April 19, 1927. 1,625,205

W. F. GRUMME

INTERNAL COMBUSTION ENGINE

Filed July 3, 1925 2 Sheets-Sheet 1

Fig. 1.

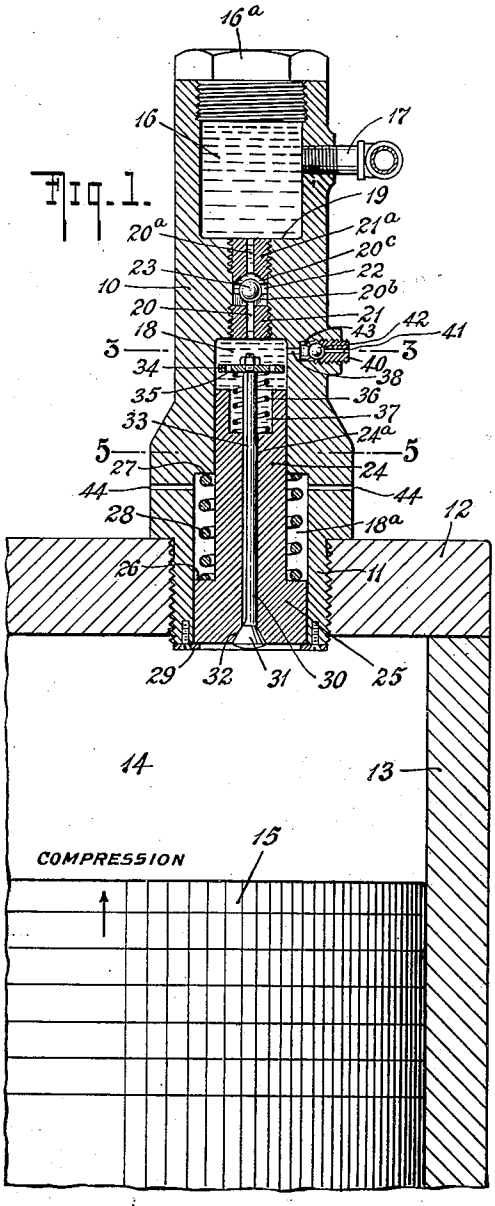
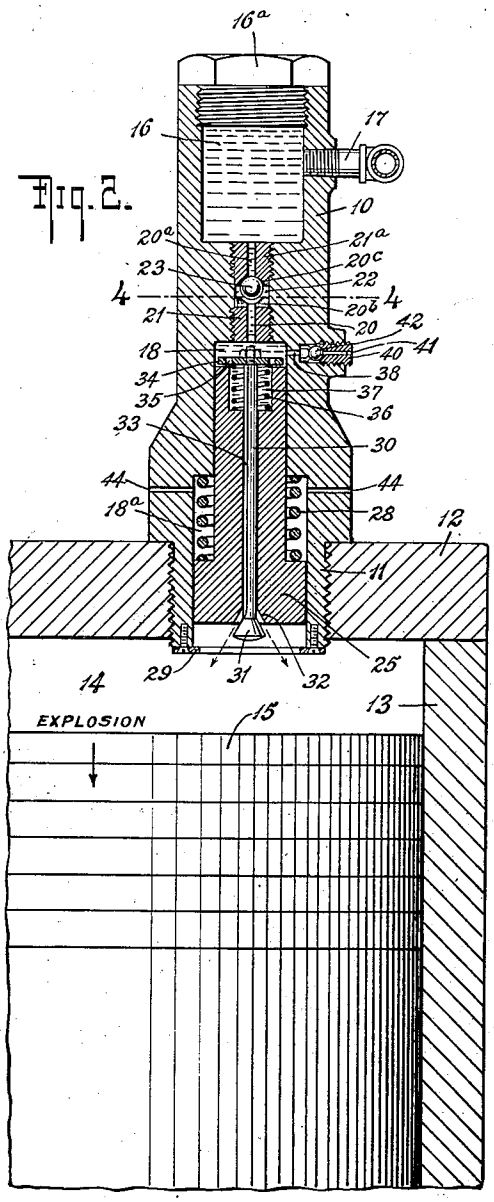


Fig. 2.



WITNESS

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Fig. 3.

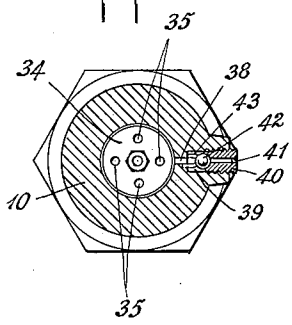


Fig. 4.

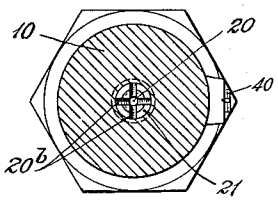


Fig. 5.

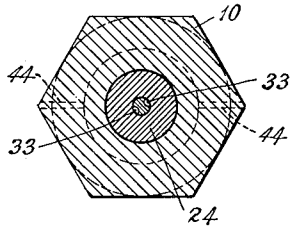
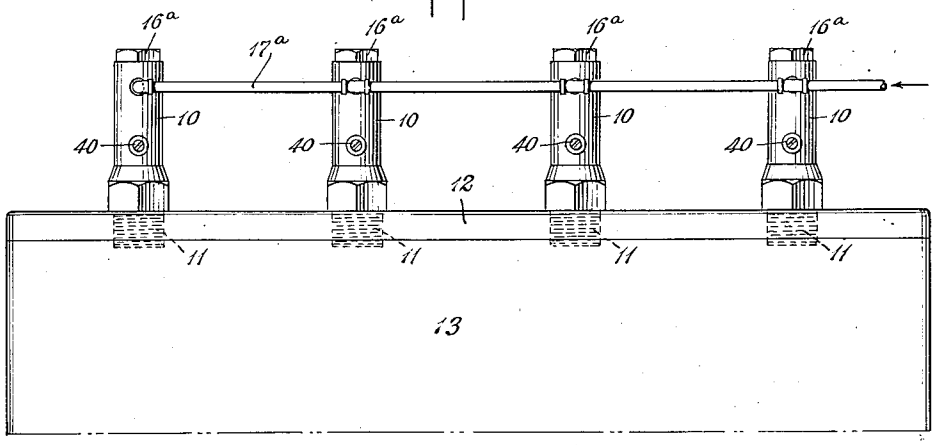


Fig. 6.



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UNITED STATES PATENT OFFICE.

WILLIAM F. GRUMME, OF NEW YORK, N. Y.

INTERNAL-COMBUSTION ENGINE.

Application filed July 3, 1925. Serial No. 41,276.

My invention relates to internal combustion engines and more particularly to devices whereby regulable quantities of water may be automatically injected into the cylinders of such engine during the explosion periods thereof for improving the operation and the thermal efficiency of such engine. The object of the invention is to provide a device of the indicated character which is extremely simple in construction and of maximum efficiency in operation. Other more specific objects will appear from the description hereinafter and the features of novelty will be pointed out in the claims.

In the accompanying drawings, which illustrate an example of the invention without defining its limits, Fig. 1 is a sectional elevation showing the invention in place upon the cylinder of an internal combustion engine; Fig. 2 is a similar view with the parts in a different position; Fig. 3 is a horizontal section on the line 3—3 of Fig. 1; Fig. 4 is a similar view on the line 4—4 of Fig. 2; Fig. 5 is a horizontal section on the line 5—5 of Fig. 1 and Fig. 6 is a diagrammatic view showing the invention applied to a multiple cylinder engine.

In its illustrated form, the device comprises a casing 10 of generally cylindrical form which is provided at its lower end with a reduced externally screwthreaded neck 11 adapted to be screwed into the wall 12 of the cylinder 13 of an internal combustion engine so as to establish communication with the combustion chamber 14 thereof. The piston of the engine is indicated at 15, it being understood that the piston is connected in the customary manner with a crank shaft or other mechanical element to which mechanical motion is to be imparted. The casing 10 is provided at its upper end with a main chamber 16 adapted to contain water, gas, or other predetermined material, said chamber 16 being connected by means of a tube 17 with a source of water or other supply such as, for instance, the cooling system of an internal combustion engine; in the preferred arrangement the chamber 16 is closed at its uper end by means of a removable cap 16^a which as shown may be in screwthreaded connection with the casing 10; the removal of the cap 16^a makes the interior of the chamber 16 easily accessible for any purpose. An auxiliary chamber 18 is provided in the interior of the casing 10 at the lower end thereof and is separated from the chamber 16 by means of a wall 19 as shown in Figs. 1 and 2; the chambers 16 and 18 communicate with each other through the medium of restricted passages 20 and 20^a which for the purpose of simplifying the construction may be formed in plugs 21 and 21^a screwthreaded into the wall 19 from opposite directions. The inner end of the plug 21 is constructed and arranged in a manner to prevent the passage 21 from being completely sealed for the purpose which will appear more fully hereinafter; thus cruciform slots 20^b may be provided at the inner end of the plug 21 for this purpose as shown in Figs. 1, 2, and 4. The plug 21^a, on the other hand, is provided at its inner end with a valve seat 20^c constructed and arranged to permit passage 20^a to be completely sealed at its inner end as shown in Fig. 2. The arrangement is such that the inner ends of the plugs 21 and 21^a, in the operative position thereof, are spaced from each other to provide a valve chamber 22 in which a ball or other check valve 23 is movably located, said valve 23 cooperating with the slots 20^b and the valve seat 20^c to control the passage of water from the chamber 16 to the chamber 18 through the passages 20 and 20^a in a manner to be more fully described hereinafter. A piston 24 is slidably fitted in the auxiliary chamber 18 and may be provided with an enlarged inner end 25 slidably fitted in a secondary chamber 18^a which forms a continuation of the chamber 18 but is sealed against communication therewith by the piston 24. With this arrangement, an annular shoulder 26 is formed upon the piston 24 and a similar annular shoulder 27 is formed at the point of connection between the auxiliary chamber 18 and the secondary chamber 18^a; the shoulders 26 and 27 comprise abutments respectively for the opposite ends of a compression spring 28 located within the secondary chamber 18^a and exerting a tension tending to normally force the piston 24 in a direction toward the combustion chamber 14. Any suitable means may be provided for preventing the piston 24 from being forced out of the secondary chamber 18^a by the action of said spring 28; in the illustrated example, this means is shown in the form of an annular member 29 secured upon the inner end of the reduced neck 11 and projecting into the path of the enlarged end 25 of the piston 24 as shown in Figs. 1 and

2. The piston 24 is further provided with an axially extending bore 24^a of relatively small diameter in which the stem 30 of a control valve 31 is movably located; the control valve 31 is shown of conical form and cooperates with a correspondingly formed seat 32 formed at the inner end of the aforesaid bore 24^a. The stem 30 extends beyond the upper end of the piston 24 and is provided with one or more channels or grooves 33 extending lengthwise of said stem 30 from its upper end to the valve 31, said stem at its upper end carrying a disc 34 provided with apertures 35 and substantially fitting the auxiliary chamber 18 as illustrated in Fig. 1. A coil spring 36 bears with its one end against the disc 34 and has its other end seated in a recess 37 provided in the piston 24 at the upper end thereof as shown in Figs 1 and 2; the spring 36 exerts a tension tending to normally maintain the control valve 31 in a closed position against its seat 32 as illustrated in Fig. 1. To increase the efficiency of the device, an air vent 38 may be provided for selectively establishing communication between the auxiliary chamber 18 and the atmosphere, said vent leading to an internally threaded valve chamber 39 in which a threaded plug 40 is adjustably mounted as shown in Figs. 1, 2, and 3; the plug 40 is provided with an axial passage 41 which terminates at its inner end in a valve seat for the ball or other valve 42. The latter is prevented from completely sealing the vent 38 by means of pins 43, which project from the inner end of the vent 38 toward the passage 41. The position and operative range of the valve 42 and the consequent admission of air is determined by the adjustment of the screw-threaded plug 40, it being understood that normally the pressure of the water or its equivalent in the auxiliary chamber 18 maintains the valve 42 in a position to seal the passage 41 as shown in Figs. 1, 2, and 3. To prevent the formation of an air cushion in the secondary chamber 18^a, air vents 44 may be provided at diametrically opposite points in the casing 10 so as to establish communication between the secondary chamber 18^a and the atmosphere.

In the normal condition of the device, the chambers 16 and 18 each contain a supply of water or other predetermined liquid or gas or a combination of both, the quantity contained in the auxiliary chamber 18 being predetermined with respect to the requirements of the particular engine for which the device is designed. The check valve 23, by the pressure of the water or its equivalent in the chamber 16, is maintained in position to close the channel against the cruciform slots 20^b so that the passages 20 and 20^a are in communication with each other and the connection between the chamber 16 and the auxiliary chamber 18 is consequently open as shown in Fig. 1; the control valve 31 is normally held in its closed position, against its seat 32 by the action of the spring 36, as clearly shown in Fig. 1 of the drawings. As the engine piston 15 travels upwardly during the operative cycle of the internal combustion engine, it will at a predetermined stage compress the combustion mixture in the combustion chamber 14 in the usual manner; it will be understood that the spring 28 is of sufficient strength to prevent this compression of the combustion mixture from shifting the piston 24 in the casing 10 from the position shown in Fg. 1 of the drawings. As an explosion of the combustion mixture takes place in the customary manner, the force of this explosion, in addition to actuating the piston 15 in the conventional manner, is sufficient to overcome the resistance of the spring 28 and accordingly will shift the piston 24 upwardly in the chambers 18 and 18^a to approximately the position shown in Fig. 2. As this occurs, the inertia of the control valve and its associated parts assisted by the pressure of the water contained in the auxiliary chamber 18, which in effect will be counter to the pressure exerted by the explosive forces upon the piston 24, will substantially fix the disc 34 and with it the stem 30 and valve 31 against movement so that in effect the piston 24 may be said to travel lengthwise of the stem 30. It will be understood that the coil spring 36 is of such a type as to permit his operation, which consequently moves the control valve to an open position away from its seat 32 as indicated in Fig. 2 of the drawings. As soon as this takes place, the water in the auxiliary chamber 18 will pass through the apertures 35 of the disc 34 and through the channel 33 into the combustion chamber 14. The charge of water thus injected into the combustion chamber not only serves to cool the walls thereof, but by being almost instantaneously converted into steam by the heat of the exploded gases adds its expansion effect to that of the aforesaid exploded gases and thereby increases the operative efficiency of the engine as well as its thermal effectiveness. As the described upward movement of the piston 24 under the impulse of the force of the explosion takes place, the check valve 23 is forced upwardly against the seat 20^c at the inner end of the passage 20^a and thus closes said passage 20^a to prevent any water or its equivalent from passing from the chamber 16 to the chamber 18 during such time as the valve 31 is open; in this way, flooding of the combustion chamber 14 is prevented and only the desired amount of water or its equivalent is injected into the same. After the aforesaid explosion has occurred and water from the auxilary chamber 18 has been injected into the combustion chamber

14, the spring 28 will restore the piston 24 to its normal position and at the same time the spring 36 will return the control valve 31 to its closed position against its seat 32. At the same time the ball valve 23 will be returned to a position against the cruciform slots 20^b and thereby open the communication between the passages 20 and 20^a so that a new supply of water or its equivalent will pass from the chamber 16 to the chamber 18 to constitute a new charge to be subsequently introduced into the combustion chamber 14. The above mentioned operations are successively repeated in operative sequence so that a predetermined charge of water or other predetermined liquid or gas is injected into the combustion chamber each time the combustion mixture is exploded. If the amount of water or its equivalent which is being injected into the combustion chamber 14 constitutes the proper and desired charge, the plug 40 will be adjusted to lock the ball valve 42 between the pins 43 and the inner end of the passage 41 so that communication between the chamber 18 and the atmosphere is positively cut off. If, on the other hand, too much water or its equivalent is being injected into said combustion chamber the amount may be cut down by adjusting the plug 40 outwardly to a predetermined extent to permit the valve 42 to have a predetermined play between the pins 43 and the valve seat at the inner end of the passage 41. Under such conditions, each time the water or its equivalent is injected into the combustion chamber 14, the suction created thereby will draw the ball valve 42 away from the end of the passage 41 so that a quantity of air will pass into the chamber 18. As a result of this the charge which is introduced into the cylinder will be composed of a mixture of water or its equivalent and air so that the amount of water or its equivalent will be reduced to an extent corresponding to the amount of air which is drawn in. It will be obvious that the greater the amount of air which is admitted to the auxiliary chamber 18, the less will be the supply of water which is transferred from said auxiliary chamber through the passage 33 to the combustion chamber 14 each time the elements are operated in the manner hereinbefore set forth. As the adjustment of the piston 24 under the effects of the explosion takes place, a sufficient amount of the air which is contained within the secondary chamber 18^a is forced out through the air vents 44 to prevent the formation of an air cushion therein, a corresponding amount of air being drawn back into said secondary chamber 18^a as the piston 24 resumes its normal position.

If the engine in which the invention is embodied comprises a multiplicity of cylinders, each cylinder will be provided with one of the novel water injecting devices; in such cases, as shown diagrammatically in Fig. 6, the main chambers 16 of the several devices may be interconnected by having the tubes 17 all lead to a pipe 17^a which in turn is connected with a source of water or other predetermined liquid or gas.

The device is extremely simple in construction and comprises a minimum of parts easily put together and easily accessible without the necessity for any skilled attention. The device in its operation serves to materially increase the effective stroke of the piston and prevents decline of pressure which follows the ignition of an ordinary explosive charge. The device serves to convert a considerable portion of heat evolved into energy for the double purpose of increasing the efficiency of the engine and for eliminating a certain proportion of the evolved heat which is thus converted into energy and transmitted to the mechanical element being driven by the engine.

In addition to its other advantages the device, in practice, acts to prevent carbon formation and deposits in the cylinders.

Various changes in the specific form shown and described may be made within the scope of the claims without departing from the spirit of my invention.

I claim:

1. A device for injecting a predetermined fluid into the cylinder of an internal combustion engine, comprising a casing mounted upon the engine cylinder in communication with the combustion chamber thereof, said casing having an internal fluid chamber, a piston movable in said casing by the explosion forces of the mixture in the combustion chamber, and extending into said internal fluid chamber in the form of a plunger; said piston having an axial bore whereby communication is established between said fluid chamber and the combustion chamber, a valve stem movably mounted in the axial bore of said piston and projecting beyond the upper end of said bore into said fluid chamber, said valve stem being arranged to permit a flow of said fluid therethrough, a valve at the lower end thereof, said stem controlling the inner end of said bore and a spring effective to maintain said valve in its closing position and to return it thereto.

2. A device for injecting a predetermined fluid into the cylinder of an internal combustion engine, comprising a casing mounted upon the engine cylinder in communication with the combustion chamber thereof, said casing having a main fluid chamber and an auxiliary fluid chamber spaced apart and connected with each other, a check-valve in the connection between said two chambers, a piston slidably fitted in said auxiliary chamber and movable by the explosive

forces of the combustion mixture, said piston having a reduced axial bore whereby communication is established between the auxiliary fluid chamber and the combustion chamber, a valve seat at the inner end of said piston bore, a stem movably mounted in the piston bore and arranged to permit a flow of fluid therethrough, a valve carried by said piston and cooperating with said seat to control the flow of fluid through said piston bore and a spring effective to maintain said valve against said seat and to return it thereto.

3. A device for injecting a predetermined fluid into the cylinder of an internal combustion engine, comprising a casing detachably connected with the engine cylinder and having an internal secondary chamber communicating with the combustion chamber thereof, said casing further having an auxiliary fluid chamber and a main fluid chamber connected with each other by means of restricted passages having their opposed ends spaced apart and terminating in and communicating with a valve-chamber, a check-valve in said valve-chamber cooperating with the opposed ends of said passages to control the flow of a fluid from the main to the auxiliary chamber, a piston slidably fitted in said auxiliary fluid chamber and having its inner portion slidably fitted in said internal secondary chamber, said piston having a reduced axial bore whereby communication is established between said fluid auxiliary chamber and said combustion chamber, a valve-seat at the inner end of said bore, a stem slidably mounted in said piston-bore and channelled lengthwise to permit a flow of fluid through said bore, a control valve at the inner end of said stem cooperating with said valve-seat to control the flow of fluid through said piston-bore, a perforated disc at the outer end of said stem and movable thereby in said auxiliary chamber, a spring effective upon said disc whereby said control valve is maintained on and returned to its seat and a second spring effective upon said piston for maintaining it against movement during the compression stroke of the engine and for permitting said piston to yield under the explosive forces of the combustion mixture.

4. A device for injecting a predetermined fluid into the cylinder of an internal combustion engine, comprising a casing mounted upon the engine cylinder in communication with the combustion chamber thereof, said casing having an internal fluid chamber, a piston slidably fitted in said casing and having an axial bore whereby communication is established between the fluid chamber and the combustion chamber of the engine, and a valve carried by said piston and controlling the flow of fluid through said axial bore, said piston being moved in said casing by the explosive forces of the combustion mixture and said valve by its inertia, remaining stationary relatively to said piston and being thereby adjusted to an open position to permit fluid to be injected into said combustion chamber, said valve partaking of the movement of the piston as soon as the inertia has been overcome.

In testimony whereof I have hereunto set my hand.

WILLIAM F. GRUMME.