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HYDROPNEUMATICALLY CONTROLLED SERVOMOTOR

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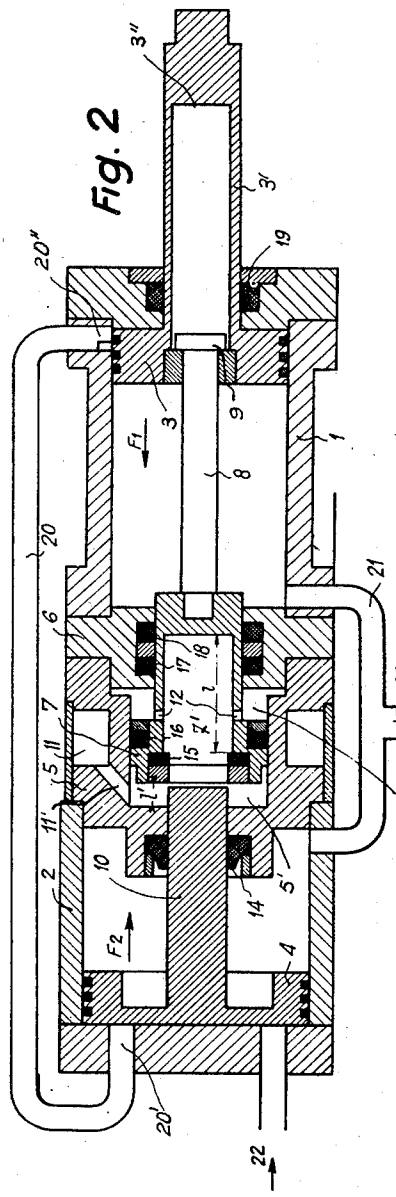


Fig. 2

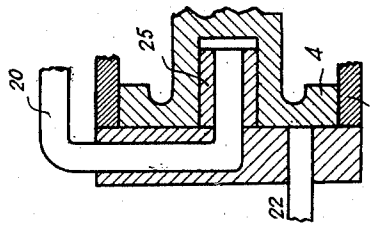


Fig. 4

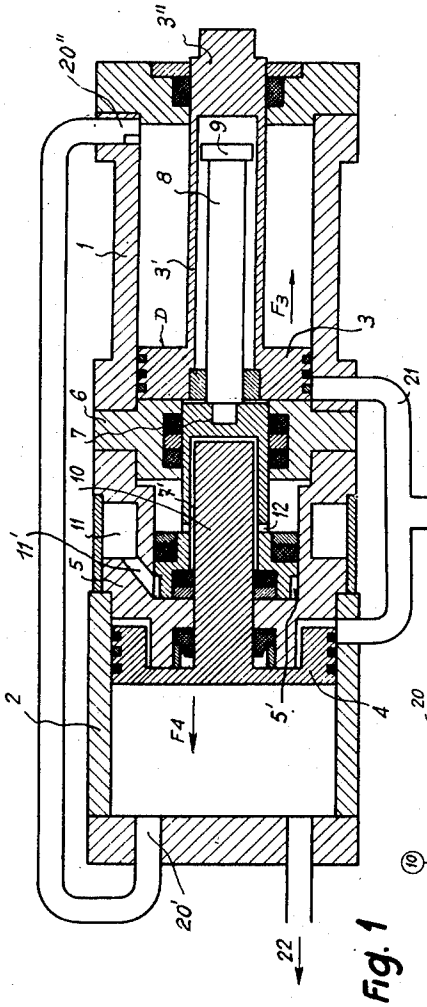


Fig. 3

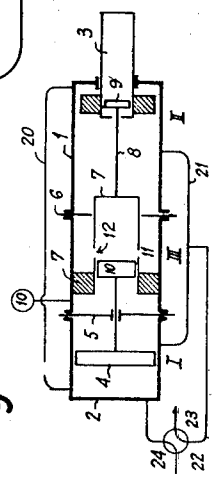


Fig. 1

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HYDROPNEUMATICALLY CONTROLLED SERVOMOTOR

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6 Claims. (Cl. 60—97)

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The invention relates to servo-motors actuated by fluid pressure, of the reciprocating type, and it concerns more particularly an improved servo-motor normally actuated by pneumatic means during the major portion of the cycle of operation, hydraulic actuating means coming into action during a minor portion of this cycle of operation to provide additional power.

The object of the invention is to provide an improved apparatus adapted to perform, with a minimum expenditure of power, an operation which, at a certain stage, presents a higher resistance than that offered during the other stages of the operation, by bringing into action an additional source of power enabling this higher resistance to be overcome, the rest of the operation being performed with more moderate power, thereby realising an economy of power.

As an example, the operation of casting aluminium alloys and other alloys in permanent chilled moulds can be mentioned. This operation calls for a considerable force to separate the movable parts from the fixed parts of the mould, owing to the shrinking of the metal, whereas the further stages of the operation, which only require the displacement of the disengaged movable parts of the mould, require but little power. This is but one particular example among the many applications of the invention, and it will be selected as an illustration to explain it.

The invention has for its object, particularly, to provide servo-motor operated by pneumatic means during the stages of the operation which do not call for an exceptional supply of power, in combination with hydraulic means which automatically bring into play a supplementary source of power at the stage of the operation which requires additional power, for example, in the application mentioned above, for the purpose of extracting the movable parts of the moulds.

Referring to the drawing, which illustrates, by way of example only, a preferred arrangement of the apparatus according to the invention:

Fig. 1 is a diagram showing the disposition of the several devices the combination of which constitutes the invention.

Figs. 2 and 3 are cross-sectional views of the apparatus in two different positions, with the pistons at the ends of the working and of the idle stroke, respectively.

Fig. 4 is a fragmentary cross sectional view of a modification adapted to introduce a time lag in the coming into action of the hydraulic means.

In its simplest form, the apparatus consists of two co-axial pneumatic cylinders 1 (at the front,

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that is, towards the mechanism to be actuated) and 2 (at the back), in which reciprocate two pistons 3 and 4, respectively; these two cylinders are separated by a third co-axial cylinder disposed between the bottom of cylinder 1 and the head of cylinder 2, fulfilling the function of a hydraulic cylinder. In the figures, the head 5 of the cylinder 2 is extended forward and bored to constitute the third cylinder, 5', in which is adapted to reciprocate a third piston 7 which it itself hollow and adapted to receive a plunger 10 integral with the piston 4 and guided by the head 5 of the cylinder 2, through which it passes, so that it acts also as a piston rod in connection with the piston 4 with which it constitutes a differential piston, of which this plunger is the portion of lesser diameter.

In the body of the head 5 is provided a circular chamber 11, surrounding the said third cylinder with the interior of which it communicates by a passage 11' when the piston 4 is in the position shown in Fig. 2, with the plunger 10 almost entirely withdrawn from the cylinder 5'. Means (not shown) enable a liquid to be introduced in the chamber 11, whence, when the piston 4 and the plunger 10 are in the position just referred to, this liquid flows along the passages 11' into the space 7' inside the hollow piston 7 and thence, through orifices 12 in the wall of the latter, into an annular space 13 behind the body, of larger diameter, of the piston 7; this in-flow of liquid is however cut off as soon as the piston 4, beginning its forward stroke, pushes the plunger 10 through the neck of the open end of the space 7', effectually closing the latter.

It will be seen that the differential piston 4—10 constitutes an amplifier for the fluid pressure exerted on the back face of the piston 4 by fluid (here a gaseous fluid) entering at 22, this pressure being transmitted by the plunger 10 and magnified in the ratio of the area of the piston 4 to the area of the plunger 10, so that the liquid in the chamber 13 is subjected to a relatively considerable pressure which is applied on the face of the piston 7, pushing it away from the piston 3, that is, in the same direction as the motion of the piston 3 when it performs its power stroke under the action of gaseous fluid introduced in the cylinder 1 by the conduit 20.

The piston 3 is provided with a piston rod 3' which is hollow and adapted to receive a rod 8 fixed on the piston 7 and provided with a stop 9 so disposed that, as the piston 3 nears the end of its forward stroke, this stop butts against a nut or like member 3'' on the piston 3 with the

result that the piston 7 is pulled forward, uncovering the passages 11', ready for the next power stroke.

Various packings 14, 15, 16, 17, 18 and 19 ensure the fluid-tightness of the several sliding contacts.

A conduit 20 between ports provided at the outer ends of the cylinders 1 and 2 puts these two cylinders in permanent communication; another conduit 21 between ports provided at the inner ends of these two cylinders puts them likewise in permanent communication; a pipe 22 opening in the cylinder 2 at its outer end either admits a compressed gaseous fluid in this cylinder or is open to exhaust and another pipe 23 opening in the conduit 21 either admits a compressed gaseous fluid in both the cylinders 1 and 2 or opens these two cylinders to exhaust. A suitable distributor 24 (Fig. 1) opens these pipes 22 and 23 alternatively to admission or to exhaust, one being open to admission while the other one is open to exhaust, and reciprocally.

In operation the various parts being in the position shown in Fig. 2, with the servo-motor at the end of its forward stroke (that is, the stroke towards the mechanism to be actuated), the complete operation is performed on the double acting principle, in four stages, as follows:

First stage.—A gaseous fluid under pressure is introduced in the cylinder 2 by the pipe 22, the piston 4 begins to move, uncovering the port 20', thereby enabling the fluid to proceed by the conduit 20 till the port 20'', blocked by the piston 3; the plunger 10 enters the space 7' and compresses the fluid in the spaces 7' and 13, the piston 7 begins to move in the opposite direction to that of the plunger, and pulls the piston 3 which uncovers the port 20'' slightly, enabling the fluid to enter the cylinder; the motion proceeds under the combined action of both pistons 3 and 7, exerting their maximum power. This stage corresponds, for example, to the beginning of the withdrawal of the moulds, as explained above.

Second stage.—When the piston 7 reaches the end of its power stroke, the piston 3 continues to move alone under pneumatic pressure only till it reaches the end of the cylinder; meanwhile, any fluid behind this piston escapes to exhaust by the passages 21 and 23; similarly, any fluid in front of the piston 4 passes through these passages to exhaust. This stage corresponds to the further disengagement of the movable parts of the chilled moulds, enabling the castings to be removed from the moulds.

Third stage.—The passage 22 is open to exhaust while 23 is open to admission: the two pistons 3 and 4 move in opposite directions towards the outer ends of their respective cylinders; the piston 3 drives the fluid in front of it by the conduit 20, the cylinder 2 and the pipe 22. The hydraulic cylinder is, of course, idle (Fig. 3).

Fourth stage.—Near the end of its stroke, the piston 3 engages the stop 9 on the rod 8, thereby pulling the piston 7 forward, back to the position shown in Fig. 2; liquid is again admitted in the spaces 7' and 13, to make up for any seepage; the reaction of the piston 7 provides a braking action and prevents a shock at the moment when the moulds are closed for a new casting operation.

The action of the hydraulic part of the machine may take place during the whole power stroke of the piston 3 or only during a portion of this stroke. The moments when this action begins and ceases may also be varied: they depend on the position of the stop 9 on the rod 8 and of the apertures 12 in the wall of the piston 7 or on the length of the plunger 10.

In the embodiment described above, it is seen that, at the beginning of the stroke of the piston 4 in the forward direction, the conduit 20 becomes open to pneumatic pressure; it may be useful to introduce a time lag between these two operations, so that the opening of the passage 20 to admission only takes place after the piston 4 has performed a certain displacement. To obtain this result, the bottom of the cylinder 2 is provided with a hollow boss 25 (Fig. 4) which enters in a corresponding recess in the piston 4 and the conduit 20 is made to open inside the hollow boss, so that it is only when the displacement of the piston 4 is sufficiently pronounced to uncover the opening of this conduit 20 in the hollow boss, that the gaseous fluid under pressure can enter this passage 20.

The hydraulic part of the machine being independent of the pneumatic part, it is possible to obtain different combinations of displacements and of the power of one or the other arrangement. For example, one may provide fluid cylinders the stroke of which is longer or shorter or one may mount on one of the pneumatic cylinders different kinds of fluid-pressure amplifiers, with variable strokes.

The distributor 24 shown in Fig. 1 is intended for manual operation. Any other equivalent arrangement could of course be employed for the same purpose.

Instead of the first stage of operations being performed under the joint action of the pneumatic piston 3 and of the hydraulic piston, it can be performed under the action of the hydraulic piston alone, the port 20'' remaining closed to admission until the operation can be pursued with pneumatic power only.

In the embodiment, the two pneumatic pistons move in opposite directions; the apparatus may however be designed so that they move in the same direction.

What we claim is:

1. In a servo-motor of the type described, three coaxial fluid-pressure cylinders, namely, a first cylinder, means for admitting a compressed gaseous fluid to the said first cylinder, a piston in the said first cylinder, a piston rod, integral with the said piston, connected mechanically to the mechanism to be actuated, a second cylinder, means for admitting a compressed gaseous fluid to this second cylinder, a differential piston in the said second cylinder, comprising two piston elements of different diameters and constituting a fluid-pressure magnifying device, a third cylinder, a piston in this third cylinder, means for admitting a liquid in this third cylinder, means for transmitting the fluid pressure on the piston in the second cylinder, magnified by the said fluid-pressure magnifying device, to the piston in the said third cylinder, in the same direction as the power stroke of the first cylinder and means for temporarily connecting positively the pistons in the first and in the third cylinder during the stage of the operation which requires additional power for its performance.

2. In a servo-motor of the type described, three co-axial fluid-pressure cylinders, namely, a first cylinder, a piston in this first cylinder, means for admitting a gaseous fluid under pressure in the said first cylinder, on either side of the said piston, alternately, a piston rod, integral with the said piston, connected mechanically to the mechanism to be actuated, a second cylinder, a

piston in this second cylinder, means for admitting a gaseous fluid under pressure to the said second cylinder, on either side of the piston in this second cylinder, alternately, a plunger of lesser diameter than the latter said piston, constituting, together with the latter said piston, a fluid-pressure magnifying device, a third cylinder, a piston in this third cylinder bored cylindrically along a portion of its length to such a diameter as to just receive the said plunger, the assembly of second cylinder, piston in this second cylinder, plunger and bored piston in the third cylinder constituting a fluid-pressure magnifying device, means for admitting a liquid to the said third cylinder and to the said bored piston, means for transmitting the fluid pressure on the piston in the second cylinder to the liquid in the third cylinder, against the piston in the said third cylinder, in the direction of the power stroke of the first cylinder and means for temporarily connecting positively the pistons in the first and in the third cylinder during the stage of the operation which requires additional power for its performance.

3. The servo-motor defined in claim 2, in which the space inside the bored piston in the third cylinder communicates by orfices in the wall of this bored piston with the space in the front part of the third cylinder, both spaces being cut off from the means for admitting the liquid in the third cylinder by the plunger when it enters into the first aforementioned space.

4. The servo-motor defined in claim 2, in which the mechanical means temporarily connecting the first and the third piston comprise a rod fixed on the said third piston, on the side thereof towards the first cylinder, a stop on the said rod and means for engaging said stop with the first piston, positively, during the stage which requires additional power for its performance.

5. The servo-motor defined in claim 2, in which the means for the admission of a compressed gaseous fluid against the pistons in the first and the second cylinders comprises a conduit having connecting ports opening into the said cylinders at the outer ends thereof and putting them in communication at the beginning of their working stroke, and a pipe opening into the second cylinder, at the back thereof, adapted to be connected to a source of compressed gaseous fluid, and the

means for the admission of a compressed gaseous fluid in the same cylinders at the beginning of the back or return strokes of the pistons in these two cylinders, respectively, comprises a conduit adapted to be connected to a source of compressed gaseous fluid, connecting ports opening into the said two cylinders at the inner ends thereof, said means for the admission of a compressed gaseous fluid at the beginning of a working stroke and of a back or return stroke, respectively, serving also, alternatively, for the exhaust of the used gaseous fluid, each of said two conduits serving for the admission while the other conduit is open to exhaust.

6. The servo-motor defined in claim 2, in combination with means for delaying the beginning of the power stroke of the first piston with respect to the beginning of the power stroke of the second piston, said means comprising a conduit putting in communication the outer or front end of the first cylinder and the inside of a hollow boss provided on the bottom of the second cylinder, internally thereof, said boss being adapted to fit in a recess in the piston in the second cylinder when this piston is at the end of its back or return stroke and to be uncovered by the said piston thereby opening the admission to the first cylinder, when the said piston has moved a predetermined distance.

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