C. D. McCLINTOCK.

INTERNAL COMBUSTION ENGINE.

APPLICATION FILED JUNE 23, 1908.

922,613. Patented May 25, 1909.

Fig. 2.

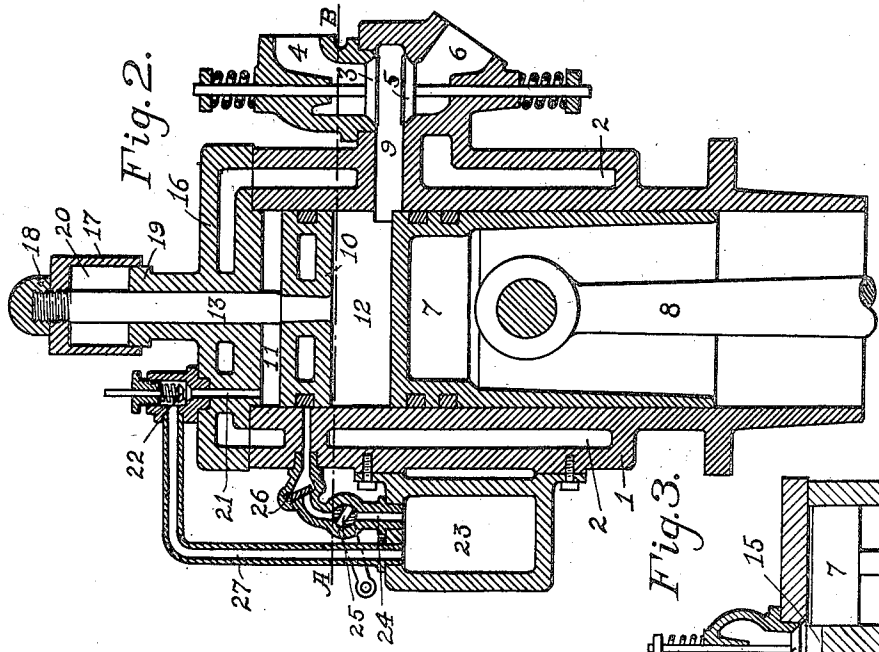


Fig. 3.

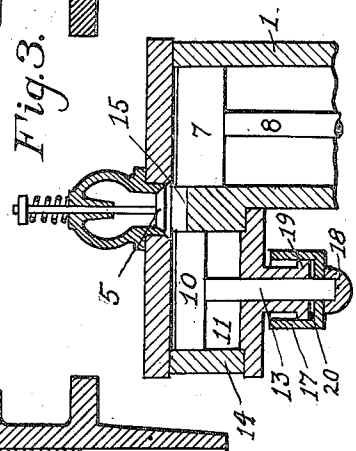
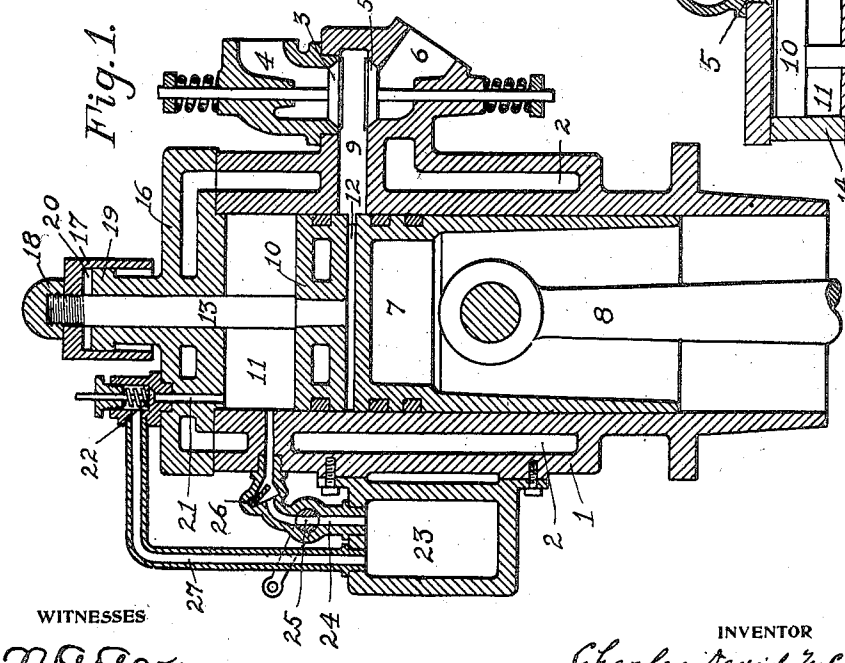


Fig. 1.



WITNESSES

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CHARLES DAVID McCLINTOCK, OF OAKLAND, CALIFORNIA, ASSIGNOR OF ONE-HALF TO SAMUEL RUSSELL BOGUE, OF SAN FRANCISCO, CALIFORNIA.

INTERNAL-COMBUSTION ENGINE.

No. 922,613. Specification of Letters Patent. Patented May 25, 1909.

Application filed June 23, 1908. Serial No. 439,957.

To all whom it may concern:

Be it known that I, CHARLES DAVID McCLINTOCK, a citizen of the United States, residing at Oakland, in the county of Alameda and State of California, have invented certain new and useful Improvements in Internal-Combustion Engines, of which the following is a specification.

My invention relates to the class of internal-combustion engines, and it consists, essentially, in conjunction with the working piston of the engine, and an elastic-cushioned wall of the combustion chamber, of means for increasing and decreasing the resistance of said wall and allowing it to move during the compression of the charge.

In practice my invention will be carried out by a construction in which the usual reciprocating piston, here called the working piston, acts in conjunction with another reciprocating piston, here called the air piston, both pistons being adapted to work in the same cylinder, or in separate cylinders connected to each other by a pass-way or port; the air piston being adapted to separate the usual clearance space into two parts; that part between the two pistons being here called the combustion chamber, and that part between the air piston and the fixed head of the cylinder being here called the air chamber.

In connection with the several results of this type of internal combustion engine, to-wit, to thoroughly scavenge or clear the combustion chamber of the non-combustible or waste products of each explosion before the introduction of the fresh charge of explosive mixture for the next explosion; to provide an air chamber affording an elastic-cushion to receive the impact or percussion effect of the explosion of the charge (which occurs before the end of the compression stroke of the working piston) and thereby greatly lessen the back pressure on the working parts of the engine, and at the same time, reduce vibration; and to store up the energy of the impact or percussion effect of each explosion in this air chamber, in the form of compressed air to be used immediately thereafter to perform work (through the medium of the free moving air piston and the gases in the combustion chamber) on the working piston of the engine, the object of my invention is to regulate the pressure of air in the air chamber by means under control of a suitable governor, or by hand, in such a way as to vary the volume of the combustion chamber or clearance space, as it is commonly called, at a certain pre-determined ratio to the quantity of explosive mixture taken into the cylinder during the suction stroke of the working piston; thus effecting the ignition of the explosive charge at nearly constant pressure for any quantity of the combustible, whether full charge or a fraction of the full charge, and thereby obtaining nearly the same terminal or maximum pressure, with consequent economy of fuel for all practical variations, of the quantity of the explosive charge. This feature of variable clearance, as I call it, also makes the engine controllable to a degree not possible with engines burning their charge of explosive at constant volume and variable pressure in a combustion chamber of fixed volume, it having been found that the combustion of gases or explosive mixtures of air and oil-vapor in closed cylinders is greatly aided by compression before ignition, and, also, that a higher pressure is obtained by such combustion under pressure. This device aims to keep the pressure of ignition practically constant for all quantities of the explosive charge. The volume of each explosive charge is to be regulated by the usual means of throttling, or by some suitable positive cut-off mechanism controllable by the usual governor, or by hand. I attain these results by the mechanism illustrated in the accompanying drawings, in which:—

Figure 1, is a vertical section of my internal combustion engine, the pistons being at the end of their respective instrokes, this being their relative position at the instant of complete expulsion of the burned products of the previous explosion. Fig. 2, is a vertical section showing the relative position of the pistons at the instant of the explosion of the charge in the combustion chamber. Fig. 3 is a sectional view showing the air piston in a chamber separate from the engine cylinder, but communicating therewith.

The main cylinder 1, with its water spaces 2, its inlet valve 3 and inlet opening 4, its exhaust valve 5 and exhaust opening 6, its working piston 7 and co-acting connecting rod 8, and its port 9, are, substantially, the same, in arrangement and operation, as in other internal-combustion engines.

In Fig. 2, the line A—B, marks, approxi-

mately, the top or outer end of an ordinary single acting cylinder as in common use on internal combustion engines, and the portion of the cylinder shown in this figure above this line is, in this form, an extension of the cylinder which provides for the air piston 10 and the air chamber 11. In adapting my invention to an ordinary single acting cylinder I prefer this form of extending or lengthening the cylinder, as shown, the piston 10 fitting closely, but free to move therein, and being adapted to separate the air chamber 11, from the combustion chamber 12.

To the air piston 10, and co-acting therewith, is attached the guide rod or stem 13, working in and closely fitting the opening in the cylinder head 16. Attached to the guide rod 13 is the small cylinder 17, the same being threaded and screwed on the guide rod 13, and further secured by the lock nut 18. The fixed piston or collar 19 on the cylinder head 16 is adapted to fit closely to the inner walls of the small cylinder 17, forming the inclosed air space 20 which is designed to provide an elastic-cushion to check the instroke of the air piston 10, and prevent it from coming in violent contact with the working piston 7. The small opening or port 21 connects the adjustable relief valve 22 with the air chamber 11, and the said relief valve is adapted to open automatically when the pressure in the air chamber 11 reaches a maximum for which the relief valve has previously been set.

The object of the adjustment of the maximum pressure in the air chamber 11 is apparent by the following:—Let it be assumed that the engine is just started, and the air in the air chamber 11 stands at the temperature and pressure of the atmosphere. It will be seen that the air in the air chamber 11 will become heated as the engine warms up after starting and the increase of pressure, due to the air being confined, will, by resisting the compression of the charge and reducing the volume of the clearance space, cause a higher pre-compression of the explosive charge in the combustion chamber 12. Thus, by adjusting the maximum pressure in the air chamber 11 by means of the relief valve 22 (which adjustment will also fix the minimum pressure) a wide range of pre-compression pressures may be had. This feature readily adapts the engines to the use of different fuels, requiring different degrees of pre-compression for their proper combustion, and it also provides a means for adjusting the engine to the use of any one kind of explosive mixture in such a way as to obtain complete combustion and the maximum amount of work for the fuel consumed.

The relief valve 22 only provides a means for limiting the maximum pressure, as by loosening the spring by which it is adjusted, it will allow some of the air in the air chamber 11 to escape, and thereby reduce both the maximum and minimum pressure; or by tightening the spring, the pressure in the air chamber 11 will rise to the maximum pressure for which the relief valve 22 is set before allowing any of the air in the air chamber to escape in the air reservoir hereinafter described, thereby maintaining a higher pre-compression pressure in the combustion chamber 12 by reducing its volume.

The action or operation of an internal-combustion engine of this type, as far as described is as follows:—On starting the engine let it be assumed that the working piston 7 and the air piston 10 are in the positions shown in Fig. 1, both pistons being then at the end of their respective in-strokes. Now start the working piston 7 on its first out-stroke by turning the engine shaft (not shown in the drawing) when a partial vacuum will be produced in the combustion chamber 12 which allows the inlet valve 3 to open by the pressure of the atmosphere; or this inlet valve may be mechanically operated, so as to open immediately after the working piston 7 starts on its first out-stroke. The opening of this inlet valve 3 admits the charge or explosive mixture which flows into the combustion chamber 12 as the working piston 7 recedes. This operation, when a full charge of the explosive mixture is required, continues to the end of the first out-stroke, commonly called the "suction stroke", at which point the inlet valve 3 closes and the working piston 7 starts on its first in-stroke, commonly called the "compression stroke". It will be noted that the air piston 10 remains stationary during this first out-stroke or "suction stroke" of the working piston 7. Now, at the beginning of the first in-stroke or "compression stroke" of the working piston 7, the valves 5 and 3 being closed, the charge in the combustion chamber 12 stands at approximately, the pressure of the atmosphere, and as the piston 7 advances, the volume of this charge is reduced and its temperature increased, both by the attendant compression, and by coming in contact with the heated walls of the cylinder 1 and the pistons 7 and 10. These combined conditions cause a rapid rise in the pressure of the charge, and when this pressure has reached a point where it slightly exceeds the pressure of the air in the air chamber 11, the air piston 10 begins to move on its first out-stroke, thereby compressing the air in the air chamber 11, and maintaining a practical balance of pressures in the air chamber 11 and the combustion chamber 12 throughout the "compression stroke". Near the end of this "compression stroke" and when the proper pre-compression of the charge has been attained the charge is ignited, and explodes violently in the combustion chamber 12, causing an immediate rise of pressure therein, which instantly forces the air piston 10 still farther

into the air chamber 11 until a practical balance of pressures has again been reached in the two chambers. Let it be now assumed that the working piston 7 and the air piston 10 have reached the end of their respective "compression strokes", and that the highest temperature of the burning charge and maximum pressure in both the combustion chamber 12 and the air chamber 11 have been attained. It should be remembered that the ultimate stroke of the air piston 10 is only about three-tenths of the stroke of the working piston 7 and that after the maximum pre-compression in the combustion chamber 12 has been reached, the greater part of the stroke of the air piston has been made; therefore, a very small movement of the air-piston 10 at the time of the explosion of the charge is sufficient to greatly increase the pressure of the air in the air chamber 11, and, also, that this slight movement of the air piston, caused by the explosion of the charge, has no material effect on the pressure or volume of the burning gases, the combustion chamber 12 now being comparatively large, and the air chamber 11 small. The compression and expansion of the air and the gases forming the explosive charge, follow very nearly the law, "Pressure times volume equals a constant". Now the working piston 7 starts on its second out-stroke, commonly called the "working stroke" or "impulse stroke", and the pressure of the gases in the combustion chamber 12 immediately begins to fall as the gases expand. At the same time the compressed air in the air chamber 11 also begins to expand, always tending to keep a practical balance of pressure in the two chambers, and driving the air piston 10 on its in-stroke. This expansion of gas and air continues throughout the working stroke.

The air piston 10 may be considered as merely floating between the gases in the combustion chamber 12 and the compressed air in the air chamber 11, and so gives to the working piston 7 the stored up energy of the impact of the explosion of the charge, which is lost in all internal combustion engines having a fixed or immovable cylinder head, and a combustion chamber of unvarying volume. No part of the force of the exploding gases is here lost, except the unavoidable loss of heat by convection and radiation through the walls of the cylinder; and the direct effect of storing up the energy of this impact by the use of these improvements, as herein described, is to maintain a higher mean pressure on the working piston 7 throughout its working or "impulse stroke". Now, the second out-stroke or "impulse stroke" of the working piston 7 has been completed, and the exhaust valve 5 is opened mechanically when the gases, still under a pressure greater than the atmosphere, rush out through the exhaust opening 6. This causes the pressure of the gases in the combustion chamber 12 to fall to that of the atmosphere; and the air piston 10, being relieved of this pressure on the side next the combustion chamber 12 and impelled by the pressure of air in the air chamber 11, quickly completes its in-stroke. At the same time, and while the burned gases are flowing from the combustion chamber, the working piston 7 makes its second in-stroke, commonly called the "exhaust stroke", and at the completion of the stroke, the working piston 7 and the air piston 10 are again in the position shown in Fig. 1, being then very close together, and practically effecting the complete expulsion of the burned or non-combustible products of the previous explosion.

It is not essential that the air piston 10 be located in an extension of the main cylinder, for in some cases it may be in a separate chamber 14 connected with the main cylinder by a passport 15, as shown in Fig. 3.

The foregoing description of the four phases of the working cycle only contemplates the use of a full charge of the explosive mixture, from which is obtained the maximum amount of work which the engine is capable of delivering. Now, let us consider the main object of the invention, namely; means for varying the clearance space in which the combustion of the fuel takes place, by means of which a fraction of the full charge may be taken into the cylinder and exploded at practically the same pre-compression pressure as with a full charge, but with a corresponding decrease of volume. With this condition carried out as claimed herein, very nearly the same terminal or maximum pressure should be reached with complete combustion whether the volume of the charge be a full charge or a fraction thereof. This condition makes for economy of fuel and delivers the greatest possible amount of work to the piston by causing a uniform rate of propagation of heat through the charge, at a time when this heat and the relatively high pressure, resulting therefrom, are greatest. I accomplish the variable clearance or variable volume of the combustion chamber in proportion to the charge taken in, by the following means: At some convenient point on or near the main cylinder 1 of the engine, is placed the air-reservoir 23. This air reservoir may contain atmospheric air under pressure from an air pump operated by the engine (preferably), or by hand, or it may be filled with the spent gases from the exhaust of the engine, which will give the necessary pressure, without a pump; or it may be filled with steam generated by the heat of the exhaust gases, or by a separate heater. Either air, spent gas or steam will work equally well for the purpose, provided the necessary pres-

sure is maintained in the air reservoir. I prefer to use spent gas from the exhaust as the simplest means to the desired end.

From the air reservoir 23 and connecting with the air chamber 11 of the engine, is a tube or pipe 24 having an intervening air valve 25, and a check valve 26 adapted to control the flow of compressed air, gas or steam from the air reservoir to the air chamber. This air valve is to be automatically operated by the usual governor, or by hand, the object being to increase the initial pressure of air, gas or steam in the air chamber at the same time with the corresponding decrease of charge taken into the working cylinder of the engine. The opening of this air valve may never be sufficient for an extreme change of charge from full charge to minimum charge, else it might exceed the requirements of the more moderate changes of charge. It is rather intended to control, under moderate changes of charge at each explosion, or gradually for any radical or extreme change, requiring probably five or six full working cycles of the engine to accomplish the complete change from full charge to minimum charge. Also leading from the air chamber 11 is the pass-way or port 27, to which is connected the automatic relief valve 22, which is nothing more than the ordinary safety "pop" valve common to all pressure service devices. This relief valve is adjustable to the required maximum pressure of the exploding charge in the combustion chamber, which pressure will also be present in the air chamber 11, and is adapted to open automatically when this predetermined maximum pressure has been reached, discharging the overplus of pressure into the air reservoir, and keeping the maximum pressure in the air chamber at the desired point for all working conditions of the engine. Thus it will be seen that by means of the air valve 25, and the supply of air, spent gas or stream flowing through it to the air chamber, the correct initial pressure or pre-compression pressure of the explosive charge may be controlled and practically maintained at the desired point, when acting in conjunction with the relief valve 22, which positively corrects any over compression of the charge by reason of the too free supply of compressed air, spent gas or steam from the air reservoir to the air chamber.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

In an internal combustion engine, and in combination with its working piston, a second piston forming the opposing wall of the combustion chamber, a pneumatic cushion behind said second piston and means for increasing and decreasing the resistance of said pneumatic cushion and allowing said second piston to move during the compression of the charge.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

CHARLES DAVID McCLINTOCK.

Witnesses:

WM. F. BOOTH,

D. B. RICHARDS.