIT HYDRAULIQUE OPTIMISÉ

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Description

[0001] The present invention relates to a breaker for excavators with optimized hydraulic circuit

[0002] At the state of the art there are known various embodiments of breakers for excavators, such as disclosed in EP 1 964 647 A2.

[0003] The principle according to which known breakers work can be described with reference to figure 1. In these excavators hydraulic liquid under pressure goes in an active thrust chamber (11) through ducts (12) connected to an input socket (13) for the liquid under pressure. To these ducts (12) is connected a first volume (142) of an accumulator (14). An elastic membrane (143) divides said volume full of liquid under pressure (142) from a second volume containing nitrogen (141). Therefore, the elastic membrane (143) allows the volume (141) to be exploited as an accumulation volume. The principal function of the accumulator (14) is to accumulate oil in the passive step (when the piston goes from BDC to TDC) in order to return it in active step when the flow rate needed in the thrust chamber (11) is greater than the one provided at the inlet (13) of the breaker.

[0004] During the active thrust step, the pressure exerted by the oil contained in the active thrust chamber (11) acts on the upper surface (151) of a piston (15) which transmits the force exerted by the oil to the tool (16) which is used to break.

[0005] A distributor (17) is concentric with respect to the piston (15). The distributor is needed to put the active thrust chamber (11) alternately in communication with both the low pressure portion of the circuit (18) connected to the return under low pressure of the oil, and with the high pressure inlet (13).

[0006] When the piston (15) is in the thrust step, the thrust chamber (11) is separated from the low pressure portion (18) of the hydraulic circuit by the distributor (17).

[0007] It is also provided a passive thrust chamber (20) connected to the oil supply under pressure through a series of ducts (21). Only for illustration, in figure 1 it is shown only one duct which connects the passive thrust chamber to the supplying circuit, but it is also possible to use different configurations, for example three ducts arranged at 120°.

[0008] On the lower surface (152) of the piston (15) which faces the passive thrust chamber (20) the oil under pressure acts on a circular crown, whose area is clearly smaller than the area (151) on which the oil acts in the active thrust chamber (11).

[0009] Therefore there is an unbalance between the two forces acting on the piston in vertical direction, and this unbalance thrusts the piston downwards. The downwards stroke of the piston (15) is the active part of the cycle. In this step, the piston, by striking on the tool, transmits it its kinetic energy and so exerts a force on the tool of the breaker, which then breaks the material being worked.

[0010] When the piston (15) reaches the bottom dead center, the system is such that, in that position, the piston (15) leaves free the lower portion of the distributor (17). Since the lower portion of the distributor (17) is greater than the upper one, the resultant of the forces acting on the distributor is such that it is moved upwards.

[0011] In its vertical movement the distributor (17) closes first the high pressure gap and then opens the discharge gap of the active thrust chamber (11), thus disconnecting the active thrust chamber (11) from the high pressure circuit and connecting it to the low pressure one. In this way, the new resultant of the forces acting on the piston (15) is such that it is thrust upwards and it is put again in the starting position, reestablishing the cycle as well. The bypass (19) serves when the distributor, while going down, closes the discharge gap. In this moment, the oil which is between the distributor (17) and the piston (15) (in this step, the distributor is inserted around the piston) has to be discharged because the distributor (17) is going down, and the discharge occurs through the bypass (19). As yet said, the piston (15) acts on a tool (16) used to break the material being worked. The tool (16) is provided with a groove (163) whose ends (161, 162) define the maximum axial amplitude possible allowed by the tool. In the groove (163) of the tool (16) is in fact engaged a tool-stopper (25) integral with the breaker (1), which limits the axial amplitude allowed by the tool (16).

[0012] The described functioning is typical of breakers for hydraulic hammers known at the state of the art.

[0013] The breakers for excavators known at the state of the art have many drawbacks, among which the fact that the described functioning is independent of the fact that the bit of the tool (16) is actually working material or not. This is a problem since the force as a whole exerted by the pressure of the liquid provided in the active thrust chamber (11) on the piston (15) and so on the tool (16), which should serve to break the material being worked, when the bit idles is discharged on the tool-stopper (25), thus subjecting it to high stresses which can lead shortly to deformation of the same and so to expensive machine-stop times.

[0014] Another drawback of the breakers known at the state of the art is linked to the sudden pressure variations, which are provided in the hydraulic circuit during the cycle, caused by a not optimized conformation of the hydraulic circuit. In fact, in order to reduce the absorbed torque of the pumps, the last generation excavators use oil pumps with variable piston displacement with reduced maximum flow rates with respect to the one used in the old excavators. This implies that, while the flow rate at the breaker inlet is reduced with respect to flow rate traditionally used in the breakers, at the accumulators there are requested greater expansions, which cause greater pressure variations and so an efficiency reduction. In particular, during the active step of the cycle, when the thrust chamber is put under pressure by the oil of the circuit under high pressure, pushing the piston downwards to strike the tool, it is needed to guarantee that the chamber is under pressure for the whole active step notwithstanding the expansion due to the piston going down. In order to do so, it is needed that the hydraulic circuit of the breaker is such that it guarantees, once the conditions of flow rate and supplying pressure determined by the excavator on which the breaker is mounted are fixed, the passage of the flow rate needed to constantly fill the volume of the thrust chamber. As a way of example, and without this limiting the aims of the invention, it is needed to guarantee a good functioning with oil flow rates supplied by the excavator reduced by 20% with respect to an excavator of equal weight known at the state of the art. Approximately, a hammer of 200 kg according to the present invention uses flow rates between 40-45 1/min.

[0015] Another drawback of breakers for excavators known at the state of the art is linked to the need of increaseing the mass of the piston, with equal dimension of the same and same piston displacement, in order to increase the force transmitted to the tool.

[0016] In fact the theoretical maximum potential striking energy is constant and can be obtained by the following expression:

$$\text{Pressure x thrust area x piston stroke} = 0{,}5 \text{ x mass x speed}^2$$

[0017] Therefore by doubling the mass, the speed is reduced by a ratio equal to 1/radQ(2), about equal to 1,414<2. It is deduced that the momentum, resulting from the product of the piston mass for its speed increases while the piston mass increases as well, and since the force transmitted to the tool is equal to the momentum variation in time, since the striking time is about constant at the mass variation and the starting momentum is equal to zero (stationary tool) it is deduced that, at equal piston displacement and supplying pressure, the force transmitted increases while the tool mass increases as well.

[0018] So it is clear that a technical problem linked to the optimization of the pistons is to increase the mass of the piston while maintaining constant the supplying pressure, the piston displacement and the whole dimension of the breaker.

[0019] Therefore, aim of the present invention is to provide a piston with optimized geometry to increase the mass of the piston while maintaining equal breaker dimension.

[0020] According to another aim the present invention provides a breaker for excavators which solves the problems of the state of the art, and in particular which is provided with a system which allows to disconnect automatically the tool from the high pressure circuit when not actually working on the material to be destroyed. Moreover, the breaker object of the present invention aims at providing a hydraulic circuit optimized to guarantee a correct functioning of the breaker with low oil flow rates.

[0021] The breaker, object of the present invention, realizes the prefixed aims since it is a hydraulic breaker for excavator comprising a piston configurated such that it can slide alternatively inside said breaker under the thrust of a hydraulic liquid contained in a circuit comprising at least a first thrust chamber, said active, and a second thrust chamber, said passive, characterized in that the piston is provided, at the active thrust chamber, with a projection with a diameter (C) smaller than the diameter (A) of the thrust chamber, said projection being contained in the active thrust chamber as a whole, and having, preferably, an axial extension equal to at least half diameter of said thrust chamber.

[0022] In addition the invention provides a breaker for excavator with a by-pass system to avoid idle working. Said bypass system comprises a bypass between the high pressure portion and the low pressure portion of the hydraulic circuit, configured such that, in normal working conditions (so with a resistance provided to the tool by the material being worked) the bypass is closed by the piston. Without resistance provided by the material being worked to the tool, the tool (and so the piston) is subject to a greater axial excursion. In this case the bypass is freed and the high pressure circuit is put in communication, through the bypass gap, with the low pressure circuit. In this way, inside the breaker there is only low pressure, the piston is blocked in its position at BDC and cannot go up again any more. The breaker stops functioning. When the operator positions the breaker against the material to be worked again, the bypass is closed and the normal functioning, previously described, is reestablished.

[0023] These and other advantages will be clear from the following description of the invention with reference to the appended figures 1 to 9.

Figure 1 shows an embodiment of a breaker known at the state of the art, and whose functioning was described at the beginning.

Figure 2 shows a preferred embodiment of the breaker according to the present invention.

Figure 3 shows a detail of the embodiment of the discharge gaps according to another preferred embodiment of the breaker according to the present invention;

Figure 4 shows a detail of an embodiment of the discharge gaps according to the known state of the art.

Figure 5 shows a detail of the discharge bypass comprised in the breaker according to the present invention;

Figure 6 shows a detail of the oil supplying system of a preferred embodiment of the breaker according to the present invention.

Figure 7 shows a graph with the flow of the pressure in the thrust chamber and of the discharge pressure during the typical cycle of a breaker known at the state of the art

Figure 8 shows a preferred embodiment of the piston according to the present invention.

Figure 9 shows the piston shown in figure 8 mounted inside a breaker according to the present invention.

Figure 10 and figure 11 show two embodiments of breakers for excavators known at the state of the art, described in EP1964647 and US4281587.

[0024] As it is shown in figure 8, the piston (15) according to the present invention is symmetrically shaped around an axis (150) and is provided with three diameter discontinuities which define four different diameter sections (A, B, C, D).

[0025] In particular, the discontinuity between the greater diameter section (B) and the smaller diameter section (D), when the piston (15) is mounted in the breaker (1) as it is shown in figures 2, 9, 5 faces the passive thrust chamber (20). The circular crown deriving from the discontinuity defines the surface on which the pressure of the liquid present in the thrust chamber (20) acts in axial direction.

[0026] The section with diameter (A), which in the piston according to the present invention is smaller than the diameter (B), is in the active thrust chamber and defines the thrust surface in axial direction of the liquid under pressure. The presence of another diameter section (C), said diameter (C) being smaller than the diameter of the active thrust surface (A) allows to occupy at least partially the volume of the active thrust chamber, increasing the mass of the piston while maintaining equal dimensions of the breaker (1) and piston displacement.

[0027] In order to understand the technical effect obtained by means of this configuration of the piston, it is to be considered that in the embodiments known at the state of the art, shown for example in figures 10 and 11, the piston is provided with a projection at the active thrust chamber. The projection, which is actually a piston section with smaller diameter of the active thrust chamber diameter, is extended beyond the upper limit of the active thrust chamber. The liquid under pressure acts on a surface having circular crown shape defined outside by the diameter of the active thrust chamber and inside by the diameter of the projection.

[0028] In the piston according to the present invention instead, at the active thrust chamber the piston is provided with a projection with diameter (C) smaller than the diameter (A) of the thrust chamber. Said projection, contrary to what happens in the embodiments of the state of the art, is contained as a whole in the active thrust chamber.

[0029] In this way, the liquid under pressure can act on a circular surface defined by the diameter (A) of the thrust chamber (increasing the force exerted at equal pressure), but the reduction in piston mass is limited at the minimum. According to a not limiting preferred embodiment, the axial extension of the projection is equal to at least half of the diameter of the thrust chamber.

[0030] Therefore, this measure increases the force exerted by the piston (15) on the tool (16). Moreover, the presence of the projection with diameter (C), by reducing the volume of the active thrust chamber (11) when the piston is around its upper dead point and the gap under high pressure is freed, allows a more rapid pressurization of the active thrust chamber (11).

[0031] As it is shown in figure 2, the breaker for excavator according to the present invention comprises a piston (15), which acts on the tool (16) according to what described at the beginning.

[0032] The high pressure supplying circuit of the breaker comprises an inlet (13) connected with the active thrust chamber (11) and, through the duct (21), with the passive thrust chamber (20). The supplying circuit is also provided with an annular groove (22) communicating with the high pressure circuit.

[0033] As yet described, the shape of the piston (15) according to the present invention is such that the side surface of the piston is provided with some diameter discontinuities and in particular the piston in the upper portion has a diameter (A) smaller than the cylinder in which it slides, so that it is created a recess between the piston (15), the cylinder and the reduction bushing (24) arranged between the piston and the cylinder, where it is obtained the duct (23).

[0034] In the lower portion with respect to the portion with diameter (A), the diameter (B) of the piston (15) is such that the piston (15) slides in the seat obtained in the body of the breaker (1), and at the same time that the sealing with respect to the bypass is obtained, the bypass comprising the annular groove (22) or a series of holes provided in radial direction on the inner surface of the sliding seat of the piston. In practice, when at the annular groove (22) there is the portion with greater diameter (B) of the piston (15), the groove is not communicating with other ducts other than the supplying duct (21).

[0035] According to another embodiment not shown in figure, the annular groove (22) can be substituted by one or more holes provided in radial direction, or by ducts of other shape, as long as they are useful to the aim.

[0036] If the piston has a greater amplitude than the working one, the portion of the piston with smaller diameter (A) is at the annular groove (22). In this way, the annular groove (22) communicates, through the duct (23), with the return under low pressure of the oil (18).

[0037] Therefore, a preferred path is created for the oil under pressure made up of the supplying section (21), the annular groove (22) and the return duct (23). The possibility for the oil to follow this preferred path depends on the axial position of the piston, and so, of the tool. As yet said, this implies that in the hammer there is only low pressure, because the high pressure inlet (13) is short-circuited with the low pressure outlet (18).

[0038] When the tool meets resistance, it tends to thrust the piston upwards, thus maintaining the axial functioning amplitude in the range. When the thrust exerted by the material being worked is removed, the piston tends to thrust downwards the tool beyond the allowed limit. In this way, however, it is freed the annular groove (22), which, by realizing the described by-pass, annuls the pressure forces acting on the piston, which is blocked at the lower dead point, leaving the groove (22) in communication with the groove (154) and so with the duct (23).

[0039] Thus, it is realized a breaker for excavator according to the prefixed aims.

[0040] According to other preferred embodiments, the just described breaker can be modified as better described in the following.

[0041] In particular, the variations with respect to the known state of the art, aim at reducing the piston displacement in case of equal force exerted, at optimizing the ratio between the accumulator volume and the piston displacement, in addition to the layout of the high and low pressure circuits in order to reduce the charge loss and at the same to avoid pressure peaks.

[0042] The piston displacement of a breaker is given by the upper surface of the piston, i.e. the surface of the active thrust chamber, multiplied for its stroke. During the active step, when the thrust chamber is put under pressure by the oil of high circuit, thrusting the piston downwards to strike the tool, it is needed to guarantee that the chamber is pressurized for the whole active step notwithstanding the expansion due to the piston going down. Having an insufficient oil flow rate implies a worst pressurization and a reduction of the striking speed of the piston on the tool. To avoid this phenomenon, in the breaker for excavators according to the present invention the piston displacement is reduced, reducing the diameter (A) of the thrust chamber. For example, without this being limiting for the aims of the present invention, for hammers between 200 and 300 kg it is presumable the use of thrust chambers with diameter between 40 and 45mm. The reduction of the piston displacement implies that during the active step the hammer needs less oil, so it can also function with lower flow rates. But in order to maintain a correct functioning of the system it is needed that the geometry of the piston (15) is modified. In particular, the piston (15) is provided with a diameter of active thrust smaller than the one of passive thrust (A<B). It is particularly useful to act on the diameter instead on the stroke to reduce the piston displacement, because, since the piston displacement is proportional to the diameter squared, to intervene on the diameter has a greater action than to intervene on the stroke. Reducing the diameter of the active thrust chamber, and maintaining however unaltered the mass of the piston (15), since this one determines the kinetic energy for the breaking, it is needed to increase the diameter of the piston (15) in the lower portion, in order not to have to increase its length. Further, the just described provision of the projection with diameter (C) allows the mass to be further increased at equal dimension of the piston (15).

[0043] The increase in length can be in fact disadvantageous for dimension reasons and also because too thin pistons are not apt to transmit the striking energy to the tool, which has dimensions more or less fixed for commercial reasons. Generally, it is convenient that the piston has about the same diameter as the tool, but never lower, in order to maximize the striking energy transmission. Therefore, the variations of diameter of the piston allow the interface with the tool to be maintained unvaried and optimized to transmit the striking energy, without modifying the tool and without increasing the axial dimension of the breaker. This allows also to use yet existing tools for breakers known at the state of the art with pistons with the same weight.

[0044] As yet said, a fundamental element for the breaker performance is the accumulator. It has to be able to provide in active step the needed flow rate to pressurize the active thrust chamber, but it is important that the variation between the maximum and minimum pressure is the lowest possible so that the membrane is not stressed and to stabilize the functioning range of the breaker, thus avoiding too high pressure variations which have effect on the oil pump functioning. In fact, the greater the pressure under which the circuit works, the lower the flow rate supplied by the oil supplying pump. For this reason, it is ideal to work with a constant supplying pressure during all the cycle.

[0045] For this reason, according to a preferred embodiment of the breaker according to the present invention, even reducing the piston displacement of the breaker with respect to what known at the state of the art at equal force exerted by the breaker, there have been maintained accumulators with volumes similar to those traditionally used on breakers known at the state of the art. The ratio between the volume of the accumulator and the hammer piston displacement according to the present invention is preferably between 10 and 14, contrary to what known at the state of the art, in which such ratio is lower than 10.

[0046] Concerning the high pressure circuit in the breaker according to the present invention there have been adopted some measures to reduce the charge loss in the hydraulic circuit between the inlet of the breaker/accumulator and the inlet gap in the active thrust chamber. Such measures are:

- introduction of a chamfer (30) shown in figure 6, at the intersection between the duct (144) connecting the accumulator (14) to the active thrust chamber (11) and the duct (31) connecting the inlet (13) with the inlet gap in the active thrust chamber so that it is favoured the oil direction change avoiding the vortexes formation;

- alignment of the inlet duct of the breaker (13) with the inlet duct (31) in the active thrust chamber, in order to reduce the deviations in the oil path connecting the inlet to the thrust chamber.
- increase in the area of the inlet gap in the active thrust chamber. In particular, the ratio between the area of the inlet gap and piston displacement is greater than 1.5E-02m^{-1}.

[0047] Also the low pressure circuit of the breaker according to the present invention is modified with respect to the known state of the art. The low pressure circuit is in fact connected to the high circuit through the ratio of the active and passive thrust areas of the piston. In passive step the piston is subject to the action of two forces acting in vertical direction. The first, which brings it again upwards is given by the product of the high pressure for the passive thrust chamber.

[0048] The other force is given by the product of the pressure in the active thrust chamber, which in this step is connected with the low pressure portion of the hydraulic circuit, for the active thrust area. Since the active thrust area is greater than the passive one, it follows that in order to make the piston go up again from BDC to TDC the high pressure cannot be lower than a minimum value, in function of the ratio of the two areas multiplied for the pressure in the thrust chamber in this step. At the end of the active step the active thrust chamber is in connection with the high pressure. The distributor begins to go up and closes the high pressure. From now on until the moment in which it opens the discharge gaps there are generally 4-6 mm of stroke in which the distributor goes up and all the gaps are closed.

[0049] Such value cannot be brought to zero owing to the working tolerances and considering the wear of the components in time. This means that the volume of such a chamber increases, owing to the difference between the outer upper and lower diameter of the distributor. Since the oil is not compressible, to such expansion corresponds a loss in pressure in the active thrust chamber.

[0050] Theoretically, it can be reached also a lower pressure than the vapour tension, even if the pressure depends really also on inner drawings and on the air quantity dissolved in the oil. In any case, when the low pressure gap is freed it can happen that the pressure in the active thrust chamber is lower than the one of recirculation, therefore the chamber is pressurized almost instantly. However, in this step, the piston has yet began again its going up step, so when the active thrust chamber is pressurized, the force needed to make the piston go up again increases suddenly by a very great value, equal to the product of the ratio between the two areas previously cited for the pressure jump which occurred in chamber. This causes pressure oscillatory phenomena at the inlet detected on some breakers, and shown in figure 7.

[0051] The increase in high pressure gap at values greater than 1.5E-02m^{-1} with respect to the piston displacement avoid the described inconvenient, for two reasons:

- during the active step the thrust chamber is better pressurized and so it reaches final higher pressure values, so also with the following expansion due to the distributor going up again, the final pressure will be higher and so near the recirculation one;
- the increase in dimensions of the inlet gap in the active thrust chamber has reduced the length of the piston stroke during which all the gaps are closed. Such stroke can be considered approximately equal to 2mm. It follows that the expansion connected to a reduced stroke creates a lower pressure jump.

[0052] The low pressure circuit of the breaker according to the present invention eliminates the annular chamber around the piston. Referring to the figure 3, while the distributor goes down from TDC to BDC, the oil is first discharged through the primary discharge gap (50) and when this is closed through the secondary one (40).

[0053] In the breakers known at the state of the art, the secondary gap (40) is normally closed by the piston, but during the active step, while the piston goes down, at a certain point, the secondary gap is freed and put in communication with an annular chamber (42) obtained in the piston which in turn is in communication with the discharge. The oil reaches the discharge passing through a chamber (42) obtained in the volume of the piston. Obviously this annular chamber is in movement since the piston is going down.

[0054] In the breaker according to according to the present invention, the secondary discharge gap (40) is directly in connection with the discharge, through an annular compensation chamber (41) obtained in the body of the breaker and not in the piston. In this way, the oil makes less road and the discharge loss is reduced. Therefore, lowering the average pressure at the discharge allows to lower the maximum inlet pressure avoiding that it reaches too high values. The compensation chambers are aimed at attenuating possible pressure peaks when the distributor begins again its going up. In this step, in fact, until the distributor does not close the high pressure gap, the low circuit is in communication with the high one through the secondary discharge gap. This step is very short (< 1 ms), but during this step a pressure peak in the low circuit could be created.

[0055] The compensation chambers serve to attenuate such peak.

Claims

1. **1.** Breaker for excavator (1) comprising:

   - a body (10) inside which a hydraulic circuit is formed which can be supplied from outside with liquid under pressure, said hydraulic circuit comprising:

     - an inlet (13) for the liquid under pressure;
     - an outlet (18) for the return of the liquid under pressure to the supplying circuit;
     - an active thrust chamber (11) and a passive thrust chamber (20);
     - ducts (12, 21) to connect said active thrust chamber (11) and said passive thrust chamber (20) to said inlet (13);

   - a piston (15) configured so that it can slide in a reciprocating motion inside said breaker under the thrust of said liquid under pressure, said piston (15) being provided, at the active thrust chamber, with a projection having a diameter (C) smaller than the diameter of the active thrust surface, said projection being wholly contained inside the active thrust chamber,

     - a tool (16) coaxially positioned to said piston (15) and configured to slide axially between a first and a second position;
     - a distributor (17), positioned concentrically to said piston (15) and configured to slide axially putting in communication, alternatively, the active thrust chamber (11) with the high pressure portion or the low pressure portion of the hydraulic circuit, said distributor being configured to assuming at least a position where the distributor is inserted around the piston;

   Characterized in that
   Said breaker further comprises

   - a bypass between said ducts (12, 21) which connects said thrust chambers (11, 20) to said inlet (13) and outlet (18), configured so that said bypass is free when the piston (15) is in a position with an axial excursion greater than a predetermined limit position;
   - an accumulator (14) comprising a first volume (142) connected to said circuit containing the liquid under pressure and a second volume (141) separated from said first volume (142) by an elastic membrane (143) and **in that** said piston (15) and said projection are configured so that the liquid under pressure can act on a circular surface defined by the diameter of said active thrust chamber (11).

2. Breaker for excavator (1) according to claim 1, further comprising a tool-stopper (21) integral with said metal body and **characterized in that** said first and second position are defined by the engagement of the ends (161, 162) of a groove (163) obtained in said tool (16) on said tool-stopper (21).

3. Breaker for excavator according to any one of claims 1 to 2, **characterized in that** said bypass comprises an annular groove (22) concentric to the piston (15), communicating with said ducts (12, 21) to connect said active thrust chamber and said passive thrust chamber to said inlet (13).

4. Breaker for excavator according to any one of claims 1 to 2, **characterized in that** said bypass comprises one or more holes provided in radial direction on the inner surface of the sliding seat of said piston (15), communicating with said ducts (12, 21) to connect said active thrust chamber and said passive thrust chamber to said inlet (13).

5. Breaker for excavator according to any one of claims 3 or 4, **characterized in that** the section of said piston (15) that, in working position, is in correspondence of said annular groove (22) or said holes provided in radial direction, has a diameter (B) such that the piston (15) slides in the seat obtained in the body of the breaker (1), and at the same time it is obtained a seal with respect to the annular groove (22) or the holes provided in radial direction on the inner surface of the sliding seat of the piston, and **in that**, said piston (15) has further a section, having a diameter (A) minor than said diameter (B) previously defined, said further section being in correspondence of said annular groove (22) or said radial holes when the axial amplitude of the piston is greater than said limit position, thus freeing said bypass and putting in communication said inlet (13) with said return under low pressure of the oil (18).

6. Breaker for excavator according to any one of the preceding claims, further comprising an annular chamber (41) in communication with the outlet (18) of the hydraulic circuit and arranged concentrically to said piston (15), which is put in communication with said passive thrust chamber (20) during the piston going down, thus allowing to discharge the oil from said passive thrust chamber at the outlet of the hydraulic circuit **characterized in that** said annular chamber (41) is obtained in the metal body of said breaker.

7. Breaker for excavator according to claim 1, **characterized in that** the ratio between said first volume (142) of said accumulator (14) and the piston displacement of the breaker is preferably between 10 and 14.

8. Breaker for excavator according to any one of claims 6 or 7 **characterized in that** at the intersection between the duct (144) connecting the accumulator (14) with the active thrust chamber (11) and the duct (31) connecting the inlet (13) with the active thrust chamber is provided a chamfer so that the oil direction change is favoured avoiding the formation of vortexes.

9. Breaker for excavator according to any one of the preceding claims, **characterized in that** the ratio between the area of the inlet gap in the active thrust chamber (11) and the piston displacement is greater than $1.5E\text{-}02m^{-1}$.

Patentansprüche

1. Baggerbrecher (1) umfassend:

    - einen Körper (10), in dem ein Hydraulikkreis gebildet ist, der von außen mit Flüssigkeit unter Druck versorgt werden kann, wobei der Hydraulikkreis umfasst:

        - einen Einlass (13) für die unter Druck stehende Flüssigkeit;
        - einen Auslass (18) für die Rückführung der unter Druck stehenden Flüssigkeit in den Versorgungskreis;
        - eine aktive Schubkammer (11) und eine passive Schubkammer (20);
        - Leitungen (12, 21) zum Verbinden der aktiven Schubkammer (11) und der passiven Schubkammer (20) mit dem Einlass (13);
        - einen Kolben (15), der so konfiguriert ist, dass es in einer Hin- und Herbewegung im Inneren des Baggerbrechers unter dem Schub der Flüssigkeit unter Druck gleiten kann; wobei der Kolben (15) an der aktiven Schubkammer von einem Vorsprung versehen ist, die einen Durchmesser (C) aufweist, der kleiner ist als der Durchmesser der aktiven Schubfläche, wobei der Vorsprung gänzlich innerhalb der aktiven Schubkammer enthalten ist,
        - ein Werkzeug (16), das koaxial zu dem Kolben (15) positioniert ist und konfiguriert ist, um axial zwischen einer ersten und einer zweiten Position zu gleiten;
        - ein Verteiler (17), der konzentrisch zu den Kolben (15) ist und derart konfiguriert ist, dass er axial alternativ in Kommunikation mit der aktiven Schubkammer (11) mit dem Hochdruckteil oder dem Niederdruckteil des Hydraulikkreises gleiten kann, wobei der Verteiler derart konfiguriert ist, dass er zumindest eine Position einnimmt, in der der Verteiler um den Kolben herum eingeführt ist;

    dadurch gekennzeichnet dass,
    der Baggerbecher ferner umfasst

    - einen Bypass zwischen den Leitungen (12, 21), der die Schubkammern (11, 20) mit dem Einlass (13) und dem Auslass (18) verbindet und ist derart konfiguriert, dass der Bypass frei ist, wenn sich der Kolben (15) in einer Position befindet, die eine axiale Auslenkung aufweist, die größer als eine vorbestimmte Grenzposition ist;
    - einen Akkumulator (14) mit einem ersten Volumen (142), das mit dem Kreislauf verbunden ist, der die unter Druck stehende Flüssigkeit enthält, und mit einem zweiten Volumen (141), das von dem ersten Volumen (142) durch eine elastische Membran (143) getrennt ist

    und dass
    der Kolben (15) und der Vorsprung so konfiguriert sind, dass die unter Druck stehende Flüssigkeit auf eine kreisförmige Oberfläche wirken kann, die durch den Durchmesser der aktiven Schubkammer (11) definiert ist.

2. Baggerbrecher (1) nach Anspruch 1, ferner umfassend einen Werkzeugstopper (21), der integral mit dem Metallkörper ist, und **dadurch gekennzeichnet, dass** die erste und zweite Position durch den Eingriff der Enden (161, 162) einer Nut (163) definiert sind, die in dem Werkzeug (16) (163) an dem Werkzeugstopper (21) enthalten ist.

3. Baggerbrecher nach einem der Ansprüche 1 bis 2, **dadurch gekennzeichnet, dass** der Bypass eine zum Kolben (15) konzentrische ringförmige Nut (22) aufweist, die mit den Leitungen (12, 21) kommuniziert, um die aktive Schubkammer und die passive Schubkammer zum Einlass (13) zu verbinden.

4. Baggerbrecher nach einem der Ansprüche 1 bis 2, **dadurch gekennzeichnet, dass** der Bypass ein oder mehrere Löcher umfasst, die in radialer Richtung an der Innenfläche des Schiebesitzes des Kolbens (15) vorgesehen sind und mit den Leitungen (12, 21) in Verbindung stehen, um die aktive Schubkammer und die passive Schubkammer mit dem Einlass (13) zu verbinden.

5. Baggerbrecher nach einem der Ansprüche 3 oder 4, **dadurch gekennzeichnet, dass** der Querschnitt des Kolbens (15), der in der Arbeitsstellung in Entsprechung der ringförmigen Nut (22) oder der Löcher in radialer Richtung vorgesehen ist, einen solchen Durchmesser (B) aufweist, dass der Kolben (15) in dem im Körper des Baggerbrechers (1) erhaltenen Sitz gleitet und gleichzeitig eine Abdichtung gegenüber der ringförmigen Nut (22) oder den Löchern erreicht wird, die in radialer Richtung an der Innenfläche des Gleitsitzes des Kolbens vorgesehen sind, und dadurch, dass der Kolben (15) ferner einen Abschnitt mit einem Durchmesser (A) aufweist, der kleiner als der zuvor definierte Durchmesser (B) ist, wobei der weitere Abschnitt ist in Übereinstimmung mit der ringförmigen Nut (22) oder den radialen Löchern, wenn die axiale Amplitude des Kolbens größer als die Grenzposition ist, wodurch der Bypass freigegeben ist und der Einlass (13) mit dem Rücklauf unter niedrigem Druck des Öls (18) verbunden wird.

6. Baggerbrecher nach einem der vorhergehenden Ansprüche, ferner umfassend eine ringförmige Kammer (41), die mit dem Auslass (18) des Hydraulikkreises in Verbindung steht und konzentrisch zu dem Kolben (15) angeordnet ist, wobei die passive Schubkammer (20) während des Absenkens des Kolbens ermöglicht, das Öl aus der passiven Schubkammer am Auslass des Hydraulikkreises abzulassen, **dadurch gekennzeichnet, dass** die ringförmige Kammer (41) im Metallkörper des Baggerbrechers erhalten wird.

7. Baggerbrecher nach Anspruch 1, **dadurch gekennzeichnet, dass** das Verhältnis zwischen dem ersten Volumen (142) des Akkumulators (14) und der Kolbenverdrängung des Baggerbrechers vorzugsweise zwischen 10 und 14 beträgt.

8. Baggerbrecher nach einem der Ansprüche 6 oder 7, **dadurch gekennzeichnet, dass** an der Kreuzung zwischen der Leitung (144), die den Akkumulator (14) mit der aktiven Schubkammer (11) verbindet, und der Leitung (31), die den Einlass (13) mit der aktiven Schubkammerverbindet, ist eine Fase vorgesehen, damit die Ölrichtungsänderung begünstigt wird und Wirbelbildung vermieden wird.

9. Baggerbrecher nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Verhältnis zwischen der Fläche des Einlaufspaltes in der aktiven Schubkammer (11) und dem Kolbenverschiebung größer als 1,5E-02m^{-1} ist.

Revendications

1. Brise-roche pour excavatrice (1) comprenant :

- un corps (10) à l'intérieur duquel est formé un circuit hydraulique pouvant être alimenté de l'extérieur avec un liquide sous pression, ledit circuit hydraulique comprenant:

  - une entrée (13) pour le liquide sous pression;
  - une sortie (18) pour le retour du liquide sous pression vers le circuit d'alimentation ;
  - une chambre de poussée active (11) et une chambre de poussée passive (20);
  - des conduits (12, 21) pour relier ladite chambre de poussée active (11) et ladite chambre de poussée passive (20) à ladite entrée (13);
  - un piston (15) configuré pour pouvoir coulisser dans un mouvement alternatif à l'intérieur dudit brise-roche sous la poussée dudit liquide sous pression, ledit piston (15) étant pourvu, au niveau de la chambre de poussée active, d'une saillie ayant un diamètre (C) inférieur au diamètre de la surface de poussée active, ladite saillie étant entièrement contenue à l'intérieur de la chambre de poussée active ;
  - un outil (16) positionné coaxialement audit piston (15) et configuré pour coulisser axialement entre une première et une deuxième position;
  - un distributeur (17), positionné concentriquement audit piston (15) et configuré pour coulisser axialement

en mettant en communication, alternativement, la chambre de poussée active (11) avec la partie haute pression ou la partie basse pression du circuit hydraulique, ledit distributeur étant configuré pour prendre au moins une position où le distributeur est inséré autour du piston;

caractérisé en ce
ledit brise-roche comprend en outre

- une dérivation entre lesdits conduits (12, 21) qui relie lesdites chambres de poussée (11, 20) auxdites entrée (13) et sortie (18), configurée pour que ladite dérivation soit libre lorsque le piston (15) est en position avec une excursion axiale supérieure à une position limite prédéterminée;
- un accumulateur (14) comprenant un premier volume (142) relié audit circuit contenant le liquide sous pression et un deuxième volume (141) séparé dudit premier volume (142) par une membrane élastique (143)

et en ce que
ledit piston (15) et ladite saillie sont configurés pour que le liquide sous pression puisse agir sur une surface circulaire définie par le diamètre de ladite chambre de poussée active (11).

2. Brise-roche pour excavatrice (1) selon la revendication 1, comprenant en outre un arrêt d'outil solidaire dudit corps métallique et **caractérisé en ce que** lesdites première et deuxième positions sont définies par l'engagement des extrémités (161, 162) d'une rainure (163) obtenue dans ledit outil (16) sur ledit arrêt d'outil (21).

3. Brise-roche pour excavatrice selon l'une quelconque des revendications 1 à 2, **caractérisé en ce que** ladite dérivation comprend un rainure annulaire (22) concentrique au piston (15), communiquant avec lesdits conduits (12, 21) pour relier ladite chambre de poussée active et ladite chambre de poussée passive à ladite entrée (13).

4. Brise-roche pour excavatrice selon l'une quelconque des revendications 1 à 2, **caractérisé en ce que** ladite dérivation comprend un ou plusieurs trous ménagés en direction radiale sur la surface intérieure du siège coulissant dudit piston (15), communiquant avec lesdits conduits (12, 21) pour relier ladite chambre de poussée active et ladite chambre de poussée passive à ladite entrée (13).

5. Brise-roche pour excavatrice selon l'une quelconque des revendications 3 ou 4, **caractérisé en ce que** la section dudit piston (15) qui, en position de travail, est en correspondance de ladite rainure annulaire (22) ou desdits trous prévus en direction radiale, a un diamètre (B) tel que le piston (15) coulisse dans le siège obtenu dans le corps du brise-roche (1), et en même temps on obtient une étanchéité par rapport à la rainure annulaire (22) ou aux trous prévus dans la direction radiale sur la surface intérieure du siège coulissant du piston, et **en ce que** ledit piston (15) a en outre une section ayant un diamètre (A) inférieur audit diamètre (B) précédemment défini, ladite autre section étant en correspondance de ladite rainure annulaire (22) ou desdits trous radiaux lorsque l'amplitude axiale du piston est supérieure à ladite position limite, libérant ainsi ladite dérivation et mettant en communication ladite entrée (13) avec ledit retour sous basse pression de l'huile (18).

6. Brise-roche pour excavatrice selon l'une quelconque des revendications précédentes, comprenant en outre une chambre annulaire (41) en communication avec la sortie (18) du circuit hydraulique et disposée concentriquement audit piston (15), qui est mise en communication avec ladite chambre de poussée passive (20) lors de la descente du piston, permettant ainsi d'évacuer l'huile de ladite chambre de poussée passive en sortie du circuit hydraulique **caractérisé en ce que** ladite chambre annulaire (41) est obtenue dans le corps métallique dudit brise-roche.

7. Brise-roche pour excavatrice selon la revendication 1, **caractérisé en ce que** le rapport entre ledit premier volume (142) dudit accumulateur (14) et la cylindrée du piston du brise-roche est de préférence compris entre 10 et 14.

8. Brise-roche pour excavatrice selon l'une quelconque des revendications 6 ou 7, **caractérisé en ce qu'**à l'intersection entre le conduit (144) reliant l'accumulateur (14) à la chambre de poussée active (11) et le conduit (31) reliant l'entrée (13) avec la chambre de poussée active est prévu un chanfrein afin que le changement de direction de l'huile soit favorisé en évitant la formation de vortex.

9. Brise-roche pour excavatrice selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le rapport entre la surface de l'espace d'entrée dans la chambre de poussée active (11) et la cylindrée du piston est supérieur à 1, $5E\text{-}02m^{-1}$.

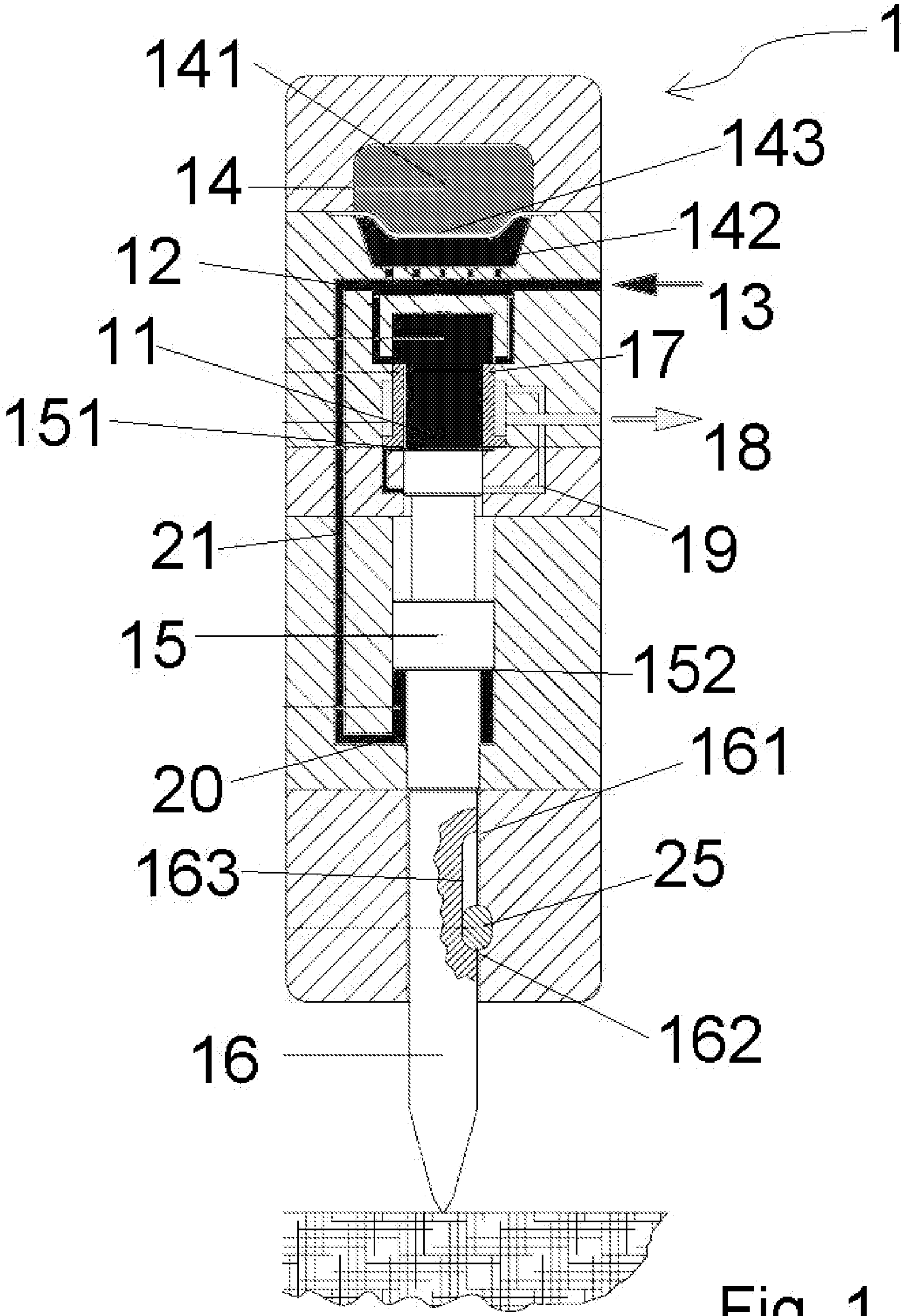

Fig. 1

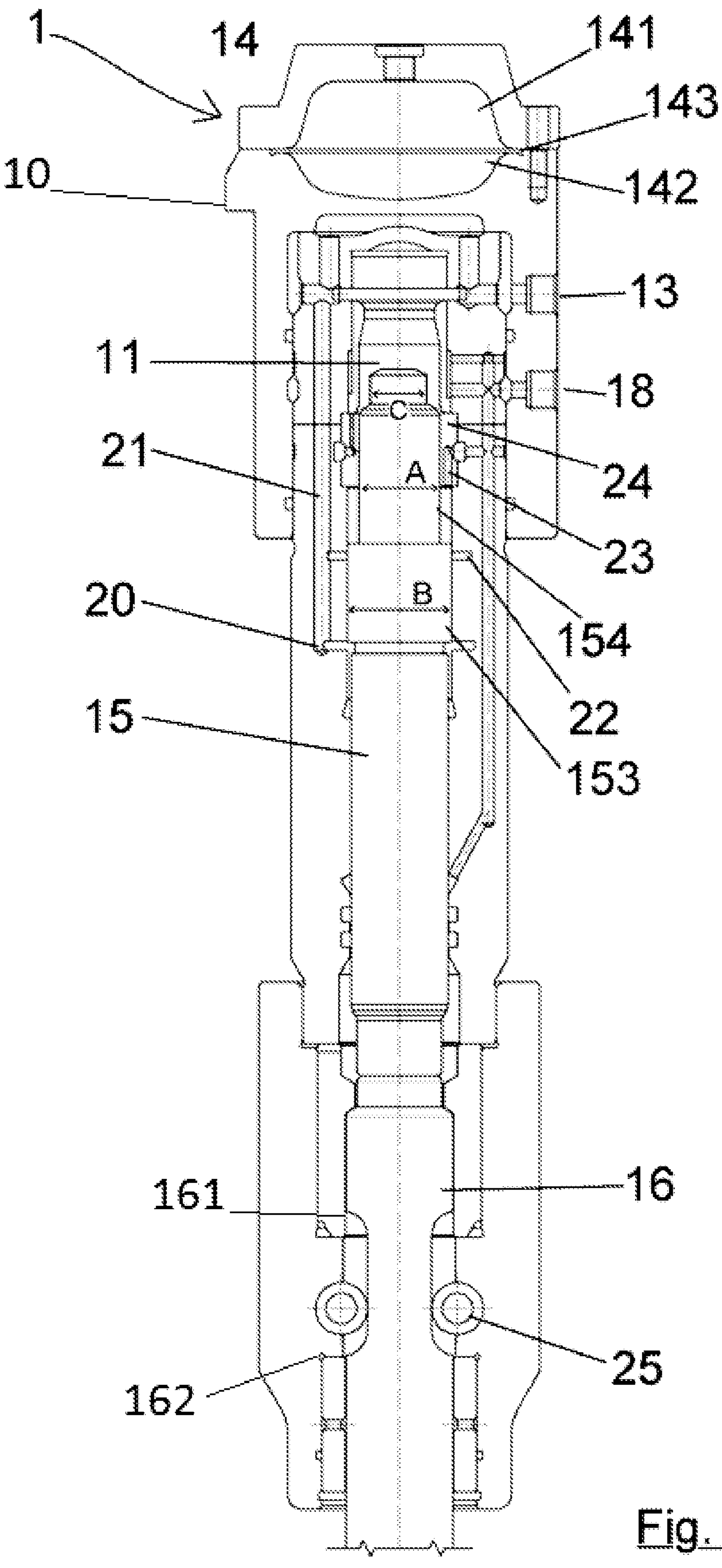
1
14
141
143
142
10
13
11
18
C
21
24
A
23
20
154
B
22
15
153
161
16
25
162

Fig. 2

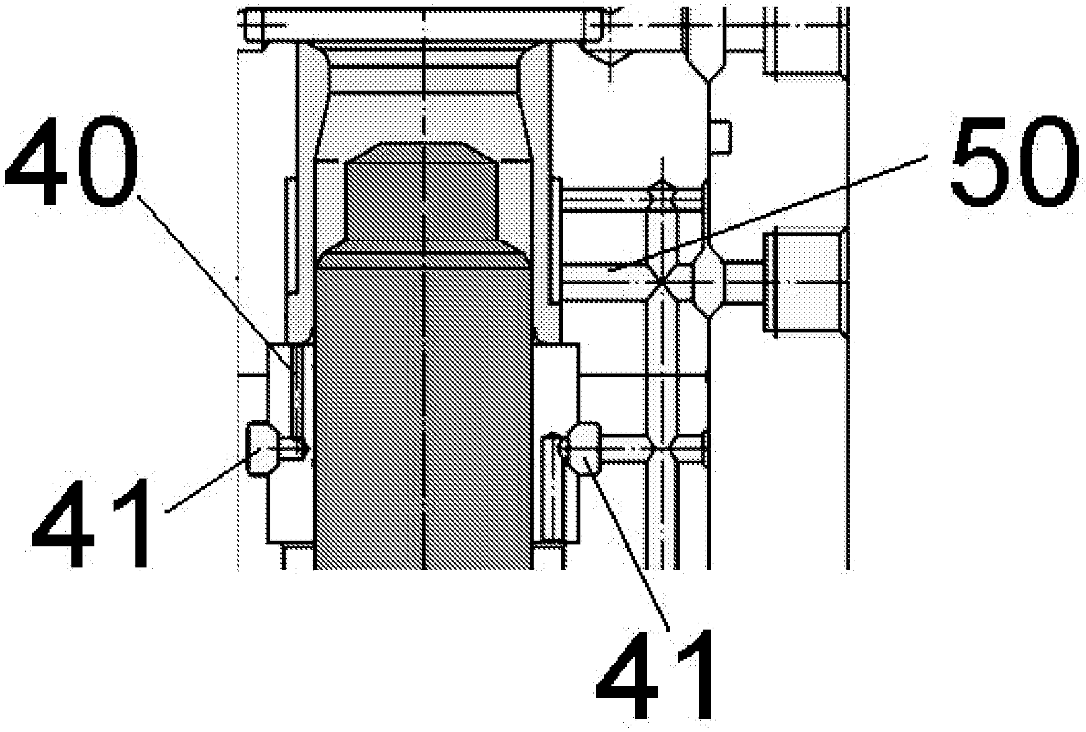

Fig. 3

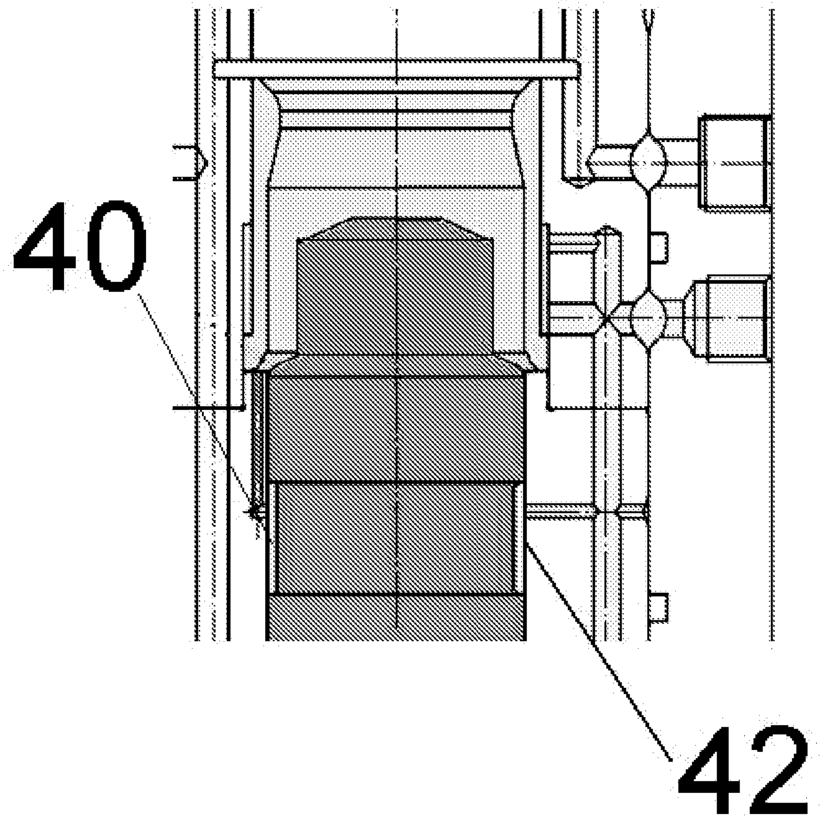

Fig 4

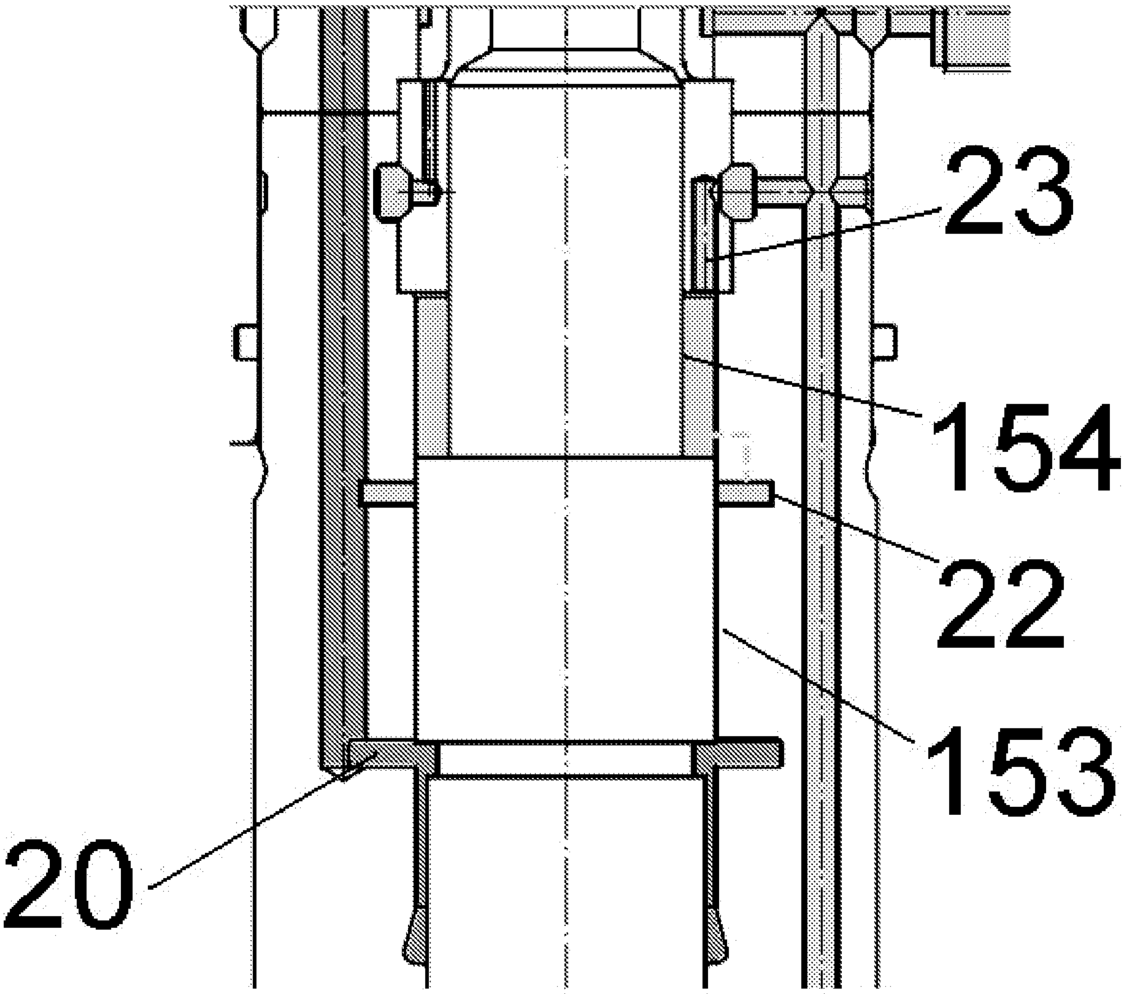

Fig. 5

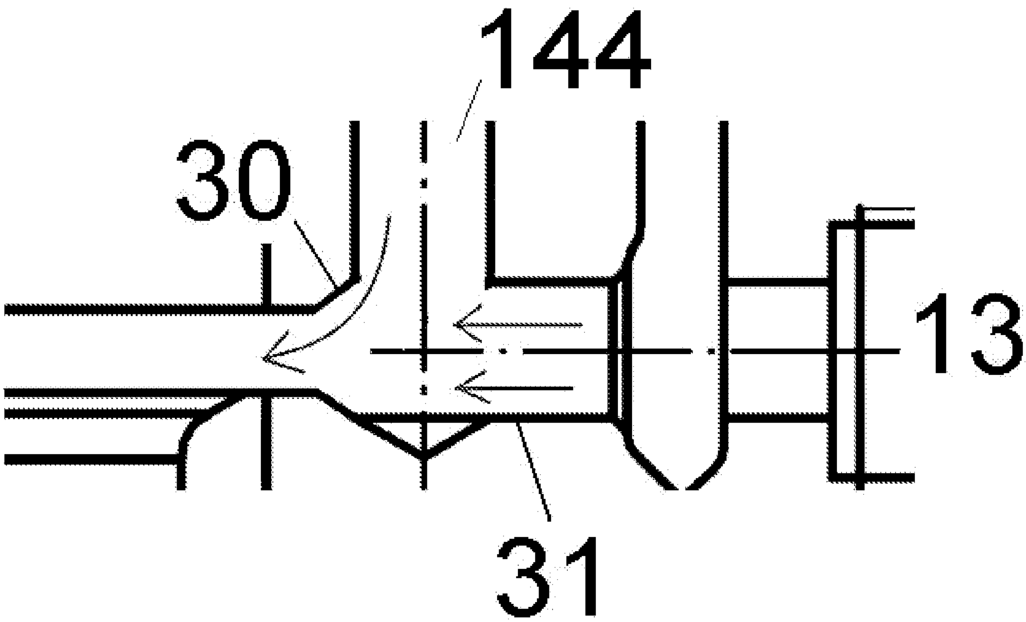

Fig. 6

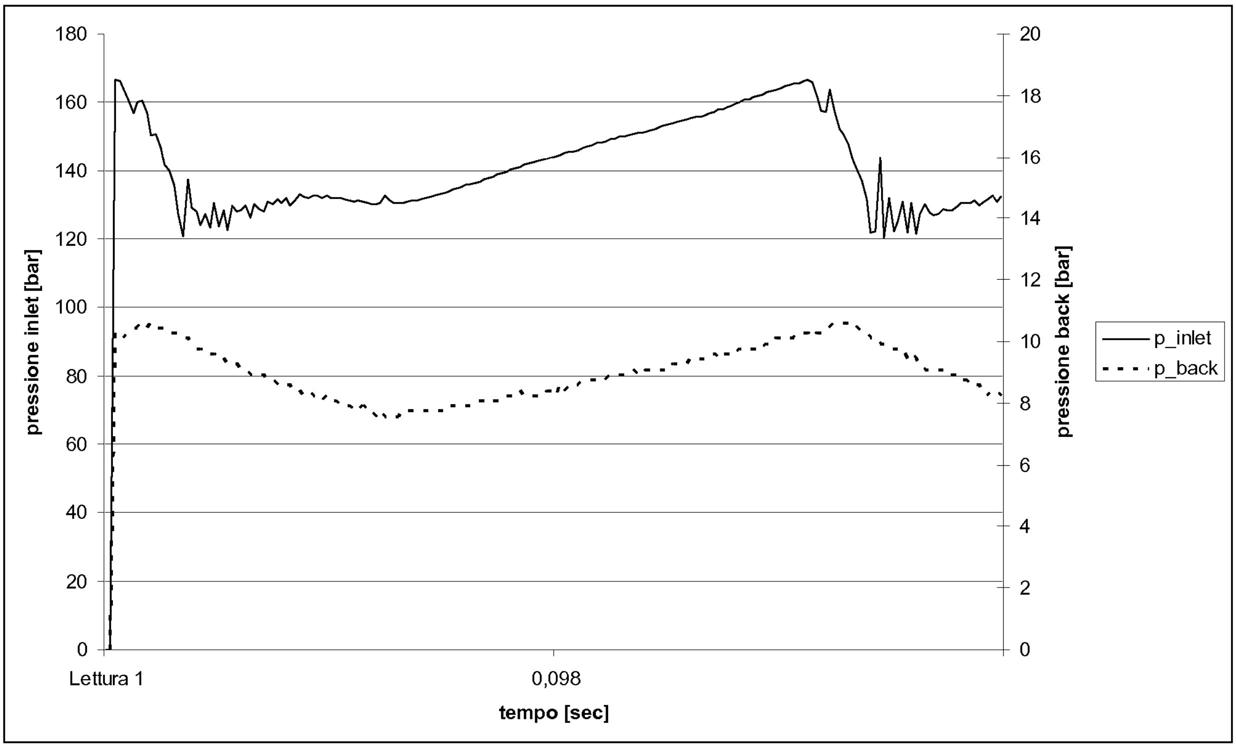
180
160
140
120
100
80
60
40
20
0
pressione inlet [bar]
20
18
16
14
12
10
8
6
4
2
0
pressione back [bar]
p_inlet
p_back
Lettura 1
0,098
tempo [sec]

Fig. 7

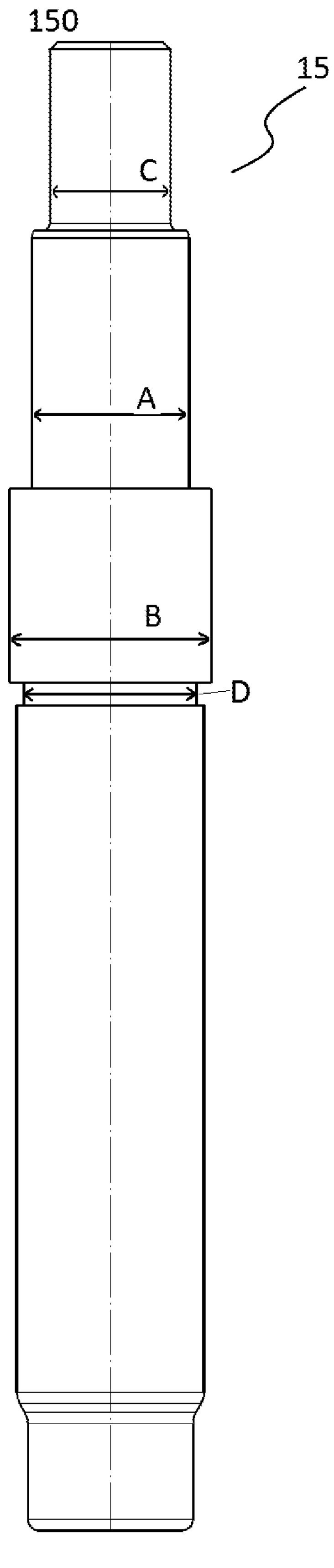

Fig. 8

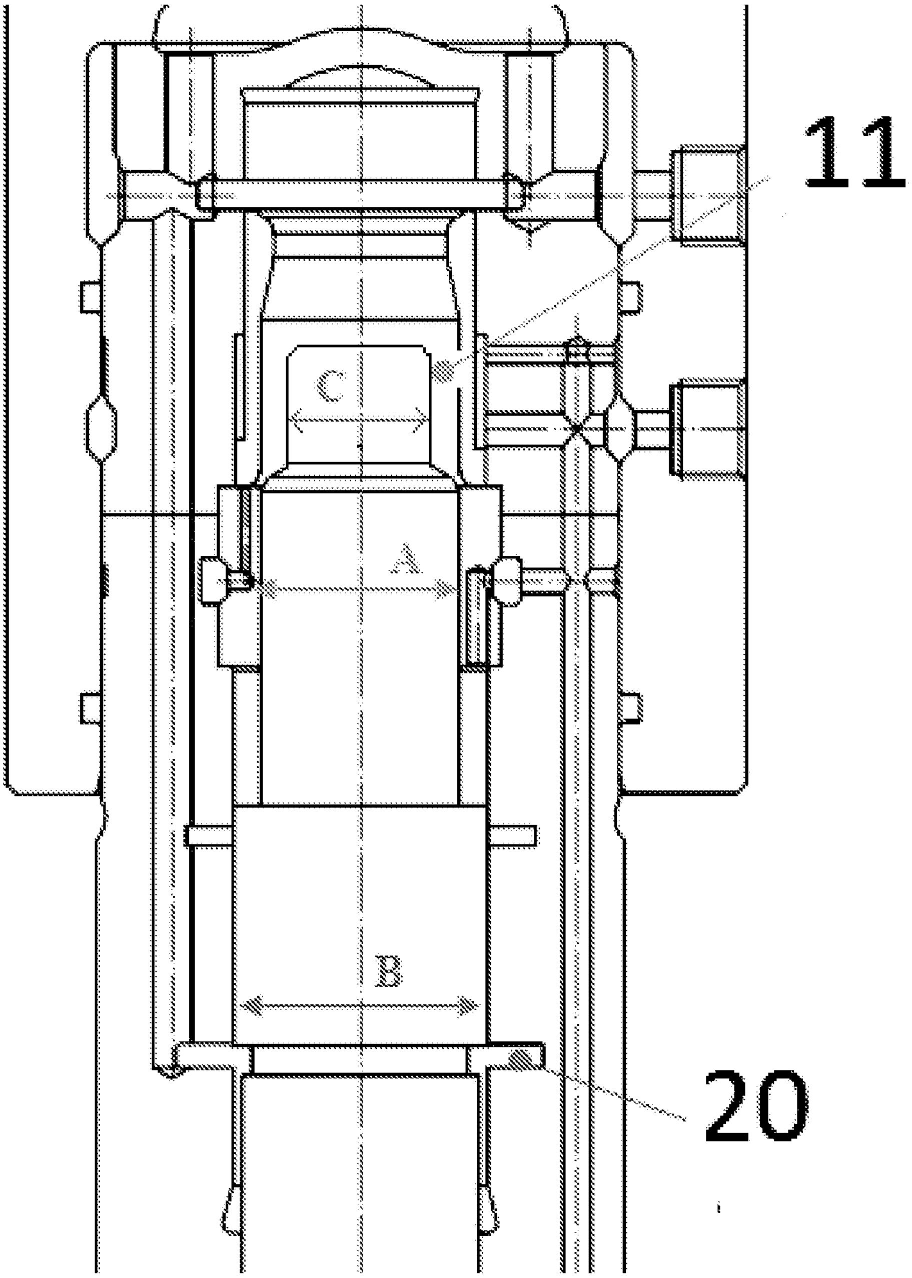

Fig. 9

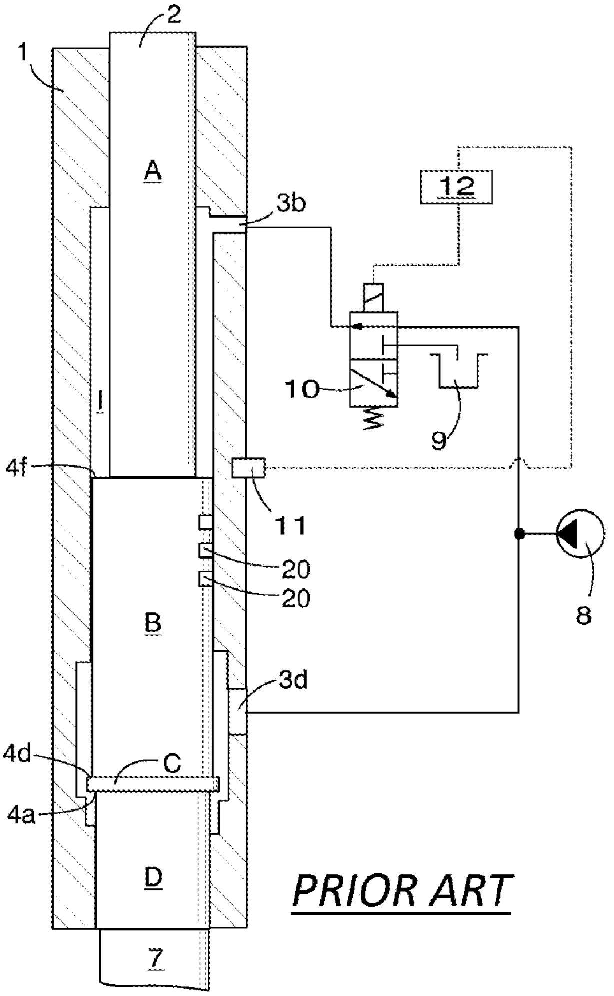

Fig. 10

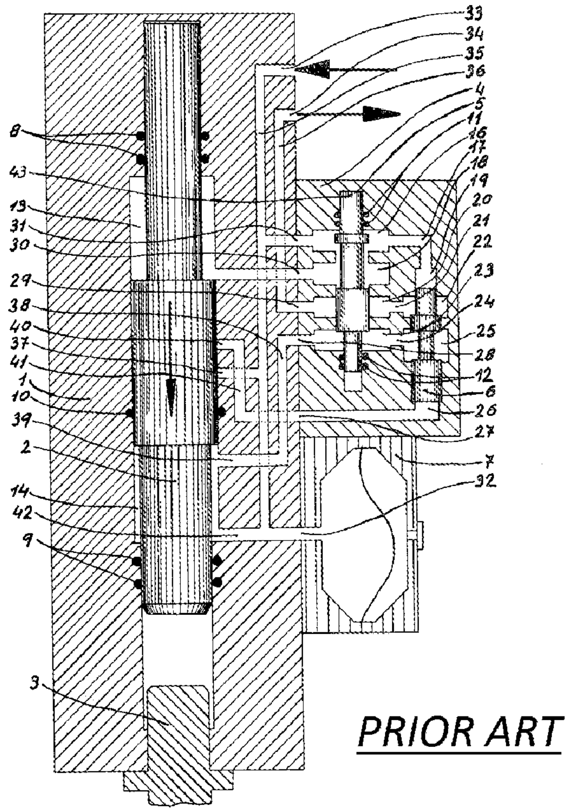

Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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