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GAS ENGINE VALVE GEAR

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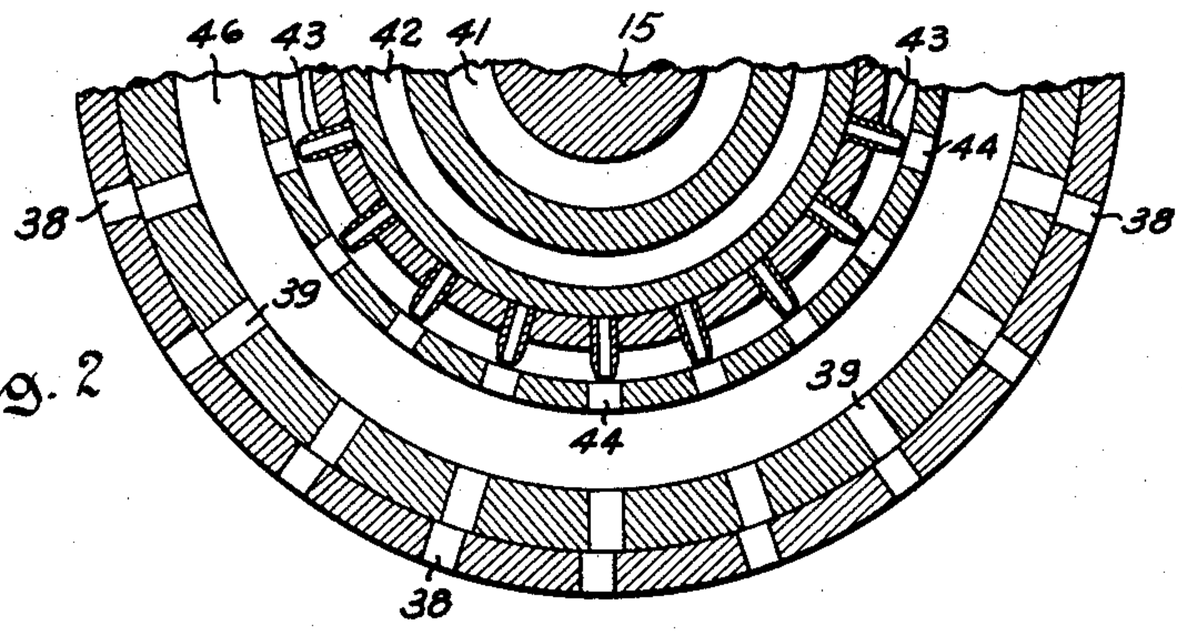

Fig. 2

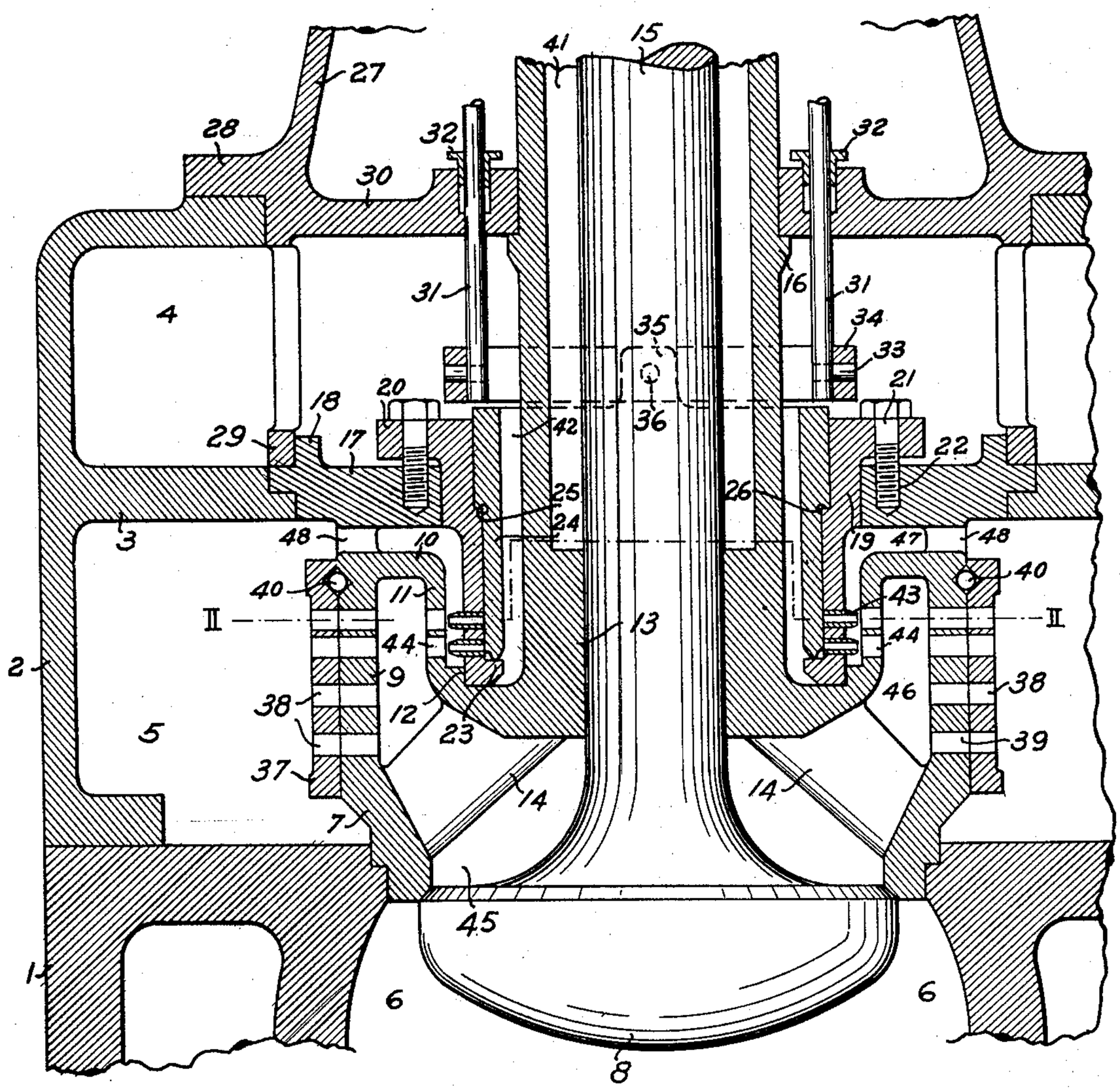

Fig. 1

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GAS ENGINE VALVE GEAR

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21 Claims. (Cl. 123—120)

This invention relates in general to improvements in gas engines and relates more specifically to a combined mixing and inlet valve device in which the mixing of gas with air is effected in a plurality of stages.

An object of the invention is to provide an improved combined mixing and inlet valve device for effecting an intimate mixing of gas, having a relatively high B. t. u. or heat value, with air in a plurality of stages by forming a multiplicity of comparatively thin gas streams and causing these to impinge against and be surrounded by air streams passing through common ports and then adjustably admitting air streams into the mixture so formed.

Another object of the invention is to provide a combined mixing and inlet valve device which permits of desired close adjustments of the gas valve thereof in accordance with the loads on the engine to effect high efficiencies with the engine burning natural or any other very rich gas.

Another object of the invention is to provide a combined mixing and inlet valve device which permits of close regulation of relatively small volumes of gas required in an engine to which the device is applied.

Another object of the invention is to provide a combined mixing and inlet valve device having a sliding gas valve and a rotatable air valve, both being concentric with the stem of the inlet valve carried by the device, the former being governor controlled and the latter being manually or governor controlled or both.

Another object of the invention is to provide a combined mixing and inlet valve device so constructed and arranged for mounting on an engine cylinder and with the valve mechanism therein and elements adjacent thereto so arranged that replacement of the valves and elements adjacent thereto may be easily and expeditiously made.

Another object of the invention is to provide a combined mixing and inlet valve device having an inlet valve seat with integral concentric spaced cylindrical air and gas and air port containing portions and an integral inlet valve guide sleeve portion provided with an annular space for receiving a compression spring which normally retains the inlet valve against its seat.

Another object of the invention is to provide a combined mixing and inlet valve device which is simple and compact in construction and efficient in operation.

These and other objects and advantages of the present invention will be apparent from a reading of the specification and of the drawing forming a part thereof and on which the same reference numerals are used to designate the same parts in the two views.

Fig. 1 is a fragmentary longitudinal vertical section through the combined mixing and inlet valve device and a cylinder of a gas engine.

Fig. 2 is a fragmentary horizontal section taken on line II—II of Fig. 1.

Referring to Fig. 1 of the drawing, 1 represents a horizontal cylinder of a gas engine upon the top of which is secured the combined mixing and inlet valve device which includes a casing 2 provided with a partition 3 which with an annular plate 17 forms an upper gas chamber 4 and a lower air chamber 5. Inlets to these chambers may conveniently be provided in the elongated portion of casing 2 shown broken away at the right hand side of Fig. 1.

Cylinder 1 is provided with an inlet port 6 and in line with this port, the top, partition and bottom of casing 2 are similarly provided with apertures, these apertures, however, being slightly larger than the size of the inlet port 6 where it emerges through the outer surface of the cylinder.

Located concentric with the port 6 is the main inlet valve seat 7 which in the construction shown projects into the inlet port 6 and affords a seat for the main inlet valve 8 on the lower surface thereof. The inlet valve seat has an outer, apertured cylindrical wall portion 9 which is connected by a horizontal disk portion 10 with an inwardly positioned also concentric, apertured cylindrical wall portion 11. The lower end of wall portion 11 is enlarged and provided with an inwardly extending annular abutment surface 12 which is integrally formed with the lower end of the main inlet valve guide sleeve 13. Preferably formed integrally with the inlet valve seat 7 is a series of helical substantially radial ribs or guide vanes 14, which in turn are united with the guide sleeve 13 which extends upwardly beyond the upper surface of casing 2. This guide sleeve is provided with a bore to receive the valve stem 15 of the main inlet valve 8. The upper portion of the guide sleeve 13 is provided with a bore concentric with the bore which receives the valve stem 15 but of a larger diameter than the latter so as to provide an annular space 41 for receiving a helical main inlet valve spring, not shown on the draw-

ing. This spring surrounds valve stem 15 and its purpose is to normally retain the inlet valve 8 against its seat.

Concentric with the inlet valve seat 7 and valve guide sleeve 13 integral therewith in their operative positions on cylinder 1 is a cylindrical aperture of different diameters in the partition 3 of casing 2. This construction provides a seat for the complementary peripheral edge portions of annular plate 17. This plate in alinement with its innermost outer peripheral edge portion is provided on its upper face with an annular abutment shoulder 18. Within a central cylindrical aperture in plate 17 is received a nozzle carrying sleeve 19 provided with an outwardly extending upper annular end flange 20 having apertures for receiving studs 21 which enter threaded apertures 22 in plate 17. The lower portion of this sleeve is of a reduced outer diameter so as to provide a space between this outer surface and the adjacent surface of the wall portion 11 that is substantially equal to the space between the lower surface of the annular plate 17 and the adjacent surface of the horizontal disk portion 10 of valve seat 7, these spaces providing an auxiliary air passage 47, and is equal to the diameter of annular abutment surface 12 on valve seat 7 with which sleeve 19 engages. The length of the sleeve 19 and the thickness of its annular flange 20, are so proportioned and designed that an appreciable space is had between the flange and the top of annular plate 17, so that the sleeve may be firmly pressed downwardly against the horizontal surface of the connecting portion between cylindrical wall 11 and sleeve 13 by manipulating the studs 21. The lower end of sleeve 19 is provided with an inwardly extending annular flange 23, the upper surface of which forms a seat for a gas valve 24.

This gas valve 24 is in the form of a sleeve of two outer diameters so as to have the seat on sleeve 19 above described and also one thereon at a point intermediate the length of the valve as shown at 25. This intermediate seat may conveniently be provided by making the upper portion of the inner cylindrical surface of sleeve 19 of a larger diameter than the diameter of its lower portion and correspondingly increase the outer diameter of the upper portion of the gas valve as shown. The edge in valve 24 resulting from this construction is preferably made round by the formation of an annular groove 26 therein. The seating end of gas valve 24 is also provided with annular grooves as shown. In order to provide an annular gas passage 42 around guide sleeve 13, the diameter of the inner surface of gas valve 24 is made larger than the diameter of the adjacent cylindrical surface of the guide sleeve 13. This gas passage communicates with port 6 of the engine through a plurality of nozzles and openings which will later be described in detail.

On the top of the casing 2 is a bonnet 27 having an outwardly extending annular flange 28 which in the assembled position on the casing 2 engages the surface of the top thereof adjacent a circular opening therein which is concentric with valve-stem 15 and port 6 of cylinder 1. A grated cylinder 29 depending from the bonnet 27 engages the outer surface of the shoulder 18 and bears against the outer edge portion of annular plate 17. This construction permits plate 17 to be securely held in fixed position by drawing the annular flange of the bonnet and the adjacent wall of the top of casing 2 together, as for instance by bolts, not shown, or by any other suitable clamping means. And at the same time plate 17 will engage the annular series of spaced ribs 48 carried by disk portion 10 of valve seat 7 to firmly hold the valve seat within the inlet port 6.

The bonnet 27 is further provided with a bottom 30 having an opening at its center which receives the upper portion of guide sleeve 13. A packing ring resting on a shoulder 16 of the guide sleeve is ordinarily engaged by the bottom 30 to seal the same against leakage of gas past sleeve 13. The bottom 30 is further provided with diametrically opposite openings through which the stems 31 of the gas valve lifting or reciprocating means pass. In order to prevent a leakage of gas through these openings, stuffing boxes 32 may be provided. The means shown for lifting gas valve 24 is of a universal joint type and therefore valve 24 is permitted to center itself in the sleeve 19 and its alinement therewith is independent of the stems 31. In the construction shown the lower ends of stems 31 are provided with outwardly extending horizontal dowels 33 the inner ends of which are seated in stems 31. Pivoted on these outwardly projecting portions of the dowels 33 is a ring 34. This ring in turn is pivotally connected to gas valve 24 by means of dowels 36 seated in apertures in diametrically opposed ears 35 extending upwardly from gas valve 24 and whose outwardly projecting ends are received in diametrically opposed apertures in the ring 34, positioned 90 degrees from the apertures that receive dowels 33. The means cooperating with stems 31 for reciprocating gas valve 24 in accordance with the load on the gas engine forms no part of this invention and may be carried out by any suitable mechanism for instance, such as disclosed in the patent to Sprado, No. 1,529,637, issued March 10, 1925.

37 is an adjustable air valve in the form of a sleeve provided with a plurality of holes or ports 38. This valve surrounds the cylindrical wall portion 9 of valve seat 7, similarly provided with registering holes or ports 39. In the construction shown air valve 37 is held in operative relation with wall portion 9 by means of a plurality of balls that move in a rectangular race consisting of substantially V-shaped opposed registering grooves in air valve 37 and wall portion 9. The balls enter the race through suitable channels, not shown, in the top of cylindrical wall portion 9, which lead into the race.

The new and novel means cooperating with gas valve 24 which makes possible a satisfactory operation of a gas engine, using a gas that has a rather high B. t. u. or heat value such as natural gas, equipped with this means, will now be described. This means comprises a plurality of holes in the lower portion of sleeve 19 in which are positioned a plurality of short tubes or nozzles 43 whose outwardly projecting ends are preferably chamfered as shown. The outwardly extending ends of these nozzles extend to a short distance from the inner surface of cylindrical wall portion 11 and the nozzles are in substantial axial alinement with a plurality of ports 44 in said wall portion. In the construction shown two annular series, an upper and a like lower series of nozzles and cooperating

ports, are provided but it will be apparent that this arrangement may be departed from as long as the same desired result is obtained. As for instance, the distribution of the nozzles 43 in sleeve 19 may be on a helical line of the desired pitch on the outer cylindrical surface of sleeve 19, with the openings or ports 44 disposed in the cylindrical wall portion 11 to conform to this distribution of nozzles 43.

45 represents the mixing chamber which has an upper annular portion 46 between the ports 44 and 39. The helical guide vanes 14 in the intermediate space of mixing chamber 45 serve to finally mix the gaseous fluid prior to its admission into the port 6 of the engine cylinder, by effecting a whirling motion of the air and gas constituents of said gaseous fluid in mixing chamber 45.

The above described combined mixing and inlet valve device has been especially designed for use in connection with gas engines burning high B. t. u. or heat value gases, as for instance natural gas. Although the B. t. u. value of a cubic foot of different kinds of natural gas may be different depending upon the source of the natural gas, a ratio of air to gas of 13 to 1 by volume is a possible ratio for such a gas in order to effect a perfect combustion of the gas. Because of this relatively high ratio of air to gas the various gas valves of the prior art are not very suitable for use in connection with gas engines burning natural gas for the reason that they do not permit of the necessary close regulation of the gas valve when using natural gas to make the amount of gas consumed proportional to the load on the engine for all loads on the engine. The applicant with his device provides the necessary regulation by virtue of the nozzles 43 which present a multiplicity of small openings suitably arranged in sleeve 19 so that the aggregate area of the openings may be satisfactorily controlled by moving the gas valve 24. A very appreciable displacement of the gas valve from its initial position corresponding to a no load condition on the engine to its position corresponding to full load on the engine is necessary and therefore adjustments of the valve to meet the fuel requirements of intermediate loads on the engine can be made with the desired and necessary precision required for maximum efficiency in the operation of the gas engine.

The operation of the disclosed combined mixing and inlet valve device is as follows:

With the engine started and the air valve 37 and the gas valve 24 operated from the engine governor by any suitable means such for instance as disclosed in the patent to Sprado, 1,529,637, referred to above, suction will exist in the mixing chamber when the main valve 8 is opened due to the suction in the engine cylinder. The gas valve will then be opened permitting gas to flow from the annular passage 42 into the nozzles 43. The gas passes through the nozzles 43 and at the orifices of the nozzles the gas streams impinging therefrom are engaged and surrounded by annular streams of air from the auxiliary air passage 47 whereby the air and gas become intimately mixed which is essential for complete combustion. The intimate fuel mixture of a certain proportion passes through the ports 44 into the annular portion 46 of the mixing chamber 45. The proportion of the mixture formed at this portion of the apparatus is determined by the relative effective areas of the nozzle openings and the area of the ports 44. The proportion of this mixture may be further varied by adjustment of the air valve 37 to change the effective openings of ports 39. The resulting mixture flows toward the lower portion of mixing chamber 45 and in so doing is given a whirling motion by reason of helical guide vanes 14 causing the constituents of the gaseous mixture to become still more intimately mixed and passes in such a condition into the cylinder inlet port 6 to be subsequently fired and combustion thereof to take place and accordingly do work on the piston of the engine.

It should be understood that it is not desired to limit the invention to the exact details of construction and operation of the apparatus herein shown and described, for various modifications within the scope of the claims may occur to persons skilled in the art.

It is claimed and desired to secure by Letters Patent:

1. In combination with a gas engine inlet port, a main inlet valve, a seat member for said valve having integral spaced concentric cylindrical wall portions forming a mixing chamber communicable with said inlet port and having an inner valve guide sleeve for guiding the stem of the inlet valve, a casing having a centrally aperture partition, defining a gas chamber and an air chamber about said seat member, means within said apertured partition for controlling the flow of gas from said gas chamber through said aperture, ports in one of said wall portions through which gas from said gas chamber and air from said air chamber are simultaneously passed into said mixing chamber.

2. In combination with a gas engine inlet port, a main inlet valve, a seat member for said valve having spaced concentric cylindrical wall portions defining an annular mixing chamber, communicable with said inlet port and having an inner guide sleeve for said valve, a casing provided with a partition having a central opening for receiving the said guide sleeve and which forms a gas chamber and an air chamber, relatively movable members in the said opening and forming with the said guide sleeve an annular passage for gas, means for moving one of said members to control the flow of gas from said passage and means in the other of said members for directing this gas into ports in the cylindrical wall portion adjacent said members, through which air from said air chamber simultaneously flows before it passes into said annular mixing chamber.

3. In combination with a gas engine inlet port, a main inlet valve, a seat member for said valve, a casing provided with a partition carrying a plate to form a gas chamber and an air chamber, said plate being provided with a central opening for receiving the stem of said valve, a guide sleeve for said valve on said seat member, a ported cylindrical wall, in substantial alinement with the opening in said plate, also on said seat member, means comprising relatively movable members for providing a gas passage around said guide sleeve, which passage communicates with said gas chamber and one of said relatively movable members forming with said cylindrical wall an air passage which communicates with ports in said cylindrical wall, a plurality of nozzles positioned in openings in one of said relatively movable members, permanently located in substantial alinement with said ports in said cylindrical wall and means for moving the other of said relatively movable

members for controlling the flow of gas through said nozzles which gas is intimately mixed with air from said air passage while passing simultaneously therewith through said ports.

4. In combination with the inlet port of a gas engine, a main inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, means in said casing for forming a gas chamber and an air chamber, means and an element thereof for respectively forming with said seat member a gas passage and an air passage communicating respectively, with said gas and air chambers, said means also controlling the flow of gas streams which pass simultaneously with air streams from said air passage, through ports common to said passages, to effect a certain proportion of mixture and desired intimacy thereof.

5. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, means in said casing for forming a gas chamber and an air chamber, means comprising relatively slidable elements for forming with said seat member, a gas passage and an air passage communicating respectively, with said gas and air chambers, one of said elements having a plurality of small apertures that are uncoverable by the sliding of the other of said elements, for controlling the flow of gas streams which pass simultaneously with air streams from said air passage through ports in said seat member which are in substantial alinement with said apertures in said apertured element, to effect a certain proportion of mixture and desired intimacy thereof.

6. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, means in said casing for forming a gas chamber and an air chamber, means comprising relatively slidable sleeve elements for forming with said seat member, a gas passage and an air passage communicating respectively, with said gas and air chambers, a plurality of nozzles in one of said sleeve elements which are in substantial alinement with ports in said seat member, said air passage being in open communication with said ports, and means to slide the other of said sleeve elements, to permit the simultaneous flow of gas streams from said gas passage and air streams from said air passage through said ports and thereby effect a certain proportion of mixture and desired intimacy thereof.

7. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, an air valve in a portion of said seat member, means in said casing for forming a gas chamber and an air chamber which surrounds said air valve, another portion of said seat member provided with ports, forming with said air valve portion a mixing chamber communicable with said inlet port, means comprising relatively slidable elements for forming with another portion of said seat member, a gas passage and with said ported portion an air passage, communicating respectively, with said gas and air chambers, said air passage communicating with said ports in said seat member, one of said elements having a large number of small openings in substantial alinement with said ports and means for sliding the other of said elements to uncover the openings and thus permit the simultaneous flow of gas and air streams from said passages through said ports and thereby effect a certain proportion of fuel mixture and desired intimacy thereof in said mixing chamber, the proportion of this mixture being alterable by adjusting said air valve to admit more or less air directly into said mixing chamber.

8. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, means in said casing forming a gas chamber and an air chamber, a mixing chamber, communicable with said inlet port, intermediate said chambers, partly formed by a ported wall portion of the seat member, an air passage in open communication with said mixing chamber through ports in said ported wall portion and means comprising a stationary member, provided with apertures in substantial alinement with the ports in said wall portion, and a cooperating valve member, for controlling the flow of gas streams which pass simultaneously with air streams from said air passage through said ports in said wall portion, thereby providing in said mixing chamber a fuel mixture having a certain proportion and desired intimacy of mixture.

9. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, means in said casing forming a gas chamber and an air chamber, a mixing chamber, communicable with said inlet port, intermediate said chambers, partly formed by a ported wall portion of the seat member, an air passage in open communication with said mixing chamber through ports in said ported wall portion and means comprising a stationary member, provided with a large number of openings in which a plurality of small diameter bore nozzles are positioned and a cooperating valve member, for controlling the flow of gas streams which pass simultaneously with air streams from said air passage through said ports in said wall portion, thereby providing in said mixing chamber a fuel mixture having a certain proportion and desired intimacy of mixture.

10. In combination with the inlet port of a gas engine, a gas chamber and an air chamber, a mixing chamber, communicable with said inlet port, intermediate said chambers, an air passage between said mixing chamber and said gas chamber and a gas passage between said mixing chamber and said gas chamber, said air passage being in open communication with said mixing chamber through a plurality of ports and means for controlling the flow of gas from said gas passage through said ports, to effect a desired intimacy of mixture and certain proportion thereof in said mixing chamber and means for controlling a direct flow of air from said air chamber into said mixing chamber to further vary the proportion of the fuel mixture in said mixing chamber.

11. In combination with the inlet port of a gas engine, a gas chamber and an air chamber, a mixing chamber, communicable with said inlet port, intermediate said chambers, an air passage between said mixing chamber and said gas chamber, in open communication with said

mixing chamber through a plurality of ports and means for controlling the flow of gas from said gas chamber through said ports, to effect a desired intimacy and certain proportion of mixture in said mixing chamber and means for controlling a direct flow of air from said air chamber into said mixing chamber to further vary the proportion of the fuel mixture in said mixing chamber.

12. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve and forming a mixing chamber communicable with said port, means forming a gas chamber and an air chamber, about said seat member, an air passage in open communication with said mixing chamber through a plurality of ports in said seat member, means for controlling the flow of gas streams from said gas chamber, which pass simultaneously with air streams from said air passage through said plurality of ports, to effect a certain proportion and desired intimacy of mixture in said mixing chamber and means for controlling a direct flow of air into said mixing chamber through another plurality of ports in said seat member.

13. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve and having spaced cylindrical ported wall portions which form a mixing chamber communicable with said inlet port, means forming a gas chamber and an air chamber, about said seat member, an air passage in open communication with said mixing chamber, through a plurality of ports in one of said cylindrical wall portions, means comprising a fixed member having a plurality of apertures that are in substantial alinement with said plurality of ports and a cooperating movable member for controlling the flow of gas streams, which pass simultaneously with air streams from said air passage through said plurality of ports, to effect a certain proportion and desired intimacy of mixture in said mixing chamber and means for controlling a direct flow of air into said mixing chamber through a plurality of ports in the other of said cylindrical wall portions.

14. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve and having spaced annular ported wall portions which form a mixing chamber communicable with said inlet port, means forming a gas chamber and an air chamber, about said seat member, an air passage in open communication with said mixing chamber through a plurality of ports in one of said annular wall portions, means comprising a fixed member having a plurality of apertures that are in substantial alinement with said plurality of ports, said apertures being provided with nozzles extending to said plurality of ports and a cooperating movable member, for controlling the flow of gas streams which pass simultaneously with air streams from said air passage through said plurality of ports, to effect a certain proportion and desired intimacy of mixture in said mixing chamber, and an air valve for controlling a direct flow of air into said mixing chamber through a plurality of ports in the other of said annular wall portions.

15. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve and forming an annular mixing chamber communicable with said port, means forming a gas chamber and an air chamber, about said seat member, an air passage, surrounding and in open communication with said mixing chamber, through a plurality of ports in said seat member, means for controlling the flow of gas streams from said gas chamber, which pass simultaneously with air streams from said air passage through said plurality of ports, to effect a certain proportion and intimacy of mixture in said mixing chamber and means for controlling a direct flow of air into said mixing chamber through another plurality of ports in said seat member.

16. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, means in said casing forming a gas chamber and an air chamber, a mixing chamber, communicable with said inlet port, intermediate said chambers, formed by spaced inner and outer wall portions of the seat member, each having a plurality of ports, an air passage in open communication with said mixing chamber through said ports in said inner wall portion, means comprising a stationary member provided with a plurality of relatively small openings that substantially register with the ports in said inner wall portion and a cooperating valve member, for controlling the flow of gas streams which pass simultaneously with air streams from said air passage through said ports in said inner wall portion, thereby providing in said mixing chamber a fuel mixture having a desired intimacy and of a certain proportion and means comprising an air valve on said outer ported wall portion for further adjusting the proportion of the fuel mixture in said mixing chamber.

17. In combination with the inlet port of a gas engine, a main poppet inlet valve, a seat member for said valve mounted on said inlet port, a casing surrounding said seat member, means in said casing forming a gas chamber and an air chamber, a mixing chamber, communicable with said inlet port, intermediate said chambers, formed by spaced inner and outer wall portions of the seat member, each having a plurality of ports, an air passage in open communication with said mixing chamber through said ports in said inner wall portion, means comprising a stationary member, provided with a large number of openings in which small diameter bore nozzles are positioned and a cooperating valve member, for controlling the flow of gas streams which pass simultaneously with air streams from said air passage through said ports in said inner wall portion, thereby providing in said mixing chamber a fuel mixture having a desired intimacy and of a certain proportion and means comprising an air valve on said outer ported wall portion for further adjusting the proportion of the fuel mixture in said mixing chamber.

18. In combination with the inlet port of a gas engine, an annular mixing chamber communicable with said port, a gas chamber, an air chamber, an air passage surrounding and in open communication with said mixing chamber through a plurality of ports, means for controlling the flow of gas streams which pass simultaneously with air streams from said air passage through said plurality of ports, to effect a first mixing stage and means for controlling a direct flow of air into said mixing chamber through another plurality of ports, to effect a second mixing stage.

19. In combination with the inlet port of a gas engine, a mixing chamber communicable with said inlet port, an air chamber and a gas chamber, means for controlling the flow of gas streams which pass simultaneously with air streams from said air chamber through common ports leading into said mixing chamber, to effect a first mixing stage and means for controlling a direct flow of air into said mixing chamber through other ports to thereby effect a second mixing stage.

20. In combination with the inlet port of a gas engine, a gas chamber and an air chamber, a mixing chamber, communicable with said inlet port, intermediate said chambers, an air passage between said mixing chamber and said gas chamber, in open communication with said mixing chamber through a plurality of ports, and means for controlling the flow of gas from said gas chamber through said ports, to effect a desired intimacy and certain proportion of mixture in said mixing chamber.

21. In combination with the inlet port of a gas engine, a mixing chamber communicable with said inlet port, an air chamber in communication with said mixing chamber through a plurality of ports, a gas chamber, and means for controlling the flow of gas streams which pass simultaneously with air streams from said air chamber through said ports into said mixing chamber.

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