Jan. 15, 1929. 1,698,757

C. F. G. KJELLBERG

INTERNAL COMBUSTION MOTOR

Filed June 22, 1925 2 Sheets-Sheet 1

Fig. 3

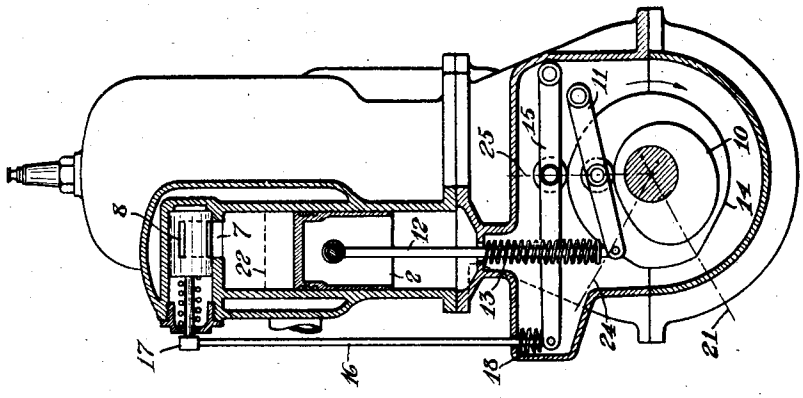


Fig. 2

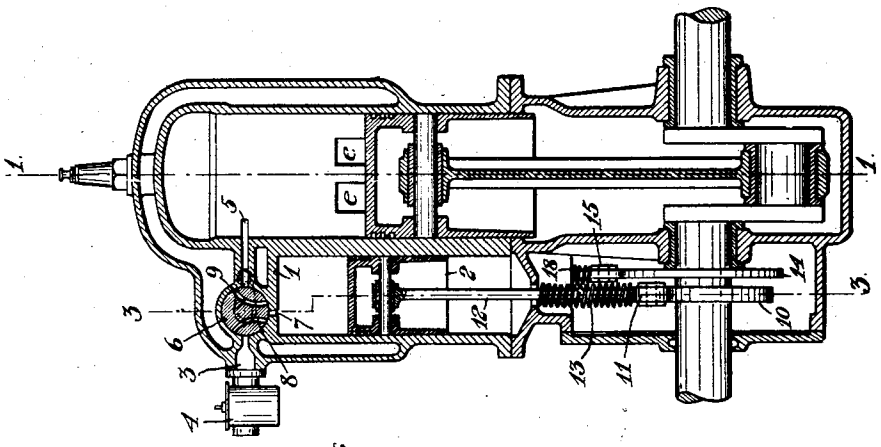
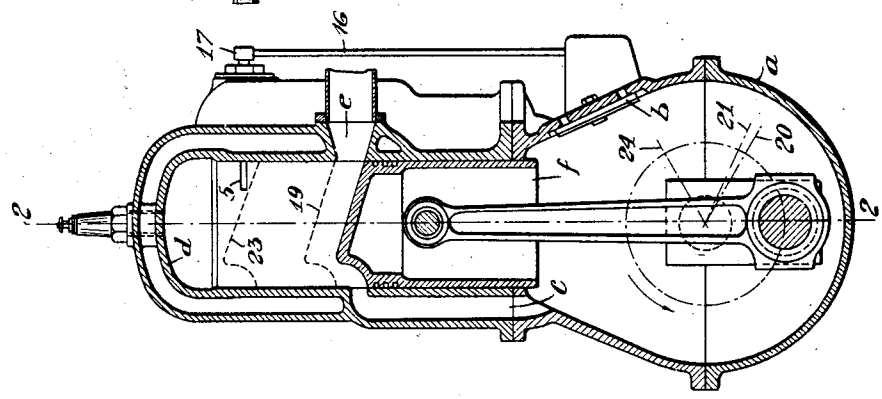


Fig. 1



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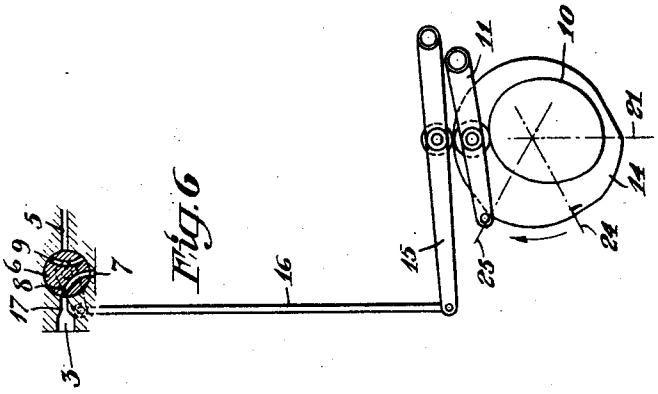


Fig. 6

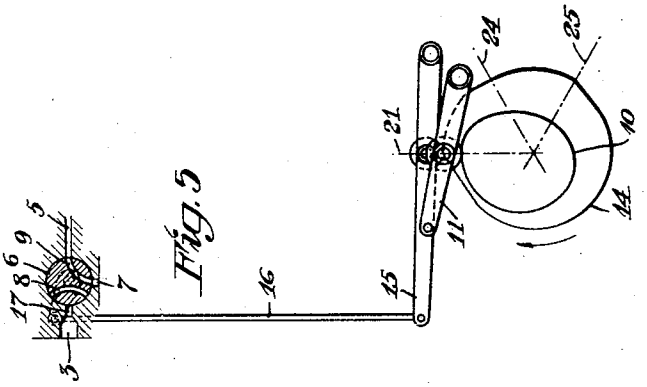


Fig. 5

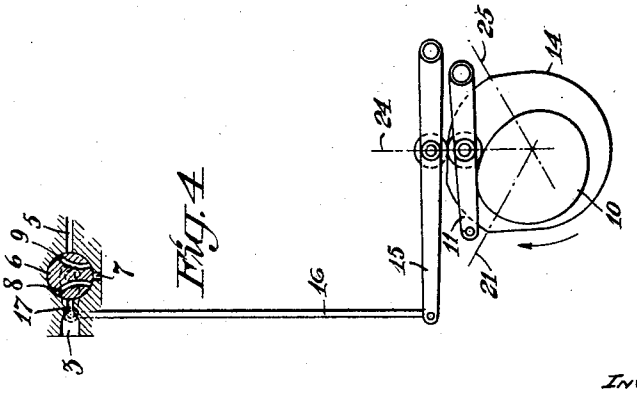


Fig. 4

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UNITED STATES PATENT OFFICE.

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INTERNAL-COMBUSTION MOTOR.

Application filed June 22, 1925, Serial No. 38,646, and in Sweden April 3, 1924.

The present invention relates to two-stroke cycle internal combustion motors, and particularly to such motors which are provided with a pump for introducing an additional supply of air to increase the charge of the working cylinder and, thus, the output of the motor, and to such motors where the whole of the quantity of air present in the pump cylinder is forced into the working cylinder, in order to serve in its entirety as an explosive fuel mixture. The invention is directed to regulating means for the pump so devised that the requisite induction pressure of the pump does not exceed the pressure of compression attained in the working cylinder at the end of the induction period, besides which the work to be effected by the motor to drive the piston of the pump will be the least possible.

In order to relieve the working cylinder of the combusted gases of explosion in a two-stroke cycle motor of common design, a scavenging air pump is provided which expels the gases of combustion, and also fills the working cylinder with fresh air. In order that the gases of combustion may be removed from the cylinder, there are provided channels adapted to be opened before the working piston has completed its working stroke, and for the short period available it is necessary that the outlet channels stand open also during a portion of the compression stroke of the piston. The volume of air removed out of the working cylinder through the outlet channels during the compression stroke reduces the charge of the working cylinder, and it is this volume of air which, primarily, is to be supplied to the working cylinder to complete the charge. In order further to increase the output of the motor, a larger volume of air than the one removed through the outlets may be supplied to the cylinder, and the working cylinder thus receives a surplus charge.

It is previously known, in a two-stroke cycle internal combustion motor, to increase the charge of the working cylinder by the arrangement of a pump adapted to force a quantity of air determined by the volume of the pump cylinder, into the working cylinder, during the period of the compression stroke of the working piston determined by the position occupied by the working piston when the outlet openings are closed, and by the position in which the explosive gas mixture is ignited, in such a manner, that the piston of the pump for instance is actuated by a cam which is so adjusted that the pump stroke is completed during the said period of induction.

Ordinarily, the outlet openings are closed, when during the compression stroke the working piston has moved a distance corresponding to 60° of the movement of the crank pin, and inasmuch as the position of ignition generally corresponds to a position of the crank pin located 25 degrees to 30 degrees before the position of maximum compression, and because the air supplied must be introduced into the working cylinder some time before the piston has reached the position of ignition, i. e. when the crank pin is located at a point about 60 degrees before the point corresponding to the maximum compression, there will remain 60 degrees for the induction period. This involves that the pump piston must complete the whole induction stroke during a movement of the working piston corresponding to 60 degrees of the movement of the crank pin. From this it follows that the velocity of induction of the pump piston will be very high. The greater the speed of the piston, the greater will the forces of acceleration be, and the greater will be the work required to drive the pump. This greater amount of work reduces the efficiency of the motor to a corresponding extent. If the induction stroke of the pump begins earlier than the outlets have been closed, a portion of the air pressed into the working cylinder will be lost through the outlet openings. If, on the other hand, the induction stroke to any extent terminates later, the air supplied will not have sufficient time to mix with the air present in the working cylinder, before ignition takes place. Again, if a spring actuated valve is arranged in the conduit between the pump cylinder and the working cylinder, the spring load may counteract the induction of air into the working cylinder before the outlet openings are closed, but at the same time such spring load offers a resistance during the induction period, so that the induction pressure in the pump is increased in the same degree beyond the pressure of compression attained in the working cylinder.

The present invention removes the drawbacks set forth herein in such a manner that the pump piston may begin the compression stroke long before the induction of the air into the working cylinder commences, with-

out any portion of the pump volume being introduced into the working cylinder before the outlet openings are closed, and the pressure of compression attained in the pump will not be higher than the compression pressure attained in the working cylinder at the end of the compression period.

The invention is illustrated by way of example in the accompanying drawings where, Figs. 1, 2 and 3 show an embodiment of a two-stroke cycle motor in which the invention has been utilized, whereas Figs. 4, 5 and 6 are diagrammatic representations of the control mechanism in various positions. Fig. 1 shows a section of the motor on the line 1—1 in Fig. 2, the working piston occupying the position in which the compression stroke begins. Fig. 2 is a longitudinal section of the motor on the line 2—2 in Fig. 1, and taken through the pump cylinder as well as through the working cylinder. Fig. 3 is a section on the line 3—3 in Fig. 2, the control mechanism being in the position corresponding to the positions of the working and the pump pistons represented in Figs. 2 and 3, wherein the pump system commences the compression stroke. Fig. 4 discloses the position of the control mechanism, when the outlets of the working cylinder are closed, and the induction is about to begin. Fig. 5 illustrates the position of the control mechanism at the end of the induction stroke of the pump piston, and Fig. 6 the position of the control mechanism during the suction stroke of the pump piston.

In the present case, the crank casing *a* of the motor takes the form of a scavenging pump, the air being sucked during the compression stroke of the working piston, through the valve *b*, and pressed during the working stroke of the working piston *f*, through the channel *c*, into the working cylinder *d*, the air then expelling the combusted gases through the outlet *e*. The scavenging pump may, without the principle of the invention being departed from, be arranged in any suitable way other than in the crank casing, and the channel may also be disposed in the upper portion of the working cylinder, and be provided with any cut-off means other than the working piston *f*. In the present case, the cylinder 1 of the additional charge pump is arranged with its piston 2 parallel to the working cylinder *d*, but it may, without departing from the principle of the invention, be located in any other suitable way. The cylinder 1 of the pump communicates through a suction channel 3, with the atmosphere or, perhaps, with a carburettor 4. The induction of the air, or of the fuel mixture, into the pump, takes place through a channel 5 opening into the upper portion of the working cylinder *d*, said channel 5 being located so that the piston *f* of the working cylinder does not cover the channel 5 before the induction of the charge is completed. The channel 5 may, without the principle of the invention being departed from, be arranged in any suitable place in the upper portion of the working cylinder *d*, but the most advantageous is to place the channel 5 in such a manner that the working piston 1 will cover channel 5 immediately after the induction has taken place, in order that the highest pressure of explosion in the working cylinder shall not affect the channel 5. Provided between channels 3 and 5 is a valve 6 controlling, by a rotary motion, the inlets of the channels 3 and 5 and the connecting channel 7 of the pump cylinder 1. The controlling channel, that is to say channel 8 for the suction into the pump, and channel 9 for the induction of the charge into the working cylinder, are arranged with an intermediate position in such a manner that, when the valve stops in this intermediate position, the two channels 3 and 5 are cut off from the connecting channel 7 of the pump. The valve 6 may either be arranged as a rotary valve, as shown in the drawing, or as a slide valve, or, two valves may be provided which are separately controllable, without the principle of the invention being departed from, said two valves being closed in the above mentioned intermediate position. The piston 2 of the pump receives its motion for the induction stroke through the action of a cam disk 10 adapted to raise an arm 11 which, again, is adapted to actuate the pump piston 2 by means of the connecting rod 12. According to the drawing, there is also provided a spring 13 actuating the pump piston 2 in the suction stroke. In place of the spring, there may, for instance, be arranged another cam for the suction stroke and, also, the pump piston 2 may be actuated by some other driving means having the same effect, without the principle of the invention being departed from. The valve 6 receives its rotary motion during the compression stroke of the pump piston 2, through the action of a cam disk 14 adapted to lift an arm 15, which, in turn, is adapted to actuate, through the medium of a connecting rod 16, an arm 17 connected with the valve 6. The rotary motion, for the suction stroke of the pump piston 2, is imparted to the valve 6 through the action of a spring 18. The valve 6 may, without the principle of the invention being departed from, receive its motion through some driving means other than that described.

As disclosed in Figs. 1, 2 and 3 of the drawing, the working piston *f* has completed the working stroke, and scavenging is taking place. At the same time the piston 2 of the charge pump has completed the suction stroke and is about to commence the induction stroke. The outlet openings *e* are still entirely open. The valve 6, which with its channel 8 has connected the channels 3 and 7 for suction in the next preceding moment, now closes the connecting channel 7 of the pump.

At the motion of the crank shaft in the direction of the arrow the working piston *f* is displaced by the crank shaft, and the pump piston 2 is displaced by the cam disk 10, in an upward direction. The connecting channel 7 of the pump being closed, the air in the pump will be compressed at the displacement of the piston 2, until the working piston *f* has reached the position 19 indicated in dash lines in Fig. 1, the outlet openings *e* being then closed, the corresponding position for the crank shaft being indicated in Fig. 1 by the line 20. Immediately thereafter, that is to say at the position of the crank shaft indicated by the line 21 in Fig. 1, the valve 6 has assumed the position disclosed in Fig. 5 through the action of the cam 14, while the pump piston 2 has reached a position indicated by the dash lines 22 in Fig. 3. Thus the pump has been brought into communication with the working cylinder through the connecting channel 7, the valve channel 9 and the channel 5, after which the induction of the charge commences. The induction of the charge takes place at the continued motion of the pump piston 2, until the pump stroke terminates, or, when the pump piston has practically reached the top of the cylinder. In this position the working piston has reached the line 23 indicated in Fig. 1, said line corresponding to the line 24 in Fig. 1 indicating the position of the crank shaft, and to the position occupied by the valve 6 and its cam 14 in Fig. 5. In this position, the pump piston 2 commences the suction stroke, during which the valve 6 assumes the position indicated in Fig. 6, so that the connecting channel 7 is brought into communication with the suction channel 3 through the valve channel 8. The valve 6 maintains this position until the pump piston 2 has nearly completed the suction stroke. In order to elucidate the various positions in Figs. 3. 4, 5 and 6, the periods of displacement of the cam disks are designated with corresponding numbers 21, 24 and 25. Inasmuch as the angle of displacement of the pump piston 2 depends on the number of revolutions of the motor, on the time of closing the outlet openings, and on other circumstances, the positions indicated in the drawing for the working piston, the pump piston and the valve may be displaced, without the principle of the invention being departed from.

What I claim as new and desire to secure by Letters Patent of the United States of America is:—

1. In an internal combustion engine of the piston controlled exhaust port type, a pump for introducing an additional charge into the cylinder, a valve controlled passage between the pump and the cylinder, driving means for said pump timed to begin the pump induction stroke before the cylinder exhaust port is closed, and mechanism for actuating the valve to open the passage after the cylinder exhaust port is closed.

2. In an internal combustion engine of the piston controlled exhaust port type, a pump for introducing an additional charge into the working cylinder, a pump inlet port, a pump outlet port communicating with the working cylinder, a pump cylinder port, a valve controlling said pump ports, mechanism for positively actuating said valve, and driving means for said pump timed to begin the pump compression stroke before the cylinder exhaust port is closed.

3. In an internal combustion engine of the piston controlled exhaust port type, a pump for introducing an additional charge into the working cylinder, a pump inlet port, a pump outlet port communicating with the working cylinder, a pump cylinder port, a valve controlling said pump ports, cam means for actuating said valve, said cam means being set to establish communication between the pump cylinder port and the outlet port after the cylinder exhaust port is closed, and driving means for said pump timed to begin the pump compression stroke before the cylinder exhaust port is closed.

4. In an internal combustion engine of the piston controlled exhaust port type, a pump for introducing an additional charge into the working cylinder, a pump inlet port, a pump outlet port communicating with the working cylinder at a point before the position reached by the piston head at upper dead center, a pump cylinder port, a valve controlling said pump ports, mechanism for actuating said valve, and driving means for said pump timed to begin the pump induction stroke before the cylinder exhaust port is closed.

5. In an internal combustion motor of the two cycle type, a working cylinder, a working piston therein, outlet openings in said cylinder adapted to be closed at the beginning of the compression stroke, a pump for introducing an additional charge into said cylinder, a piston in said pump, piston operating means driven from the motor shaft and irregularly actuating said piston to increase the average velocity of said piston during its induction stroke in proportion to the average velocity of said working piston, said piston operating means being timed to begin actuation of said piston for the induction stroke before said outlet openings are closed, a passage connecting said pump with said working cylinder, a valve in said passage, and valve actuation means driven by the motor shaft to open said valve after said outlet openings have been closed.

6. In an internal combustion engine of the two cycle type, a working cylinder, exhaust ports in said working cylinder adapted to be closed at the beginning of the compression

stroke, a pump cylinder, a piston therein, a valve member, a passageway from said pump cylinder to said valve member, a second passageway from said valve member to said working cylinder, a third passageway from a source of air to said valve member, said valve member comprising a plurality of channels in spaced relation to each other and adapted to perform the operations of establishing communication between said first passageway and said third passageway for the purpose of admitting air into said pump cylinder, of establishing communication between said first passageway and said second passageway for the purpose of admitting air into said working cylinder, and of closing said first passageway from said second and third passageways, a motor shaft, mechanism actuating said pump piston to begin the pump induction stroke before the cylinder exhaust ports are closed, valve operating means comprising a cam actuated member driven from said motor shaft to operate said valve member to establish communication between said first and second passageways after said exhaust ports are closed.

7. In an internal combustion engine as claimed in claim 6, said cam having a suction position, an intermediate position, and an induction position, the intermediate position holding the valve member in closed position during the first part of the pump piston induction stroke, and the induction position establishing communication between the first passageway and the second passageway after said exhaust ports have been closed.

8. In an internal combustion engine as claimed in claim 6, said passageway from said valve member to said working cylinder opening into said working cylinder at a point below the position reached by said piston on completion of the compression stroke.

In testimony whereof I affix my signature.

CARL FREDRIK GUNNAR KJELLBERG.