Dec. 27, 1927. 1,653,925

E. W. PETTER ET AL

INTERNAL COMBUSTION ENGINE

Filed April 14, 1925 2 Sheets-Sheet 1

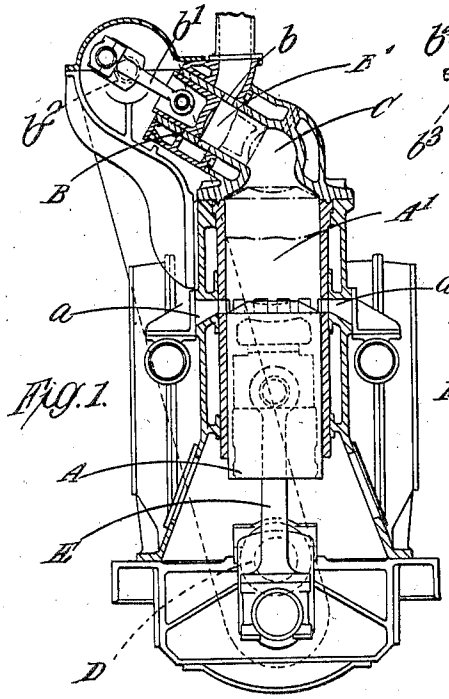


Fig. 1.

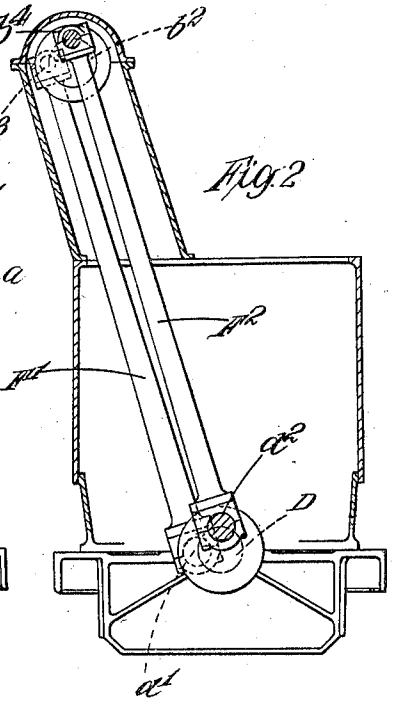


Fig. 2.

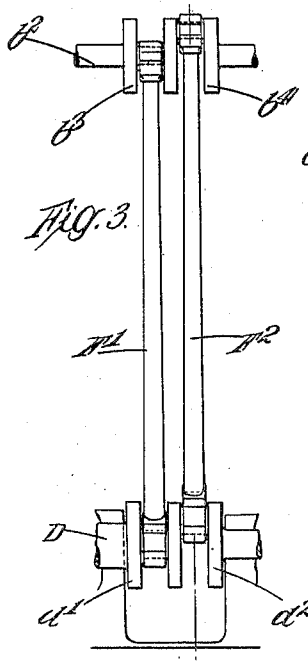


Fig. 3.

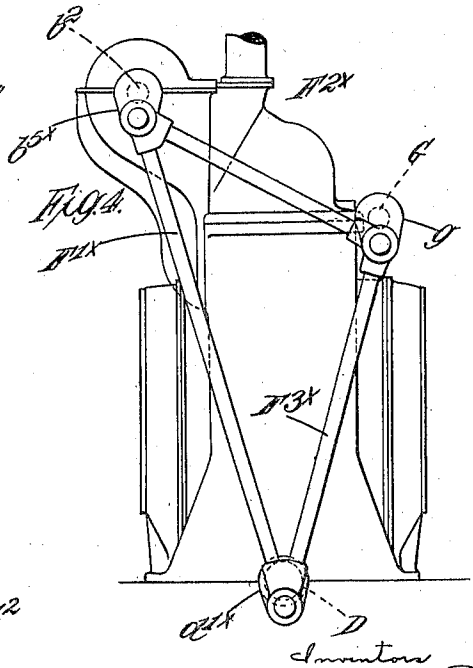


Fig. 4.

Inventors
Ernest Willoughby Petter
and
James Hutton
By Parsons, Davis, Marin & Edmonds
Attorneys

Dec. 27, 1927.

1,653,925

E. W. PETTER ET AL.

INTERNAL COMBUSTION ENGINE

Filed April 14, 1925

2 Sheets-Sheet 2

Fig. 5.

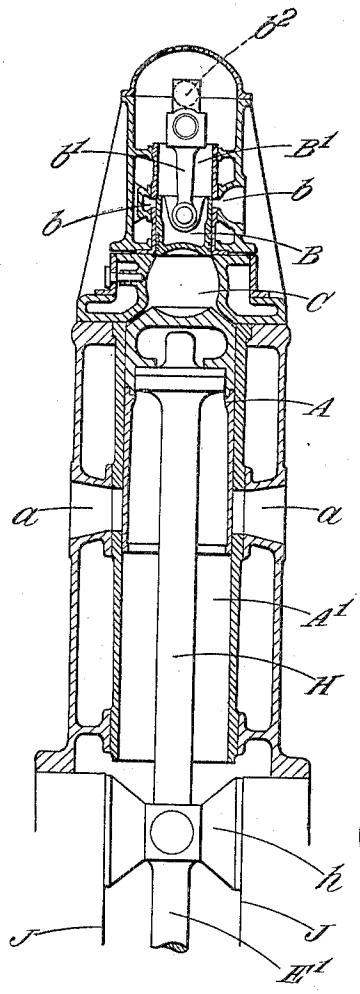
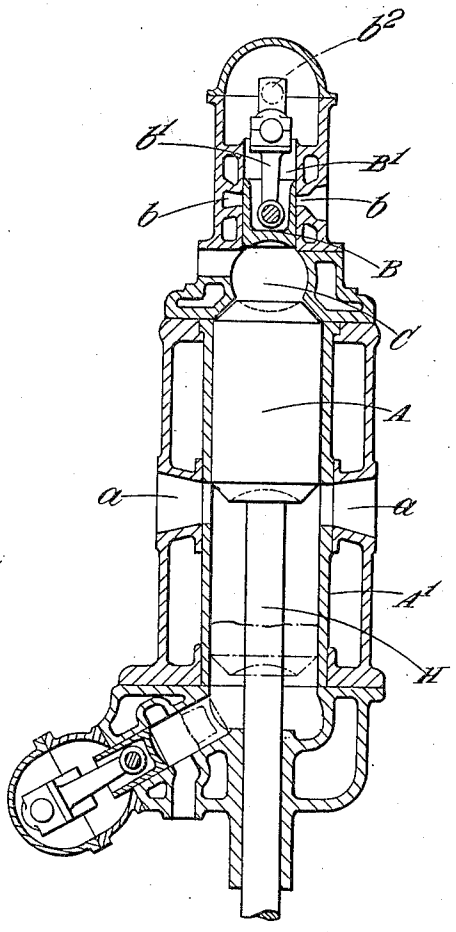


Fig. 6.



Inventors
Ernest Willoughby Petter
and
James Hutton
By
Pennie, Davis, Marvin & Edmonds
Attorneys

Patented Dec. 27, 1927. 1,653,925

UNITED STATES PATENT OFFICE.

ERNEST WILLOUGHBY PETTER AND JAMES HUTTON, OF IPSWICH, ENGLAND, ASSIGNORS TO VICKERS-PETTERS LIMITED, OF IPSWICH, ENGLAND, A BRITISH COMPANY.

INTERNAL-COMBUSTION ENGINE.

Application filed April 14, 1925, Serial No. 22,958, and in Great Britain May 7, 1924.

This invention relates to internal combustion engines of the two-stroke single and double acting type in which liquid fuel is injected with or without air into a combustion space or chamber common to a plurality of pistons and in which the admission of the scavenging air and the exit of the exhaust gases take place through ports or passages controlled by the said pistons. Engines of this kind have been constructed with opposed pistons having the combustion space or chamber between them and in certain cases it has been proposed to employ in place of one of the opposed pistons two (or more) auxiliary pistons of equal diameter and stroke arranged to work either parallel or obliquely with respect to the other or main piston which has a greater stroke than the auxiliary pistons.

According to this invention our improved engine is provided with two pistons of different diameter and stroke connected to the engine crank shaft through suitable gear, the piston of larger diameter and stroke functioning mainly as a power piston, the cylinders in which said pistons work having inlet and exhaust ports controlled thereby and arranged on opposite or different sides of a common combustion chamber the walls of the cylinders at their inner or adjacent ends and the inner ends of the pistons being so shaped that when the pistons are at their in-stroke the said combustion space is of more or less spherical shape. The valve piston may be arranged to cover and uncover the exhaust ports and the power piston to cover and uncover the inlet ports for the air for scavenging purposes, or vice versa.

In order that the said invention may be clearly understood and readily carried into effect the same will now be described more fully with reference to the accompanying drawings, in which:—

Figure 1 is a vertical transverse section of an internal combustion engine constructed in accordance with our invention.

Figure 2 is a vertical section and

Figure 3 is a side elevation showing a suitable form of gearing for connecting the valve piston to the engine crank shaft.

Figure 4 is an end view showing a modification of the gearing for connecting the valve piston to the engine crank shaft, and,

Figure 5 is a vertical section of an internal combustion engine also constructed according to our invention but with the valve piston arranged to work in line with the power piston instead of obliquely thereto as in Figure 1.

Figure 6 is a vertical transverse section similar to Figure 5 showing our invention applied to an internal combustion engine of the two-stroke double acting type.

Like letters of reference are used to denote similar parts.

A is the power piston and a a the ports or passages it controls for admitting the air for scavenging purposes to the working cylinder A^1. B is the valve piston and b b are the ports it controls for permitting the exhaust gases to escape from the working cylinder. The said pistons A and B are arranged on opposite or different sides of the combustion space C and their inner ends are formed with curved recesses or cavities and the inner or adjacent ends of the cylinders in which the pistons work are formed with curved walls so that when said pistons are at their full in-stroke, the said combustion space has a more or less spherical shape which has certain advantages as hereinafter mentioned.

In Figure 1 the valve piston B is arranged to work in a cylinder B^1 the axis of which is inclined to the axis of the cylinder A^1. The power piston A is connected to the crank shaft D of the engine by a connecting rod E in the usual manner. The valve piston B is of less diameter than the power piston A and has a shorter stroke. It is connected by means of a connecting rod b^1 to a crank shaft b^2 which is parallel to the engine crank shaft D and is connected thereto through gearing which in the example illustrated in Figures 2 and 3 comprises two cranks b^3 b^4 arranged at right angles to each other on the crank shaft b^2 each crank being connected to similarly arranged cranks d^1 d^2 on the engine crank shaft D by connecting rods F^1 F^2. This arrangement of double cranks and connecting rods prevents dead centre positions. Any other form of gearing can be used so long as it enables the valve piston B to open

and close the exhaust ports *b b* at the proper times in relation to the movement of the power piston A in opening and closing the air inlet ports *a a*. During the working of the engine the pistons A and B are moved apart under the influence of the burning fuel in the combustion space C, the piston A imparting motion and conveying power to the engine crank shaft and at or near the end of its out-stroke uncovering the ports *a a* to allow the scavenging air which is supplied from a suitable source to enter the working cylinder A^1, the piston B meanwhile moving outward in its cylinder B^1 to uncover the exhaust ports *b b* thereby permitting the exhaust gases to escape through said ports. By reason of the more or less spherical shape of the combustion space C the heat arising from the combustion of the charge is concentrated in the valve piston cylinder B^1 which being of smaller diameter than the working cylinder A^1 is more efficiently cooled and less liable to heat stresses than the larger cylinder and also enables the hot exhaust gases to be conveniently dispersed by the scavenging air which enters through the aforesaid ports *a a* and causes the exhaust to leave through the aforesaid exhaust ports *b b* the disposition of said ports enabling a uniflow scavenge to be obtained. After the two pistons have reached the extremity of their out-stroke they are returned or moved inward in their cylinders, the power piston A by the kinetic energy of the engine fly wheel and the valve piston B by the same source of energy which is transmitted to it by means of the aforesaid gearing connecting it to the engine crank shaft. At or near the end of the movement of the pistons in performing their in-stroke and after they have covered the ports *a a* and *b b* respectively, a working charge of fuel is introduced into the combustion space C and ignited, after which the cycle of operations described above is repeated. The scavenging air may be supplied by means of any form of scavenge pump such as a rotary blower, a rotary compressor, or reciprocating or semi-rotary scavenge pumps, driven independently or from the engine.

In Figure 4 we have shown a modification of the gearing for connecting the valve piston to the engine crank shaft wherein a crank b^{5x} on the crank shaft b^2 of the valve piston is connected by a rod or member F^{1x} to a crank d^{1x} on the engine crank shaft D and also by a rod or member F^{2x} to a crank *g* on an auxiliary shaft G carried in bearings on a suitable part of the casing of the engine the crank *g* also being connected to the crank d^{1x} on the engine crank shaft by a rod or member F^{3x}. In this figure the said rods or members F^{1x} F^{2x} and F^{3x} are shown as forming part of a triangular frame.

In Figure 5 we have shown another form of our improved engine in which the valve piston works in line with the line of action of the power piston which in this case is shown with a fixed piston rod H terminating in a cross head *h* working in guides J and connected to the engine crank shaft through a connecting rod E^1, the working of the two pistons being effected in a similar manner to that described above in connection with Figures 1 to 4.

In Figure 6 we have shown our invention applied to an engine of the two-stroke double acting type, in which the valve piston at one end of the working cylinder works in line with the line of action of the power piston as in Figure 5 and the valve piston at the other end of the working cylinder works in a line inclined to the line of action of the said power piston as in Figure 1.

Although we have described our invention more particularly with reference to an engine in which the ports or passages controlled by the power piston serve to admit the scavenging air and the ports or passages controlled by the valve piston serve as the exhaust ports, which is the preferred arrangement, the functions of the ports or passages may be reversed, that it to say, the ports controlled by the power piston might serve as the exhaust ports and the ports controlled by the valve piston as the scavenging air inlet ports.

Our invention is applicable to either single cylinder engines, or engines of the multi-cylinder type, arranged vertically or horizontally and single or double acting.

What we claim and desire to secure by Letters Patent of the United States is:—

1. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their movements therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber of approximately spherical shape is formed between said pistons from which chamber said cylinders extend radially, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, and means for connecting the piston of smaller diameter to the said crank shaft so that it has a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

2. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their move-

ments therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber of approximately spherical shape is formed between said pistons from which chambers said cylinders extend radially, with their axes making with each other an angle substantially exceeding a right angle, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, and means for connecting the piston of smaller diameter to said crank shaft so that it has a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

3. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their movements therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber of approximately spherical shape is formed between said pistons from which chamber said cylinders extend with their axes in alignment, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston and means for connecting the piston of smaller diameter to the said crank shaft so that it has a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

4. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons one of which is of larger diameter than the other and both having concave recesses in their inner faces, cylinders in which said pistons work and which have scavenging air inlet and exhaust ports controlled by said pistons during their movements therein the inner ends of said cylinders being curved so that when the pistons are at their in-stroke a combustion chamber of approximately spherical shape is formed between said pistons, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, and means for connecting the piston of smaller diameter to said crank shaft so the it has a stroke substantially shorter than that of the larger piston and functions mainly as a valve.

5. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work, the larger cylinder having scavenging air inlet ports uncovered by the larger diameter piston during its outward movements and the smaller cylinder having exhaust ports uncovered by the smaller diameter piston during its outward movements the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke, a combustion chamber of approximately spherical shape is formed between said pistons from which chamber said cylinders extend radially, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, and means for connecting the piston of smaller diameter to the said crank shaft so that it has a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

6. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their movements therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber of approximately spherical shape is formed between said pistons said cylinders being arranged on different sides of said chamber, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, a short throw crank on said crank shaft, a second short throw crank arranged parallel to the former short throw crank and contiguous to said smaller diameter piston, means for connecting the latter piston to the second short throw crank, and driving means between said short throw cranks, whereby said smaller diameter piston has a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

7. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their movements therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber of approximately spherical shape is formed between said pistons from which chamber said cylinders extend radially, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, a short throw crank on said crank shaft, a second short throw crank arranged parallel to the former short throw crank and contiguous to said smaller

diameter piston, means for connecting the latter piston to the second short throw crank, and driving means between said short throw cranks, whereby said smaller diameter piston has a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

8. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their movements therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber is formed between the inner ends of said pistons of approximately spherical shape, said cylinders being arranged on different sides of said chamber, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, a short throw crank on said crank shaft, a second short throw crank arranged parallel to the former short throw crank and contiguous to said smaller diameter piston, means for connecting the latter piston to the second short throw crank, a third short throw crank so situated that lines joining the three short throw cranks form a triangle, and a triangular frame connected at its corners to said three short throw cranks whereby said smaller diameter piston is caused to have a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

9. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of a larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their movement therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber is formed between the inner ends of said pistons of approximately spherical shape from which chamber said cylinders extend radially, means for connecting the piston of larger diameter to the crank shaft of the engine so that it functions mainly as a power piston, a short throw crank on said crank shaft, a second short throw crank arranged parallel to the former short throw crank and contiguous to said smaller diameter piston, means for connecting the latter piston to the second short throw crank, a third short throw crank so situated that lines joining the three short throw cranks form a triangle, and a triangular frame connected at its corners to said three short throw cranks whereby said smaller diameter piston is caused to have a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

10. In a two-stroke internal combustion engine of the injected liquid fuel type, the combination of two pistons having curved inner ends one of which is of larger diameter than the other, cylinders in which said pistons work having inlet and exhaust ports controlled by said pistons during their movements therein the inner ends of said cylinders being so shaped that when the pistons are at their in-stroke a combustion chamber is formed between the inner ends of said pistons of approximately spherical shape from which chamber said cylinders extend radially with their axes making with each other an angle substantially exceeding a right angle, means for connecting the piston of the larger diameter to the crank shaft of the engine so that this piston functions mainly as a power piston, a short throw crank on said crank shaft, a second short throw crank arranged parallel to the former short throw crank and contiguous to said smaller diameter piston, means for connecting the latter piston to the second short throw crank, a third short throw crank so situated that lines joining the three short throw cranks form a triangle, and a triangular frame connected at its corners to said three short throw cranks whereby said smaller diameter piston is caused to have a stroke substantially shorter than that of the larger diameter piston and functions mainly as a valve.

11. In a two-stroke double-acting internal combustion engine of the injected liquid fuel type, the combination with the elements claimed in claim 1, of a second small diameter piston arranged at the end of the large diameter cylinder opposite to that at which the first small diameter piston is arranged, a cylinder in which said second small diameter piston works and which has ports controlled by the movements of the latter piston, a combustion chamber into which the inner end of the last mentioned cylinder and the contiguous end of the large diameter cylinder open, and means interposed between the crank shaft and the second small diameter piston whereby the latter has a substantially shorter stroke than that of the large diameter piston and functions mainly as a valve.

12. In a two-stroke double-acting internal combustion engine of the injected liquid fuel type, the combination with the elements claimed in claim 3, of a second small diameter piston arranged at the end of the large diameter cylinder opposite to that at which the first small diameter piston is arranged, a

cylinder in which said second small diameter piston works and which has ports controlled by the movements of the latter piston, a second combustion chamber into which the inner end of the latter cylinder and the contiguous end of the large diameter cylinder open, and means interposed between the crank shaft and the second small diameter piston whereby the latter has a substantially shorter stroke than that of the large diameter piston and functions mainly as a valve.

ERNEST WILLOUGHBY PETTER.
JAMES HUTTON.