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<p>Priority 190291 IT RM91000116.</p> <p>Priority : 19.02.91</p> <p>Date of publication of application : 26.08.92 Bulletin 92/35</p> <p>Designated Contracting States : AT BE CH DE ES FR GB LI NL SE</p> <p>Applicant : INIZIATIVE INDUSTRIALI POMEZIA S.p.A. Via Montedoro 6 I-00040 Pomezia, Rome (IT)</p>	<p>Inventor : Claudi, Vittorio, c/o Iniziative Industriali Pomezia S.p.A., Via Montedoro 6 I-00040 Pomezia (Rome) (IT)</p> <p>Representative : Taliercio, Antonio et al ING. BARZANO' & ZANARDO ROMA S.p.A. Via Piemonte, 26 I-00187 Roma (IT)</p>
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Improvement to oil pressure operated actuator cylinder assemblies, having the piston forward/return strokes synchronized also under unbalanced loads.

The object of the invention is an assembly of two, three or more oil pressure operated actuator cylinders with the piston forward/return strokes synchronized also under unbalanced loads, having a delivery pipe to the pressure chamber of the first cylinder and an exhaust pipe from the return chamber of the last cylinder of the assembly, as well as a transfer pipe from the return chamber of each cylinder to the pressure chamber of the subsequent cylinder, eventually endowed with bifurcations with gate valves for the introduction/withdrawal of liquid, wherein the inside diameter of the first cylinder, the outside diameter of the rod thereof, the inside diameter of the second cylinder, the outside diameter of the rod thereof and the inside diameter of the last cylinder of the assembly are dimensionally related so as to answer precisely and rigorously determined numerical ratios (Figure 4).

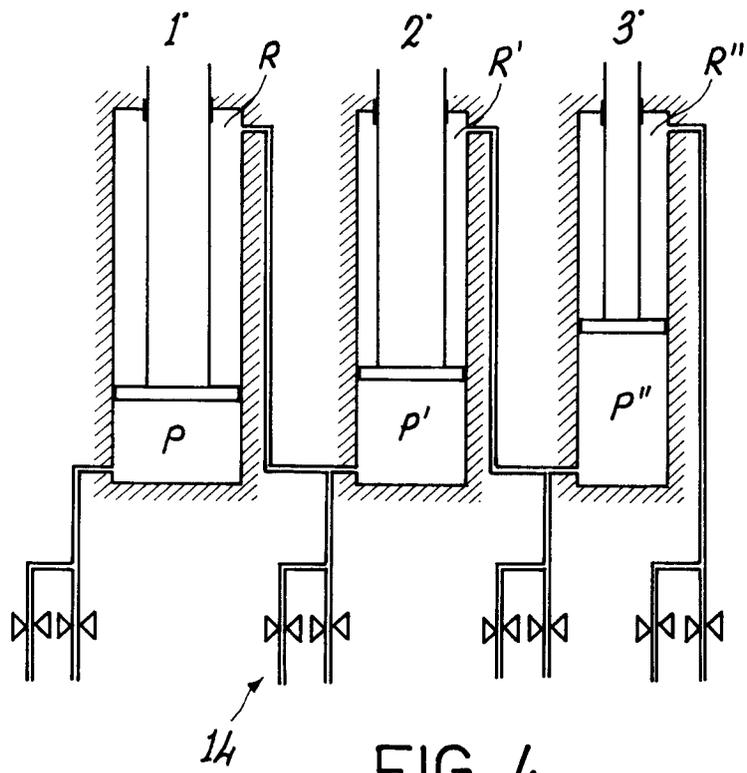


FIG. 4

The present invention generally relates to the assemblies of oil pressure operated cylinders that cooperate to actuate loads, and more particularly it relates to assemblies of oil pressure operated cylinders so structured, as to ensure the synchronism of the forward/return strokes, also in the case of unbalanced loads.

As is known, there are several circumstances in which the actuation of loads is carried into effect by means of assemblies of cooperating oil pressure operated cylinders. In these applications there is the problem of ensuring that the pistons of such oil pressure operated assemblies move by closely related entities, also when the actuated loads are unbalanced, so as to have a correct distribution of stresses.

This problem has been solved till now by resorting to the employment of double-piston cylinders, or to valves or flow control devices, or to systems with two piston pumps and the like. Such solutions have not proved satisfactory because, for instance, the system based upon the employment of double piston cylinders specifically has the drawback of an excessive length and the other systems have a poor precision and/or high costs.

Therefore, in view of the present state of the art, the object of the present invention is specifically to improve the assemblies of two, three or more oil pressure operated actuator cylinders so as to render the forward and return strokes of the respective pistons synchronized with each other, also when subjected to a single oleohydrodynamic pressure source.

For the solution of the problem given in connection with an assembly of two cylinders, the present invention is based upon the principle of utilizing precise and special size ratios among:

- the inside diameter of the first actuator cylinder;
- the outside diameter of the rod of the same, and
- the inside diameter of the second actuator cylinder.

For the solution of the problem given in connection with an assembly of three cylinders, the present invention is analogously based upon the principle of utilizing precise and special size ratios among:

- the inside diameter of the first cylinder;
- the outside diameter of the rod of the same;
- the inside diameter of the second cylinder;
- the outside diameter of the rod of the same second cylinder, and
- the inside diameter of the third cylinder.

In practical terms, the present invention is based upon the principle of an absolutely equal transfer of the oleodynamic fluid from a cylinder to the other and therefore upon a correspondingly rigorously precise sizing of the pressure chambers and of the return chambers of the various cylinders of the assembly.

In an embodiment, therefore, a delivery pipe to the pressure chamber of the first cylinder, a series of transfer pipes from the return chamber of a cylinder to

the pressure chamber of the subsequent cylinder and an exhaust pipe from the return chamber of the last cylinder are provided.

In another embodiment, designed in particular to modify the relative positioning of the pistons in each cylinder, the pipe for the delivery to the pressure chamber of the first cylinder and the exhaust pipe from the return chamber of the last cylinder are bifurcated, and an analogous bifurcation is connected with each transfer pipe from the return chamber of each cylinder to the pressure chamber of the subsequent cylinder. Moreover, a gate valve is provided in each branch of each bifurcation.

Further features and advantages of the present invention will become apparent from the following of the disclosure with reference to the annexed drawings, wherein the preferred embodiments are represented as a matter of illustration and not of restriction.

In the drawings:

figures 1 and 2 show an assembly of two cylinders and an assembly of three cylinders, respectively, without the possibility to modify the relative positioning of the pistons;

figures 3 and 4 show an assembly of two cylinders and an assembly of three cylinders with bifurcated fittings for the modification of the relative positioning of the pistons.

With reference to figures 1 and 2, it is seen that a delivery pipe 10 to the pressure chamber P of the first cylinder and an exhaust pipe 11 from the return chamber R' or R'', respectively, of the last cylinder of the assembly are provided. Between the return chamber R or R', respectively, of each cylinder and the pressure chamber P' and P'', respectively, of each cylinder a transfer pipe 12 and 13, respectively, is provided.

In order to have a synchronized displacement of the pistons of the various cylinders the quantity of fluid that is transferred from a cylinder to the other through said transfer pipes 12 and 13 has to be absolutely the same. This equality of the quantities of fluid is achieved with a suitable volumetric sizing of the pressure P and return R chambers of the various cylinders. As such volumetric sizings depend on the inside diameters of the various cylinders and on the outside diameters of the piston rods, the present invention has specified two series of numbers for the two-cylinder assembly and one series of numbers for the three-cylinder assembly, that establish the ratios among the abovementioned parameters.

In particular, for an assembly of two actuator cylinders, connected according to the scheme of figure 1, the critical parameters whereof are:

- the inside diameter of the first cylinder,
- the outside diameter of the rod of the same and
- the inside diameter of the second cylinder, the size ratios are determined by the following series

of numbers, taken per se or multiplied by any common factor different from zero:

- inside diameter of the first cylinder = 17;
- outside diameter of the rod of the same = 8;
- inside diameter of the second cylinder = 15.

In a practical application, such a series of ratios has taken the actual values of 85-40-75.

Another series of size ratios, represented naturally with numbers, that has proved effective in an assembly of two actuator cylinders, again taken per se or multiplied by a common factor different from zero, is the following:

- inside diameter of the first cylinder = 5;
- outside diameter of the rod of the same = 3;
- inside diameter of the second cylinder = 4.

In a practical application such numbers have taken the actual values of 75-45-60.

As regards the assemblies of three actuator cylinders, connected according to the scheme of figure 2, the critical parameters whereof are:

- the inside diameter of the first cylinder;
- the outside diameter of the rod of the same;
- the inside diameter of the second cylinder;
- the outside diameter of the rod of the same;
- the inside diameter of the third cylinder, the size ratios are determined by the following series of numbers, taken per se or multiplied by any common factor different from zero
- inside diameter of the first cylinder = 17;
- outside diameter of the rod of the same = 8;
- inside diameter of the second cylinder = 15;
- outside diameter of the rod of the same = 9;
- inside diameter of the third cylinder = 12.

In a practical application, such a series of ratios has taken the actual values of 85-40-75-45-60.

The outside diameter of the rod of the second cylinder, in the case of an assembly of two actuator cylinders, and the outside diameter of the rod of the third cylinder, in the case of an assembly of three actuator cylinders, are unimportant in connection with the synchronization of the forward or return strokes of the pistons of the actuators.

The modification of the relative positioning of the pistons in the assemblies of two or three actuator cylinders can be carried out by means of the introduction or the withdrawal of specific hydraulic liquid quantities in the interested cylinders. The schemes to selectively carry out such introductions or withdrawals are reported in figures 3 and 4, respectively, for the assemblies of two or three actuator cylinders. As is seen, such schemes provide bifurcations 14 inserted in the delivery pipe to the pressure chamber P of the first actuator cylinder, in the exhaust pipe of the last actuator cylinder of each assembly, as well as in each transfer pipe from the return chamber R, R' of an actuator cylinder to the pressure chamber P', P'' of each subsequent actuator cylinder in each assembly.

In the two branches of each bifurcation 14 gate

valves are inserted which allow the extraction and the introduction, respectively, of the hydraulic liquid.

It is understood that, once the modification or the adjustment of the relative positions of the pistons has been effected, the actuators will equally maintain the property of moving the pistons synchronously with each other.

In the above preferred embodiments have been disclosed, but it is to be expressly understood that variations and modifications, as well as adaptations to a number of cylinders different from the exemplified ones, can be made by those skilled in the art, without so departing from the scope of the protection of the present invention.

Claims

1. An assembly of oil pressure operated actuator cylinders with synchronized piston forward/return strokes, having a delivery pipe to the pressure chamber of the first cylinder and an exhaust pipe from the return chamber of the last cylinder of the assembly, as well as a transfer pipe from the return chamber of each cylinder to the pressure chamber of the subsequent cylinder, **characterized in that** in a two-cylinder assembly, the inside diameter of the first cylinder, the outside diameter of the rod of the same and the inside diameter of the second cylinder are dimensionally related so as to answer the following ratios:
 - inside diameter of the first cylinder = 17;
 - outside diameter of the rod of the same = 8;
 - inside diameter of the second cylinder = 15, such ratios being taken per se or multiplied by any common factor different from zero.
2. The assembly of actuator cylinders according to Claim 1, characterized in that such ratios take the following specific values: 85-40-75.
3. An assembly of oil pressure operated actuator cylinders with synchronized piston forward/return strokes having a delivery pipe to the pressure chamber of the first cylinder and an exhaust pipe from the return chamber of the last cylinder of the assembly, as well as a transfer pipe from the return chamber of each cylinder to the pressure chamber of the subsequent cylinder, **characterized in that**, in an assembly of two cylinders, the inside diameter of the first cylinder, the outside diameter of the rod of the same and the inside diameter of the second cylinder are dimensionally related so as to answer the following ratios:
 - inside diameter of the first cylinder = 5;
 - outside diameter of the rod of the same = 3;
 - inside diameter of the second cylinder = 4,

such ratios being taken per se or multiplied by any common factor different from zero.

4. The assembly of actuator cylinders according to Claim 3, characterized in that such ratios take the following specific values: 75-45-60. 5
5. An assembly of oil pressure operated cylinders with synchronized piston forward/return strokes having a delivery pipe to the pressure chamber of the first cylinder and an exhaust pipe from the return chamber of the last cylinder of the assembly, as well as transfer pipes from the return chamber of each cylinder to the pressure chamber of the subsequent cylinder, **characterized in that**, in an assembly of three cylinders, the inside diameter of the first cylinder, the outside diameter of the rod of the same, the inside diameter of the second cylinder, the outside diameter of the rod of the same and the inside diameter of the third cylinder are dimensionally related so as to answer the following ratios: 10
 15
 20
 25
 30
 – inside diameter of the first cylinder = 17;
 – outside diameter of the rod of the same = 8;
 – inside diameter of the second cylinder = 15;
 – outside diameter of the rod of the same = 9;
 – inside diameter of the third cylinder = 12,
 such ratios being taken per se or multiplied by any common factor different from zero.
6. The assembly of actuator cylinders according to Claim 5, characterized in that such ratios take the following specific values: 85-40-75-45-60.
7. The assembly of actuator cylinders according to Claims 1, 3 and 5, characterized in that, for the modification or the adjustment of the relative positions of the pistons by means of the introduction/withdrawal of liquid, the delivery pipe to the pressure chamber of the first cylinder and the exhaust pipe from the return chamber of the last cylinder of the assembly are bifurcated, and an analogous bifurcation is inserted in each transfer pipe from the return chamber of each cylinder and, moreover, a gate chamber of the subsequent cylinder and, moreover, a gate valve is inserted in each branch of each bifurcation. 35
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8. The improvement to oil pressure operated actuator cylinder assemblies having the piston forward/return strokes synchronized also under unbalanced loads according to anyone of the preceding claims and substantially as depicted and disclosed. 50
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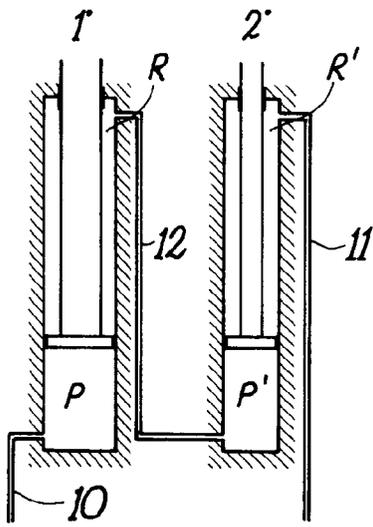


FIG. 1

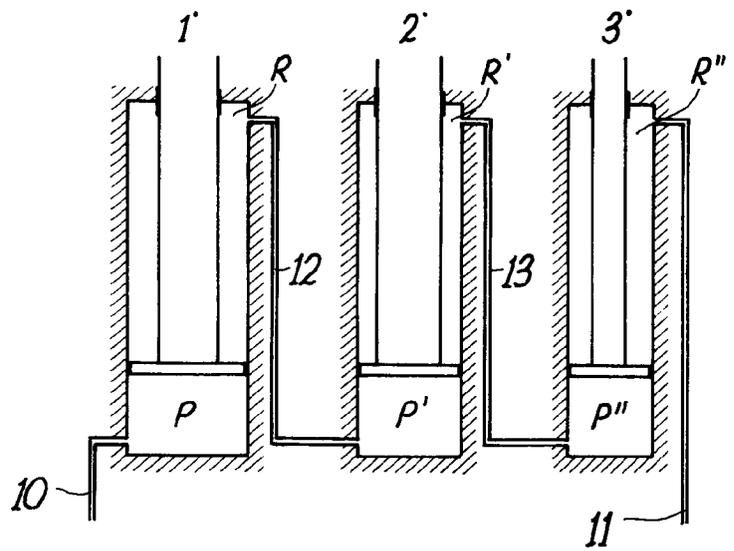


FIG. 2

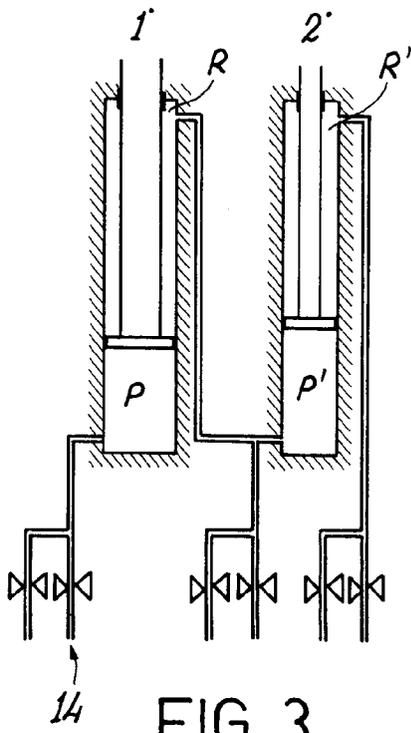


FIG. 3

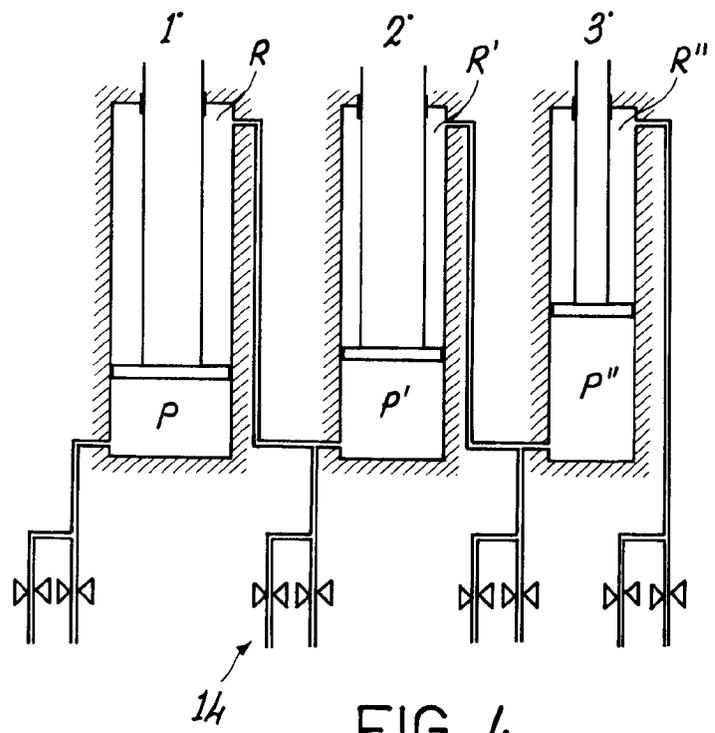


FIG. 4



European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 83 0033

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.5)
X	FR-A-2 102 362 (STUBBE) * the whole document * ---	1-8	F15B11/22
A	FR-A-2 372 115 (KEMPF) ---		
A	FR-A-1 480 130 (ELECTRICITE DE FRANCE) -----		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			F15B
Place of search	Date of completion of the search	Examiner	
THE HAGUE	04 MAY 1992	KNOPS J.	
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