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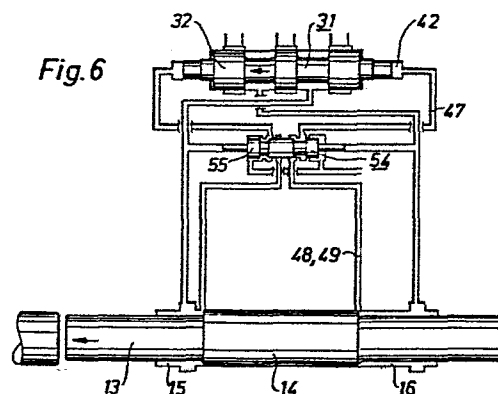
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(54) **Hydraulic percussive machine.**

(57) In a hydraulic percussive rock drill, the bistable distribution valve (31) for controlling the reciprocation of the piston hammer (13) has control chambers (41, 42) which, when pressurized urge the distribution valve to switch over. The control chambers (41, 42) are pressurized through control passages (43, 44; 47, 48) that end in the cylinder for the piston hammer (13). An auxiliary valve (54) controls the control passages (43, 44; 47, 48). As soon as the distribution valve (31) has shifted its position, the one of the control chambers (43, 44; 47, 48) that effected the movement of the distribution valve (31) is drained through the auxiliary valve (54) so that the distribution valve (31) is prepared for the next movement. The rapid operation of the auxiliary valve (54) permits for the selection of very short piston hammer strokes and high impact frequencies.

Fig. 6



0161227Hydraulic Percussive MachineBackground of the Invention

This invention relates to an hydraulic percussive machine, in particular a rock drill, comprising a piston hammer reciprocable in a cylinder for repetitively impacting upon an anvil, a distribution valve coupled to an inlet, to an outlet and to a connection conduit that leads to a cylinder chamber formed between the piston hammer and the cylinder, said distribution valve having a first position for pressurizing said connection conduit and a second position for draining same, a first control piston surface in a first control chamber arranged to switch over the distribution valve into said first position when pressurized, a second control chamber arranged to switch over the distribution valve into said second position when pressurized, a piston hammer controlled first control passage between the cylinder and said first control chamber for pressurizing the latter when the piston hammer reaches a predetermined position and a piston hammer controlled second control passage between the cylinder and said second control chamber for pressurizing the latter when the piston hammer reaches a predetermined position.

Rock drills of the kind to which the present invention pertains are described in EP-A- 35005. The combination of soft rock and a small diameter drill bit requires light blows whereas the combination of hard rock and a big diameter drill bit requires heavy blows. Therefore it is common to provide for a selection of the stroke length for example as described in the above mentioned publication. When the stroke length is reduced, the hydraulic line pressure is usually increased in order to maintain a high impact power.

Normally, in a rock drill of the kind described above, the stroke of the hammer piston can for example be varied between 60 and 30 mm and the impact frequency will then vary for example between 30 and 60 Hz. However, high frequencies and short strokes cannot be achieved.

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It is an object of the invention to provide an hydraulic percussive machine e.g. a rock drill, in which the piston hammer can perform short strokes at high frequency. Another object is to permit for a wide range of adjustment of the stroke. These objects are achieved by the features defined in the characterizing part of claim 1.

Brief Description of the Drawings

Fig 1 is a circuit diagram of a percussive rock drill.

Fig 2 is a schematic longitudinal section through the front end of the rock drill.

Fig 3 is a circuit diagram corresponding to Fig 1 but somewhat simplified.

Figs 4-6 are diagrams corresponding to Fig 3 but showing some movable parts in other positions.

Detailed Description

The rock drill illustrated on the drawings comprises a housing 11 forming a stepped cylinder 12 for a piston hammer 13 that has a single land 14. A front cylinder chamber 15 and a rear cylinder chamber 16 are formed between the cylinder 12 and the piston hammer 13. The annular front surface 17 of the land 14 is located in the front cylinder chamber 15 and the annular rear surface 18 of the land 14 is located in the rear cylinder chamber 16. The area of the surface 18 is usually greater than the area of the surface 17. The piston hammer is driven by the alternating pressure in the cylinder chambers 15, 16. The piston hammer 13 impacts on an anvil formed by the upper end face 19 of a drill string adapter 20 that is operatively coupled to the drive shaft 21 of a non-illustrated hydraulic motor through a chuck 22 (Fig 2). The chuck 22 has a bushing 23 that is in splined connection with the chuck. The adapter 20 has a widened portion 24 that is in splined connection with the chuck bushing 23. The rear end faces of the splines of the widened portion 24 of the adapter takes support on a recoil damping piston 26. The damping piston 26 is forced forwardly into its foremost

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position, in which it is shown, by the hydraulic pressure in a cylinder chamber 27 that is constantly pressurized through a passage 28. The damping piston 26 yields from its illustrated position if the drill string and its adapter 20 recoils but it returns immediately to its illustrated position because of the pressure in the cylinder chamber 27. The actual design of the recoil damper can advantageously be as described in EP-A-58650.

A distribution valve 31 with a valving spool 32 is connected to pump (not shown) and to tank (not shown) through an inlet 33 and two outlets 34 respectively, and it is connected to the front cylinder chamber 15 and the rear cylinder chamber 16 through two connection conduits 35, 36 respectively. The two outlets 34 can be coupled to a common drain conduit that leads to the tank. The valving spool 32 has two plungers 37, 38 with end faces 39, 40 in control chambers 41, 42. The control chamber 41 is connected to eight discrete ports into the cylinder 12 via a control passage 43, 44 that is branched into eight branches forming the above mentioned discrete ports. Only the two axially outermost branches 45, 46 are shown. The branches between them are only indicated by their center lines (shown by chain lines).

The control chamber 42 is also connected to eight discrete ports into the cylinder 12 via a control passage 47, 48 that is branched into eight branches forming the ports. Only the two axially outermost branches 49, 50 are shown. The branches between them are only indicated by their center lines (shown by chain lines). The axial distances between the ports in the two sets of eight ports are smaller than the diameter of the ports. Therefore, the branches are arranged in three rows, but this is trivial and not illustrated in the drawings.

The two sets of branches 45, 46 and 49, 50 are controlled by a selector valve in the form of an axially displaceable spool 51 with two recesses 52, 53. There are non-illustrated means for holding the spool 51 fixed in pre-selected axial positions. In Fig 1 the ports of the two branches 45, 49 are selected to convey pressure signals

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from the cylinder chambers 15, 16 to the control chambers 41, 42. By means of the axially displaceable selector valve 51, another pair of branches can be selected to convey the pressure signals. Thus, by means of the selector valve 51, the length of the piston hammer stroke can be pre-selected as described in EP-A-35005 and EP-A-112810.

In the control passages 43, 44 and 47, 48 there is an auxiliary valve 54 with a valving spool 55. The control passages thus comprises portions 43 and 47 between the distribution valve 31 and the auxiliary valve 54, portions 44, 48 between the auxiliary valve 54 and the selector valve 51 and the two sets of branches 45, 46 and 49, 50 between the selector valve 51 and the cylinder 12.

The spool 55 of the auxiliary valve 54 has plungers 56, 57 with piston surfaces 58, 59 in branches 60, 61 of the connection conduits 35, 36. A drain passage 62 leads from the auxiliary valve to the tank. The drain passage 62 is not connected to the main drains 34.

The spool 32 of the distribution valve 31 has two annular piston surfaces 62, 63, the areas of which are only a fraction of the areas of the end faces 39, 40 of the plungers 37, 38. Bores 64, 65 in the valving spool 32 lead to the annular piston surfaces 62, 63.

The operation will be described with reference to Figs 3-6. For clarity, the selector valve 51 is not shown in the figures and only the two branches 45, 49 of the two sets of branches 45, 46 and 49, 50 are shown, which are made operative by the selector valve 51 when the latter is fixed in its position shown in Fig 1. In Figs 3-6, only a selection of the reference numerals of Fig 1 is shown. Reference numerals which are not necessary for the understanding of the operation as described are left out.

In Fig 3, the piston hammer 13 has just struck the adapter 20. The distribution valve spool 32 is in its left hand position in which it pressurizes the front cylinder chamber 15 through the connection passage 35 and drains the rear cylinder chamber 16 through the

connection passage 36. The auxiliary valve spool 55 is in its right hand position because of the pressure acting on its piston surface 58. In this position, it connects the two parts 43 and 44, 45 of the control passage 43, 44 whereas it blocks the part 48, 49, 50 of the control passage 47, 48 and connects the other part 47 to drain. The distribution valve spool 32 is positively held in position because of the pressure conveyed through the bore 65 and acting on its annular piston surface 63.

Thus, the piston hammer 13 moves rearwardly (to the right in Fig 3) after impacting on the adapter 20. When the hammer piston land 14 uncovers the port of the control passage 43, 44 as shown in Fig 4, the pressure from the pressurized cylinder chamber 15 is conveyed to the control chamber 41 of the distribution valve 31 so that the distribution valve spool 32 switches over into its position shown in Fig 5. In Fig 4, the distribution valve spool 32 is shown in the middle of its movement. In its position shown in Fig 5, the distribution valve 31 pressurizes the connection conduit 36. Since there will be pressure on the piston surface 59 of the auxiliary valve spool 55 as soon as the distribution valve spool 32 has switched over to its position of Fig 5, the auxiliary valve spool 55 will also switch over to its position of Fig 5 and drain the control chamber 41. There will, however, be pressure on the holding surface 62 because of the bore 64 and the distribution valve spool 32 will therefore be positively held in position.

Because of the pressure in the cylinder chamber 16, the piston hammer 13 will decelerate to stop and then accelerate forwardly in its working stroke. Just prior to impacting on the adapter 20, the piston hammer 13 will uncover the port of the control passage 47, 48 as shown in Fig 6 and the pressure in the cylinder chamber 16 will be conveyed to the control chamber 42 so that the distribution valve spool 32 will switch over to its position of Fig 3. In Fig 6, the distribution valve spool 32 is shown in its transient middle position during its movement to the left in the figure. The pressure will reach the cylinder chamber 15 just when the piston hammer 13 strikes the adapter 20. The auxiliary valve spool 55 switches again

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over to its position of Fig 3 when the connection conduit 35 is pressurized. The piston hammer 13 starts another return stroke and the cycle is repeated.

As described above, when one of the control chambers 41, 42 becomes pressurized, the distribution valve spool 32 shifts position and pressurizes one of the connection conduits 35, 36. Then, the rapid auxiliary valve spool 55 shifts position so that it drains the control chamber 41, 42 that was last pressurized and effected the distribution valve 32 to shift position. Thus, the draining of one of the control chambers 41, 42 takes place well in advance of the pressurization of the other control chamber, which permits for a high impact frequency and a selection of short piston hammer strokes. The stroke is a direct function of which of the passages 45-46, 49-50 are opened by the selector valve 51. When the stroke is short the impact frequency is high and vice versa. The stroke can for example be varied between 7 mm and 60 mm by means of the selector valve 51 when the piston hammer is 40-60 cm long and weighs for example 70 kg and the impact frequency can accordingly vary between 150 Hz and 50 Hz. Since the branches 45-46 and 49-50 are not used to drain the control chambers but are temporarily blocked by the auxiliary valve spool 55, any pressure peaks occurring in the cylinder chambers 15, 16 when the latter are connected to the tank via the outlets 34 can not reach the control chambers 41, 42. Therefore these pressure peaks can not influence the distribution valve spool 32. Thus, the operation of the distribution valve 31 will be very reliable and the holding surfaces 62, 63 can be made comparatively small.

In the described embodiment of the invention, the two cylinder chambers 15, 16 are alternately pressurized and drained through the distribution valve 31. Alternatively, one of the cylinder chambers 15, 16 can be constantly pressurized whereas the distribution valve 31 alternately pressurizes and drains the other cylinder chamber in order to effect reciprocation of the piston hammer 13. Then, the valve 54 can be arranged to drain both control chambers 41, 41 but it would also be possible to have the valve 54

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drain only the control chamber that opens into the alternately pressurized cylinder chamber provided that the valve switching area of this control chamber is greater than the corresponding area of the control chamber that opens into the constantly pressurized cylinder chamber. Also other modifications can be made within the scope of the claims.

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Claims:

1. A hydraulic percussive machine, in particular a rock drill, comprising a piston hammer (13) reciprocable in a cylinder (12) for repetitively impacting upon an anvil (20), a distribution valve (31) coupled to an inlet (33), to an outlet (34) and to a connection conduit (35, 36) that leads to a cylinder chamber (15, 16) formed between the piston hammer (13) and the cylinder (12), said distribution valve (31) having a first position for pressurizing said connection conduit (35, 36) and a second position for draining same, a first control chamber (41, 42) arranged to switch over the distribution valve (31) into said first position when pressurized, a second control chamber (41, 42) for switching over the distribution valve (31) into said second position when pressurized, a piston hammer controlled first control passage (43, 33; 47, 48) coupled between the cylinder (12) and said first control chamber (41, 42) for pressurizing said first control chamber when the piston hammer (13) reaches a predetermined position and a piston hammer controlled second control passage (43, 44; 47, 48) coupled between the cylinder (12) and said second control chamber (41, 42) for pressurizing said second control chamber when the piston hammer reaches a predetermined position,

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valve means (54) arranged to drain the control chamber (41, 42), that was pressurized last, in response to the distribution valve (31) having shifted its position as a result of the pressurization of said last pressurized control chamber (41, 42).

2. A hydraulic percussive machine according to claim 1,

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that said valve means (54) is arranged in said first and second control passages (43, 44; 47, 48) and has a position in which it holds said first control passage (43, 44; 47, 48) open while draining the part of said second control passage (43, 44; 47, 48) that leads to the respective control chamber (41, 42) and blocking the part of said second control passage (43, 44; 47, 48) that leads to the cylinder (12), and another position in which it holds said

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second control passage (43, 44; 47, 48) open while draining the part of

said first control passage (43, 44; 47, 48) that leads to the respective control chamber (41, 42) and blocking the part of the first control passage (43, 44; 47, 48) that leads to the cylinder (12).

3. A hydraulic percussive machine according to claim 1 or 2, characterized in that there are two of said connection conduits (35, 36) and two of said cylinder chambers (15, 16), each connection conduit being coupled to a cylinder chamber (15, 16) and the distribution valve (31) is arranged to pressurize one of said connection conduits and drain the other when in one of its positions and to drain said one of the connection conduits and pressurize the other when in its other position.

4. A hydraulic percussive machine according to claim 3, characterized in that said valve means (54) is arranged to be controlled by the pressure in said two connection conduits (35, 36).

5. A hydraulic percussive machine according to claim 4, characterized in that said valve means (54) comprises a valve spool (55) having two opposed piston surfaces (58, 59) for switching the spool between its positions, each of said two opposed piston surfaces being coupled to a respective one of said connection conduits (35, 36).

6. A hydraulic percussive machine according to any one of the preceding claims, characterized by means (51; 45, 46; 49, 50) for preselecting the stroke of the piston hammer (13).

7. A hydraulic percussive machine, comprising a piston hammer (13) reciprocable in a cylinder (12) for repetitively impacting upon

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an anvil (20), a distribution valve (31) coupled to a pressure fluid inlet (33), to a pressure fluid outlet (34) and to a connection conduit (35, 36) that leads to a cylinder chamber (15, 16) formed between the piston hammer (13) and the cylinder (12), said distribution valve (31) having a first position for pressurizing said connection conduit (35, 36) and a second position for draining same, a first control chamber (41, 42) coupled to the distribution valve (31) for switching over the distribution valve (31) into said first position when pressurized, a second control chamber (41, 42) coupled to the distribution valve (31) for switching over the distribution valve (31) into said second position when pressurized, a piston hammer controlled first control passage (43, 44; 47, 48) coupled between the cylinder (12) and said first control chamber (41, 42) for pressurizing said first control chamber when the piston hammer (13) reaches a predetermined position, and a piston hammer controlled second control passage (43, 44; 47, 48) coupled between the cylinder (12) and said second control chamber (41, 42) for pressurizing said second control chamber when the piston hammer reaches a predetermined position,

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valve means (54) arranged to drain at least one of the control chambers (41, 42) in response to the distribution valve (31) having shifted its position as a result of the pressurization of said one of the control chambers.

8. A hydraulic percussive machine, comprising a piston hammer (13) reciprocable in a cylinder (12) for repetitively impacting upon an anvil (20), a distribution valve (31) for controlling the reciprocation of the piston hammer (13) coupled to a pressure fluid inlet (33), to a pressure fluid outlet (34) and to a connection conduit (35, 36) that leads to a cylinder chamber (15, 16) formed between the piston hammer (13) and the cylinder (12), said distribution valve (31) having a position for pressurizing said connection conduit (35, 36) and a position for draining same, a control chamber (41 or 42) coupled to the distribution valve (31) for switching over the distribution valve (31) into one of its positions when pressurized, means (41, 43, 44 or 42, 47, 48) for

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switching over the distribution valve (31) into the other of its position, and a piston hammer controlled control passage (43, 44 or 47, 48) coupled between the cylinder (12) and said control chamber (41, 42) for pressurizing said control chamber when the piston hammer (13) reaches a predetermined position,

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valve means (54) arranged to drain said control chamber (41 or 42) in response to the distribution valve (31) having shifted its position as a result of the pressurization of said control chamber.

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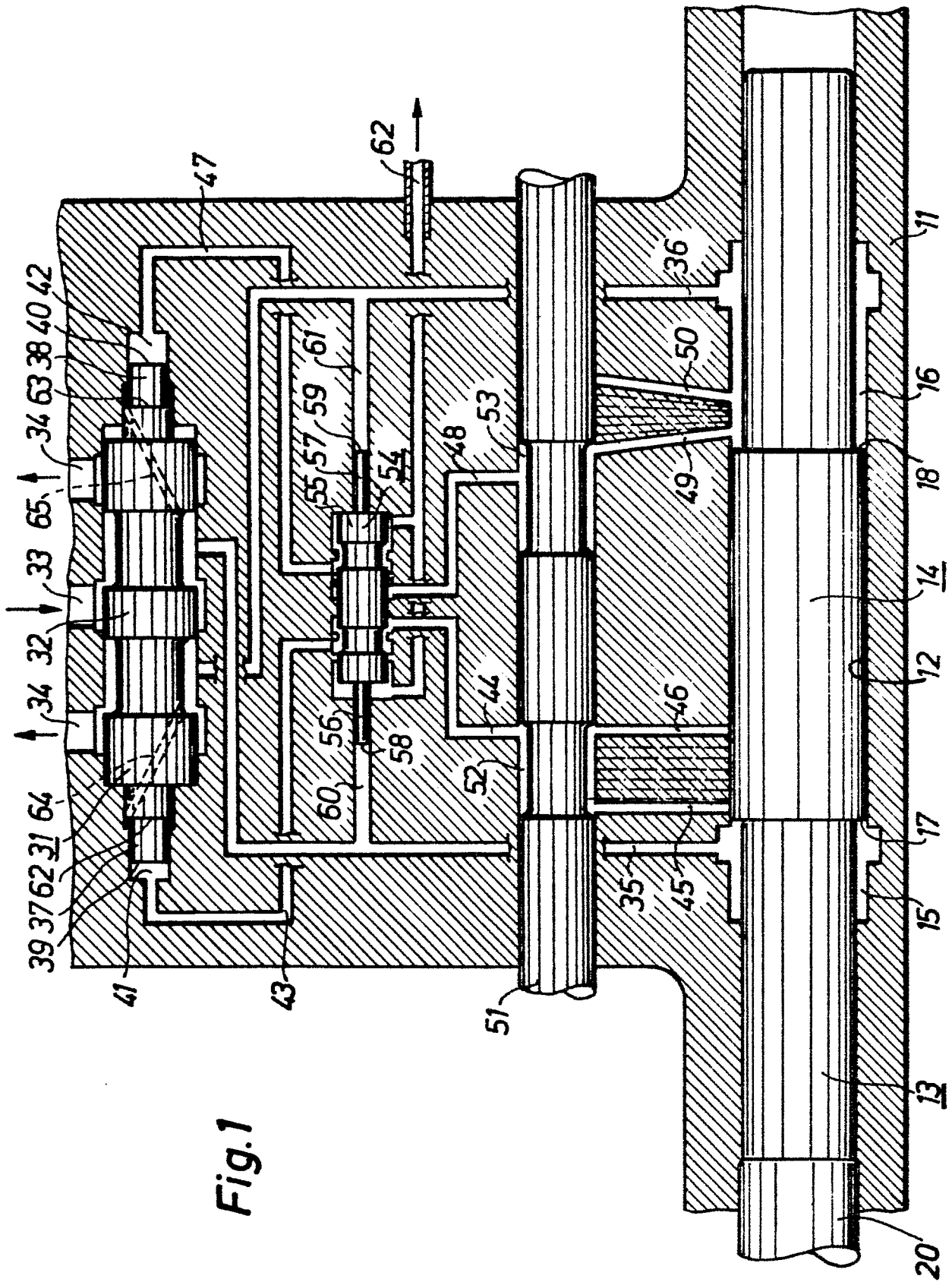


Fig. 1

Fig. 2

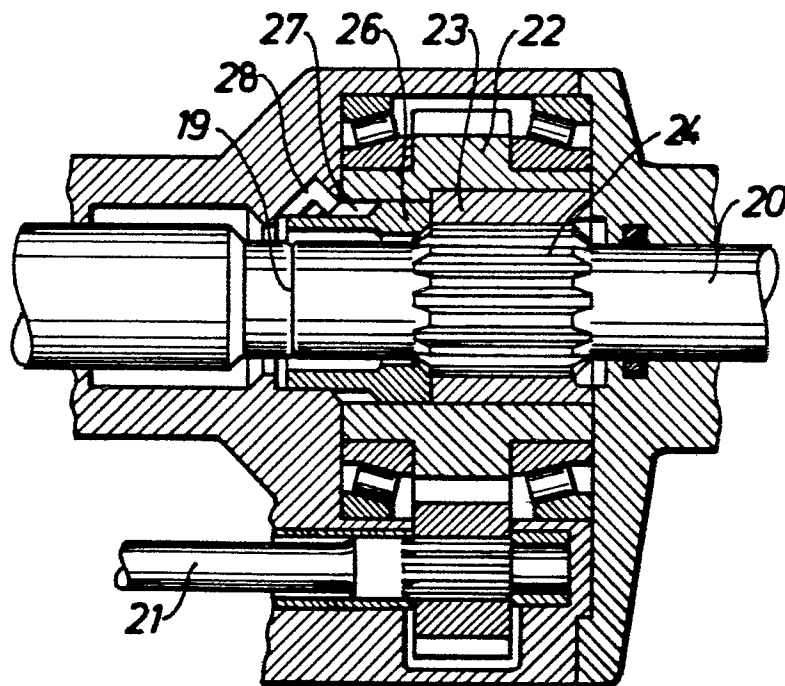


Fig. 3

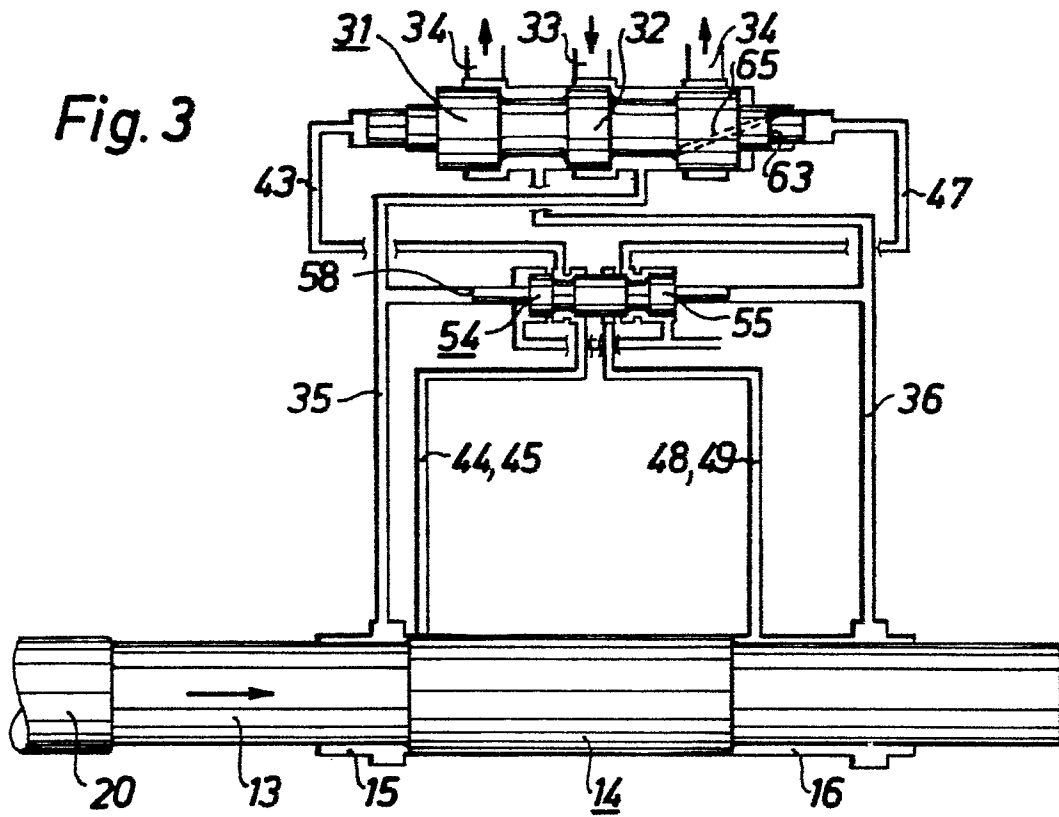


Fig. 4

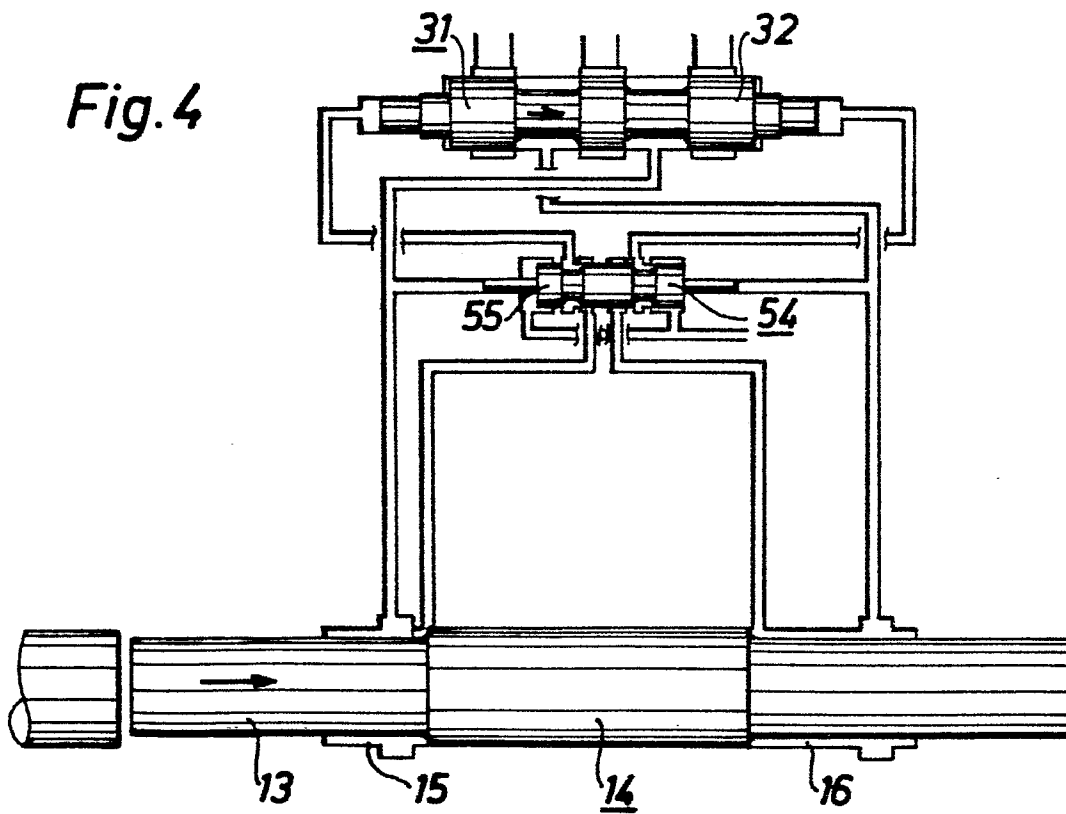


Fig.5

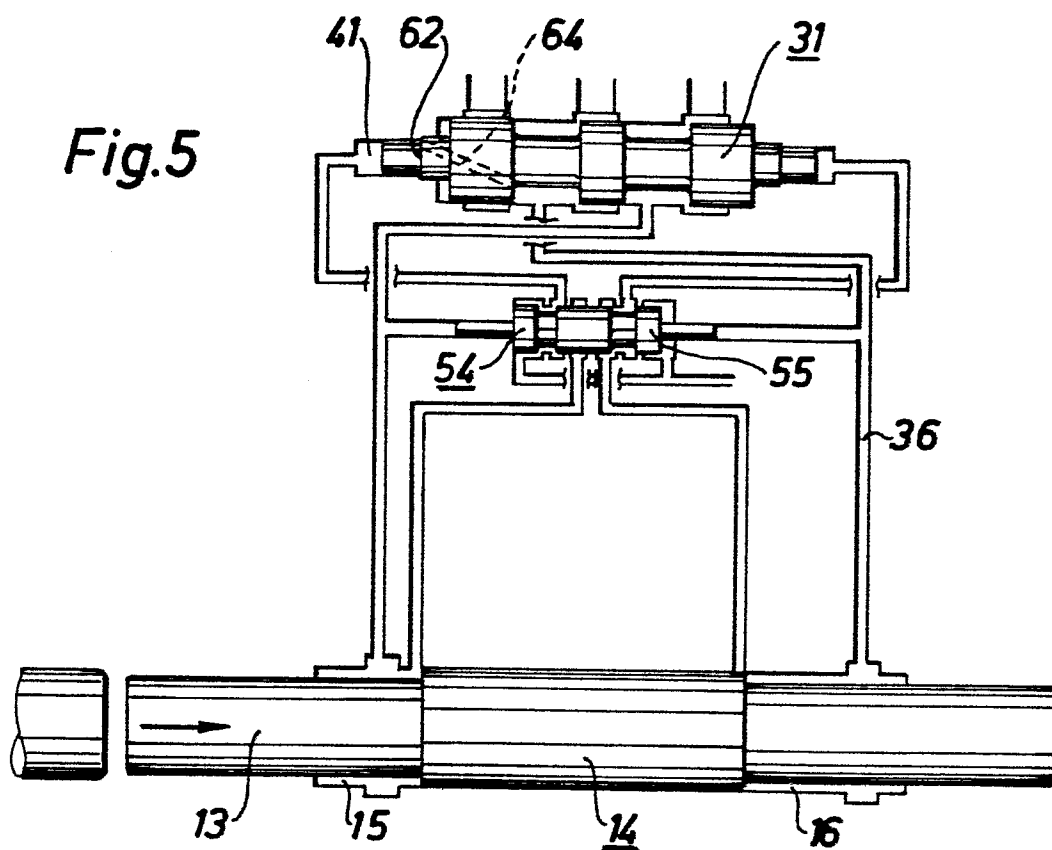
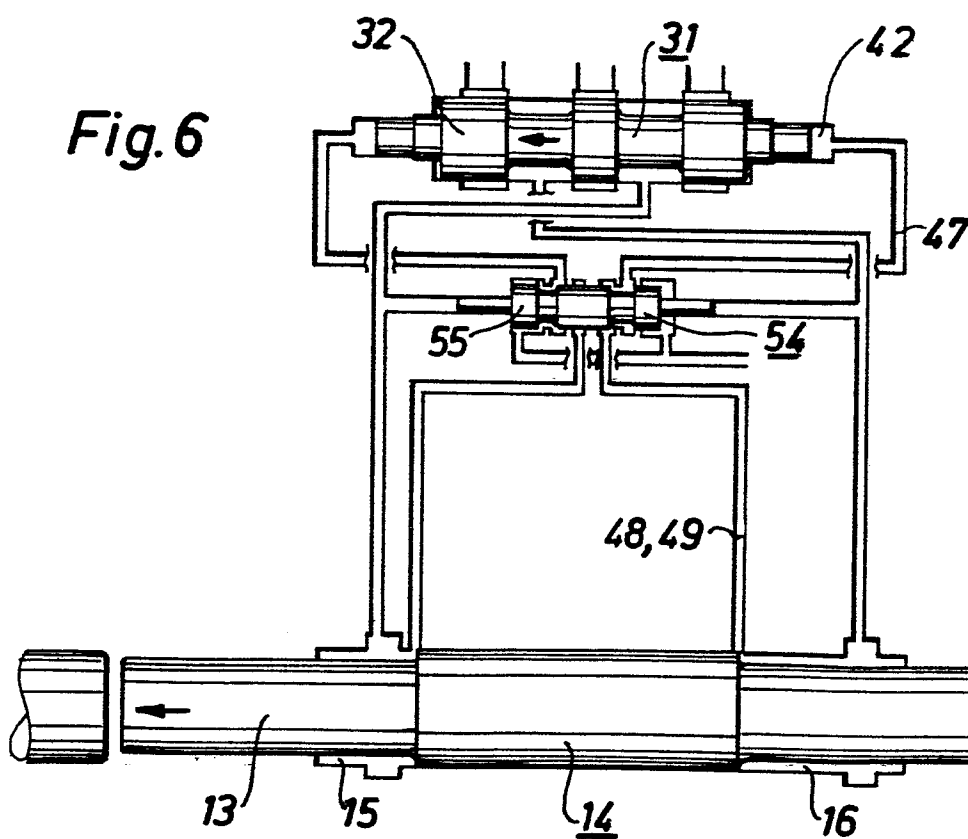


Fig.6





European Patent
Office

EUROPEAN SEARCH REPORT

0161227

Application number

EP 85 85 0135

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	US-A-4 172 411 (MATSUDA et al.) * Whole document *	1,7,8	B 25 D 9/26 B 06 B 1/18 E 21 C 3/20 F 01 L 25/06 F 03 C 1/00
A	FR-A-1 007 678 (STRUNK) * Page 1, left-hand column, last line - right-hand column, line 14 *	1-8	
A	FR-A-2 004 864 (FRIEDRICH KRUPP GmbH) * Whole document *	1-8	
A	US-A-2 517 243 (ROSE)		
A	DE-A-2 849 292 (PHILLIPS et al.)		
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 25 D B 06 B E 21 C F 01 B F 01 L F 03 C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 03-07-1985	Examiner BENZE W.E.
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	