March 16, 1926. 1,576,761

Z. S. HOFFMAN

INTERNAL COMBUSTION ENGINE

Filed Nov. 25, 1924

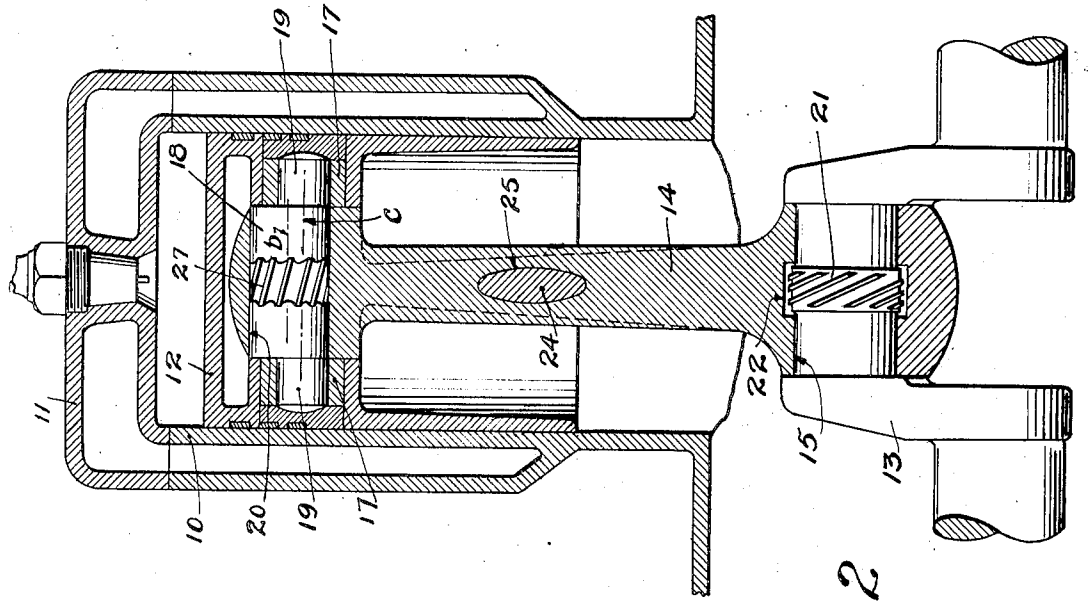
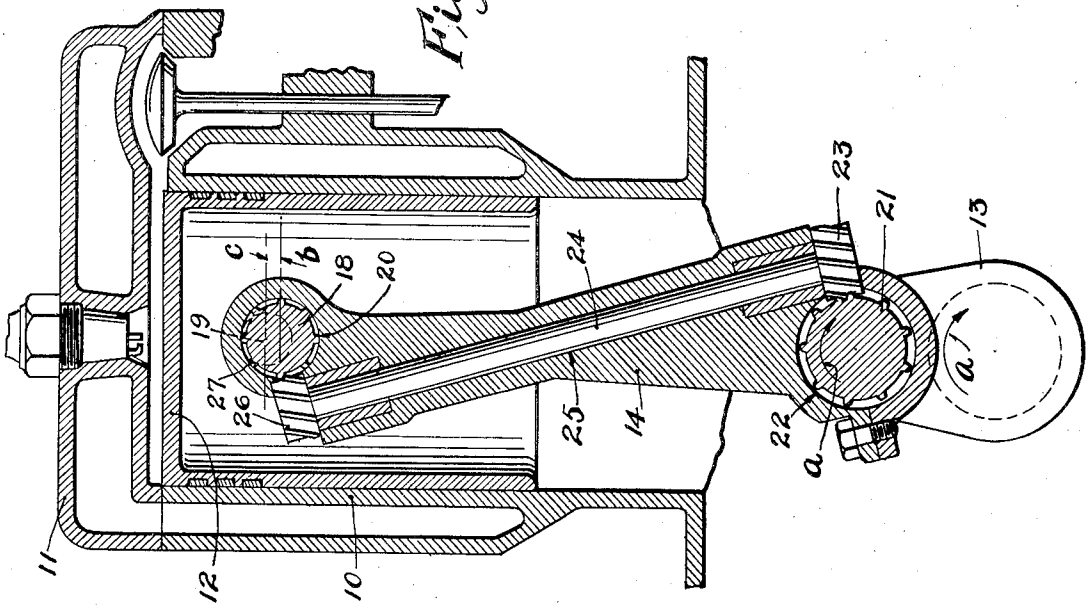


Fig. 2

Fig. 1



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INTERNAL-COMBUSTION ENGINE.

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To all whom it may concern:

Be it known that I, ZACHARIAH S. HOFFMAN, a citizen of the United States, residing at Irvington, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

This invention relates to internal combustion engines, and more particularly to engines of that general type which operate on a four phase cycle.

Among the objects of this invention is to provide an engine which shall automatically purge the gases of combustion completely from the cylinder thus increasing the efficiency of the engine and decreasing the consumption of fuel thereby.

Another object of this invention is to provide a four phase cycle engine whose piston will automatically completely expel the burnt gases from the cylinder thus permitting the cylinder to be filled with a wholly fresh charge whereby the available power output of the engine is increased while the consumption of fuel per unit of power is decreased.

In the prior art, four phase cycle engines are operated with the usual clearance between the piston and the head of the cylinder for the purpose of providing space for the gases when compressed preparatory to firing. This arrangement results in an incomplete purging of the burnt gases from the cylinder upon the exhaust stroke, burnt gases being left within the cylinder in sufficient quantity to fill said clearance. When a fresh charge is taken into the cylinder these burnt gases mix with said charge, dilute the same, and hinder combustion. Moreover, they reduce the effective capacity of the cylinder, and consequently the power available from the engine. It is to remedy these defects, that applicant has provided the invention disclosed herein.

With the foregoing and other objects in view the invention consists in the arrangement and combination of parts hereinafter described and claimed, and while the invention is not restricted to the exact details of construction disclosed or suggested herein, still for the purpose of illustrating a practical embodiment of the invention reference is had to the accompanying drawings in which like reference characters designate the same parts in the several views, and in which—

Figure 1 is a view of the engine in section showing the operating mechanism at the end of the exhaust stroke.

Fig. 2 is a central sectional view of Fig. 1 but showing the engine at the end of the compression stroke.

Referring now more particularly to the drawings, I show the engine as comprising a cylinder 10, and a head 11 which are water-jacketed in the usual manner. Within the cylinder is a conventional piston 12 which operates a power transmission member such as a crank 13. Intermediate between the piston and the crank, and transmitting power therebetween is a mechanism which operates as a connecting rod, eccentric means being provided to render the stroke of the piston variable in a predetermined manner. More specifically, said mechanism comprises a rigid member 14 which is arranged to carry actuating members to cooperate with said eccentric means for the purpose aforesaid. Said member or connecting rod can have direct engagement with said crank as in a bearing 15, while the end of the connecting rod at the piston is seated adjacent to a bearing 17 which carries an eccentric member such as a wrist pin 18 having offset or eccentric trunnions 19. The main body of the wrist pin which is cylindrical rotates within a bearing 20 formed in the piston. It will thus be observed that if the wrist pin is rotated the piston is caused to move relatively to the connecting rod, and that if this is done in a properly timed manner while the engine is in operation, the stroke of the piston can be increased when exhaust occurs, for the purpose of bringing the piston into relative proximity to the head of the cylinder thus insuring a proper purging of the burnt gases from the cylinder.

As a means for operating the wrist pin or cam member in a predetermined and properly timed manner, I show mechanism such as a gear train actuated by a suitable timing member such as the crank 13. More specifically, the rotation of the crank is utilized to operate the cam member so as to render the same effective once in every two rotations of the crank to bring the piston into proximity to the head as above stated. Thus the crank is provided with a gear 21

formed thereon in a suitable manner and preferably integral therewith, the crank bearing having an annular recess 22 to receive said gear. Co-operating with said gear is a worm wheel 23 mounted rotatably upon the connecting rod as upon a spindle 24 to which it is secured. Said spindle extends along the connecting rod in rotatable relation thereto, and is preferably housed within a bearing 25 formed lengthwise of said connecting rod and at an angle to the line of centers of the wrist pin 18 and the gear 21. Thus the worm wheel 26 mounted upon the spindle 24 at the end thereof opposite to the worm wheel 23 is located upon one side of the line of centers aforesaid, while the other worm wheel is located upon the other side. This permits of a compact construction of the engine by affording a central connecting structure for the piston of minimum width and thus increasing the available clearances between said structure and the side walls of the cylinder. Meshing with the worm wheel 26 is a gear 27 which acts with the wrist pin or cam member and is preferably formed by cutting directly into the surface of said wrist pin.

It will be seen that when the crank operates in the direction shown by arrow *a* the gear 21 will revolve with it around the axis of the shaft and because of this revolution of the gear it will rotate in like direction around its own axis and once for every rotation of the crank shaft. The intermediate mechanism between the gears 21 and 27 is so designed as to compel the gear 27 to rotate once while the gear 21 rotates twice. Thus at the end of the exhaust stroke the piston will be in the position shown in Fig. 1, the axis *c* of the trunnions 19 being then by the action of the eccentric in the uppermost position and above the axis *b* of the wrist pin. After the crank has made a complete rotation and intake and compression has occurred, the eccentric has made a half turn bringing the axis *c* below the axis *b*, thus providing a clearance for the gases at the end of the compression stroke between the piston and the head of the cylinder, such clearance being designed according to the practice most favorable for compression. Combustion will now occur, and during the next rotation of the crank, expansion and exhaust of the gases will take place, the eccentric making in the meantime another half turn to bring the piston into proximity to the cylinder head as shown in Fig. 1 for the sake of complete purging of the burnt gases.

The result of completely purging the burnt gases from the cylinder at the end of the exhaust stroke are that the effective cylinder volume is increased permitting of a greater generation of power by the engine. Moreover, when the burnt or inert gases are removed, mixing or diffusion of the gases occurs more rapidly thus requiring a smaller quantity of fuel per unit of power generated. The speed of diffusion is also greater, and the velocity of flame propagation is increased, thus permitting of a more perfect combustion and at a higher temperature. The percentage of unburnt fuel is thus decreased, and a considerable saving in fuel as well as a greater generation of power thereby effected. The purer the mixture can be maintained that is fired the less will be the deposition of carbon and other foul matter in the cylinder and valves, demanding regrinding of the valve seats less frequently than as usual.

I claim:

1. In an internal combustion engine, the combination with a cylinder, a piston reciprocating therein, and a power transmitting means actuated by said piston, of a connecting structure between said piston and said means, said structure comprising an eccentric member to render variable the distance between said piston and said power transmitting means in accordance with the eccentricity of said eccentric member, and a gear mechanism actuated by said power transmitting means for operating said eccentric member, said structure comprising a spindle extending lengthwise of the connecting structure to transmit motion between parts of said gear mechanism.

2. In an internal combustion engine, the combination with a cylinder, a piston reciprocating therein, and a power transmitting means actuated by said piston, of a connecting structure between said piston and said means, said structure comprising an eccentric member to render variable the distance between said piston and said power transmitting means in accordance with the eccentricity of said eccentric member, and a gear mechanism actuated by said power transmitting means for operating said eccentric member, said structure comprising a plurality of gears upon opposite sides of the same, and a spindle connecting said gears.

3. In the herein described internal combustion engine, the combination with a cylinder, a piston reciprocating therein, and a crank member actuated by said piston, of a connecting structure between said member and said piston comprising an eccentric member for pivotally connecting said piston and said structure and rendering said structure movable relatively to said piston in accordance with the rotational position of said eccentric, gears carried by said eccentric and said crank members, a pair of spaced alined gears meshing individually with the gears aforesaid, and a spindle extending along said structure and connecting said alined gears.

4. The combination as in claim 3 wherein

said alined gears lie upon opposite sides of said structure for the purpose of affording the maximum clearances about said structure.

5. In an internal combustion engine, the combination with a cylinder, a piston reciprocating therein, and a crank, of a connecting structure between said piston and said crank, said structure comprising an eccentric member to render variable the distance between the piston and the crank, said eccentric member being located at said piston and remote from said crank, and a gear mechanism operative by said crank for actuating said eccentric member.

6. In a power transmitting device, the combination of a reciprocating member, and mechanism including a crank to co-operate with said member and rotate when said member reciprocates, said mechanism comprising likewise a gear train operative through the rotation of said crank, and an eccentric at said member rotatable by said gear train for varying the throw of said member.

7. In a power transmitting device, the combination with a reciprocatory member, of means to which said reciprocatory member is connected, said means comprising a rotatable eccentric, a connecting structure having pivotal engagement with said eccentric to reciprocate with said reciprocatory member and whereby the relation of said structure to said reciprocatory member is varied, and means for rotating said eccentric as aforesaid including a rotating spindle extending lengthwise of said connecting structure.

In testimony whereof I affix my signature.

ZACHARIAH S. HOFFMAN.