

Feb. 8, 1949.

D. E. MEITZLER

2,461,222

ACCUMULATOR INJECTION SYSTEM

Filed May 11, 1943

4 Sheets-Sheet 1

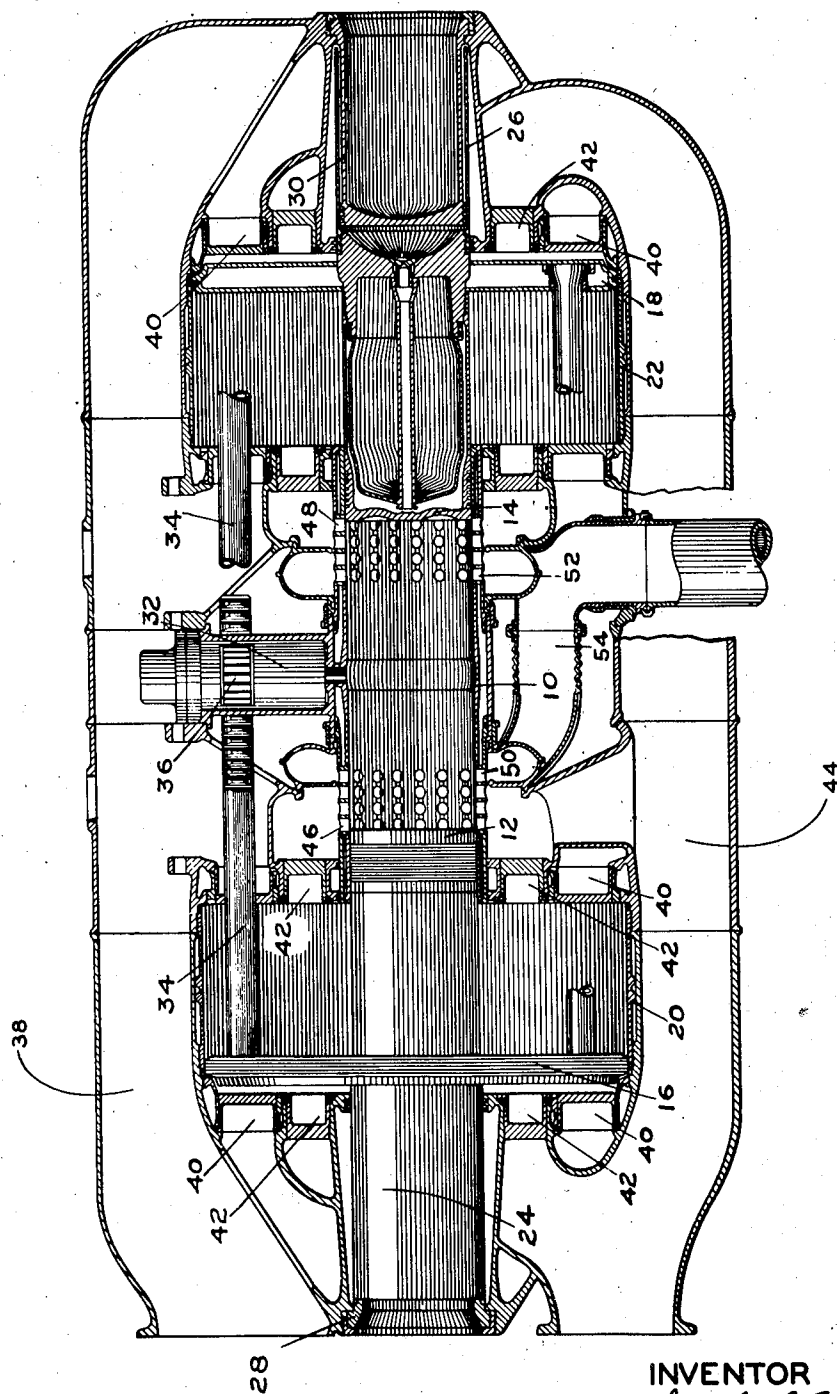


FIG. 1

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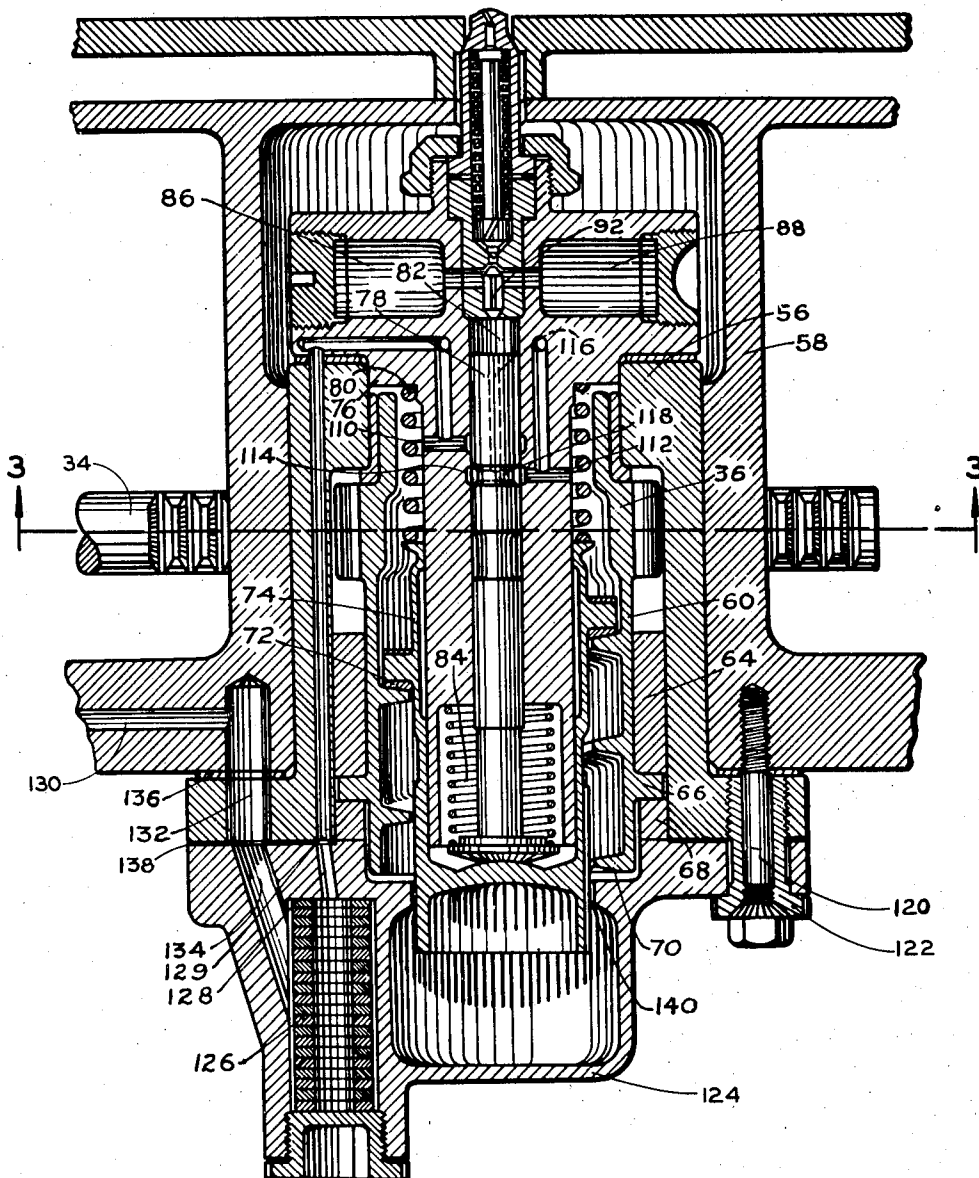
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4 Sheets-Sheet 2



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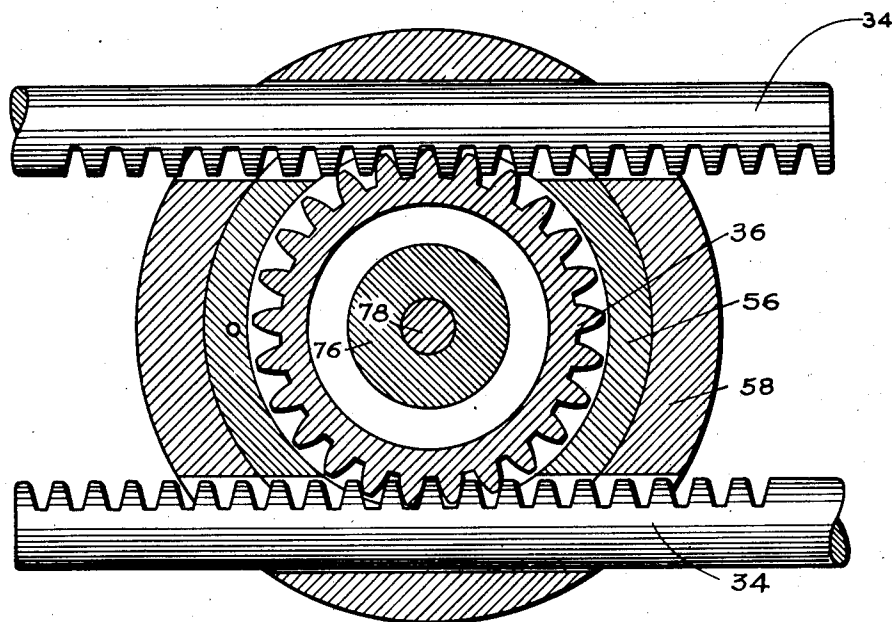


FIG. 3

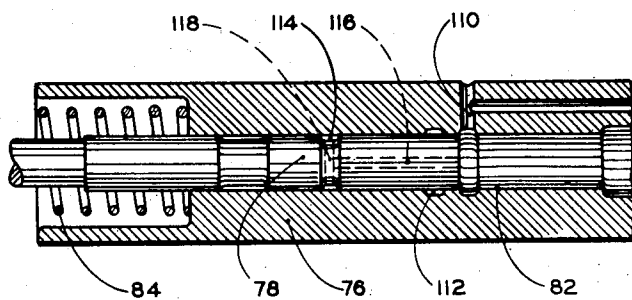


FIG. 4

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4 Sheets-Sheet 4

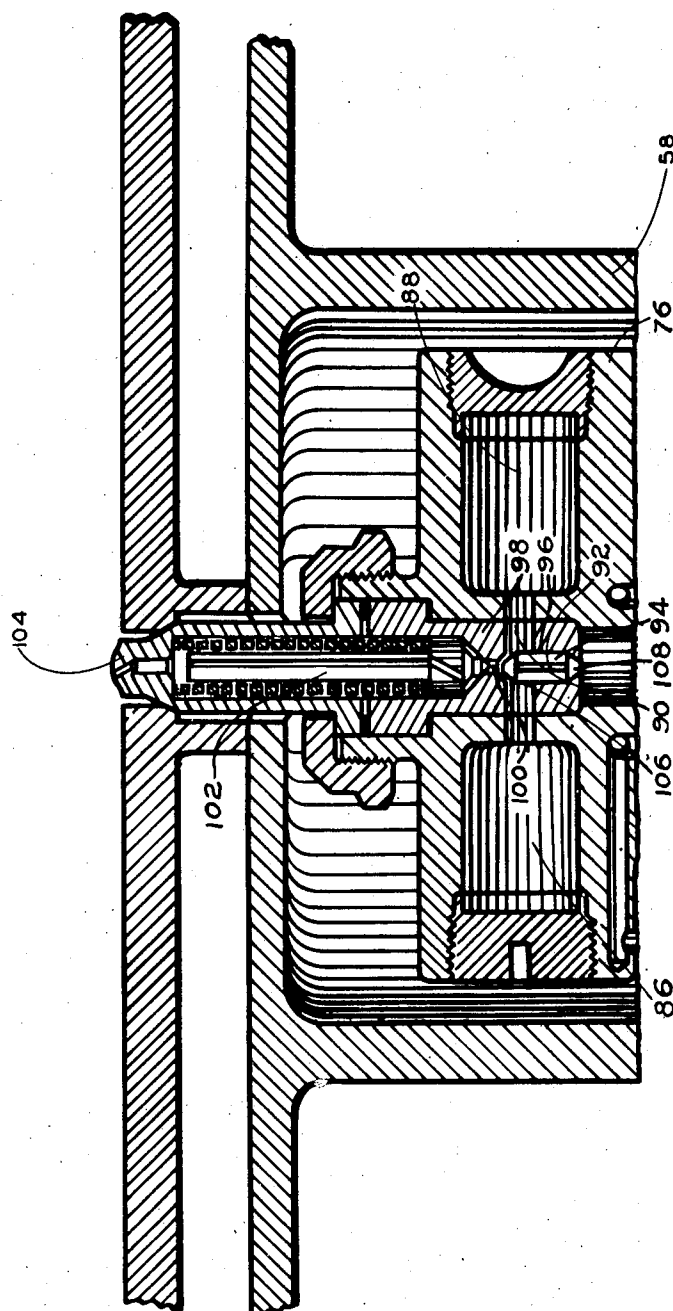


FIG. 5

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2,461,222

ACCUMULATOR INJECTION SYSTEM

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6 Claims. (Cl. 230-56)

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This invention relates to fuel injection apparatus, particularly for free-piston engine-and-compressor units.

In free-piston units the opposed pistons may be maintained at equal distances from the center of the engine cylinder by a restraining linkage which includes racks extending from the pistons, and a pinion engaging the racks. Such linkages have served to actuate fuel pumps. The axis of the interconnecting pinion is normally at right angles to the axis of the engine cylinder. If the pump also extends radially, actuation of the pump from the pinion is difficult. An object of this invention is to actuate a radially positioned pump from the oscillating pinion by a simple driving connection.

Another feature is the mounting of the pump coaxially with the restraining pinion and the actuating of the pump by the oscillation of the pinion. Still another feature is the support of the pinion by an external bearing in such manner that the pump may extend through the pinion and be actuated thereby.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawing which illustrates what is now considered to be a preferred embodiment of the invention.

Fig. 1 is a sectional view through the free-piston engine-and-compressor unit showing the restraining linkage.

Fig. 2 is a sectional view through the injection device and the supporting bracket.

Fig. 3 is a sectional view on line 3-3 of Fig. 2 showing the rack drive.

Fig. 4 is a fragmentary section of the injection plunger and surrounding casing, showing the plunger at the start of its injection stroke.

Fig. 5 is a sectional view on a larger scale of a part of the device of Fig. 2.

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 by one or more devices 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 including racks 34 on the compressor pistons meshing with a pinion 36 (Figs. 2 and 3).

Intake manifold 38 conducts air to intake valves 40 through which air alternately enters opposite ends of the compressor cylinders. The compressed air leaves the cylinders through discharge valves 42, also at opposite ends of the compressor cylinders, and passes through scavenge manifold 44, through ports 46 and 48 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 50 and 52 into exhaust manifold 54.

Pinion 36 is supported in a housing 56 forming part of the injection device 32 which is mounted in a tubular bracket 58. The pinion is integral with a shaft 60 journaled in the housing, and supported by a ring 64 in housing 56. A radial flange 66 on the shaft which is held between the end of bearing ring 64 and a thrust ring 68 prevents endwise movement of the pinion.

The inner surface of shaft 60 has a helix 70 engaging several spaced shoes 72 on a cup 74. This cup is positioned over a casing 76 in which injection plunger 78 is movable. A coil spring 80 urges cup 74 axially to hold the shoes in contact with the helix. As pinion 36 is oscillated by racks 34, plunger 78 is moved longitudinally in its bore 82 in casing 76, since the end of plunger 78 is held against the cup by a coil spring 84.

The injection system may be the accumulator type, as shown. Casing 76 may have opposed accumulator chambers 86 and 88 interconnected by a passage 90, Fig. 5. Fuel from the end of bore 82 reaches the chambers through a groove 92 in an accumulator valve 94 which slides in a bore 96 in a ring 98 in casing 76. Fuel escapes from accumulator chambers through a passage 100 and past a check valve 102 to the nozzle 104. The accumulator valve 94 moves endwise to engage a seat 106 at the end of passage 100 or a seat 108 in ring 98 for closing groove 92.

As the plunger 78 is moved on the injection stroke (to the right from the position of Fig. 4), fuel which entered the end of bore 82 through an inlet port 110 is forced into the accumulator chambers through groove 92 until a discharge port 112 is uncovered by a groove 114 in the plunger. This groove 114 is connected to the head of the plunger by passages 116 and 118. When port 112 is uncovered (plunger position of Fig. 2), the pressure at the end of the plunger drops suddenly so that the pressure acting on

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valve 94 to hold it against seat 106 is relieved. This valve then moves against seat 108 and fuel discharges past check valve 102 and through nozzle 104.

The entire fuel injection system is thus mounted within pinion 36 which forms a part of the restraining linkage and the injection plunger is actuated by the oscillation of the pinion as the engine pistons reciprocate.

The injection device is mounted as a unit in tubular bracket 58. Housing 56 with the device assembled therein is held in the bracket by studs 120. These studs 120 pass through hollow studs 122 which hold a cap 124 on housing 56. Cap 124 also has mounted therein a filter element 126, the end of which communicates with passages 128 and 129 in cap 124 and housing 56 through which fuel reaches inlet port 110. Fuel is delivered to the filter through a passage 130 in bracket 58 and passages 132 and 134 in housing 56 and cap 124. With this arrangement the filter element is removed as a unit with the injection device. Thus, any foreign matter that may be in passages 130 or 132 when a device is dismounted from bracket 58 will be filtered out before the fuel reaches the injection pump. Gaskets 136 and 138 may be used to prevent leakage of fuel.

Cap 124 may also have splines 140 interengaging splines on cup 74 to prevent rotation of the cup during its reciprocation.

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. A free-piston compressor having opposed pistons and a restraining linkage connecting said pistons and including an oscillatory pinion, in combination with a fuel injection pump including a casing having a bore, a plunger in said bore and coaxial with the pinion, said pinion surrounding said casing with the plunger concentric to the pinion axis, and cooperating means connecting the pump plunger and pinion for reciprocating the pump plunger in response to the pinion oscillation.

2. A free-piston compressor having opposed pistons and a restraining linkage connecting said pistons and including an oscillatory pinion, in combination with a fuel injection pump, said pump including a casing at least partially within and surrounded by said pinion and having a bore coaxial with the pinion, a reciprocating plunger in said bore and also coaxial with the pinion, a thrust cup engaging the plunger, and means interconnecting the pinion and the thrust cup for reciprocating said cup and said plunger as the pinion oscillates.

3. A free-piston compressor having opposed pistons and a restraining linkage connecting said pistons and including an oscillatory pinion, in combination with a fuel injection pump including a casing having a bore, a plunger in said bore and coaxial with the pinion, said pinion sur-

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rounding said casing with the plunger concentric to the pinion axis, and cooperating means connecting the pump plunger and pinion for reciprocating the plunger in response to pinion oscillation, said means including a helix element and cooperating elements engaging said helix element, one of said elements being connected to the pinion and the other being connected to the plunger.

4. A free-piston compressor having opposed pistons and a restraining linkage connecting said pistons and including an oscillatory pinion, in combination with a fuel injection pump including a casing having a bore, a plunger in said bore and coaxial with the pinion, said pinion surrounding said casing with the plunger concentric to the pinion axis, and cooperating means connecting the pump plunger and pinion for reciprocating the plunger in response to the oscillation of the pinion, said means including a helix on the pinion and cooperating lugs engaging the helix and connected to the plunger.

5. A free-piston compressor having opposed pistons, and a restraining linkage connecting said pistons and including an oscillatory pinion, in combination with a fuel injection device including a casing having a bore, and a plunger reciprocating in said bore, said device being surrounded by the pinion, the axis of the pinion being substantially concentric with the longitudinal axis of the plunger.

6. A free-piston compressor having opposed pistons, and a restraining linkage connecting said pistons and including an oscillatory pinion, in combination with a fuel injection device including a casing having a bore, and a plunger reciprocating in said bore, said device being surrounded by the pinion, the axis of the pinion being substantially concentric with the longitudinal axis of the plunger, and means responsive to oscillation of the pinion for reciprocating the plunger causing the injection of fuel by said device.

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