The invention relates to actuator mechanisms and particularly provides a shock-absorbing actuator apparatus comprising of an actuator piston buffered by both a mechanical buffer and a hydraulic buffer, the mechanical buffer being comprised of stacked Belleville washers, a driven element carried on a buffer rod, and a driving element carried on a buffer rod, the structure acting to cushion the movement of an actuator piston.

5 Claims, 2 Drawing Figures
ACTUATOR AND LATCH

CROSS REFERENCE TO RELATED APPLICATION

This is a division of application Ser. No. 97,686, filed on Dec. 14, 1970, now U.S. Pat. No. 3,742,813.

BACKGROUND AND SUMMARY OF THE INVENTION

The invention relates to actuator mechanisms and particularly comprises a shock-absorbing actuator apparatus comprised of an actuator piston buffered by both a mechanical buffer and a hydraulic buffer. The mechanical buffer consists of stacked Belleville washers, a driven element carried on a buffer piston rod, and a driving element carried on a buffer rod, the present structure acting to cushion the movement of an actuator piston.

Accordingly, it is an object of the invention to provide a shock-absorbing actuator apparatus having dual buffering capability for cushioning the movement of an actuator piston within the apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged detail section showing the forward portion of the present actuator apparatus; and,

FIG. 2 is an enlarged detail section showing the aft portion of the present actuator apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring particularly to FIG. 1, the actuator 68 includes a latch 81 having a cylindrical wall 81a to which is attached a latch housing 84. The wall 81a is closed at its forward end by an end wall 85 which is apertured to receive a hollow piston rod 86, the rod 86 having a fitting 87 for connection to structure (not shown) to be displaced by the rod 86. A packing gland 88 surrounds the piston rod 86 within the forward portion of the latch 81.

The latch housing 84 includes a base 89 which has a sleeve 90 that extends through an opening 91 in the wall 81a, and a cylinder 92 in which is mounted a piston 93. The piston 93 is mounted for sliding movement in the cylinder 92 and is sealed against leakage by an O-ring 94, the inner piston wall, the wall of the cylinder 92 and the outer wall of the sleeve 90 defining an air chamber 95.

Mounted on the inner wall of the piston 93 is a latch bolt 96 which has a beveled inner end face 97, and an axial bore 98 that communicates between the chamber 95 and the interior of the latch 81. Stops 99 are formed on the outer surface of the piston 93 at each side of the latch bolt and are engageable with the base 89 for limiting inward travel of said bolt. The piston 93 has a stem 100 which extends outwardly within the latch housing 84 axially thereof and has its outer end portion slidable in an opening in an end wall 101, said end wall having a guide flange 102 surrounding said opening. A cap 103 clamps the end wall 101 in place and is formed with a recess 104 to receive the outer end of the stem when the latch bolt is in retracted position, as will be described hereinafter. A coil spring 105 surrounds the stem 100 within the outer portion of the latch housing and between the end wall 101 and the outer surface of the piston 93 and urges said piston inwardly. Formed in the wall 81a of the latch opposite the bolt 96 is a service opening 107 to which is connected the high pressure air line 82 to admit or discharge high pressure air.

The actuator 68 has a main cylinder 110 which is connected to the aft end portion of the latch 81. More specifically, the forward end portion of the main cylinder is reduced in diameter and the aft end portion of the wall 81a of the latch is recessed so that said cylinder and latch may be fitted tightly together. An O-ring 111 and suitable lock nut and washer, 112 and 113, respectively, are used to assure a tightly sealed connection.

Mounted for sliding movement in the main cylinder 110 and connected to the aft end of the piston rod 86 is a main actuator piston 114. The main actuator piston 114 is formed with a reduced forward end portion 115 which defines a shoulder 116, for engagement with a straight side wall of the latch bolt 96, and a tapered forward end 117 for engagement with the tapered end wall 97 of said bolt, as will be described hereinafter.

The actuator piston 114 is hollow throughout its length and has a striker 118 mounted in its aft end, said striker comprising a hollow sleeve 119 and a flange 120, the latter substantially covering the aft end of the piston. As best seen in FIG. 2, the piston 114 receives the forward end portion of a buffer rod 121, said buffer rod extending through the sleeve 119 and into the hollow piston rod 86. A head 122 is fixed to the forward end portion of the buffer rod 121 and is engageable with the forward end of the striker sleeve 119 during a portion of the travel of the main actuator piston 114.

The aft end portion of the main cylinder 110 is reduced to fit tightly into a coupling sleeve 124 which serves to connect a hydraulic buffer unit 125 to said cylinder. As best seen in FIG. 2, the coupling sleeve 124 has a service port 126 to which is connected one end of the air line 83, that portion of the wall of the sleeve which is adjacent the service port being reduced in thickness to define an annular manifold 127 that communicates with the interior of the main cylinder 110 near its lower end through openings 128 which are arranged in an annular series.

The hydraulic buffer unit 125 includes a cylindrical buffer body 130 to the aft end of which is secured a mounting plate 131. Mounted in the body 130 is a buffer piston 132 which has a piston rod 133 and a stem 134. The forward end of the body 130 is secured to the aft end of the coupling sleeve 124, said body being provided with a wall 135 having a relatively wide annular sump 136 substantially medially of the body and a relatively narrow annular sump 137 near its aft end. Between the sumps the wall 135 is gradually increased in thickness, toward the aft end of the body 130, to define a tapered section 138 and a chamber within said tapered section.

The aft end of the buffer unit 125 has a plug 140 mounted therein, the plug being screwed into position, being apertured to receive the stem 134 therethrough, and having packing 141 surrounding said stem. As will be seen in FIGS. 1 and 2, the stem 134 has an axial bore 142 and ports 143 which communicate between the chamber 139 and the exterior of the buffer unit 125 at its aft end. The bore 142 and ports 143 permit the introduction of hydraulic fluid to the interior of the chamber within the tapered section 138. A cap 144 closes the bore 142 at its aft end, and a by-pass 145,
having a check valve 146, extends between the sumps 136 and 137.

A buffer piston rod 133 is of larger diameter than the buffer rod 121 and is provided with a stepped in diameter socket 147 which receives a stepped in diameter aft end portion 148 of said rod 121. A pin 149 connects the two rods 121 and 133. The forward end portion of the piston rod 133 is reduced in diameter to define a shoulder 150, and surrounding said reduced portion and bearing against said shoulder is the driven element 151 of a primary buffer 152. The buffer 152 includes, in addition to the driven element 151, a driving element 153, a cushioning disk 154 on the forward end of the driving element, and a plurality of stacked "Belleville" springs 155. The cushioning disk 154 is of relatively soft material, such as "Teflon". The driving element 153 is slidable on the aft end portion of the buffer rod 121 and has a longitudinally extending slot 156 which receives a coupling pin 157 on said buffer rod. The slot and pin arrangement permits limited movement between the buffer rod 121 and the driven element 153. A recess 158 in the aft end of the driving element 153 slidably receives the forwardmost portion of the buffer piston rod 133.

The operation of the actuator 68 will now be described. Air under pressure is admitted to the interior of the latch 81 from the line 82 through the service opening 107. This high pressure air will pass through the bore in the latch bolt 96 into the chamber 95 and will act on the piston 93 for forcing it outwardly in the cylinder 92 against the compression of the coil spring 105. This piston movement will withdraw the bolt from behind the shoulder 116, thus allowing the actuator piston 114 to move in the main cylinder 110.

The high pressure air that operates the latch 81, as above described, also, and upon release of the latch, moves the main actuator piston 114 aft in the main cylinder 110, and about the buffer rod 121, for moving that structure (not shown) which is attached thereto.

Under normal operating conditions, with air at 250 psi acting on the main actuator piston 114, considerable shock is experienced and is buffered by the buffer unit 125 (FIG. 2). More specifically, when the piston 114 approaches the aft end of its travel, the striker 118 thereon engages the driving element 153 of the primary buffer 152 and moves it toward the driven element 151, against the compression of the Belleville spring 155. The driven element 151, acting against the shoulder 150, moves the buffer piston rod 133 and the buffer rod 121, which is secured thereto, in an aft direction, within the limit of travel imposed by the coupling pin 157 in the slot 156, for moving the buffer piston 132 aft in the tapered section 138 of the buffer unit 125. Movement of the buffer piston 132 will cause hydraulic fluid, shown at 160, to flow about said piston and into the forward end of the buffer unit, the tapered section 138 acting on the piston, which is of uniform diameter, to provide progressively increasing restriction of the hydraulic fluid flow to enhance buffering action.

What is claimed is:

1. A shock-absorbing actuator apparatus comprising:
   a) an actuator body having a central longitudinal chamber formed therein;
   b) a hollow piston rod disposed within the central chamber of the actuator body and slidably movable longitudinally therein, the piston rod at a first end thereof extending externally of the actuator body and being connected to an object which is to be displaced on operation of the actuator apparatus;
   c) an actuator piston disposed within the central chamber of the actuator body and having a centrally disposed longitudinal aperture therein, a second end of the piston rod being fixedly received within a first end of the aperture, the piston having a reduced forward end portion defining a shoulder and a tapered forward end defining a camming surface;
   d) a striker means carried by the actuator piston at a second end thereof opposite said first end;
   e) a buffer rod disposed within the central chamber of the actuator body, a first end of the buffer rod extending through the aperture in the actuator piston at a second end of the actuator piston and being extendible into the hollow piston rod on movement of said piston rod toward the buffer rod;
   f) latch means having a bolt engageable with the shoulder on the actuator piston, said bolt being displaceable from the shoulder by a fluid under pressure to permit movement of the actuator piston in the actuator body, the fluid acting also to displace the actuator piston; buffer means for cushioning movement of the actuator piston on movement thereof toward the second end of the actuator body, said buffer means including a primary buffer and a secondary buffer, the primary buffer comprising, a buffer piston rod connected to the aforementioned buffer rod and axially aligned therewith,
   g) a driven element on the buffer piston rod, a driving element mounted for limited sliding movement on the buffer rod and on the buffer piston rod, and
   h) means for introducing fluid under pressure into the actuator body to operate the latch means and to displace the actuator piston within the actuator body.

2. The apparatus of claim 1 wherein the latch means further comprises:
   a) a latch housing having a cylinder therein;
   b) a latch piston in the cylinder and mounting the bolt; and, a base for said latch housing, said base and said piston defining a fluid chamber and said bolt having a bore communicating between the interior of the latch housing and said fluid chamber, the fluid introduced into the actuator body flowing through said bore into said fluid chamber for displacing the bolt from said shoulder for releasing the actuator piston.

3. The apparatus of claim 1 wherein said spring means comprise a plurality of stacked Belleville washers.

4. The apparatus of claim 1 wherein the secondary buffer comprises:
   a) a buffer body joined to the actuator body and having a wall formed with a sump, said wall being tapered in thickness toward one end; and,
   b) a buffer piston on the buffer piston rod and movable therewith in the buffer body toward said tapered wall for displacing a fluid in said buffer body about said piston and through said sump, whereby the
5 movement of said buffer piston and buffer piston rod is buffered.

5. The apparatus of claim 4 wherein the spring means of the primary buffer comprises a plurality of stacked Belleville washers, the washers of at least one pair of said washers being positioned with their concave surfaces in opposed relation.

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