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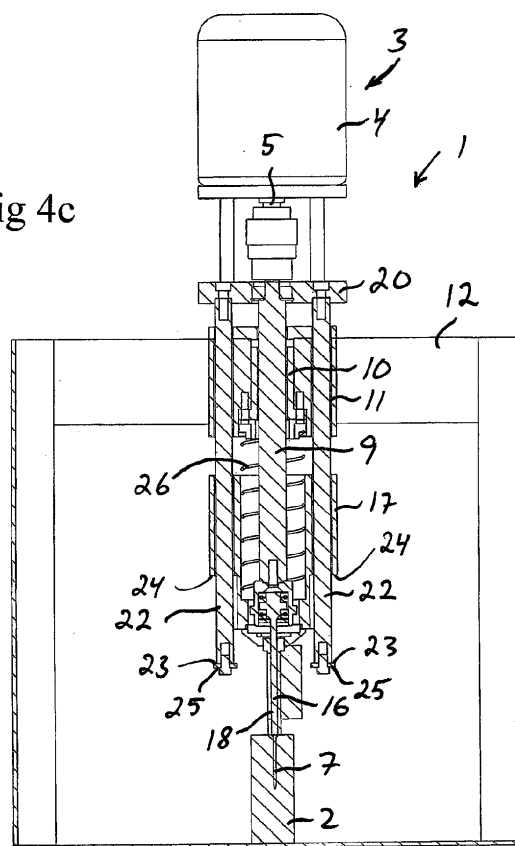
(54) **Machine for driving fastening members into workpieces**

(57) A machine for driving fastening members into workpieces, comprising:

- a reversible drive motor (3);
- an axially displaceable tool (6); and
- a motion conversion mechanism comprising a screw rod (9) and a nut (10) which co-operates with the screw rod, for converting a rotary motion of the output shaft of the drive motor into an axial translational motion of the tool.

The nut is axially fixed to a holder unit (11) and is prevented from being displaced in the axial direction in connection with a mutual rotation between the screw rod and the nut, the screw rod being displaced in relation to the nut and the holder unit in the axial direction when the screw rod and the nut are subjected to a mutual rotation under the effect of the drive motor. The tool is arranged to be displaced together with the screw rod in the axial direction downwards into engagement with a fastening member when the screw rod and the nut are subjected to a mutual rotation in a first direction and in the axial direction upwards out of engagement with the fastening member when the screw rod and the nut are subjected to a mutual rotation in a second direction.

Fig 4c



Description

[0001] The present invention relates to a machine according to the preamble of claim 1 for driving fastening members, for instance in the form of nails or screws, into workpieces.

[0002] In a conventional pneumatically driven nailing machine, a tool is made to exert a striking action against a nail in order to strike the nail into a workpiece. A disadvantage with such a striking nailing machine is that the sound level is high due to the exerted striking action. Furthermore, there is a risk of damages to the workpiece due to the impacts generated when the nail is struck into the workpiece. In order to avoid these disadvantages, it might be desirable to drive nails into a workpiece by pressing them into the workpiece by press force instead of striking them into the workpiece by striking force. This might indeed be done by means of a pneumatically driven machine, but it will then be difficult to regulate the exerted press force with good exactness and the machine will in addition be slow due to the limitations associated with the pneumatic operation.

[0003] In order to drive nails into a workpiece by press force, it is also possible to use an electrically driven machine where a motion conversion mechanism converts a rotary motion of an output shaft of a reversible drive motor into an axial translational motion of a tool. A machine of this type is for instance disclosed in the Japanese patent document JP 11076519 A. In the machine according to JP 11076519 A, a screw rod is connected to the output shaft of the drive motor in order to be rotated by this output shaft. This screw rod co-operates with a nut, which is rotatably mounted in a holder unit. The holder unit is displaceably mounted to a stand and carries a tool, which is intended to be pressed against a nail in order to drive the nail into a plate. On rotation of the screw rod, the nut is made to move upwards or downwards along the screw rod, whereby also the holder unit and the tool are moved in the corresponding direction.

OBJECT OF THE INVENTION

[0004] The object of the present invention is to provide a machine of the type mentioned by way of introduction with a new and favourable design.

SUMMARY OF THE INVENTION

[0005] According to the present invention, said object is achieved by means of a machine having the features defined in claim 1.

[0006] The machine according to the invention comprises:

- a reversible drive motor with an output shaft;
- an axially displaceable tool, which is intended to engage with a fastening member in order to drive the fastening member into a workpiece;

- a motion conversion mechanism for converting a rotary motion of the output shaft of the drive motor into an axial translational motion of the tool, this motion conversion mechanism comprising a screw rod and a nut which co-operates with the screw rod; and
- a holder unit, here denominated first holder unit, in which the nut is arranged.

[0007] The nut is axially fixed to the first holder unit so that the nut is prevented from being displaced in the axial direction in connection with a mutual rotation between the screw rod and the nut and so that the screw rod is made to be displaced in relation to the nut and this holder unit in the axial direction when the screw rod and the nut are subjected to a mutual rotation under the effect of the drive motor. Furthermore, the tool is connected to the screw rod in order to be displaced together with this screw rod in the axial direction downwards into engagement with a fastening member when the screw rod and the nut are subjected to a mutual rotation in a first direction under the effect of the drive motor, and in the axial direction upwards out of engagement with said fastening member when the screw rod and the nut are subjected to a mutual rotation in a second direction under the effect of the drive motor.

[0008] In the machine according to the invention, the nut-co-operating with the screw rod is consequently not displaced in its axial direction in connection with a mutual rotation between the screw rod and the nut. On the contrary, it is the screw rod that is displaced in its axial direction in connection with a mutual rotation between the screw rod and the nut. This represents a new working principle for a machine of the type here in question and will i.a. give the advantage that the tool can be connected directly to the screw rod concentrically therewith. The machine will hereby be well-balanced with respect to the transmission of force from the screw rod to the tool, at the same time as the transmission mechanism between the screw rod and the tool can be configured in a simple manner.

[0009] According to an embodiment of the invention, the machine comprises a second holder unit, which is provided with a guide channel for receiving a fastening member, the tool being displaceable downwards in this guide channel in order to drive a fastening member received in the guide channel out of the guide channel and into a workpiece when the screw rod and the nut are subjected to a mutual rotation in said first direction under the effect of the drive motor.

[0010] Another embodiment of the invention is characterized in:

- that the machine comprises a support member arranged above the first holder unit, which support member is connected to the screw rod in order to be displaced together with the screw rod when the screw rod and the nut are subjected to a mutual rotation under the effect of the drive motor;

- that the second holder unit is connected to the support member via one or more elongated connecting elements, the respective connecting element extending along the screw rod and being carried by the support member and slideably mounted to the second holder unit;
- that the respective connecting element is provided with a shoulder at its lower end, which shoulder is arranged for engagement with a corresponding shoulder on the second holder unit;
- that the respective connecting element is displaceable downwards in relation to the second holder unit when the second holder unit is in a lowered position bearing against a workpiece and the screw rod and the nut are subjected to a mutual rotation in said first direction under the effect of the drive motor; and
- that the second holder unit, while being carried by said connecting elements through said shoulders, is displaceable upwards in the direction towards the first holder unit from said lowered position to an elevated position when the screw rod and the nut are subjected to a mutual rotation in said second direction under the effect of the drive motor.

[0011] The second holder unit can hereby, during the initial part of a sequence for driving a fastening member into a workpiece, be displaced downwards together with the screw rod into contact with a workpiece so as to then remain in this position when the screw rod and the tool are displaced further downwards in order to drive a fastening member held in the second holder unit into the work piece. When the screw rod thereafter is displaced upwards, it will lift the second holder unit away from the workpiece via said connecting elements so as to allow the workpiece to be fed forwards. By means of said connecting elements, the displacement motions of the second holder unit are consequently automatically co-ordinated with the axial displacement motions of the screw rod and the tool in a simple and functional manner.

[0012] According to another embodiment of the invention, the machine comprises a spring member acting between the first holder unit and the second holder unit, the second holder unit being displaceable in the direction towards the first holder unit against the action of this spring member. This spring member secures that the second holder unit is pressed with a suitable force against the workpiece when this holder unit is lowered into contact with the workpiece under the effect of the screw rod.

[0013] According to another embodiment of the invention, the screw rod is connected to the output shaft of the drive motor in order to be rotated by this output shaft, the nut being non-rotatably arranged in the first holder unit so that the screw rod is made to be displaced in relation to the nut and the first holder unit in the axial direction together with the drive motor when the screw rod is rotated in relation to the nut under the effect of the drive motor.

[0014] According to another embodiment of the inven-

tion, the nut is rotatably mounted to the first holder unit and connected to the output shaft of the drive motor in order to be rotated by this output shaft, the screw rod being non-rotatably arranged so that the screw rod is made to be displaced in relation to the nut and the first holder unit in the axial direction when the nut is rotated in relation to the screw rod under the effect of the drive motor.

[0015] Other favourable features of the machine according to the invention will appear from the dependent claims and the description following below.

BRIEF DESCRIPTION OF THE DRAWING

[0016] The invention will in the following be more closely described by means of embodiment examples, with reference to the appended drawings. It is shown in:

- | | |
|------------|--|
| Fig 1 | a schematic front view of a machine according to a first embodiment of the present invention, |
| Fig 2 | a partly cut lateral view according to the line II-II in Fig 1, |
| Fig 3 | a schematic lateral view of the machine of Fig 1, |
| Figs 4a-4c | partly cut front views according to the line IV-IV in Fig 3, with the machine shown in different positions during a sequence for driving a nail into a workpiece, |
| Fig 5 | a schematic lateral view of a machine according to a second embodiment of the present invention, |
| Fig 6 | a cut front view according to the line VI-VI in Fig 5, |
| Fig 7 | a schematic lateral view of a machine according to a third embodiment of the present invention, |
| Figs 8a-8b | partly cut front views according to the line VIII-VIII in Fig 7, with the machine shown in different positions during a sequence for driving a screw into a workpiece, and |
| Fig 9 | a cut lateral view of a coupling device included in the machine of Fig 7. |

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

[0017] Machines 1, 1', 1" according to different embodiments of the present invention for driving fastening members into a workpiece 2 are shown in Figs 1-9.

[0018] The respective machine 1, 1', 1'' comprises a reversible drive motor 3 with a motor housing 4 and an output shaft 5. The drive motor is suitably an electric motor. The machine further comprises an axially displaceable tool 6, 6'', which is intended to engage with a fastening member 7, 7'' in order to drive the fastening member into a workpiece 2. A rotary motion of the output shaft 5 of the drive motor is converted into an axial translational motion of the tool 6, 6'' by means of a motion conversion mechanism 8, so that the tool 6, 6'' is made to be displaced in the vertical direction downward into engagement with a fastening member 7, 7'' in connection with a rotation of the output shaft 5 in a first rotational direction, and in the vertical direction upwards out of engagement with said fastening member 7, 7'' in connection with a rotation of the output shaft 5 in the opposite rotational direction. The motion conversion mechanism 8 comprises a screw rod 9 and a nut 10 which co-operates with the screw rod. The nut 10 is axially fixed to a first holder unit 11 so that the nut is prevented from being displaced in the axial direction in connection with a mutual rotation between the screw rod 9 and the nut 10, and so that the screw rod is made to be displaced in relation to the nut and the holder unit 11 in the axial direction when the screw rod and the nut are subjected to a mutual rotation under the effect of the drive motor 3. The holder unit 11 is immovably fixed to a machine stand 12.

[0019] The screw rod 9 is preferably a ball screw and the nut 10 a ball nut. The screw rod could alternatively be a slide screw.

[0020] The machines 1, 1' illustrated in Figs 1-6 constitute nail driving machines and are configured to drive fastening members 7 in the form of nails into workpieces. By these machines 1, 1', the tool 6 is a nail driving tool which is attached to the lower end of the screw rod 9 in order to be displaced together with the screw rod in the axial direction when the screw rod 9 and the nut 10 are subjected to a mutual rotation under the effect of the drive motor 3. By these machines 1, 1', the tool 6 is axially fixed to the lower end of the screw rod 9 and prevented from being displaced in the axial direction in relation to the screw rod. In the embodiments illustrated in Figs 1-6, the tool 6 is suspended in the screw rod 9 by means of a sleeve-shaped connecting member 13, which at one of its ends is fixed to the lower end of the screw rod. The connecting member 13 has an internal space, which is accessible through an opening at the other end of the connecting member. The tool 6 extends into the internal space of the connecting member 13 through said opening and is at its upper end provided with a mounting section 15, which is received in this space. The tool 6 is also provided with an elongated section 16, which has the shape of a pin and extends vertically downwards from the mounting section 15 in alignment with the centre axis of the screw rod. This elongated section 16 and the screw rod 9 are consequently concentric.

[0021] The machine 1'' illustrated in Figs 7-8 constitutes a screw driving machine and is configured to drive

fastening members 7'' in the form of screws into workpieces. By this machine 1'', the tool 6'' is a screw tool which is connected to the lower end of the screw rod 9 by means of a coupling device 40, which is arranged:

- to transmit torque from the screw rod 9 to the tool 6'' when the screw rod 9 is rotated in a first direction under the effect of the drive motor 3; and
- to allow the screw rod 9 to be rotated in relation to the tool 6'' when the screw rod is rotated in a second direction under the effect of the drive motor 3, so that no torque is transmitted from the screw rod 9 to the tool 6'' when the screw rod is rotated in this second direction under the effect of the drive motor 3.

[0022] The tool 6'' is elongated and extends vertically downwards from the coupling device 40 in alignment with the centre axis of the screw rod. The tool 6'' and the screw rod 9 are consequently concentric.

[0023] The respective machine 1, 1', 1'' also comprises a second holder unit 17, which is displaceable in the vertical direction in relation to the first holder unit 11 and which is provided with a guide channel 18 for receiving a fastening member 7, 7''. The lower end of the tool 6, 6'' is displaceable downwards in this guide channel 18 in order to drive a fastening member 7, 7'' received in the guide channel out of the guide channel and into a workpiece 2 when the screw rod 9 and the nut 10 are subjected to a mutual rotation in said first direction under the effect of the drive motor 3, as illustrated in Figs 4a-4c and in Figs 8a-8b.

[0024] A magazine 19 for fastening members is attached to the second holder unit 17. Fastening members 7, 7'' are one by one feedable into the guide channel 18 by means of feeding means arranged in the magazine 19.

[0025] A support member 20 is arranged above the first holder unit 11. In the illustrated embodiments, this support member 20 consists of a plate. The support member 20 is connected to the screw rod 9 in order to be displaced together with the screw rod in the axial direction when the screw rod 9 and the nut 10 are subjected to a mutual rotation under the effect of the drive motor 3. The second holder unit 17 is connected to the support member 20 via a number of elongated connecting elements 22, for instance in the form of rods, which extend along the screw rod 9. The respective connecting element 22 is attached to and carried by the support member 20 and slideably mounted to the second holder unit 17. In the illustrated embodiments, the connecting elements 22 are also slideably mounted to the first holder unit 11. The connecting elements 22 are suitably two in number and arranged in parallel with each other on opposite sides of the screw rod 9. The respective connecting element 22 is provided with a shoulder 23 (see Figs 4c, 6 and 8b) at its lower end, which shoulder is arranged for engagement with a corresponding shoulder 24 on the second holder unit 17. In the illustrated embodiments, the first-mentioned shoulder 23 is formed by a washer 25, which is

attached to the lower end of the connecting element 22 and projects radially therefrom.

[0026] The respective connecting element 22 is displaceable downwards in relation to the second holder unit 17 when the second holder unit is in a lowered position bearing against a workpiece 2 (see Fig 4b) and the screw rod 9 and the nut 10 are subjected to a mutual rotation in said first direction under the effect of the drive motor 3, as illustrated in Figs 4b and 4c. Furthermore, the second holder unit 17 is, while being carried by the connecting elements 22 through the shoulders 23, 24, displaceable upwards in the direction towards the first holder unit 11 from said lowered position (see Figs 4b and 8b) to an elevated position (see Figs 4a and 8a) when the screw rod 9 and the nut 10 are subjected to a mutual rotation in said second direction under the effect of the drive motor 3. By means of the connecting elements 22, the second holder unit 17 can consequently be lifted up from a workpiece 2 after the driving of a fastening member 7, 7" into the workpiece, so as to thereby allow the workpiece 2 to be fed forwards.

[0027] One or more spring members 26, for instance in the form of compression springs, are arranged to act between the first holder unit 11 and the second holder unit 17. The second holder unit 17 is displaceable in the direction towards the first holder unit 11 against the action of these spring members 26. In the illustrated embodiments, the respective spring member 26 consists of a helical spring fitted between the holder units 11, 17, which spring bears against a downwards facing support surface on the first holder unit 11 at one of its ends and bears against an upwards facing support surface on the second holder unit 17 at its other end. In the embodiments illustrated in Figs 1-6, this helical spring 26 surrounds the screw rod 9 and is received in an internal space 27 in the second holder unit 17.

[0028] In the embodiment illustrated in Figs 7-8, the second holder unit 17 comprises a lower part 17a and an upper part 17b, which are fixed to each other by means of a number of connecting rods 17c (see Fig 7), which extend between said lower and upper parts 17a, 17b in parallel with the screw rod 9. The connecting elements 22 are slideably mounted to the lower part 17a of the second holder unit and also to its upper part 17b. In the illustrated example, the spring members 26 acting between the first holder unit 11 and the second holder unit 17 are three in number and arranged to bear against the upper part 17b of the second holder unit.

[0029] One or more spring members 51, for instance in the form of compression springs, may be arranged to act between the support member 20 and the first holder unit 11, as illustrated in Fig 7. The support member 20 is in this case displaceable in the direction towards the first holding unit 11 against the action of these spring members 51. In the embodiment illustrated in Figs 7-8, the respective spring member 51 consists of a helical spring fitted between the support member 20 and the first holder unit 11, which spring bears against a downwards

facing support surface on the support member 20 at one of its ends and bears against an upwards facing support surface on the first holder unit 11 at its other end.

[0030] In the embodiments illustrated in Figs 1-4 and Figs 7-8, the screw rod 9 is connected to the output shaft 5 of the drive motor in order to be rotated by this output shaft. The nut 10 is in this case non-rotatably arranged in the first holder unit 11, so that the screw rod 9 is made to be displaced in relation to the nut 10 and this holder unit 11 in the axial direction together with the drive motor 3 when the screw rod is rotated in relation to the nut under the effect of the drive motor. The drive motor 3 is carried by the screw rod 9, which in its turn is carried by the machine stand 12 via the nut 10 and the holder unit 11. Consequently, the drive motor 3 moves together with the screw rod 9 in a vertical displacement motion in relation to the nut 10, the holder unit 11 and the machine stand 12 when the screw rod 9 is rotated about its longitudinal axis under the effect of the drive motor. The support member 20 is in this case arranged between the drive motor 3 and the first holder unit 11, and the screw rod 9 is rotatably mounted to the support member 20. The support member 20 is connected to the motor housing 4 in order to be displaced together with the drive motor 3 and the screw rod 9 in the axial direction when the screw rod is rotated in relation to the nut 10 under the effect of the drive motor 3. In the illustrated examples, the support member 20 is connected to the motor housing 4 by means of a number of connecting rods 21, which extend between the motor housing 4 and the support member 20 in parallel with the output shaft 5 of the drive motor.

[0031] In the embodiment illustrated in Figs 5 and 6, the nut 10 is rotatably mounted in the first holder unit 11 and connected to the output shaft 5 of the drive motor in order to be rotated by this output shaft. The drive motor 3 is in this case carried by the machine stand 12 by being attached to this either directly or via the first holder unit 11. In the illustrated example, the drive motor 3 is attached to the holder unit 11 by means of a holding member 32. In the illustrated example, the output shaft 5 of the drive motor extends in parallel with the screw rod 9 and the nut 10. A first belt pulley 33 is non-rotatably connected to the output shaft 5 of the drive motor and a second belt pulley 34 is non-rotatably connected to the nut 10. A driving belt 35 is arranged about these belt pulleys 33, 34 and is in engagement with these in order to transmit a rotary motion of the output shaft 5 of the drive motor to a rotary motion of the nut 10. In this case, the screw rod 9 is non-rotatably connected to the support member 20 and consequently not rotatable in relation to the holder units 11, 17 and the machine stand 12. Hereby, the screw rod 9 is made to be displaced in relation to the nut 10 and the first holder unit 11 in the axial direction when the nut is rotated in relation to the screw rod under the effect of the drive motor 3.

[0032] In the embodiment illustrated in Figs 1-4, the tool 6 is rotatably mounted to the screw rod 9 so that a mutual rotation between the tool and the screw rod is

enabled. Transmission of torque from the screw rod 9 to the tool 6 is hereby avoided, and when the tool is pressed against a nail head in order to drive a nail into a workpiece the tool 6 will therefore not rotate in relation to the nail head.

[0033] In the embodiment illustrated in Figs 1-4, the screw rod 9 is connected to the output shaft 5 of the drive motor by means of a safety connector 28, which is arranged to disconnect the output shaft 5 of the drive motor from the screw rod 9 and thereby allow mutual rotation between these when the torque between the output shaft of the drive motor and the screw rod exceeds a given limit value. Hereby, the press force that can be exerted by the tool 6 against a workpiece 2 is limited, and it is thereby secured that the tool 6 is not pressed too hard against the workpiece. It will hereby be possible to avoid an overloading of the machine and damages to the workpiece.

[0034] The respective machine 1, 1', 1" is suitably provided with a sensor 29 (see Fig 2), preferably in the form of an inductive sensor, for detecting a lower position of the tool 6, 6", and an electronic control unit (not shown), which is connected to this sensor 29. The control unit is adapted to reverse the drive motor 3 when receiving from the sensor 29 a signal indicating that the tool 6, 6" has reached this lower position. In the embodiment illustrated in Figs 1-4, this sensor 29 is mounted on a plate 30 (see Fig 1), which is attached to the second holder unit 17 and adjustable into different vertical positions on this holder unit so as to thereby allow an adjustment of the lower end position of the tool. The sensor 29 may for instance be arranged to establish that the tool 6 has reached the lower position by detecting when a ring-shaped and radially projecting projection 31 (see Fig 2) on the sleeve-shaped connecting member 13 has reached the level of the sensor.

[0035] The respective machine 1, 1', 1" is suitably also provided with a further sensor (not shown), preferably in the form of an inductive sensor, for detecting an upper position of the tool 6, 6". Said control unit is adapted to stop or reverse the drive motor 3 when receiving from this sensor a signal indicating that the tool 6, 6" has reached this upper position. The last-mentioned sensor may be attached to the first holder unit 11 or to the machine stand 12.

[0036] Different stages during a sequence for driving a nail 7 into a workpiece 2 by means of the machine 1 described above are illustrated in Figs 4a-4c. At an initial stage, the screw rod 9, the drive motor 3, the tool 6 and the second holder unit 17 are in an upper position, as illustrated in Fig 4a. In this position, the second holder unit 17 rests against the shoulders 23 on the connecting elements 22, and the spring member 26 is pre-loaded and strives to press the second holder unit 17 downwards away from the first holder unit 11. A workpiece 2 can now be introduced under the second holder unit 17. Thereafter, the screw rod 9 is rotated in a first rotational direction under the effect of the output shaft 5 of the drive motor,

whereby the screw rod 9 is rotated in relation to the nut 10 and thereby made to move together with the drive motor 3, the connecting elements 22, the tool 6 and the second holder unit 17 vertically downwards in relation to the first holder unit 11. The second holder unit 17 will follow in this motion downwards until it comes to bear against the workpiece 2, as illustrated in Fig 4b. The second holder unit 17 is now kept in contact with the workpiece 2 under the action of the spring member 26. On the continued rotation of the screw rod 9 in this first rotational direction, the screw rod 9 will move together with the drive motor 3, the connecting elements 22 and the tool 6 vertically downwards in relation to the second holder unit 17, whereby the elongated section 16 of the tool is displaced downwards in the guide channel 18 and presses a nail 7 received in the guide channel out of the guide channel and into the workpiece 2, as illustrated in Fig 4c. The tool 6 has now reached its lower position and the drive motor 3 is reversed under the effect of the sensor 29 and the above-mentioned control unit so that the screw rod 9 is rotated in a second rotational direction opposite the above-mentioned first rotational direction. Hereby, the screw rod 9 is made to move together with the drive motor 3, the connecting elements 22 and the tool 6 vertically upwards in relation to the second holder unit 17 until the shoulders 23 on the connecting elements 22 comes to bear against the corresponding shoulders 24 on the second holder unit 17. The elongated section 16 of the tool has now reached an upper position in the guide channel 18 and leaves room in the guide channel for the feeding of a new nail 7 into the guide channel. On the continued rotation of the screw rod 9 in this second rotational direction, the second holder unit 17 will be lifted up from the workpiece 2 by the connecting elements 22 so that the workpiece can be fed forwards a desired distance in relation to the second holder unit 17. The drive motor 3 can then be reversed and the above-described sequence repeated in order to drive a new nail into the workpiece. The machine 1' according to Figs 5 and 6 operates in a corresponding manner, with the differences that it is the nut 10 and not the screw rod 9 that is rotated by the drive motor 3 and that the drive motor remains stationary and is not displaced together with the screw rod 9 during the nail driving sequence.

[0037] The above-mentioned coupling device 40 of the machine 1" according to Figs 7-8 is shown in closer detail in Fig 9. This coupling device 40 is rotatably mounted in a third holder unit 36, which is displaceable in the vertical direction in relation to the first and second holder units 11, 17. The third holder unit 36 is connected to the support member 20 via the above-mentioned connecting elements 22, which are slideably mounted to the third holder unit 36. The respective connecting element 22 is provided with a shoulder 37 (see Fig 8b), which is arranged for engagement with a corresponding shoulder 38 on the third holder unit 36. The respective connecting element 22 is displaceable downwards in relation to the third holder unit 36 when the second holder unit 17 is in a lowered

position bearing against a workpiece (see Fig 8b) and the screw rod 9 and the nut 10 are subjected to a mutual rotation in said first direction under the effect of the drive motor 3. Furthermore, the third holder unit 36 is, while being carried by said connecting elements 22 through said shoulders 37, 38, displaceable upwards in the direction towards the first holder unit 11 when the screw rod 9 and the nut 10 are subjected to a mutual rotation in said second direction under the effect of the drive motor 3.

[0038] A spring member 39, for instance in the form of a compression spring, is arranged to act between the first holder unit 11 and the third holder unit 36. The third holder unit 36 is displaceable in the direction towards the first holder unit 11 against the action of this spring member 39. In the embodiment illustrated in Figs 7-8, this spring member 39 consists of a helical spring fitted between the holder units 11, 36, which spring bears against a downwards facing support surface on the first holder unit 11 at one of its ends and bears against an upwards facing support surface on the third holder unit 36 at its other end. In the illustrated example, this helical spring 39 surrounds the screw rod 9 and is received in an internal space 50 in the first holder unit 11.

[0039] The coupling device 40 comprises a coupling sleeve 41, which is rotatable in relation to the third holder unit 36. Furthermore, the coupling sleeve 41 is axially fixed to the third holder unit 36 and prevented from being displaced in the axial direction in relation to this holder unit. The screw rod 9 is non-rotatably connected to the coupling sleeve 41 via a coupling member 42, which is fixed to the lower end of the screw rod and received inside the coupling sleeve 41 through an opening at the upper end of the coupling sleeve. The coupling sleeve 41 is provided with internal splines which are in engagement with external splines on the coupling member 42 in order to transmit torque from the screw rod 9 to the coupling sleeve 41. The coupling member 42 and the coupling sleeve 41 are displaceable in relation to each other in the axial direction in order to be able to take up the mutual axial displacement differences that may ensue between the screw rod 9 and the tool 6" in connection with the screwing of a screw 7" into a workpiece due to different pitch of thread of the screw rod and the screw. The coupling device 40 is in that manner arranged to allow the screw rod 9 and the tool 6" to be displaced in relation to each other in the axial direction when the second holder unit 17 is in a lowered position bearing against a workpiece.

[0040] Furthermore, the coupling device 40 comprises a base part 43, which is rotatably mounted to the third holder unit 36 by means of an upper bearing 44 and a lower bearing 45. The base part 43 is at its upper end fixedly connected to the coupling sleeve 41 and at its lower end connected to the tool 6" by means of a one-way clutch 46. Furthermore, the tool 6" is rotatably mounted to the base part 43 by means of a stabilizing bearing 47. The one-way clutch 46 may for instance consist of a

free hub of needle bearing type and is arranged to transmit torque from the base part 43 to the tool 6" when the screw rod 9 is rotated in the above-mentioned first direction and not transmit any torque from the base part 43 to the tool 6" when the screw rod 9 is rotated in the above-mentioned second direction. The tool 6" consequently rotates together with the screw rod 9 when the screw rod is rotated in said first direction, and the screw rod 9 and the base part 43 of the coupling device are allowed to rotate in relation to the tool 6" when the screw rod 9 is rotated in said second direction. In the embodiment illustrated in Figs 7-9, the tool 6" comprises an upper bit holder 6a and a lower tool bit 6b detachably attached to the bit holder.

[0041] Different stages during a sequence for driving a screw 7" into a workpiece 2 by means of the machine 1" described above are illustrated in Figs 8a-8b. At an initial stage, the screw rod 9, the drive motor 3, the tool 6" and the second and third holder units 17, 36 are in an upper position, as illustrated in Fig 8a. In this position, the second holder unit 17 rests against the shoulders 23 on the connecting elements 22, and the spring members 26 are pre-loaded and strive to press the second holder unit 17 downwards away from the first holder unit 11. In the corresponding manner, the third holder unit 36 rests against the shoulders 37 on the connecting elements 22, and the spring member 39 is pre-loaded and strives to press the third holder unit 36 and the tool 6" downwards away from the first holder unit 11. A workpiece 2 may now be introduced under the second holder unit 17. Thereafter, the screw rod 9 is rotated in a first rotational direction under the effect of the output shaft 5 of the drive motor, whereby the screw rod 9 is rotated in relation to the nut 10 and thereby made to move together with the drive motor 3, the connecting elements 22, the second and third holder units 17, 36 and the tool 6" vertically downwards in relation to the first holder unit 11. The second holder unit 17 will follow in this motion downwards until it comes to bear against the workpiece 2. The second holder unit 17 is now kept in contact with the workpiece 2 under the action of the spring members 26. On the continued rotation of the screw rod 9 in this first rotational direction, the screw rod 9 will move together with the drive motor 3, the connecting elements 22, the third holder unit 36 and the tool 6" vertically downwards in relation to the second holder unit 17, whereby the tool 6" while rotating is displaced downwards in the guide channel 18 and screws a screw 7" received in the guide channel into the workpiece 2, as illustrated in Fig 8b. The drive motor 3 is then reversed so that the screw rod 9 is rotated in a second rotational direction opposite the above-mentioned first rotational direction. The screw rod 9 is hereby made to move together with the drive motor 3 and the connecting elements 22 vertically upwards in relation to the second and third holder units 17, 36 so that the shoulders 23, 37 on the connecting elements 22 come to bear against the corresponding shoulders 24, 38 on the second and third holder units 17, 36, whereupon the tool

6" and the second holding unit 17 will be lifted up from the workpiece 2 by the connecting elements 22 so that the workpiece can be fed forwards a desired distance in relation to the second holder unit 17. The drive motor 3 can then be reversed and the above-described sequence repeated in order to drive a new screw into the workpiece.

[0042] The invention is of course not in any way limited to the embodiments described above. On the contrary, several possibilities to modifications thereof should be apparent to a person with ordinary skill in the art without thereby deviating from the basic idea of the invention as defined in the appended claims.

Claims

1. A machine for driving fastening members, for instance in the form of nails or screws, into workpieces, which machine (1, 1', 1'') comprises:

- a reversible drive motor (3) with an output shaft (5);
- an axially displaceable tool (6, 6''), which is intended to engage with a fastening member in order to drive the fastening member into a workpiece; and

- a motion conversion mechanism (8) for converting a rotary motion of the output shaft (5) of the drive motor into an axial translational motion of the tool (6, 6''), this motion conversion mechanism (8) comprising a screw rod (9) and a nut (10) which co-operates with the screw rod,

characterized in:

- **that** the nut (10) is arranged in a holder unit (11), here denominated first holder unit, the nut (10) being axially fixed to this holder unit (11) so that the nut is prevented from being displaced in the axial direction in connection with a mutual rotation between the screw rod (9) and the nut and so that the screw rod is made to be displaced in relation to the nut (10) and this holder unit (11) in the axial direction when the screw rod and the nut are subjected to a mutual rotation under the effect of the drive motor (3); and

- **that** the tool (6, 6'') is connected to the screw rod (9) in order to be displaced together with this screw rod in the axial direction downwards into engagement with a fastening member when the screw rod (9) and the nut (10) are subjected to a mutual rotation in a first direction under the effect of the drive motor (3), and in the axial direction upwards out of engagement with said fastening member when the screw rod (9) and the nut (10) are subjected to a mutual rotation in a second direction under the effect of the drive motor (3).

2. A machine according to claim 1, **characterized in**

that the machine (1, 1', 1'') comprises a second holder unit (17), which is provided with a guide channel (18) for receiving a fastening member, the tool (6, 6'') being displaceable downwards in this guide channel (18) in order to drive a fastening member received in the guide channel out of the guide channel and into a workpiece when the screw rod (9) and the nut (10) are subjected to a mutual rotation in said first direction under the effect of the drive motor (3).

3. A machine according to claim 2, **characterized in:**

- **that** the machine (1, 1', 1'') comprises a support member (20) arranged above the first holder unit (11), which support member is connected to the screw rod (9) in order to be displaced together with the screw rod when the screw rod (9) and the nut (10) are subjected to a mutual rotation under the effect of the drive motor (3);

- **that** the second holder unit (17) is connected to the support member (20) via one or more elongated connecting elements (22), the respective connecting element (22) extending along the screw rod (9) and being carried by the support member (20) and slideably mounted to the second holder unit (17);

- **that** the respective connecting element (22) is provided with a shoulder (23) at its lower end, which shoulder is arranged for engagement with a corresponding shoulder (24) on the second holder unit (17);

- **that** the respective connecting element (22) is displaceable downwards in relation to the second holder unit (17) when the second holder unit (17) is in a lowered position bearing against a workpiece and the screw rod (9) and the nut (10) are subjected to a mutual rotation in said first direction under the effect of the drive motor (3); and

- **that** the second holder unit (17), while being carried by said connecting elements (22) through said shoulders (23, 24), is displaceable upwards in the direction towards the first holder unit (11) from said lowered position to an elevated position when the screw rod (9) and the nut (10) are subjected to a mutual rotation in said second direction under the effect of the drive motor (3).

4. A machine according to claim 3, **characterized in** **that** the machine (1, 1', 1'') comprises a spring member (26) acting between the first holder unit (11) and the second holder unit (17), the second holder unit (17) being displaceable in the direction towards the first holder unit (11) against the action of this spring member.

5. A machine according to claim 3 or 4, **characterized**

in that the respective connecting element (22) is slideably mounted to the first holder unit (11).

6. A machine according to any of claims 3-5, **characterized in that** the respective connecting element (22) consists of a rod, the machine preferably comprising two such connecting elements (22) arranged in parallel with each other on opposite sides of the screw rod (9).

7. A machine according to any of claims 1-6, **characterized in:**

- that the screw rod (9) is connected to the output shaft (5) of the drive motor in order to be rotated by this output shaft; and

- that the nut (10) is non-rotatably arranged in the first holder unit (11) so that the screw rod (9) is made to be displaced in relation to the nut and the first holder unit in the axial direction together with the drive motor (3) when the screw rod is rotated in relation to the nut (10) under the effect of the drive motor.

8. A machine according to claim 7 in combination with claim 3, **characterized in that** the screw rod (9) is rotatably mounted to the support member (20).

9. A machine according to claim 7 or 8, **characterized in that** the tool (6") constitutes a screw tool and is connected to the screw rod (9) by means of a coupling device (40), which is arranged:

- to transmit torque from the screw rod (9) to the tool (6") when the screw rod (9) is rotated in said first direction under the effect of the drive motor (3); and

- to allow the screw rod (9) to rotate in relation to the tool (6") when the screw rod is rotated in said second direction under the effect of the drive motor (3) so that no torque is transmitted from the screw rod (9) to the tool (6") when the screw rod is rotated in this second direction under the effect of the drive motor (3).

10. A machine according to claim 9 in combination with claim 3, **characterized in:**

- that the coupling device (40) is rotatably mounted in a third holder unit (36), which is displaceable in the vertical direction in relation to the first and second holder units (11, 17);

- that the third holder unit (36) is connected to the support member (20) via said connecting elements (22);

- that the respective connecting element (22) is provided with a shoulder (37), which is arranged for engagement with a corresponding shoulder

(38) on the third holder unit (36);

- that the respective connecting element (22) is displaceable downwards in relation to the third holder unit (36) when the second holder unit (17) is in a lowered position bearing against a workpiece and the screw rod (9) and the nut (10) are subjected to a mutual rotation in said first direction under the effect of the drive motor (3);

- that the third holder unit (36), while being carried by said connecting elements (22) through said shoulders (37, 38), is displaceable upwards in the direction towards the first holder unit (11) when the screw rod (9) and the nut (10) are subjected to a mutual rotation in said second direction under the effect of the drive motor (3).

11. A machine according to claim 10, **characterized in that** the machine (1") comprises a spring member (39) acting between the first holder unit (11) and the third holder unit (36), the third holder unit (36) being displaceable in the direction towards the first holder unit (11) against the action of this spring member.

12. A machine according to claim 10 or 11, **characterized in that** the coupling device (40) is arranged to allow the screw rod (9) and the tool (6") to be displaced in relation to each other in the axial direction when the second holder unit (17) is in a lowered position bearing against a workpiece.

13. A machine according to any of claims 1-6, **characterized in:**

- that the nut (10) is rotatably mounted in the first holder unit (11) and connected to the output shaft (5) of the drive motor in order to be rotated by this output shaft; and

- that the screw rod (9) is non-rotatably arranged so that the screw rod is made to be displaced in relation to the nut (10) and the first holder unit (11) in the axial direction when the nut is rotated in relation to the screw rod under the effect of the drive motor (3).

14. A machine according to any of claims 1-8 or 13, **characterized in that** the tool (6) constitutes a nail driving tool, the tool (6) being axially fixed to the lower end of the screw rod (9) and being prevented from being displaced in the axial direction in relation to the screw rod.

15. A machine according to any of claims 1-14, **characterized in that** the machine (1, 1', 1") comprises a sensor (29), preferably in the form of an inductive sensor, for detecting a lower position of the tool (6, 6"), and an electronic control unit connected to this sensor (29), the control unit being adapted to reverse the drive motor (3) when receiving from the sensor

(29) a signal which indicates that the tool (6, 6") has reached this lower position, the sensor (29) preferably being attached to the second holder unit (17) and adjustable into different vertical positions on this holder unit to thereby allow an adjustment of the lower end position of the tool. 5

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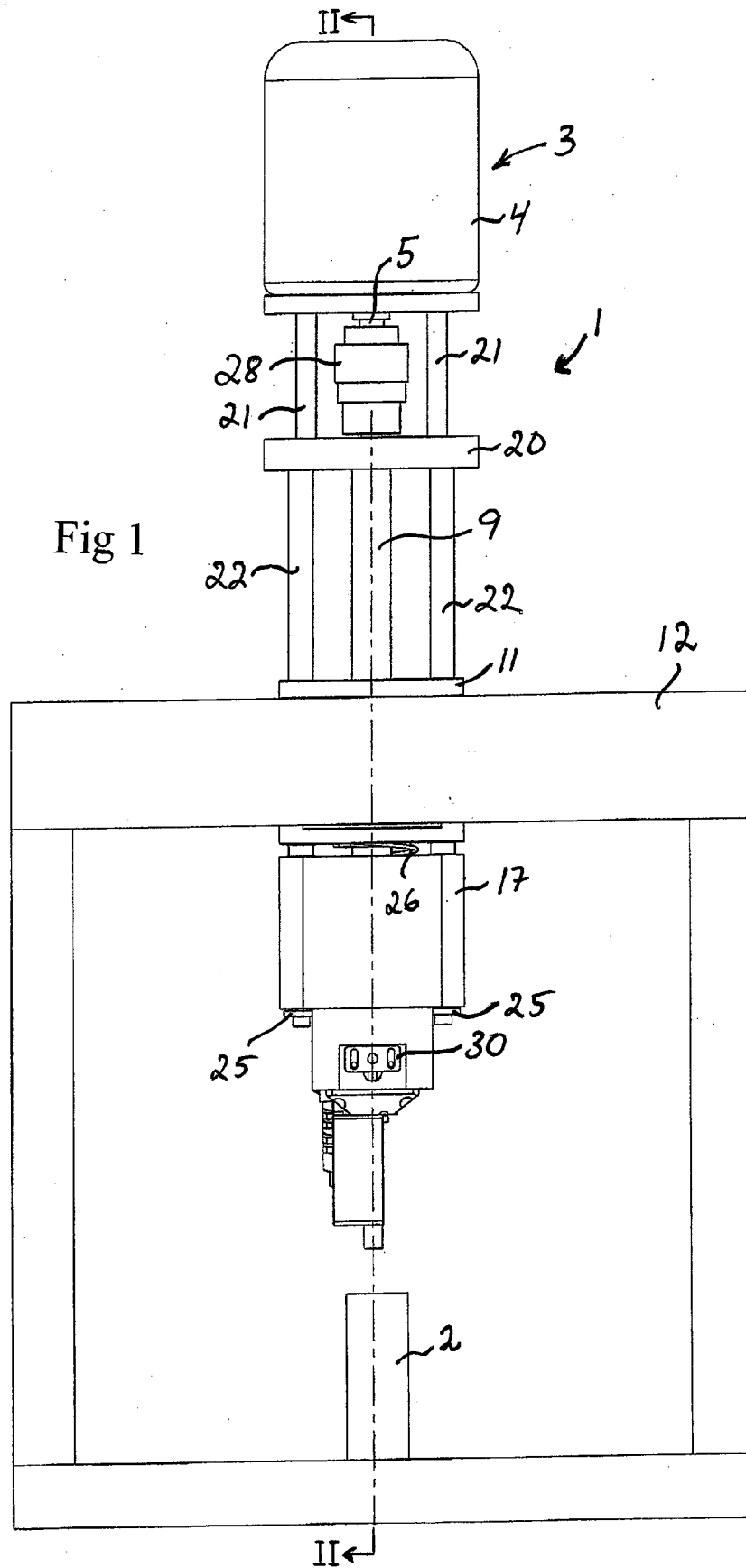
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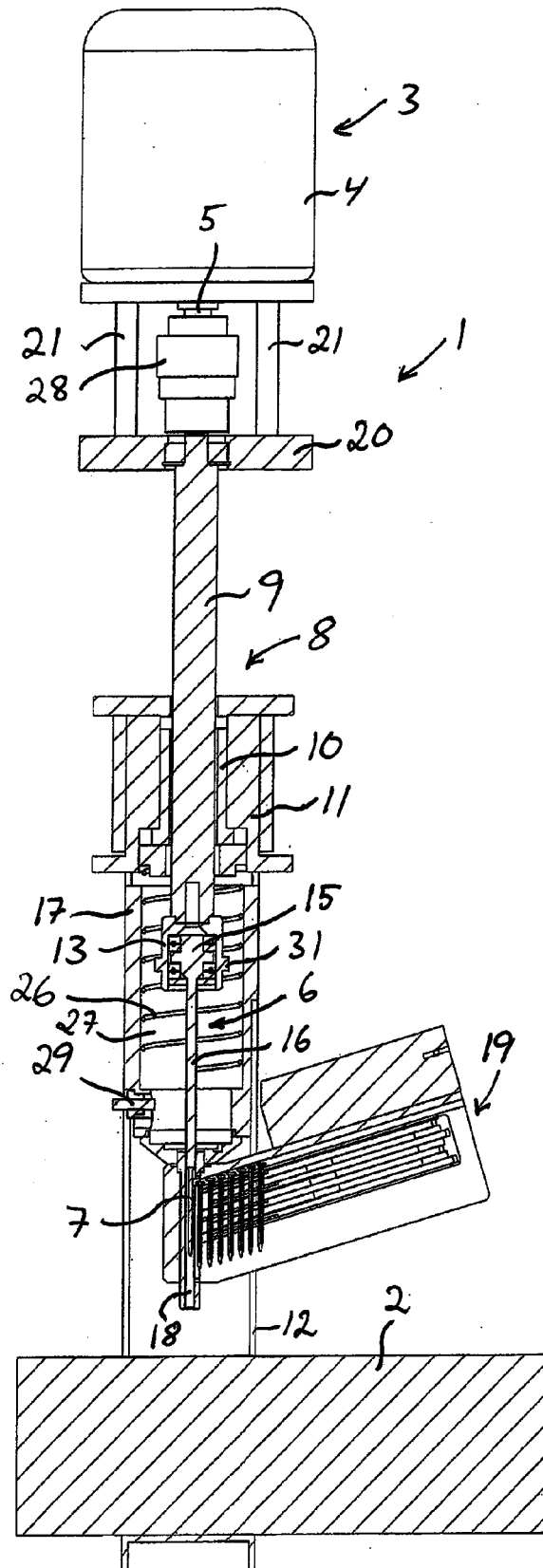
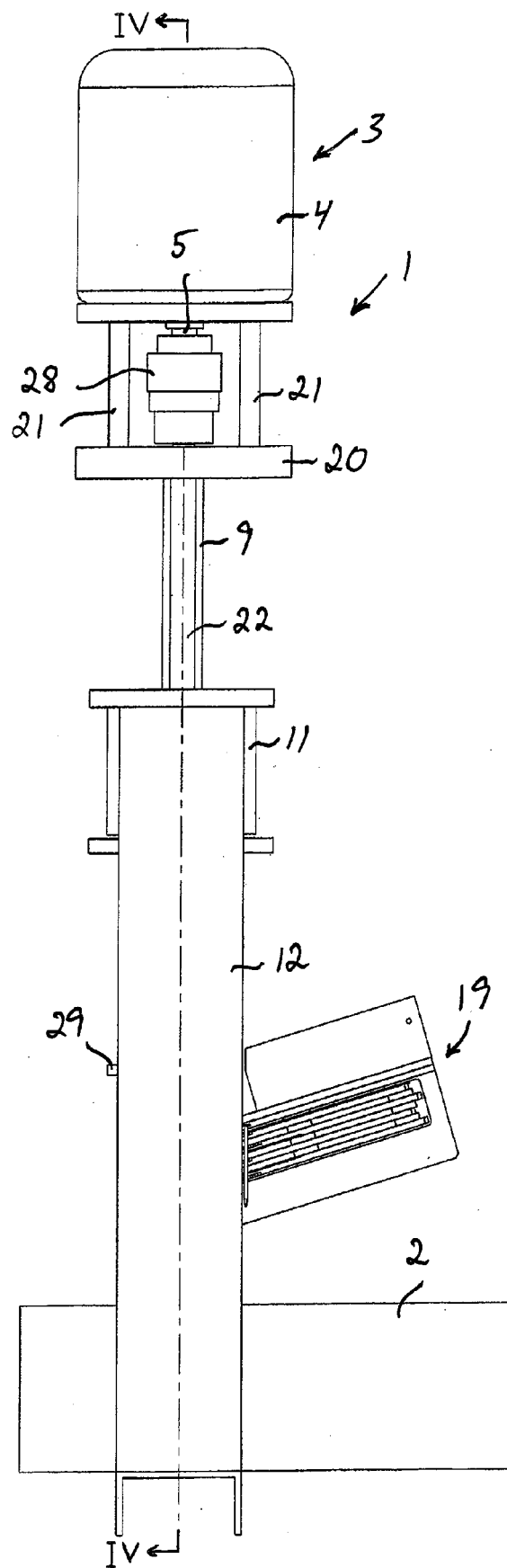
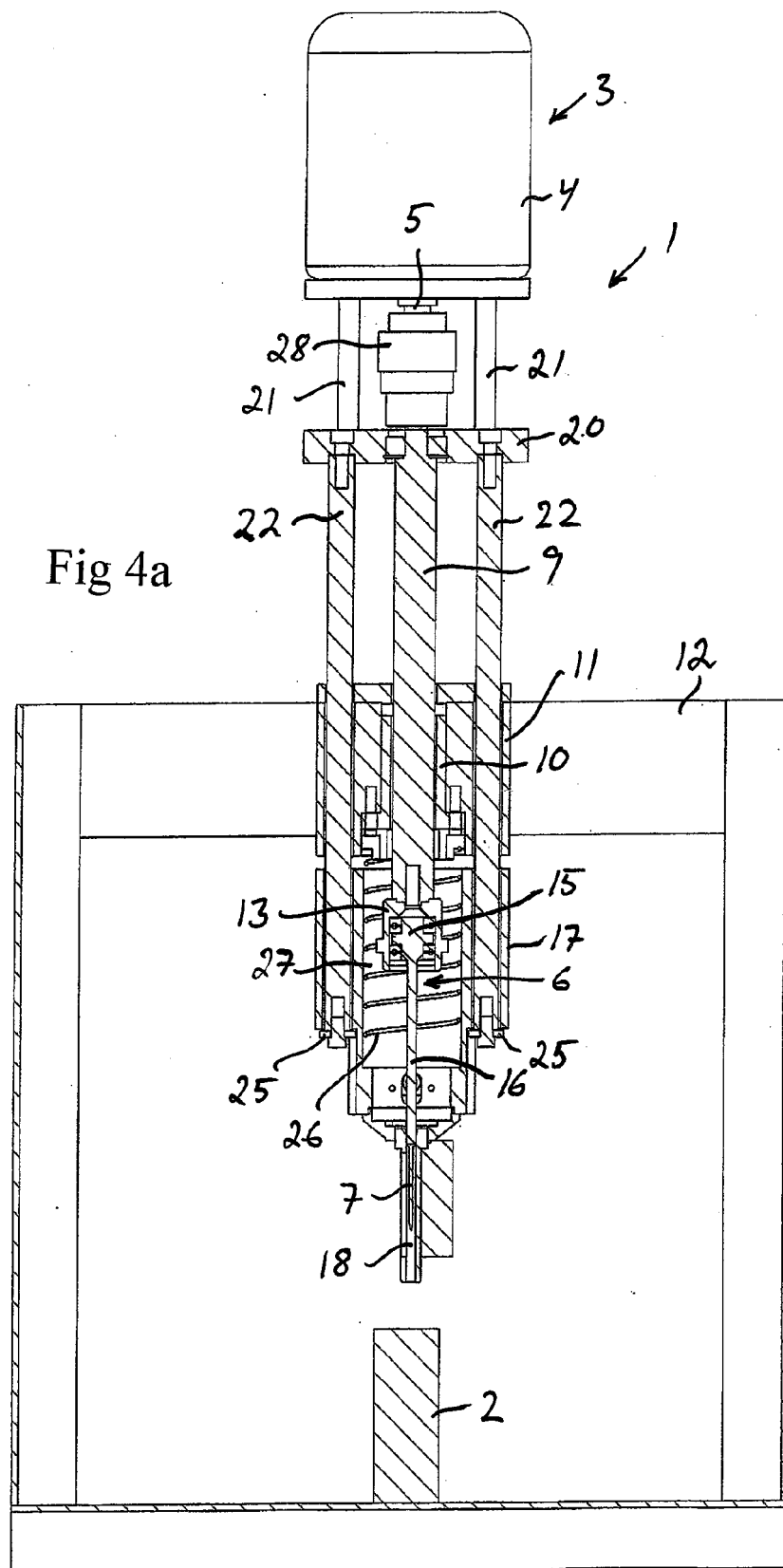


Fig 2

Fig 3





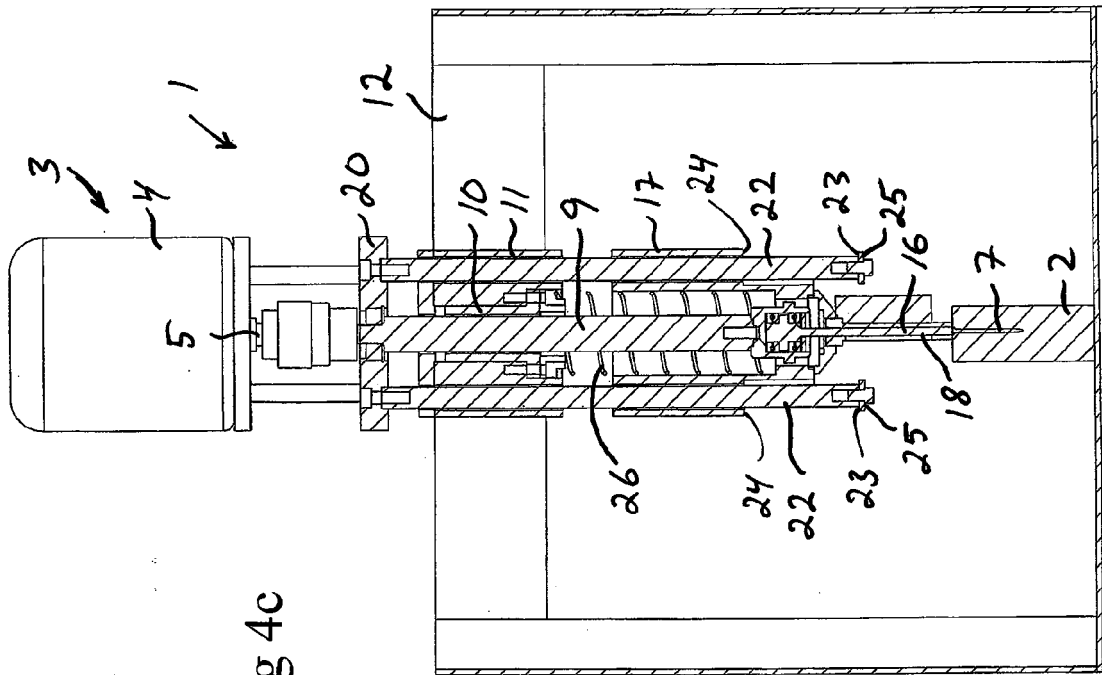


Fig 4c

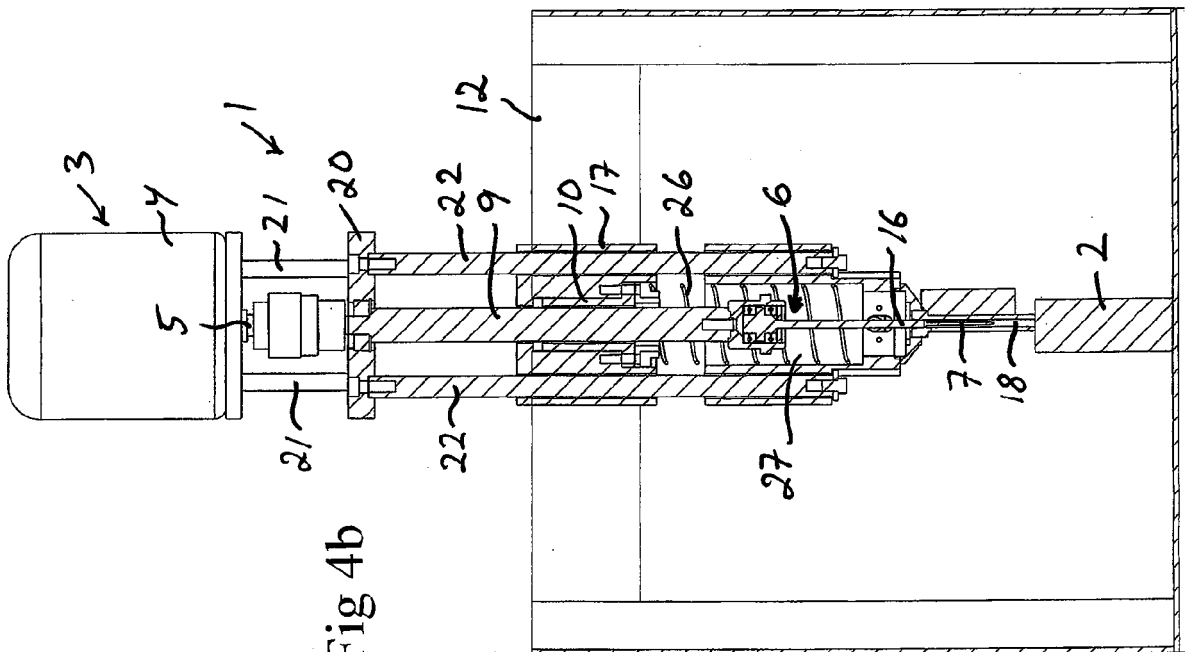


Fig 4b

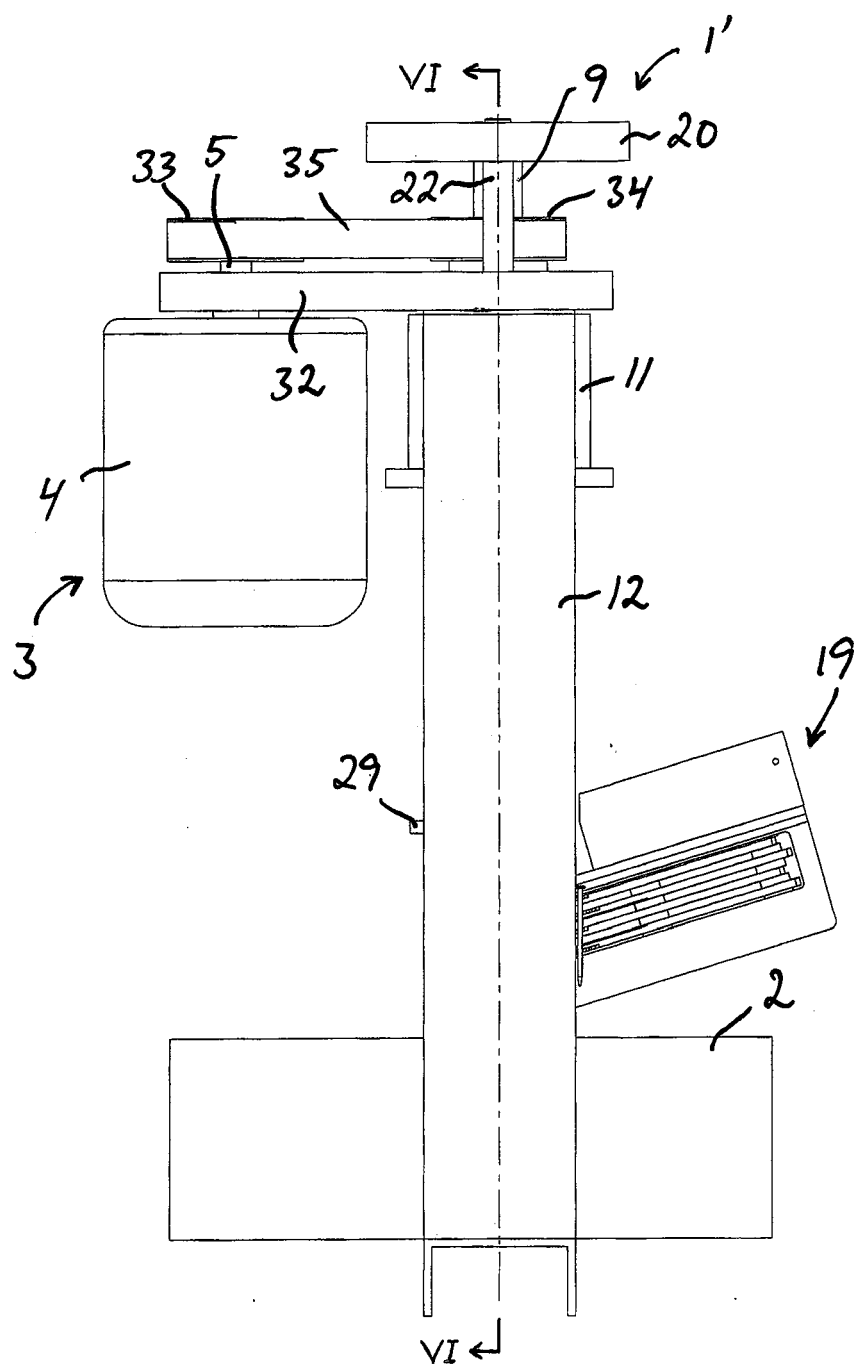


Fig 5

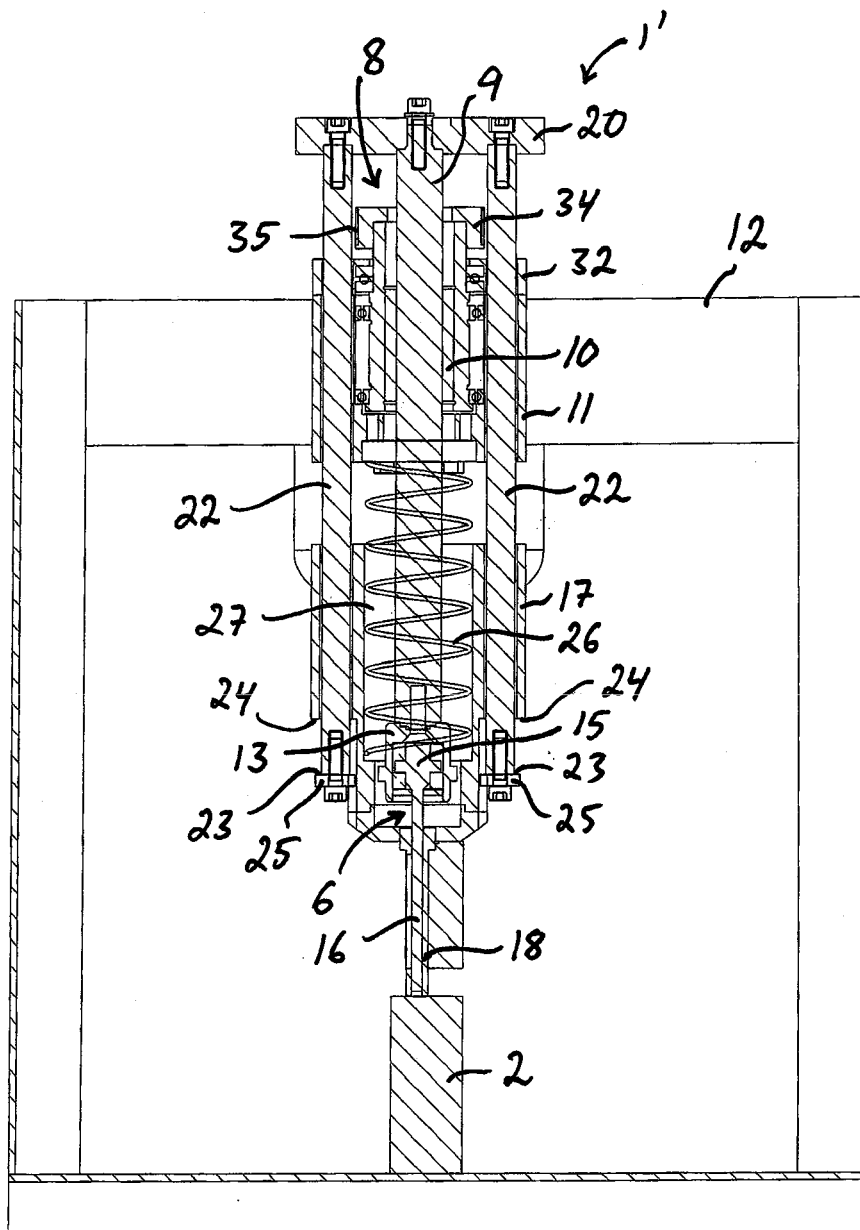
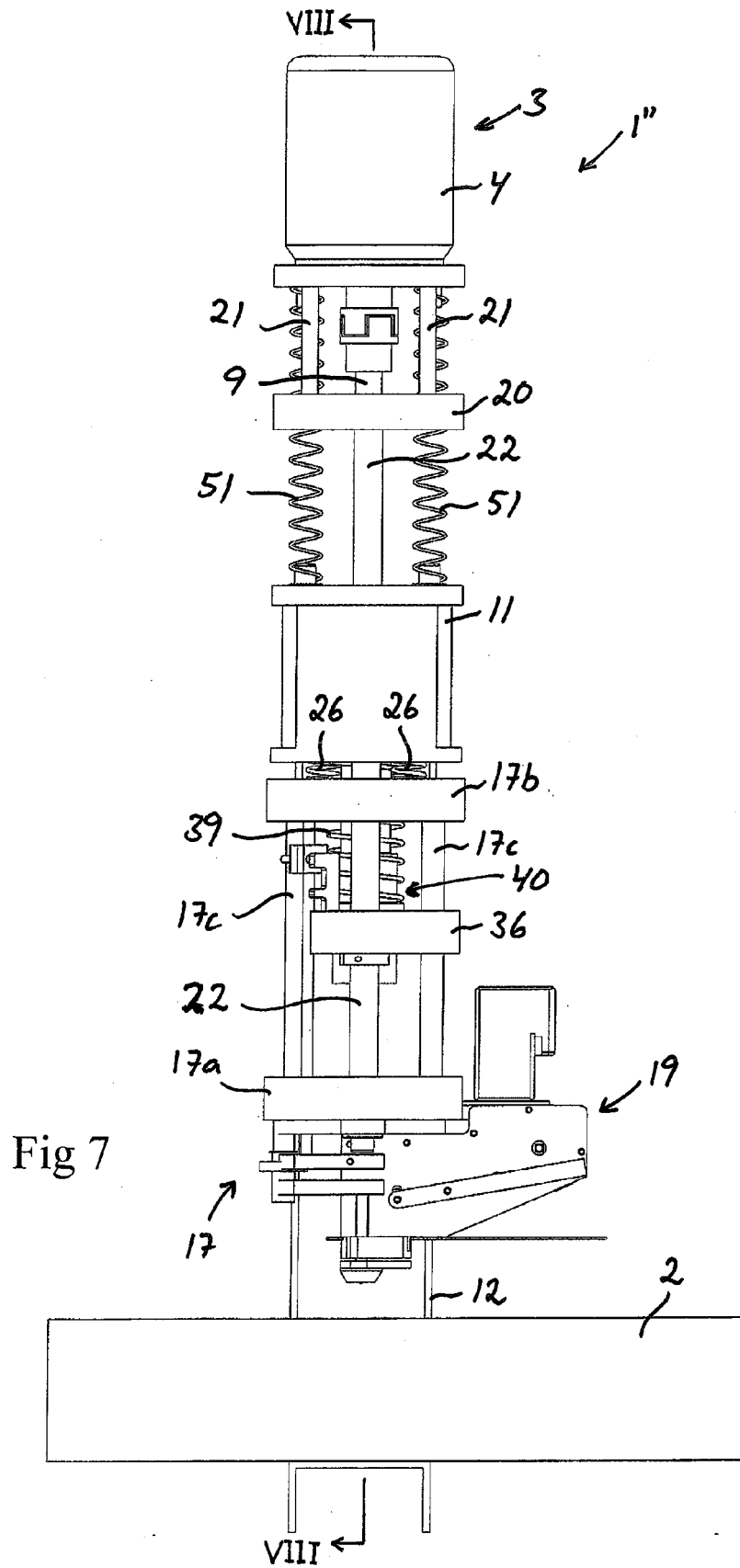
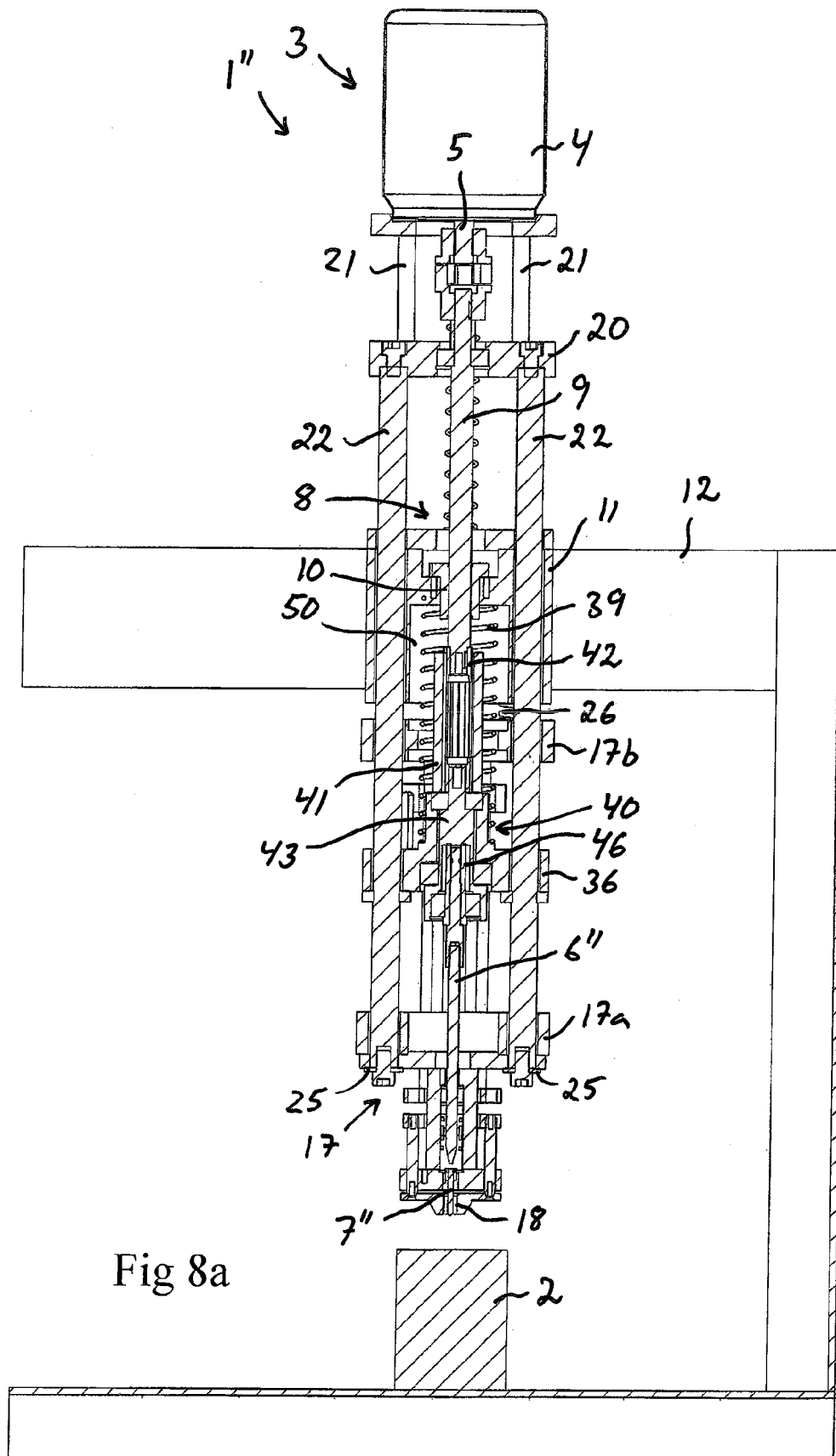
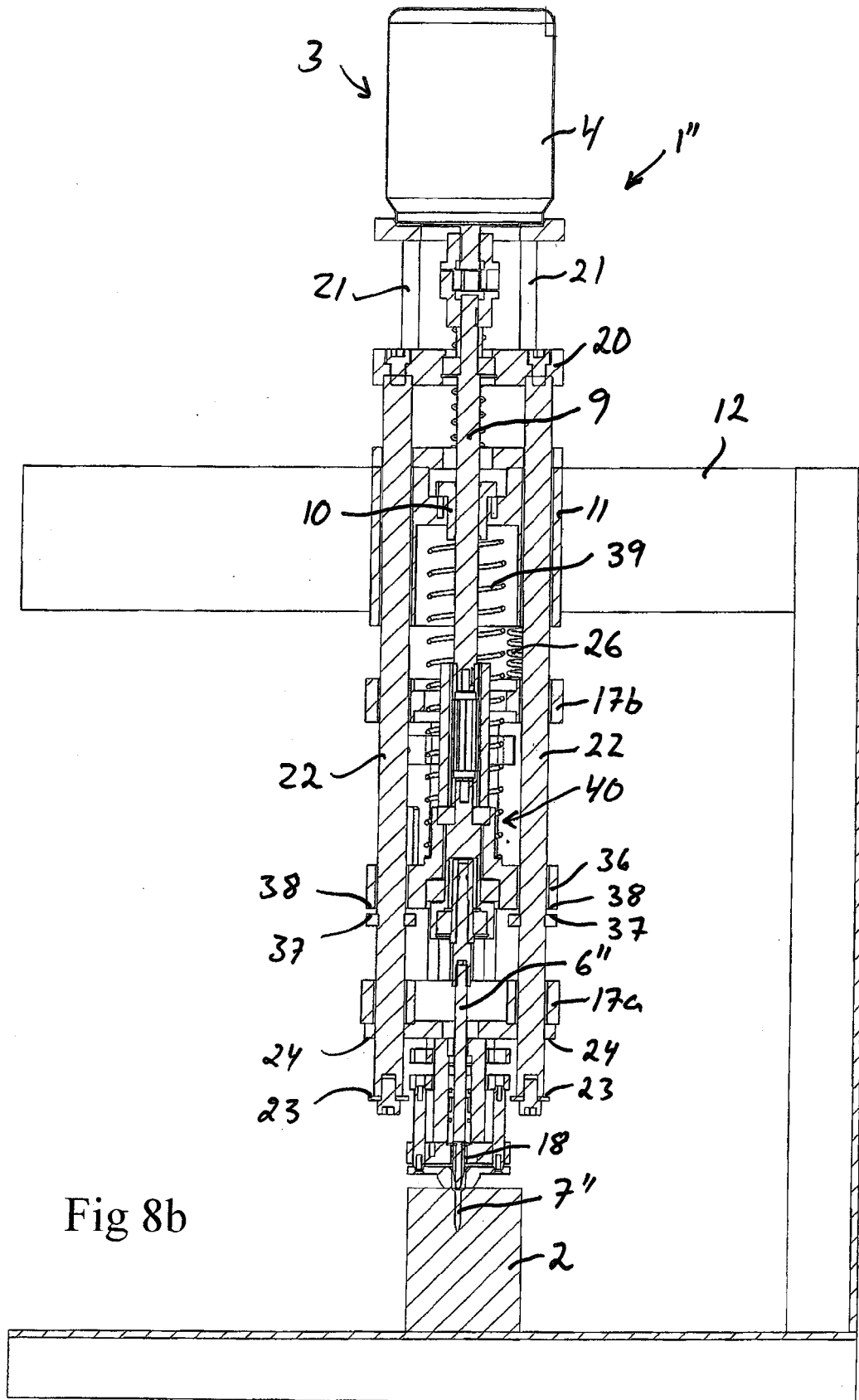


Fig 6







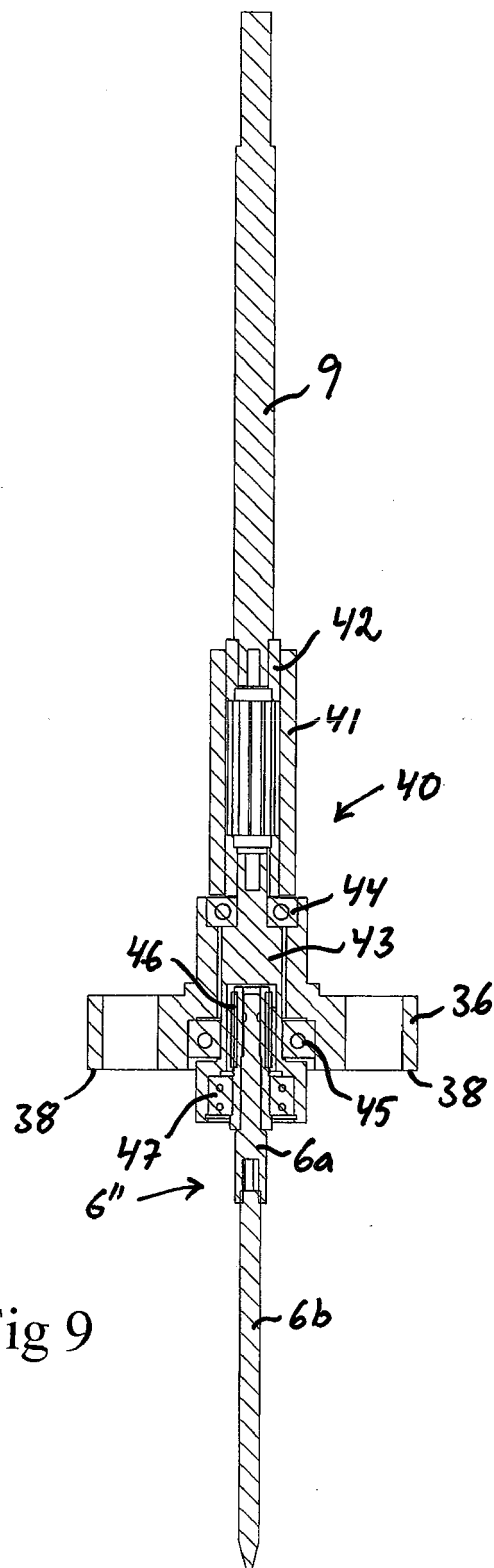


Fig 9



EUROPEAN SEARCH REPORT

Application Number
EP 11 16 3634

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 782 726 A (RYDER FRANCIS E [US] ET AL) 8 November 1988 (1988-11-08)	1	INV. B27F7/11 B23P19/06
Y	* column 4, lines 32-42; figures 5,6,9 *	2,7-9, 13-15	
Y	----- DE 33 33 427 A1 (REICH MASCHF GMBH KARL [DE]) 4 April 1985 (1985-04-04)	2,13	
A	* page 7, lines 13-16; figure 1 *	1,15	
Y	----- US 1 574 490 A (KUMLER HERVEY R ET AL) 23 February 1926 (1926-02-23)	7-9	
A	* page 3, lines 96-100; figures 1,10,12,13 *	3-6	
Y	----- US 3 982 678 A (OLSON JEROME A) 28 September 1976 (1976-09-28)	14	
Y	----- US 2 799 871 A (EDWARD TOROSIAN) 23 July 1957 (1957-07-23)	15	
A	* column 2, lines 22-29; figures 2,3 *	1	TECHNICAL FIELDS SEARCHED (IPC)
			B27F B23P B25C
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 17 August 2011	Examiner Matzdorf, Udo
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 11 16 3634

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17-08-2011

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4782726	A	08-11-1988	NONE	
DE 3333427	A1	04-04-1985	JP 60104660 A US 4625597 A	10-06-1985 02-12-1986
US 1574490	A	23-02-1926	NONE	
US 3982678	A	28-09-1976	NONE	
US 2799871	A	23-07-1957	NONE	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 11076519 A [0003]