March 6, 1962 H. D. SAMUEL, JR., ETAL 3,023,740

DELAYED PNEUMATIC ACTUATOR

Filed May 25, 1960

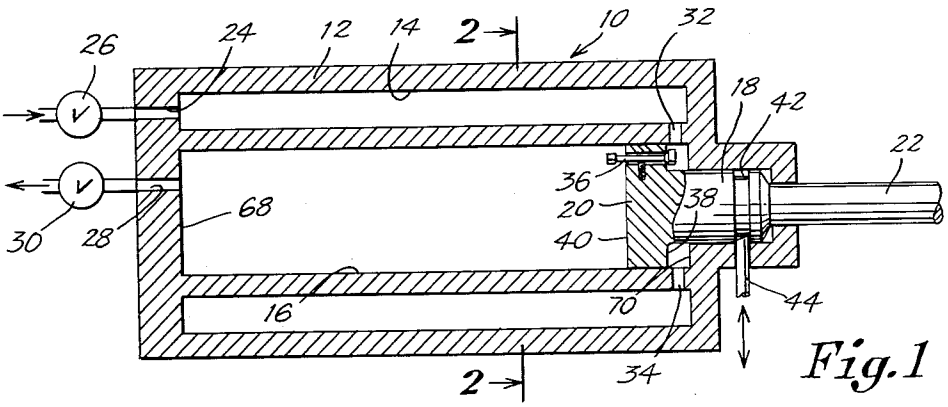


Fig. 1

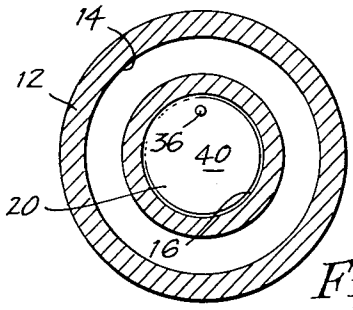


Fig. 2

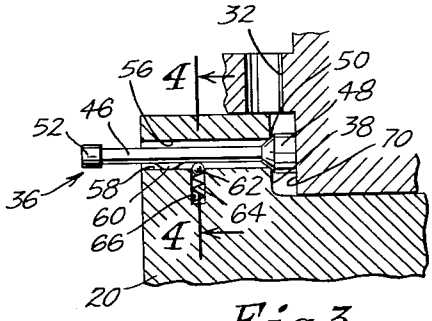


Fig. 3

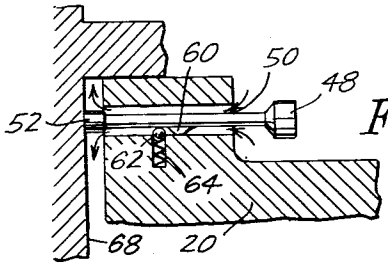


Fig. 5

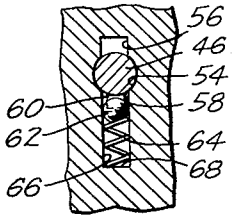


Fig. 4

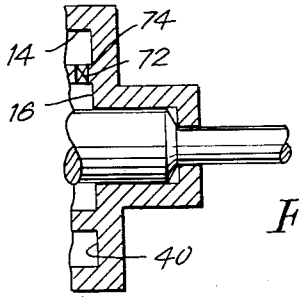


Fig. 6

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DELAYED PNEUMATIC ACTUATOR

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This invention relates to a pneumatic spring type actuator and more particularly relates to a self-contained delay type actuator which may be energized subsequent to its being charged with driving fluid.

Pneumatic actuators are well known and have been used for a wide variety of purposes, such as opening and closing valves, as catapult devices, and for use in all types of ejecting functions.

In most instances the actuator is energized at the time it is connected or otherwise coupled to the source of energizing fluid, such as a high pressure gas.

The present invention provides a novel actuator which is self-contained in that it provides its own storage volume for the high pressure gas such as compressed air. Hence, the device may be charged and disconnected from the high pressure gas source and left to be actuated by an energizing signal at some later time. By means of a novel combination of a piston type actuator mechanism, a storage volume and a transfer valve, rapid delayed type actuation as well as reciprocation is possible with the use of only a minimum of stored gas. The device is small, of relatively simple inexpensive construction, and completely reliable in operation.

It is therefore a primary object of the present invention to provide an improved pneumatic actuator.

Another object of the present invention is to provide a delayed type pneumatic actuator or pneumatic spring.

Another object of the present invention is to provide a completely self-contained pneumatic actuator.

Still another object of the present invention is to provide a pneumatic actuator which consumes a minimum of air.

These and other objects and advantages of the invention will be more apparent upon reference to the following specification, claims, and appended drawings, wherein:

FIGURE 1 is a cross section through the novel actuator of the present invention;

FIGURE 2 is a cross section taken along line 2—2 of FIGURE 1;

FIGURE 3 is an enlarged view of the transfer valve shown in FIGURE 1;

FIGURE 4 is a cross section through the transfer valve taken along line 4—4 of FIGURE 3;

FIGURE 5 is an enlarged view of the transfer valve in the open position at the opposite end of the cylinder; and

FIGURE 6 is a fragmentary showing of a modified embodiment of the actuator of the present invention.

Referring to the drawings, FIGURES 1 and 2 show the actuator of the present invention generally indicated at **10** comprising a cylinder housing **12** defining an annular storage chamber **14** surrounding a piston chamber **16**. Slidably received within chamber **16** is a reciprocating piston **18** having a piston head **20** and a piston rod **22** for connection to a valve, catapult mechanism, or other device to be actuated. High pressure gas, such as compressed air gains access to the actuator through an inlet port **24** by way of valve **26**. Gas exhaust from piston chamber **16** is through outlet port **28** and through outlet valve **30**. Annular storage chamber **14** communicates with piston chamber **16** by means of a plurality of annularly spaced passageways, two of which are indicated at **32** and **34** in FIGURE 1.

Head **20** of piston **18** carries a transfer valve **36** which

when open, provides a passage for the gas completely through the piston head from rear surface **38** to front surface **40**. The body portion of the piston is provided with an annular groove **42** which receives a sear pin **44**. The sear pin **44** is slidable through housing **12** and engages in the slot **42** to restrain the piston against movement and retain it in the cocked position. The pin **44** may be reciprocated away from the slot **42** as indicated by the arrows in FIGURE 1 to release the piston for movement along chamber **16**.

FIGURE 3 is an enlarged fragmentary view showing a portion of the actuator of FIGURE 1 illustrating the details of the transfer valve **36**. FIGURE 4 is a cross section taken along line 4—4 of FIGURE 3 drawn to an even further enlarged scale, so that the details of the transfer valve may be readily apparent. The transfer valve **36** comprises a valve pin **46** having a valve head **48** at one end resting in a valve seat **50** formed on the back surface **38** of the piston head **20**. At the opposite end of pin **46** is an enlarged stop **52** for preventing movement of the pin completely through the piston head.

Transfer valve pin **46** is slidably received in a circular channel **54** passing completely through the valve head. Extending upwardly from channel **54** is a substantially rectangular slot **56** and downwardly from channel **54** a similar slot **58**. Approximately midway of its ends pin **45** is provided with a projection or tab **60** slidable in lower slot **58**. Tab **60** is adapted to engage ball **62** secured to one end of a helical compression spring **64** received in a well **66** communicating with the lower slot **58**. The opposite ends of spring **64** is secured to the bottom of well **66** as indicated at **68** in FIGURE 4. Ball **66** and spring **64** bearing against tab **60** act to detent the transfer valve in both the open and closed positions.

While FIGURE 3 shows the transfer valve in the closed position with head **48** resting on seat **50**, FIGURE 5 shows the transfer valve in the open position with piston head **20** at the opposite end of piston chamber **16**. In the open position, air or other gas passes beneath the head **48** and through the slots **56** and **58** to the opposite side of the piston head as indicated by the arrows in FIGURE 5. Stop **52** on the end of the transfer pin is large enough to keep the pin from falling out of the channel **54**, but not so large as to prevent the air from passing outwardly between the stop and the front face **40** of the piston head.

In operation, valve **26** is opened and the storage volume **14** is charged with high pressure gas through inlet port **24**. This gas may be compressed air or any other suitable compressible fluid. Valve **26** is then closed and the charge of compressed gas stored for any desired length of time in the annular chamber **14**. During this storage time, piston **18** is restrained against movement by the sear pin **44** received in annular slot **42**.

When the firing pin or sear pin **44** is withdrawn, that is, moved downwardly as indicated in FIGURE 1, the piston **18** is free to move under the influence of the compressed gas passing radially inwardly from annular chamber **14** through passageways such as **32** and **34** as shown in FIGURE 1. This compressed gas acts on the back face **38** of the piston so as to drive it to the left along cylinder **16** as shown in the drawing. At this time transfer valve **36** is in the closed position as shown in FIGURE 3. When the piston is at rest and retained by sear pin **44** head **48** of the transfer valve spaces the back surface **38** of the piston from the cylinder wall so that the gas passing through passageways **32** and **34** at all times has free access to the back surface of the piston. Throughout the entire charging and actuation, valve **30** is closed.

At the end of the piston stroke, stop **52** of the transfer valve pin engages the end wall **68** of the piston chamber

so that the transfer valve is moved to the open position indicated in FIGURE 5. The valve, as described above, is detented by means of ball **62** and spring **66** acting against tab **60** so that the transfer valve is positively retained in both the open and closed positions. The high pressure gas in back of piston head **20** holds the piston momentarily against wall **68** and retains the transfer valve open until some of the gas passes through channels **56** and **58** to the front surface **40** of the piston head.

By means of gas transfer through the transfer valve, pressure on opposite sides of the piston head is equalized and since the surface area of front face **40** is greater than the surface area of rear face **38** exposed to the pressure gas, the piston is moved to its original position indicated in FIGURES 1 and 3. As the head **48** of the transfer valve comes in engagement with the end wall **70** of the piston cylinder, the transfer pin is driven to the closed position of FIGURE 3, and is relatched in this position by the sear pin **44**.

After the piston has returned to its original position, and is relatched, valve **30** is opened and the gas bled off to atmosphere or vented to other apparatus as desired through outlet port **28**. Valve **30** is then closed and the actuator is ready for an additional cycle of operation.

FIGURE 6 shows a modified embodiment of the novel actuator of the present invention wherein the sear pin and annular retaining groove or slot **42** is eliminated and its function replaced by valve **72** in the single passageway **74** joining annular storage chamber **14** with the piston cylinder chamber **16**. Valve **72** may take any of a wide variety of conventional forms and by way of example only, may be electrically actuated by means of suitable sealed leads passing through the walls of housing **12**. Opening of valve **72** connects storage chamber **14** with the rear surface of the piston so that the compressed gas stored in chamber **14** drives the piston in the same manner as the embodiment shown in FIGURE 1. It is believed that the remaining portions of the cycle are apparent from the description of the embodiment of FIGURE 1, and further discussion is deemed unwarranted.

An important gas conserving feature of the present invention is that the only air or other gas dumped overboard is the air in chamber **16** after the piston is returned to its initial position. The remaining air in chamber **14** constitutes an initial charge which reduces the quantity of air required to recharge chamber **14** to the desired pressure.

It is apparent from the above that the present invention provides a novel actuator which is completely self-contained and which may provide any desired delay between the pneumatic charging of the actuator and the time it is actually fired or tripped. The cylindrical storage chamber stores sufficient gas for a complete cycle with charging being accomplished between cycles. Although the device may be used for rapid actuation, it has the advantage that no large valves are required. The air or other high pressure gas used for the firing stroke is not immediately dumped overboard after firing, but is first used to return the piston to its original position. By means of the transfer valve **36** it is possible to obtain the optimum and most efficient use of a minimum quantity of storage fluid so that the storage volume or size of storage chamber **14** may be kept to a minimum. It is apparent that any direct bleed connection through the piston head tends to substantially lessen the efficiency of the stored gas, requiring either a substantially greater volume or the utilization of a higher pressure than is necessary with the present device.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

What is claimed and desired to be secured by United States Letters Patent is:

1. A fluid actuator comprising a housing having a piston chamber, a piston slidably received for reciprocation within said chamber, said piston having a start of stroke position near one end of said chamber, said housing including an annular storage chamber surrounding said piston chamber, valve means for connecting said storage chamber to a source of pressurized compressible fluid, means for establishing fluid communication between said storage chamber and said one end of said piston chamber, said piston including an annular groove, a movable firing pin received in said groove to restrain said piston from movement along said piston chamber, release of said firing pin permitting compressed fluid in said storage chamber to drive said piston to the other end of said piston chamber, a normally closed transfer valve connecting the opposite sides of said piston, means for opening said transfer valve when said piston reaches said other end of said piston chamber to equalize the pressure on opposite sides of said piston, said piston having a greater area on the side facing said other end of said piston chamber whereby pressure equalization causes said piston to be returned by said fluid to said start of stroke position and means for reclosing said transfer valve when said piston reaches the first end of said piston chamber, said transfer valve being actuated into the open and closed positions by engagement with the opposite ends of said piston chamber and being positively detented into both the open and closed positions.

2. A fluid actuator according to claim 1 including valve means for discharging fluid from said piston chamber after said piston has returned to its start of stroke position.

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