Feb. 8, 1949. D. E. MEITZLER 2,461,224

OVERSTROKE CONTROL FOR FREE-PISTON UNITS

Filed Aug. 23, 1944 3 Sheets-Sheet 1

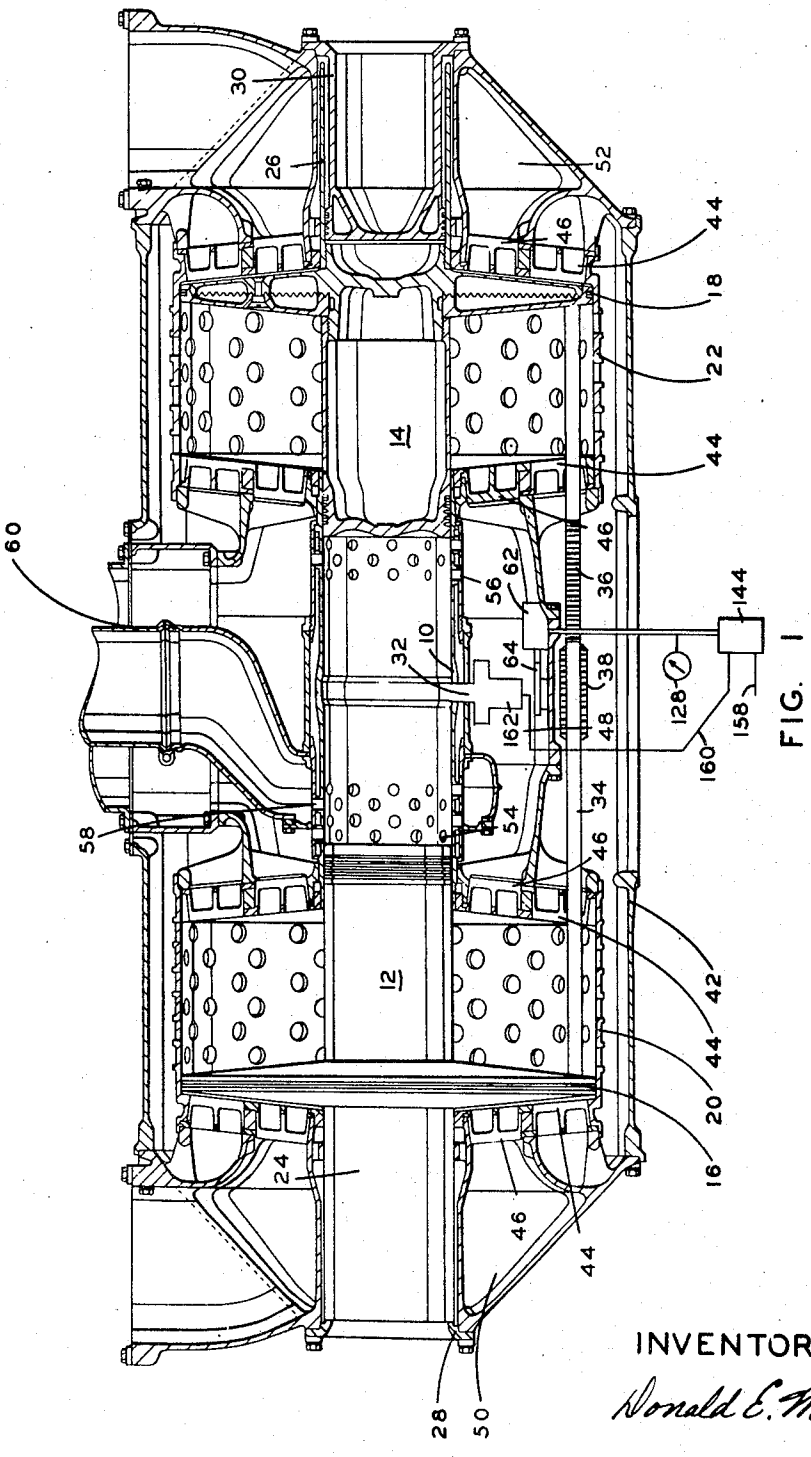


FIG. 1

INVENTOR

Donald E. Meitzler

Feb. 8, 1949. D. E. MEITZLER 2,461,224

OVERSTROKE CONTROL FOR FREE-PISTON UNITS

Filed Aug. 23, 1944 3 Sheets-Sheet 2

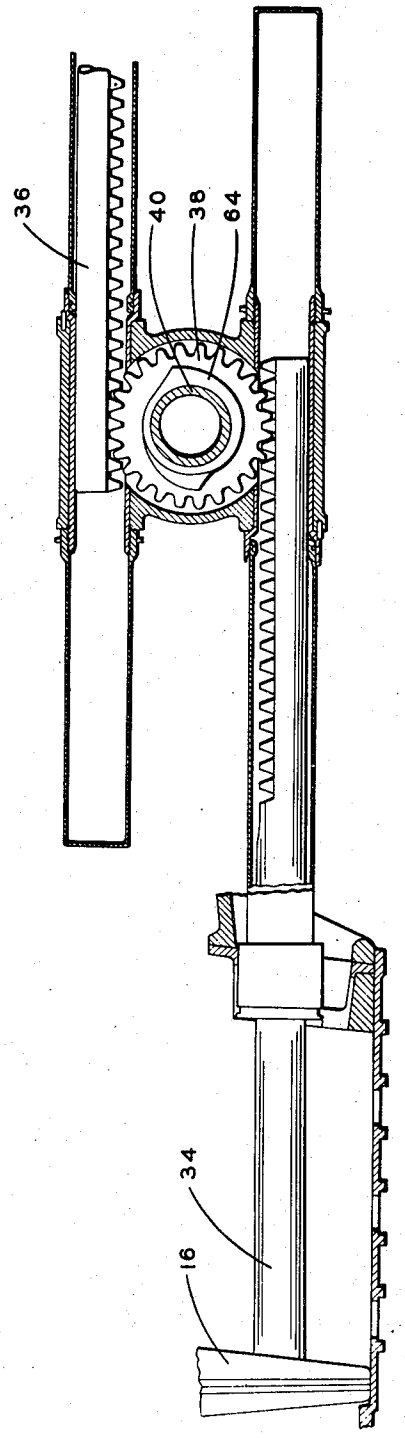


FIG. 2

INVENTOR

Donald E. Meitzler

Feb. 8, 1949. D. E. MEITZLER 2,461,224

OVERSTROKE CONTROL FOR FREE-PISTON UNITS

Filed Aug. 23, 1944 3 Sheets-Sheet 3

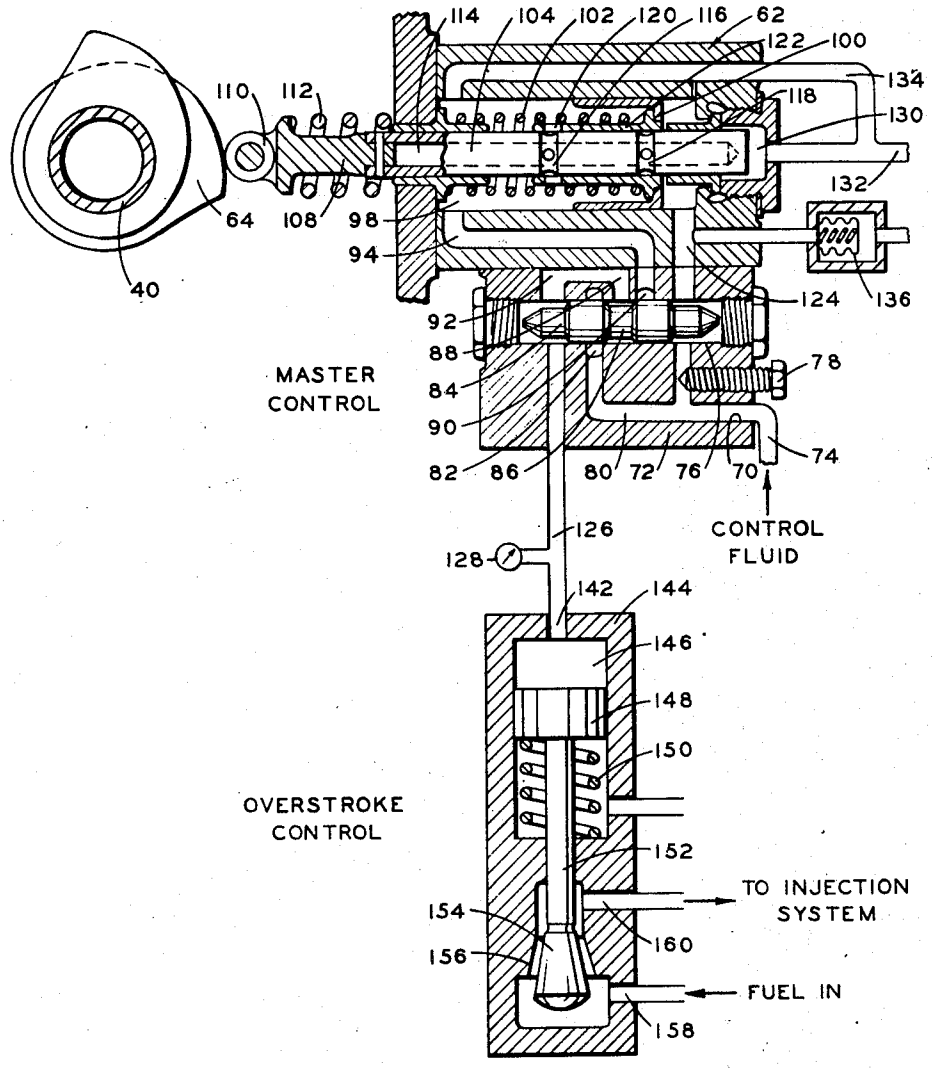


FIG. 3

INVENTOR

Donald E. Meitzler

Patented Feb. 8, 1949

2,461,224

UNITED STATES PATENT OFFICE

2,461,224

OVERSTROKE CONTROL FOR FREE-PISTON UNITS

Donald E. Meitzler, Manchester, Conn., assignor to United Aircraft Corporation, East Hartford, Conn., a corporation of Delaware

Application August 23, 1944, Serial No. 550,896

1 Claim. (Cl. 230—56)

1

This invention relates to a control for the fuel supply to a free-piston unit.

The length and position of the piston stroke in a free-piston unit are affected by changes in the operating conditions, and unless such changes are compensated for, the length of the stroke may, under certain conditions, become excessive. A feature of this invention is a control for the fuel supply which becomes operative in the event of piston overstroke.

Another feature is a fuel cut-off which shuts off the fuel supply and stops the unit when the end position of the piston stroke is outside the desired limits.

The copending application of Kalitinsky, Serial No. 550,883, filed August 23, 1944, on which Patent 2,420,483 has been issued, discloses a stroke indicating device or master control for the pistons of a free-piston unit. A feature of the present invention is the control of the fuel supply in response to an indicating device of this character.

Other objects and advantages will be apparent from the specification and claim, and from the accompanying drawings which illustrate an embodiment of the invention.

Fig. 1 is a sectional view through the unit.

Fig. 2 is a sectional view showing the restraining linkage for the pistons.

Fig. 3 is a diagrammatic view of the master control and the control for the fuel supply.

The unit shown includes an engine cylinder 10 having reciprocating pistons 12 and 14 to which compressor pistons 16 and 18 in cylinders 20 and 22 are integrally connected. Sleeves 24 and 26 attached to the compressor pistons complete the reciprocating piston assemblies. The sleeves in combination with stationary pistons 28 and 30 form air spring cylinders.

The piston assemblies are moved apart by the burning of fuel injected into engine cylinder 10 through one or more nozzles 32. Air compressed in the air spring cylinders on the power stroke returns the piston assemblies. The assemblies are always maintained at equal distances from the center of the engine cylinder by a linkage, which may include racks 34 and 36, Fig. 2, extending from the piston assemblies and meshing with a pinion 38 on a shaft 40.

Intake manifold 42, which extends around the compressor and engine cylinders, conducts air to intake valves 44 in the heads of the compressor cylinders through which air alternately enters opposite ends of these cylinders. The compressed air leaves the cylinders through discharge valves 46, also at opposite ends of the

2

compressor cylinders and passes into a central scavenge chamber 48 and end chambers 50 and 52. These chambers may be connected by a scavenge manifold, not shown.

Compressed gas from the chambers enters engine ports 54 and 56 which are uncovered by pistons 12 and 14 at the end of the power stroke, thereby permitting air to be blown through the engine cylinder. Gas in the engine cylinder is discharged through exhaust ports 58 into exhaust manifold 60.

The location of the outer end of the piston stroke is indicated by a master control 62. This control is actuated by a cam 64 turning with the pinion 38, as shown in Fig. 2. Since this pinion is oscillated directly from the pistons, the movement of cam 64 is proportional to the piston stroke.

Fluid under pressure from a constant pressure source enters a passage 70 in a casing 72 through a conduit 74. This passage intersects a bore 76 adjacent its outer end and a throttling screw 78 controls the rate of flow into bore 76. A branch passage 80 from passage 70 connects with a port 82 in bore 76. A plunger 84 in bore 76 has a groove 86 which connects a port 88 alternately with port 82 or a port 90. Port 88 is connected by a passage 92 to the inner end of bore 76. Port 90 is connected by a channel 94 in casing 72 and in an adjacent casing 96 to the inner end of a bore 98 in casing 96.

A piston 100 in bore 98 is moved to the right by a calibrated spring 102. A plunger 104 extends through the piston and carries on its projecting end a push rod 108. This rod has a roller 110 held against cam 64 by a spring 112. Plunger 104 has a central passage 114 connected with spaced grooves 116 and 118 in the plunger. Groove 116 aligns with openings 120 in a sleeve 122 carried by piston 100 and groove 118 is adapted to be uncovered by the end of sleeve 122 as the plunger is moved to the right by the cam as the pistons approach the outer ends of their stroke.

Fluid under pressure from the right hand end of bore 76 enters the outer end of bore 98 through a connecting channel 124, moving piston 100 against the action of spring 102. As plunger 104 is moved by cam 64 the groove 118 is uncovered by sleeve 122 to permit discharge of fluid from the right hand end of bore 98. The pressure in the right hand end of bore 98 varies in accordance with the compression of the spring, and as the piston stroke becomes shorter, the piston 100

moves inward increasing the spring tension and increasing the pressure at the end of bore 98.

Since the change in pressure on the outer end of plunger 84 is proportional to the change in the location of the end position of the piston stroke, the pressure on the inner end of plunger 84, which balances the pressure on the outer end, must vary in the same manner. In this way the pressure in the discharge conduit 126 is proportional to the spacing of the actual end of the piston stroke from the extreme outer position of the piston, and changes in the pressure of the fluid in this conduit will be proportional to changes in the end position of the piston stroke. This pressure (and change in pressure) may indicate on a calibrated gauge (not shown) the exact position of the end of the piston stroke and may be used for actuating the fuel control means.

The outer end of plunger 104 may reciprocate in a chamber 130 connected by a conduit 132 to a sump, not shown. The inner end of bore 98 may be connected by a conduit 134 to conduit 132. It may be advantageous to reduce pressure surges in channel 124 by means of a bellows 136.

Control fluid from the outer master control may be used to cut off the supply of fuel in the event that the length of stroke becomes excessive or if the end of the actual piston stroke approaches outer dead center. As shown conduit 126 is connected to a port 142 in a casing 144 for the overstroke control. This port communicates with the end of a bore 146 in which a plunger 148 is slidable, this plunger being held in the position shown by a spring 150.

Plunger 148 has a projecting stem 152 on the end of which is a tapered plug 154 engaging a seat 156 between the fuel inlet port 158 and the fuel outlet port 160 which is connected to the injection system 162. The injection system may be of the type shown in the coopending application of Meitzler, Serial Number 486,625, filed May 11, 1943.

During the normal stroke of the free-piston compressor the control fluid from the master control has a high enough pressure to move plunger 148 downwardly against the action of spring 150 to move the plug 154 away from its seat and permit fuel to reach the injection system. As the length of the stroke becomes excessive thereby causing the actual outer end position of the piston stroke to approach outer dead center the pressure of the control fluid decreases, permitting valve plug 154 to be moved upwardly for reducing the fuel supply to the engine. The tendency of a reduction in the fuel supply is to shorten the piston stroke. If the outer end of the actual piston stroke continues to approach the outer dead center position the valve will be closed more and more until plug 154 seats fully and cuts off the supply of fuel to the injection system.

In operation, the piston assemblies normally reciprocate in such a way that the engine pistons do not touch on the inward stroke and the compressor pistons do not go far enough on the outward stroke to engage with the cylinder heads. On each outward stroke, cam 64 moves plunger 104 toward the right, Fig. 3, to cause the piston to uncover the groove 118 thereby allowing fluid under pressure to escape from the space at the right of the piston 100. Thus, the location of the piston 100 is determined by the position of the groove 118 at the outer end of the movement of the plunger 104, and the spring 102 accordingly determines the pressure acting on the piston 100 and the pressure at opposite ends of the plunger 84. If the engine piston stroke shortens, the pressure builds up on the piston 100 moving it to the left until it reaches a position such that the groove 118 will be uncovered at the outer end of the engine piston stroke. This increase in pressure, as the stroke shortens, is transmitted to the gage 128 and also to the bore 146 thereby moving the valve 154 down to increase the flow area for the fuel through the valve 144 to the fuel injection system.

Conversely, if the stroke of the engine piston increases in length, the plunger 104 is moved farther to the right at the outer end of each piston stroke thereby venting the space at the right of the piston 100 to allow the piston 100 to move toward the right thereby reducing the pressure at opposite ends of the plunger 84. This reduced pressure is transmitted through conduit 126 to bore 146 thereby allowing the valve plug 154 to be moved upward by the spring 150 for reducing the flow area through the over-stroke control. If the length of the piston stroke becomes excessive, the pressure in the bore 146 will drop to such an extent that the supply of fuel to the injection system will be completely cut off to stop the free-piston unit.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described but may be used in other ways without departure from its spirit as defined by the following claim.

I claim:

A free-piston unit including an engine cylinder and piston, means for injecting fuel into said engine cylinder, means responsive to piston movement for changing the pressure of a control fluid proportionally to the change in the position of the piston at the end of successive strokes, and a plunger actuated by said control fluid and movable in response to changes in pressure of said fluid, a valve mechanically connected to and movable at all times with said plunger, said valve being controlled by said plunger for cutting off the supply of fuel to said injecting means if the piston moves beyond a predetermined limit and a spring acting on said valve and plunger in a direction to open said valve in opposition to the pressure of said control fluid on said plunger.

DONALD E. MEITZLER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,038,442	Pescara	Apr. 21, 1936
2,064,976	Janicke	Dec. 22, 1936
2,084,823	Pateras-Pescara	June 22, 1937
2,086,228	Janicke	July 6, 1937
2,090,709	Steiner	Aug. 24, 1937
2,102,121	Janicke	Dec. 14, 1937
2,147,935	Steiner	Feb. 21, 1939
2,168,828	Pescara	Aug. 8, 1939
2,182,063	Steiner	Dec. 5, 1939
2,200,892	Pateras-Pescara	May 14, 1940
2,344,058	Pateras-Pescara	Mar. 14, 1944
2,434,778	Welsh	Jan. 20, 1948
2,434,877	Welsh et al.	Jan. 20, 1948

FOREIGN PATENTS

Number	Country	Date
438,929	Great Britain	Nov. 26, 1935
541,779	Great Britain	Dec. 11, 1941