

UNITED STATES PATENT OFFICE

2,157,486

INTERNAL COMBUSTION ENGINE WITH ADJUSTABLE PRESSURE

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Application August 30, 1935, Serial No. 38,626
In Austria September 19, 1934

4 Claims. (Cl. 123-78)

This invention relates to internal combustion engines. The invention consists in the arrangement whereby one and the same movable wall member or auxiliary piston arranged in the combustion chamber, or in a chamber communicating therewith, is so loaded by two counterbalancing resilient means of different magnitudes, comprising gaseous pressures, that the smaller resilient pressure is overcome by the compression pressure and the greater resilient pressure by the higher combustion or explosion pressure in the combustion chamber, and the wall member or auxiliary piston is moved backward as each of these counteracting forces is overcome. The result is thereby obtained that during the first backward movement the compression pressure is kept constant, independently of the particular amount of the charge admitted to the engine, and by the second backward movement of the wall member or auxiliary piston, potential energy is stored up in the latter in a well known manner, which, during the following drop in pressure in the combustion chamber, is given back again in the performance of work.

By the selection of counteracting resilient means of different moduli acting on one or more wall members, such as mostly correspond to the substantially different pressures during the compression and working stroke, it is possible to provide, for the two strokes, definite and completely separate conditions adapted to them, which can easily be predetermined and controlled in their effects and can also be easily controlled in further sequence by regulation.

The resilient walls may be formed by pistons, diaphragms or the like, and in special forms of construction by the main piston or working cylinder itself.

A form of construction of the machine is preferable which is characterised by two or more wall members or pistons, which are arranged in the combustion space or in a space communicating with it, and which are so loaded by gaseous pressures of different moduli that one or more pistons are moved backward by the compression pressure and one or more pistons by the working pressure.

If the counter-loadings of different moduli or the length of the movements of the wall members (strokes of the piston or pistons), or both the counter-loadings and the length of the movements of the wall members, are capable of being regulated, it becomes possible to control the operations carried out by the movable wall members as desired, so that for any given case the

conditions that are most suitable in practice can be provided.

The pressure conditions can be regulated by adjusting the counterbalancing resilient means acting upon the wall members or pistons and the sizes of the clearance space and of the compression space can be regulated by adjusting the length of the movements of the wall members.

Two examples of construction of the invention are diagrammatically illustrated in axial section in Figures 1 and 2 of the accompanying drawing.

In the constructional example of Figure 1, which relates to an engine working on the four-stroke cycle for instance, 1 is the working piston, and 2 an auxiliary piston which is subject to a gaseous pressure prevailing in the space 3, this space 3 being enclosed by the auxiliary piston 2 and a second auxiliary piston 2' located above it, above which, in the space 4, a greater gaseous pressure is maintained than in the space 3. The space 3 is in constant communication through an opening 10 with a large space (not shown) in which the pressure, (gas or air), is maintained at the desired height. The space 4 is in constant communication through openings 11 and 12 with a second large space (not shown) in which the desired higher pressure prevails. The pressures, which are concerned as counter-pressures to the pressure prevailing in the interior of the working cylinder, are thereby maintained at practically constant heights. Under the influence of these two pressures the auxiliary piston 2 assumes its lowest position, which is determined for instance by a rod 6 connected with the auxiliary piston and guided at 5, together with a nut 7 screwed on to it. By screwing this nut up and down the lowest position of the auxiliary piston 2 can be altered. For the auxiliary piston 2 a limitation of stroke is preferably provided. This consists, in the example illustrated, of a screw 17 with a stop 18 for the rod 6. To the auxiliary piston 2 is given a certain amount of clearance 6' in relation to the rod 6.

This device works in the following manner: When the working piston 1 moves upwards, with the exhaust valve opened, it expels the burnt gases until it almost touches at the upper dead centre, the auxiliary piston 2, which, in consequence of the resilient pressure thereon, is occupying its lowest position. Since the clearance space, at least between the working piston 1 and the auxiliary piston 2, is thereby reduced to a minimum, the expulsion of the combustion gases takes place more completely than hitherto.

The ensuing suction of the mixture of fuel and air is greatly improved with respect to quantity and purity of the mixture drawn in, in consequence of the substantial diminution in the size of the clearance space.

During the compression stroke of the working piston 1, the pressure in the working cylinder increases until it corresponds approximately to the pressure in the space 3 whereupon the auxiliary piston 2 is eventually pressed backward until the completion of the stroke of the working piston 1, whereby the compression pressure is not further increased. The size of the compression space between pistons 1 and 2, and therefore the modulus of the compression pressure, is thereby determined from the outset at each compression stroke independently of the amount of charge admitted to the main cylinder.

Upon explosion of the charge the pressure between the two pistons 1 and 2 rises so powerfully and suddenly that the auxiliary piston 2 is pushed backward, overcoming even the rather high gaseous pressure in the space 4, and thereby stores up potential energy, and provides an enlarged working space and a correspondingly diminished maximum pressure, which corresponds substantially to the gaseous pressure in the space 4. In the succeeding working stroke of the cycle the auxiliary piston 2 gives up the stored potential energy again with performance of work, in that it follows up the working piston 1 right to the end of its stroke, and thereby maintains the working space and the working pressure, during a portion of the stroke of the working piston, approximately at the same magnitude. Hence instead of a rather high and rapidly diminishing pressure in the main cylinder, a lower pressure exists, which remains about the same during a portion of the piston stroke. The indicator diagram will accordingly no longer exhibit the undesirable peak; this is replaced by a line extending for a certain distance approximately parallel to the axis of the abscissae, thereby attaining an approximation to the constant-pressure diagram of a Diesel engine or else to a steam-engine diagram. The expansion of the combustion gases thereby comes into action later.

By selecting different gaseous pressures in the space 3 and different gaseous pressures in the space 4, both the working pressure and the compression pressure can be controlled.

The aggregate advantages thus associated are as follows: Attainment of a more uniform torque on the crank, elimination of the knocking of the motor and better utilization of fuel. This arises from the fact that the maximum working pressure, instead of being operative only for a short time in an unfavourable crank position is operative for a longer time with a more favourable crank position. Furthermore, in consequence of diminution of the maximum pressures, less heat is imparted to the device and hence not so much heat has to be removed by cooling as hitherto; thus the thermal efficiency of the motor is also improved. Moreover, in consequence of the elimination of excessive combustion pressures and temperatures, greater durability and greater elasticity of the motor are attained. Owing to the diminution in the maximum pressure it is easier to keep the cylinder, piston and so forth fluidtight, the corresponding constructional parts may be of lighter dimensions, their inertia is reduced, and a cheaper construction becomes possible. The relationship between speed of revolu-

tion and power output of the motor is advantageously influenced as shown by the more favourable diagram; it therefore has a better output even at a rather low speed, thus improving the hill-climbing properties of motor vehicles. Lower speeds may be maintained without the occurrence of knocking. Owing to the improved quantity and quality of the charge, higher speeds of revolution are also attainable without a compressor, thereby saving energy. By the more uniform stressing of the machine parts the risk of breakage is diminished.

With this constructional example the piston strokes in both directions can be regulated.

Figure 2 shows the advantageous employment of two pistons, namely a relatively large counter-piston 2 in the working cylinder and a smaller counter-piston 14 in a special cylinder 15. Both pistons are subject on their outer sides to the pressure of a gas: the piston 2 to a high pressure and the piston 14 to a low pressure. Similarly as in Figure 1, the space 3' above the piston 14 is in constant communication through opening 10 with a large space in which the desired pressure prevails while the space 4' above the piston 2 is in constant communication through openings 11, 12 with a second large space in which the desired higher pressure prevails. By 8 and 9 are denoted the suction valve and the exhaust valve respectively, and 16 is the sparking plug. 8' and 9' respectively designate ports of admission and exhaust for the valves 8 and 9.

With this arrangement the small piston 14 serves for adjusting the compression pressure, and the larger piston 2 for adjusting the maximum working pressure. Both the pistons are adjustable, both in respect to loading and in respect to length of travel, the piston strokes in this constructional example being adjustable in one direction only.

What we claim is:

1. In an internal combustion engine in combination with the working chamber of the cylinder and the working piston, two movable walls of which at least one closes the said working chamber, means to keep these walls on their side remote from the working chamber of the cylinder under practically constant pressure of a medium of pressure which is opposing the pressure within the said working chamber, said pressures being of a different force, the wall subjected to the lower counter-acting pressure being moved backward by the compression pressure within the cylinder, whereby the compression pressure is being kept constant regardless of the amount of the charge, the other wall being exposed to the higher counter-pressure will be moved backward only by the higher combustion pressure, whereby potential energy is stored posed to the higher counter-pressure will be turned to the working piston.

2. In an internal combustion engine in combination with the working chamber of the cylinder and the working piston a movable wall which closes the working cylinder, means exposing the said movable wall on its side remote from the working chamber of the cylinder to a practically constant counter-pressure of a medium of pressure which counter-acts the pressure within the working cylinder, a second movable wall, arranged behind the first mentioned wall, means connecting said movable wall members, said means allowing limited relative movement between same, means exposing this wall on its back-

side to a practically constant, but higher than the
aforementioned pressure, of a medium of pressure
counter-acting the pressure within the said work-
ing chamber, the first mentioned wall being
moved backward by the compression pressure
whereby the compression pressure is being kept
constant, regardless of the amount of the charge,
the second wall will be moved backward only by
the higher combustion pressure, whereby po-
tential energy is stored, which during the ex-
pansion stroke, will be returned to the working
piston.

3. An internal combustion engine according to
claim 1, provided with means suitable to adjust
the stroke of the two movable walls in the direc-
tion toward the working piston.

4. In an internal combustion engine, a work-
ing cylinder, a working piston and a plurality of

auxiliary pistons in said cylinder, said pistons
dividing said cylinder into a combustion cham-
ber and fluid pressure chambers, means for
maintaining fluid pressure in said fluid pressure
chambers, the pressure maintained in the cham-
ber adjoining the combustion chamber being less
than that of compression in the combustion
chamber and the pressure in the next adjoining
chamber being greater than the maximum com-
pression pressure but less than the combustion
pressure, means connecting said auxiliary pis-
tons, said means allowing limited relative move-
ment between said auxiliary pistons whereby the
exhaust gases are more completely expelled and
the energy of the combustion is more gradually
applied to the working piston.

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