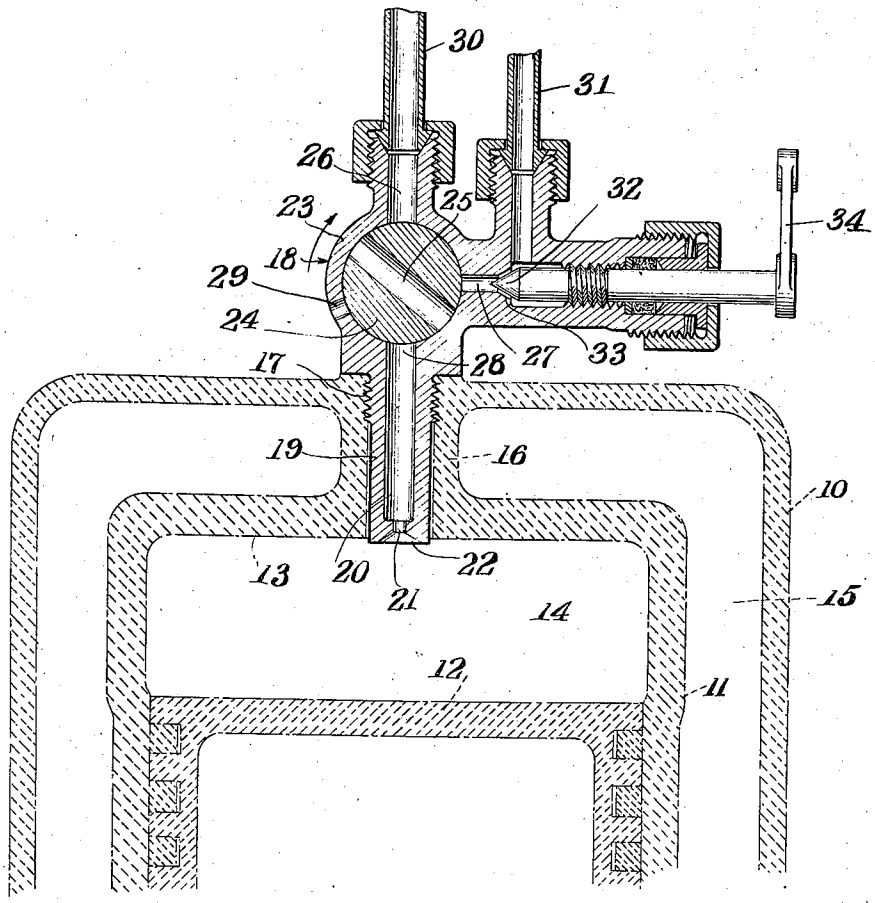
Dec. 7, 1926. 1,609,386

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FUEL METERING VALVE

Filed May 31, 1923



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Patented Dec. 7, 1926. 1,609,386

UNITED STATES PATENT OFFICE.

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FUEL-METERING VALVE.

Application filed May 31, 1923. Serial No. 642,465.

The invention relates in general to a valvular control for supplying a mixture of combustible fuel and combustion supporting air to the explosive chamber of an internal combustion engine, and the invention constitutes an improvement in such devices of the type in which a rotating metering valve is operatively connected to work in synchronism with the engine so as to feed a measured volume of liquid fuel into the path of a stream of compressed air leading to the engine.

In connection with such devices it has been known to cause a solid stream of liquid fuel to flow into a measuring pocket in the rotary valve and which valve in its turning movement is designed to shut off the supply of fuel and then to carry a measured quantity of the solid liquid fuel into line with a blast of compressed air which acts to blow the liquid into the engine. Even if it be admitted that such constructions were practical with the high firing point gasoline, and at the relatively slow operation of engines in use at the time experiments were tried with such devices, it is obvious that under present day conditions, with fuels which are not readily subject either to vaporization or to combustion, and where engine operation has attained extremely high speeds, any device which depends upon the necessary slow flow of a charge of liquid in a solid stream into an explosive chamber and the subsequent firing would be inoperable due, among other reasons, to the fact that the fuel could not complete its combustion reaction within the short time period available while the liquid is permitted to remain in the chamber.

Accordingly, the primary object of this invention is to retain the advantages inherent in the rotary valve type of fuel control, such as sensitiveness to variations in engine demands for supplying the requisite amount of fuel and at the same time to provide a modification of the old structure which will permit of an efficient operation even when used in connection with the conventional high speed engines and which will permit the use of the difficultly vaporizable gasoline and other fuel now in general use.

Broadly, this phase of the invention is obtained by what may be identified as a two-step treatment of the fuel as it passes through the metering device. Instead of attempting to measure liquid fuel in the form of a solid stream as was the case in the previously known devices, the fuel supply is broken up into fine liquid particles widely separated and the metering valve in this case is caused to abstract from the nebulous cloud-like mass of finely diffused liquid particles, such volumetric mass as will constitute sufficient fuel to supply the necessary hydrocarbon to charge the engine cylinder when working at that speed for which the engine is set in its normal operation. Forming the liquid into a cloud of finely divided particles has the advantage in that a more thorough and more rapid mixing with the combustion supporting air is attained than would be the case with a solid liquid stream and this breaking up of fuel stream has the further advantage in that greater accuracy may be attained in measuring the fuel necessary for each charge and greater refinement is provided for controlling the enriching of the fuel mixture fed to the engine than would be the case in an attempt to control a solid liquid stream.

Another object of the invention is to provide a simplified construction of mixing chamber for insuring a time delay in the passage of the commingled fuel and air before it is drawn or forced into the explosive chamber. Accordingly the invention features, as a step incidental to the commingling of the divided fuel with its combustion supporting oxygen, the interpositioning of a mixing chamber between the metering valve and the explosive chamber, which mixing chamber will be at all times in open communication with the explosive chamber.

Referring to an incidental detail of construction the disclosure includes a form of fuel mixture discharge port leading from the mixing chamber into the explosive chamber so constricted as to retard the normal free flow from the mixing chamber into the explosive chamber. In this way there is provided a time interval sufficient to permit the thorough intermingling of the fuel particles with the air particles while in the mixing chamber and incidentally to insure a constant discharge of the fuel into the explosive chamber in the form of a widely diffused spray capable of spreading over the intake end of the explosive chamber.

In the form of the invention herein selected for illustration the inner end of the

mixing chamber discharging into the explosive chamber is exposed to the heat of combustion as well as the heat of compression in the explosive chamber and is thus liable to constitute a hot spot which might automatically fire the charge in the explosive chamber or otherwise pre-ignite the explosive charge. Accordingly, another object of the invention is to provide a construction of mixing chamber which tend to maintain the fuel at a temperature adjacent to but below its firing point. In the device herein illustrated the mixing chamber is disposed with relation to the usual water jacketed space found in internal combustion engines, so as to maintain the temperature in the mixing chamber at a point sufficiently high to assist in the vaporization of the cloud of liquid fuel therein but at a temperature sufficiently low to prevent preignition of the fuel either in the mixing or in the explosive chambers.

Another object of the invention is to provide a simple, manually actuated control for varying the richness of the mixture supplied to the engine and in this way provide an accurate control for responding to variable engine demands.

Another object of the invention is to provide in connection with the rotary valve a simplified means for discharging the valve pocket of any gas pressure which might tend to accumulate therein and thus automatically restore the valve pocket in position to receive in sequence a fresh supply of fuel and a succeeding supply of propelling air at each cycle of operation of the valve.

Various other objects and advantages of the invention will be in part obvious from an inspection of the accompanying drawings and in part will be more fully set forth in the following particular description of one form of mechanism embodying my invention, and the invention also consists in certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

In the accompanying drawings there is shown in outline the upper portion of one cylinder of an internal combustion engine of conventional design equipped with a preferred embodiment of the invention, both shown in axial section.

In the drawings there is shown an engine cylinder 10 with an inner piston cylinder 11 reciprocally mounted in which is a piston 12 and between the head 13 of which cylinder and the piston 12 is formed the usual explosive chamber 14. It is understood that the combustible fuel in the chamber is fired by some suitable form of spark plug or other firing device not herein illustrated. The space between the inner and outer cylinders constitute a water jacketed space 15 which surrounds and tends to cool a connecting tube 16 at the top of the cylinder. The tube 16 is threaded as shown at 17 and into the bore of the tube is demountably screwed an attachment 18 particularly constituting the subject-matter of this disclosure.

The portion of the attachment extending through the tube 16 in screw threaded engagement therewith constitutes a hollow, tubular plug 19 with its bore relatively long and providing a mixing chamber 20. The inner end of the chamber is constantly opened through a liquid fuel discharging vent 21, directly into the explosive chamber. This vent is constricted and in actual practice has a cross-sectional area of about one-ninth of the similar area of the mixing chamber. The outer end of the vent is flared as shown at 22 and this construction constitutes in effect, a spray nozzle for spraying the mixture of fuel and air discharged from the mixing chamber into the explosive chamber in the form of a wide spreading, diffused spray or mist of fine fuel particles.

The attachment 18 includes a valve casing 23 at the outer end of the mixing chamber 20 and positioned in the valve casing is a rotary valve 24 of the cylinder type. This valve is suitably connected to some rotating part of the engine so as to turn in proper relation to the action of the piston as is usual in such constructions. The valve 24 is provided with a measuring pocket 25 extending diametrically therethrough and has a preset, measured volume. The valve casing is provided with four ports, which, considered clock-wise, forms in order a compressed air inlet 26, a fuel inlet port 27, a discharge port 28 leading into the mixing chamber, and a bleeding port 29 opening into the external atmosphere. The ports 26 and 28 are disposed in alignment with the axis of the mixing chamber and are so arranged that when the chamber 25 provides open communication therebetween the compressed air from the source of compressed air, indicated symbolically by the pipe 30, forces the fuel in the pocket 25 therefrom and into the mixing chamber.

It is a feature of this disclosure that the liquid be in a finely divided state as it passes through the port 27 into the measuring pocket in the rotating valve. The liquid fuel is fed under pressure from the source, indicated symbolically by the supply pipe 31, and is caused to pass a spray valve 32 and through the port 27. The end of the spray valve is of the conical type and is mounted for adjustment relative to its frusto-conical seat 33 and in this way the rate of fuel fed to the metering valve per unit of time as well as the physical character of the fuel is regulated. This regulation is practically attained by manual control and for this pur-

pose the valve is rotated relatively to its seat through a control level 34.

In operation and assuming that the valve 32 has been set to supply the requisite amount of fuel necessary to supply the engine at the speed and under the load condition in which it may be working, the fuel in its passage past the valve 32 is changed from its solid stream condition in the pipe 31 into an open finely divided condition. The fuel in this nebulous condition is discharged into the pocket 25 when the pocket in its rotary movement becomes aligned with the port 27. As the pocket, while open to the passageway 27, has greater receiving capacity than the passageway has supplying capacity there results a tendency of the liquid cloud to expand and thus act as a gas. As the valve continues to turn in the clockwise direction indicated by the arrow it is brought into position aligned with both the air inlet and with the mixing chamber. The air pressure acts on the fuel to eject the same from the pocket into the mixing chamber and acts to supply combustion supporting air as long as the pocket is open to the air inlet port 26. The continued movement of the rotary valve shuts off the upper end of the mixing chamber and traps a small portion of air in the pocket. The succeeding movement of the rotary valve brings the pocket into alignment with the bleeding port 29 and the compressed air trapped in the measuring pocket is permitted to discharge into the external atmosphere. In this way pressure conditions in the measuring pocket are restored practically to atmospheric condition and the valve pocket is again in position to receive a fresh charge of fuel from the port 27 thus completing a cycle of rotary movement.

As the air and divided fuel is ejected into the mixing chamber it will promptly begin to flow past the spray nozzle into the explosive chamber but the constriction provided by the spray nozzle will retard the normal freedom of movement and this retardation within the mixing chamber, while lasting but for a fraction of a second will be sufficient to insure the thorough mixing of the combustion supporting air with the finely divided fuel particles. In effect every combustible particle will be surrounded with the requisite oxygen necessary to effect a complete combustion of the particle.

It will be understood that the device herein disclosed is of the two-cycle type and that the parts are formed to work in the usual sequence of admitting a charge, as hereinbefore described, and while the metering valve is in position closing the mixing chamber, the engine performs its cycle of compressing the charge, firing the charge and opening the explosive chamber through its usual exhaust prior to the movement of the rotary valve in position to admit the next succeeding mixture of fuel and air.

By means of a device of the character described, it is possible to supply an internal combustion engine of the high speed type with fuel and air intimately mixed in their proper combustion ratio to meet the variable engine demands even though a poor grade of fuel is used.

It is obviously within the scope of the invention to replace the rotary valve herein disclosed with a rotary valve having a different sized pocket so that by a proper selection of different sized pockets variable amounts of fuel may be metered for supplying different engines and by varying the working pressures on the fuel and air supplied these factors may be proportioned in the resulting mixtures. During the operation of the engine the richness of the fuel may be readily varied simply by adjusting the hand lever 44 and in this way an economical operation of the engine is attained.

Having thus described my invention, I claim:

1. In an internal combustion engine, the combination with a water jacketed wall of an attachment constituting a fuel charge forming device, said attachment including a hollow plug extending through the wall and constituting a mixing chamber surrounded by the water space in the wall and cooled thereby, said mixing chamber having its inner end opening directly into the explosive chamber of the engine and the end of the plug facing the engine explosive chamber exposed to the heat in the same, an air cooled valve casing at the outer end of the mixing chamber and disposed exterior to the outlines of the engine, a metering valve mounted for rotary movement in said casing and provided with a measuring pocket, said casing provided with a fuel inlet port, and a compressed air port disposed in circumferentially spaced relation and both discharging into the pocket when the pocket in its rotary movement faces the same, and said pocket at one point in its cycle of rotary movement opening into the mixing chamber, said mixing chamber being open to the explosive chamber and said valve timed to close the outer end of the mixing chamber during the compression stroke of the engine, and means operable in timed sequence and while the mixing chamber is so closed, to permit the valve pocket successively to discharge into the outer atmosphere and then to receive a fresh charge of fuel.

2. In an internal combustion engine, the combination with a water jacketed wall, of an attachment constituting a fuel charge forming device including a hollow plug extending through the wall and constituting a mixing chamber surrounded by the water

space, cooled thereby and having its inner end opening directly into the explosive chamber of the engine and exposed to the heat of the chamber, an air cooled valve casing at the outer end of the mixing chamber and disposed exterior to the outlines of the engine, a metering valve mounted for rotary movement in said casing and provided with a measuring pocket, said casing provided with a fuel inlet port and a compressed air port disposed in circumferentially spaced relation and both discharging into the pocket and said pocket at one point in its cycle of rotary movement opening into the mixing chamber, said mixing chamber being open to the explosive chamber and said valve timed to close the outer end of the mixing chamber during the compression stroke of the engine.

3. In an internal combustion engine, the combination with a water jacketed wall, of an attachment constituting a fuel charge forming device, and including a hollow plug extending through the wall and constituting a mixing chamber surrounded by the water space, cooled thereby, and having its inner end opening directly into the explosive chamber of the engine and exposed to the heat of the chamber, an air cooled valve casing at the outer end of the mixing chamber and disposed exterior to the outlines of the engine, a metering valve mounted for rotary movement in said casing and provided with a measuring pocket, said casing provided with a fuel inlet port and a compressed air port disposed in circumferentially spaced relation and both discharging into the pocket and said pocket at one point in its cycle of rotary movement opening into the mixing chamber.

4. In an internal combustion engine, the combination of an explosive chamber, a plug fitted to extrude through the wall of and to extend into the chamber, and including a valve casing, a metering valve mounted in said valve casing for rotary movement, said casing and its contained rotary valve being spaced from said chamber and exposed to the external atmosphere whereby the valve and its casing are air cooled, said valve provided with a measuring pocket extending diametrically therethrough, three passageways extending through the valve casing, circumferentially spaced apart, and controlled by the valve, one of said passageways adapted to be connected to a source of air under pressure, the second to a source of fuel, and the third constituting a relatively long passageway disposed between the valve and the outlet opening of the same into the explosive chamber, said opening being at all times open to the explosive chamber, said measuring pocket and said long passageway collectively constituting a mixing chamber having a capacity to insure the mixing of the fuel and air before it is discharged therefrom into the explosive chamber.

5. An attachment for an internal combustion engine constituting a fuel charge forming device including a mixing chamber having a spray nozzle for discharging therefrom into the explosive chamber of the engine, a rotary valve provided with a measuring pocket, means for supplying a charge of liquid fuel in a finely divided state to said pocket, and means for causing a supply of combustion supporting compressed air to sweep such fuel charge from the pocket into the mixing chamber and the passageway between the mixing chamber and the explosive chamber being constricted to retard the freedom of flow into the explosive chamber.

6. An attachment for an internal combustion engine, constituting a fuel charge forming device including a mixing chamber adapted to discharge into the explosive chamber of the engine, a rotary metering valve for controlling the volume of the charges discharged into the mixing chamber, a source of compressed air controlled by said valve and leading therethrough into the mixing chamber, a source of liquid fuel under pressure and leading through the valve into the mixing chamber and a manually actuated control for regulating the flow of liquid fuel into the metering valve and the discharge port leading from the mixing chamber being constricted to form a spray nozzle.

7. An attachment for an internal combustion engine constituting a fuel charge forming device including a mixing chamber having a spray nozzle for discharging therefrom into the explosive chamber of the engine, a rotary valve provided with a measuring pocket, means for supplying a charge of liquid fuel in a finely divided state to said pocket and means for causing a supply of combustion supporting compressed air to sweep such fuel charge from the pocket into the mixing chamber.

8. In an internal combustion engine, the combination of a long mixing chamber discharging at one end through a constantly open but constricted port into the explosive chamber of the engine, a metering valve at the end of the chamber opposite the open constricted port for periodically discharging into the mixing chamber and along a line axially of the chamber a measured charge of liquid fuel together with a charge of combustion supporting air, said constricted port acting to retard the free flow of the fuel and air from the mixing chamber into the explosive chamber and thus acting to insure a through mixing of the fuel and air while in the mixing chamber.

9. In an internal combustion engine, the

combination of a mixing chamber discharging through a constantly open constricted spray nozzle directly into the explosive chamber of the engine, and a metering valve for periodically discharging into said mixing chamber a charge of fuel in a finely divided condition together with a charge of combustion supporting air variable means for supplying the fuel in a finely divided condition to the metering valve and said valve operating to shut off the mixing chamber from the source of supply of said air and from said variable fuel supplying means except when the valve is in its operative position discharging the charge of air and fuel into the mixing chamber.

10. In an internal combustion engine, the combination of a mixing chamber discharging through a constantly open spray nozzle directly into the explosive chamber of the engine, a metering valve for periodically discharging into said mixing chamber a charge of fuel in a finely divided condition together with a charge of combustion supporting air and means for supplying fuel in a finely divided condition to the metering valve.

11. In an internal combustion engine, the combination of an explosive chamber, means providing a mixing chamber open to the explosive chamber, means providing a source of liquid fuel in a finely divided state, means providing a source of compressed air, a rotary metering valve provided with a measuring pocket disposed in one position during its cycle of rotary movement to receive a charge of the finely divided fuel from said fuel source and disposed in another position to align simultaneously with both the air source and the mixing chamber, whereby a charge of air is caused to mix intimately and rapidly with a measured charge of the finely divided fuel and to drive the mixture into the explosive chamber.

12. In a device for forming a measured charge of fuel for an internal combustion engine, comprising a metering valve mounted for rotary movement and provided with a measuring pocket, means for supplying to said pocket a stream of liquid fuel in a finely divided state, and means for supplying to said pocket a stream of air under pressure, the mass of air and fuel supplied per cycle of rotary movement of the valve being operably dependent upon the speed of rotation of the valve and on the pressure on the fuel and air.

13. In a device of the class described, the combination of a metering valve mounted for rotary movement and provided with a measuring pocket, a source of liquid fuel leading to the valve at one point in its cycle of rotary movement, means between the source and the valve for causing the liquid fuel to discharge into the pocket in a finely divided condition, and means operable at a succeeding point in the cycle of rotary movement of the valve for causing compressed air to sweep the fuel from the pocket.

14. An attachment for an internal combustion engine, constituting a fuel charge forming device including a mixing chamber adapted to discharge into the explosive chamber of the engine, a rotary metering valve for controlling the volume of the charges discharged into the mixing chamber, a source of compressed air controlled by said valve and leading therethrough into the mixing chamber, a source of liquid fuel under pressure and leading through the valve into the mixing chamber and a manually actuated spray valve for regulating the flow of liquid fuel into the metering valve.

15. In an internal combustion engine, the combination with an engine head having an explosive chamber therein, of an attachment separable from the head and including a relatively long plug fitted to extend through the wall of the engine and provided at one end with a mixing chamber constantly in direct open communication with the explosive chamber, means providing a source of liquid fuel in a finely divided condition to said mixing chamber, means for supplying a source of combustion supporting air under pressure to said mixing chamber, and a single metering valve for controlling the discharge of such fuel and of the air from said sources into the mixing chamber.

16. In a device for forming a measured charge of fuel for an internal combustion engine, comprising a metering valve mounted for rotary movement and provided with a measuring pocket, means for supplying to said pocket a stream of liquid fuel in a finely divided state, means for supplying to said pocket a stream of air under pressure, the mass of air and fuel supplied per cycle of rotary movement of the valve being operably dependent upon the speed of rotation of the pendent upon the speed of rotation of the valve, and manually actuated means independent of said valve speed for controlling the flow of the liquid fuel, thereby providing a control for varying the richness of the fuel discharged from the device.

17. In an internal combustion engine, a fuel control including a valve casing, a metering valve mounted for rotary movement in said casing and provided with a measuring pocket extending diametrically therethrough, said casing provided with three passageways controlled by said valve in its rotary movement, two of said passageways being aligned and adapted to be placed in communication by the pocket in the valve in its rotary movement, one of said two passageways constituting an inlet for compressed air and the other constituting a fuel discharge port, the other of said passage-

ways disposed between the aligned passageways, means for discharging liquid fuel in a finely divided state through said last named passageway and means operable in timed sequence following the discharge of the fuel therefrom for opening the pocket directly to the external atmosphere and thus permit the pocket to exhaust before receiving the succeeding charge of fuel and air.

18. In an internal combustion engine, a fuel control including a valve casing, a metering valve mounted for rotary movement in said casing and provided with a measuring pocket extending diametrically therethrough, said casing provided with three passageways controlled by said valve in its rotary movement, two of said passageways being aligned and adapted to be placed in communication by the pocket in the valve in its rotary movement, one of said two passageways constituting an inlet for compressed air and the other constituting a fuel discharge port, the third passageway disposed between the aligned passageways and constituting a liquid fuel inlet, and a bleeding vent open to the measuring pocket after the same has passed its position opening into the mixing chamber thereby to permit the pocket to exhaust into the external atmosphere.

Signed at New York city, in the county of New York and State of New York this 10th day of May, A. D. 1923.

ALBERT BOYD STREETER.