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(54) **A vibrator for compacting soil and the like.**

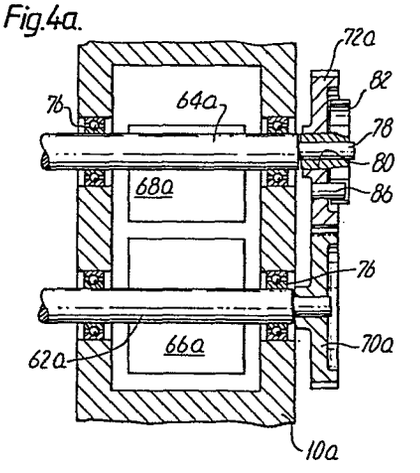
(57) The invention relates to a vibrator for compacting soil.

The object of the invention is to provide a vibrator having an improved manoeuvrability.

The vibrator comprises a bottom plate (8) and a vibratory element (10) supported thereby. The vibratory element comprises two in synchronized opposite directions rotatable shafts (62, 64) driven by hydraulic motors and each supporting an excentric weight (66, 68). The relative position of the excentric weights is adjustable in order to impart to the vibratory element a vibratory motion which has the desired direction.

The vibratory element (10) comprises two hydraulic motors (12, 14) connected with each of the shafts which are connected with each other by means of a device (70, 72) for transmitting the rotational motion of the one shaft to the other shaft. At least one portion of the motion transmission device connected with the one of the shafts is rotatable in relation to the shaft between two engagement positions which are positioned at an angle distance from each other. The vibrator comprises a control device (30) for supplying a main flow of hydraulic fluid to either the one or the other hydraulic motor (12, 14). On each occasion the shafts are driven by the one or the other hydraulic motor, one of the shafts being thereby driven directly and the other shaft being driven indirectly through the motion transmission device. Thereby the portion of the motion transmission device rotatable in relation to its shaft takes different engagement positions dependent on whether the portion connected with the shaft is driven directly by the hydraulic motor connected with said shaft or indirectly by the hydraulic motor connected with the other shaft.

Fig.4a.

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The present invention relates to a vibrator for vibrating soil. For compacting crushed rock, earth, sand, street and road paving materials and so on by means of vibrations there is used a vibrator comprising a bottom plate supported by the soil and a vibratory element supported by the bottom plate for transmitting vibratory motions to the bottom plate. In a previously known vibrator the vibratory element comprises two in synchronized opposite directions rotatable shafts driven by hydraulic motors and each supporting one excentric weight. When driving the excentric weights in a rotational motion by means of the shafts there is imparted a vibratory motion to the vibratory element. By adjusting the relative position of the excentric weight it is possible to adjust the direction of the vibratory motion in a desired way. When adjusting the relative position of the excentric weights in such a way that the direction of the vibratory motion forms an angle with the vertical plane there is provided a motion of the vibrator at the same time as the vibration of the soil takes place. In a previously known vibrator it is possible to adjust said relative position between the excentric weights while the vibrator is working in order to provide a motion of the vibrator forwards or backwards during the vibration.

A drawback in previously known vibrators of the kind described above is that the selector device for providing the changing of the relative position of the excentric weights is complicated and difficult to control. Of course, this provides a restriction of the total manoeuvrability of the soil vibrator which in turn reduces the possibilities of operating the vibrator close to obstacles of different kinds.

In accordance therewith it is the object of the present invention to provide a vibrator which by comprising an improved device for providing the changing of the relative position of the excentric weights presents an improved and simplified function and an improved manoeuvrability.

In order to comply with this object the vibrator according to the invention is characterized in that the vibratory element comprises two hydraulic motors each connected with one shaft, that the shafts are connected with each other by means of a device for transmitting the rotational motion of one shaft to the other shaft, a portion of the motion transmission device connected with at least one of said shafts is rotatable in relation to said shaft between two engaging positions positioned at an angle distance from each other, and that the vibrator comprises a control device for supplying a main flow of hydraulic fluid to either of the two hydraulic motors, the shafts being on each occasion driven substantially by the one or the other of the hydraulic motors, the one shaft being thereby driven

directly and the other shaft being driven indirectly through the motion transmission device, the portion of the motion transmission device rotatable in relation to its shaft thereby taking different engagement positions dependent on the shaft being driven directly by the hydraulic motor connected with this shaft or indirectly by the hydraulic motor connected with the other shaft for providing different relative rotational positions of the shafts and the excentric weights supported thereby.

In a vibrator of this kind the control device can be formed as an electrically controlled selector valve which can be switched between two positions for supplying either the one or the other hydraulic motor a main flow of hydraulic fluid in order to provide said adjustment or changing of the relative positions of the excentric weights. Thus, in a vibrator according to the invention it is possible to reverse the direction of movement of the vibrator by operating a simple electric switch. It is recognized that a vibrator according to the invention is extremely simple to operate and can be operated with a great accuracy.

In a preferred embodiment of the vibrator according to the invention the motion transmission device comprises two gears which engage each other, one gear being fixedly connected with one shaft and the other being connected with the other shaft in such a way that it is rotatable between two engagement positions positioned at an angle distance from each other.

In addition to the fact that the vibrator according to the invention is easy to operate it is also an advantage that the said construction of the vibrator solves the problem of self-synchronization present in vibrators of said kind. The self-synchronization provides that the excentric weights take a position in which they are running in phase with each other and do not take the desired relative position in which the vibratory motions have the desired direction. In a vibrator according to the invention this self-synchronization will not appear as the hydraulic motor driven through the motion transmission device will provide a breaking action on the shaft connected therewith which in turn provides that the engagement positions which are required for obtaining the desired direction of the vibratory motions will be maintained on all occasions.

The invention is described in the following with reference to the accompanying drawings. Figs. 1a, 1b and 1c are a side view, a plan view and a front view, respectively, of a vibrator according to the invention. Figs 2a and 2b are a plan view partly in section a section along line II-II of Fig. 2a a vibratory unit included in the vibrator according to the invention. Figs 3a and 3b are schematic

views of two different operative positions of a hydraulic drive system included in a vibrator according to the invention. Figs 4a and 4b show portions of an embodiment of a vibratory unit included in the vibrator according to the invention.

The vibrator according the invention and shown in the drawings is intended for vibrating the soil and comprises a top portion 2 and a bottom portion 4 which are connected with each other by means of vibration absorbers 6 schematically shown. The bottom portion 4 comprises a bottom plate 8 and a vibratory element 10 supported thereby. The vibratory element 10 comprises two hydraulic motors 12 and 14 for driving the vibratory element.

The top portion 2 comprises a manoeuvring handle 16, a combustion engine 18 for driving a hydraulic pump 20 which is connected with the hydraulic motors 12 and 14 for the operation thereof, the top portion 2 also comprises a hydraulic oil tank having a filling device 24.

From the hydraulic oil tank there extends a suction line 26 to the hydraulic pump 20. A main pressure line 28 extends from the hydraulic pump 20 to an electrically operated selector valve 30. From the selector valve 30 there extend a line 32 to the hydraulic motor 12 and a line 34 to the hydraulic motor 14. By means of the selector valve 30 the hydraulic oil pressure can be supplied either to the hydraulic motor 12 through the line 32 or to the hydraulic motor 14 through the line 34. Return lines 36 and 38 extend from the hydraulic motors 12 and 14, respectively, and are connected with each other to a common return line 40 which extends back to the hydraulic oil tank 22 through a return oil filter 42. A check valve 44 is connected between the line 32 and the return line 36, and a check valve 46 is connected between the line 34 and the return line 38. A tank line 48 extends from the selector valve 30. A pressure limiting valve 52 is connected between the main pressure line 28 and the tank line 48.

The manoeuvring handle 16 is connected with the top portion 2 of the vibrator by means of vibration absorbers 53 limiting the transmission of the vibratory motions of the vibrator to the handle. The manoeuvring handle 16 is provided with a control element for starting and stopping the vibratory motion and a control element 56 in the form of a pressure switch for switching the selector valve 13 between forward and backward movement of the vibrator.

Figs.2a and 2b are schematic views showing the construction of the vibratory unit 10 of the vibrator. The vibratory unit comprises a vibratory housing 60 in which two shafts 62 and 64 are rotatably journalled. Each shaft 62 and 64 supports an

excentric weight 66 and 68, respectively. The excentric weights 66 and 68 are fixedly connected with the shaft belonging thereto. The shaft 62 supports a gear 20 unrotatably connected with the shaft. The shaft 64 supports a gear 72 which engages the gear 70. The gear 72 is rotatable in relation to the shaft 64 between two positions positioned at an angle distance of $180^{0}$ from each other. In these positions there is an engagement between contact elements connected with the shaft and the gear, respectively. The construction of the contact elements is not shown in Figs 2a and 2b but is clearly in Figs 4a and 4b. Thus, by rotating the shaft 64 in relation to the gear 22 it is possible to provide two different relative positions between the excentric weights 66 and 68. These two relative positions are constituted by the relative position shown in Figs 2a and 2b and a position in which the excentric weight 68 is rotated over an angle of $180^{0}$ from the position shown in Figs 2a and 2b while the excentric weight 66 is in the same position as shown in Figs 2a and 2b.

While the vibratory unit 10 is running either the hydraulic motor 12 or the hydraulic motor 14 is supplied with hydraulic pressure oil from the hydraulic pump 20. Thereby, the shaft which is connected with the driven hydraulic motor will be driven directly while the other shaft will be driven indirectly through the gears 70 and 72. Irrespectively of which hydraulic motor 12 and 14 is driven directly the shafts 62 and 64 will be driven in synchronism in opposite directions, the shaft 62 being driven in the clockwise direction and the shaft 64 being driven in the counter-clockwise direction according to Fig. 2b. While the shaft 62 is driven directly by the hydraulic motor 12 the shaft 64 is rotated through the gears 70 and 72, an engagement thereby being provided between the contact members of the shaft 64 and the gear 72 in the relative position of the excentric weights 66 and 68 shown in Figs 2a and 2b. In this relative position of the excentric weights the vibratory element performs a vibratory motion which is directed obliquely upwards to the right and downwards to the left according to Fig. 2b. Thereby the non-driven hydraulic motor 14 operates as a pump, which creates a resistance against the rotation of the shaft 64 which is sufficient for maintaining the engagement between the contacting members and prevent the so called self-synchronization.

Switching of the selector valve 30 provides that the hydraulic oil pressure is supplied to the hydraulic motor 14 instead of to the hydraulic motor 12, in turn providing that the hydraulic motor 12 will rotate the shaft 64 so that the engagement between the contact portions of the shaft and the gear 72 is discontinued and is restored not until the shaft 64 and therewith the excentric weight 68 have been rotated over an angle of $180^{0}$ from the position shown in

Figs 2a and 2b. In this new relative position between the excentric weights 68 and 66 the shaft 62 with its excentric weight 66 will be driven in synchronism with the shaft 64 and its excentric weight 68. Because of the changed relative position between the excentric weights 66 and 68 the direction of the vibratory motions of the vibratory unit 10 will be changed so that the vibratory unit will in this position perform a motion directed upwards to the left and downwards to the right according to Fig. 2b. Thus, it is possible to adjust the vibratory direction of the vibratory unit 10 by means of a simple switching of the selector valve 30.

In Figs 3a and 3b there is shown the hydraulic system of the vibrator in the two relative positions between the excentric weights 66 and 68 described above. In Fig. 3a the selector valve 30 is adjusted for directing hydraulic pressure oil from the hydraulic pump 20 and the pressure line 28 to the hydraulic motor 12 through the line 33. From the hydraulic motor 12 the hydraulic oil flows to the return line 36 and the return line 40 to the tank 22 through the oil filter 42. Thereby, the check valve 44 is in a closed position to direct the whole hydraulic oil flow through the hydraulic motor 12. As described with reference to Figs 2a and 2b the hydraulic motor 14 is driven by the hydraulic motor 12 through the gears 70 and 72 and the shafts 62 and 64. Thereby the hydraulic motor 12 acts as a pump and circulates hydraulic oil in the clockwise direction in the circuit constituted by the hydraulic motor 14, the line 38, the check valve 46 and back to the hydraulic motor 14. In order to prevent that the circuit in which the hydraulic motor 14 is positioned is emptied because of the pressure drop created by the check valve 46 and the hydraulic motor 14 there is provided a restriction 74 in the line 40 providing substantially the same flow resistance as the check valve 46 and the hydraulic motor 14. In this position of balance of the pressure drops in the system there is no return flow to the tank 22 through the line 34 and the line 48.

In order to prevent that a too high pressure is supplied to the hydraulic motors 12 and 14 from the hydraulic pump 20 a pressure limiting valve 52 is provided between the pressure line 28 and the tank line 48. When the pressure resistance in the pressure line 28 and/or the lines 32 and 34 is too high an overflow takes place from the pressure line 28 to the tank 22 through the pressure limiting valve 52 and the tank line 48.

In Fig. 3b the selector valve 30 is shown in a position for supplying hydraulic oil to the hydraulic motor 14 in order to drive this motor directly instead of directly driving the hydraulic motor 12. Thus, in the position of the hydraulic system shown in Fig. 3b the excentric weights 66 and 68 take another relative position than was the case when the hydraulic system was operated in accordance

with Fig. 3a. In the position of the hydraulic system shown in Fig. 3b the hydraulic motor 12 is driven through the gears 70 and 72 and the shafts 62 and 64 for acting as a pump. As the hydraulic system is operated in equivalent ways in other respects in the positions shown in Figs 3a and 3b there is not required any detailed description of the operation in the position shown in Fig. 3b.

Fig. 4a is a plan view on an enlarged scale of a portion of the vibratory element of the vibrator, Fig. 4b is an end view of a detail of Fig. 4a. In Figs 4a and 4b the portions of the vibratory element having correspondence in Figs 2a and 2b are provided with the same reference numerals as in said Figs with the addition "a". The shafts 62a and 64a are journalled in the housing 10a by means of conventional bearings 76. Each shaft 62a and 64a support an excentric weight 66a and 68a,, respectively. A gear 70a is fixedly connected with the shaft 66a. A gear 72a is positioned on a stub shaft 78 on the shaft 64a. Between the stub shaft 78 and the hub of the gear 72a there is positioned a sleeve 80 supporting a substantially semi-circular disc 82. The disc 82 is formed with semi-circular engagement surfaces 84 which are positioned at an angle distance of $180^{o}$ from each other. The sleeve 80 including the disc 82 is unrotatably connected with the stub shaft 78, while the gear 72a is rotatably positioned on the sleeve 80. The gear 72a is provided with a pin 86 which is adapted to engage the engagement surfaces 84 of the disc 82. It is recognized that there exists a driving engagement between the shaft 64a and the gear 72a in two different adjustment positions which are positioned at an angle distance of $180^{o}$ from each other. As described above with reference to Figs 2a and 2b the different relative positions will be taken dependent on whether the shaft 64a is driven directly by the hydraulic motor connected therewith (not shown in Fig. 4a) or the shaft 64a is driven by the other hydraulic motor through the shaft 62a and the gears 70a and 72a.

As appears from the above description the vibrator according to the invention is extremely easy to operate because of the fact that the whole operation is provided by switching a selector valve which in a simple manner is operated electrically and that the hydraulic oil so to say provides an adjustment function by means of servo-action. Additionally it is a great advantage that the vibratory element can be positioned completely enclosed as the vibrator is often operated in a dustry and smoky atmosphere.

It is recognized that the vibrator can be modified within the scope of the following claims. For example it is possible to provide the vibrator with more than one vibratory element, the elements thereby being positioned so that the vibrator is manoeuvrable for turning in the sidewise directions. It is, of course, also possible

to adapt the selector valve 30 for manual operation instead of electric operation. Additionally, it is possible to provide the said engagement positions of the motion transmission device at another angle distance than 180°.

# C L A I M S

1. A vibrator for compacting soil comprising a bottom plate (8) and a vibratory element (10) supported thereby, the vibratory element comprising two in synchronized opposite directions rotatable shafts (62, 64) driven by hydraulic motors and each supporting an excentric weight (66, 88), the relative position of the excentric weights being adjustable for imparting to the vibratory element a vibratory motion which has a desired direction, c h a r a c t e r i z e d in that the vibratory element (10) comprises two hydraulic motors (12, 14) connected with each of said shafts (62, 64), that the shafts (62, 64) are connected with each other by means of a device (70, 72) for transmitting the rotational motion of the one shaft to the other shaft, at least one portion of the motion transmission device connected with one of the shafts being rotatable in relation to the shaft between two engagement positions which are positioned at an angle distance from each other, and that the vibrator comprises a control device (30) for supplying either to the one or the other hydraulic motor (12, 14) a main flow of a hydraulic fluid, the shafts being on each occasion driven by the one or the other of the hydraulic motors, the one shaft being driven directly and the other shaft being driven indirectly through the motion transmission device, the portion of the motion transmission device rotatable in relation to its shaft thereby taking different engagement positions dependent on whether the shaft connected with said portion is driven directly from the hydraulic motor connected with said shaft or indirectly from the hydraulic motor connected with the other shaft in order to provide different relative rotational positions of the shafts and the excentric weights (66, 68) supported thereby.

2. A vibrator as claimed in claim 1, c h a r a c t e r i z e d in that the control device is constituted by an electrically operated selector valve (30).

3. A vibrator as claimed in claim 1 or 2, c h a r a c t e r i z e d in that the motion transmission device comprises two gears (70, 72), of which one is fixedly connected with the one shaft (62) and the other is connected with the other shaft (64) in such a way that it is rotatable between two engagement positions positioned at an angle distance from each other, the gears engaging each other.

4. A vibrator as claimed in claim 3, c h a r a c t e r i z e d in that the engagement positions are positioned at an angle distance of $180^{o}$ from each other.

5. A vibrator as claimed in claim 3 or 4, c h a r a c t e r i z e d in that

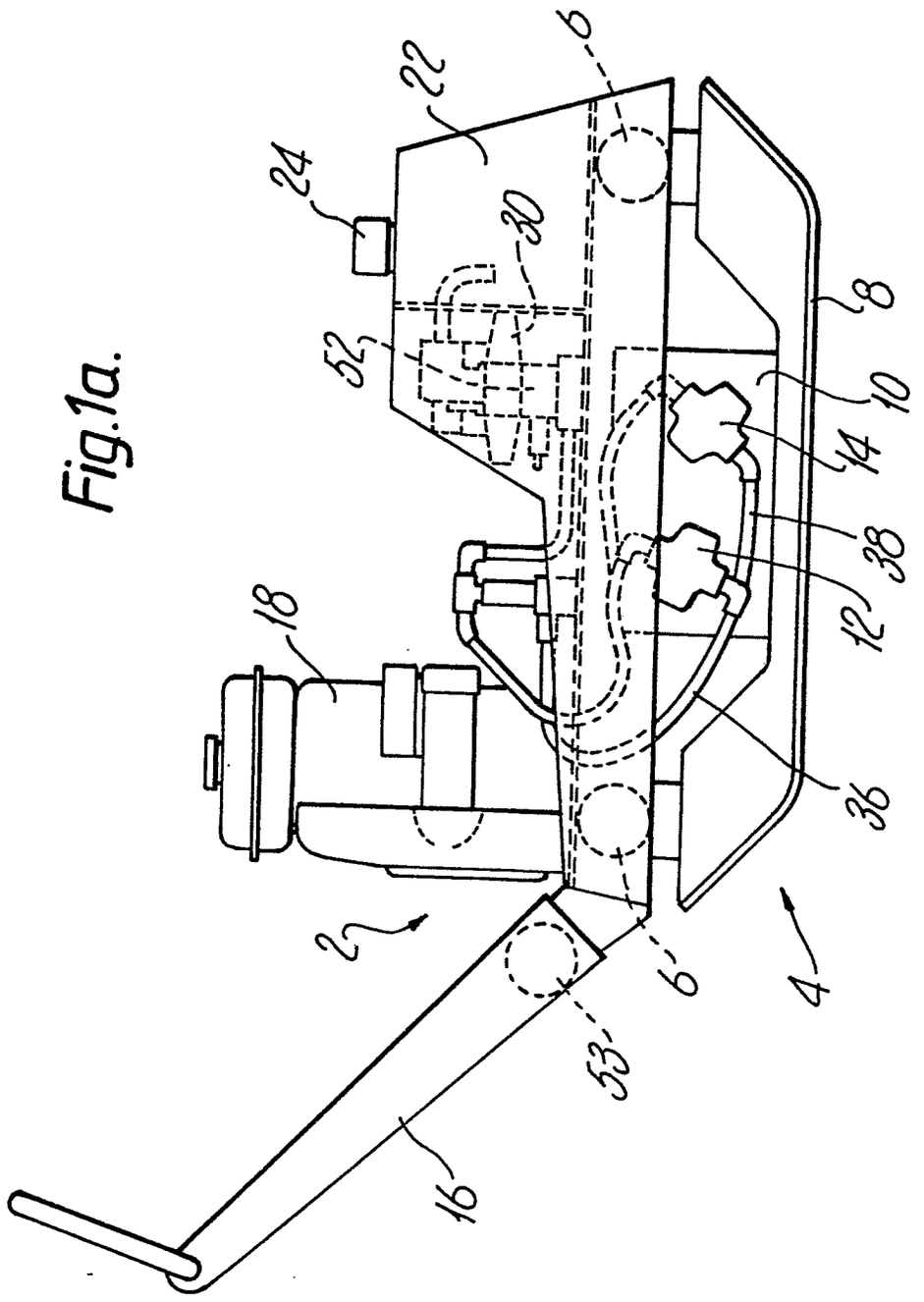
the gear (72) which is rotatably connected with the shaft (64) supports a pin (86) which is adapted to engage one or another of two engagement surfaces (84) provided on a portion (82) fixedly connected with the shaft, when the gear is rotated in relation to the shaft.

6. A vibrator as claimed in claim 5, c h a r a c t e r i z e d in that the pin (86) and/or the engagement surfaces (84) are provided with chock-absorbing elements.

7. A vibrator as claimed in any of the preceding claims, c h a r a c t e r - i z e d by a hydraulic system having return lines which downstream the hydraulic motors are connected with each other to a common line (4) and that this line is provided with a restriction (74).

8. A vibrator as claimed in any of the preceding claims, c h a r a c t e r - i z e d in that the hydraulic motor which is on each occasion indirectly driven per se and/or the construction of the circuit in which said motor is running is counter-acting said indirect driving that the intended engagement position is maintained.

Fig.1a.



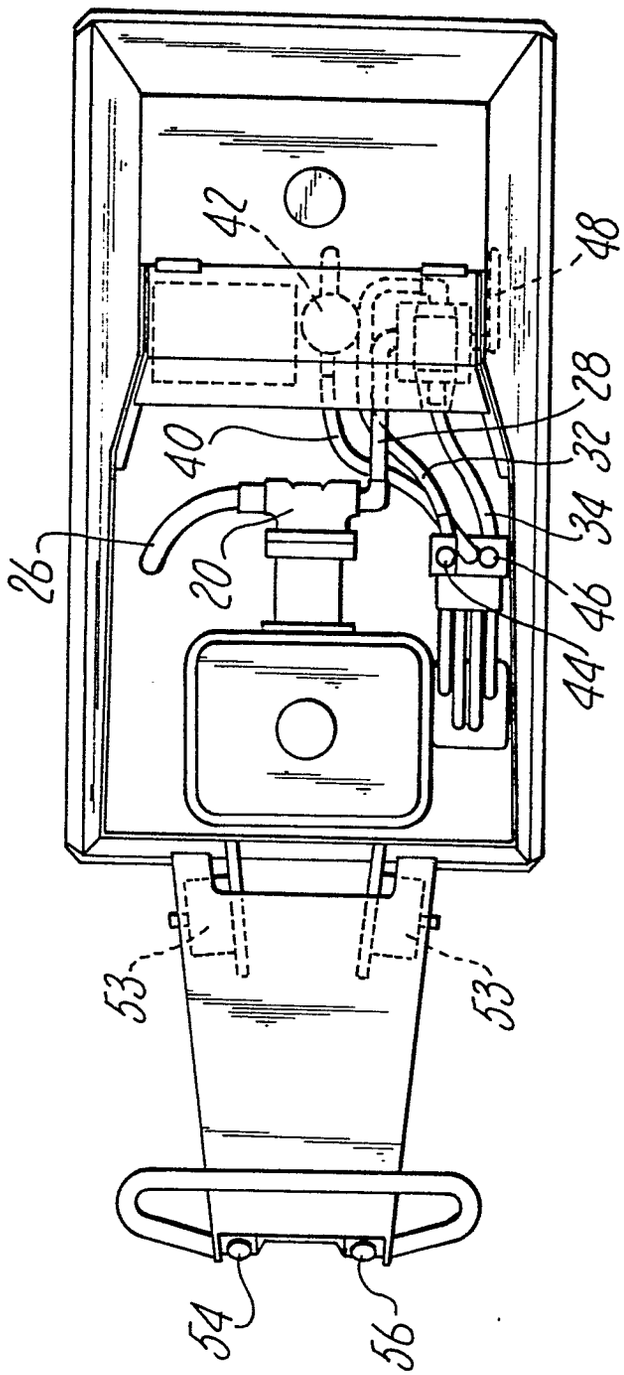



Fig.1b.

Fig.1c.

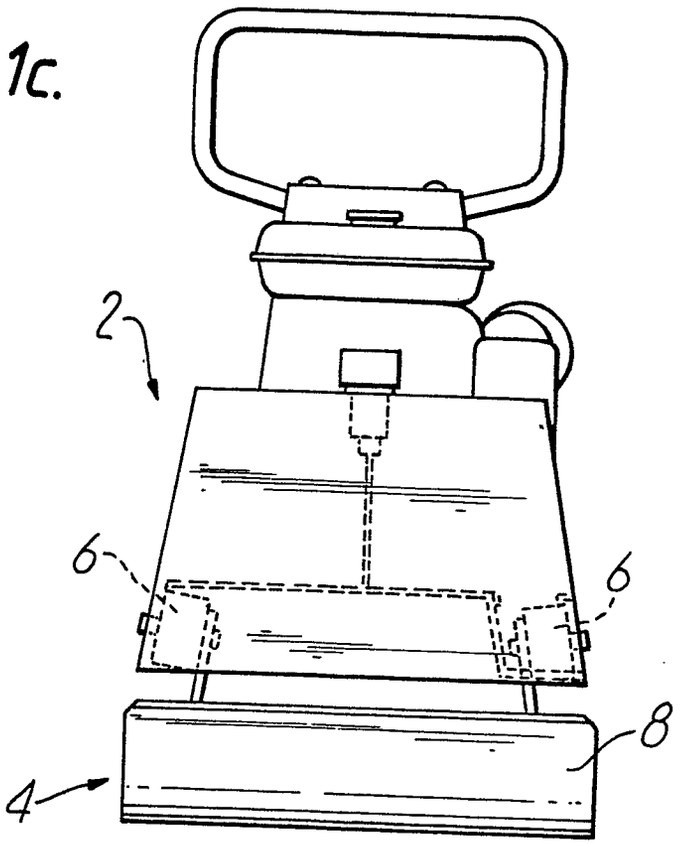



Fig.2a.

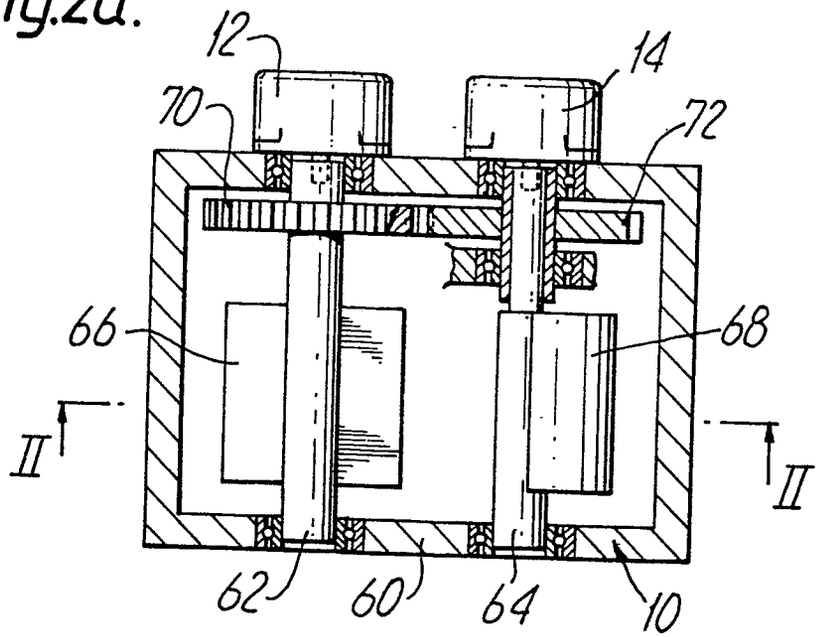


Fig.2b.

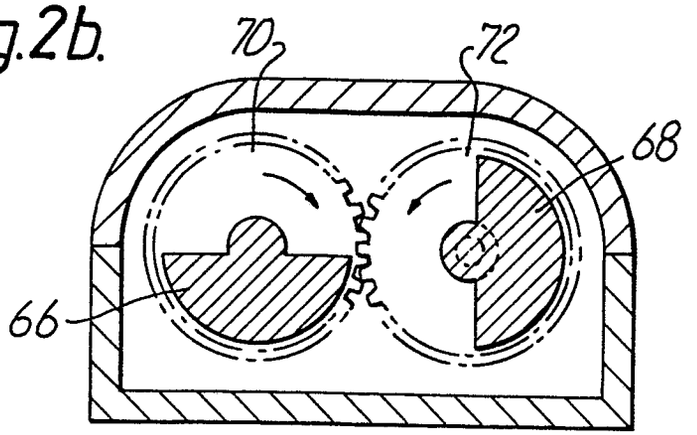



Fig.3a.

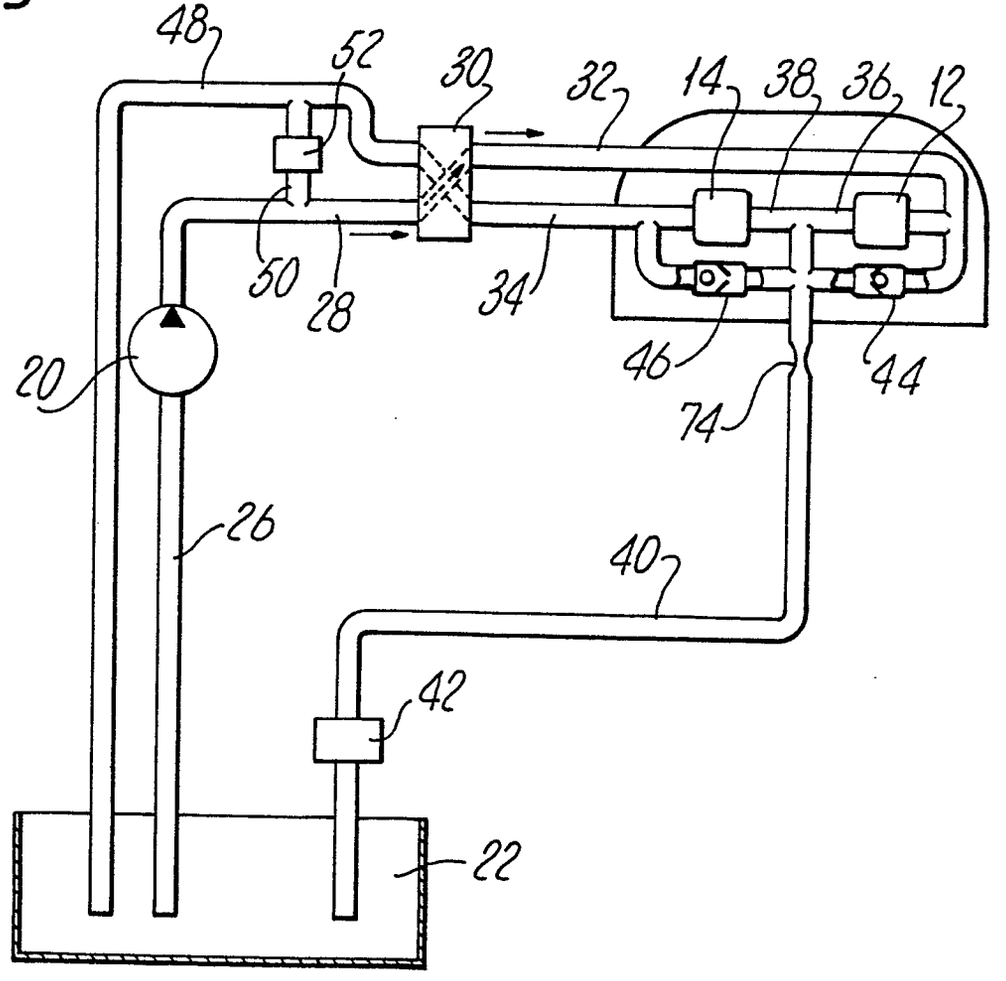


Fig. 3b.

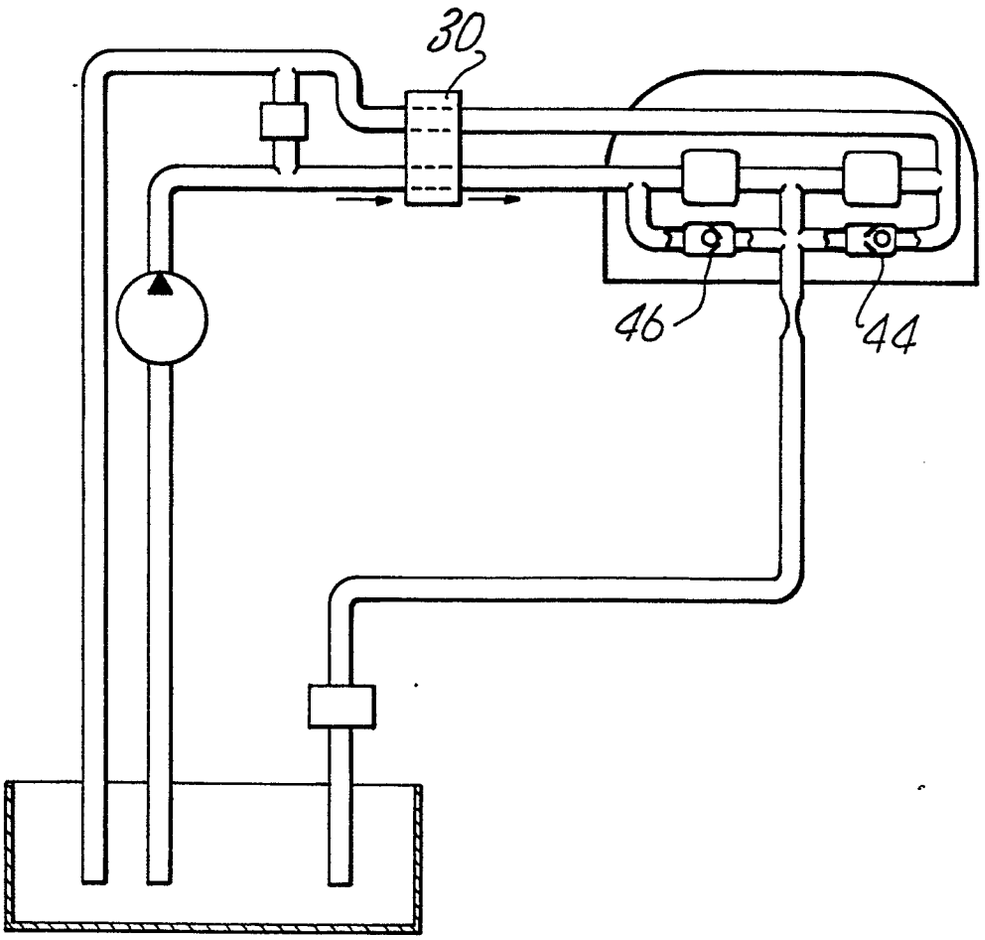


Fig.4a.

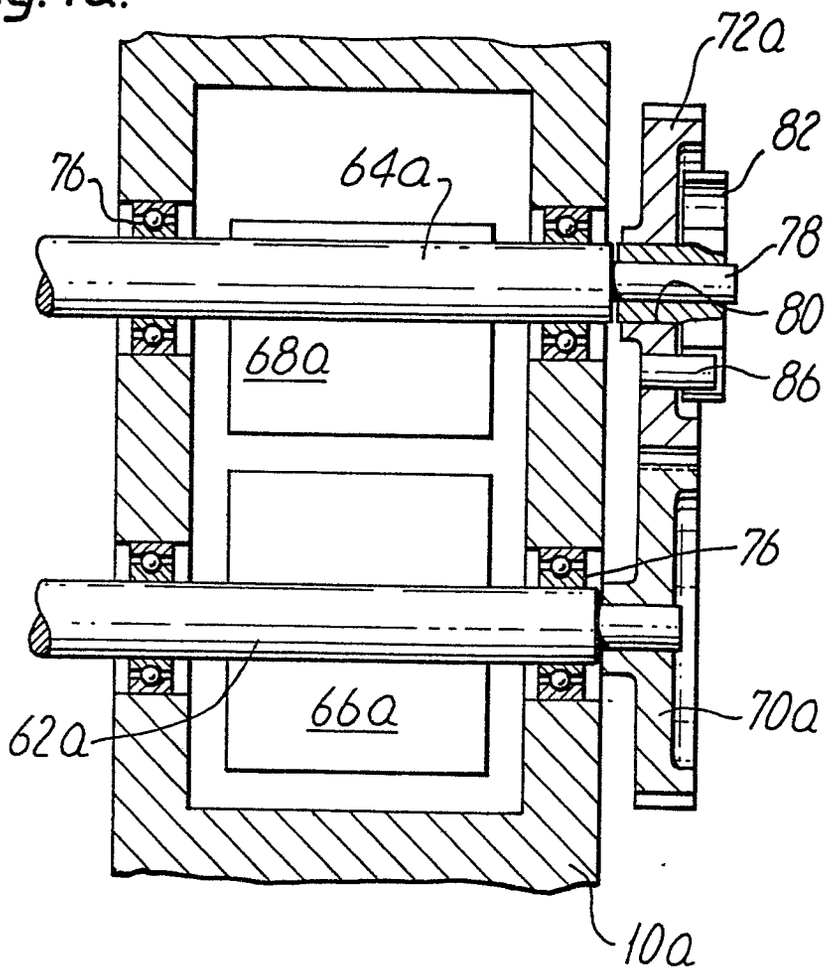
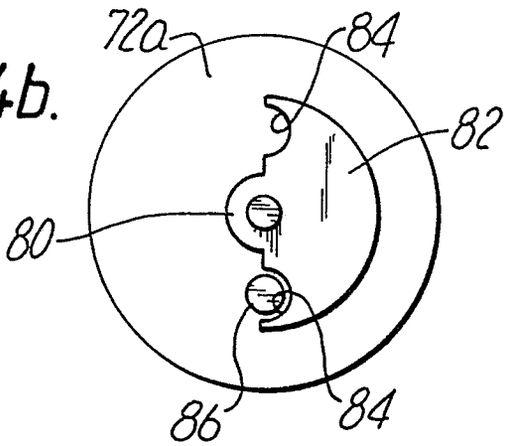



Fig.4b.



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# EUROPEAN SEARCH REPORT

Application number

EP 81 85 0239

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim |
|---|---|---|
| X | US - A - 3 670 631 (GAYLORD)<br>* Column 2, lines 51-55, 66-75; column 3, lines 1-75; column 4, lines 6-52; figures 3 to 6 * | 1,2,4, 5,7,8 |
| X | US - A - 2 952 193 (CONVERSE)<br>* Column 1, lines 71-72; column 2, lines 1-17, 24-71; column 3, lines 1-10; figures 1 to 3 * | 1,2,7 |
| A | DE - A - 1 634 477 (BUCKAU)<br>* Page 4, lines 2-28; page 5, lines 1-10; figures 1 to 3 * | 3,4 |
| A | FR - A - 1 473 491 (ZAKLADY) | |
| A | US - A - 2 938 438 (HAMILTON) | |
| A | US - A - 3 505 885 (WASCHULEWSKI) | |

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

E 02 D 3/074

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

E 02 D
E 01 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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D: document cited in the application
L: document cited for other reasons

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The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| The Hague | 18-03-1982 | RUYMBEKE |

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