Oct. 29, 1929. A. G. SHERMAN 1,733,431

INTERNAL COMBUSTION ENGINE

Filed Aug. 15, 1925 3 Sheets-Sheet 1

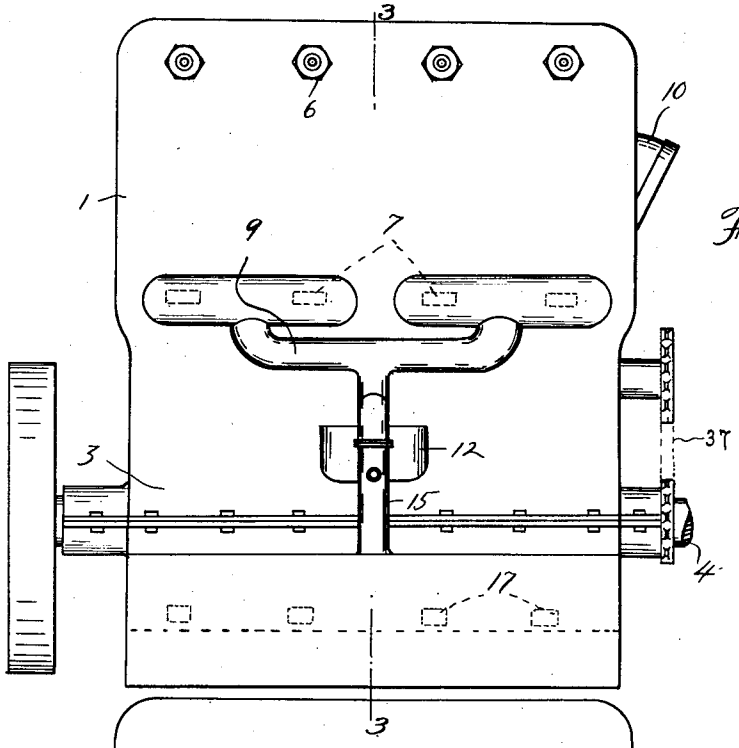


Fig. 1

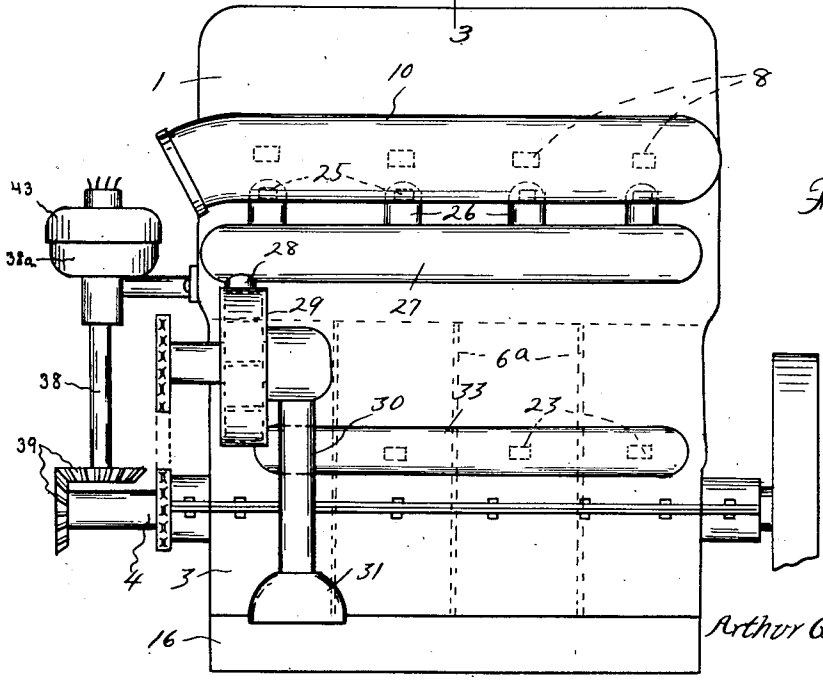


Fig. 2

Inventor
Arthur G. Sherman

By J. D. Murray
Attorney

Oct. 29, 1929. A. G. SHERMAN 1,733,431

INTERNAL COMBUSTION ENGINE

Filed Aug. 15, 1925 3 Sheets-Sheet 2

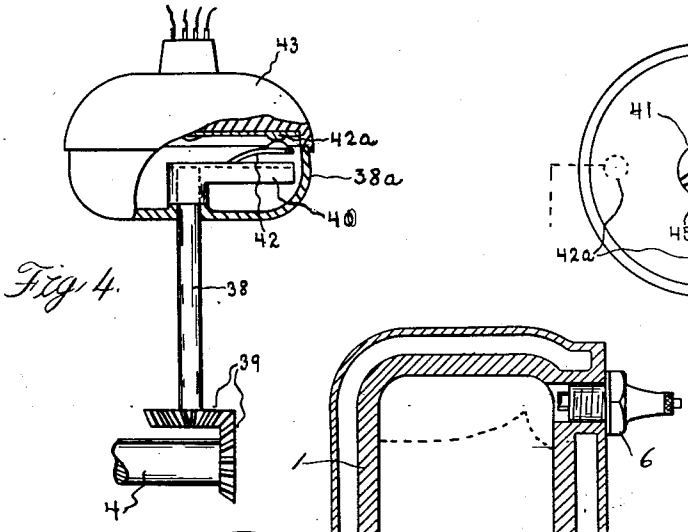


Fig. 4.

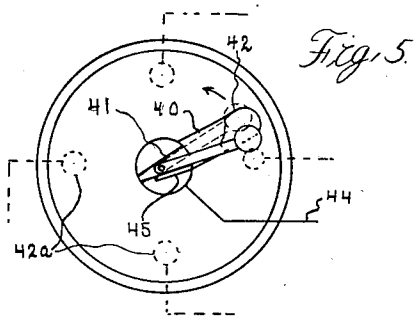


Fig. 5.

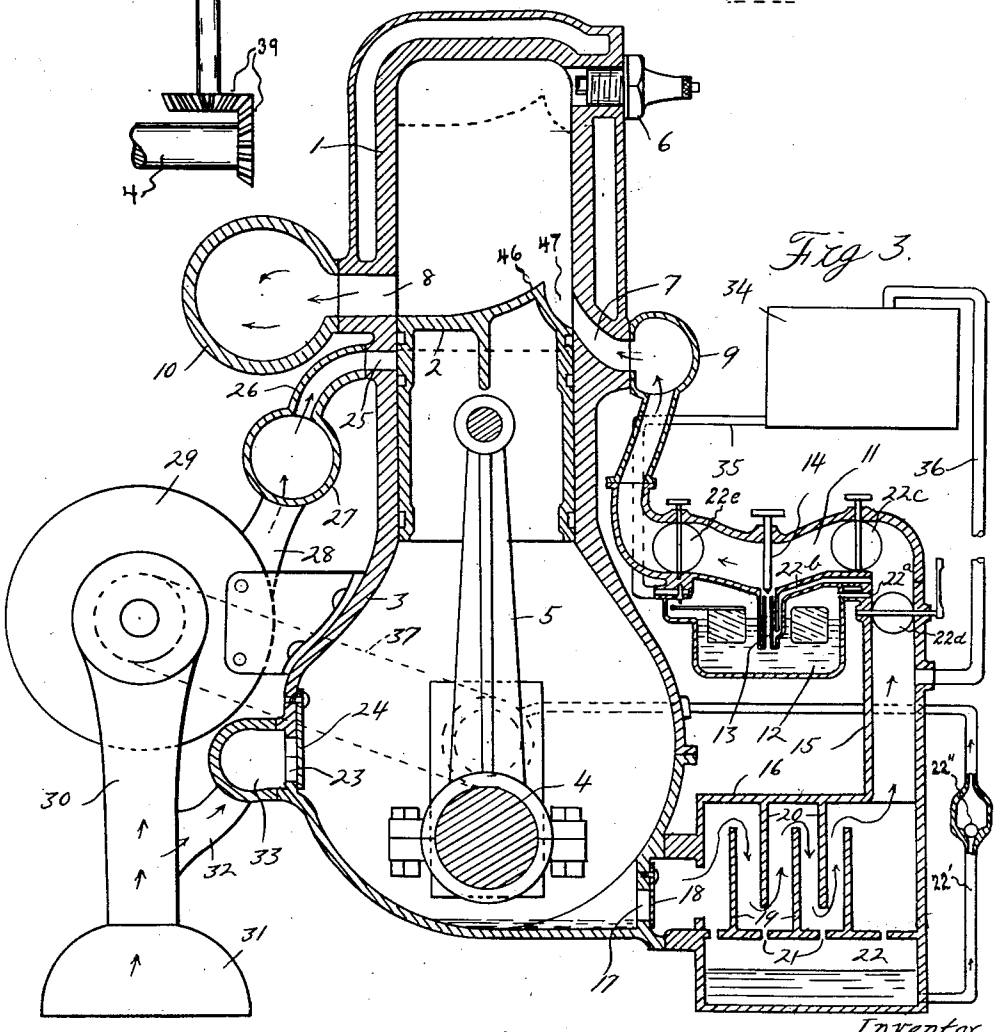


Fig. 3.

Inventor
Arthur G. Sherman

By J. A. Murray Attorney

Oct. 29, 1929. A. G. SHERMAN 1,733,431

INTERNAL COMBUSTION ENGINE

Filed Aug. 15, 1925 3 Sheets-Sheet 3

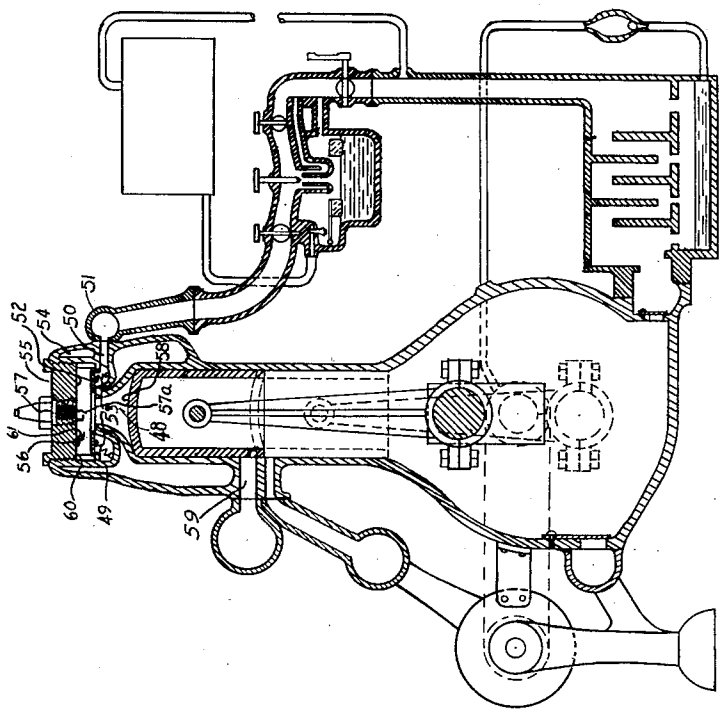


Fig. 7

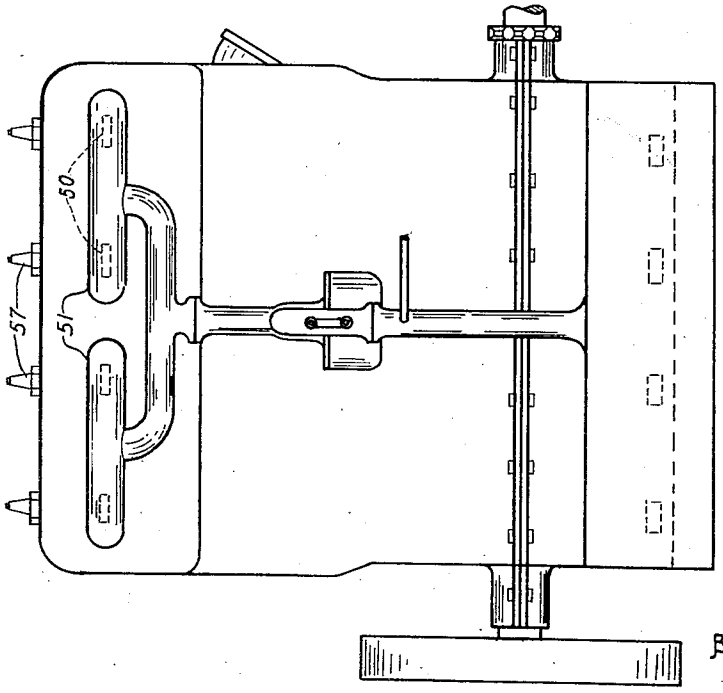


Fig. 6

Inventor
ARTHUR G. SHERMAN

By J. J. Murray
Attorney

Patented Oct. 29, 1929 1,733,431

UNITED STATES PATENT OFFICE

ARTHUR G. SHERMAN, OF DETROIT, MICHIGAN

INTERNAL-COMBUSTION ENGINE

Application filed August 15, 1925. Serial No. 50,433.

This invention relates to internal combustion engines and to carbureting and fuel injecting apparatus for such engines.

While the invention has features applicable to both four cycle and two cycle engines, its use is particularly desirable with engines of the two cycle type in view of its elimination of certain objectionable features of such engines. It is well known that two cycle engines are in many respects superior to those of the four cycle type owing to the provision by the former for twice the number of power strokes afforded by the latter. Thus, for a given development of power, a two cycle engine may be smaller and lighter than a four cycle engine and will develop such power more steadily and flexibly. Also, the absence of cam shafts and cam actuated valves simplifies the construction of two cycle engines and lessens both their original cost and their upkeep expense, as compared to four cycle engines. Despite these numerous advantages of the two cycle type, the four cycle engine is at the present time far more extensively used, this being due primarily to the fact that the present two cycle system of delivering an explosive mixture to the crankcase and thence to the cylinders is not satisfactory, particularly under starting conditions. Before such an engine is in condition to start, it is necessary to crank the shaft repeatedly in order to fill the crank case with a combustible mixture. This is laborious and particularly so in cold weather when the fuel tends to rapidly condense as the mixture is introduced into the crank case. Even after the engine has warmed up and is running normally, there is sufficient crank case condensation to prevent delivery of a constant-value mixture to the cylinders.

It is one object of the present invention to eliminate these objections by delivering an explosive mixture directly from a carburetor to the cylinder (or cylinders) of a two cycle engine, rather than through the crank case, and to compress air in the crank case for delivery to the carburetor rather than compressing the mixture therein, as is now the usual practice.

Another object is to provide an improved means for introducing a charge under superatmospheric pressure into the cylinders of an internal combustion engine, regardless of its number of cycles.

Still another object is to provide a two cycle engine in which compressed air is delivered to the air inlet of a carburetor so that the resulting mixture may be delivered under pressure to the engine cylinders, and to reduce the necessary capacity of the blower or other air compressing means by discharging therefrom into the crank case of the engine and utiliziing piston travel of the engine to further build up the air pressure.

A still further object is to deliver the fuel mixture to a multi-cylinder two cycle engine under a more uniform pressure than is permitted by present constructions.

The invention seeks also to locate the spark-forming device of a two cycle engine so as to insure the spark being formed in proximity to a pure fuel mixture.

Utilization of the crank case of a two cycle engine as a lubricant container is also a feature of the engine, as is delivery of air from said crank case to the carburetor and separation of lubricant from said air in the course of such delivery.

Automatic prevention of rotation of the engine in the wrong direction when being started is also an aim of the invention.

These and various other objects the invention attains by the construction hereinafter described and illustrated in and accompanying drawing, wherein:

Fig. 1 is a front view of a two cycle engine equipped with the improved charge forming and injecting means.

Fig. 2 is a rear view of the same.

Fig. 3 is a view of said engine in sectional elevation, taken on line 3—3 of Fig. 1.

Fig. 4 is a detail view in side elevation of the ignition timer, showing a provision for breaking the ignition circuit, in the event of initial turning of the motor in the wrong direction.

Fig. 5 is a top view of the timer casing with its cover removed.

Fig. 6 is a front view of an alternative form of the engine.

Fig. 7 is a vertical sectional elevation of the same, similar to Fig. 3.

In the views the reference character 1 designates the cylinders, 2 a piston, 3 the crank case, 4 the crank shaft, 5 a connecting rod, and 6 a spark plug of a multi-cylinder, two cycle engine. The crank case is divided by suitable upright partitions 6^a into individual compartments, one of which is formed beneath and in communication with each cylinder, and it will hereinafter appear that these compartments are included in a lubricant circulation system. Each cylinder has an inlet port 7 and exhaust port 8 arranged in the usual substantially opposed relation, so as to be uncovered by the piston as the latter completes its power stroke. The intake ports 7 of the several cylinders are adapted to receive a fuel mixture from a common manifold 9 and the several exhaust ports 8 of the engine discharge to a common manifold 10.

A carburetor comprising a mixing passage 11 and a float chamber 12 has a discharge connection from said passage to the manifold 9. Fuel is delivered from said float chamber to the passage 11 by a suitable nozzle 13 controlled, as is common practice, by needle valve 14. Air under superatmospheric pressure is delivered to the mixing passage 11 through a pipe 15 from a combined air manifold and lubricant separator 16. Air, carrying in suspension a certain amount of lubricant, is delivered into said manifold from the several compartments of the crank case 3 by way of ports 17, controlled by check valves 18, opening under the air pressure set up by the power strokes of the pistons, and closing against any back flow.

Within the manifold 16 a series of alternately arranged upstanding baffles 19 and depending baffles 20 form a tortuous air passage within which any lubricant entrained by the air tends to fall out of suspension. Such lubricant then drains through suitable outlets 21 in the floor of said manifold into a chamber 22 formed by the lower portion of the manifold 16. From said chamber a pipe 22′, controlled by a check valve 22″, delivers the lubricant to the engine shaft bearings, from which the excess returns into the crank case.

In the carburetor practice now generally followed, atmospheric pressure is maintained in the float chamber and the differential between such pressure and that reduced pressure induced by the engine in the mixing passage is relied upon to maintain a fuel discharge to the mixing chamber from the float chamber. A departure from such practice is essential in the present invention, since superatmospheric pressure exists in the mixing passage. The float chamber 12 is not open to the atmosphere but is connected by an air duct 22^a to the inlet portion of the passage 11 and air is also delivered to the base of the nozzle 13 from the inlet portion of the passage 11 by a duct 22^b. The differential between the air pressures existing in the inlet of the passage 11 and at the nozzle outlet will effect a fuel discharge from the nozzle, and the volume of this discharge may be regularly increased by closing, more or less, a throttle 22^c which controls the inlet of the passage 11 just beyond the openings of the ducts. Throttles 22^d and 22^e are also provided in the passage 11 controlling respectively the air delivery to said passage and the mixture flow therefrom.

For admission of air under atmospheric pressure to the crank case, each compartment of the latter is provided with a port 23, controlled by a check valve 24 preventing outflow. Provision is also made for delivering air under superatmospheric pressure to the crank-case. Thus each cylinder 1 is formed with a port 25 closed by the corresponding piston except when the latter is in its raised limiting position. In such position of the piston, said port is uncovered to admit air under superatmospheric pressure to the corresponding crank case compartment. The several ports 25 are connected by branches 26 with a manifold 27 to which leads the outlet pipe 28 of a blower 29, or other source of compressed air. The inlet pipe 30 of said blower terminates in an air cleaner 31, of any suitable construction, and a branch 32 from the pipe 30 delivers air to a manifold 33 from which the several ports 23 open to the crank case.

Preferably a liquid fuel tank 34, which has the usual fuel delivery connection 35 to the float chamber 12, is connected as indicated at 36 to the pipe 15 so that air pressure existing in said tank and in the mixture passage of the carburetor will be substantially balanced. Thus the existence of superatmospheric pressure in the float chamber will not interfere with the flow of fuel to said chamber.

38 designates a timer shaft which is driven from the crank-shaft 4 through bevel gears 39. Within the timer casing, said shaft carries upon its upper end an arm 40, which is formed with a radial groove 41 within which a contact arm 42 is pivoted to the arm 40. Said contact arm is adapted terminally to successively bear upon a series of contact buttons 42^a when the shaft 38 is driven, said buttons being carried by the cover 43 of the timer casing.

When the direction of rotation of the timer shaft is normal, as indicated by the arrow in Fig. 5, the contact arm 42 is included in the ignition circuit 44 through engagement of said arm with a terminal 45 carried by the arm 40. If, however, upon starting of the engine, it tends to turn in a backward direction, the contact arm 42, is swung to the position shown in dash lines in Fig. 5, and the

ignition circuit is broken, stopping the engine.

It will be noted that the piston 2 has a baffle member 46 formed by its top and that this baffle member, when the piston is lowered, lies opposite to the inlet 7, tending to deflect the incoming charge upwardly, as is common practice. Said baffle member forms with the cylinder wall a pocket 47 and the spark plug 6, as is best seen in Fig. 3, occupies a highly desirable position with respect to this pocket. That is to say, the spark plug is mounted in the cylinder wall adjacent to the head of the cylinder and is adjacent to the line of reciprocation of said baffle so that when the piston has completed its compression stroke, the pocket 47, containing a portion of the charge, substantially uncontaminated by products of combustion, is close adjacent to said spark-plug, and ignition of the mixture when the spark is formed is thus rendered practically certain.

In the operation of the described engine, the blower 29 is driven in any suitable manner, as for example, through a belt connection 37 to the crank-shaft, and said blower maintains a constant pressure of air in the manifold 27. On the up-stroke of any piston 2, air is drawn into the corresponding crank case compartment through the port 23 so that upon completion of such stroke, said compartment is full of air at substantially atmospheric pressure. In terminating its upstroke, the piston uncovers the corresponding air port 25, permitting a rush of air under superatmospheric pressure from the manifold 27 into the compartment below said piston. Thus, when the piston begins its downstroke, it encounters air under superatmospheric pressure and further builds up such pressure. The air thus compressed in the crank case compartment, escapes by way of the corresponding port 17 to the manifold 16 within which it is freed from any lubricant that may have escaped with it from the crankcase. Since in a multi-cylinder engine, at least one piston thereof is always descending, it is evident that delivery of compressed air to the manifold 16 will be substantially continuous and will further be proportioned to the discharge of air from said manifold to the engine cylinders by way of the pipe 15, the mixing passage 11, the manifold 9, and the ports 7.

By thus preventing the pistons on their suction strokes, from effecting any drop of pressure in the manifold 16 and in the delivery passages leading therefrom to the engine cylinders, the rate of delivery of mixture to the cylinders is kept much more uniform during the entire period that the corresponding intake ports are uncovered, than is possible in the present construction of two-cycle engines. As is well known, there is a decided advantage in delivering the charge to the cylinders under a pressure sustained throughout the charging period, the expulsion of the spent combustion products being under such conditions more complete, and the tendency of the mixture to commingle with such products being decreased. Also, a fuller charge is, under such conditions, delivered to the cylinders.

There is a decided advantage in delivering air from the blower 29 to the crank case and thence to the carburetor rather than direct to carburetor. This arrangement permits use of the crank case, as a compression chamber within which the initial compression of air effected by the blower is considerably raised by the pistons, on their power strokes. By thus producing a first stage of air compression by the blower and a higher stage of compression by the engine pistons, a blower of much less capacity is required than would be necessary if the blower alone were relied upon to effect the desired compression.

One of the desirable features of the described engine is the adaptability thereto of such lubricant circulation systems as are not applicable to two cycle engines of ordinary construction. That is to say, use of the crank case in ordinary two cycle engines as a compression chamber for the explosive charge, prevents including the crank case in a lubricant circulation system since the lubricant would commingle undesirably with the charge. Use of the crank case for compression of air, unmixed with fuel, as provided for by the present invention, does not prohibit circulation of lubricant through the crank case, since separation of the lubricant from the air before delivery of the latter to the carburetor is readily accomplished. It is to be understood that in the disclosed circulation system, the air pressure in the manifold 16 is greater than that in any crank case compartment when the piston above said compartment is making its compression stroke and at such times the valve 22'' will unseat and oil will flow to the bearings in said compartment. When the pressure in any compartment exceeds that in the corresponding pipe 22' the valve 22'' will seat.

Figures 6 and 7 show an alternative form of the engine similar to the construction already described except as regards admission of the charge to the engine cylinders. As shown in said figures, the upper portion of each cylinder is restricted as indicated at 48 to form a central intake port for the explosive mixture and around said port is formed an annular passage 49 to which the mixture is delivered as indicated at 50 from a manifold 51, common to all of the cylinders. The flow of the mixture from the passage 49 to the port 48 is controlled by a valve 52 of ring form, preferably having the nature of a sheet metal stamping. Said valve seats downwardly upon the annulus which forms the

passage 49, the central opening of the valve registering with the port 48, and a plurality of coiled springs 53 may be located within the passage 49 to urge said valve to its seat. The water jacket of the cylinder projects above the annulus 49 as indicated at 54 and is screw threaded to receive a plug 55 which together with the annulus 49 forms a chamber 56 for the valve 52. In the plug 55 is centrally mounted a spark plug, or the like, 57, which forms a spark gap 57ª within the valve chamber 56. The piston 58 omits the baffle member employed in the first described form of the engine, the piston top being preferably convex as shown. Since the remaining features of this construction conform to the description of Figures 1–5, these features require no further description in this connection.

In the operation of this modified construction, when the piston is at the lower end of its stroke, as is indicated in dash lines, and the exhaust port 59 is uncovered, the pressure above the piston immediately drops to such an extent that the pressure existing in the annular passage 49 exceeds that within the valve chamber 56, so that the valve 52 is raised from its seat and the mixture rushes into the cylinder from said passage through the port 48. On the up stroke of the piston, the resulting compression produced above the piston soon raises the pressure in excess of that of the mixture in the passage 49 whereupon the valve 52 seats, due to said pressure differential, to the springs 53 and to gravity, and during the remainder of the compression stroke the relatively high pressure produced above said valve holds the same firmly seated. During the power stroke, the pressure of the exploded charge also acts to hold said valve firmly to its seat until the piston completes said stroke and uncovers the exhaust port, thus relieving downward pressure upon said valve. The described cycle is then repeated.

It is an advantage of this alternative construction that the charge is admitted to the cylinder at the opposite end thereof to that from which the exhaust escapes so that the incoming mixture may more readily drive out the exhaust gases without being appreciably contaminated by the latter. Also the described arrangement permits a very rapid delivery of the mixture into the cylinder since the port 48 is of large capacity and provision is made for a flow of the mixture into said port around its entire periphery.

A still further advantage of this construction lies in the fact that the valve seat is readily machined, and that the valve chamber is readily accessible for the purpose of inspection or replacement of parts. Location of the coiled springs 53 within the intake passage 49 is very important in avoiding an overheating and resulting detempering of said springs. In the specified location, said springs derive a cooling effect both from the incoming charge and from the water jacket within which the annulus 49 is immersed. The formation of the valve 52 as a sheet metal stamping is important from the viewpoint of low cost quantity production. Preferably the wall of the valve casing 56 is ribbed vertically as indicated at 60 to guide the valve in its seating and unseating movement and lugs 61 are formed upon the bottom of the plug 55 to space the valve 52 from said plug in its raised position so that the incoming gases may flow upwardly between the ribs 60 and across the top of the valve 52 when the same is unseated as well as under said valve, in passing to the port 48. This is of value in maintaining the temperature of said valve below the burning point and also in effecting reseating of the valve. It is to be noted that the location of the spark gap 57ª within the chamber 56 is such as to insure a mixture practically free from any contamination by the exhaust gases since even though some residue of the latter may remain when compression of the mixture begins, such residue is not likely to be carried up into the chamber 56. It is to be noted that the disclosed mounting of the valve 52 with relation to the water jacket is highly favorable to rapid cooling of said valve by conduction of heat from the valve to its seat and thence to said jacket.

What I claim is:

1. In an internal combustion engine, a cylinder having an air inlet port, a piston reciprocatory in said cylinder, and uncovering said port substantially at the termination of its compression stroke, a crank shaft actuable by said piston, a crank case housing said shaft and having a port for the admission of air under atmospheric pressure, a check valve preventing the outflow of air through said port, means for delivering air under superatmospheric pressure to said piston-controlled port, a passage leading from the crank case to the cylinder, and means for carbureting air flowing through said passage.

2. In an internal combustion engine, a combination with a plurality of cylinders, and a plurality of pistons reciprocatory in said cylinders, a crank shaft actuable by said pistons, a crank case housing said shaft, and forming separate compartments individually opening directly into said cylinders, each of said compartments having an inlet for air at atmospheric pressure, means for delivering additional air at superatmospheric pressure into each compartment substantially at the termination of the compression stroke of the corresponding piston, a manifold with which each of said compartments has discharge connection, check valves preventing return flow from said manifold to the crank case, and means for delivering air from said manifold to the several cylinders of the engine, and for carbureting such air.

3. In an internal combustion engine, a plurality of cylinders, pistons reciprocatory therein, a crank shaft actuable by said pistons, a crank case housing said crank shaft, and further forming a lubricant reservoir, said crank case forming compartments in individual communication with said cylinders, each of said compartments having an air inlet and an air outlet, a manifold in communication with the air outlets of said compartments, lubricant separating means within said manifold, a mixture delivery manifold in communication with the several cylinders, a passage leading from the first mentioned to the second mentioned manifold, and means for carbureting air flowing through said passage.

4. In an internal combustion engine, a cylinder, a piston reciprocatory therein, a crank shaft actuable by said piston, a crank case housing said shaft and opening into the lower end of said cylinder and ported for the induction of air, substantially at atmospheric pressure, responsive to the compression stroke of said piston, means for introducing an additional charge of air under super-atmospheric pressure into the crank case substantially at the termination of the compression stroke of the piston, means controlled by the piston for delivering air from the crank case to the compression chamber of the cylinder, and means for carbureting the last mentioned air in the course of its delivery.

5. If an internal combustion engine, a cylinder having in its lateral wall a port for admission of air and also having in its lateral wall a port for admission of a fuel mixture, a piston reciprocatory in said cylinder adapted to uncover said air admission port substantially at completion of its compression stroke and to uncover said fuel inlet port substantially at completion of its power stroke, a crank shaft, a drive connection to said shaft from said piston, a crank case housing said shaft and ported for induction of air at substantially atmospheric pressure responsive to the compression stroke of the piston, means for delivering air under superatmospheric pressure to said air inlet port of the cylinder, a passage leading from the crank case to said fuel inlet port of the cylinder whereby the flow from the crank case to the cylinder is induced by the compression of air in the crank case, and means associated with said passage for carbureting the air flow therethrough.

6. In an internal combustion engine, a cylinder having in its lateral wall a port for admission of air and having a fuel inlet port, a piston reciprocatory in said cylinder, adapted to uncover said air admission port substantially at completion of its compression stroke, a crank shaft, a drive connection to said shaft from said piston, a crank case housing said shaft and ported for induction of air at substantially atmospheric pressure responsive to the compression stroke of the piston, means for delivering air under super-atmospheric pressure to said air inlet port of the cylinder, a passage leading from the crank case to said fuel inlet port of the cylinder whereby the flow from the crank case to the cylinder is induced by the compression of air in the crank case, and means associated with said passage for carbureting the air flow therethrough.

7. In an internal combustion engine, a cylinder having a fuel inlet port, a piston reciprocatory in said cylinder, a crank shaft actuable by said piston, a crank case communicating with said cylinder and housing said shaft, ported for induction of air at substantially atmospheric pressure responsive to the compression stroke of said piston, means for compressing air, a passage providing for the delivery of compressed air from the last-named means to the crank case, said piston exercising control of communication of said passage with the crank case, whereby such communication is normally cut off and is established substantially upon completion of the compression stroke of the piston, a passage leading from the crank case to said fuel inlet port, providing for a flow of air to said inlet port responsive to air compression in the crank case, and means associated with said passage for carbureting the air flowing therethrough.

8. In an internal combustion engine, a cylinder having in its lateral wall a port for admission of air and having a fuel inlet port, a piston reciprocatory in said cylinder adapted to uncover said air admission port substantially at completion of its compression stroke, a crank shaft, a drive connection to said shaft from said piston, a crank case housing said shaft, an air cleaner, an air delivery passage leading from said cleaner and having discharge connection with the crank case, means for delivering air under super atmospheric pressure from said cleaner to said air inlet port of the cylinder, a passage leading from the crank case to said fuel inlet port, providing for a flow of air to said inlet port responsive to air compression in the crank case, and means associated with said passage for carbureting the air flowing therethrough.

9. In an internal combustion engine, a plurality of cylinders, pistons reciprocatory in said cylinders, a power transmission member jointly driven by said pistons, compartments individually communicating with said cylinders, forming air compression chambers, means for introducing compressed air into each compartment upon completion of the compression stroke of the corresponding piston, said piston being adapted on its power stroke to further compress such air, an air manifold connected to all of said compartments, means for establishing a flow of air

to each of the cylinders from said manifold, and means for carbureting the air in the course of such flow.

10. In an internal combustion engine, a cylinder having a headed end and formed with an air inlet port, a mixture inlet and an exhaust port in its lateral wall remote from said headed end, means for delivering air under super-atmospheric pressure to said air inlet port, a piston reciprocatory in said cylinder and uncovering said air inlet port substantially at completion of its compression stroke, and uncovering said mixture inlet and exhaust ports substantially at completion of its power stroke, a crank shaft actuable by said piston, a crank case housing said shaft and ported for induction of air at substantially atmospheric pressure, responsive to the compression stroke of the piston, a passage leading from the crank case to the mixture inlet port, and means for carbureting the air flow through said passage.

11. The combination with the fuel delivery passage of an internal combustion engine, of means for driving compressed air through said passage, a carburetor comprising a reservoir having an outlet to said passage, an air connection to said reservoir from a point in said passage in advance of said outlet, and a throttle in said passage between said connection point and said outlet.

In testimony whereof I sign this specification.

ARTHUR G. SHERMAN.