Oct. 28, 1958 A. M. STOTT ET AL 2,857,889

ONE STROKE THRUSTER WITH SPEED REDUCER

Filed March 6, 1957

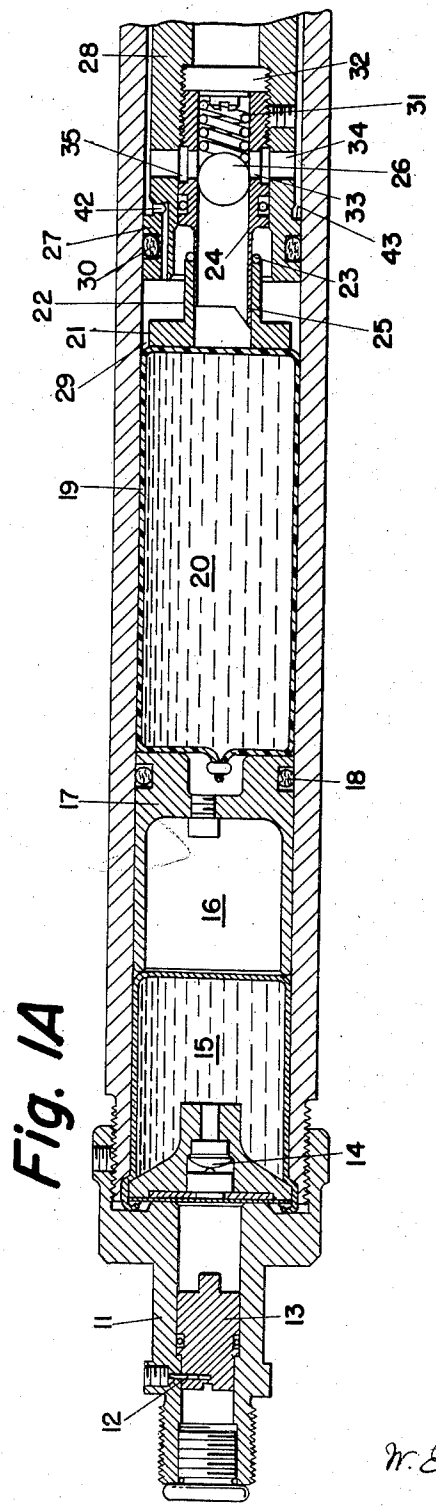

Fig. 1A

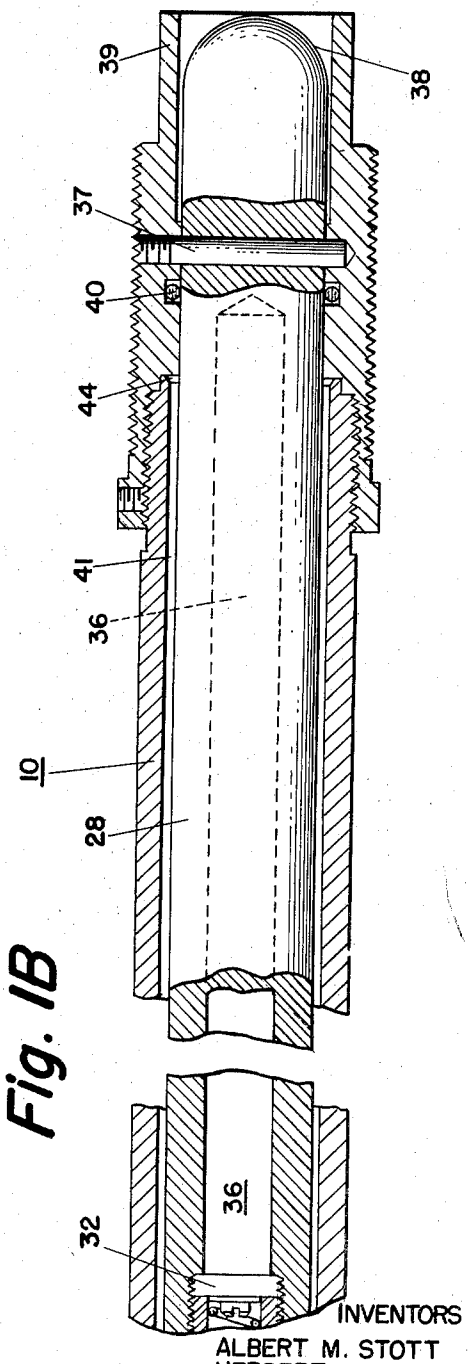

Fig. 1B

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United States Patent Office 2,857,889
Patented Oct. 28, 1958

2,857,889

ONE STROKE THRUSTER WITH SPEED REDUCER

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Application March 6, 1957, Serial No. 644,426

5 Claims. (Cl. 123—24)

(Granted under Title 35, U. S. Code (1952), sec. 266)

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

This invention relates to a mechanism for moving a seat on a high speed airplane prior to its being ejected forcibly therefrom. It is known that the speed of such seat movement must be within a prescribed range from the standpoint of protecting personnel against jolt and protecting the plane from dangerous structural over-loads. Heretofore, cartridge actuated catapults and thrusters for various purposes have been used, but such devices have not been appropriate within the confined and cramped space available in a plane for moving the seats because the pressures available for short movements have been either unsuitable or the speeds of movements too rapid.

An object of this invention is to provide a cartridge actuated thruster for moving a seat in a plane regardless of the adjusted position of the seat and for other uses requiring comparatively short travel at safe speeds. A further object is to provide such a thruster having a single stroke speed reducing mechanism compactly embodied therein which acts to closely control speeds over the load and temperature range.

According to this invention, a cartridge actuated piston operates a second piston by an interposed liquid. A check valve on the second piston allows liquid to flow into a restricted space on an opposite side of a second piston for cushioning its movement. During movement of the piston and integral piston rod, the check valve is closed and a high pressure is developed on the liquid in such restricted space by limiting liquid escape through a constricted passageway whose cross sectional area determines to a large extent the speed of the second piston and the thrust output. In addition, the burning rate of the propellant is controlled with respect to the stroke and mass being positioned. Instead of escaping to the outside, liquid from the constriction is fed back to the space between the pistons where the pressure is lower than that in said restricted space.

The two figures of the drawing are a longitudinal cross section of a preferred embodiment of this invention, Figs. 1A and 1B being at opposite ends of the same thruster.

Referring to the drawings, the cylinder **10** is provided at its left end with a fitting **11** to which may be attached any convenient source of pressure such as a gas pressure cylinder or some cartridge device capable of delivering the appropriate pressure of about 1,000 lbs./sq. in. to the firing pin **13**. A shear pin **12** releases the firing pin for movement as soon as adequate pressure exists on the left side of the firing pin. As shown in the drawing, the firing pin is provided with a suitable packing around its periphery and after rupture of the shear pin **12**, the firing pin **13** impinges upon the primer **14** and related parts causing the propellent charge **15** to be set off. After being set off, the products of combustion from the cartridge **15** fill the space **16** within the skirt of the piston **17** and move the piston to the right. This piston is also provided with suitable packing **18** as illustrated.

A flexible container **19** holds an oily silicone liquid of low viscosity under wide temperature changes. The particular liquid selected has such nearly uniform viscosity throughout a temperature range from plus 160° Fahrenheit to minus 65° Fahrenheit. Movement of the first piston **17** to the right causes similar movement to the right of the flange **21** having attached thereto a tube **22** fitting over an inner tube **24** secured to the second piston. Under suitable pressure a snap ring **23**, shown as being located on the inner tube **24**, is moved out of place and the outer tube continues its movement to the right exposing an end of the inner tube as illustrated. On the end of the inner tube is an arcuate shaped punch **25** adapted to pierce the flexible container **19** with an arcuate shaped cut so that a flap on the bag exists through which the liquid is then able to escape and flow to the ball check valve **26**. This ball check valve is shown in the drawing as being threadedly secured within a second piston **27**, the right end of which could be designated as a rod **28**. The terms "piston" and "rod" as used herein are broad enough to cover a plunger as illustrated or other equivalent. The flange **21** contains a peripheral clearance space **29** for purposes disclosed hereinafter. The piston **27** is provided with appropriate packing **30**. The spring **31** cooperates with the ball check valve **26** and with the plug **32** to control the stress in the spring. A number of passageways **33** in the inner tube **24** are connected with a similar number of passageways **34** in the piston **27** by means of a circular depression or undercut **35** in an outer portion of the inner tube **24**.

The piston and piston rod have a hollow central portion **36** for the purpose of lightening their weight. In the thruster illustrated a shear pin **37** at the right end of the piston rod ruptures on application of the pressure developing about 2,000 lbs. force, and after this rupture the piston rod is forced outwardly. The right end **38** of the piston rod is shaped conveniently for cooperation with whatever type of load it engages during any portion of its stroke; in the embodiment illustrated this right end is shown as being rounded. A cap **39** is threaded or otherwise secured to the cylinder and is provided with appropriate packing **40** between the piston rod **28** and the inner wall of said cap.

A restricted space **41** is provided between the inside of the cylinder **10** and the outside of the piston rod **28**, this space being available for development of a high pressure on liquid after it has passed the ball check valve illustrated. Because the ends of this restriced space **41** are of small cross sectional area, the outward movement of the piston and piston rod tends to compress liquid within this restricted space **41** and develop a higher than usual pressure after the ball check valve has closed. Within the second piston **27**, and at the left end of the restricted space **41**, is a constricted passageway **42** through which liquid under pressure in the space **41** may be forced. The size of the constricted passageway **42** is effective in controlling the rate of outward travel of the piston and piston rod and the thrust output. When a shoulder **43** at the left end of the restriced space **41** has been moved to the right and impinges upon the shoulder **44** shown in the cap **39**, engagement of these two shoulders acts as an abutment to stop or limit outward movement of the piston and piston rod.

Thus, in operation, firing of the cartridge **15** moves the piston **17** to the right, imposing pressure upon the container **19** and also upon the flange **21**. As the flange is moved to the right, the arcuate punch **25** perforates the container allowing liquid to flow to the ball check valve **26** in the piston **27**. This check valve opens upon attainment of a predetermined pressure allowing liquid to flow radially outward through the passageways **33** and

34 into the restricted space 41 between the piston rods and the cylinder. As the piston and piston rod are moved to the right, the force causing the displacement becomes sufficient to rupture the shearing pin 37. After the rupture of the shear pin 37, the piston and piston rod continue their movement to the right placing pressure on the liquid in the restricted space 41 and raising its pressure to a value higher than that on the input side of the check valve. The rate of outward movement of the piston and piston rod depends on the cross sectional area of the constricted passageway 42 through which liquid is allowed to move rearwardly or to the left, filling the space to the left of the piston 27 and passing around the flange 21 and into and around the space occupied by the flexible container which by this time will have become compressed to contain folds and other irregularities. Also, the rate is substantially retarded regardless of whether the load is encountered at the beginning or end of stroke.

Among the advantages of this invention may be mentioned the provision, for the first time, of a reduction of speed for a one-stroke thruster operated by a cartridge. High pressure is developed in the liquid in the space 41 due to the small annulus area at the ends of this space, this area being smaller in cross sectional area than the effective area of the piston subject to the incoming liquid from the rubber bag. A desirable feature of the present construction is the absence of any leakage of liquid or gas to the outside, both pressures being contained within the package or outer casing. An especially noteworthy feature is the adaptability of the present thruster for functioning under extreme cold to which an airplane may be subjected at great heights. The piston 17 may be called a floating one inasmuch as it is not directly connected to the piston rod 28. When a floating piston is used in the illustrated combination with a continually open constricted passageway 42, the floating piston will have a shorter stroke than the main piston 27 due to these two pistons moving farther apart as they move forward, and as liquid from the restricted high pressure chamber 41 is fed into the low pressure chamber between them occupied by the container 19. When an aircraft seat is to be moved and the seat position is adjustable the thruster can start with or without load, contact the seat without excessive jar and then position it without exceeding the permissible velocity, acceleration, or rate of change of acceleration. A speed of 6 to 12 feet per second is desirable for such a seat. The contents of the container are adapted for use under a wide range of temperature because any expansion in the flexible container need not be objectionable. The foregoing advantages of a floating piston are made possible by the addition to the total length of the thruster of an amount no greater than the axial length of the floating piston. The shorter stroke of the floating piston makes for a more desirable initial to final expansion ratio of the propellent gases.

We claim:

1. A thruster including a casing which encloses means for producing a fluid pressure, a flexible container enclosing a fluid, a perforated flange having a first tubular extension, a first piston arranged to move said container and said flange in response to said pressure, a second piston having a central opening terminating in a second tubular extension extending into said first tubular extension and providing a cutting edge for puncturing said container in response to said movement, a power applying member fixed to said second piston and arranged to form within said casing a space having a transverse area substantially less than the transverse area of said second piston, a valve arranged in said central opening to admit some of said fluid to said space and to be closed in response to a pressure increase in said admitted fluid, and a restricted passageway extending longitudinally of said second piston for cushioning the effect of said increased liquid pressure.

2. A thruster including a casing enclosing means for producing a fluid pressure, a flexible container enclosing a fluid, a member having an opening terminating in a first tubular extension, a first piston arranged to move said container and said member in response to said pressure, a second piston having a central opening terminating in a second tubular extension extending into said first tubular extension and providing a cutting edge for puncturing said container in response to said movement and applying said fluid to said second piston, a power applying member fixed to said second piston, and means for fixing said power applying member to said casing until the pressure of said applied fluid has attained a predetermined value.

3. In a thruster having a casing enclosing means for applying an operating pressure and for releasing a fluid in response to said pressure, the combination of a piston movable in response to said released fluid and having a central opening, a power applying member fixed to said piston and arranged to form with said casing a space having a transverse area substantially less than the transverse area of said piston, a valve arranged in said central opening to admit operating fluid to said space and to be closed in response to a predetermined increase in the pressure of said admitted fluid, and restricted passageway means extending longitudinally of said piston for controlling the effect of said increased liquid pressure on said power applying member.

4. In a method of operating a thruster having a casing which encloses a piston fixed to a power applying member, the steps which include generating an operating pressure, utilizing said pressure to a fluid to said piston, confining some of said fluid so that its pressure is increased in response to movement of said piston, and venting said confined fluid in response to said increased pressure at a rate dependent on the desired thrust of said power applying member.

5. In a method of operating a thruster having a casing which encloses a piston fixed to a power applying member, the steps which include generating an operating pressure, utilizing said pressure to a fluid to said piston, confining some of said fluid so that its pressure is increased in response to movement of said piston, and venting said confined fluid to the rear of said piston in response to said increased pressure at a rate dependent on the desired thrust of said power applying member.

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