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2,439,482

STARTING SYSTEM FOR FREE PISTON ENGINES

Filed July 23, 1943

2 Sheets-Sheet 1

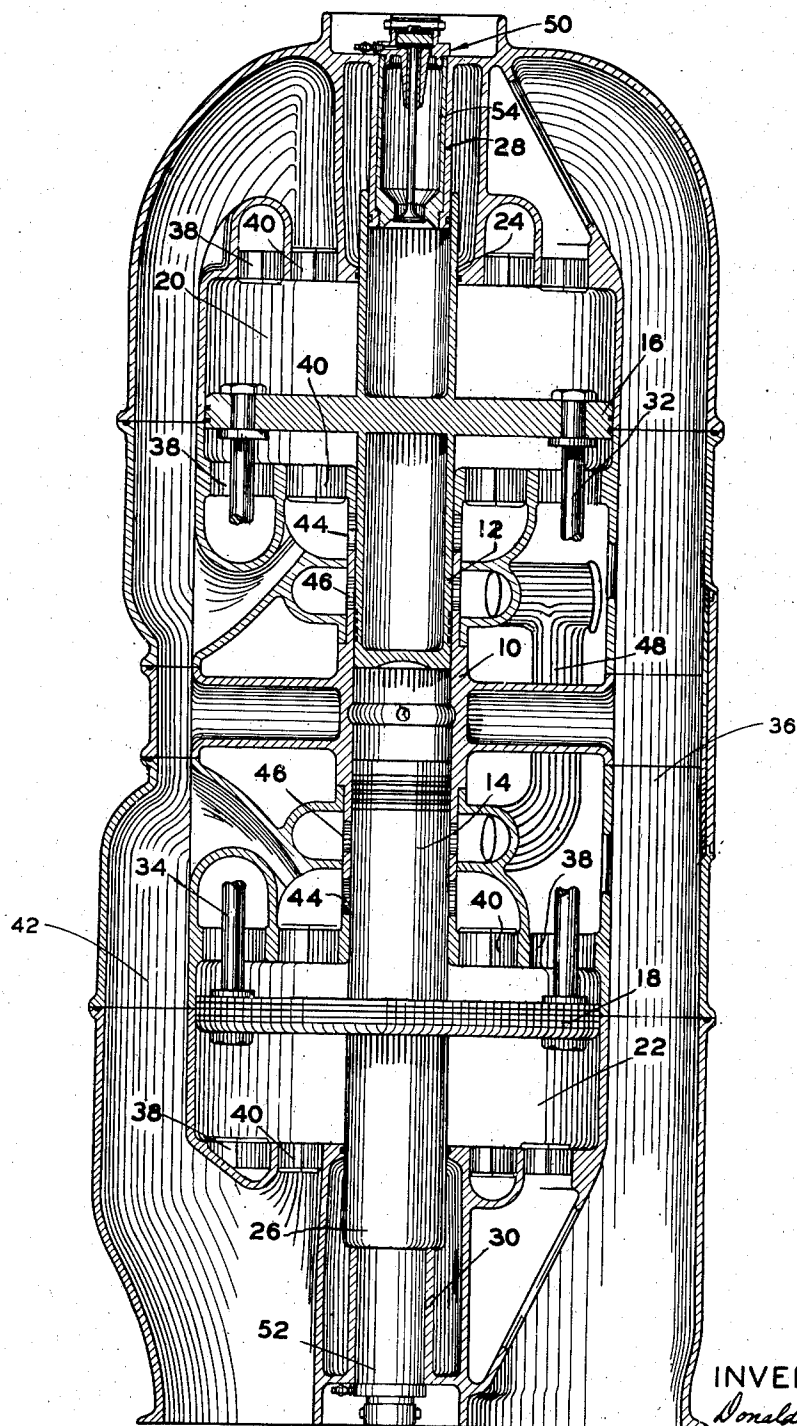


FIG. 1

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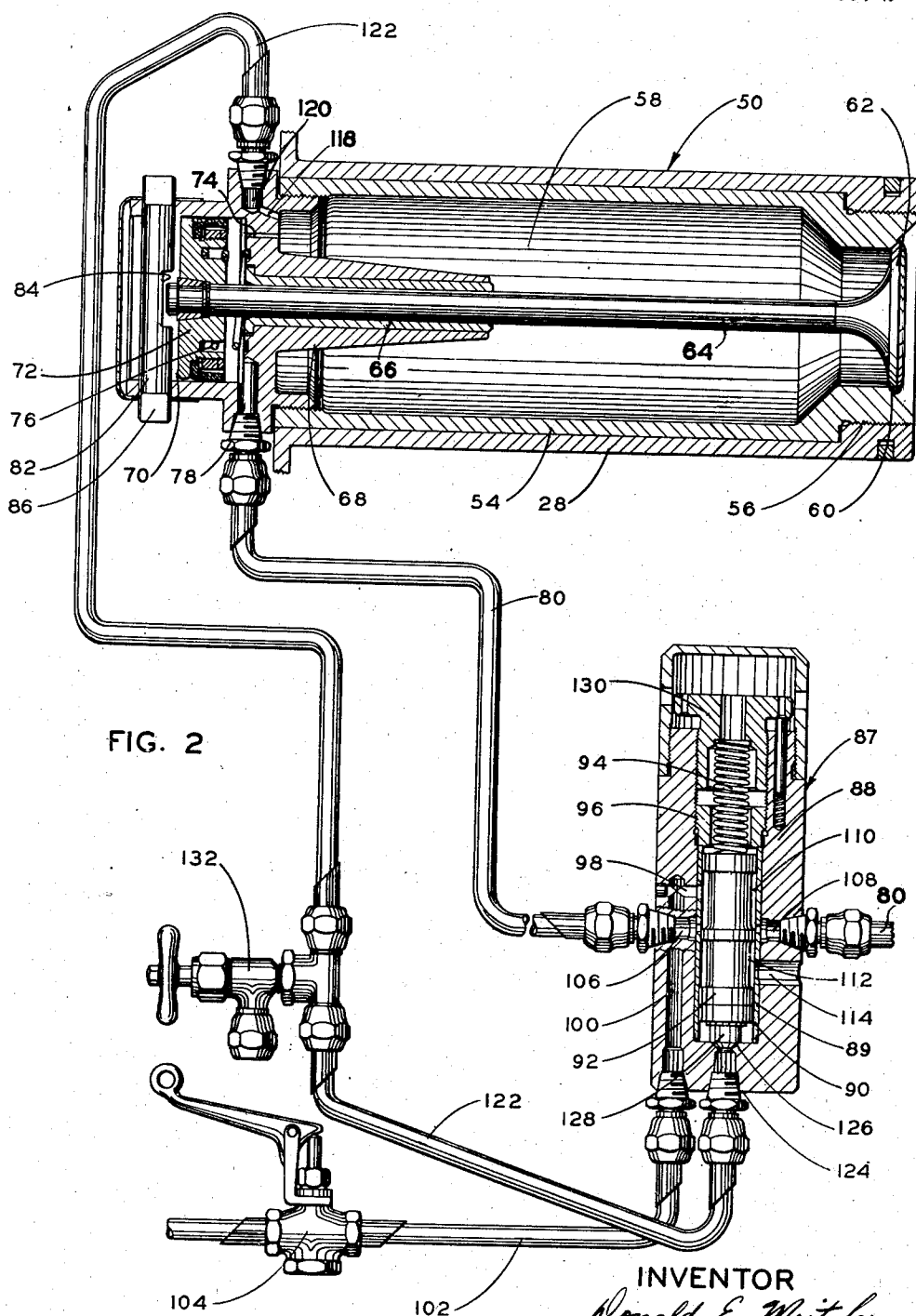


FIG. 2

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STARTING SYSTEM FOR FREE
PISTON ENGINESDonald E. Meitzler, Manchester, Conn., assignor
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Application July 23, 1943, Serial No. 495,927

11 Claims. (Cl. 60—14)

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This invention relates to an engine starting mechanism and particularly to a starter for free-piston engine-and-compressor units.

Conventional free - piston engine - and - compressor units may be started by admitting gas under pressure into a part of the unit, such as the air springs. The volume and pressure of the gas admitted must be controlled in order to assure the necessary length of piston stroke. A feature of this invention is the automatic discharge into the unit of a measured quantity of gas for starting.

In accumulator devices having a chamber in which the desired volume and pressure of gas is developed, the discharge of gas from the chamber has been effected by manually cutting off the supply of gas to the device and opening the supply port to the atmosphere. A feature of this invention is the automatic discharge of gas from the chamber as soon as the desired pressure has been developed.

The co-pending Cooper application, Serial No. 495,926, filed July 23, 1943, shows an accumulator valve having a storage chamber from which gas is released into the air spring of a free-piston engine-and-compressor unit for starting the engine. An object of this invention is to provide an automatic control for that type of device.

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

Fig. 1 is a side elevation partly in section of a free-piston unit incorporating the starting mechanism.

Fig. 2 is a diagrammatic view of the starting mechanism.

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. Air compressed in the air spring cylinders on the power stroke returns the piston assemblies. These assemblies are maintained at equal distances from the center of the engine cylinder by a linkage of which rods 32 and 34, extending from the compressor, may form a part.

Intake manifold 36 conducts air to intake valves 38 through which air alternately enters

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opposite ends of the compressor cylinders. The compressed air leaves the cylinders through discharge valves 40, also at opposite ends of the compressor cylinders, and passes through scavange manifold 42 through ports 44 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 and exhaust ports 46 into exhaust manifold 48. Valves 36 and 38 may be the type shown in Huff Patent No. 1,599,414, dated September 14, 1926.

Starting devices 50 and 52 for the unit are mounted in air spring pistons 28 and 30. The devices are similar and only device 50 in piston 28 will be described in detail. This device includes a housing 54 held within piston 28 by interengaging threads 56 and having accumulator or storage chamber 58, Fig. 2. This chamber has a port 60 communicating with the air spring cylinder and closed by a poppet valve 62. The stem 64 of this valve is slideable in a guide 66 in a cap 68 forming a part of housing 54. Valve 62 closes port 60 by movement toward the storage chamber and is opened by movement away from the storage chamber, so that the pressure of the gas within the storage chamber assists in opening of the valve, and pressure of gas in the air spring holds the valve closed during operation of the unit.

Cap 68, which closes the end of chamber 58, has a bore forming a cylinder 70 which receives a piston 72 on the end of valve stem 64. The inner end of cylinder 70 is connected with the storage chamber by a restricted channel 74. A coil spring 76 in the cylinder moves the piston toward valve closing position. Cap 68 has an inlet channel 78 intersecting the inner end of cylinder 70 and a conduit 80 is connected to this channel.

When gas under pressure is introduced to the device through conduit 80, pressure beneath piston 72 assists spring 76 in keeping the valve closed. Gas under pressure enters storage chamber 58 through restricted channel 74 and accumulates in the chamber. The pressure of the gas acting on the piston (which is at least as large as the valve) and the pressure of spring 76 will keep the valve closed, since pressure in the storage chamber cannot exceed the pressure on the piston.

After a sufficient pressure has been built up in the storage chamber, conduit 80 is opened to the atmosphere. This results in a sudden drop in pressure on the piston holding the valve closed. The pressure in storage chamber 58 acting on

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valve 62 opens the valve and the gas stored in the chamber is discharged quickly through the valve port into the air spring.

Throttling channel 74 is so proportioned that a negligible volume of gas escapes from the storage chamber into cylinder 70, while valve 62 is open. As soon as the gas discharges from the chamber, the valve is closed by spring 76.

In starting the free-piston unit, the engine pistons are first moved to the outer ends of their strokes. Gas is conducted from a source through conduits 80 to starting devices 50 and 52. Release of pressure in conduits 80 causes a sudden inrush of compressed air from the valve mechanisms into the air springs which moves the engine pistons toward each other, to the inner ends of their strokes.

The same action occurs in both air springs and the opposed pistons are simultaneously moved toward each other. The storage chambers in the starting devices accommodate the required amount of gas for engine starting without causing an excessive piston stroke. The valves are closed immediately after the discharge of gas into the air springs and discharge of gas from the air springs into the accumulator chambers is prevented during operation of the engine.

Cap 68 has a transversely extending pin 82 which is notched at 84 in line with valve stem 64. The outer ends of pin 82 are flattened as shown at 86 to receive a wrench for turning the pin. When pin 82 is turned, it will engage the end of valve stem 64 and open the valve for relieving pressure in the air spring. The structure of these starting devices is described and claimed in the co-pending Cooper application, Serial No. 495,926, filed July 23, 1943.

Either or both starting devices 50 and 52 may be controlled by an automatically operating valve 87 which admits gas under pressure to the device and causes the poppet valve to open at a predetermined pressure in the storage chamber. Valve 87 includes a casing 88 having a bore 89 receiving a stationary sleeve 90 in which a valve plunger 92 is movable, the plunger being normally held in the position of Fig. 2 by a spring 94. Sleeve 90 is held within casing 88 by a clamping nut 96.

Casing 88 has a port 98 connected by a channel 100 and conduit 102 to a source of gas under pressure, an inlet control valve 104 admitting gas to valve 87 when desired.

Casing 88 also has a port 106 connected by conduit 80 to device 50. An opposed port 108 may be connected by a similar conduit to device 52. Plunger 92 has a groove 110 which, when the plunger is in normal position shown, provides fluid connection between inlet port 98 and port 106, thereby directing gas from the source to the accumulator device.

Plunger 92 has another annular groove 112 which upon upward movement of the plunger establishes fluid connection from port 106 to one or more large discharge ports 114 in casing 88, these discharge ports communicating with the atmosphere.

Plunger 92 is automatically shifted from the position of Fig. 2 when the gas pressure in the accumulator chamber has reached a predetermined value. Chamber 58 has a port 118 connected by a channel 120 and conduit 122 to a port 124 at the end of the valve plunger. This port has a valve seat 126 engaged by a valve 128 on the end of plunger 92. Valve 128 is smaller in diameter than the main part of the plunger and

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when the plunger is raised from valve seat 126, gas from port 124 enters the plunger bore and causes an immediate motion of the plunger against the action of spring 94. Adjustment of the tension of spring 94 by a nut 130 controls the pressure at which the control valve 87 operates.

In operation, the engine pistons are first moved to the outer ends of their strokes. Gas is then admitted to valve 87 by manually controlled valve 104. Gas entering valve 87 passes around groove 110 and through port 106 to cylinder 70 of device 50. Gas reaches device 52 by port 108 in a similar way. Gas under pressure reaches storage chamber 58 through channel 74 which connects with cylinder 70. As gas pressure increases in chamber 58, the pressure in port 124 increases correspondingly until the pressure on the end of plunger 92 overcomes the action of spring 94 and moves plunger 92 to connect port 106 to discharge port 114. This movement of plunger 92 admits gas under pressure into the air springs (if both devices 50 and 52 are connected to valve 87), thereby moving the engine pistons inwardly to start the compressor unit. A manual valve 132 may be provided in conduit 122 for relieving the pressure in this conduit.

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 claims.

I claim:

1. An accumulator device having an accumulator chamber, a valve closing a port for said chamber and movable by pressure in the chamber acting directly on the valve for opening it, and means for holding said valve closed against the pressure in said chamber, in combination with a control valve responsive to changes in pressure in said chamber for cutting off the supply of gas to said chamber and for releasing said valve-holding means when pressure in the chamber reaches a predetermined value.

2. An accumulator device having a chamber in which gas under pressure is stored, a valve closing a port for said chamber and movable by pressure in the chamber acting on the valve for opening it, a piston connected to said valve, and means for introducing gas to one side of said piston for holding said valve closed, in combination with a control valve responsive to changes in pressure in the chamber for automatically cutting off the supply of gas to said chamber and for releasing the gas pressure acting on the piston.

3. An accumulator device having a storage chamber, a valve closing a port for said chamber and movable by pressure in the chamber acting on the valve for opening it, a cylinder, a piston movable in said cylinder, and connected to said valve, and means for directing gas under pressure to said cylinder for holding the valve closed in combination with a control valve responsive to pressure in said chamber and automatically operative when pressure in the storage chamber reaches a predetermined value for cutting off the supply of gas to the chamber and connecting the cylinder to the atmosphere.

4. An accumulator device having a storage chamber, a valve closing a port for said chamber, a cylinder, a piston movable in said cylinder and connected to said valve, means for directing gas under pressure to said cylinder for holding the valve closed, and a throttling passage between said chamber and said cylinder through which gas is supplied to said chamber, in combination

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with a pressure operated control valve responsive to pressure in the chamber and for connecting the cylinder to the atmosphere when pressure in the storage chamber reaches a predetermined value and a fluid connection from said chamber to the control valve.

5. An accumulator device having a storage chamber, a valve closing a port for said chamber, and means for holding said valve closed against the pressure in said chamber, in combination with a control valve normally directing gas to said chamber, and a connection from said chamber to said control valve for operating said control valve to cut off the supply of gas to the chamber and to release the valve-holding means.

6. In a control mechanism, an accumulator device having a ported chamber with a valve closing the port, and a piston connected to said valve, pressure on the piston holding the valve closed, in combination with a control valve for admitting fluid to said device for holding the valve closed and for storing fluid in said chamber, said control valve being movable in response to pressure in the chamber for cutting off the supply of fluid to said chamber and for relieving the pressure on the piston.

7. In a control mechanism, an accumulator device having a ported chamber with a valve closing the port, and a piston connected to said valve, pressure on the piston holding the valve closed, in combination with a control valve for admitting fluid to said device for holding the valve closed and for storing fluid in said chamber, said control valve being movable to another position for relieving the pressure on the piston, and means associated with said valve and responsive to pressure changes in the chamber for shifting said valve from one position to the other when pressure in the chamber reaches a predetermined value.

8. An accumulator device for use in starting a free-piston unit, said device being connected to the air spring for admitting air under pressure to said spring, said accumulator device having a storage chamber, a valve closing the port for said chamber, a cylinder, a piston movable in said cylinder and connected to said valve, and means for directing gas under pressure to said cylinder for holding the valve closed, in combination with a pressure operated control valve responsive to pressure changes in the chamber and automatically operative when pressure in the storage chamber reaches a predetermined value for cutting off the supply of gas to the chamber and for connecting the cylinder to the atmosphere.

9. An accumulator device for use in starting a free-piston unit, said device being connected to the air spring for admitting air under pressure to said spring, said accumulator device having a storage chamber, a valve closing the port for said chamber, a cylinder, a piston movable in said cylinder and connected to said valve, means for admitting gas under pressure to said cylinder for

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holding the valve closed, and means for admitting gas from said cylinder to said chamber, in combination with a pressure operated control valve responsive to changes in pressure in the chamber and automatically operative when pressure in the storage chamber reaches a predetermined value for cutting off the supply of gas to the cylinder and for connecting the cylinder to the atmosphere.

10. The combination with an accumulator device having a chamber in which gas is accumulated under pressure, and a valve closing the port for said chamber, of a control valve for admitting gas under pressure to said chamber and for causing said port-closing valve to open when the pressure in the chamber reaches a predetermined value, said control valve including a casing, a plunger slidable in said casing and movable for controlling the flow of gas through said casing, a fluid connection from the chamber to one end of the casing whereby the pressure in the chamber is transmitted to the end of the plunger and a spring urging the plunger against the pressure acting on said plunger.

11. The combination with an accumulator device having a chamber in which gas is accumulated under pressure and a valve closing the port for said chamber, of a control valve for admitting gas under pressure to said chamber and for causing said port-closing valve to open when the pressure in the chamber reaches a predetermined value, said control valve including a casing, a plunger slidable in said casing and movable for controlling the flow of gas through said casing, a fluid connection from the chamber to one end of the casing whereby the pressure in the chamber is transmitted to the end of the plunger, a spring urging the plunger against the pressure acting on said plunger and means for adjusting the effect of the spring for controlling the pressure at which the plunger will move.

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