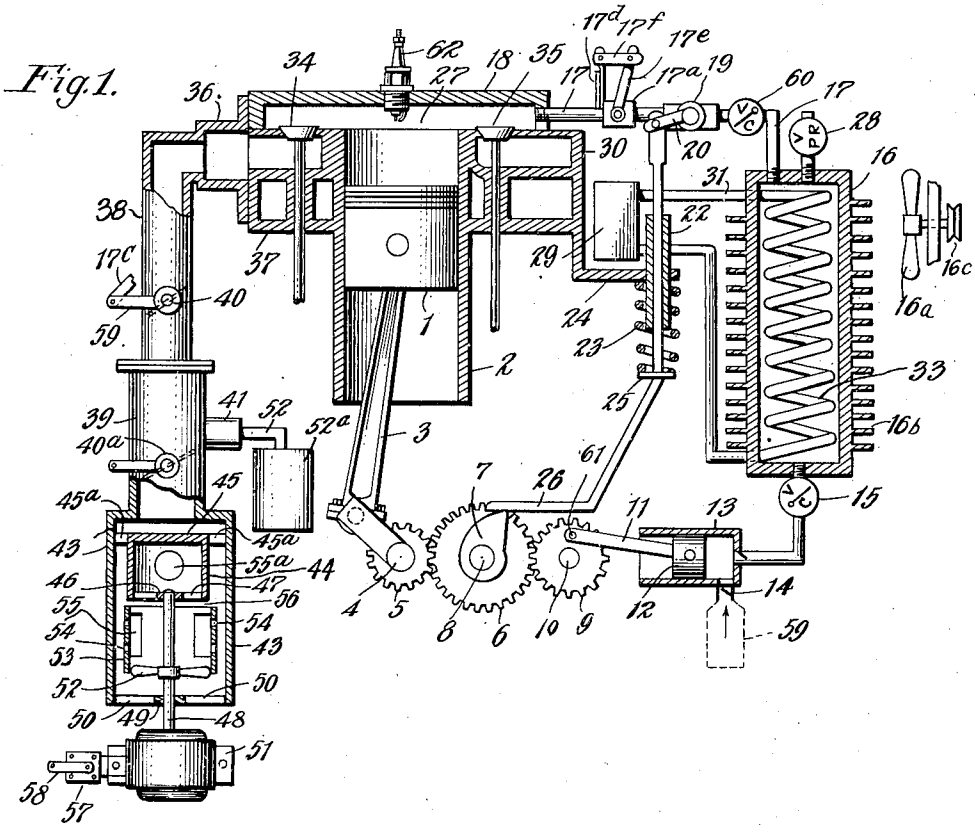
March 29, 1938. A. G. THOMAS 2,112,751

INTERNAL COMBUSTION ENGINE

Filed April 21, 1936

Fig. 1.



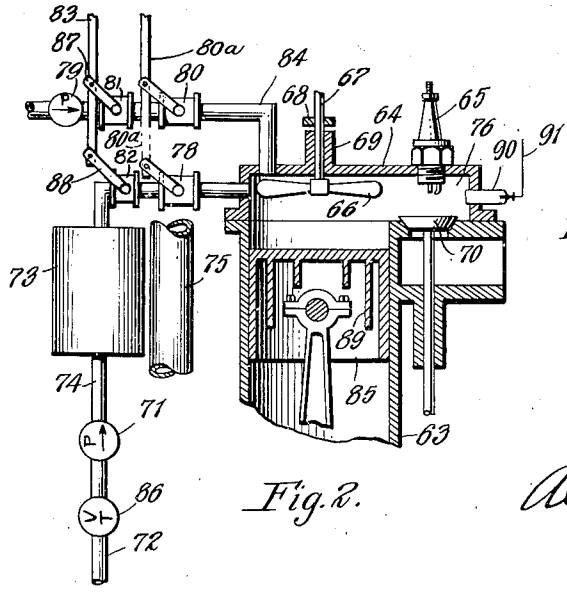
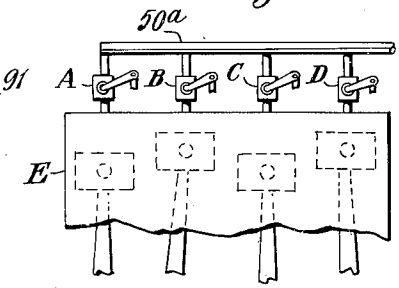


Fig. 2.

Fig. 3.



Inventor.

Albert G. Thomas

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INTERNAL COMBUSTION ENGINE

Albert G. Thomas, Lynchburg, Va.

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10 Claims. (Cl. 123—75)

This invention relates to internal combustion engines and especially to engines such as those used in motor cars and airplanes.

An object is to provide an engine in which pre-ignition and "knocking" are greatly reduced or eliminated, by the admission of a cooling gas such as air to the cylinders.

Another object is to provide more complete combustion through the addition of oxygen to the air supply, with the result that more power is generated, and less carbon monoxide.

Still another object is to provide novel and efficient mixing devices for fuel and air, also efficient mixing systems within the cylinders.

These and other objects will appear in the following description.

In the drawing:

Figure 1 represents a part-sectional elevation of an engine cylinder and associated mechanism for increasing the oxygen content of the air and for cooling the charge.

Figure 2 is a fragmentary, part-sectional elevation of a cylinder with a novel fuel-mixing and piston cooling design.

Figure 3 is an elevation of a multi-cylinder engine with a plurality of air admission valves.

In Figure 1 piston 1 is reciprocated in cylinder 2 by connecting rod 3, in usual manner. Crank shaft 4 has fastened to it gear 5 which meshes with larger gear 6 to which is fastened cam 7 so that both are rotatable together on shaft 8 which is fixed to some part of the engine. Small gear 9, rotatable on shaft 10 fixed to the engine, is pivoted to piston 12 by pivot 61 so that air is drawn in at 14 and forced through check valve 15 and into heavy compression tank 16, when crank shaft 4 is rotating. Other check valves, as indicated diagrammatically in cylinder 13, are provided as usual. The quantity of air supplied to tank 16 will therefore increase in direct proportion to the speed of the engine.

Pipe 17 leads from air tank 16 through cylinder head 18, so that air from this tank may be supplied to the cylinder 2, by opening throttle valve 19. Throttle arm 20 is pivoted to rod 21 which is slidable in, and preferably keyed to prevent rotation in guide sleeve 22 fastened to the engine framework. Compression spring 23, pressing against engine framework 24 and flange 25 on rod 21, normally urges rod 21 in a downward direction to keep throttle valve 19 closed. Rod 21 is bent to form arm 26 which rests on cam 7 and is lifted periodically by cam 7 as will be described later, to admit air to combustion chamber 27. Tank 16 is provided with pressure release valve 28 to guard against excessive pressure in this tank. Check valve 60 may be provided.

Cooling unit 29, represented diagrammatically, is placed contiguous to exhaust manifold 30 so that heat from the exhaust will operate the cooling device to circulate a cooling medium through pipes 31 and 32 and cooling coil 33 placed in tank 16. This invention is not concerned with the particular form of cooling unit 29 since such devices are well known as exemplified by the Electrolux refrigerator. The method of applying heat to the unit and the uses to which the cooling effects are put are considered to be novel however. While the air in tank 16 is shown as being cooled by coil 33, it may also be reduced in temperature by radiating fins 16b on cylinder 16, and by a stream of air. Air becomes heated upon being compressed and it is desirable to cool it again—since if it entered combustion chamber 27 at too high a temperature its cooling effect would be greatly reduced.

The usual inlet and exhaust valves 34 and 35 respectively are shown. Fuel inlet manifold 36 is fastened to the cylinder block 37 as usual and is supplied with the air-fuel mixture by pipe 38 leading from carburetor or other mixing device 39, throttle valve 40 being provided to control the flow. The carburetor bowl 41 is supplied with gasoline or other fuel by pipe 52 which is extended and connected to fuel tank 52a.

Enlarged air intake pipe 43 is provided with mechanism for increasing the oxygen density of the air by centrifugal action. Cylinder 44 is integral with pipe 43, being supported by slotted or perforated wall 45, the perforations being shown at 45a. Cylinder face 46, perforated by holes 47, serves as bearing for one end of rotatable shaft 48, the other bearing being face 49 of pipe cylinder 43. Face 49 is perforated by holes 50 to admit air. Motor 51 revolves shaft 48 at a high rate of speed when it is energized by current from the car battery or from the generator. Fan 52 is fastened to and revolves with shaft 48 and fastened to the tips of fan 52 is cylindrical centrifuge casing 53 to the inside of which are fastened axially parallel vanes 55 which serve to impart a rapid rotary movement to the air as it is forced through pipe 43 by fan 52. Perforations 54 are provided in casing 53, and cylinder 44 has hole 55a leading to the atmosphere through a suitable pipe.

Now if motor 51 is not revolving, air will be supplied to carburetor 39 in a normal manner but when motor 51 is energized to revolve centrifuge 53 at high speed the oxygen molecules be-

ing heavier than the nitrogen molecules, will be thrown through holes 54 and will press against pipe casing 43. The oxygen-enriched air will therefore pass through slots 45a and into carburetor 39. The central portion of the air, partially denuded of oxygen, will be forced through holes 47 and out of hole 55a to the atmosphere. This rejected air will consist largely of nitrogen, with of course a certain amount of oxygen remaining. There are other gases in air such as argon etc., but oxygen and nitrogen constitute the preponderant bulk and therefore only those two gases will be considered.

The smaller the gap 56 separating centrifuge 53 and cylinder 44 the less nitrogen will be mixed with the air drawn into the carburetor since, with small clearance, nearly all of the central air will pass out of hole 55. Likewise the degree of separation of the oxygen can be controlled by varying the speed of motor 51 and by adjusting the clearance between centrifuge 53 and pipe wall 43. Blades similar to vanes 55 may be placed on the outside of centrifuge 53 also.

Motor 51 may have speed control box 57 with control lever 58 so that the speed of the motor may be increased as the speed of the engine increases.

By increasing the oxygen density of the air mixed with the fuel more thorough combustion will take place with the result that more power will be generated and less carbon and carbon monoxide will be formed. Oxygen may of course be supplied to the combustion chamber from a tank of compressed oxygen as tank 59 which may be placed to feed into tank 16 or it may be fed through carburetor air pipe 43. In the past such feeding of additional oxygen would have been impracticable since it would have tended to lower the temperature necessary for pre-ignition but with my improved fuel cooling system using injected air on compression strokes, it is possible to add oxygen.

The general principle governing the operation of this cooling system is that of admitting to the combustion chamber, on the compression stroke, a certain amount of cooled air under a pressure considerably higher than the maximum pressure developed in the combustion chamber during the compression stroke, before igniting the mixture with a spark. This cooled air will then rush into the fuel-air mixture in the chamber and will mix thoroughly with these vapors or gases and at the same time will expand and tend to cool since the pressure in the combustion chamber is lower than the pressure forcing the air in. Therefore, the added air will exert a cooling effect on the fuel-air mixture to offset the normal increase of temperature of the mixture on the compression stroke. The quantity of air admitted may be increased as the compression is increased so that all during the compression stroke there will be a balance between the cooling effect of the air and the heating effect of compression. In this way the resulting temperature of the fuel-air mixture may be kept below that necessary to cause pre-ignition, but above the dew point of the fuel vapors, so that condensation will not take place. Therefore, when the mixture is finally ignited by the spark the full effects of the charge will be realized and in addition there will be less trouble from "knocking" which is often caused by too high a temperature within the cylinders. Furthermore, much higher compression ratios can be used than heretofore.

The air supply to the carburetor may be restricted by means of throttle 40a so that the additional cooling air will make up the normal air content for the mixture, or the cooling air may constitute an added quantity within reasonable limits. The reduced supply of air to the carburetor as a result of partially closing throttle 40a will produce a choking effect so that more fuel will be drawn into the cylinder. Then additional cooling air may be forced into the combustion chamber to form a normal fuel air mixture, but the quantity of both will be greater. This will be supercharging in effect and will produce increased power.

This system of cooling the fuel-air mixture directly is radically different from past methods which have relied upon cooling various parts of the engine or cylinders to prevent pre-ignition and knocking. Such methods have never been very satisfactory.

Engines built according to my system will, then have the following advantages: (1) higher compression ratio (2) greater power for a given weight (3) less cooling troubles (4) less carbon monoxide and carbon formation (5) better acceleration, less pre-ignition and less knocking; (6) cheaper fuel may be used with satisfactory results.

Tank 16 is made with heavy walls to withstand fairly high pressures. If, for instance, the maximum pressure in chamber 27, on the compression stroke is 150 pounds, a high pressure for former engines, then tank 16 would be made to withstand pressures of from 200 to 250 pounds per square inch or more. These figures are merely illustrative, but give some idea of the pressures involved.

Cam 7 is so shaped that it lifts rod 21 to open throttle valve 19 gradually on the compression stroke, in proportion to the temperature of the compressed charge so that as more heat is developed, more air will be admitted to cool the charge, so that a proper resultant temperature will be maintained. Cam 7 is shaped to cause a sharp cut-off of throttle 19 toward the end of the compression stroke, just before firing the charge, but if desired the cut-off may be gradual and check valve 60 may be provided to prevent the expanding gases in chamber 27 from rushing into tank 16, when the charge is fired. Throttle 19 could of course be eliminated so that cooling air would be forced into the cylinder 2 at all times except on the firing stroke. This air would exert a beneficial cooling and scavenging effect on the exhaust stroke but would reduce the suction on the intake.

Cam 7 as shown is fastened to gear 6 which reduces the rate of rotation of shaft 8 as compared to crank shaft 4, so that throttle 19 will be opened at the beginning of the compression stroke and will be closed near the end of that stroke, remaining closed until the next compression stroke. But the speed of rotation and shape of cam 7 may be so designed that air will be passed through throttle valve 19 in increasing amount during the compression stroke; then valve 19 may be cut off during the firing stroke and may be opened wide during the exhaust stroke to cool the combustion chamber, cylinder walls and piston, and at the same time to help discharge the burned gases. Then cam 7 will open valve 19 the proper amount on the next compression stroke.

Air may be admitted to combustion chamber 27 in any way desired or in any direction for best mixing or cooling effects.

While tank 16 is preferable, it is not necessary

since piston 12 may be made to force air directly into combustion chamber 27, suitable timing being provided by a proper choice of gearing and location of pivot 61. Spark plug 62 is provided as usual.

It will be noted that the hotter the engine becomes the greater will be the cooling effect produced by unit 29 so that cooling coil 33 will chill the air in tank 16 more as the temperature of exhaust manifold 30 rises. The temperature of the cooling air will therefore be automatically regulated according to the needs of the engine. This would also be true in case tank 16 were cooled by a fan driven directly by some moving part of the engine. Likewise thermostatic valve 17a in line 17 will regulate the flow of air in proportion to the temperature of the engine. Bimetal strip 17d is fastened to valve 17a and is linked at one end to valve arm 17e by means of pivoted arm 17f so that valve 17a will be opened more as the temperature of the engine becomes hotter.

While only one cylinder is shown in Figure 1 it is obvious that the same principle may be applied to an engine of any number of cylinders as shown in the fragmentary view of Figure 3 in which air is supplied through manifold 50a to the proper cylinders of engine E, control valves A, B, C, and D, being cam operated as described in connection with Figure 1.

In Figure 2 cylinder 63 has cylinder head 64 with spark plug 65, as usual. Rotatable fan or mixer 66 is fastened to shaft 67 to which is fastened collar 68 which presses against the upper face of bearing 69 in which shaft 67 may be rotated at high speed by a motor or by being geared to some moving part of the engine. This rotating fan will then mix the fuel and air thoroughly on the intake and compression strokes and will also assist in forcing the burned gases out of exhaust port 70 on the exhaust stroke. In addition, fan 66 may be made of relatively thin metal of rather large area so that the metal will take up heat on the compression stroke to prevent preignition and will cool rapidly on the exhaust stroke. This metal may be perforated if desired, to enhance heat transfer and mixing.

Pump 71 draws fuel through pipe 72 from a suitable tank, not shown. This pump may be of any suitable type and is preferably driven directly by the engine. It sprays fuel into heating tank 73 through pipe 74, which may have a reduced orifice. Tank 73 is heated by exhaust pipe 75 so that the fuel in that tank is thoroughly vaporized before passing into combustion chamber 76 through pipe 77 which is provided with throttle valve 78. Air is forced into combustion chamber 76 by pump 79 driven by the engine and through pipe 84 which is provided with throttle valve 80. Cut-off valve 81 controls the flow of air through pipe 84 and a similar cut-off valve 82 controls the flow of fuel vapor through pipe 77. These two valves are linked together as shown so that they may be opened or closed simultaneously by rod 83 which may be actuated by a cam similar to cam 7 of Figure 1. Rod 83 and the associated cam are arranged to open valves 81 and 82 at the beginning of the intake stroke of piston 85 and to close at the end of this stroke, to remain closed until the beginning of the next intake stroke.

Throttle valves 78 and 80, illustrated diagrammatically, may be linked together by link 80a in similar manner to valves 81 and 82 so that they may be manually opened or closed simultaneously to control the amount of fuel vapor and air entering combustion chamber and cylinder 63 on the intake stroke while valves 81 and 82 are open. If desired, another throttle valve 86 may be placed in pipe line 72 to control the feeding of fuel to pump 71 and therefore to vaporizing chamber 73. Throttle 80, controlling the air supply, will naturally have a larger opening than throttle 78 controlling the fuel but they may be designed to keep the same fuel-air ratio for all throttle openings or by adjusting the linkage points of the throttle arms similar to arms 87 and 88 on rod 83, the proportion of air to fuel may be increased or vice versa as the throttles are opened. It is obvious that valves 78 and 80 need not be linked together but could be separately controlled. Air flowing from pipe 84 strikes against fuel flowing from pipe 77 creating turbulence that will assist in mixing the two. The air in pipe 84 may also be heated by exhaust pipe 75.

Advantages of this type of mixing device are that the fuel and air may be definitely mixed in any proportions desired for any speed of the engine and the fuel is thoroughly vaporized before passing into the cylinder, and is mixed after reaching the cylinder.

Piston 85 is provided with cooling fins 89 to reduce the temperature of the piston face and walls. High voltage tube 90 charged by wire 91 connected to a suitable source of potential, may be fastened in cylinder head 64 to irradiate the fuel-air mixture with X-rays, ultra-violet light, or electrons just before or at the time of ignition of the mixture by spark plug 65. This is for the purpose of ionizing the fuel and air molecules to promote better combustion. Pumps 71 and 79 may be eliminated and the air and fuel can be drawn into the cylinder by vacuum action.

Many variations and combinations of the principles and devices outlined in the foregoing specification may be made without departing from the spirit of my invention. For instance, air of increased oxygen density may be supplied to Diesel engines as well as to the type illustrated. Furthermore, engines built upon the general lines as illustrated in Figures 2 and 6 may be operated upon the Diesel principle as well as otherwise. Many other variations will be readily apparent to those skilled in the art.

What I claim is:

1. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite said mixture, means for injecting cooling gas into said mixture during said compression of said mixture, and means for increasing the rate of injecting said cooling gas as the degree of said compression is increased.

2. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite said mixture, means for injecting cooling air into said mixture during said compression of said mixture, and means for increasing the rate of injecting said cooling air as the degree of said compression is increased.

3. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite said mixture, means for injecting cooling gas into said mixture during the latter part of said compression, and means for varying the amount of said gas injected in proportion to the temperature of said engine.

4. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite

said mixture, and means for injecting cooling gas into said mixture during the entire period of said compression.

5. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite said mixture, and means for injecting cooling gas into said mixture during the latter part of said compression.

6. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burner gases, sparking means to ignite said mixture, and means for injecting during said compression, cooling gas into said mixture at higher pressure than the maximum compression pressure of said mixture.

7. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite said mixture, means for compressing air, means for cooling said air, a valve controlling the flow of said air into said mixture, said valve being automatically opened to admit said air to said mixture during said compression, and said valve being automatically closed to stop the flow of said air near the end of the periods of said compression.

8. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite said mixture, means for compressing air, a valve controlling the flow of said air into said mixture, said valve being automatically opened to admit said air to said mixture during said compression, and said valve being automatically closed to stop the flow of said air near the end of the periods of said compression.

9. In an internal combustion engine, means for producing mixture of air and fuel, means for producing compression of said mixture, means for ejecting burned gases, means for restricting the proportion of air in said mixture, and means for admitting cooling air to said mixture largely during the lattter part of said compression, in sufficient quantity to make normal proportions of air-to-fuel, and sparking means to ignite the final charge of said air and said fuel.

10. In an internal combustion engine, means for producing compression of fuel mixture, means for ejecting burned gases, sparking means to ignite said mixture, means for injecting cooling gas into said mixture during said compression of said mixture, means for regulating the amount of said gas injected so that the temperature of said mixture will be maintained above the condensation point and below the ignition point until said mixture is ignited by said sparking means.

ALBERT G. THOMAS.