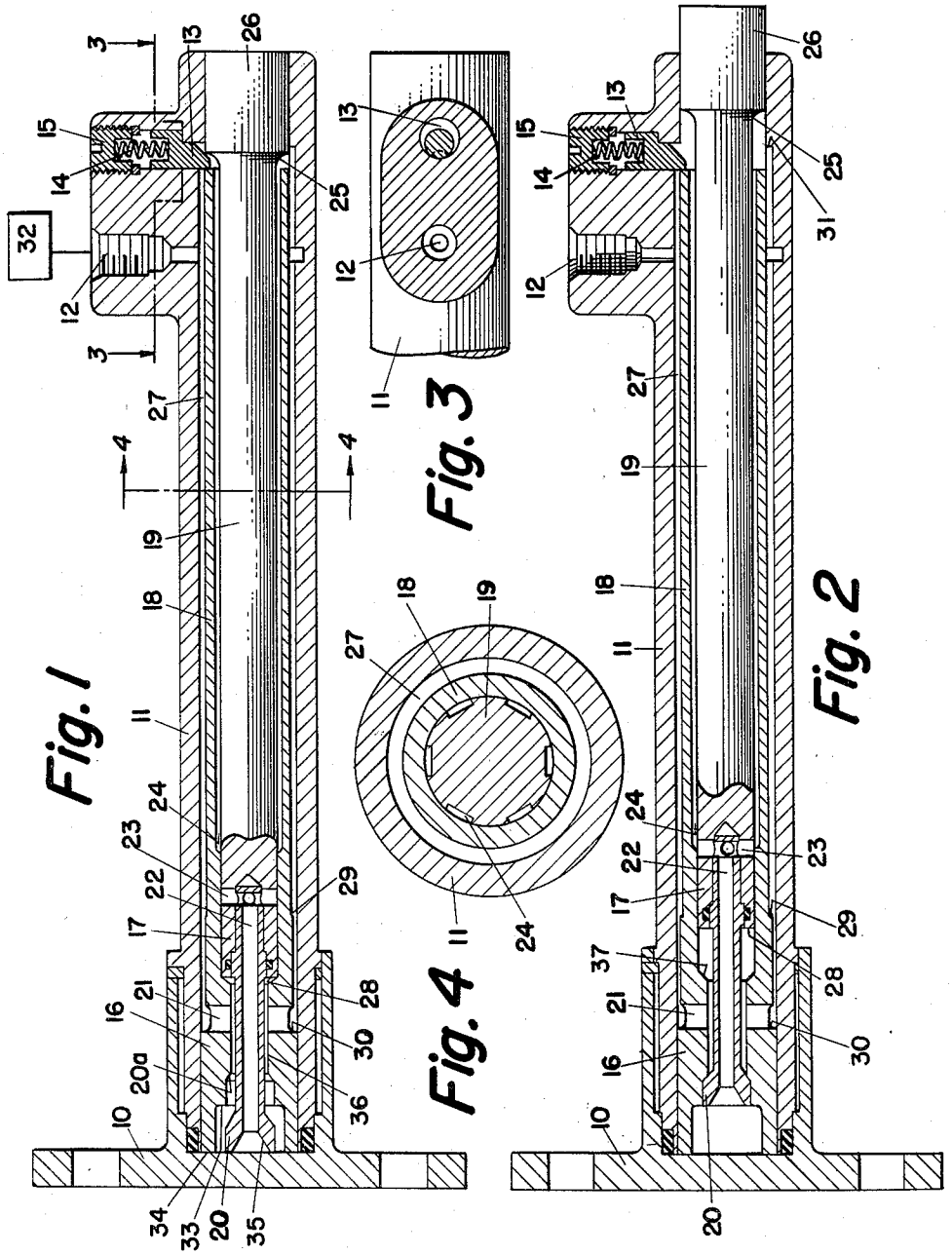
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SINGLE CYCLE SELF RETRACTING THRUSTER

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# SINGLE CYCLE SELF RETRACTING THRUSTER

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The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to a single cycle self retracting thruster by means of which a load such as a bomb or other material to be thrown out of a rapidly moving airplane, may be ejected safely without danger of the same being thrown back into or against the plane. An object is to provide such a device which is simple, compact, and capable of retracting its power applying element after ejection of a load from some of the fluid pressure applied thereto. A further object is to provide a device for ejecting a load from a high speed plane under a higher rate of acceleration than is permissible for the ejection of personnel.

According to this invention, an inner and outer piston are relatively movable within a cylinder and also movable outwardly together and an automatic valve between these pistons is closed under diminution of load to exhaust fluid pressure acting on one side of the larger outer piston during its power stroke, whereby without exhausting fluid pressure on the opposite side of that piston, the same may be retracted by the residual pressure thereon.

Referring to the drawing,

Fig. 1 shows a longitudinal section through a preferred embodiment of the present invention.

Fig. 2 is a longitudinal section through the same device with the supply valve closed and the outer piston retracted with the inner piston after a load has been released.

Fig. 3 is a cross-sectional view on the line 3—3 of Fig. 1.

Fig. 4 is the section on the line 4—4 of Fig. 1.

Referring to the drawings, a support 10 is fixed to a main spar or other main portion of the plane which can support or restrain loads. The cylinder 11 is secured to the support 10 and carries at its opposite end a fixture 12 by means of which a supply of fluid pressure is provided for the cylinder 11. A preferred source of fluid pressure is some known type of cartridge conveniently represented by the numeral 32. Adjacent the supply passageway 12 is a latch body 13 of circular cross section as shown in Fig. 3. This latch is pressed downward by a spring 14 cooperating with the latch body 13 and with an externally threaded screw 15 by means of which the stress on the spring may be adjusted. Having a sliding fit within the cylinder 11 is an outer piston 16 having secured thereto an outer piston rod 18. An inner piston 17 is of substantially the same diameter as the inner piston rod 19, the right end of which bears against a load such as a bomb that is to be ejected. In a pressure fluid flow path between the inner and outer pistons is a valve 20 carried by the inner piston 17 while the outer piston 16 provides an abutment 20*a* against which the valve closes and limits outward movement of this inner piston 17. A transverse passageway 21 extends through the outer piston and a longitudinal passageway 22 is provided in the inner piston 17, and valve 20, this last passageway being connected to



another transverse passageway 23. The inner piston has a sliding fit within the outer piston and when the passageway 23 has been moved to the right in Fig. 1 far enough to bring it in contact with the clearance spaces 24, then gas may be exhausted and the valve closed as will be described hereinafter. The clearance spaces 24 are shown in Fig. 4 as being six in number. These may be in either the inner rod 19 as in Fig. 4 or in the inner surface of piston rod 18 as in Fig. 2 but need not be in both. A shoulder 25 is shown at the right end of the inner piston being the wall against which the outer piston 18 may press in moving the inner piston and its load outwardly. The end portion 26 at the right end of the inner piston is that against which the load or bomb is pressed as the load is thrust outwardly. A supply passageway 27 leads from the intake 12 to the left to the transverse passageway 21 as will be hereinafter described.

The valve 20 is threaded or otherwise secured to the inner piston. This valve 20 is open during at least the major portion of the outward thrust of the pistons. As shown in the drawing the outer piston is of three different diameters, the larger end constitutes the sealing and bearing surface of piston portion 16 by means of which the piston rod 18 is supported and guided. The next smaller diameter surface is to the left of shoulder 29. The main portion of the outer piston rod 18 is of the diameter shown in the drawing. The inner piston and rod together are in three different diameters as shown in drawing, at the left and smaller end of the inner piston rod is the valve 20 which cuts off the supply of pressure fluid to the passageways 22, 23 and 24. On its long mid-portion flat grooves or longitudinal portions 24 are cut to allow gas to exhaust as will be described hereinafter. The right or enlarged end 26 of the inner piston rod is of large diameter and serves as a guide only when the main body of the outer piston rod is received within the cylinder.

In operation, a cartridge actuated device or other source 32 of fluid pressure is connected at the supply passageway 12 and upon the supply of gas thereto raises the pressure within the cylinder 11 and lifts the latch 13 from engagement with the outer piston rod 18 so that said rod may be moved to the right. Gas also moves to the left from the supply passage 12 through the elongated passageway 27 around the outer rod 18 to the transverse passageway 21 leading into the space between the outer piston and the stem of the valve 20. Fluid pressure then passes to the space to the left of the valve seat 20*a*. The effective area against which fluid pressure moves both pistons outwardly and together is that due to the total areas radially within the outside of the smallest portion of the outer piston rod 18. The force tending to move the inner piston 17 outwardly after the outer piston has been stopped by shoulder 29 engaging abutment 31 is the inertia of the inner piston plus fluid pressure on the left or inner end of this piston 17 and valve 20. The cross-sectional area of the outer piston to which the supply pressure is subjected is much larger than that pressing on the inner piston or inner piston rod due to an area varying as the square of the radius of a circle with the result that the outer piston is moved to the right until either shoulder 25 is engaged by the enlarged right end of piston rod 18 or until abutment wall 37 engages the left end of the inner piston 17 depending on where the greater clearance is located. Thus it is the outer piston and piston rod which thrust against the inner piston rod to move it and the load contiguous with end portion 26 outwardly. On reduction of the load, to a some predetermined lowered value, as occurs when the outer piston shoulder 29 strikes abutment 31, the inner piston is moved to the right with respect to the outer piston as much as the longitudinal clearance between them permits by means of inertia and fluid pressure acting upon the end face 28 of the inner

piston. The inner piston may move to the right under its own inertia as well as under the influence of fluid pressure as mentioned above. As the valve **20** reaches the end of its travel, its right or outer tapered surface, contacts the seat **20***a* and the valve is closed. At or before the actual closing of the valve, the transverse passageway **23** engages the enlarged space around the inner piston rod so that exhaust of fluid pressure takes place through the passageways **22, 23** and thence out passageways **24** into the atmosphere. The exhaust of pressure acting upon the left end of the inner piston rod has the effect of causing the residual pressure in the passageway **27** and gas source **32** to move the outer piston to the left, retracting it to its original position shown in Fig. 1. When the outer piston reaches the end of its return or retraction stroke and abuts the support **10**, the latch **13** has at that time had an opportunity to engage the right end of the outer piston rod holding the same against movement to the right until the next stroke when fluid pressure causes it to be moved as previously described.

Among the advantages of this invention may be mentioned the fact that a compact and simple device is provided, herein called a reciprocator, for the purpose of giving any load such as a bomb an outward impetus of a desired value. A preferred source of pressure to provide force for such rapid acceleration under small and compact dimensions is a cartridge actuated device. One specimen of this invention consisted of a unit that had a stroke of 18 inches or thereabout. Usually, this thruster or reciprocator is intended for imparting to a load a directional thrust far greater than gravity and sufficient to overcome any aerodynamic load encountered which might tend to throw the mass back into or against the plane. The vent passageways **24** must be open to the atmosphere at the right end of the inner piston rod for the exhaust of pressure after the valve **20** has closed. The effective area for holding the valve **20** closed against opening is the cross-sectional area of the inner piston **17** minus the cross-sectional area of the passageway **22**.

We claim:

1. In a reciprocating mechanism for ejecting a load from an aircraft and a gas pressure device for activating said mechanism, the combination therewith of the improvement for providing a simple and compact mechanism capable of being retracted, said improvement including means for exhausting gas adjacent the end of a stroke of said mechanism from a portion of gas in response to release of the load by said mechanism, means for retracting said ejecting mechanism after actuation of said gas exhausting means, said retracting means being responsive to another portion of the same gas effecting actuation of said ejecting mechanism, and an automatic valve in said mechanism in a fluid pressure path between the gas exhausted and the gas utilized for retraction.

2. A load ejecting mechanism according to claim 1 in which said automatic valve is opened in response to a differential gas pressure and is closed at least partially in response to its inertia.

3. A load ejecting mechanism according to claim 1 in which said gas pressure device includes an explosive cartridge.



4. A reciprocator or thruster comprising a cylinder, an outer piston therein, an outer piston rod connected to said outer piston, an inner piston within the outer piston, an inner piston rod connected to said inner piston, the inner piston and rod being movable relative to said outer piston and its rod, a supply passageway in said cylinder, a valve in a fluid pressure path between said inner and outer pistons and normally open while said piston rods are under load, the inner piston and rod being ejected with a load by said outer piston and rod under fluid pressure, the area of the outer piston subject to supply pressure being larger than the area of the inner piston subjected to the same supply pressure, said valve being closed and the inner piston and rod being movable with respect to the outer piston in response to the outer piston reaching an end of its travel, and to a diminution of load on the inner piston to some predetermined amount, and an exhaust port opened by movement of said valve and inner piston relative to said outer piston for reducing gas pressure on one side of said outer piston.

5. A single cycle reciprocating thruster provided with a cylinder, a fluid pressure connection leading into said cylinder, an outer piston within said cylinder, a piston rod for said piston, an inner piston within said outer piston, a piston rod on said inner piston leading out of said cylinder, a passageway leading from said connection to both sides of said outer piston, a valve in said passageway, an abutment in said cylinder for limiting outward movement of the outer piston and its rod as both pistons are moved together by fluid pressure on a power applying side of said pistons and closing said valve after impact of the outer piston and its rod upon said abutment while allowing continued movement of said inner piston and its rod, a passageway from the power applying end of said pistons to the atmosphere, an enlargement on an outer end portion of said inner piston, a valve in said second passageway located between said pistons and rods opening after said outer piston has been stopped by said abutment as the inner piston continues outward movement and exhausting fluid pressure on the power applying end of said pistons to the atmosphere after said enlargement has moved out of said cylinder, the power applying side of both pistons having a larger effective area than their opposite sides, whereby after exhaustion of pressure on said pistons residual fluid pressure on the side of the outer piston opposite to its power applying side may retract said outer piston to its initial position and pull said inner piston with it by means of said first mentioned valve.

6. A thruster according to claim 5 in which a spring latch is provided for holding said outer piston and its rod as well as said inner piston from coming out of said cylinder, said latch being moved to release said pistons for outward movement upon fluid pressure from said connection building up in said cylinder.

**References Cited** in the file of this patent

UNITED STATES PATENTS

205,674 Pennypacker ---------- July 2, 1878

FOREIGN PATENTS

868,247 France ---------- Sept. 22, 1941