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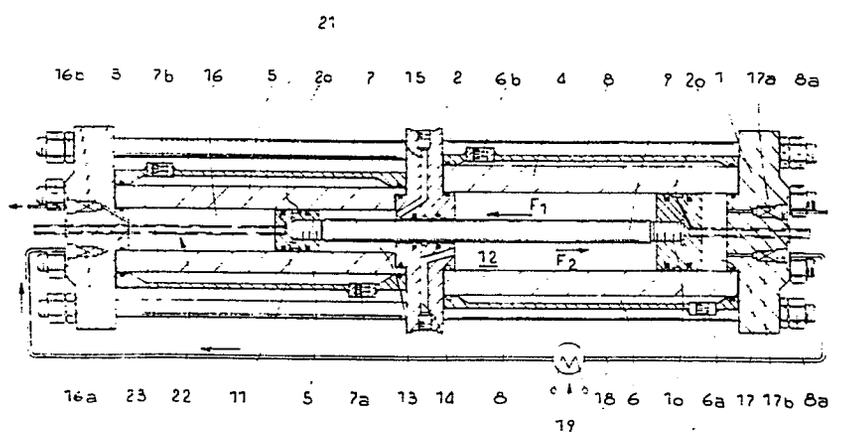
(54) **A reciprocating, hydraulically operated, positive displacement compressor.**

(57) The compressor has three coaxial heads, 1, 2 and 3, in between which and coaxial therewith are stably interposed two liners, 4 and 5.

Inside each of the said liners slides impermeably a piston, 10 and 11, the two pistons being connected one to the other through a rod 9 that slides guided by the central head 2. The two chambers 12 and 13 through which the rod passes, terminate at oil hydraulic control means destined for the operation of the assembly constituted by the rod 9 and the pistons 10 and 11.

The remaining two chambers, 17 and 16, each define a compression stage.

With the compressor in question there is practically no buckling stress on the rod 9 and, furthermore, the number of heads, 1, 2 and 3, liners, 4 and 5, and pistons, 10 and 11, is less than in similar known compressors that are operated hydraulically and are of the same capacity and compression ratio.



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A reciprocating, hydraulically operated, positive displacement compressor

The compressor is of the type that incorporates two compression stages of identical compression ratio (twin single stage compression) or two cascaded compression stages (two stage compression).

Hydraulically operated compressors are already known that are constituted by four coaxial heads in between which are stably interposed in succession three coaxial liners.

In the centre liner slides impermeably the plunger of a hydraulic double acting jack provided with two rods that slide impermeably in the two heads that delimitate the chambers of the said jack. Via a traditional coupling of either the rigid or the floating type, the extremities of the said rod are connected to two pumping pistons that slide impermeably in the two liners positioned bilaterally with respect to the liner in which the aforementioned plunger slides. Together with the liners concerned, the said pistons define two compression stages.

In one direction, the stroke of the plunger causes intake in one stage and compression in the other stage; in the opposite direction, instead, the reverse occurs.

If one stops to consider what happens to a rod of the jack, it is obvious that the said rod is subjected to tensile stress during the intake stroke on the part of the pumping piston concerned, and to compression stress during the compression stroke on the part of the said pumping piston, which causes, on the rod, the stress resulting from axial loading compression known as "buckling stress", along with all the problems derived there from.

In cases when the connection of the rod to the pumping piston is of the floating type, the extremity of the rod goes and "knocks", at each compression stroke, against the relevant head of the said piston, which causes dangerous denting in the said head.

The object of the invention is to make available a hydraulically operated, positive displacement, reciprocating compressor whose conformation is such as to limit, if not render nil, the buckling stress on the rods that control the pumping pistons, as well as to present, with respect to those known of the same capacity and compression ratio, a lesser number of heads, liners and pistons.

The characteristics of the invention are emphasized in the text that follows, with reference to the one accompanying figure wherein a longitudinal section view of the compressor in question is depicted.

With reference to the said figure, at 1, 2 and 3 have been shown, one coaxial with the other, a first, a second and a third head, respectively; in between the said heads, a first liner 4 and a second liner 5, one coaxial with the other, are stably interposed in succession, the inside diameter of the former being greater than that of the latter. The locking one to the other of the heads and the liners is achieved in a manner in itself known: for example through a plurality of tie rods 8 that tighten, with the aid of suitable nuts 8a, the external heads 1 and 3 on to the corresponding extremities of the liners 4 and 5.

A first piston 10 and a second piston 11 slide impermeably inside the liners 4 and 5, respectively. The said pistons being connected one to the other, in accordance with known systems, through a rod 9 that slides impermeably in

an axial through housing provided in the second head 2.

Along with the corresponding liner 4, the piston 10 defines two chambers, 17 and 12, the latter being the one through which the rod 9 passes. The piston 11, jointly with the corresponding liner 5, defines two chambers, 16 and 13, the latter being the one through which the rod 9 passes.

The chambers 12 and 13 communicate with corresponding ducts, 14 and 15, provided in the head 2 and terminating at hydraulic control means (not illustrated) destined to send oil under pressure alternately into the chamber 12 and into the chamber 13.

The chamber 17 (or first compression stage of the compressor) communicates with the outside via an intake valve 17a provided in the head 1. The said head is also provided with a delivery valve 17b which, through a duct 18 (on which a device 19 exerts an action for cooling the compressed gas), terminates at the intake valve 16a (of the chamber 16) provided in the head 3. In the latter there is also a delivery valve 16b of the said chamber 16.

The cooling of the liners 4 and 5 is achieved in a way in itself known with provision being made for the said liners to have hollow spaces, 6 and 7, which, via the orifices 6a, 7a and 7b, terminate at a circuit (not illustrated since of a known type) for circulating water.

The admission of oil under pressure into the chamber 13 causes the translation in the direction F_1 of the assembly constituted by the rod 9 and the pistons 11 and 10 : this causes the compression stroke for the chamber 16 (the second compression stage of the compressor) and the intake stroke for the chamber 17.

The reversal in the motion of the said assembly (achieved in accordance with known systems that are not illustrated) occurs when pressurized oil ceased to be inserted into the chamber 13 and pressurized oil is admitted into the chamber 12. In the said situation, the aforementioned assembly moves in the direction F_2 realizing the compression stroke for the chamber 17 and the intake stroke for the chamber 16. It should be noted, in this connection, that the displacement of the said assembly in the direction F_2 is rendered easier by the gas which, via the valve 16a, goes into the chamber 16 (subjected to the intake stroke). The said gas is, in fact, under pressure since it is coming from the chamber 12 in which the compression stroke is in progress.

Since the pressurized oil acts directly on the pistons 10 and 11, it thus ensues that the rod 9 is not subjected to buckling stress, other than to a minimum extent because of the thrust exerted on the piston 11 by the pressurized gas at the time the intake stroke is taking place in the chamber 16. Furthermore, tensile stress is also negligible for the said rod, and this extremely advantageous from the rod dimensioning point of view.

Each of the said pistons defines two chambers, one of which contains the oil and the other, the gas. The sealing of the said piston with respect to the corresponding liner is achieved in a manner in itself known.

In order to avoid the blow-by of oil from the chamber concerned towards the one that contains the gas, or vice versa in order to prevent the blow-by of gas from the latter towards the chamber that contains the oil, all that need be done is to provide the said piston with an external annular groove 20 which, via a duct 21 in the body of

the said piston, is placed in communication with the outside of the compressor through a longitudinal canal 23 made in a rod 22. The said rod 22 is secured, in a way in itself known, to the front of the said piston, that is to say, the opposite extremity to that facing the rod 9, and it slides guided, in an axial direction, by a corresponding through housing provided centrally in the head opposite the aforementioned front of the piston.

The solution that has just been described, in addition to discharging externally (that is to say, "purging", to use the jargon adopted by technicians in the field) the oil or the gas that has gone past the corresponding gaskets, furnishes the user with an indication of any gasket whose sealing function is not being properly carried out; in other words, should gas be escaping it means that the gas sealing gasket is giving trouble and, likewise, if oil is leaking, that the oil sealing gasket is not functioning properly.

In the description given herein, it is supposed that the inside diameter of the liner 4 is greater than that of the liner 5 whereby it is possible to create a two-stage compressor with the two compression stages cascaded. If, instead, a compressor with two identical compression stages (namely stages of the same compression ratio and of the same volumetric capacity) is wanted, it is sufficient to render identical the inside diameters of the liners 4 and 5 : in such cases, no buckling stress at all is applied to the rod 9.

The conformation of the compressor is such as to render it reversible; this means that instead of sending oil under pressure into the chambers 13 and 12 and of utilizing the chambers 17 and 16 as compression stages, it is

alternatively possible to send oil under pressure into the chambers 17 and 16 and to utilize the chambers 12 and 13 as compression stages : obviously with this latter mentioned solution, the ducts 14 and 15 would need to be provided in the heads 1 and 3, respectively, while the intake valves 17a-16a and the delivery valves 17b-16b would need to be provided in the head 2.

The breather rods 22 also have the task of equalizing, for two-stage compression, whenever oil is sent into the chambers 16 and 17, the thrust areas of the oil on the pistons 10 and 11, and this can be achieved by adjusting the diameters of the two rods 22 so as to compensate for the differences in the diameters of the liners 5 and 4.

The compressor, additionally to the above mentioned advantage (namely that buckling stress on the rod 9 is practically inexistent), offers other advantages in consequence of the limited axial development and the reduced number of component parts compared with the compressors known to date of obviously the same compression ratio and volumetric capacity.

In fact, the compressor only employs three heads, two liners and two pistons, in place of the four heads, three liners and three pistons provided in the known compressors.

Another advantage results from the fact that there is no need to provide circuits for lubricating the surfaces of the chambers 16 and 17 since for this the film of oil that remains on the said surfaces when the relevant pistons translate in the directions that define the intake strokes in the said chambers is sufficient.

It is understood that the foregoing description has been

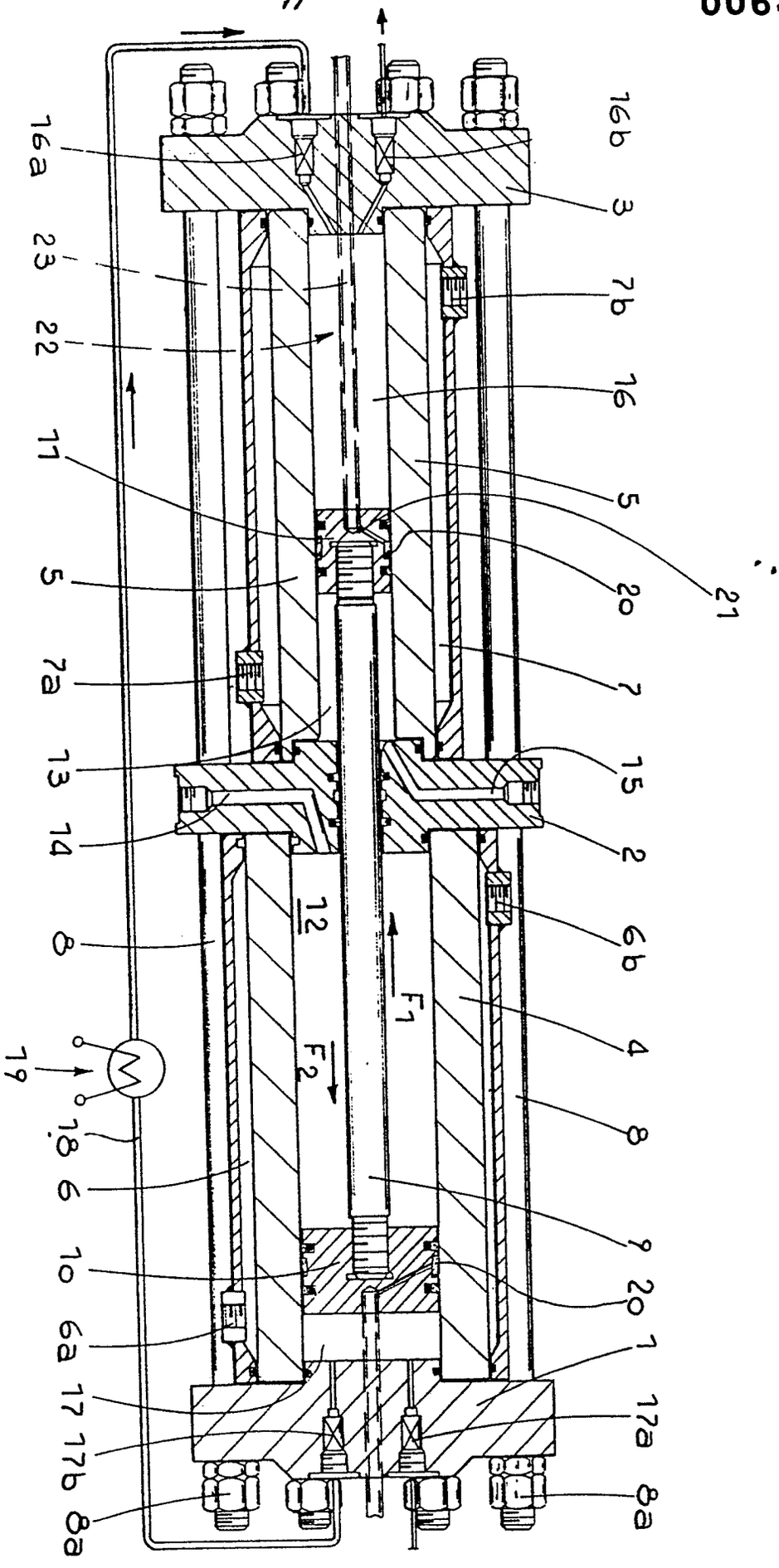
given purely as an unlimited example and thus that possible variants of a practical nature to the constructional details can be taken as all falling within the technical solution as described above and claimed hereinafter.

Claims:

1. A reciprocating, hydraulically operated, positive displacement compressor, characterized by the fact that it comprises : three coaxial heads, 1, 2 and 3, namely a first, a second and a third head in between which are stably interposed in succession two liners, 4 and 5, coaxial one with the other, namely a first and a second liner; a first piston 10 that slides impermeably inside the first liner 4; a second piston 11 that slides impermeably inside the second liner 5; a rod 9 that connects the said pistons 10 and 11 and slides impermeably,guided in a through housing provided in the second head 2; ducts, 14 and 15, provided in one or more heads and connecting two chambers adjacent or opposite among the four chambers, 12, 13, 16 and 17, defined by the said pistons 10 and 11 together with the corresponding liners 4 and 5, with hydraulic means for controlling the operation of the assembly constituted by the rod 9 and the pistons 10 and 11; and gas intake and delivery valves 16a-17a and 16b-17b provided in one or more heads, that connect the remaining two chambers with sources and users of gas, respectively.

2. A compressor according to the previous claim, wherein for each piston it is envisaged that there be a rod 22 connected to the piston concerned at the opposite extremity to that facing the rod 9, that slides impermeably, guided by a through housing provided in the head opposite the said connection extremity of the piston, the said rod 22 having in it a longitudinal through hole 23 that communicates, on one side, with the outside, and on the other, with a duct 21 in the body of the said piston which, in turn, communicates with an annular groove 20 made in the sliding surface of the piston with the relevant liner.

3. A compressor according to Claim 2, wherein there is a difference in the diameters of the liners 4 and 5, and characterized by the fact that the said two rods 22 are each of a diameter such as to define identical thrust surfaces in the corresponding faces of the pistons 10 and 11.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EUROPEAN SEARCH REPORT

Application number
EP 82 83 0099

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. ³)
Y	DE-A-2 161 459 (SLIFER) *Page 3, line 11 to page 6, line 14* & GB - A - 1 307 963	1,2	F 04 B 9/10 F 04 B 25/00
Y	GB-A- 165 253 (BARNER) *Page 3, line 64 to page 4, line 80*	1,3	
A	US-A-2 411 020 (BLASUTTA) *Column 3, line 66 to column 4, line 16*	2	
A	US-A-3 162 133 (SMITH)		
A	FR-A- 796 685 (AUBERT)		

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

F 04 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	03-08-1982	BAATH C.

CATEGORY OF CITED DOCUMENTS

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