

⑫

EUROPEAN PATENT APPLICATION

⑫ Application number: **81300360.5**

⑤① Int. Cl.³: **F 15 B 11/04**

⑫ Date of filing: **27.01.81**

④③ Date of publication of application: **11.08.82**
Bulletin 82/32

⑦① Applicant: **Weyman, Henry Walter, Waterworks Road**
Barbourne, Worcester WR1 3EZ (GB)

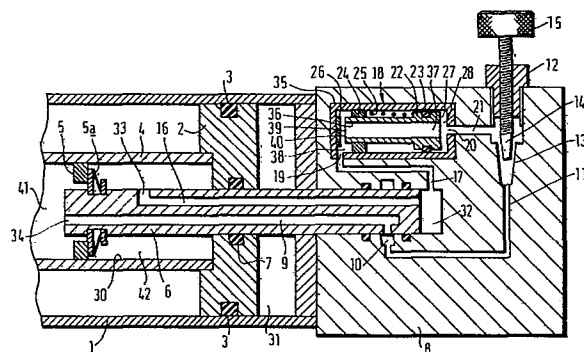
⑦② Inventor: **Weyman, Henry Walter, Waterworks Road**
Barbourne, Worcester WR1 3EZ (GB)

⑧④ Designated Contracting States: **DE FR IT NL SE**

⑦④ Representative: **Attfield, Donald James et al, Prudential**
Buildings 5 St. Philip's Place, Birmingham B3 2AF (GB)

⑤④ **Pneumatic cylinder assemblies.**

⑤⑦ Disclosed is an apparatus for controlling the rate of flow of hydraulic fluid when used in hydraulic damping of a pneumatic piston (1) moving in its cylinder (2), including a hydraulic piston (5) contained in a cylinder (30), the said piston (5) being driven by operation of the pneumatic piston (1) causing fluid to be displaced through a hydraulic circuit from one side of the said piston (5) to the other, said circuit including a fluid flow control consisting of a variable flow control needle valve (12) and a low pressure governor (18) located upstream of the said needle valve (12).



EP 0 057 301 A1

-1-

PNEUMATIC CYLINDER ASSEMBLIES

The present invention relates to a method and apparatus for controlling the rate of flow of fluid in a high pressure hydraulic fluid circuit and is especially concerned with controlling the ram speed of a piston in a pneumatic piston
5 and cylinder assembly incorporating hydraulic damping.

When it is necessary to control the rate of flow of fluid in a hydraulic circuit the fluid is normally caused to pass through an orifice whose size may be varied to regulate the flow rate. A common example is in the use of hydraulic
10 damping to control ram speed, that is the speed of movement of the piston, of a pneumatic cylinder; this arrangement is necessary because air, being compressible, does not allow control by flow restriction to be applied directly to the pneumatic cylinder. An example of such use is described and
15 illustrated in my British patent No. 1,320,335. In such applications the operation of the pneumatic cylinder drives the hydraulic cylinder, displacing oil from one side of the hydraulic piston to the other side via an interconnecting circuit. If a metering orifice is located in the circuit to restrict the
20 oil flow, the thrust of the piston in a pneumatic piston and cylinder assembly causes a build up of hydraulic pressure and the resulting rate of flow is dependent upon the size of the orifice and the pressure drop across it. If the orifice size is variable, for example by employing a needle valve, the rate
25 of flow and therefore the ram speed of the pneumatic cylinder may be controlled as required; for example to control the feed rate of a cutting tool.

Since reduction in size normally permits wider use of equipment, the natural development in hydraulic systems is towards a
30 reduction in the size of components. The consequent reduction in the surface areas of the pistons employed in the piston and cylinder assemblies automatically leads to the use of higher hydraulic pressures to operate the required forces, and

-2-

pressures of the order of 100 kg/sq cm are not uncommon. In order to achieve low flow rates in the hydraulic circuit, and therefore low ram speeds of the pneumatic piston, at these hydraulic pressures, the dimensions of the metering orifice must be reduced to the same order as the size of particles normally present in commercially available fine grades of hydraulic fluids. Under these conditions the particles, which may have a diameter of less than 5 microns, collect at the orifice causing silting and resulting in intermittent and erratic flow rate. Thus the ram speed of the pneumatic cylinder may be caused to slow down progressively along its stroke and there could even be a total loss of pneumatic piston movement. Furthermore with the high pressures applied at the control orifice, control is extremely sensitive and small adjustments of orifice size result in large changes in flow rate.

I have now found that this problem may be ameliorated by placing a pressure reducing valve i.e. a low pressure governor, into the hydraulic circuit upstream of the flow control orifice to drop the pressure to a controlled low pressure, typically about 7 kg/sq cm. When low pressures of this order are applied to the flow control orifice, the low flow rates required to produce low ram speeds are obtained at orifice openings wide enough to avoid the danger of silting and the control responses also less sensitive to adjustments of orifice size. Thus the incorporation of a low pressure governor enables low flow rates to be selected, maintained consistently and fine adjustments to flow rates made without the need for minute adjustments of orifice settings. It is highly desirable that the low pressure governor be of a design such that the controlled pressure is substantially independent of changes in applied pressure and demanded flow rates. Furthermore, since this governor must also pass the oil through a fine restriction in order to reduce the pressure, it should also automatically clear itself of any silting.

-3-

In a pneumatic piston and cylinder assembly incorporating hydraulic damping, the hydraulic piston has a piston rod on one side and not on the other and therefore a hydraulic fluid reservoir must be available to accept the difference in volume
5 on the retraction stroke and to return it on the extension stroke. In order that the hydraulic fluid from the reservoir may be returned to the cylinder, the reservoir must be pressurised, for example by a piston with spring loading or by the application of external pressure such as a compressed
10 air supply. Since this reservoir pressure is present as a back pressure on the downstream side of the control orifice, it can be used to significantly reduce the pressure drop across the control orifice thus assisting in maintaining low and consistent flow rates within the hydraulic circuit.

15 From one aspect, therefore, the present invention provides a method for controlling the rate of flow of hydraulic fluid in a high pressure hydraulic fluid circuit in which hydraulic fluid under high pressure is caused to pass through a variable flow control orifice to a hydraulic fluid reservoir contained
20 in the circuit wherein the hydraulic fluid under pressure is first caused to pass through a low pressure governor whereby the pressure drop across the said flow control orifice is reduced enabling more accurate control of the rate of flow of fluid through said orifice.

25 From another aspect the invention provides a pneumatic piston and cylinder assembly including means for controlling the ram speed of the piston wherein said means comprises a hydraulic piston and cylinder assembly the hydraulic piston being driven by the operation of the pneumatic piston
30 causing hydraulic fluid to be displaced from one side of the said hydraulic piston to the other side thereof via an interconnecting hydraulic circuit, said hydraulic circuit including flow controlling means for controlling the rate of flow of hydraulic fluid therein whereby the ram speed of the
35 pneumatic piston is controlled, said flow controlling means

-4-

including in said hydraulic circuit a variable flow control orifice and a low pressure governor located upstream of said orifice, said hydraulic circuit further including a hydraulic fluid reservoir located downstream of said variable flow
5 orifice, which reservoir is maintained under constant pressure.

The low pressure governor may comprise a chamber having an inlet and outlet for the hydraulic fluid and including a movable wall connected to means for controlling the flow of fluid into the said chamber in response to a movement of said
10 wall resulting from an increase in hydraulic pressure on the outlet side of said chamber.

The above mentioned chamber may be formed from a cylinder incorporating a piston and associated piston rod movable therein said piston and piston rod having coaxial passageways
15 extending therethrough, the free end of the piston rod forming one valve seat in a valve means having two co-operating valve seats for controlling the flow of hydraulic fluid into said cylinder and free end being urged away from the co-operating valve seat by resilient means acting against said piston..

20 An apparatus employing one embodiment of the invention will now be described by way of example only with reference to the accompanying drawing which is a diagrammatic cross-sectional view through a portion of the pneumatic cylinder assembly and hydraulic flow control valve assembly according to the present
25 invention.

A pneumatic cylinder 1 has a piston 2 which slides within cylinder 1 and is sealed by means of seal 3. The piston 2 is carried on a piston rod 4 which is free to slide within the end piece of the assembly (not shown). One end of the assembly
30 is sealed by a closure block 8.

A hydraulic damping cylinder assembly is provided within cylinder 1, the cylinder 30 being formed within

-5-

the pneumatic piston rod 4. A piston 5 is carried by the hydraulic piston rod 6 and slides within the cylinder 30 and is sealed against the cylinder 30 by means not shown, to provide chambers 41 and 42 on either side of said piston.

5 Piston 2 is sealed against rod 6 by means of the sealing ring 7.

The right hand end of the cylinder assembly 1 is closed by closure means 8 in which one end of the piston rod 6 is secured. A hydraulic fluid bore 16 runs the length of the piston rod 6 10 from an inlet 33 on the right hand side of piston 5 to a chamber 32 in the closure block 8.

A passageway 17 connects chamber 32 with a pressure governor generally indicated at 18, via inlet 19.

A hydraulic bore passes the length of rod 6 from an outlet 34 15 positioned at the front of the piston rod and to the left of piston 5 the other end communicating with an annular passageway 10, contained in closure block 8, which is interconnected via passageway 11 with the outlet side of a flow control valve 12.

20 The flow control valve 12 comprises a conical valve seat 13 with which co-operates a needle valve 14 adjustable by means of the knurled knob 15.

Pressure governor 18 comprises a cylindrical chamber 35 which carries a hollow piston 22 having an end face 27, and which is 25 sealed against the cylinder 35 by sealing ring 23, and a free end 40. The associated piston rod 36 is freely movable within the annular ring 24 against which it is sealed by a rubber ring (not shown). The piston 22 and piston rod 36 contain an axial hollow space 37 running the full length thereof, the 30 right hand end of the passageway 37 communicating with the

-6-

space 28 between the end face 27 of the piston 22 and the end wall of the cylinder 35. Outlet 20 communicates with space 28 and via the passage 21, with the inlet side of the flow control valve 12. The opposite end of the axial
5 passageway 37 communicates with inlet 19 via the annular space 38. A rubber seal 26 is fixed to the end wall of the cylinder 35 opposite the free end 40 of the piston rod 36. A coil spring 25 is positioned between the annular ring 24 carrying the piston rod 36 and piston 22 to normally maintain
10 a gap 39 between the free end of the piston rod 36 and the seal 26.

In operation air is forced into the space 31 in cylinder 1 by means not shown and causes piston 2 and associated piston rod 4 to move to the left. Hydraulic fluid on the right hand of
15 piston 5 is then forced into unit 33 and through passageway 16 in piston rod 6 into the space 32 and then via passageway 17 and inlet 19 into the pressure governor 18. The hydraulic fluid flows through passageway 37 in piston rod 36 and piston 22 into space 28 and out of pressure governor via outlet 20
20 and via passage 21 into the inlet side of the flow control valve 12.

Because its end area is very small, the force applied to the free end of piston rod 36 by the high pressure at inlet 19 is small. Consequently, the pressure increasing in the space 28
25 builds up the force on face 27 of piston 22, until it overcomes the opposing force of the spring 25, thereby forcing the piston 22 and piston rod 36 to the left until the free end of piston rod 36 contacts the seal 26 and halts the flow of hydraulic fluid. The control pressure in the space 28 and at
30 the outlet 20 of the pressure governor is therefore determined by the force of coil spring 25. In practice the piston 22 and associated rod 36 will normally take up a position within cylinder 35 which will vary according to any changes in

-7-

pressure on either the input or output sides of the governor 18 to give a stable output pressure. In this condition, the bulk of the hydraulic pressure available in the hydraulic circuit is dropped across the narrow space between the free end of
5 piston rod 36 and the seal 26 leaving only the low controlled output pressure (typically 7 kg/sq cm) to be dropped across the flow control valve 12. Should silting occur at the narrow space at the free end of piston rod 36, the pressure in the outlet space 28 must fall, causing the spring 25 to move the
10 piston 22 and piston rod 36 to the right, increasing the gap at the free end of piston rod 36 and automatically clearing the silting.

In this apparatus the hydraulic fluid reservoir 41 is formed by the chamber in the cylinder 30 on the left hand side of piston
15 5 and is pressurised by means of a spring loaded piston located at the end of the said chamber or by an external supply of compressed air as described in patent No. 1,320,335.

-8-

What I claim is:

1. A method for controlling the rate of flow of hydraulic fluid in a high pressure hydraulic fluid circuit in which hydraulic fluid under high pressure is caused to pass through a variable flow control orifice to a hydraulic fluid reservoir
5 contained in the circuit, characterised in that the hydraulic fluid under pressure is first caused to pass through a low pressure governor whereby the pressure drop across the said flow control orifice is reduced enabling more accurate control of the rate of flow of fluid through said orifice.
- 10 2. A pneumatic piston and cylinder assembly (1,2) characterised in that it includes a hydraulic piston (5) and cylinder assembly (30) for controlling the ram speed of the pneumatic piston (1), the hydraulic piston (5) being driven by the operation of the pneumatic piston (1) causing hydraulic fluid to be displaced
15 from one side of the said hydraulic piston (5) to the other side thereof via an interconnecting hydraulic circuit, said hydraulic circuit including flow controlling means for controlling the rate of flow of hydraulic fluid therein whereby the ram speed of the pneumatic piston (1) is controlled, said flow controlling
20 means including in said hydraulic circuit a variable flow control orifice (13) and a low pressure governor (18) located upstream of said orifice, said hydraulic circuit further including a hydraulic fluid reservoir (40) maintained under constant pressure and located downstream of said variable flow orifice (12).
- 25 3. An assembly according to claim 2 characterised in that the variable flow control orifice (13) is a needle valve (12).
4. An assembly according to claim 2 or claim 3 characterised in that the low pressure governor (18) comprises a chamber (35) having an inlet and outlet for the hydraulic fluid and including
30 a movable wall (22) connected to the means (25,26,40) for controlling the flow of fluid into the said chamber in response

-9-

to a movement of said wall resulting from an increase in hydraulic pressure on the outlet side of said chamber (35).

5. An assembly according to claim 4 characterised in that
5 said chamber is a cylinder (35) incorporating a piston (22)
and associated piston rod (36) movable therein, said piston
(22) and piston rod (36) having coaxial passageways (37)
extending therethrough, the free end (40) of the piston rod
forming one valve seat in a valve means having two co-operating
10 valve seats (40,26) for controlling the flow of hydraulic
fluid into said cylinder said free end (40) being urged away
from the co-operating valve seat by resilient means (25) acting
against said piston.

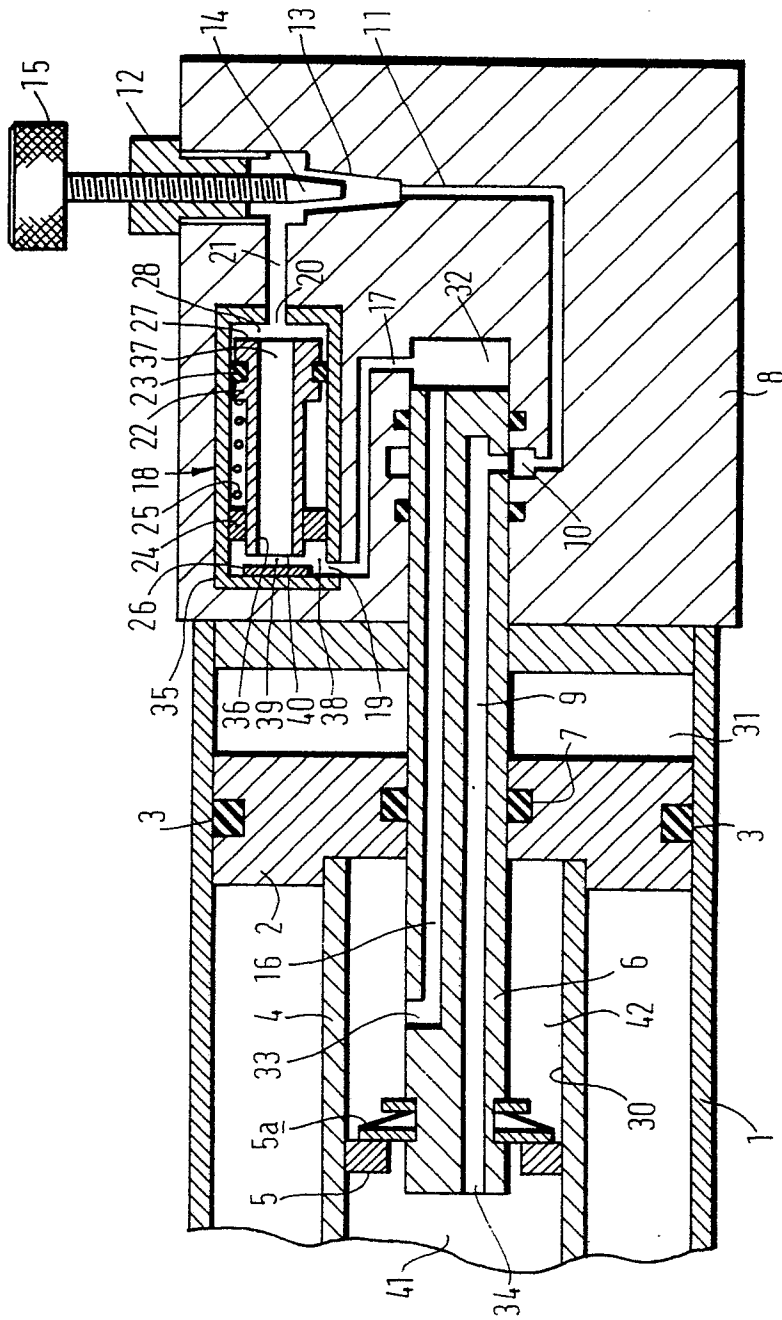
6. A pneumatic piston and cylinder assembly according to any
15 one of claims 2 to 5 characterised in that the said assembly
comprises a pneumatic cylinder (2); a pneumatic piston (1) and
piston rod (4) slidable therein; a hydraulic cylinder
assembly interconnected with said pneumatic cylinder assembly
and including a hydraulic piston (5) and piston rod (6)
20 slidable therein, said hydraulic piston (5) providing on
opposite sides thereof, first and second chambers (41,42)
within said hydraulic cylinder (30); a hydraulic circuit inter-
connecting said first and second chambers (41,42) in the
hydraulic cylinder (30); a variable flow control valve (12)
25 located in said hydraulic circuit between said first and second
chambers (41,42) and a low pressure governor (18) located in
said hydraulic circuit in series with said flow control valve
(12) and one of said first and second chambers (41,42) in said
hydraulic cylinder (30).

30 7. An assembly according to any one of claims 2 to 6 charac-
terised in that the hydraulic piston and cylinder assembly is
located within the pneumatic piston rod (4), the cylinder (30)
of the said hydraulic piston and cylinder assembly being formed
by the said pneumatic piston rod (4).

-10-

8. An assembly according to any one of claims 2 to 7 characterised in that the hydraulic fluid reservoir is pressurised by a spring loaded piston acting against said hydraulic fluid.

9. An assembly according to any one of claims 2 to 7 characterised in that the hydraulic fluid reservoir is pressurised by a piston acting against said hydraulic fluid under the influence of an external supply of compressed air.



0057301



European Patent
Office

EUROPEAN SEARCH REPORT

Application number

EP 81 30 0360

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int. Cl.)
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	
X	<u>US - A - 2 326 498 (RODAL)</u> * Page 3, right-hand column, lines 52-62 * --	1,2,4-6	F 15 B 11/04
XD	<u>GB - A - 1 320 335 (WEYMAN)</u> * Whole document * --	2,3,6-8	
X	<u>US - A - 3 890 999 (MOSKOW)</u> * Column 3, lines 10-37 * --	4,5	
	<u>US - A - 3 029 904 (GOLDRING)</u> * Column 4, line 63 - column 5, line 11 * --	1-6,8	TECHNICAL FIELDS SEARCHED (Int. Cl.) F 15 B B 23 Q
	<u>US - A - 3 176 801 (HUFF)</u> * Column 3, lines 49-52 * --	9	
	OLHYDRAULIK UND PNEUMATIK 14, no. 7, 1970, pages 295-299 Mainz, DE. KONRAD-ZIESLING, SPEYER: "Pneumatic construction units" ----	1-6	CATEGORY OF CITED DOCUMENTS X: particularly relevant A: technological background O: non-written disclosure P: intermediate document T: theory or principle underlying the invention E: conflicting application D: document cited in the application L: citation for other reasons
☒ The present search report has been drawn up for all claims			&: member of the same patent family, corresponding document
Place of search	Date of completion of the search	Examiner	
The Hague	08-09-1981	KNOPS	