Jan. 21, 1947. A. KALITINSKY 2,414,745

HYDRAULIC RESTRAINING MECHANISM FOR FREE-PISTON UNITS

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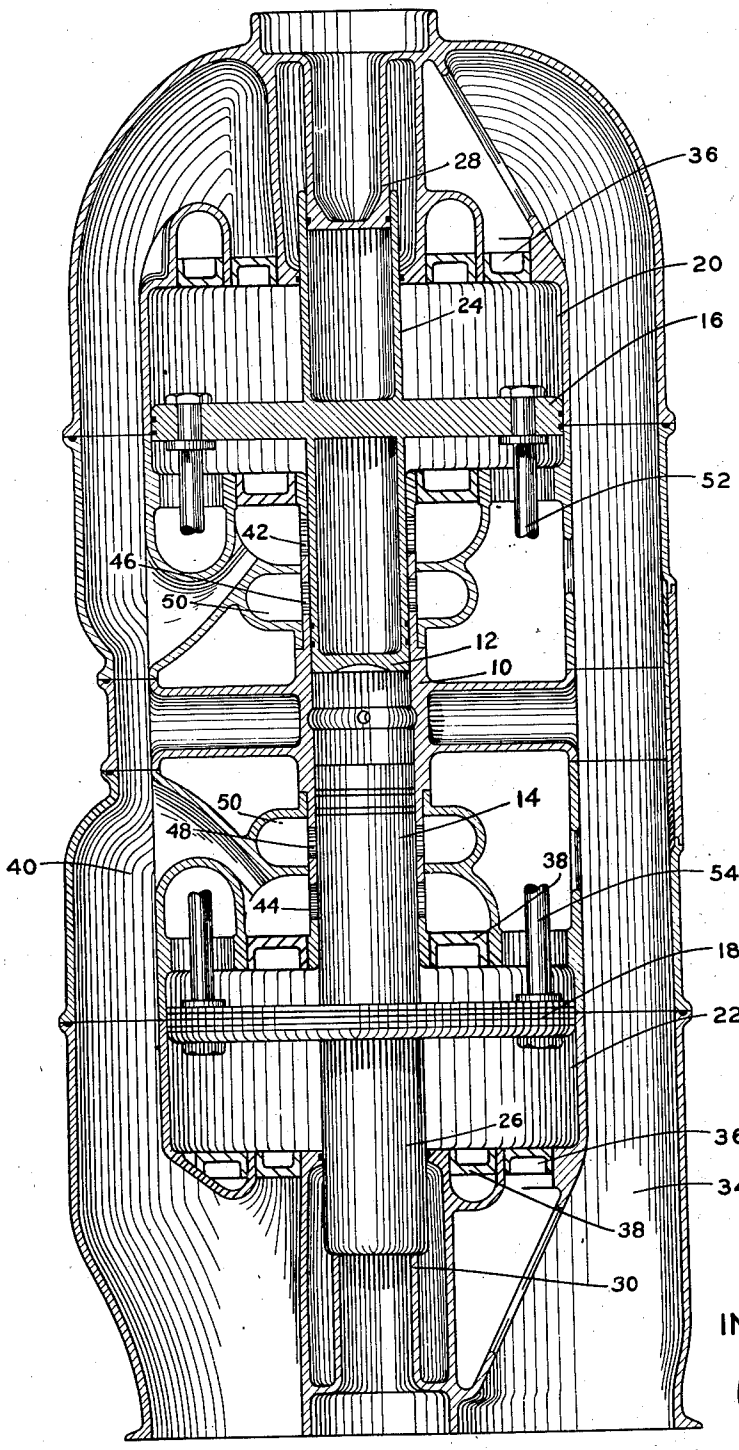


FIG. 1

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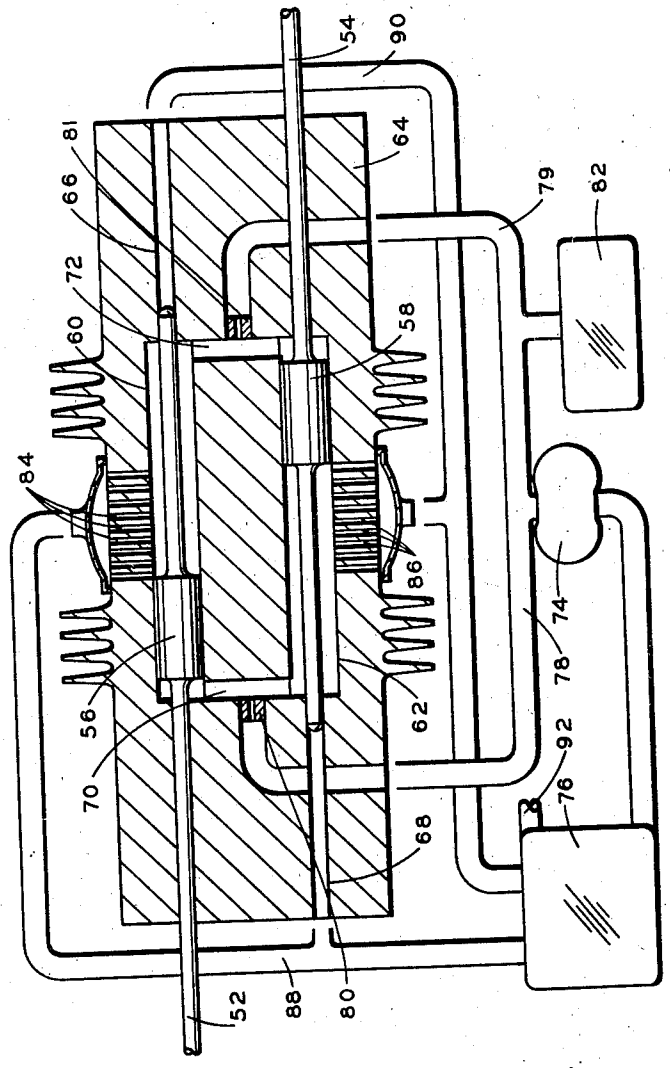


FIG. 2

INVENTOR

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HYDRAULIC RESTRAINING MECHANISM FOR FREE-PISTON UNITS

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8 Claims. (Cl. 123—46)

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The opposed pistons of a free piston engine-and-compressor unit have been maintained always at equal distances from the center of the engine by restraining devices interconnecting the pistons. The linkage devices have been, in general, of two types. One type uses a rocking lever with its ends connected by rods to the pistons. The other type uses a pinion engaging racks on a pair of rods extending from the pistons. A feature of this invention is a hydraulic restraining device to avoid a mechanical connection between the pistons.

The fluid which is moved within the mechanism as the pistons reciprocate forms a part of the moving mass of the unit. As the rate of piston reciprocation is dependent upon the moving mass, a large quantity of fluid reduces this rate. A feature of this invention is a fluid actuated restraining mechanism which has a relatively small quantity of fluid moved by the pistons.

Another feature is an arrangement for moving both pistons into symmetry when the compressor is stopped.

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

Fig. 1 is a sectional view through the unit.

Fig. 2 is a diagrammatic view, on a larger scale, of the restraining 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 by the engine cylinder. Air compressed in the air spring cylinders on the power stroke returns the piston assemblies.

Intake manifold 34 conducts air to intake valves 36 through which air automatically enters opposite ends of the compressor cylinders. The compressed air leaves the cylinders through discharge valves 38, also at opposite ends of the compressor cylinder, and passes through scavenge manifold 40 and through ports 42 and 44, which are uncovered by pistons 12 and 14 at the end of the power stroke, permitting air to be blown through the engine cylinder. Gas from the engine cylinder discharges through exhaust ports 46 and 48 into exhaust manifold 50.

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The pistons are maintained at equal distances from the center of the engine by one or more mechanisms which cause the pistons to move symmetrically toward and away from the center of the engine. Although only one mechanism is shown in detail, these mechanisms are preferably arranged in pairs on opposite sides of the engine cylinder.

The mechanism shown includes a pair of rods 52 and 54 connected to and extending from pistons 16 and 18, respectively. Each rod has an integral plunger 56 or 58 and these plungers are slidable in parallel bores 60 and 62 in a housing 64. The rods extend beyond the plungers to provide equal areas on the ends of the plungers in small bores 66 and 68 in the housing. The adjacent ends of spaced bores 60 and 62 are connected by passages 70 and 72 to permit a flow of fluid between the bores at each end. Bores 60 and 62 and passages 70 and 72 are filled with fluid so that the plungers 56 and 58 move symmetrically and cause the piston assemblies also to move symmetrically.

To compensate for leakage, fluid under pressure is directed continuously to the passages 70 and 72. A pump 74 delivers fluid from a sump 76 through similar conduits 78 and 79 to the passages 70 and 72, respectively. Orifices 80 and 81 may limit the flow of fluid into passages 70 and 72. A pressure storage tank 82 may be included in the fluid system. Between the ends of each of bores 60 and 62 are a series of small discharge passages 84 and 86 through which fluid is discharged in small quantity. The number, size and arrangement of passages 84 is duplicated by passages 86 so that when plungers 56 and 58 are symmetrical in the mechanism an equal number of passages in each bore will be covered. Any unsymmetrical movement of the plungers while the unit is operating will cause more discharge passages in one bore to be covered than are covered in the other bore so that a static pressure difference in the opposite bores is created to restore the plungers to symmetrical position. The passages 84 and 86 also allow flow of fluid through the device for cooling. Instead of orifices 80 and 81, it may be advantageous to use check valves, not shown, to prevent flow from passages 70 and 72 into conduits 78 and 79.

If the piston assemblies come to rest so that more discharge passages are covered by one plunger, a static pressure difference results which will move the plunger in the bore having the larger number of open discharge passages until

equal numbers of passages 84 and 86 are covered.

Conduits 88 and 90 collect the fluid discharged from passages 84 and 86 and deliver it to the sump 76. Leakage from the ends of bores 66 and 68 is also collected by these conduits. Sump 76 which may act as a settling and degassing tank may have a vent 92. The tank 82 may be used in the pressure lines to maintain desired pressures.

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 restraining mechanism for the opposed pistons of a free-piston unit including a rod extending from each piston, each rod having a double-acting plunger spaced from the piston, a housing having spaced bores in which the plungers are movable, conduits between adjoining ends of the bores, means for introducing fluid under pressure to each conduit, and a series of ports of small area in each bore adapted to be uncovered and covered by the plungers during their stroke.

2. A restraining mechanism for the opposed pistons of a free-piston unit including a rod extending from each piston, each rod having a double-acting plunger spaced from the piston, a housing having spaced bores in which the plungers are movable, conduits between adjoining ends of the bores, means for introducing fluid under pressure to each conduit, and a series of ports of small area in each bore adapted to be uncovered and covered by the plungers during their stroke, said ports being spaced axially of the bore so that the ports are uncovered successively.

3. A restraining mechanism for the opposed pistons of a free-piston unit including a rod extending from each piston, each rod having a double-acting plunger spaced from the piston, a housing having spaced bores in which the plungers are movable, conduits between adjoining ends of the bores, means for introducing fluid under pressure to each conduit, and a series of ports of small area in each bore adapted to be uncovered and covered by the plungers during their stroke, the ports in the opposed bores being symmetrically arranged.

4. A restraining mechanism for the opposed pistons of a free-piston unit including a rod extending from each piston, each rod having a double-acting plunger spaced from the piston, a housing having spaced bores in which the plungers are movable, conduits between adjoining ends of the bores, means for introducing fluid under pressure to each conduit, and a series of ports of small area in each bore adapted to be uncovered and covered by the plungers during their stroke, the ports in the opposed bores being symmetrically arranged, and spaced axially from each other in each bore whereby the plungers uncover the ports successively.

5. A restraining mechanism for the opposed pistons of a free-piston engine-and-compressor unit, said mechanism including a pair of rods, one rod extending from each piston, a plunger on each rod, a housing having bores in which said plungers reciprocate, conduits between adjacent ends of the bores, said bores and conduits being filled with fluid, whereby movements of the plungers are synchronized, and means for venting each bore in proportion to the length of the plunger stroke.

6. A restraining mechanism for the opposed pistons of a free-piston engine-and-compressor unit, said mechanism including a pair of rods, one rod extending from each piston, a plunger on each rod, a housing having bores in which said plungers reciprocate, and conduits between adjacent ends of the bores, and a means for maintaining a substantially constant volume of fluid in said bores and conduits.

7. A restraining mechanism for the opposed pistons of a free-piston engine-and-compressor unit, said mechanism including a pair of rods, one rod extending from each piston, a plunger on each rod, a housing having bores in which said plungers reciprocate, and conduits between adjacent ends of the bores, and a means for maintaining a substantially constant volume of fluid in said bores and conduits, said means including a source of fluid under pressure, means for directing fluid from said source to said bores and conduits, and several discharge ports in each bore adapted to be uncovered successively by the plungers as they reciprocate.

8. A restraining mechanism for the opposed pistons of a free-piston engine-and-compressor unit, said mechanism including a pair of rods, one rod extending from each piston, a plunger one each rod, a housing having bores in which said plungers reciprocate, and means for controlling the fluid pressures in said bores for causing the plungers to remain in symmetrical relation, including means for venting said bore as the plungers reciprocate.

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