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X-RAY APPARATUS

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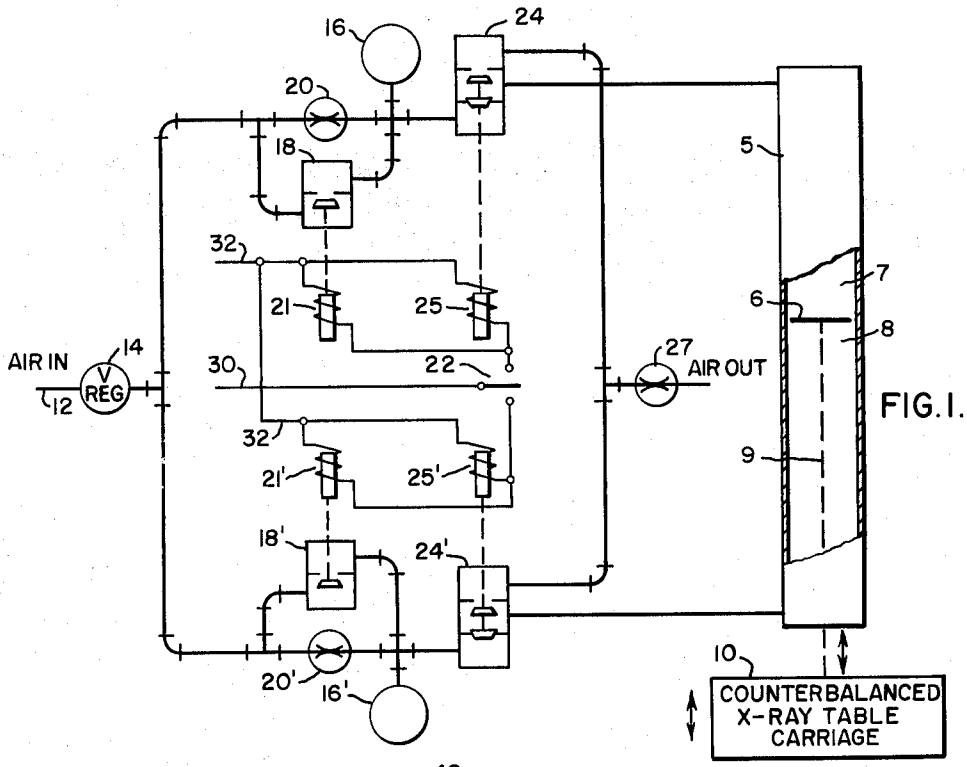


FIG. 1.

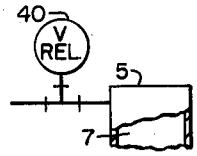


FIG. 2.

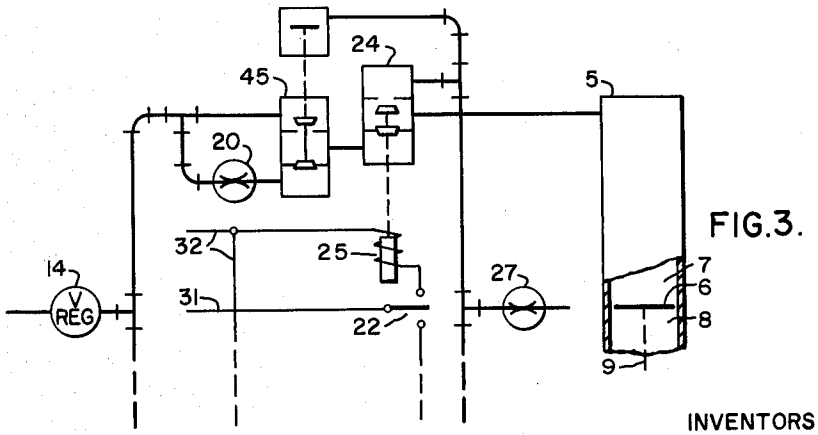


FIG. 3.

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1

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X-RAY APPARATUS

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The present invention relates to X-ray apparatus, and more particularly to a fluid pressure actuator system for actuating counterbalanced X-ray table carriages.

Power actuation of counterbalanced X-ray carriages represents a relatively high-inertia low-friction load. For example, the usual counterbalanced cross-carriage, which moves transversely of the table, when moved includes the inertia load of such cross-carriage, the spotfilm tower which such cross-carriage supports, the spotfilm device carried by the tower, as well as the counterweight carried by the tower, a total inertia load of about two-hundred fifty pounds, or by way of further example, the spotfilm carriage, which moves perpendicularly of the X-ray table top, when moved includes the inertia load of such spotfilm carriage, the spotfilm device supported by the spotfilm carriage, and the spotfilm counterweight supported on the spotfilm carriage, a total weight of about one-hundred fifty pounds. Power actuation of these loads, heretofore has been done by electric motors, which has been suitable but less than highly desirable in the need for a variety of kinematic trappings required to establish an effective operative connection between the high-speed rotary output of such motors with the relatively-slow linearly moved carriages, in addition to the need for somewhat complex devices and techniques for controlling acceleration, deceleration, and coasting of the carriages. The total mechanism for such electric motor drive inherently tends to be complex, heavy, and noisy in operation.

In view of the foregoing remarks, it has become a prime object of the present invention to provide a power actuating system for counterbalanced X-ray table carriages which is highly effective, relatively simple, light-weight and quiet in operation.

In accordance with general features of the invention, the actuating system of the present invention comprises: a double-acting cylinder means including the usual reciprocable piston in operative connection with the counterbalanced X-ray table carriage; a source of fluid under pressure; and means operable to effect an initial rapid supply of fluid under pressure from such fluid pressure source to one end of the cylinder for a brief initial period of time to start movement of the X-ray carriage, and operable automatically to restrict continued supply of fluid under pressure to such end of the cylinder following such brief period of time.

Other objects, features, and advantages of the invention will become apparent from the following detailed description, when taken in connection with the accompanying drawings, in which:

FIGURE 1 is schematic representation of an illustrative embodiment of the invention;

FIG. 2 is a modification of the system of FIG. 1; and

FIG. 3 is an alternate embodiment of the invention.

Referring to FIG. 1, the system of the present invention comprises a double-acting cylinder device 5 having

2

a reciprocable piston 6 subject opposingly to pressure of fluid in pressure chambers 7 and 8 at its opposite sides and attached to a piston rod 9 which is operatively connected to a counterbalanced X-ray table carriage 10, indicated in block diagram form in behalf of simplifying description of the invention. By establishing a preponderance in presssure in one or the other of chambers 7 and 8 selectively the piston 6 will move accordingly to actuate the carriage 10 in a respective direction. A compressed-air supply line 12 and regulating valve device 14 constitutes a source of fluid under pressure. The means for effecting initial rapid supply and subsequent restricted supply to one end of the cylinder, to chamber 7 for example, includes: a compressed-air storage volume means 16; a normally-open on-off valve 18 connected in parallel with a choke 20 and operated by a solenoid 21 controlled by an operator's selector switch 22, to control rapid charging of the storage volume means 16; and a selector valve 24 operated by a solenoid 25 also under control of the operator's selector switch 22, to selectively establish communication of the cylinder chamber 7 with chamber 8 and a normally-open restricted release communication including a choke 27, or with the choke 20 and the storage volume means 16.

The chamber 8 is provided with counterpart components which are given the same reference numbers distinguished with a prime mark, with the exception of the operator's selector valve 22 and the release choke 27, which are shared in common in control of cylinder operation in the two directions.

In operation of the system of FIG. 1, actuation of the operator's selector switch 22 upwardly as viewed in the drawing will complete an energizing circuit from electrical source lines 30 and 32 through solenoid coils 21 and 25 to close the normally-open on-off valve 18 and actuate the selector valve 24 to close cylinder chamber 7 to the release choke 27 and open such chamber to the compressed-air storage volume means 16 and to the choke 20, whereupon compressed-air stored in such storage volume means at the pressure of the regulating valve 14 will flow rapidly into cylinder chamber 7 via the valve 24 to cause the piston 6 to initiate movement of the X-ray carriage 10. This will occur rapidly, and, in the case of pneumatic operation, as exemplified herein, can occur at a rate which will vary according to the initial position of the piston 6, since such position determines the size of the chamber 7 at the instant of such introduction of compressed air, which in turn determines the initial equalization pressure exerted against the piston when compressed air from volume means 16 rapidly expands into such cylinder chamber, hence affecting the rate of initiating piston movement. The effect tends to be self-compensating from the point of view that the greater equalization pressures exist at the smaller volumes of chamber 7 which results in more rapid initial acceleration where the piston 6 has the greater potential travel distance. The pressure equalization effect could be made the same for all positions of piston 6, however, by designing the storage volume means 16 to give the desired equalization pressure at maximum, end-of-stroke, volume of chamber 7, and bleeding off excess air pressure at other piston positions by a pressure relief valve 40, as shown in FIG. 2.

Immediately following such equalization of pressure between the compressed-air storage volume means 16

and the cylinder chamber 7, which initiates movement of the X-ray table carriage, continued movement in a quite smooth manner is realized, so long as the switch 22 maintains solenoids 21 and 25 energized and the piston 6 has available travel, by restricted supply of fluid under pressure from the regulating valve device 14 via the choke 20. While such movement is occurring, air in chamber 8 is compressed and displaced at an increasing rate by the piston 6 via the selector valve 24' and the choke 27 which thus becomes increasingly effective to cushion the piston 6 at the end of its stroke in the direction of chamber 8.

To terminate such actuation of the X-ray table carriage in the one direction, the selector switch 22 may be moved to deenergize solenoids 21 and 25 while allowing solenoids 21' and 25' to remain deenergized, in which case selector valve 24 connects chamber 7 to the choke 27 in common with chamber 8 for rapid equalization of pressure between the two chambers and gradual dissipation of their common pressure via such choke, while the valve 18 opens to permit recharging of the storage volume means 16 with compressed air via the regulating valve device 14.

Reversal in direction of actuation by operation of switch 22 to energize solenoids 21' and 25' for effecting supply of compressed air to chamber 8 will occur in the same manner as described in connection with chamber 7 and will actuate the X-ray table carriage 10 in the reverse direction. Such reversal can be effected immediately upon termination of supply to one or the other chamber 7 or 8 to assist in bringing the carriage 10 to a rapid stop, if desired. During such quick reversal the pressure of fluid in the released chamber 7 or 8 will momentarily equalize with pressure in the other chamber 7 or 8 due to the presence of the unrestricted communication between chambers established by the release communication to which the release choke 27 is connected. This tends to result in more rapid reversal and conservation of fluid during such rapid reversals, since the choke 27 will maintain partial pressurization of the chambers during the short intervals between rapid resupply of compressed air to such chambers.

In FIG. 3 there is shown another embodiment for arriving at equal motion-initiating cylinder pressures irrespective of piston position when using compressed air as the fluid operating medium. In this arrangement, initial supply of compressed air is effected from the regulating valve device 14 via the selector valve 24 and this rapid supply is automatically terminated by a selector valve device 45 which responds to a certain selected cylinder pressure as exists ahead of the valve 24 to disestablish the unrestricted regulator valve supply and to establish the subsequent restricted supply via the choke 20. In the FIG. 3 arrangement no storage volume means 16 is employed, and the valve 18 for controlling storage volume charging also is consequently eliminated.

When the system of FIG. 1 employs a non-expandable medium such as hydraulic fluid under pressure, the storage volume means 16 would take the form of an accumulator or expansion chamber which would include a bias means urging hydraulic fluid therefrom to enter the cylinder 5. In such case the pressure force initially exerted on the piston 6 and its initial displacement by the storage volume fluid would be constant irrespective of piston position, so that the arrangement of FIG. 2 would be unnecessary, and the arrangement of FIG. 3 could still serve as a substitute arrangement in lieu of a storage volume.

While an illustrative embodiment of the invention has been shown and described, it is intended that the appended claims embrace the true spirit and scope of the invention and embrace all minor modifications as will readily be suggested to those versed in the art.

We claim as our invention:

1. A fluid pressure actuator system for high-inertia counterbalanced X-ray table carriages, comprising a regulated-pressure compressed air supply line, a compressed-air storage volume means normally charged at a certain pressure with compressed air from said supply line, a fluid pressure cylinder device having a reciprocable piston in operative connection to an X-ray table carriage, and control means operable to establish a supply communication from said compressed-air storage volume means to said cylinder device for initiating movement of said carriage, the aforesaid being so constructed and arranged that the equalization pressure immediately resultant from establishing communication between the normally-charged storage volume means and the cylinder device varies according to the position of the piston at the time of such establishing.

2. A fluid pressure actuator system comprising a fluid pressure supply line, a cylinder device having a reciprocable piston subject to pressure of fluid in a cylinder chamber to actuate an X-ray table carriage, storage volume means, and means including flow-restricting means and operator-controlled valve means selectively operable to establish an unrestricted storage-volume-charging communication to said storage volume means from said fluid pressure supply line for fast-charging same while establishing a cylinder-chamber-release communication from said cylinder chamber, and to establish an unrestricted delivery communication from said storage volume means to said cylinder chamber in parallel with a restricted delivery communication from said supply line to said cylinder chamber while disestablishing the aforesaid storage-volume-charging and cylinder-chamber-release communications.

3. A fluid pressure actuator system as claimed in claim 2, wherein the fluid pressure supply line is connected to a source of compressed air and the charged storage volume pressure equalizes with cylinder chamber volume pressure upon establishment of the aforesaid unrestricted delivery communication for initiating movement of the carriage-actuating piston.

4. A fluid pressure actuator system as claimed in claim 3, wherein the size of the storage volume means is chosen to provide a desired cylinder chamber pressure buildup when the volume of such chamber is substantially maximized by piston position and the system includes pressure release means to vent excess equalization pressure from said cylinder chamber when at its lesser volumes at other piston positions.

5. A fluid pressure actuator system for an X-ray table carriage, comprising a fluid pressure supply line, a double-acting cylinder device having a reciprocable piston subject opposingly to pressure of fluid in cylinder chambers at its opposite sides and operatively connected to an X-ray table carriage, two volume means, and means including flow-restricting means and valve means selectively operable to establish respective unrestricted storage-volume-charging communication from said supply line to the two storage volume means while establishing unrestricted interconnection between cylinder chambers and connection of both chambers to a release flow restricting means, and to establish a respective unrestricted delivery communication from a respective one of the storage volume means to a respective cylinder chamber in parallel with a respective restricted delivery communication from said supply line to said respective cylinder chamber while disestablishing a respective one of the aforesaid storage-volume-charging communications and connection of said respective cylinder chamber to the other cylinder and to release flow restricting means.

6. A fluid pressure actuator system for an X-ray table carriage, comprising a fluid supply line, a cylinder device having a reciprocable piston subject to pressure of fluid in a cylinder chamber and operatively connected to an X-ray table carriage, means defining restricted and unrestricted cylinder-chamber-supply communications from said supply line, a pressure responsive valve device oper-

able responsively to pressure of fluid prevailing in said cylinder chamber to effectuate the unrestricted cylinder-chamber-supply communication when cylinder chamber pressure is below a certain value and to effectuate the restricted cylinder-chamber-supply communication when cylinder chamber pressure is above a certain value, and operator-controlled valve means selectively operable to connect said cylinder chamber either to a release communication or to output from said pressure responsive valve device.

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