

**DESCRIPTION****“Hydraulic hammer device for excavators”**

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The object of the present invention is a ripper-type hydraulic hammer device formed as an implement for an excavator which delivers blows to and digs up rock, concrete, asphalt, or any other type of ground and essentially consists of a hydraulic motor which receives oil flow and pressure from the excavator and is responsible for  
10 operating a series of elements hammering the ripper, giving it a movement which delivers blows to the ground.

**PRIOR ART**

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Hydraulic hammers are extremely well-known in the field of public works as a basic implement for breaking hard grounds. These hammers are generally formed by an essentially cylindrical body internally housing a piston configured for delivering blows to a ground rod which, floating on at least one bushing, is responsible for attacking  
20 the ground.

The ground rod has a vertical stroke. The operation of the hammer essentially starts from receiving oil from the excavator, putting pressure on the piston, such that it moves down very quickly and delivers blows to the ground rod, and the latter in turn  
25 delivers blows to the ground. In addition, when the piston moves up, the piston returns the oil to the excavator and loads a nitrogen chamber, such that nitrogen pressure strongly pushes against the piston, delivering blows to the ground rod and the ground accordingly.

30 Certain details of the operation may vary according to the manufacturer, but the basic operation principle is that described above.

Nevertheless, there is a significant yield loss with the conventional solution: it only uses between 50%-60% of the energy supplied by the excavator (i.e., the supplied  
35 oil). When the piston moves down, the oil sent by the machine goes directly to the

return tank after circulating without being used in any other way by the hammer. In other words, that oil does not generate any work.

5 To prevent this loss, some manufacturers use an accumulator, such that oil not used previously goes to said accumulator such that when the piston moves down, the oil remains inside the accumulator instead of being sent to the return tank, injecting it during the upward movement of the cylinder so that said ascent is faster. Nevertheless, the actual yield is hardly improved in practice, since an improvement of said yield in the order of 5%-10% is virtually unnoticeable in use.

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Another important technical problem of conventional hammers derives from the fact that the ground rod is a floating element independent of the piston, since it must logically be made of a much stronger structure. If the piston was delivering blows directly, it would have to be made of special steel, and furthermore, in the event that it wore out, the entire assembly would have to be replaced, which would increase the cost of the system disproportionately. Given the floating structure supported on special bushings, the ground rod generates side clearances during use which in a long run results in the ground rod tilting and blows being delivered to the piston in a non-planar manner, so if there is no constant maintenance, the ground rod deforms, causing the piston and therefore the hammer to break in many cases. Examples of conventional or simplified hammers can be found in patent documents US5445323 and ES2296139.

25 Patent documents describing different hammer configurations with different distributions for solving different technical problems include ES2181716 (preventing water hammer in drilling), ES1075243 (boring and delivering blows by means of rotating the ground rod) and ES2296153 (describing a hammer having a distribution valve with improved tightness).

30 Finally, various patent documents that attempt to at least partially solve some of the preceding problems and fall within the object of the invention, which is the combination of the features of a ripper-type digging device with a breaking device such as the hydraulic hammer, are described in the state of the art. Patent document US6517164 combines the advantages of hydraulic hammers and rippers. Nevertheless, its structure is not compact, rather they are elements exchangeable

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through force transmission means which, in practice, means that the implements for attacking the ground are floating implements and therefore would also tend to break along their connection and rotating shaft. Another patent document combining both devices is US4666213, but as in the preceding case they are non-integrated  
5 superimposed devices that suffer from the same problems as conventional hammers.

#### DISCLOSURE OF THE INVENTION

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To mitigate the technical problems described above, the present invention relates to a hydraulic hammer device for excavators comprising at least one ripper and an energy accumulator where the energy accumulator is integrally connected to said ripper and located on the longitudinal shaft thereof, the ground being attacked on  
15 said shaft between the retracted and deployed positions of the ripper and characterized in that it comprises a cylinder which is integrally connected to the ripper and housed therein.

A second particular embodiment comprises at least two cylinders integrally  
20 connected to the ripper and housed therein, forming between them an angle the vertex of which coincides with the shaft which attacks the ground; and where each of said cylinders comprises an energy chamber, the energy chambers of the cylinders communicating with one another, said cylinders being configured for alternating movement.

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Energy chamber is understood as the pressure chamber in the upper portion of the cylinder which is compressed by the upward movement of the plunger (caused in turn by the injection of oil from the excavator) and is responsible for thrusting said plunger in its downward movement due to the accumulated pressure. The energy  
30 chamber is typically filled with nitrogen and/or any compressible fluid, in general.

The absence of floating parts must first be pointed out. In fact, the elements responsible for delivering blows (the cylinders) are integrally connected to the ripper and housed therein, so the impact is internal, i.e., on the same element which  
35 attacks the ground, the ripper itself. Use of moving parts, such as the ground rods of

conventional hammers are thereby avoided, preventing problems due to tilted clearances and blows.

Another advantage to be pointed out is the use of energy and increase in yield  
5 compared to hammers described in the state of the art. In fact, when the first cylinder moves down, the second cylinder moves up and vice versa. Nevertheless, it must be taken into account that the cylinder that moves down always moves down faster than the cylinder that moves up. During normal operation, oil from the machine moves a first cylinder up, whereas the second cylinder moves down due to nitrogen pressure.  
10 The first cylinder sends a signal at the end of the upward movement so that the second cylinder also starts to move up, causing the first cylinder to fall. Given that the downward movement is faster than the upward movement, the cylinder that moves down makes an impact and waits to receive signal from the other cylinder. Therefore, the actual hammer-blow frequency is about twice that in a conventional  
15 hammer, and oil is always used by one of the two cylinders without needing return or oil accumulation chambers, improving the overall yield of the machine.

Typically, a piston does not have the same thrust at the start of the stroke as at the end. The energy chambers of both cylinders are communicated to prevent this.  
20 Hence, if the cylinders were linear cylinders, the pressure in both chambers would be about the same, therefore, the pressure would be kept constant in the stroke of both cylinders. Nevertheless, in practice the pressure in both chambers will not be 100% constant since, as mentioned, the cylinder that moves down does so faster than the cylinder that moves up. Nevertheless, the fluctuation of pressures is minimal, which  
25 significantly improves yield compared to conventional hammers, without changing the pressure from the machine and without sending the oil to the return tank.

Blow to the body of the ripper generates an upward reaction force. This force accumulates in the energy accumulator, preferably a pneumatic element, although  
30 other elements having similar characteristics are not ruled out. During use, reaction to the blow compresses the accumulator, i.e., loading it, whereas the accumulator is unloaded when blow is delivered, i.e., it decompresses, adding the accumulated force to that of the blow itself due to the cylinders, since the accumulator is aligned with the attacking shaft, as indicated. Furthermore, the accumulator advantageously  
35 dampens the transmission of vibrations to the rest of the machine.

Therefore, the device object of the invention improves the yield of known hydraulic or pneumatic hammers working on particularly hard grounds, furthermore improving their service life.

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Furthermore, another advantage is that the combination of a ripper and a hammer allows both breaking up the ground (by means of the cylinder) and digging up the ground (by means of the ripper) something which is impossible up until now.

10 Throughout of the description and the claims the word "comprises" and variants thereof do not intend to exclude other technical features, supplements, components or steps. For persons skilled in the art, other objects, advantages and features of the invention will be deduced in part from the description and in part from the practice of the invention. The following examples and drawings are provided by way of  
15 illustration and they are not meant to limit the present invention. Furthermore, the present invention covers all the possible combinations of particular and preferred embodiments herein indicated

## 20 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows a schematized view of the device object of the invention in a practical embodiment with two cylinders (2,3). Figure 2 shows a view of the ripper (1) which is part of the invention, and of the arrangement of the cylinders (2,3) inside  
25 same. Figure 3 shows a perspective view of the device object of the invention, in which the arrangement of the cylinders (2,3) in relation with the entire device is shown, whereas Figure 4 shows a complete view of the assembly, except the outer protections of the ripper (1). Finally, Figure 5 shows a schematized view of the device object of the invention in a practical embodiment with a single cylinder.

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## PREFERRED EMBODIMENT OF THE INVENTION

As can be seen in the attached drawings, the hydraulic hammer device for  
35 excavators object of the present invention is used for delivering blows to and digging

up extremely hard grounds, such as rock (granite) and the like. The device essentially comprises a ripper (1) itself, at the lower end of which there is arranged a tooth (11) connected to the body of the ripper (1) by means of a bolt (12) or the like, such that said tooth (11) can be replaced if it wears out.

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Inside the body of the ripper (1), in a space (13) provided for such purpose, there are housed two cylinders (2,3) integrally connected to the body of the ripper (1) and arranged with respect to one another such that the force vector (F2,F3) of both cylinders (2,3) is oriented towards one and the same point coinciding with the attack  
10 vector (F1) which attacks the bottom of the ripper and which in this embodiment coincides with the connection point (12) of the tooth (11) with the ripper (1).

In this practical embodiment, the angle is  $14^\circ$ , although said value will vary depending on the number of cylinders, since this number is only limited by the  
15 measurements of the body of the ripper (1), the only design condition being that all the force vectors are oriented towards the same point and that the latter coincides with the attack vector (F1) of the ripper (1).

Each cylinder (2,3) comprises in its upper portion an energy chamber (21,31) filled  
20 with nitrogen (a compressible fluid, in general) such that when the plunger of the cylinder moves up due to the injection of oil from the excavator (not shown in the attached drawings), the fluid (i.e., the nitrogen) is compressed and when the machine stops injecting the oil, it is the pressure in said energy chambers (21,31) that thrusts the cylinder (2,3) downwards, delivering blows to the body of the ripper  
25 (1) itself in a region of impact (14).

In another practical embodiment, said region of impact (14) can be formed by a dolly connected to the ripper (1) and replaceable in the case of deformation.

30 To keep a quasi-constant pressure in both chambers (21,31), they are communicated with one another (22), facilitating the alternating movement of both cylinders (2,3) since when the first cylinder (2) moves down, the second cylinder (3) moves up and vice versa. Given that the cylinder that moves down is always faster, when the second cylinder (3) moves up and reaches the end, it sends a signal to a  
35 valve so that the first cylinder (2), which was on stand-by, starts to move up also.

The alternating movement between both cylinders (2,3) therefore involves injecting oil to either cylinder, without returning to the machine.

5 In another particular embodiment, the hammer-blow speed can be controlled through the injection of oil (more or less oil) to the cylinders (2,3) depending on the hardness of the ground. The control element can be a shutoff cock, a valve or the like.

10 An energy accumulator (4), preferably an air cushion or a pneumatic cylinder, is integrally connected between the body of the ripper (1) and the head (5) of the machine such that it is loaded (compressed) due to the reaction force of the blow of the cylinders (2,3) and unloaded (decompressed) when the device attacks the ground, since the accumulator (4) is aligned in said shaft, adding a new force component (F4) in the blow. Due to this, the actual hammer-blow force is the sum of  $F1 + F4$ .

15 Figure 5 shows how the device comprises a ripper (1) itself, at the lower end of which there is arranged a tooth (11) connected to the body of the ripper (1) by means of a bolt (12) or the like, such that said tooth (11) can be replaced if it wears out.

20 Inside the body of the ripper (1), in a space (13) provided for such purpose, there is housed a cylinder (2) integrally connected to the body of the ripper (1) and arranged with respect to one another such that the force vector (F2) of the cylinder (2) is aligned with the attack vector (F1) which attacks the bottom of the ripper and which in this embodiment coincides with the connection point (12) of the tooth (11) with the  
25 ripper (1).

The cylinder delivers blows to a region of impact (14), where in another practical embodiment, said region of impact (14) can be formed by a dolly connected to the  
30 ripper (1) and replaceable in the case of deformation.

In another particular embodiment, the hammer-blow speed can be controlled through the injection of oil (more or less oil) to the cylinder (2) depending on the hardness of the ground. The control element can be a shutoff cock, a valve or the like.

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An energy accumulator (4), preferably an air cushion or a pneumatic cylinder, is integrally connected between the body of the ripper (1) and the head (5) of the machine such that it is loaded (compressed) due to the reaction force of the blow of the cylinder (2) and unloaded (decompressed) when the device attacks the ground, 5 since the accumulator (4) is aligned in said shaft, adding a new force component (F4) in the blow. Due to this, the actual hammer-blow force is the sum of  $F_1 (=F_2) + F_4$ .

10 Finally, it must be pointed out that the assembly formed by the ripper (1) (together, logically, with the cylinders (2,3)) and the accumulator (4) are connected to the head (5) of the machine by means of connecting rods (6).

## CLAIMS

1. A hydraulic hammer device for excavators comprising at least one ripper (1) and an energy accumulator (4); where the energy accumulator (4) is located on the longitudinal shaft of the ripper (1) and integrally connected to said ripper (1); and where said shaft (1) is on that which attacks the ground between the retracted and deployed positions of the ripper (1) and **characterized in that** it comprises at least one cylinder (2) integrally connected to the ripper (1) and housed therein.
2. The device according to claim 1, wherein the cylinder (2) is housed inside the ripper (1) in a space (13) provided for such purpose in a position longitudinally aligned with the shaft which attacks the ground (F1), such that said cylinder delivers blows to the body of the ripper (1) itself in a region of impact (14).
3. The device according to any of claims 1-2 comprising at least two cylinders (2,3) integrally connected to the ripper (1) and housed therein forming between them an angle the vertex of which coincides with the shaft which attacks the ground (F1); and where each of said cylinders (2,3) comprises an energy chamber (21,31), said energy chambers (21,31) of the cylinders communicating with one another (22), such that they allow alternating movement of both cylinders (2,3).
4. The device according to claim 3, wherein the cylinders (2,3) are arranged with respect to one another such that the force vector (F2,F3) of both cylinders (2,3) is oriented towards one and the same point coinciding with the attack vector (F1) which attacks the bottom of the ripper.
5. The device according to any of claims 3 and 4, wherein the point coinciding with the attack vector (F1) which attacks the bottom of the ripper coincides with the connection point (12) of the tooth (11) with the ripper (1).
6. The device according to any of claims 3 to 5, where the cylinders (2,3) deliver blows to the body of the ripper (1) itself in a region of impact (14).
7. The device according to any of claims 2 and 6, wherein said region of impact (14)

is a dolly integrally connected to the ripper (1).

8. The device according to any of the preceding claims comprising at least one control element for controlling the passage of oil to the cylinders (2,3).

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9. The device according to any of the preceding claims, where the energy accumulator (4) is integrally connected between the body of the ripper (1) and the head (5) of the machine.

- 10 10. The device according to claim 7, wherein the energy accumulator (4) is an air cushion.