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(54) Directional control valve to obtain in a hydraulic appliance the alternative motion of a piston operating to charge and fire a tool, specially suitable for hydraulic hammers.

(57) The directional control valve to apply to a hydraulic appliances working with uncompressible fluid, is composed of a cylindrical valve i.e. a sleeve 5 sliding in a cylindrical chamber 1, that acts as a cylinder to the piston 7 when its outside part B, or also its intermediate part A in an execution suitable to different application, penetrates inside the sleeve 5 or comes out of it.

The control valve action is caused by the hydraulic fluid when the piston moves so that it comes out or by the fluid which the piston presses when, being the exhaust ports still opened, it moves in order to penetrate into the sleeve valve 5.

The axial travel reversals of the control valve start every time the piston, by its circular edge 7c, gets a tightness touch with distributor's circular edge 5d.

This control valve permits large tightnesses of exhaust and supply ports of hydraulic fluid so that the piston 7 avoid to do this by means of its lateral surfaces, as other control valve, and therefore the device is not subjected to wear.

For its simplicity and very good functionality this directional control valve cuts manufacturing and maintenance costs; it can be, moreover, applied both to free gas recharging hammers and hammers directly actuated by under pressure hydraulic fluid.

For a better understanding, see fig. 8.

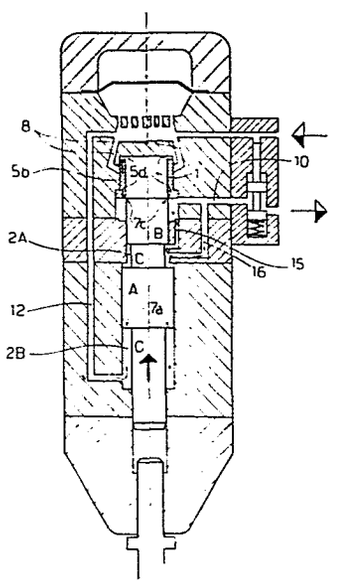

FIG 6

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Directional control valve to obtain in a hydraulic appliance the alternative motion of a piston operating to charge and fire a tool, specially suitable for hydraulic hammers.

The invention refers to a directional control valve, that is a device making use of a sleeve valve to supply or return uncompressible fluid from a cylinder e.g., of hydraulic hammer , in which a piston operating to charge and fire a tool, has to be effected to an alternate motion.
There are a large number of directional control valve for hydraulic appliances, using cylindrical control valve i.e. a sleeve coaxial to the cylinder in which the piston moves.
This, actuated by the hydraulic fluid, opens and shuts alternately the supply and return ports of the hydraulic fluid, so that it can be alternately forced on the upper or lower face of the same piston to fire it or to force it back (recharge).
These control valves as well as being subjected to continuous and strong stresses, need complex circuits for oil discharge, little working tollerances and frontal tight joints that may fail owing to an abnormal wear, caused by repeating impacts.
In some directional control valve, the valve itself, that is the sleeve, is really struck by the same piston to which has to make as shoulder, and elastic devices, as spring cushious, don't minimize the stresses the control valve is subjected to.

The invention here claimed, has the purpose of putting the above disadvantages right.

It solves the problem relative to a double effect directional control valve, sleeve valve coaxial type to the piston, for hydraulic appliances, in which the same piston has to be subjected to an alternate motion, that gives better guarantees of life and functionality, even though it is simpler and need a less careful working.

The invention solves also the problem relative to the costs of the coaxial cylindrical sleeve distribution system, cutting manufacturing and maintenance costs for its semplicity.

The invention is detailed as below in two ways for two different types of hammer , referring to the figures of the 8 drawings, herewith enclosed, which show respectively:

Fig. 1, a longitudinal section of the device applied to hammers with free nitrogen accumulator and with piston in recharging stroke;

Fig. 2, the device in the same recharging stroke, moving down to close the hydraulic fluid supply port and to open the exaust port one;

Fig. 3, the device with piston on the top dead center, closing the hydraulic fluid supply port;

Fig. 4, the device closing the supply port and piston in striking phase;

Fig. 5, the device applied to a hydraulic hammer with piston actuated directly by the fluid under pressure and accumulator of nitrogen in the expansion fase;

Fig. 6, the running of the control valve to close the supply ports of fluid under pressure and the piston in striking phase;

Fig. 7, the hammer while the piston is moving up and the valve is moving up to open the exaust ports;

Fig. 8, the device with the piston near the top dead center i.e. control valve moving down to open the supply port of the hydraulic fluid under pressure.

The control valve 5, made in steel or other suitable material, see Fig. 1, is in the form of a cylindrical sleeve, engaged along one of its edge with the annular thoot 6 which, by the lower annular rim shaped surface, knocks against 1b edge of 1a annular shaped groove having a rectangular section, in the inside face of the cylindrical chamber 1., in which the same cylindrical valve sleeve 5 works. This cylindrical chamber 1 is coaxially connected with the cylindrical chamber 2A diametrically smaller, to form with it along its contact face, an annular chamber 3 having a diameter smaller than the one of the above groove 1a in order to form a second circular shoulder 4 for limiting the stroke of the sleeve 5 itself in the upper direction. In the first application which is the easiest (Fig. 1), in the recharge stroke,the sleeve valve 5 works so that it can permit the moving up of piston 7 which has 2 different diameters Ø A and Ø C, where Ø A > Ø C, to force the gas (e.g. nitrogen) contained in a hermetical compresssion chamber 11.

This is possible thanks to the sleeve 5 which opens the supply port of duct 8 in the same cylindrical chamber 1 and permits the application of the pressure p_1 of the hydraulic fluid on the annular face 7a, of area A_1 of the piston causing a thrust $S_1 = A_1 \cdot p_1$.

In the phase 2 (Fig. 2) the piston has reached almost the top dead center fixed by the shoulder 13, pressing further the gas contained in the chamber 11 up to the maximum

pressure $p_2 < p_1$ caused by the thrust S_1 and by the area C_1 of the surface 7b.

Meanwhile the valve sleeve 5 is compelled to move down by the hydraulic fluid which, flowing in the annular chamber 3, can press against the annular surface 5a, causing a thrust higher than the one the same hydraulic fluid produces on the opposite surface 5b of smaller area, in order to close the inlet port of pipe 8 and open the outlet one by pipe 9 (see Fig. 3).

At this point, as the thrust of high pressure fluid on the annular surface 7a of piston stops and as the cylindrical chamber is connected with the outlet ducts 9 and 10, the piston, not being forced by no back pressure, goes down striking violently the tool 14 at a speed higher than the going up one.

Piston upstroke and dowrstroke speed are rispectively connected with pump supply and with espansion speed of gas compressed in the chamber 11.

The sleeve closes the inlet port of the pipe 8 until the circular edge 7c of the piston comes into contact with the edge 5d of sleeve valve itself making tight.

At this point, in fact, the compression of hydraulic fluid remaining in the chamber 1, takes place by means of the same piston and a thrust on the sleeve surface 5b by the fluid which penetrates into the chamber 1c; as the valve sleeve is opposed by no back pressure, goes up again opening, therefore, the inlet port of high pressure fluid and closing the outlet port through duct 9, so that the piston can move up owing to the fluid thrust on the annular surface 7a.

In the application shown by Figg. 5, 6, 7 and 8, the piston 7 is provided with an annular fluting 7d.

In the power stroke (Fig. 5) the inlet holes of the ducts 8 carrying the high pressure fluid are opened while the outlet holes of duct 9 are closed by the sleeve valve 5. The piston moves down even if the same high pressure hydraulic fluid acts in the same time, on the annular surface 7a of the piston, through duct 12: in fact the area A_1 of the same annular surface 7a is smaller than the area B_1 of the upper surface 7b.

Mowing down, the part B of piston allows the flow of the under pressure fluid to the annular chamber 3 (Fig. 6), so that the fluid itself can press on the annular surface 5a of the sleeve which, being larger than the annular surface 5b, causes a resultant thrust which moves up the sleeve until to close the supply ports of ducts 8 of the under pressure fluid and to open the outlet ports of the duct 9. This causes the running up of piston 7 only because of the thrust of the hydraulic fluid on the annular surface 7a of the same piston.

When the circular edge 7c of the piston comes into contact with the circular edge 5d of the sleeve (Fig. 8), making mutual tightness, the piston presses the hydraulic fluid remaining in the chamber 1 causing a pressure on the annular surface 5b of the sleeve itself,wich opposed by no back pressure, moves down until to open again the inlet ports of the duct 8 of the high pressure fluid and to permit the repetition of cycle.

Moving down to open the inlet ports of the fluid, the sleeve 5 shoves the fluid, which is in the annular space formed under the surface 5a, in the little duct 15, through the annular chamber formed by the fluting 7d of piston, in the exhaust fluid duct 16.

To increase the striking velocity i.e. the kinetic ener-

gy of the piston, and for better exploitation of the capacity of the hydraulic pump, in this directional control valve at this invention of, the appliance is equipped with a pneumatic accumulator 11a (e.g. nitrogen) with a diaphragm 18 and with a sequence and velocity controlling valve 17, which exploiting the pressure decrease taking place on the beginning of rechearging stroke for the higer hydraulic flow required by the recharge of accumulator 11a, at first closes and after throttles the outlet port of the exhaust duct 10, in order to reduce the moving up velocity of the piston.

After recharging the accumulator, when the pressure of hydraulic fluid reaches the maximum value, the reaction of the spring is no more sufficient to oppose the thrust given by the little piston 17b and therefore the outlet hole 17c of the valve is opened.

On the top dead centre, the piston impact is damped by the compressed fluid in the upper part of chamber 1 or, if part A of piston is diametrically larger than the B one to make as a shoulder by annular surface 13 of the cylindrical chamber 2A, by means of hydraulic fluid contained in the same cylindrical chamber 2A.

As detailed above, the tight surface of the sleeve control valve are very large.

The tight of inlet and outlet ports are, in fact, made by the lateral outside surfaces 5e of sleeve valve and 6b of annular tooth 6 which engages with the same sleeve.

More over it has to note that before the piston reaches its top dead centre, the sleeve valve acts as a cylinder for the same piston, moving coaxially to it in the opposite direction, in order to avoid frontal impacts and the tight of inlet and outlet ports of the hydraulic fluid by the piston itself, such as happens in other cylindrical directional

control valves,that is, making indipendent the control valve tight from the piston wear.

CLAIMS:

1° Directional control valve to obtain in a hydraulic appliance, the alternative motion of a piston to charge and fire a tool, specially suitable for hydraulic hammers, including a cilinder 1 to which the supply duct 8 and exhaust one 9 of an uncompressible hydraulic fluid are connected and in which control valve, sleeve shaped 5 and the ends B or the intermediate part A of a piston 7 move coaxially to the cylinder itself in both directions, characterized in that the same control valve 5 is fitted along one of its ends with a rectangular cross section annular tooth 6 which forces it to make a stroke fixed by the depth of a rectangular section annular fluting 1a, symmetrical to a plane normal to the axis of the same cylinder, the tooth 6 acting alternatively as a shoulder against the annular surfaces 1b and 4, the diameter of the cylindrical chamber being bigger than the one of the part of piston entering in it, that is, of that part on which the hydraulic fluid acts, in a double measure of the sleeve thickness forming the same control valve in order to permit a sliding connection both between the above part of piston and the inside surface of the cylindrical sleeve, both between the outside of this and the same cylindrical chamber 1, that is, to permit the sliding of the above piston part inside the sleeve control valve which in this phase, acts as cylinder of the above part of piston itself.

2° Directional control valve, at claim 2 of, characterized in that the reversal of the stroke of the sleeve 5 to close the supply ports and open the exhaust ones of hydraulic fluid or vice versa, to open the supply ones and close the exhaust ports, take place every time that the part of

piston penetrating into the cylindrical chamber 1 establi-shes with its circular running edge 7c a tight contact with the corresponding running edge 5d of sleeve valve, forcing the hydraulic fluid to compress at the same time the surface 5a and 5b of different area, or alternately, when the piston moves in the opposite direction, trasmitting on the face 5b of the valve 5, throug the fluid remaining in the cylindrical chamber, the pressure exerted by the same piston, the reversal stroke to open the exhaust ports and close the supply one being possible thanks to the annular fluting 3 with rectangular section in the body of the next cylindrical chamber, in which the hydraulic fluid penetrates, the same fluting as wide as to permit the developement af an annular shoulder 4, the tooth 6 of sleeve valve to limit the axial stroke, the pressure on both the faces 5a and 5b of distributor producing a working thrust in relation to the different area of the two faces, the pressure of the fluid pressed by the same piston on the face 5b of the valve producing a working thrust for no back pressure produced by the fluid itself on the face 5a, the fluid flowing trough the exhaust duct 9 or through the duct 15 and the annular fluting 7d of the piston, in the exhaust duct 16.

3° Directional control valve, at claim 1 of, characterized in that the tight closure of supplying ports of hydraulic fluid in the cylindrical chamber is made essentially by the outer lateral surface 5e of the sleeve valve i.e. the the control valve 5, while the tight closure of exhaust ports is made jointly by the above lateral surface 5e and by the surface 6b of the sleeve tooth, that is by very large surfaces.

4° Directional control valve, at claim 1 of, characterized in that the sleeve valve 5 acts as a cylinder for the piston part working in the cylindrical chamber 1, it moving continually in the opposite direction to the same piston and coaxially to this, that is, it acts as a liner of the cylyndrical chamber 1, closing and opening, at the same time, the supply and exhaust ports of hydraulic fluid and therefore preventing that the piston wear can endanger the same valve system control tight.

5° Directional control valve, at previous claims of, characterized in that in appliances as hammers exploiting in the striking, at the same time, the contemporary action of fluid pressed by the pump and the pressure on the same fluid, of gas contained in diaphraem accumulator, the same control valve provides for the continuous application, through a duct 12, of the same fluid pressure on the shaped annular surface 7a of piston with an area less than the one 7b on which the hydraulic fluid in striking phase is forced, in order to give rise of piston in the recharging phase without reducing the thrust the piston is forced to, in striking phase.

6° Directional control valve, at claim 5 of, characterized in that it can be coupled besides to means which intensify the action of hydraulic fluid on the piston in striking phase, also to means to retard the piston recharging so as a valve 17 acting in function of the hydraulic fluid, to close or throttle the exhaust ports of the hydraulic fluid, itself on the recharging of the same piston.

7° Hammer of figures 1, 2, 3, 4 type,that is with a tight

accumulator containing free nitrogen or other free gas, characterized by a directional control valve, as claimed in claims 1, 2, 3, 4.

8° Hammer, of figures 5, 6, 7, 8 type, including also a diaphraem accumulator of gas under pressure and a valve controlled by the pressure of the same hydraulic fluid, characterized by a directional control valve, as claimed in claims 1, 2, 3, 4.

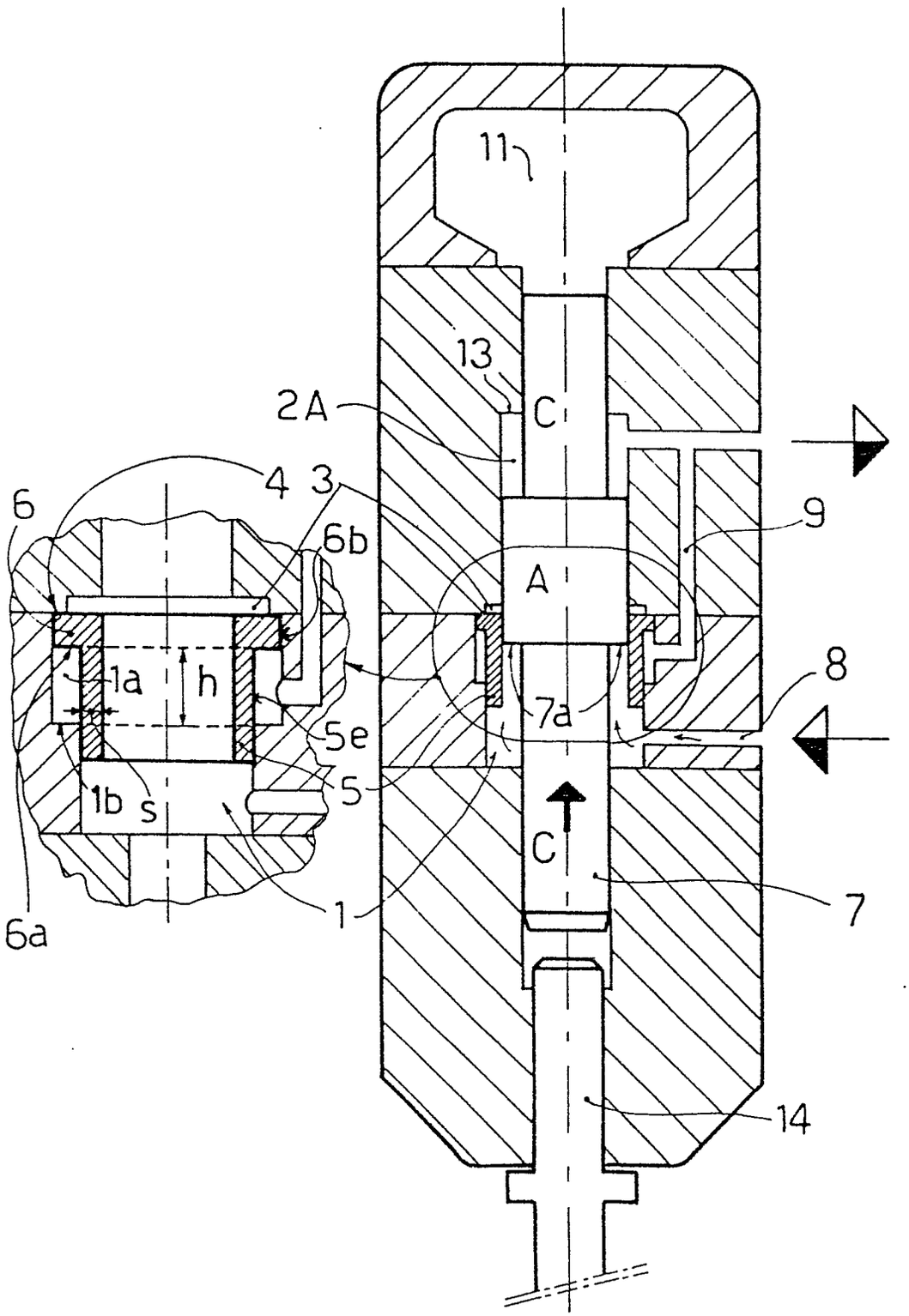

FIG. 1

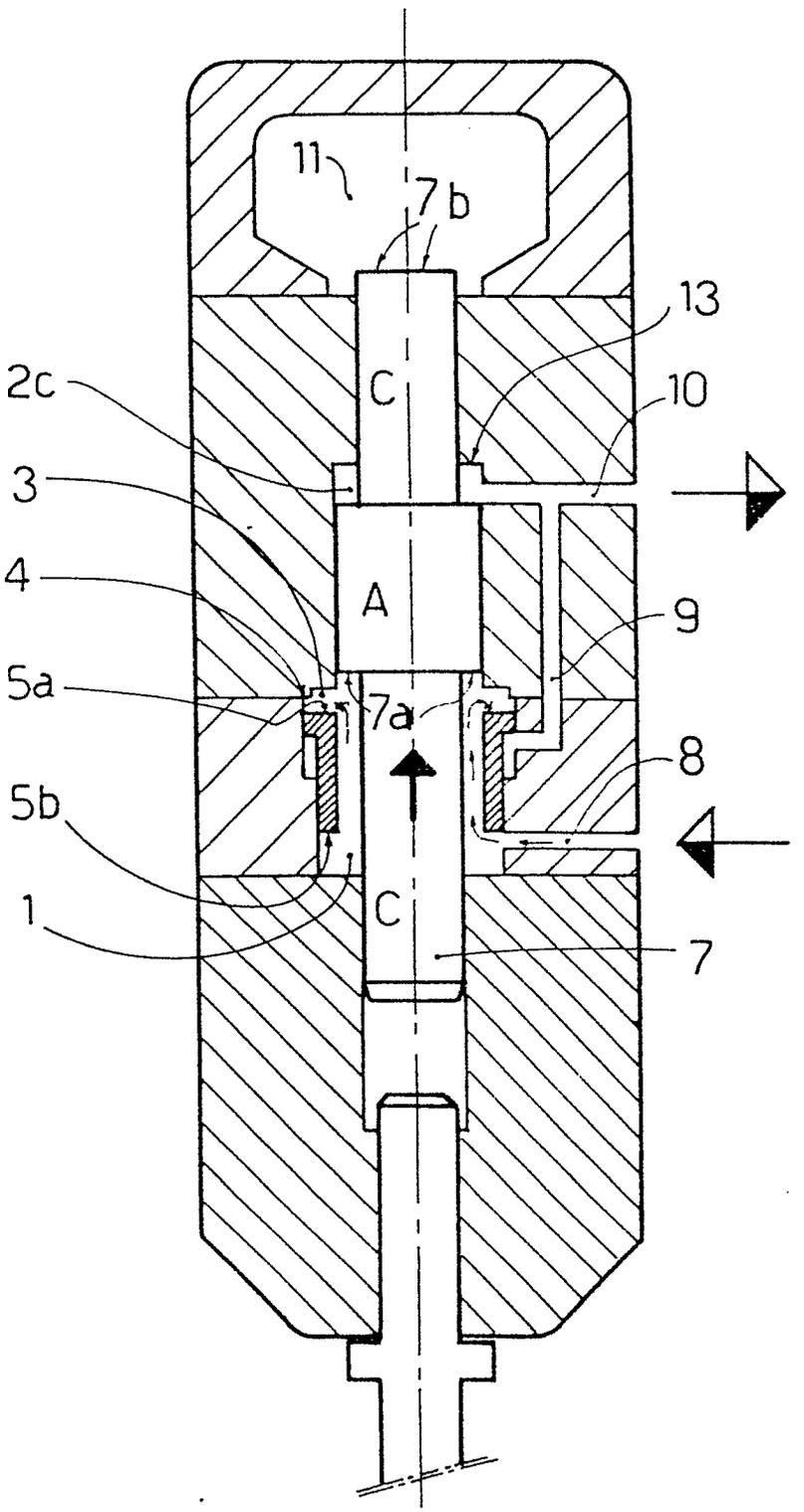

FIG. 2

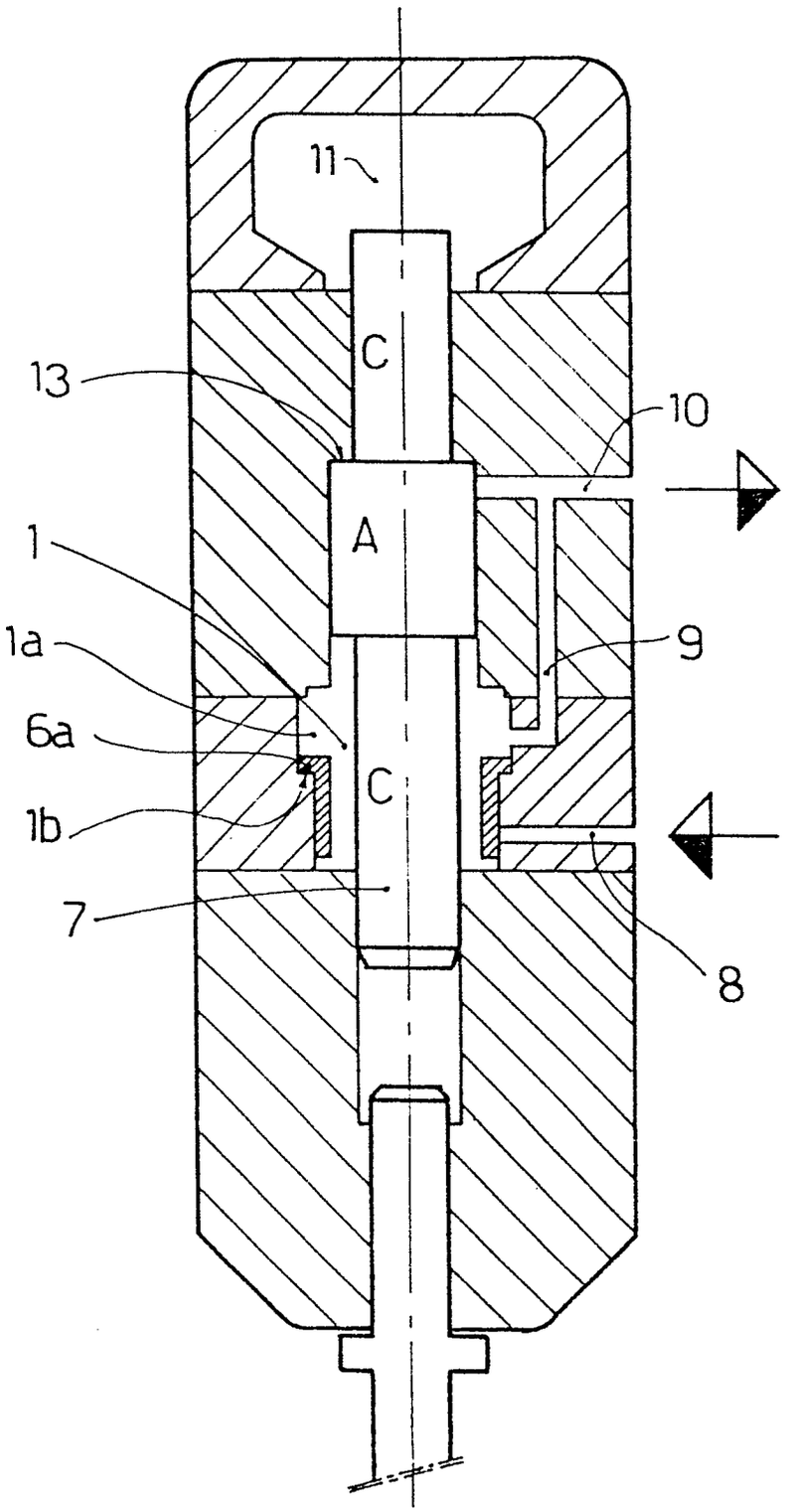

FIG. 3

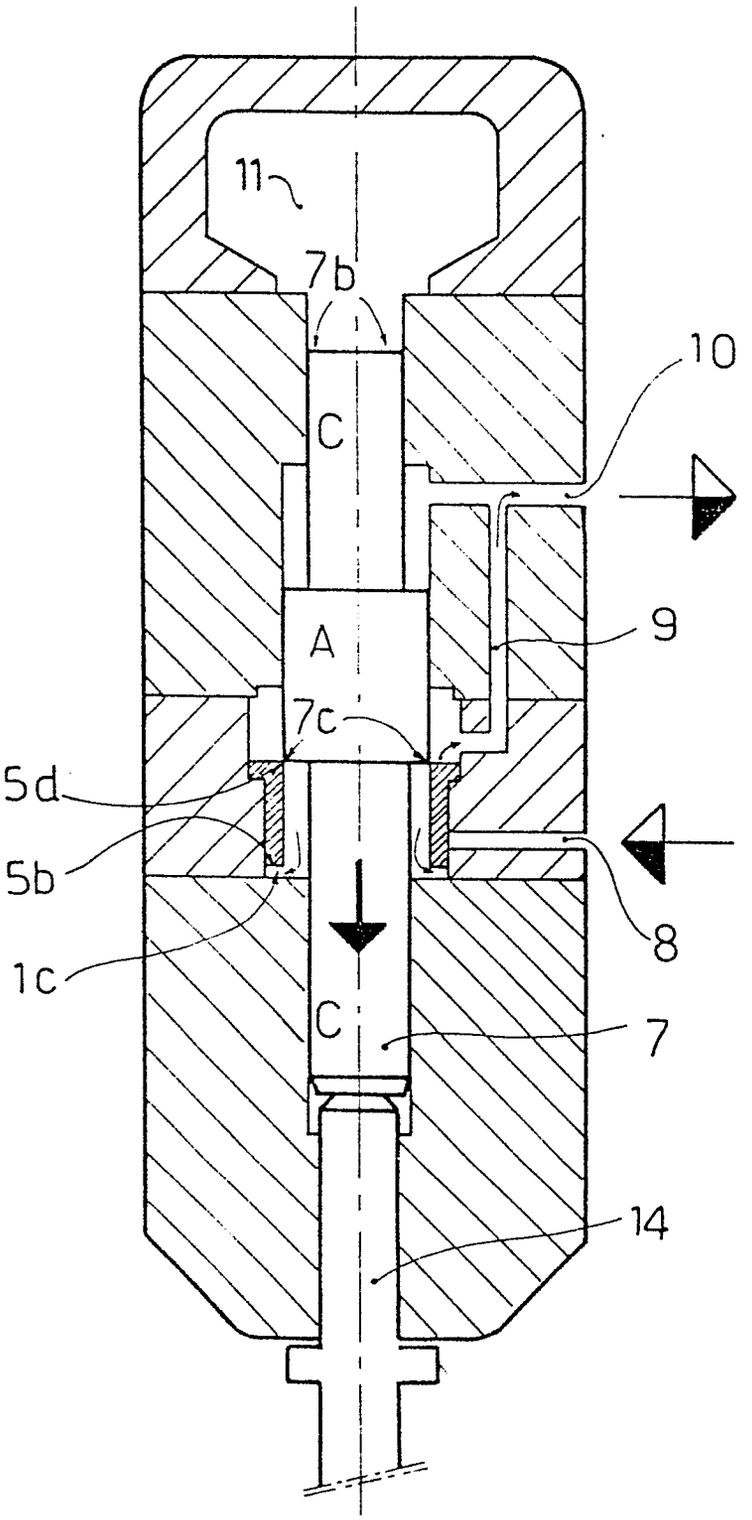

FIG. 4

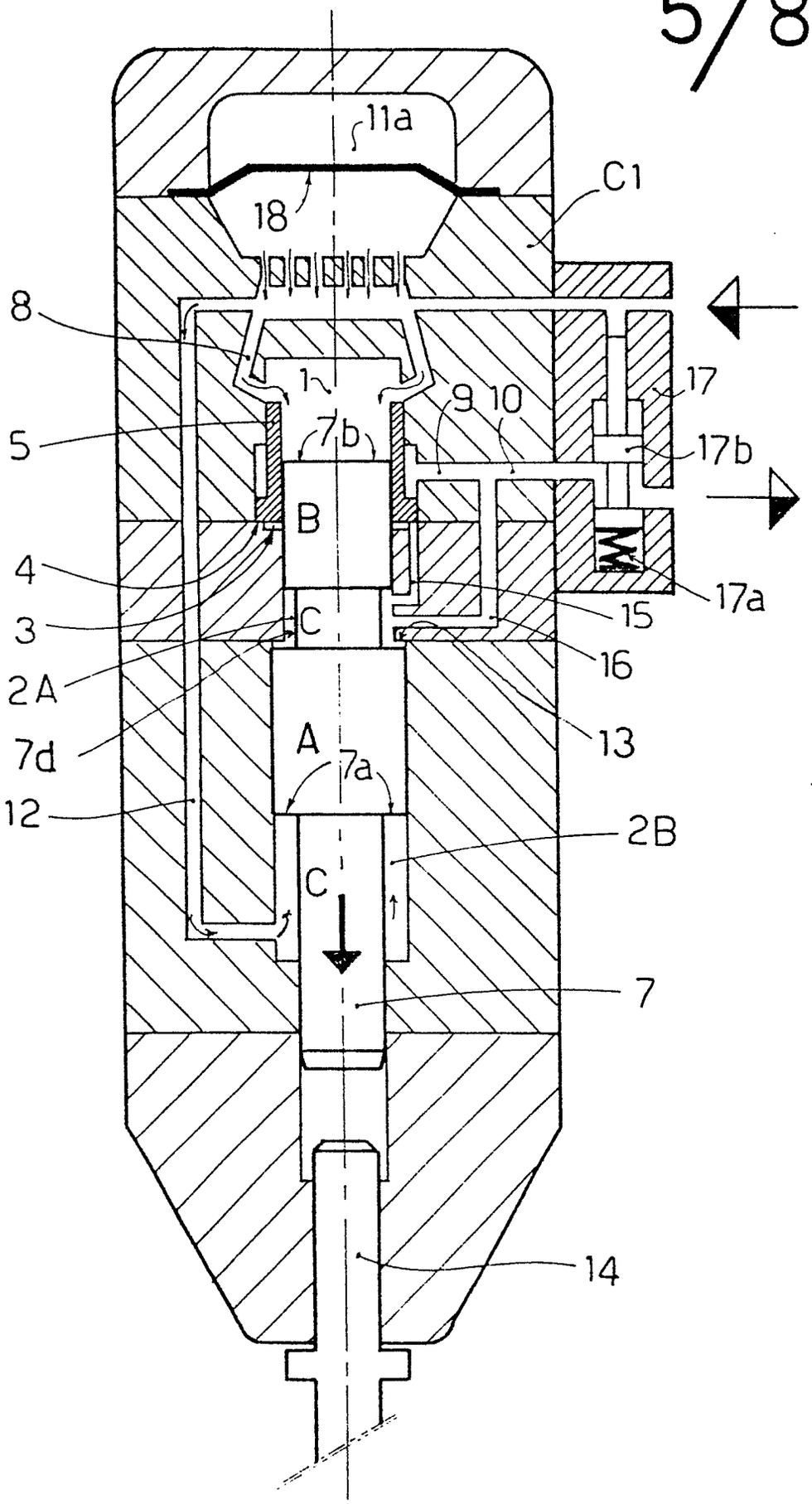

FIG.5

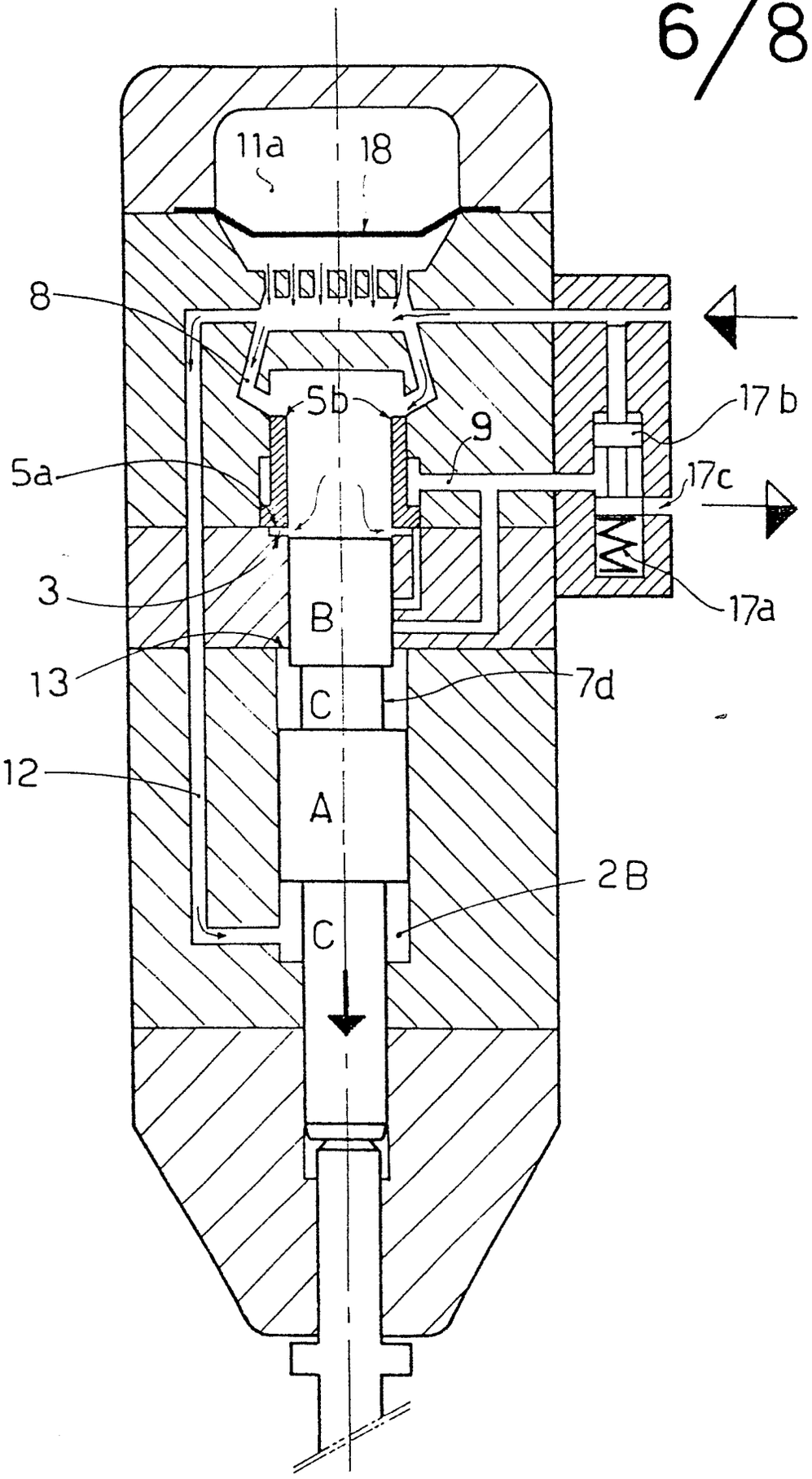

FIG. 6

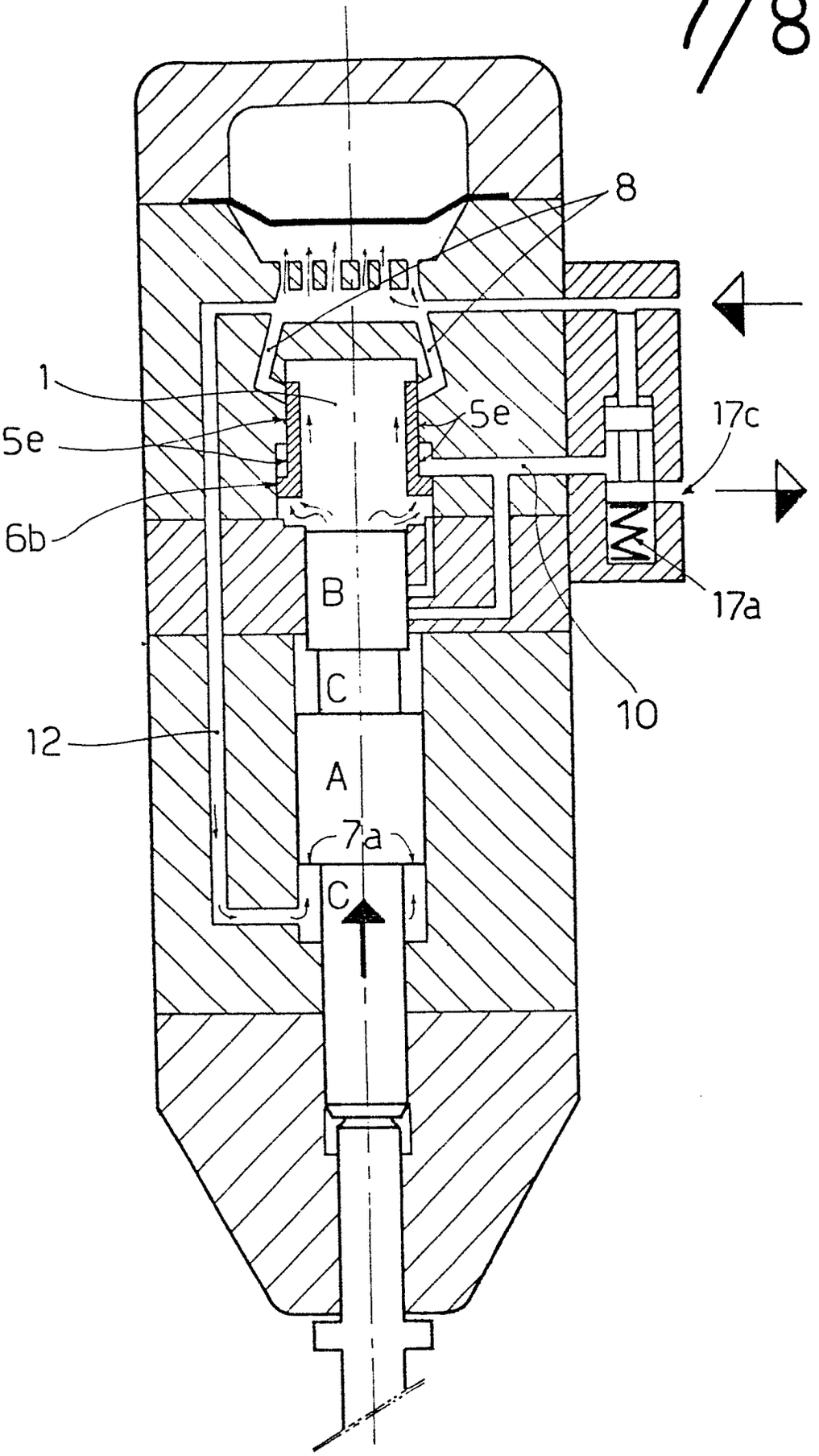

FIG. 7

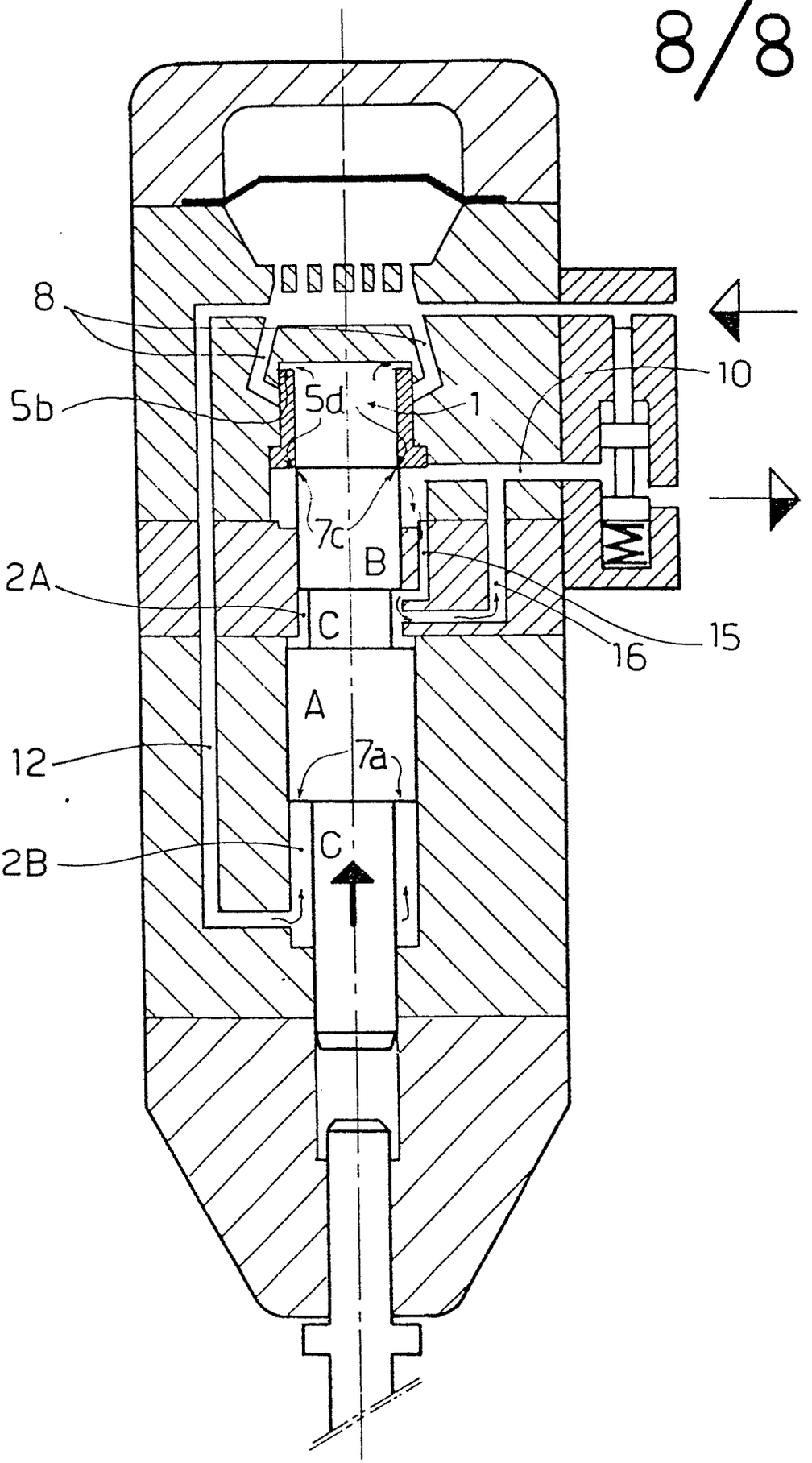

FIG. 8

European Patent Office

EUROPEAN SEARCH REPORT

0085279
Application number
EP 82 83 0014

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	US - A - 4 022 108 (V.E. JUVONEN) * column 2, line 40 - column 4, line 38; figure *	1,3
A	US - A - 3 411 592 (R. MONTABERT) * column 2, line 23 - column 4, line 15; figures 1-9 *	1,3
A	US - A - 4 143 585 (R.L. SELSAM) * column 2, line 45 - column 7, line 53; figures 1-6 *	1
A	US - A - 3 766 830 (R. MONTABERT) * column 2, line 19 - column 3, line 18; figures 1-3 *	1
A	GB - A - 2 014 651 (E.J. JUSTUS)	
A	GB - B - 1 478 251 (JOY MANUFACTURING)	

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

B 25 D 9/12

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

B 25 D
E 21 C

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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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

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25-05-1982	JAUNEZ

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