March 20, 1962 C. R. CASINI 3,025,840

CARBURETION ENGINE WITH VARIABLE-VOLUME COMBUSTION CHAMBER

Filed April 1, 1958 2 Sheets-Sheet 1

Fig. 4

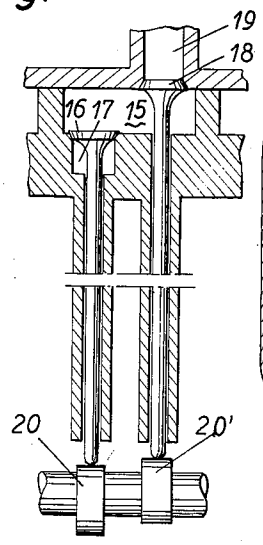
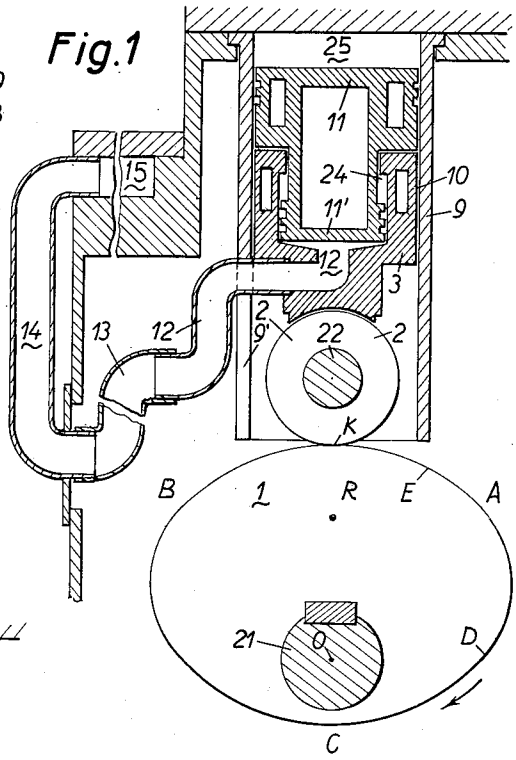


Fig. 1



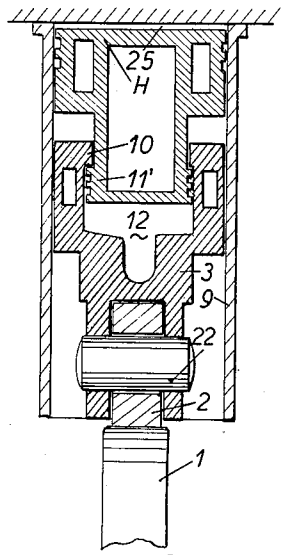


Fig. 2

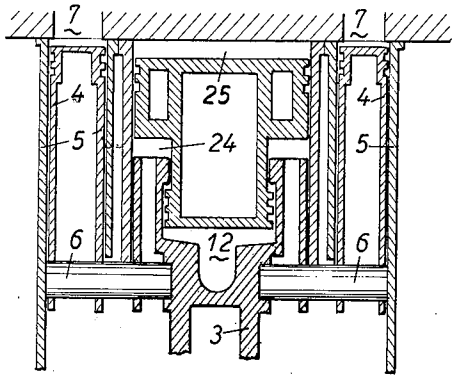


Fig. 3

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March 20, 1962 C. R. CASINI 3,025,840

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Filed April 1, 1958 2 Sheets-Sheet 2

Fig. 5

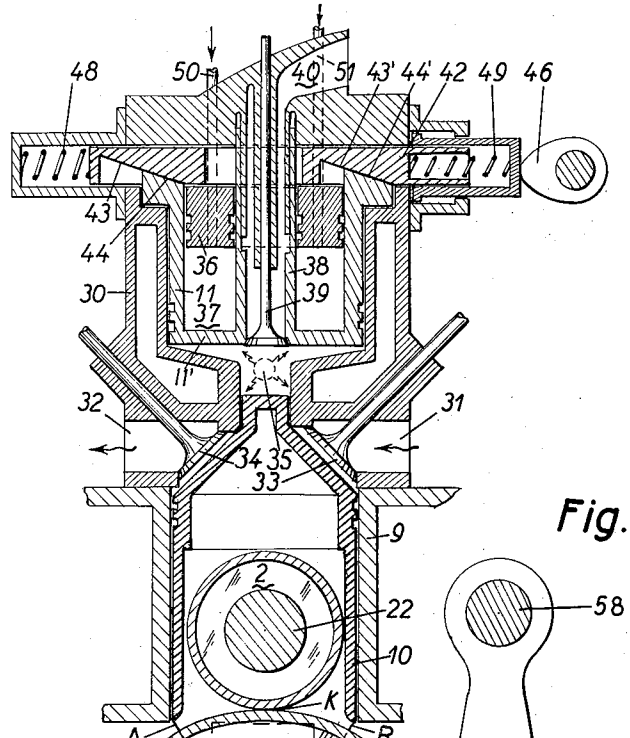
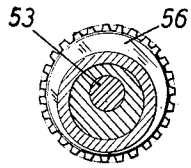


Fig. 6a



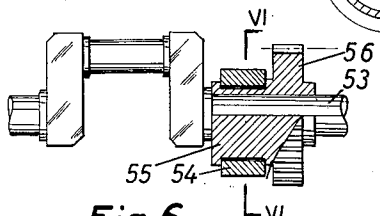
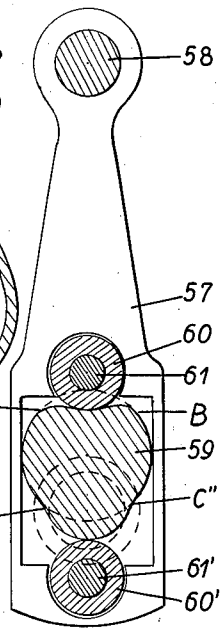


Fig. 6

Fig. 7



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CARBURETION ENGINE WITH VARIABLE-VOLUME COMBUSTION CHAMBER

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2 Claims. (Cl. 123—48)

The carburetion engines, used mostly to propel motor vehicles, are rarely made to develop the full power of which they are capable, and since in these engines the speed is adjusted by throttling the intake duct, i.e. by reducing the quantity of mixture actually drawn into the cylinder, while the volume of the combustion chamber is invariable, it follows that the pressure of the mixture at the end of the compression stroke will reach its maximum only in the rare cases when the engine is operated at full throttle, while at all other speeds this pressure decreases in proportion to the reduction in the quantity of mixture.

The object of the present invention is to obviate this defect by applying the following principles in combination with each other:

a. Varying the volume of the combustion chamber so that, at any throttle setting, the pressure of the mixture actually introduced becomes constant and equal to the pressure determined theoretically;

b. Subsequently causing the self-ignition of the mixture at a pre-determined point of the cycle, by further reducing the volume of the combustion chamber;

c. Inserting between the two piston strokes two constant-volume phases, corresponding to bottom dead center and top dead center.

These results are obtained by applying the reciprocating motion of the engine piston not to a crank but to a cam, characterized by having two arcs of a circle (corresponding to the top dead center and to the bottom dead center) concentrical to the engine shaft, so as to obtain two periods in which the piston is stationary. The volume of the combustion chamber is determined not only by the position of the piston at the end of the compression stroke, but also by the position of another piston, hereinafter referred to as "compensating piston," one face of which forms one wall of the combustion chamber. This arrangement reduces the volume below that obtained through the natural motion of the engine piston, whenever compression is lower than that corresponding to the theoretical pressure, because on the opposite face of the compensating piston acts a fluid maintained at a given pressure, which restores said pressure value. The term "theoretical pressure" is used herein to describe pressure determined by theoretical calculation of the cycle. Subsequently, self-ignition is caused through a further reduction in the volume of the compression chamber, obtained by applying to the compensating piston the pressure of a fluid from a second tank maintained at a somewhat higher pressure than the first. The engine piston, remains through all phases described above in a stationary position on the profile of the constant-volume cam, and makes it possible to achieve a balance of the pressures and self-ignition without the danger of back-pressures on the engine shaft.

Other advantages are obtained from the constant-volume sections of the cam, since with the stopping of the piston the ignition advance is eliminated, which always causes a back-thrust on the engine shaft, and the exhaust advance is likewise eliminated by having the gases operate through the entire expansion stroke, without any back-pressure of the burned gases on the piston due to the abrupt reversal of the piston motion.

Further advantages of the invention will be evident from the following description, referred to the enclosed drawings which represent, as a non-limiting example, certain embodiments of the principles described. In the drawings:

FIG. 1 is a cross-sectional view of the engine;

FIG. 2 is a similar cross-sectional view of the phase when the combustion chamber is reduced to the minimum volume;

FIG. 3 is another partial cross-sectional view, showing the parts that maintain contact between the roller and the cam;

FIG. 4 represents the group of valves for the distribution of the pressurised fluid used to reduce the combustion chamber volume;

FIG. 5 is a vertical cross-sectional view of a motor presenting certain changes from that illustrated in the preceding figures;

FIGS. 6 and 6*a* represent a construction which makes it possible to obtain the compensation of the mixture compression ratios with a connecting-rod and crank arrangement as well;

FIG. 7 represents another construction which makes it possible to achieve constant-volume combustion with a connecting-rod and crank arrangement.

With special reference to FIGS. 1 through 4, on the cam **1** keyed to the engine shaft **21** runs the roller **2** which revolves around a pivot **22** fixed to an extension block **3** of the piston **10**. The profile of the cam **1** consists of arcs of circle AB and BA, with the centers respectively on the center of the engine shaft and on a point R, the position of which is determined by the piston stroke and other engine characteristics. The point K is the point in which the roller contacts the cam.

Since during the cycle, and particularly in the intake stroke, the roller **2** would tend to leave the cam, a device is provided to press it against the latter, consisting of two parallel cylinders **5**, machined from the block and having the axes on a diametral plane of the latter. The cylinders **5**, within which slide the pistons **4**, are connected, through the ducts **7** in the head, with a tank containing fluid maintained under pressure by a compressed air device. The lower ends of the pistons are connected to a crossbar **6**, which is in turn connected to the block **3** fastened to the main piston.

The engine piston is in two parts, coaxial and aligned, and comprises a hollow base **10** and a head **11**, slidable with a seal fit within the cylinder **9**, and provided with a cylindrical extension slidable with a seal fit in the hollow part of the piston base **10**, which is also provided with shoulders **24** which limit the stroke of the piston head **11** inside the cylindrical cavity of the piston **10**.

As can be seen from FIGURES 1, 2 and 3, at the end of the compression stroke, and in addition to the stroke of piston base **10**, the piston head **11** can travel by an additional distance to reduce the volume of the combustion chamber **25**, when suitably driven by a thrust against face **11'**.

This is obtained by the action of a compressed fluid which, through the tubes **12** and **14**, connected with a flexible hose **13**, reaches the lower face **11'** of the piston from a chamber **15** fitted with two valves referred to below. The elbow pipe **12**, during the movement of the piston, slides in a slot **9'** in the lower portion of cylinder **9**.

The two valves leading into the chamber **15** are: valve **16**, which establishes a connection with a duct **17** which leads to a tank of compressed fluid, and valve **18** which, through a pipe **19**, establishes a connection between the chamber **15** and a tank containing fluid at a pressure higher than that in the other tank. Valves **16** and **18** are actuated by two cams **20** and **20'** keyed on a countershaft which revolves at half the speed of the main engine shaft.

Valve **16** is lifted by the cam **20** only during the last phase of the compression stroke. The operation of the

valves 16 and 18 is apparent from the following description.

When the roller 2, as the cam revolves clockwise, runs over the section of profile AB, which is an arc of circle with the center on the axis of the engine shaft, the piston stands still. At point B begins the intake stroke BC, which is however extended to point D, to take advantage of the kinetic energy of the mixture entering the cylinder. It is assumed that the engine feed valve is in a position corresponding to half the normal power setting, namely, the quantity of the mixture sucked in by the engine is half the quantity which can be sucked in as a maximum during the intake stroke. From D to A the compression phase takes place, and the piston is subjected to two pressures: on its head 11 and on face 11'.

At the beginning, when compression in the combustion chamber is still low, the pressure of the fluid contained in the chamber 15 keeps the head 11 raised, but when, as the piston moves, the mixture pressure increases, part of the fluid will flow back into the ducts 12, 13 and 14 through the valve 16, which during this phase has been kept open by cam 20. A new position of equilibrium will thus be established, to which corresponds, for instance, the position of piston shown in FIG. 3.

At this point therefore, at the end of the compression stroke, the volume of combustion chamber 25 will be appreciably smaller than that which would obtain in the case of full throttle setting. The term "full throttle setting" as used in the specification and claims, means full mixture admission, i.e. the maximum quantity of mixture which can be sucked in by the engine in the intake stroke. When roller 2 will be on point E of the cam, it is presumed that the equilibrium of the two forces is reached, and at this point the cam 20 closes the valve 16 and the cam 20' releases the valve 18. Greater pressure of the fluid in the tank 19 will impart a new thrust on the piston head 11, further reducing the volume of the combustion chamber, as shown in FIG. 2. It will thus be possible to achieve the highest compression ratio consistent with the anti-knocking quality of the mixture, or to cause self-ignition of the latter, independently of the spark plug, and in this connection it should be noted that it is not particularly important whether ignition takes place at any particular point of section AB, because in any case the combustion will take place at constant volume.

When pressure is created by the explosion of the mixture, the piston will be prevented from sending back the fluid into ducts 12, 13 and 14 because valves 16 and 18 are closed and tight against their seats, and will transmit full power to the main piston, and thence to the engine shaft. Thus, by locating point E at a suitable distance from the beginning of the expansion phase, complete combustion at constant volume will be obtained, clearly separating this phase from the expansion phase, i.e. closely approximating the theoretical cycle.

During the last phase of expansion, the pressure falls below that in duct 17, valve 16 will open by itself, allowing the fluid to flow out of the tank, and allowing piston head 11 to retract fully into the cavity of piston base 10, and then the cycle starts again.

A pump will regulate the pressures in the tanks into which lead ducts 17 and 19.

It is evident that the operation described above will be the same for any throttle setting.

The arrangement shown in FIG. 5 makes the main piston lighter, gives to the combustion chamber a more appropriate shape and to the roller a more advantageous position for the purpose of balancing side thrusts.

Moreover, two opposed rollers are adopted to connect the cams, with the piston, and a constant-volume profile is provided to correspond to the bottom dead center.

In FIG. 5, the parts similar to those shown in the preceding figures bear the same reference numbers. Cam 1 has a section AB which is an arc of circle with its center at O. Section C', C'' is also an arc of circle with its center in O and at the minimum distance from the center.

The section C'C''B is complementary to section BAC', i.e. it is such that the length of all cam diameters passing through points K, K' is constant, K, and K' being the points of contact between the rollers and the cam. The two opposed rollers 2 and 2' are mounted on pivots 22 and 22', respectively, the former being fastened to the piston 10 slidable with a seal fit in the cylinder in block 9, and the latter being fastened to the end of a stirrup 28 fastened to the piston 10. The stirrup 28 has a slot 29 fitting around the engine shaft.

The engine block 9 is surmounted by a head 30, fitted with intake and exhaust ducts 31 and 32, with the valves 33 and 34, respectively, which open on a conical surface of the cylinder matching the conical surface of the piston head.

A second piston 11, which compensates mixture pressures, is slidable with a seal fit in the head 30, and the two cylindrical cavities in which slide piston 10 and 11 are connected with each other through the chamber 35 in which the spark plug is located.

A guide ring 36 is fitted to the engine head 30, creating inside the compensating piston 11 a blind and sealed annular space 37, extending between the inner wall of piston 11 and the outer wall of a pipe 38 which is part of the piston 11, in the axis of which slides the stem of a valve 39 which establishes a connection between the chamber 35 and a supplementary exhaust duct 40.

In FIG. 5, piston 11 is at the end of its downward stroke, its upper end being locked by a bar 42 sliding in a cavity in the engine head and having two inclined planes 43—43', which engage two similar inclined planes 44—44' in the upper end of the compensating piston 11.

The bar 42 is actuated by a cam 46 keyed to a shaft revolving at half the speed of the engine shaft. A spring 48 maintains the bar 42 pressed against the cam 46, and another spring 49 absorbs the excess stroke of cam 46 when the inclined planes of the bar and of piston 11 engage before the cam has gone through the full stroke. Two pipes 50 and 51, connected to tanks containing fluid at different pressures lead into the annular cavity 37.

In order to operate the engine according to the embodiment described above, fluid under pressure is let into cavity 37 by means of pipe 50, so as to balance the theoretical pressure exerted by the mixture in the combustion chamber 35 at the end of the compression stroke.

Let us assume that roller 2, after the constant-volume section BA, is at point A, the beginning of the intake phase, and that the throttle is half open. Exhaust valve 34 is closed, intake valve 33 opens and auxiliary valve 39 closes. Piston 11, due to the action of the compressed fluid sent into cavity 37 through pipe 50, not counteracted by an equivalent pressure in chamber 35, will be pushed all the way down as in FIG. 5 while, unlike that which is shown in the same FIGURE, bar 42 will be moved all the way to the right.

When roller 2 is at C', phase C'—C'' begins, with the piston at a standstill during that phase. During the same phase the filling of the cylinder is completed. From C', valve 33 is closed and compression starts. While piston 10 moves upwards and compresses the mixture, the latter is vigorously agitated by the effect of the narrowed section 35. As the mixture pressure increases, piston 11 will assume with respect to it a position of balance, until the upper dead center is reached.

At this point, cam 46 moves the bar 42 from the right to the left, until the inclined planes 43—44 and 43'—44' touch. Any excess of cam stroke is absorbed by spring 49.

At a given point of section AB a valve, not shown, lets into pipe 51 the fluid at a pressure higher than that of compression of the mixture, so that the volume of the combustion chamber will undergo a further reduction, sufficient, for instance, to cause self-ignition. This downward movement of the piston 11, moves apart the in-

clined planes 44—44′ and 43—43′, but since the spring 49 is loaded, the bar 42 will move to the left until contact is restored, so that, on explosion, the piston 11 will not be allowed to move back, and the entire thrust will be transmitted to the engine piston.

As the piston 10 through the expansion phase, pressure on piston 11 will decrease, until the piston will find, lower down, a new position of balance, returning to the engine shaft the energy it had required to be moved upwards during the compression stroke.

When, at the end of the expansion stroke roller 2 is at point C′ of the cam, it will not be necessary to provide for an advance of the exhaust.

A variation of the piston stroke in relation to the actual throttle setting may also be obtained in an engine fitted with connecting rods and cranks by means of the device shown in FIGS. 6 and 6*a*, where a conventional crankshaft 53 is mounted in crankshaft bearings 54 with the interposition of an eccentric bushing 55, fitted with a gear wheel 56. By driving the gear wheels of the several crankshaft bushings in a manner dependent upon the position of the throttle setting, the volume of the combustion chamber will be varied accordingly.

Lastly, FIG. 7 shows how constant-volume combustion and exhaust can be obtained in an engine provided with connecting rods and cranks.

Connecting rod 57, mounted between piston pin 58 and crank journal 59, is provided with a rectangular slot in which said crank journal revolves. Two rollers 60 and 60′, rotatably mounted on pivots 61 and 61′ fastened to the connecting rod, follow the outline of the crank journal, which is not circular but has a depression along arc AB and a projection C′, C″, complementary to each other; since the distance between rollers is constant, they remain in contact with the crank journal.

It is evident that when, in the combustion phase, roller 60 is in contact with arc AB, the piston remains at a standstill, while when the same roller 60, in the exhaust phase, rests on arc C′, C″, the piston will likewise remain at a standstill.

Any variation in construction details will fall within the scope of the invention whenever they embody the same novel concepts set forth in the following claims.

I claim:

1. A carburetion engine, comprising a cylinder having a central portion of reduced cross-sectional area forming a combustion chamber, the volume of said combustion chamber corresponding to the minimum throttle setting, and two larger portions on opposite sides of said central portion, a main piston reciprocable within one of said larger cylinder portions, a hollow auxiliary piston reciprocable within the other one of said larger cylinder portions, at least one exhaust valve communicating with said combustion chamber, means supplying compressed fluid to said auxiliary piston, a pivot connected with said main piston, a roller carried by said pivot, an engine shaft, a cam keyed upon said engine shaft and engaging said roller for actuating said main piston to produce a compression stroke, said cam having roller-engaging surfaces shaped to provide combustion and exhaust at constant volume, and means connected with the first-mentioned means for adjusting the pressure of said compressed fluid and, consequently, the position of said auxiliary piston and the volume of said combustion chamber.

2. A carburetion engine, comprising a cylinder having a central portion of reduced cross-sectional area forming a combustion chamber, the volume of said combustion chamber corresponding to the minimum throttle setting, and two larger portions on opposite sides of said central portion, a main piston reciprocable within one of said larger cylinder portions, a hollow auxiliary piston reciprocable within the other one of said larger cylinder portions, an intake valve and an exhaust valve carried by said one larger cylinder portion, said main piston covering said intake and exhaust valves in its top dead center position, means supplying compressed fluid to said auxiliary piston, a pivot connected with said main piston, a stirrup carried by said main piston, another pivot carried by said stirrup, rollers carried by said pivots, an engine shaft, a cam keyed upon said engine shaft and engaging said rollers on opposite sides for actuating said main piston to produce a compression stroke, said cam having roller-engaging surfaces adapted to provide combustion and exhaust at constant volume, and means connected with the first-mentioned means for adjusting the pressure of said compressed fluid and, consequently, the position of said piston head and the volume of said combustion chamber.

References Cited in the file of this patent

UNITED STATES PATENTS

741,179	Sproehnle	Oct. 13, 1903
817,905	Daniel	Apr. 17, 1906
936,409	Chapman	Oct. 12, 1909
1,437,929	Brockway	Dec. 5, 1922
1,489,004	Powell	Apr. 1, 1924
1,560,492	Powell	Nov. 3, 1925
1,825,163	Schweter	Sept. 29, 1931
1,828,976	McNaught	Oct. 27, 1931
2,006,498	Dasset	July 21, 1935
2,104,802	Hansen	Jan. 11, 1938

FOREIGN PATENTS

741,563	Germany	Nov. 12, 1943