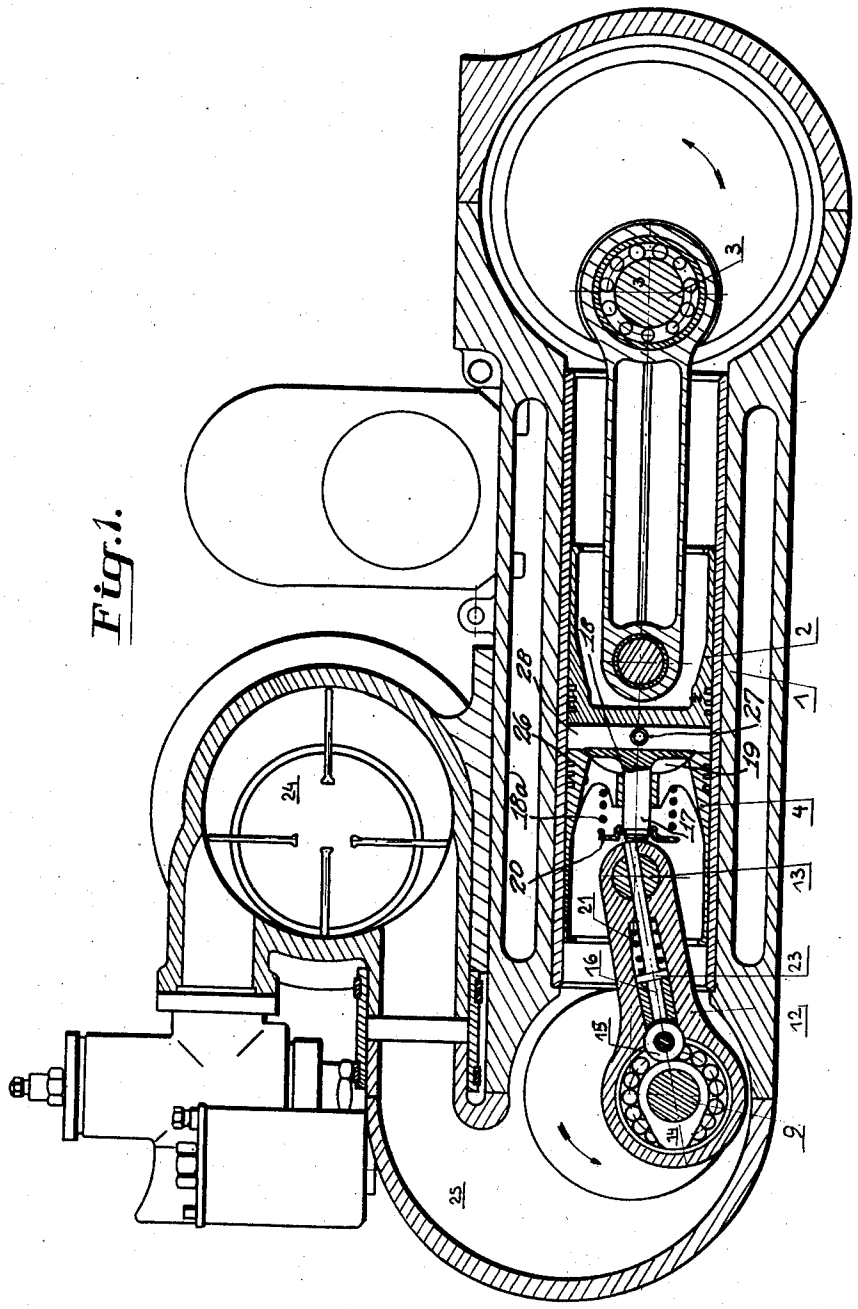
Dec. 6, 1938. G. W. PATCHETT 2,139,457

INTERNAL COMBUSTION ENGINE

Filed Aug. 5, 1936 2 Sheets-Sheet 1

Fig. 1.



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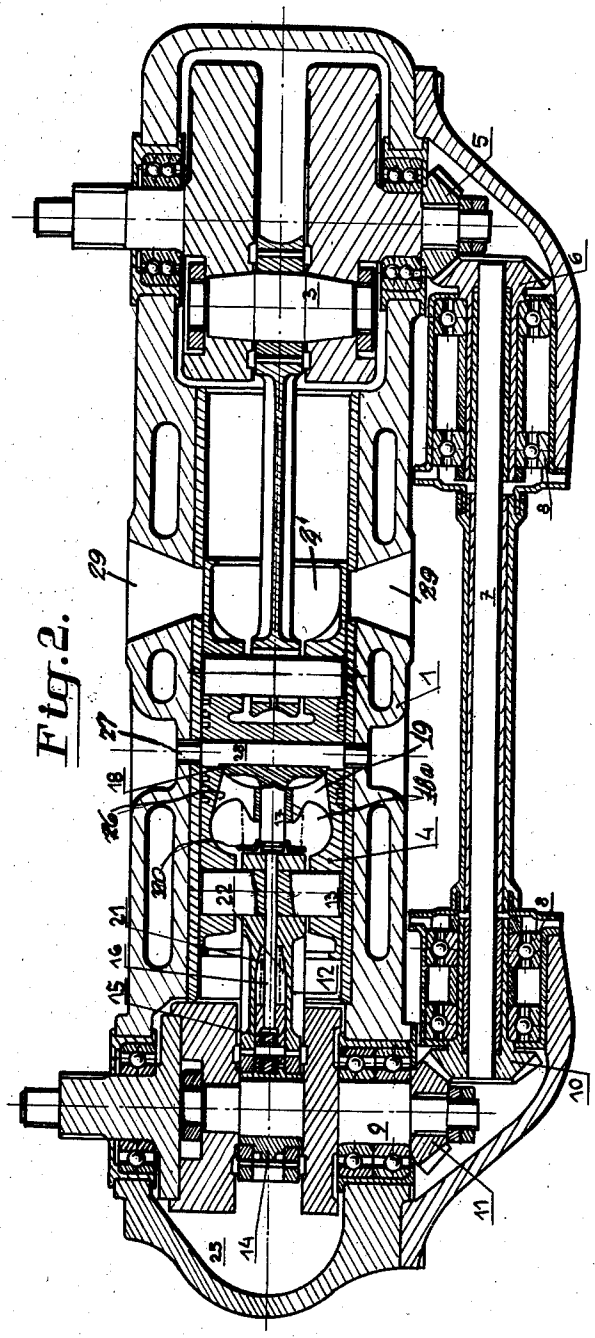

Fig. 2.

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INTERNAL COMBUSTION ENGINE

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Application August 5, 1936, Serial No. 94,402
In Great Britain August 9, 1935

21 Claims. (Cl. 123—51)

This invention relates to internal combustion engines of the two stroke cycle type and has for its object to provide an improved construction and arrangement designed to protect the ignition devices against damage by the combustion gases whilst simultaneously increasing the pressure of the explosive mixture.

According to the invention a two stroke cycle internal combustion engine is constructed having an auxiliary piston arranged to move in conjunction with the working piston and thereby to follow said working piston during the power stroke or part thereof for the purposes above indicated. During said common travel of both the working and auxiliary pistons the ignition devices are covered by the said auxiliary piston for substantially the whole explosion period beginning immediately after the effected ignition of the cylinder charge and before the main portion of said charge is set into burning condition and ending when the combustion of the charge is terminated.

Reference will now be made to the accompanying drawings which illustrate by way of example a construction according to the invention and in which:—

Figure 1 is a sectional elevation and

Figure 2 is a plan of an improved internal combustion engine.

In the construction illustrated an internal two stroke cycle combustion engine of the positive ignition type is provided having a cylinder 1 with a piston 2 operating a crank shaft 3 in the ordinary manner and a secondary piston 4 driven by said crank shaft 3 through gearing hereinafter described to follow the working piston 2 during the power stroke or a part thereof thereby covering the ignition devices to protect them from the effect of the highly compressed and heated burning gases, and simultaneously confining said gases within a smaller space than is usual in engines of this kind. The drive to the secondary piston 4 is effected by providing the main crank shaft 3 at one end with a bevel gear 5 meshing with a bevel gear 6 fixed to one end of a shaft 7 mounted in bearings 8 at the side of the engine housing and extending in a direction parallel to the axis of the cylinder 1 to a point adjacent a crank shaft 9 which is driven from the shaft 7 through bevel gears 10 and 11. The crank shaft 9 operates a connecting rod 12 connected to the secondary piston 4 by means of a gudgeon pin 13 and the crank shaft 9 has also mounted thereon a cam 14 which once in each revolution of the said crank shaft engages a roller 15 mounted at one end of an axially slidable rod 16 whose opposite end bears against the end of the stem 17 of a valve 18 mounted in the head of the secondary piston 4, this valve being normally maintained in the closed position shown by means of a spring 18a bearing at one end against webs 19 in the head of the piston and at the other end against a plate or disc 20 fixed around the end of the valve stem 17. The rod 16 is normally held inoperative and is returned to inoperative position after actuation by the cam 14 by a spring 21 mounted in a slot or recess 22 in the connecting rod and bearing against one end of said slot and against a flange or collar 23 on the rod 16.

The fuel mixture is supplied by a compressor 24 through an inlet 25 and when the valve 18 is opened the charge of fuel enters through passages 26 formed by the walls of the piston 4 and the inclined turbulence creating webs 19.

The positive ignition devices embodied in the present instance as sparking plugs are indicated at 27 opposite the combustion space 28 formed by the piston 2 at its extreme outer position and the piston 4 approaching its outer position as shown in the drawings and the cylinder is provided with exhaust ports 29.

The two crank shafts 3 and 9 rotate at the same circumferential speed but due to the fact that they constantly remain in positions which mutually form an angle of 90° the secondary piston moves with substantially its maximum speed when the main piston is moving with its minimum speed so that the highest point of compression is obtained after the main piston 2 has just passed its extreme outer position or top dead centre.

The arrangement described and represented in the drawings enables thus to have the ignition point at the moment immediately preceding the highest point of compression of the cylinder charge and to have the covering of the ignition devices accomplished immediately after ignition has started but just before the main portion of the compressed charge has been set into combustion.

As shown in Fig. 1 which illustrates the beginning of the explosion or power stroke, the crank pin of the secondary shaft 9 is moving about an arc the chord of which is substantially parallel to the axis of the cylinder so that the secondary piston is moving with substantially its highest speed and thus will cover the spark plug 27 immediately after explosion has taken place. During this period the crank pin of the main shaft 3 is moving about an arc the chord

of which is substantially perpendicular to the axis of the cylinder and the main piston is moving with substantially its lowest speed. Under these conditions of operation the spark plugs will be protected from the effect of the burning gases during substantially the whole explosion period, and also owing to the fact that both pistons are moving in the same direction the gases will be maintained under high pressure during substantially the whole power stroke. Towards the end of the power stroke the cam **14** causes the valve **18** to open and admit a fresh combustible charge or a charge of scavenging air, the secondary piston moving during this time to a lower position so as to provide a larger space for the incoming charge to be compressed during the following stroke. The compression of this charge is assisted by the secondary piston **4** which during the latter portion of the compression stroke moves towards the main piston **2** until the position shown in the drawings is again reached when the explosion or power stroke recommences.

Owing to the central position of the valve device **18** with respect to the piston the advantage is obtained of a maximum port area for instant filling of the cylinder. Further, the passage of the compressed charge or charge of air assists in cooling the piston and the adjacent cylinder walls, turbulence being created for this purpose by the angularity given to the webs **19** supporting the valve guide. This cooling action has the additional advantage of promoting the protection of the spark plug against the burning gases by the secondary piston. The valve operating rod **16** is subjected to a very small load, since the tendency to movement of the valve **18** on the induction and compression strokes is automatically that provided by the mechanical movements applied to said valve. This tendency to movement of the valve under varying pressure conditions in the cylinder may be utilized in some engines to the exclusion of the mechanism operated by the cam **14**. In such cases the valve would open automatically when the pressure in the cylinder **1** becomes less than the pressure in the crank case adjacent the inlet **25** and admit a fresh charge or a quantity of air for scavenging purposes. The valve would then be closed by its spring **18a** when the pressure in the cylinder becomes equal to that of the crank case and would be kept closed during the compression and power strokes by the internal pressure in the cylinder.

It should be understood that I do not wish to limit myself to the transmission of rotation between the crank shafts by means of bevel gears since such transmission may be very efficiently secured also by spur gearing, chain drive, or by cranks and connecting rod, or the like.

The invention is applicable to all types of internal combustion engines including those of the Diesel type, etc.

What I claim is:—

1. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the operating cycle of said working piston, and a passage in said second piston arranged to establish communication between the interior of said cylinder between said two pistons and the exterior thereof at a desired moment in the cycle of operation of said working piston.

2. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the operating cycle of said working piston, and a passage disposed substantially centrally in said second piston and arranged to establish communication between the interior of said cylinder between said two pistons and the exterior thereof at a desired moment in the cycle of operation of said working piston.

3. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the power stroke of said working piston for the purpose of maintaining the combustion gases under pressure, a valve provided in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons and a fuel supply pipe, and means for opening said valve at an appropriate moment in the cycle of operation of said working piston.

4. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the power stroke of said working piston for the purpose of maintaining the combustion gases under pressure, a valve provided in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons and an air supply pipe, and means for opening said valve at an appropriate moment in the cycle of operation of said working piston to admit a charge of scavenging air into said cylinder.

5. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the power stroke of said working piston for the purpose of maintaining the combustion gases under pressure, a valve provided in said secondary piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons and a fuel supply pipe, and means for opening said valve during the concluding portion of the power stroke in the cycle of operation of said working piston.

6. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the move-

ment of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the power stroke of said working piston for the purpose of maintaining the combustion gases under pressure, a valve provided in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons and an air supply pipe, and means for opening the said valve to admit a charge of scavenging air into said cylinder during the concluding portion of the power stroke in the cycle of operation of said working piston.

7. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the operating cycle of said working piston, a valve provided centrally in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons and the exterior thereof, and spring means for closing said valve.

8. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the operating cycle of said working piston, a valve provided centrally in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons, and a fluid supply pipe, and means associated with said valve for creating a turbulence in said fluid when supplied through said valve to the interior of said cylinder.

9. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the operating cycle of said working piston, a valve provided in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons and the exterior thereof, and timed cam-operated mechanism arranged to open said valve at an appropriate moment during the cycle of operation of said working piston.

10. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the operating cycle of said working piston, a valve provided in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons and the exterior thereof, and timed cam-operated mechanism controlled primarily by the movement of said working piston and arranged to open said valve at an appropriate moment during the cycle of operation of said working piston.

11. In a two stroke cycle internal combustion engine the combination of a cylinder, a working piston movable therein, a cylinder head comprising a second piston also movable in said cylinder, a main crank shaft connected to be operated by said working piston, a second crank shaft connected to be driven from said main crank shaft and to drive said second piston in said working cylinder, a valve in said second piston, a cam on said second crank shaft, a rod operated by said cam and movable to open said valve, and a spring for closing said valve.

12. In a two stroke cycle internal combustion engine the combination of a cylinder, a working piston movable therein a cylinder head comprising a second piston also movable in said cylinder, a main crank shaft connected to be operated by said working piston, a second crank shaft connected to be driven from said main crank shaft, a connecting rod between said second crank shaft and said second piston whereby said second crank shaft is connected to move said second piston in said working cylinder, a valve in said second piston, a cam on said second crank shaft, and means carried by said connecting rod and operable by said cam to open said valve in said second piston.

13. In a two stroke cycle internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, means for controlling the movement of said second piston whereby said second piston is constrained to follow the movement of said working piston in said cylinder during a part at least of the operating cycle of said working piston, a valve provided centrally in said second piston and arranged, when open, to establish communication between the interior of said cylinder between said two pistons, and a fluid supply pipe, turbulence being imparted to the incoming charge by the angularity given to the webs supporting the valve guide.

14. In an internal combustion engine, the combination of a cylinder, a working piston movable in said cylinder, a cylinder head constituted by a second piston also movable in said cylinder, and means for controlling the movement of said second piston whereby said second piston is constrained to move towards said working piston during the latter part of the compression stroke of the operating cycle of said working piston, so as to have the highest point of compression obtained after the main piston has passed its extreme outer position or top dead centre.

15. In an internal combustion engine, the combination of a cylinder, a working piston and an auxiliary piston, both movable in said cylinder, and means for controlling the movement of said auxiliary piston, whereby said auxiliary piston is constrained to cover the sparking plugs or other ignition devices during a part at least of the operating cycle of the said pistons to protect the said devices from the attack of the burning gases, said gases being simultaneously maintained under pressure.

16. In an internal combustion engine the combination of a cylinder, a working piston and an auxiliary piston, both movable in said cylinder, and means for controlling the movement of said

auxiliary piston, whereby said auxiliary piston is constrained to cover the sparking plugs or other ignition devices during a part at least of the power stroke of the working piston to protect the said devices from the attack of the burning gases, said gases being simultaneously maintained under pressure.

17. In a two stroke cycle internal combustion engine, the combination of a cylinder, a main piston movable in the cylinder, a main crank shaft connected to the main piston at one end of the cylinder, a cylinder head constituted by a secondary piston also movable in the cylinder, a secondary crank shaft connected to the secondary piston at the other end of the cylinder, and means adapted to drive the secondary piston substantially at its maximum speed when the main piston is moving at its minimum speed.

18. In a two stroke cycle internal combustion engine, the combination of a cylinder, a main pist n movable in the cylinder, a main crank shaft connected to the main piston at one end of the cylinder, a cylinder head constituted by a secondary piston also movable in the cylinder, a secondary crank shaft connected to the secondary piston at the other end of the cylinder, and means adapted to drive the secondary piston substantially at its maximum speed when the main piston at the beginning of the explosion period starts to change from its inner towards its outer dead center.

19. In a two stroke cycle internal combustion engine, the combination of a cylinder, a main piston movable in the cylinder, a main crank shaft connected to the main piston at one end of the cylinder, a cylinder head constituted by a secondary piston also movable in the cylinder, a secondary crank shaft connected to the secondary piston at the other end of the cylinder, positive ignition devices provided in the cylinder wall, and means adapted to drive the secondary piston from a position closely in front of the said ignition devices at substantially maximum speed in a direction to pass over the said ignition devices when the main piston at the beginning of the explosion period starts to change from its inner toward its outer dead center.

20. In a two stroke cycle internal combustion engine, the combination of a cylinder, a main piston movable in the cylinder, a main crank shaft connected to the main piston at one end of the cylinder, a cylinder head constituted by a secondary piston also movable in the cylinder, a secondary crank shaft connected to the secondary piston at the other end of the cylinder and means for rotating both crank shafts at equal angular speeds, the secondary crank pin having a smaller eccentricity than the main crank pin and being constantly in advance of substantially 90° of the main crank.

21. In a two stroke cycle internal combustion engine, the combination of a cylinder, a main piston movable in the cylinder, a main crank shaft connected to the main piston at one end of the cylinder, a cylinder head constituted by a secondary piston also movable in the cylinder, a secondary crank shaft connected to the secondary piston at the other end of the cylinder, a secondary crank pin being in advance of substantially 90° to the main crank pin and having a smaller eccentricity than the latter and a transmission between the ends of both crank shafts at the same side of the engine disposed substantially parallel to the axis of the cylinder and adapted to transmit the rotation of the main crank shaft without altering the speed thereof, to the secondary crank shaft.

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