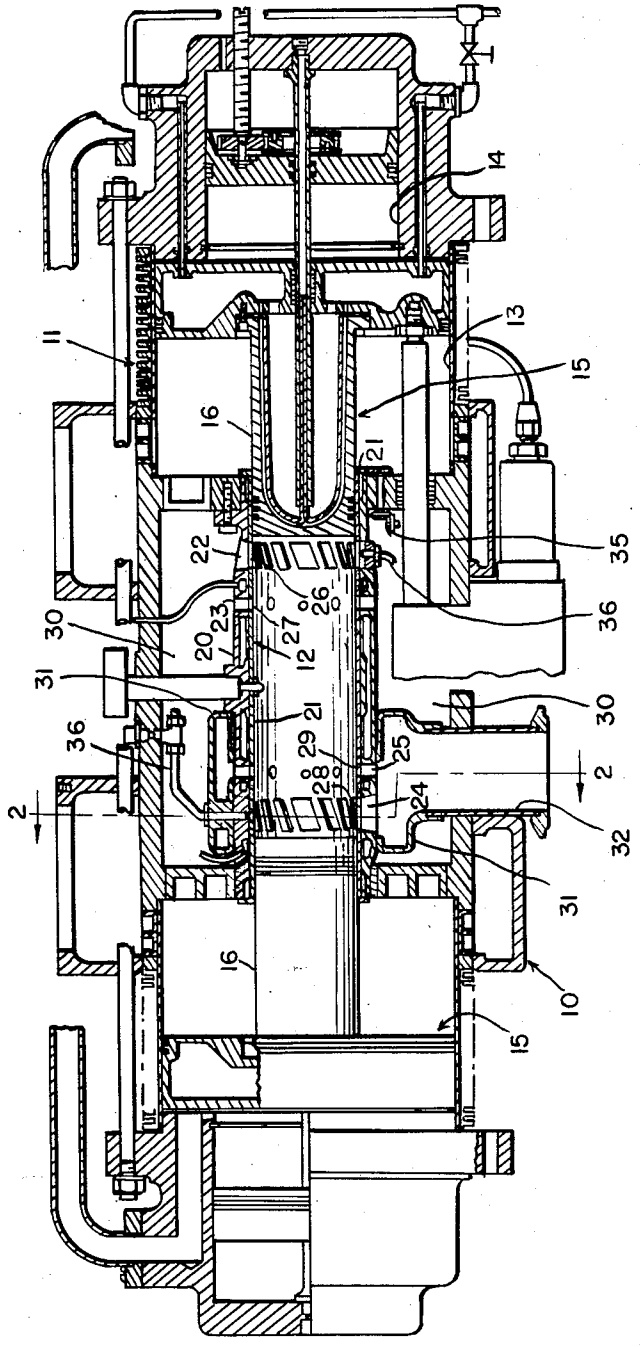
Sept. 30, 1958 C. F. BACHLE ET AL 2,853,982

FREE PISTON ENGINE

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FIG. 1.



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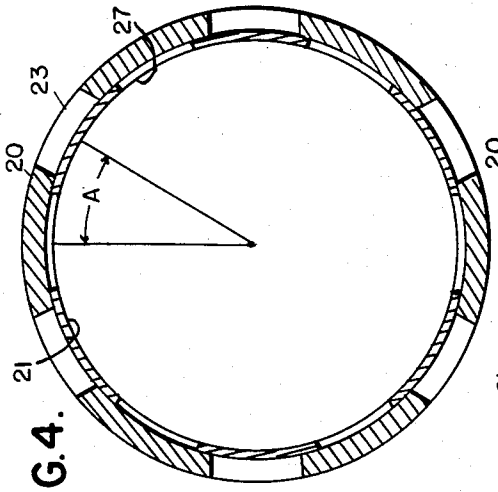


FIG. 4.

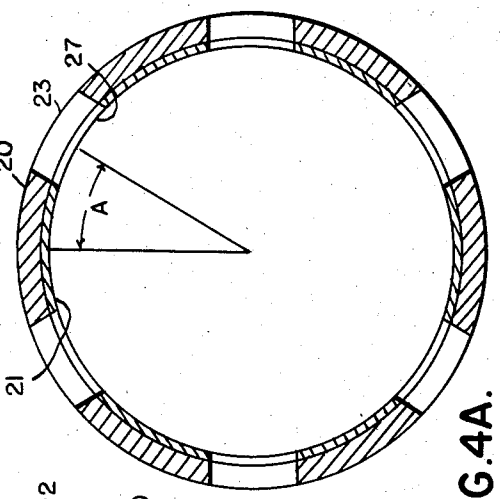


FIG. 4A.

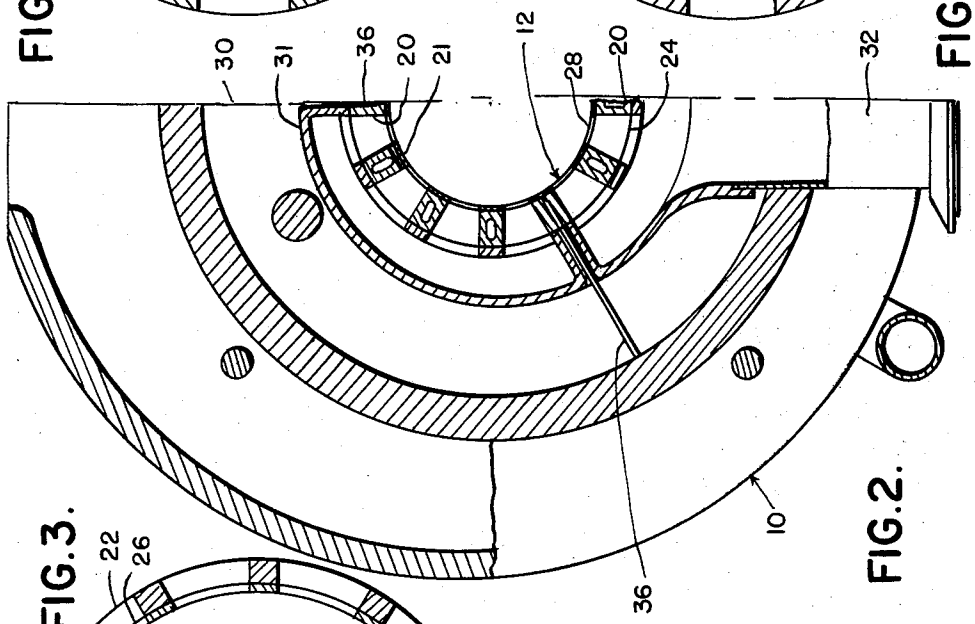


FIG. 2.

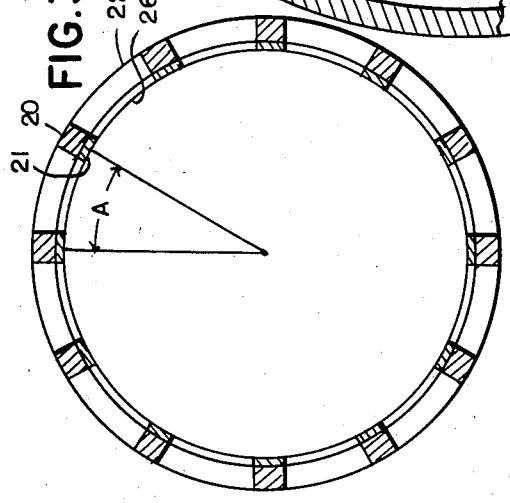


FIG. 3.

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United States Patent Office 2,853,982
Patented Sept. 30, 1958

2,853,982

FREE PISTON ENGINE

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Application September 28, 1956, Serial No. 612,619

6 Claims. (Cl. 123—46)

This invention relates to internal combustion engines of the free piston type, and more particularly to a free piston engine construction embodying means for reducing fuel consumption during engine idling operation by reducing the piston stroke of the engine.

Free piston engines, although generally more economical in operation than other engine types of comparable size, weight and power, are known to have relatively high fuel consumption during idling operation. It is proposed, therefore, to approach a more economical utilization of fuel by reducing the piston stroke during idling to a point where a minimum amount of fuel will maintain piston reciprocation.

A particular object of the invention is to attain economical fuel utilization by providing a free piston engine with a variable piston stroke.

Another object of the invention is to reduce idling fuel consumption of a free piston engine by providing controllable auxiliary intake and exhaust ports in the engine combustion chamber cylinder and disposed inwardly of the normal ports, whereby to reduce piston stroke.

A further object of the invention is to reduce idling fuel consumption of a free piston engine by constructing a combustion chamber cylinder having inner and outer intake and exhaust ports and an adjustable means for selectively opening and closing the inner ports to vary the piston stroke.

A still further object of the invention is to control the fuel consumption of a free piston engine by providing a cylinder and adjustable sleeve valve construction enabling auxiliary intake and exhaust ports in the cylinder to be opened during engine operation in which a shorter piston stroke is desired.

For a more complete understanding of the invention, reference may be had to the accompanying drawings illustrating a preferred embodiment of the invention, in which like characters refer to like parts throughout the several views and in which

Fig. 1 is a cutaway, sectional view of a preferred type of free piston engine embodying the invention.

Fig. 2 is a half section taken substantially on the line 2—2 of Fig. 1.

Fig. 3 is a diagrammatic illustration of the cylinder and sleeve valve primary porting arrangement.

Fig. 4 is a diagrammatic illustration of the cylinder and sleeve valve primary porting arrangement in the normal, or closed position, and

Fig. 4A is a diagrammatic illustration of the ports of Fig. 4 in the idling, or open position.

In Fig. 1, a preferred type of free piston engine **10** is illustrated as having a cylinder structure **11** comprising a substantially medial combustion chamber cylinder **12**, an air compressor cylinder **13**, and a bounce chamber **14**. Opposed free pistons **15** are arranged to reciprocate in the cylinder structure **11**. A power piston portion **16** of the free piston **15** operates in the combustion chamber cylinder **12**.

The combustion chamber cylinder **12** preferably comprises a jacketed cylinder structure **20** and an inner rotatably adjustable sleeve valve **21**. The cylinder structure **20** is provided with outer normal operation intake ports **22** and inner idle operation intake ports **23**, and with outer normal operation exhaust ports **24** and inner idle operation exhaust ports **25**. The sleeve valve is preferably provided with corresponding outer and inner intake ports **26** and **27** respectively, and outer and inner exhaust ports **28** and **29** respectively.

Intake scavenging air is admitted into the aforesaid intake ports from an annular air induction chamber **30**, and an exhaust gas ejected through the aforesaid exhaust ports enters an annular exhaust manifold **31** and is conducted out an exhaust duct **32**.

In the preferred embodiment of the invention, there are half as many annularly spaced inner ports as there are outer ports around the cylinder, and the sleeve valve **21**, having identically spaced and dimensioned ports, is rotatably adjusted. Other porting and valving arrangements may be utilized if desired to achieve the same result, although the illustrated construction is relatively simple in operation, as illustrated in the diagrammatic Figs. 3, 4 and 4A. For convenience the intake ports **22**, **23**, **26** and **27** are illustrated in these figures; the exhaust porting arrangement and operation being substantially similar.

In normal operation of the engine, i. e. at any speed other than idling, the outer ports **22** and **26** respectively of the cylinder structure **20** and the sleeve valve **21** are aligned, as shown in Fig. 3; and the inner ports **23** and **27** respectively of the cylinder structure **20** and the sleeve valve **21** are not aligned and the port **23** is therefore closed. During idling operation, the sleeve valve **21** is rotated an increment A corresponding to the annular dimension between two adjacent outer ports. Since there are only half as many inner ports, the increment A corresponds to only half the annular dimension between two adjacent inner ports. Thus the outer ports simply move from one open position to another open position, while the inner ports are adjusted from the closed position illustrated by Fig. 4 to the open position illustrated by Fig. 4A. In this latter position, air intake to and exhaust from the combustion chamber cylinder **12** occurs before the piston has reached its full outward stroke, thus serving to decrease the stroke and permit a decrease in the amount of fuel consumed to operate the piston.

Referring again to Fig. 1, the sleeve valve **21** may be rotated by any suitable means such as a gear driving mechanism **35**. Also it should be noted that lubrication pipes or lines **36** supplying lubricant to the cylinder may be provided as shown or in any manner familiar in the art.

Although but one preferred embodiment of the invention has been described herein, it will be apparent to one skilled in the art to which the invention pertains that various changes and modfications may be made therein without departing from the spirit of the invention or the scope of the appended claims.

We claim:

1. In an internal combustion engine of the free piston type, a cylinder structure having a combustion chamber cylinder, and a pair of free pistons oppositely reciprocating therein, said cylinder having a plurality of longitudinally spaced intake porting means and a plurality of longitudinally spaced exhaust porting means, said pistons normally operable to successively uncover each of said porting means, and selectively operable means for controlling said intake and exhaust porting means first uncovered by said pistons on their outward stroke to open same to relatively shorten the stroke of said pistons.

2. In an internal combustion engine of the free piston type, a cylinder structure having a combustion chamber cylinder and a pair of free pistons oppositely reciprocating

therein, said cylinder having a plurality of longitudinally spaced intake porting means and a plurality of longitudinally spaced exhaust porting means, each of said porting means comprising a plurality of ports spaced annularly in said cylinder, said pistons normally operable to successively uncover each of said porting means, and selectively operable means for controlling said intake and exhaust porting means first uncovered by said pistons in their outward stroke to open same to relatively shorten the stroke of said pistons.

3. In an internal combustion engine of the free piston type, a cylinder structure having a combustion chamber cylinder and a pair of free pistons oppositely reciprocating therein, said cylinder having a plurality of longitudinally spaced intake porting means and a plurality of longitudinally spaced exhaust porting means, each of said porting means comprising a plurality of ports spaced annularly in said cylinder, said pistons normally operable to successively uncover each of said porting means, and selectively operable means for controlling said intake and exhaust porting means first uncovered by said pistons in their outward stroke to open same to relatively shorten the stroke of said pistons, said selectively operable means comprising a ported sleeve valve actuated to selectively open and close said cylinder ports first uncovered by said pistons on their outward stroke.

4. In an internal combustion engine of the free piston type, a cylinder structure having a combustion chamber cylinder and a pair of free pistons oppositely reciprocating therein, said cylinder having a plurality of longitudinally spaced intake porting means and a plurality of longitudinally spaced exhaust porting means, each of said porting means comprising a plurality of ports spaced annularly in said cylinder, said pistons normally operable to successively uncover each of said porting means, and selectively operable means for controlling said intake and exhaust porting means first uncovered by said pistons in their outward stroke to open same to relatively shorten the stroke of said pistons, said selectively operable means comprising a ported sleeve valve rotatably adjusted to selectively open and close said cylinder ports first uncovered by said pistons on their outward stroke.

5. In an internal combustion engine of the free piston type, a cylinder structure having a combustion chamber cylinder, and a pair of free pistons oppositely reciprocating therein, said cylinder having a plurality of longitudinally spaced inner and outer intake porting means and a plurality of longitudinally spaced inner and outer exhaust porting means, each of said porting means comprising a plurality of ports spaced annularly in said cylinder, said pistons normally operable to successively uncover each of said porting means, and selectively operable means for controlling said inner intake and exhaust porting means to open same to relatively shorten the stroke of said pistons, said selectively operable means comprising a ported sleeve adjusted to selectively open and close said inner ports, said outer porting means comprising ports annularly dimensioned and disposed about said cylinder with respect to said sleeve valve ports whereby the adjustment of said sleeve valve will selectively close and open said inner porting means and maintain said outer porting means open during all degrees of adjustment of said sleeve valve.

6. In an internal combustion engine of the free piston type, a cylinder structure having a combustion chamber cylinder, and a pair of free pistons oppositely reciprocating therein, said cylinder having a plurality of longitudinally spaced inner and outer intake porting means and a plurality of longitudinally spaced inner and outer exhaust porting means, each of said porting means comprising a plurality of ports spaced annularly in said cylinder, said pistons normally operable to successively uncover each of said porting means and selectively operable means for controlling said inner intake and exhaust porting means to open same to relatively shorten the stroke of said pistons, said selectively operable means comprising a ported sleeve valve rotatably adjusted to selectively open and close said inner ports, said outer porting means comprising ports annularly dimensioned and disposed about said cylinder with respect to said sleeve valve ports whereby the rotatable adjustment of said sleeve valve will selectively close and open said inner porting means and maintain said outer porting means open during all degrees of adjustment of said sleeve valve.

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