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(54) IMPULSE TOOL

(57) An impulse tool comprises an anvil (10), a percussion piston (12) and a spring element (14) for generating the impact movement of the percussion piston. The tool also comprises a cylinder (16), inside which the percussion piston is configured to be movable, as well as means for tensioning the spring element. The anvil, the percussion piston, and the cylinder delimit a substantially gas-tight cavity with a variable volume, and the spring element is fitted in said cavity. The percussion piston is configured to move within the cylinder, in the direction of the longitudinal axis of the cylinder, in such a way that the percussion piston impelled by the spring element can

hit the anvil. The spring element is placed in a closed cavity, whereby its possible breaking off does not cause dangerous situations. The impulse tool can comprise means for supplying the cavity with compressed gas and for removing the gas quickly from the cavity. Introducing compressed gas into the cavity will cause an increase of the pressure in the cavity, whereby the percussion piston will move in the cylinder and the spring element will extend and be excited. When the gas is abruptly removed from the cavity, the percussion piston will hit the anvil, pulled by the extension spring.

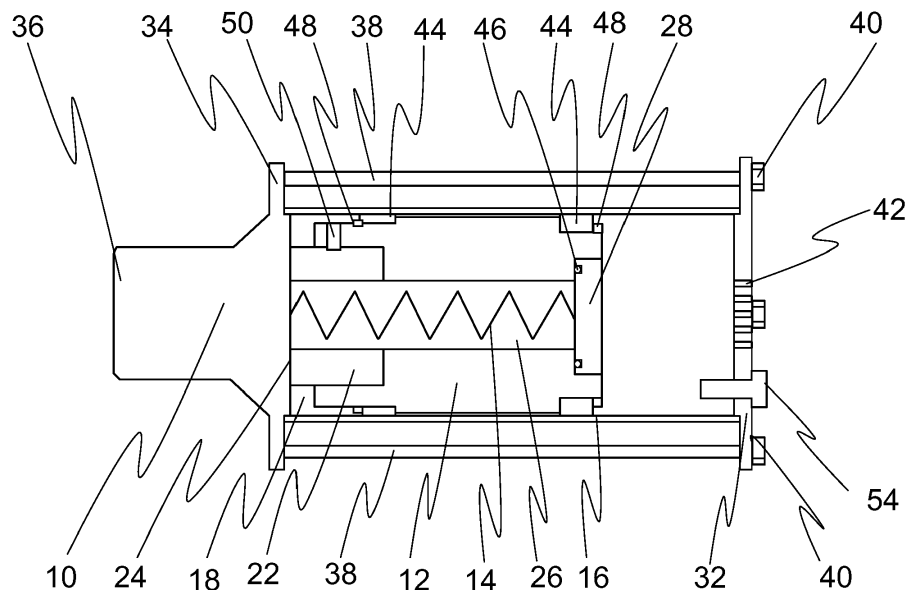


Fig. 1a

Description

[0001] The invention relates to an impulse tool including an anvil, a percussion piston, a spring element for generating a percussion movement of the percussion piston, a cylinder in which the percussion piston is configured to move, and means for tensioning the spring element.

[0002] In assembly and repair of machines and devices, impulse tools are commonly used for driving e.g. pins in holes provided for them. Impulse tools are also used for removing material stuck on surfaces of structures, such as walls of silos. Conventional impulse tools include hand-powered hammers and sledge hammers. Pneumatically driven impulse tools are also known which comprise a percussion piston enclosed in a housing and providing an impact stroke. The movement of the percussion piston is generated by a spring that is tensioned by means of compressed air. Pneumatically driven impulse tools are normally rappers that are fastened to a structure in order to generate vibration for removing material that has been stuck to the structure. Such a pneumatic impulse tool is described in publication US 3,605,915.

[0003] The springs of impulse tools equipped with extension springs can break off in an overload situation, whereby the pieces of the spring can come off the tool and cause dangerous situations.

[0004] It is an aim of the invention to present an impulse tool by which it is possible to reduce drawbacks relating to the state of the art.

[0005] The aims of the invention are achieved with an impulse tool which is characterized by what is presented in the independent claim. Some advantageous embodiments of the invention are presented in the dependent claims.

[0006] The invention relates to an impulse tool comprising an anvil, a percussion piston, and a spring element for generating a percussion movement of the percussion piston. The tool further comprises a cylinder, in which the percussion piston is configured to move, as well as means for tensioning the spring element. The anvil, the percussion piston, and the cylinder delimit a substantially gas-tight cavity with a variable volume, and the spring element is fitted in said cavity. The percussion piston is configured to move within the cylinder, in the direction of the longitudinal axis of the cylinder, in such a way that the percussion piston impelled by the spring element can hit the anvil. The percussion piston moving in the cylinder thus exerts an impact on the anvil surface that delimits the cavity, which impact is transmitted via the anvil to the outer surface of the anvil. The spring element is placed in a closed cavity, whereby its possible breaking off does not cause dangerous situations.

[0007] In an advantageous embodiment of the invention, the impulse tool comprises means for supplying compressed gas, such as compressed air, into the cavity and for removing it abruptly from the cavity. Preferably, the spring element is an extension spring with a first end

connected to the anvil and a second end connected to the percussion piston. Supplying compressed gas into the cavity will increase the pressure in the cavity, whereby the percussion piston will move in the cylinder and the extension spring will be stretched and tensioned. When the gas is abruptly removed from the cavity, the percussion piston, pulled by the extension spring, will hit the anvil. Preferably, said means for supplying compressed gas into the cavity and for removing it from the cavity comprise at least one valve. In order to enable an abrupt removal of gas, the valve should be a so-called quick exhaust valve which, in an opening situation, opens immediately to the fully open position. In this way, the gas can escape the cavity so quickly that the gas pressure in the cavity does not slow down the movement of the percussion piston towards the anvil.

[0008] In another advantageous embodiment of the impulse tool according to the invention, the percussion piston has a first end and a second end, and a through hole extending from the first end to the second end. The spring element of the impulse tool is fitted in said hole. This placement of the spring element makes it possible to increase the length of the spring element without increasing the overall length of the impulse tool. Preferably, a fixing flange for closing the hole is provided at the second end of the percussion piston, and the spring element is fastened at its second end to the fixing flange. Thus, the spring element is connected at its second end to the percussion piston, by means of the fixing flange. In this embodiment, the fixing flange is a separate part configured to be kept in place against the second end of the percussion piston by the tension of the spring element. If the gas pressure in the cavity becomes too high, the spring element is stretched and gas can escape from the gap between the fixing flange and the end face at the second end of the percussion piston. In this way, the fastening of the second end of the spring, implemented by the separate fastening flange, will prevent the gas pressure from becoming too high in the cavity delimited by the anvil, the cylinder and the percussion piston. If, for any reason, the spring element snaps off, the fastening flange will come off and the compressed gas can escape from the cavity via the hole in the percussion piston. In this way, the percussion piston cannot be catapulted outside the impulse tool when the spring element snaps.

[0009] In a third advantageous embodiment of the impulse tool according to the invention, a damping element is provided between the anvil and the percussion piston. The damping element extends the duration of the impact. However, the total impact energy will not substantially decrease. Preferably, the damping element is a stroke bushing provided at the first end of the percussion piston. Alternatively, the damping element can be arranged in the anvil, whereby the impact of the percussion piston is first received by the damping element and transferred by it to the anvil. The damping element can be made of a metal whose modulus of elasticity is lower than the mod-

ulus of elasticity of the percussion piston and of the anvil. Suitable metals include, for example, aluminium and brass.

[0010] A portable hand tool is yet another advantageous embodiment of the impulse tool according to the invention. Such a compact and portable tool of a relatively light weight can be used to replace a hammer or a sledge hammer that is conventionally used in many tasks.

[0011] The impulse tool according to the invention has the advantage of being safe to use. All the movable parts of the impulse tool are enclosed in the tool, which reduces accidents of getting squashed and strain injuries in work using the impulse tool. In situations of overpressure and breaking off of the spring element, the pressure can be relieved in a controlled manner without causing a danger to the user of the tool and to the environment.

[0012] The invention also has the advantage of having a simple structure and being reliable in operation. The spring element used as the extension spring is not fatigued as easily as a compression spring, and the way of fastening the spring element will prevent situations of severe overloading.

[0013] In the following, the invention will be described in detail. In the description, reference will be made to the appended drawings, in which

Fig. 1 a shows an example of an impulse tool according to the invention in a cross-sectional view in the longitudinal direction when the tool is in a non-excited state,

Fig. 1b shows the impulse tool of Fig. 1 a in a cross-sectional view in the longitudinal direction when the tool is in an excited state,

Fig. 2a shows an example of an advantageous embodiment of the impulse tool according to the invention in a cross-sectional view in the longitudinal direction when the tool is in the non-excited state, and

Fig. 2b shows the impulse tool of Fig. 2a in a cross-sectional view in the longitudinal direction when the tool is in the excited state.

[0014] Figures 1 a and 1 b show an example of an impulse tool according to the invention in cross-sectional views in the longitudinal direction. Figure 1a shows the impulse tool in the non-excited state, and Fig. 1b shows the same tool in the excited state. In the following description, the content of both figures will be described at the same time.

[0015] The impulse tool has the shape of a tubular cylinder 16 whose first end is provided with an anvil 10 and second end with an end plate 32. The anvil is a solid metal piece with a substantially flat impact face 24. The edge of the impact face is encircled by an annular flange 34. The surface of the flange and the impact face are on slightly different levels in such a way that a step is formed

at the edge. The end face of the first end of the cylinder 16 is placed against the surface of the flange in such a way that the section forming the impact face 24 of the anvil 10 will protrude slightly into the cylinder. The central axis of the cylinder is substantially perpendicular to the impact face 24 of the anvil 10. A cylindrical impactor 36 is provided at the end of the anvil. The impactor is that part of the impulse tool, by which the impact produced by the impulse tool is transmitted to a desired target. The impactor of the anvil can be solid, hollow, or a tubular part with an open end.

[0016] The end plate 32 is a circular metal disc. The surface of the end plate facing the cylinder 16 is provided with a central part delimited by the cylinder wall, and an annular rim part around the central part, which are on slightly different levels. The end plate is placed against the second end of the cylinder in such a way that the central part extends into the cylinder and the end face of the second end of the cylinder is placed against the rim part. In the centre of the end plate, holes 42 are provided, through which gas can flow into or out of the cylinder. The end plate and the anvil are connected to each other by means of four tie rods 38 which are fastened at their first end to the flange 34 of the anvil 10 and whose second end is passed through a hole in the end plate. The number of the tie rods can also be different from four. Preferably, 3 to 6 tie rods are provided. At the second end, the tie rods are provided with tension nuts 40 which are tightened to clamp the end plates 32 and the anvil 10 tightly against the end faces of the cylinder. The tie rods are placed at regular intervals around the cylinder, spaced from the outer surface of the cylinder. Furthermore, the end plate is provided with a threaded through hole, in which an adjusting screw 54 is driven. The end of the adjusting screw extends into the cylinder, at a distance from the surface of the end plate. By driving the adjusting screw, that is, by changing the length of the section extending into the cylinder, the impact force of the impulse tool is adjusted as will be described hereinbelow.

[0017] The cylinder, the anvil and the end plate delimit a cylindrical space which encloses a substantially cylindrical percussion piston 12. The material of the percussion piston is metal, preferably steel. The outer surface of the first end as well as the outer surface of the second end of the percussion piston is provided with a circumferential groove, in which an annular slide bearing 44 is fitted. The slide bearings are used as slide means, by which the percussion piston is movable inside the cylinder, in the direction of the central axis of the cylinder, between the first and second ends of the cylinder. The slide bearings are held in locked position at the end of the percussion piston by means of a detachable locking ring 48 so that the slide bearing is clamped between the locking ring and the edge surface of the groove. The slide bearings are dimensioned in such a way that their sliding surface is placed against the cylinder wall as closely as possible; that is, the clearance between the sliding surface of the slide bearing and the inner surface of the

cylinder is as small as possible but sufficient for the movement of the percussion piston. In this way, the slide bearings are simultaneously used as sealing means which substantially prevent gas, such as compressed air, from flowing through the gap between the slide bearing and the cylinder wall.

[0018] The percussion piston has a central through hole 26 whose first and second ends open onto the first and second end faces of the percussion piston, respectively. At the first end of the percussion piston, a cylindrical recess is provided, in which an impact bushing 22 is fitted. The impact bushing is held in locked position in the recess by a clamping screw 50. The material of the impact bushing is a metal whose modulus of elasticity is lower than the modulus of elasticity of the material of the percussion piston. The impact bushing can be made of, for example, aluminium or brass. The impact bushing is a uniform piece equipped with a central hole that is concentric and equal in diameter with the hole 26 in the percussion piston 12. At the second end of the percussion piston, a metal fixing flange 28 is placed against the end face of the percussion piston, to cover the opening of the second end of the through hole 26 in the percussion piston. A gasket ring 46 is provided between the end face of the second end of the percussion piston and the fixing flange, and fitted in the annular groove in the fixing flange. A spring element 14 is provided in the hole extending through the percussion piston and the impact bushing, and is fastened at its first end to the impact face 24 of the anvil 10 and at its second end to the fixing flange 28.

[0019] Furthermore, the impulse tool comprises a quick exhaust valve 52, through which compressed air is conveyed through the wall of the cylinder 16 into the cylinder and through which the air is allowed to quickly escape the cylinder. In the figures, only the opening of the quick exhaust valve is visible, which opens into the cylinder and is close to the first end of the cylinder (Fig. 1b). The anvil 10, the percussion piston, and the cylinder constitute a substantially gas-tight cavity 18 with a variable volume. Figure 1a shows the impulse tool in the non-excited state, in which the impact bushing 22 of the percussion piston abuts the impact face 24 of the anvil 10, whereby the volume of the cavity 18 is at its minimum. Figure 1b shows the impulse tool in the excited state, in which the cavity has been filled with compressed gas, such as pressurized air, through the quick exhaust valve 52, by which gas the percussion piston 12 has moved towards the end plate 32. In Fig. 1b, the volume of the cavity is at its maximum. By the gas pressure prevailing in the cavity, the percussion piston is moved so far that the end of the adjusting screw 54 hits the edge of the percussion piston 12, whereby the movement of the percussion piston is stopped. When the percussion piston moves towards the end plate, the spring element is extended and tensioned; in other words, the spring element is charged with elastic energy. By changing the length of the adjusting screw, it is possible to adjust the extension of the spring element and the amount of elastic

energy being charged in the spring. The first end of the hole 26 of the percussion piston opens into the cavity, so that the gas pressure prevailing in the hole is the same as in the cavity. The movement of the percussion piston will stop upon hitting the adjusting screw, after which the gas pressure in the cavity and in the hole will increase. When the gas pressure exceeds the tensile force of the spring element 14, the fixing flange will be capable of moving a few millimetres so that excess gas pressure can be released from the gap between the end face of the second end of the percussion piston and the fixing flange, to the space between the percussion piston and the end plate 32. From this space, the gas can flow through the holes 42 out of the cylinder 16. Thus, the gas pressure in the cavity 18 and the hole 26 cannot rise to a dangerous level even if the air supply were continued after the percussion piston has been excited to the extreme position.

[0020] The impulse tool according to the invention functions in the following way: The quick exhaust valve of the device is connected via a pressure hose to a pressure source, preferably a source of compressed air, such as an air compressor, and compressed gas is allowed to flow into the cavity. Then, the percussion piston will move from the non-excited state shown in Fig. 1a to the excited state shown in Fig. 1b. The impactor of the impulse tool is placed on a target to be subjected to a impact or impacts by the tool. The gas is allowed to quickly escape the cavity 18 via the quick exhaust valve 52, whereby the percussion piston is pulled by the spring element 14 at a high speed towards the anvil 10. The impact bushing 22 at the first end of the percussion piston hits the impact face 24 of the anvil, in other words, an impact is exerted on the anvil by the percussion piston and the impact bushing. The impact on the anvil is transferred to the impactor 36 and further to the target, against which the impactor has been installed. After the impact, compressed gas begins to flow into the cavity again, whereby the tool is excited to generate a new impact. The impulse tool can be set to function by single shots or to be continuous working. In the case of single shots, the user of the tool has to trigger the tool for each shot separately, and when continuous working, the tool will give a shot automatically as soon as the tool is fully excited to the impact state.

[0021] The above described impulse tool can be installed to be stationary on a structure that has to be regularly subjected to impacts, for example for removing material that has stuck onto the surface of the structure. Such structures typically include, for example, silos, conveyors and smoke ducts. The impulse tool can also be made as a hand-operated portable device by equipping it with suitable carrying means and triggering means which are used for adjusting the flow of compressed gas into and out of the cavity. In many cases, such a hand-operated impulse tool can replace a conventional hammer or sledge hammer.

[0022] Figures 2a and 2b show an example of an advantageous embodiment of an impulse tool according to

the invention in cross-sectional views in the longitudinal direction. Figure 2a shows an embodiment of the impulse tool in the non-excited state, and Fig. 2b shows the same device in the excited state. In the following, the contents of both figures will be described at the same time.

[0023] The embodiment shown in Figs. 2a and 2b comprises the same structural components as the impulse tool shown in Figs. 1 a and 1b, and the same terms and reference numerals are used for these components in the figures and in the description. The embodiment shown in Figs. 2a and 2b only deviates from the impulse tool of Figs. 1 a and 1b with respect to the fastening of the impact bushing 22 and the shape of the impact face 24 of the anvil 10. In this embodiment, the impact face is provided with a recess having the size of the end face of the impact bushing, the first end of the impact bushing being tightly fitted in it. Thus, the impact bushing is fastened to the impact face of the anvil. If necessary, the fastening of the impact bushing on the anvil can be secured by suitable fastening means, such as fastening screws. The cross section of the recess at the first end of the percussion piston 12 is dimensioned to be slightly larger than the cross section of the impact bushing so that a small clearance is left between the wall of the recess and the impact bushing 22 fitted in the recess. This clearance allows the movement of the impact bushing into and out of the recess of the percussion piston without friction.

[0024] The embodiment of the impulse tool shown in Figs. 2a and 2b works and is used in the same way as the impulse tool shown in Figs. 1 a and 1 b. When the percussion piston 12 hits the impact bushing 22 by the force of the spring element 14, the bottom of the recess of the percussion piston hits the second end of the impact bushing, whereby the impact force is transferred via the impact bushing to the anvil 10.

[0025] Some advantageous embodiments of the impulse tool according to the invention have been described above. The invention is not limited to solutions described above, but the inventive idea can be applied in different ways within the scope of the claims.

Claims

1. Impulse tool including an anvil (10), a percussion piston (12), a spring element (14) for generating a movement of the percussion piston, a cylinder (16) in which the percussion piston (12) is configured to move, and means for tensioning the spring element, **characterized in that** the anvil (10), the percussion piston (12) and the cylinder (16) delimit a substantially gas-tight cavity (18) with a variable volume, and the spring element (14) is fitted inside said cavity (18).
2. The impulse tool according to claim 1, **characterized in that** it comprises means, such as a valve (52), for

passing compressed gas, such as compressed air, into the cavity (18) and for removing it quickly from the cavity.

3. The impulse tool according to claim 1 or 2, **characterized in that** the spring element (14) is an extension spring with a first end connected to the anvil (10) and a second end connected to the percussion piston (12).
4. The impulse tool according to any of the claims 1 to 3, **characterized in that** the percussion piston (12) has a first end and a second end, and a through hole (26) extending from the first end to the second end, and that the spring element (14) is fitted in said hole (26).
5. The impulse tool according to claim 4, **characterized in that** the second end of the percussion piston (12) is provided with a fixing flange (28) for closing the hole (26), and the spring element (14) is fastened at its second end to the fixing flange (28).
6. The impulse tool according to claim 5, **characterized in that** the fixing flange (28) is configured to be kept in place at the second end of the percussion piston (12) by the spring force of the spring element (14).
7. The impulse tool according to any of the claims 1 to 6, **characterized in that** a damping element, preferably an impact bushing (22), is provided between the anvil (10) and the percussion piston (12).
8. The impulse tool according to claim 7, **characterized in that** said damping element is provided at the first end of the percussion piston (12).
9. The impulse tool according to claim 7, **characterized in that** said damping element is arranged on the anvil (10).
10. The impulse tool according to any of the claims 7 to 9, **characterized in that** the damping element is made of a metal whose modulus of elasticity is lower than the modulus of elasticity of the percussion piston (12) and the anvil (10).
11. The impulse tool according to any of the claims 1 to 10, **characterized in that** it is a portable hand tool.

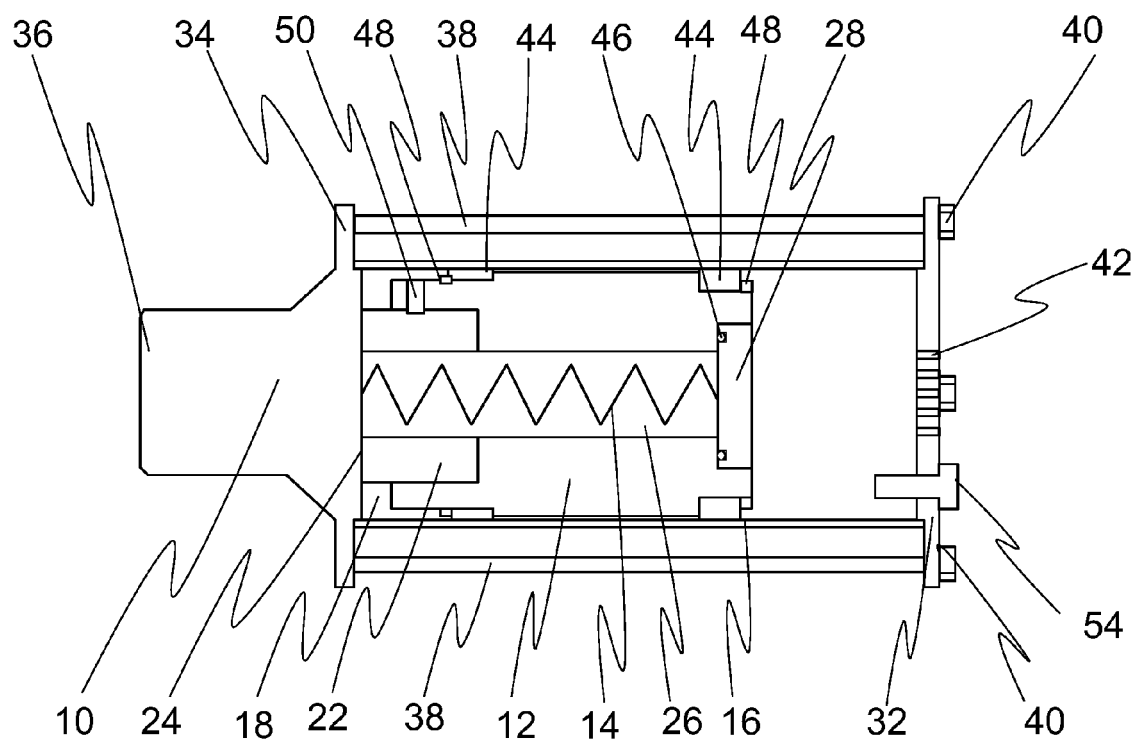


Fig. 1a

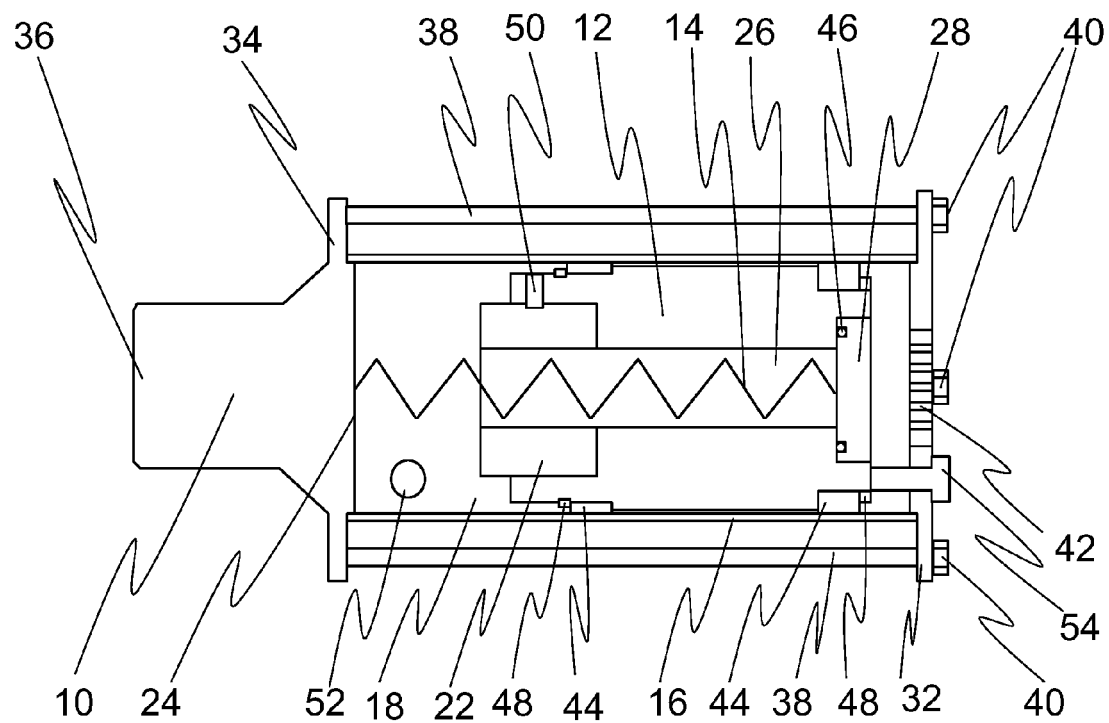


Fig. 1b

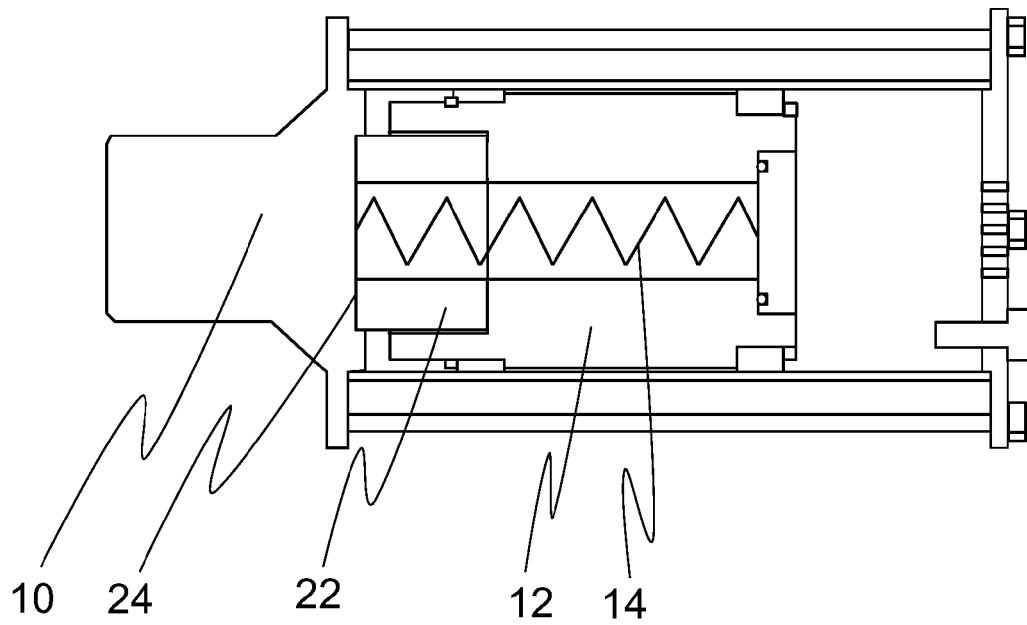


Fig. 2a

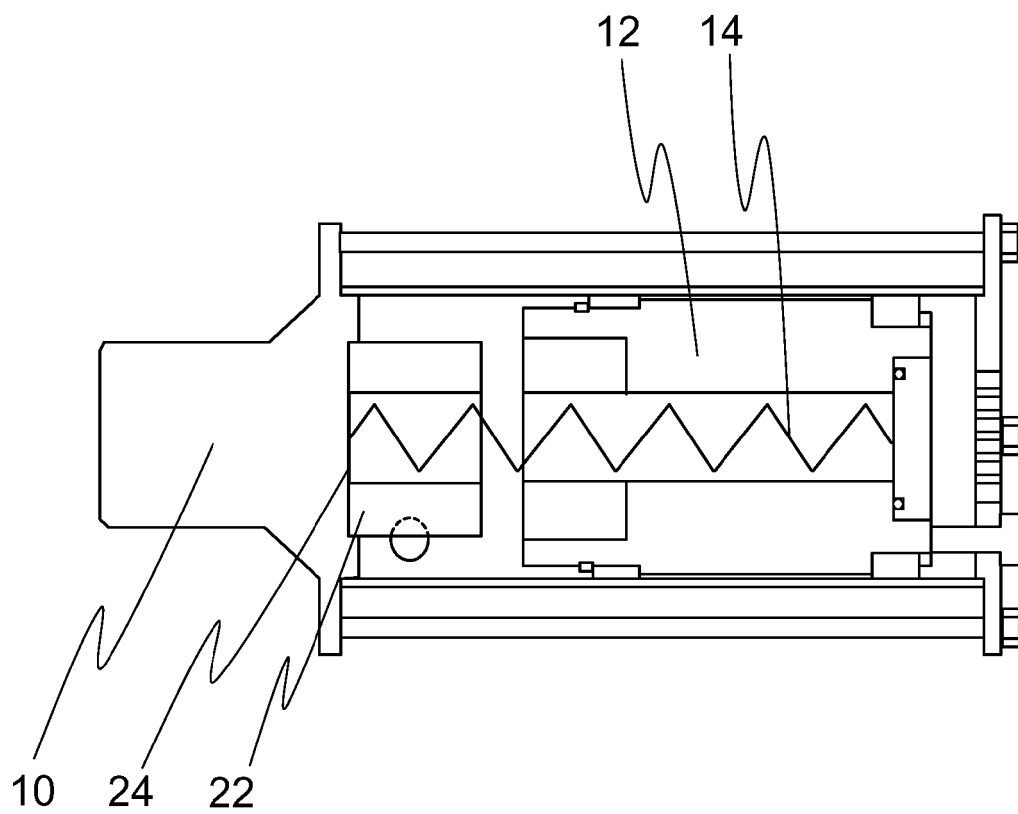


Fig. 2b



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Application Number
EP 15 15 3224

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Place of search The Hague		Date of completion of the search 24 June 2015	Examiner Rilliard, Arnaud
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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