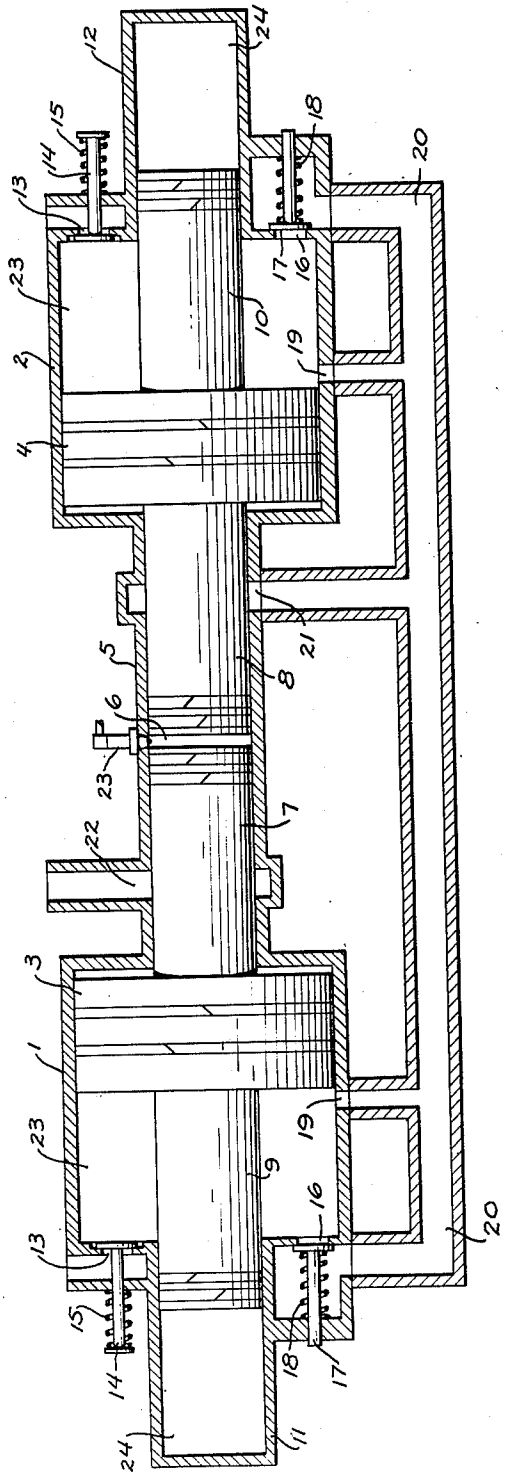
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FREE PISTON ENGINE

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## FREE PISTON ENGINE

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5 Claims. (Cl. 123—46)

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This invention relates to a free piston engine.

The free piston engine is known and has been described in a publication of the Bureau Technique Pescara entitled "The Free Piston Diesel Engine Power Gas Producer" by G. Eichelberg. Another disclosure of the free piston engine is contained in "Popular Mechanics," September 1950.

In the free piston engines of the prior art the free piston draws in a charge of air by opening an automatic air intake valve. The air charge in the air compressor chamber is below atmospheric pressure at the time the piston has reached the end of its intake stroke and starts on its compression stroke. When the explosion takes place on the combustion end of the piston, the free piston will travel a considerable distance before the air in the compression chamber reaches atmospheric pressure and the compressing of the air in the compression chamber will not start until the free piston is near the end of its compression stroke. Consequently the peak of the explosion pressure is not against the full load because when the explosion occurs, the compression is low in the air compression chamber. The peak explosion pressure is exerted against the free piston and, since the air in the compression chamber is at a sub-atmospheric pressure, the piston will travel at a very rapid speed during the initial part of its compression stroke and then will slow down as it starts to compress the air. Since the piston does not start to compress the air until the latter part of its compression stroke, the combustion chamber will have opened wide or increased to such an extent in volume that the explosion energy will be dissipated in the form of heat into the cylinder walls before the compression of the air in the compression chamber begins. Since the full force of the explosion is not directed against the compressed air or load, it is believed that the efficiency of the free piston engines so far developed is lowered.

It is an object of this invention to produce a free piston engine which is more efficient in operation than the free piston engines heretofore known. This object is accomplished by having the full force or peak explosion pressures directed against the load, that is, the peak explosion pressure is expended immediately in raising the compressed air charge from one state of high compression to another state of still higher compression.

The drawing is a schematic showing in longitudinal section of a free piston engine including

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the improvement which is the subject of this invention.

Referring to the drawing it will be seen that the instant free piston engine comprises opposed cylinders 1 and 2, pistons 3 and 4 reciprocatably mounted in cylinders 1 and 2, reduced cylinder portion 5 which provides a combustion chamber 6, reduced piston portions 7 and 8 which reciprocate in reduced cylinder portion 5, reduced piston portions 9 and 10 which reciprocate in cylinders 11 and 12, respectively, intake ports 13 controlled by valves 14 normally held closed by springs 15, exhaust ports 16 controlled by valves 17 normally held closed by springs 18, reflow ports 19, storage chamber 20 for the compressed charge, intake port 21 for combustion chamber 6 and exhaust port 22 for combustion chamber 6, injection nozzle 23 for injecting fuel into the combustion chamber 6.

The operation of my free piston engine is as follows: As shown in the drawing, the piston heads 7 and 8 are at the end of their compression stroke so that the air charge in combustion chamber 6 is fully compressed to conventional diesel compression so that when a charge of fuel, preferably liquid or hydrocarbon, is injected into combustion chamber 6 by injection nozzle 23, the fuel will ignite and combustion will occur in chamber 6. At this time piston heads 7 and 8 close ports 21 and 22 and the pressure in the air compression chambers 23 is the same as that in compression storage chamber 20, which is considerably higher than atmospheric pressure.

As the explosion occurs in chamber 6, pistons 3 and 4 move outwardly thereby compressing the air charge in chambers 23, causing exhaust valves 17 to open as the compressed charge is displaced from chambers 23 into storage chamber 20. As the pistons move outwardly on the air compression stroke, the air or gas sealed in bounce chambers 24 is compressed by the pistons 9 and 10 and this compressed air acts as a spring cushion, driving the pistons back to the center again at the end of their explosion or power stroke. As the pistons 7 and 8 move outwardly or away from each other, pistons 3 and 4 first close reflow ports 19 and near the end of the power stroke pistons 7 and 8 uncover exhaust port 22, permitting the compressed hot gases to flow through exhaust port 22 to and through a conventional gas turbine where they give up their power.

As port 21 opens, a fresh compressed charge of gas flows into the combustion chamber 6 and at the same time scavenges from the combustion

chamber any burnt gases remaining from the previous explosion. As the compressed air in the bounce chambers **24** drive the pistons **3** and **4** toward each other, air is drawn or sucked into the compression chambers **23** through intake ports **13** and as the pistons **3** and **4** near the end of their intake stroke, reflow ports **19** are opened and the compressed charge in storage chamber **20** flows through the reflow port **19** into the air compression chambers bringing the air pressure in chambers **23** to the same pressure as the charge in conduit or storage chamber **20**. As the pistons move toward each other the air charge in combustion chamber **6** is compressed and as the pistons **7** and **8** reach the position shown in the drawing, fuel is injected into the combustion chamber **6** through nozzle **23**, ignition occurs, and the cycle above described is repeated.

Although it is preferred to compress the air charge in combustion chamber **6** to a high enough pressure so that the injected fuel will burn without the need of a spark plug or electrical ignition, nevertheless, if desired, lower combustion chamber pressures with electric ignition can be used.

Conventional and known means can be used for synchronizing the two pistons so that they will travel toward and away from each other in synchrony, and conventional means (not shown) can be used for starting the engine. Starting is usually accomplished by admitting compressed air to the bounce chambers **24** so as to drive the pistons inwardly toward each other to compress the charge in combustion chamber **6** preparatory to injecting and igniting the fuel into said compressed charge.

From the above it is evident that in the above described free piston engine peak explosion pressure will be applied through pistons **7**, **3** and **8**, **4** against the load, that is, the peak explosion pressure will be applied to compress the charges in chambers **23** from one high state of compression to a higher state of compression, thereby increasing the efficiency of the instant engine over those previously known where the charge in the compression chamber is at sub-atmospheric pressure at the time the explosion occurs.

I claim:

1. In a free piston internal combustion engine, a combustion chamber, an air compression chamber, a free piston mounted within said combustion and compression chambers for reciprocation therein, intake and exhaust ports for said combustion chamber, intake and exhaust ports for said compression chamber, a reflow port for said compression chamber, a charge storage chamber communicating with said intake port for the combustion chamber, with said reflow port and with said exhaust port for the compression chamber, a valve for closing the intake port of the compression chamber during the compression stroke of said piston, a valve for closing the exhaust port of said compression chamber during the intake stroke of said piston, means for closing the intake and exhaust ports of said combustion chamber during the compression stroke of the piston in said combustion chamber and for opening said ports near the completion of the power stroke of said piston in the combustion chamber, valve means controlling the reflow port and adapted to place the compression chamber in communication with the charge storage chamber substantially at the end of the air intake stroke whereby the pressure in the charge storage chamber and the air compression chamber is substantially equalized at the time the peak explosion pressure occurs in the combustion chamber.

2. The engine claimed in claim 1 wherein the piston serves as a valve for controlling the reflow port.

3. In a free piston engine of the type including a cylinder having a combustion chamber provided with a valve controlled inlet and a valve controlled outlet and an air compression chamber provided with a valve controlled inlet and a valve controlled outlet, a free piston movable in said cylinder in one direction to compress the charge in said combustion chamber and movable in the opposite direction to compress the charge in said air compression chamber and wherein a compressed air storage tank is connected between the outlet of the air compression chamber and the inlet of the combustion chamber, the improvement which comprises means for admitting a compressed charge of air from said compressed air storage chamber to said air compression chamber during a portion of each cycle when the pressure in said combustion chamber resulting from the compression stroke of said piston is at substantially the maximum value.

4. In a free piston internal combustion engine, a cylinder, a piston reciprocably mounted in said cylinder, one end of said cylinder cooperating with said piston to serve as an air compression chamber, the other end of said cylinder cooperating with the piston to serve as a combustion chamber, valve controlled intake and exhaust ports for said air compression chamber through which air is admitted on the intake stroke of the piston and discharged on the air compression stroke of the piston, a compressed air inlet port for the combustion chamber and an exhaust port for the combustion chamber, a storage chamber for compressed air communicating with the exhaust port of the air compression chamber and the intake port of the combustion chamber, the said piston being propelled in one direction by the explosion of the fuel charge in the combustion chamber to compress air in the air compression chamber, the said piston during the intake stroke in the opposite direction in said air compression chamber drawing air into the air compression chamber and simultaneously compressing a gaseous charge in the combustion chamber, and means for admitting a compressed charge from said compressed air storage chamber to said air compression chamber during a portion of each cycle to substantially equalize the pressure in said air compression chamber and said compressed air storage chamber before the piston has materially progressed on the air compression stroke.

5. The combination called for in claim 3 wherein said last mentioned means comprises, a reflow port in said air compression chamber communicating with said compressed air storage chamber and valve means controlling said reflow port.

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