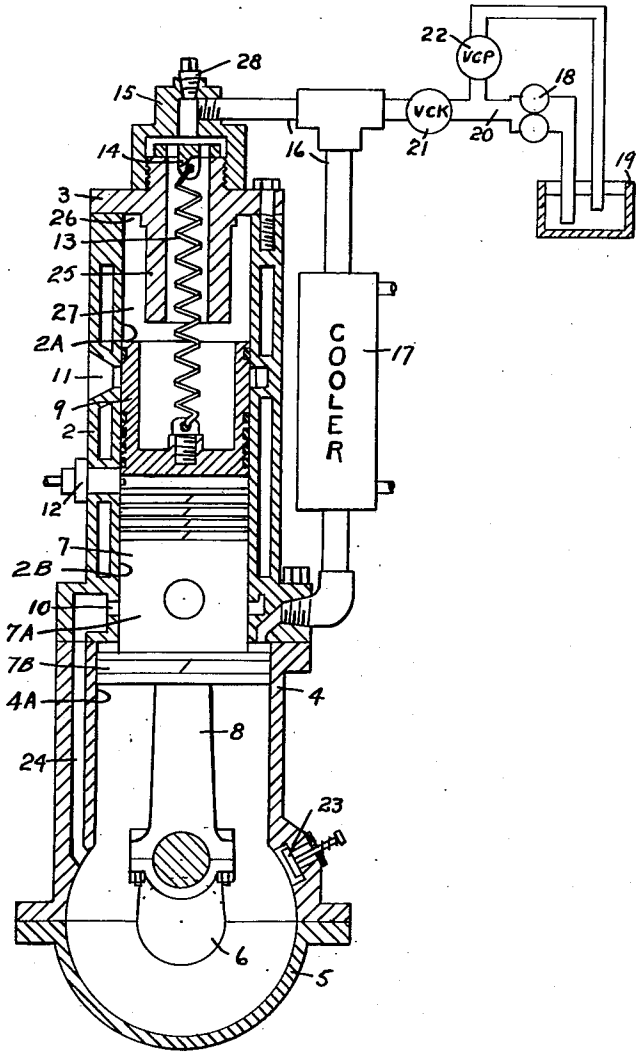
Dec. 17, 1957 L. O. FRENCH 2,816,416

TWO CYCLE INTERNAL COMBUSTION ENGINE

Filed March 21, 1955



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United States Patent Office

2,816,416

Patented Dec. 17, 1957

2,816,416

TWO CYCLE INTERNAL COMBUSTION ENGINE

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Application March 21, 1955, Serial No. 495,589

4 Claims. (Cl. 60—19)

The invention relates to two cycle internal combustion engines.

It is recognized that the uniflow opposed piston two cycle internal combustion engine is highly efficient, but because of the use of separate geared together crank shafts, usually employed, the commercial production of these engines has been quite limited as compared to other types of two cycle engines. The object of the present invention is to provide a uniflow opposed piston two cycle internal combustion engine in which both of the pistons are connected to a single crank shaft, one of the pistons being connected to said shaft in the conventional manner while the other piston is operatively connected to said shaft by an oscillatory fluid column connecting the two pistons.

The invention further consists in the several features hereinafter set forth and more particularly defined by claims at the conclusion hereof.

The drawing is a vertical cross-sectional view through an internal combustion engine embodying the invention.

In the drawing, the numeral 2 designates an engine cylinder having bores 2A and 2B, 3 a cylinder head, 4 a cylinder coaxial with the cylinder 2 and having a bore 4A, 5 a crank case, 7 a differential diameter or stepped piston operatively connected to the crank shaft 6 by a connecting rod 8 and having a part 7A working in the bore 2B and a part 7B working in the bore 4A, and 9 a piston working in the bore 2B. The cylinders 2 and 4 may be formed in one piece, if desired.

The cylinder 2 is provided with an annular set of scavenge ports 10 communicating with the bore 2A and an annular set of exhaust ports 11 of usual construction communicating with the bore 2B and has a fuel injector 12 communicating with the combustion chamber for a compression ignition engine or a spark plug (not shown) for a gasoline or gas engine.

To permit ready charging of the engine with hydraulic liquid hereinafter described and the maintenance of a low normal pressure in this liquid to permit automatic replenishment of some of this liquid, a spring 13 is connected at one end to the piston and at its other other end to an apertured anchorage 14.

The head 3 has a cap 15 in threaded engagement therewith, and this cap is connected by piping 16, including a cooler section 17, to the bore 4A. The piping and the spaces with which it connects may be charged and kept charged with a lubricant, the operating hydraulic liquid, from a pump 18 whose inlet is connected with a supply tank 19 and whose outlet connects by a pipe 20 with the piping 16 and includes a check valve 21. A pressure relief valve 22 is also connected with the piping 20 and the tank 19 so that lubricant at low pressure, for example, three to five pounds p. s. i., can be supplied to the piping 16 for filling purposes, and when during the low pressure periods of the cycle the check valve 21 can be opened, if necessary, to maintain the pressure in the hydraulic operating column.

Any suitable blower or pump may be used for furnishing scavenging air to the engine, but where the engine is a small unit, such as a small industrial power unit or a row boat motor, crank case compression may be used and an automatic inlet valve 23 and a transfer port 24 provided.

The head 3 is preferably provided with a depending tubular extension 25 that prevents undue whipping action of the tension spring 13 and also at its upper end cooperates with the bottom of the head and the cylinder to form an annular dash pot 26 to hydraulically check the outward movement of the piston.

With the above construction, assuming that the pistons 7 and 9 are in their outer positions, then as the crank shaft 6 is rotated, the parts 7A and 7B of the piston 7 force the hydraulic liquid out of the differential area between these parts to piping 16 and through the passages formed in the head 3 and anchorage 14 into the space 27 of cylinder 2 back of the piston 9 and acts on this piston to move it inwardly to compress the air between the piston part 7A and the piston 9 as shown in the drawing. When near the end of the compression stroke the air in the combustion chamber formed between the bores 2A and 2B and the two pistons has reached an ignition temperature, fuel is introduced into said chamber by the injector 12, and as this fuel burns, it raises the pressure of the gases in the combustion chamber which then act to force the pistons 7 and 9 outwardly on their working stroke. The gas thrust on the piston 9 is communicated to the hydraulic liquid in the space 27 so that some of this liquid is displaced and forced through the piping 16 into the bore 4A where it acts on the differential area of the between parts 7A and 7B of the piston 7 and thus augments the gas pressures acting on this piston and through its connecting rod 8 on the crankshaft 6. For any given stroke of the piston 9, the displacement for the differential area of the piston 7 should be equal to that of the piston 9 in the bore 2B so that while the piston 9 is a free piston, its movement is controlled by the hydraulic column and the piston 7. To permit the use of standard diameter piston rings for the cylinder 4, the stroke of the piston 9 will in most cases not be the same as that of the piston 7 but may be more or less depending on the diameter of the bore 4A. Also the bore 2B may be of smaller diameter than the bore 2A and the piston 9 then be of smaller diameter than the piston 7 to function primarily as a valve and the differential area of piston 7 be such as to accommodate such modification for any given stroke of the piston 7 without departing from the invention. Near the end of the outward movement of the pistons 7 and 9 the exhaust ports 11 are first uncovered, and then the inlet ports 10 are uncovered and scavenge air introduced to purge the cylinder of waste gas and fill it with air before these ports 10 and 11 are lapped by their respective pistons as they again move inwardly on their next compression stroke.

A pipe plug 28 may be mounted on the cap 15 to permit release of air during the initial charging of the hydraulic system.

For a spark ignition engine, the gaseous mixture may be introduced into the crank case from a suitable carburetor or be introduced as a carbureted mixture in the blower or separate pump by which it is supplied to the scavenge ports 10 and at the desired time in the cycle be ignited by a spark plug.

While the location of the exhaust ports 11 and scavenge ports 10 could be reversed, the arrangement shown has definite advantages since the usual lubrication problems incident to the use of a stepped piston controlling exhaust ports is avoided.

It is also to be noted that the hydraulic fluid with its cooler section 17 acts as a coolant for the interior of the piston 9.

I desire it to be understood that this invention is not to be limited to any particular form or arrangement of parts except in so far as such limitations are included in the claims.

What I claim as my invention is:

1. In a uniflow two cycle internal combustion engine, the combination of a cylinder structure having coaxial differential diameter bores and a bore communicating with the smaller bore of said differential diameter bores, a piston having differential diameter portions working in said differential diameter bores, a hydraulically controlled piston working in the other of said bores and cooperating with the smaller diameter portion of said first named piston and the cylinder structure to form a combustion chamber, sets of inlet and exhaust ports in said cylinder, one set of ports being controlled by the smaller diameter portion of said first named piston and the other set of ports being controlled by said hydraulically controlled pistons, a crank shaft, means including a connecting rod for connecting said first named piston with said crank shaft, a hydraulic chamber behind said hydraulically operated piston closed at one end thereby and containing a hydraulic operating fluid, the differential diameter portions of said first named piston cooperating with the annular space formed between said differential diameter bores to form an expansible and contractible hydraulic chamber containing a hydraulic fluid, and conduit means for said hydraulic fluid connecting said first named hydraulic chamber with said last named hydraulic chamber whereby said first named piston transmits the thrust of gases of combustion acting on its smaller diameter as well as the hydraulic thrust generated by the gases of combustion acting on said second named piston to said crank shaft and also acts to move said second named piston on its compression stroke.

2. The internal combustion engine as defined in claim 1 wherein means are associated with the hydraulically controlled piston to assist in charging the first named hydraulic chamber and conduit means with hydraulic operating fluid.

3. The internal combustion engine as defined in claim 1 wherein spring means are operatively connected with the hydraulically controlled piston to assist in charging the first named hydraulic chamber and conduit means with hydraulic operating fluid under low pressure.

4. The internal combustion engine as defined in claim 1 wherein means are provided for cushioning the end of the power stroke of the hydraulically controlled piston.

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