Dec. 19, 1922. 1,439,146

L. S. CHADWICK.

APPARATUS FOR VAPORIZING LIQUID FUEL.

FILED JULY 27, 1917.

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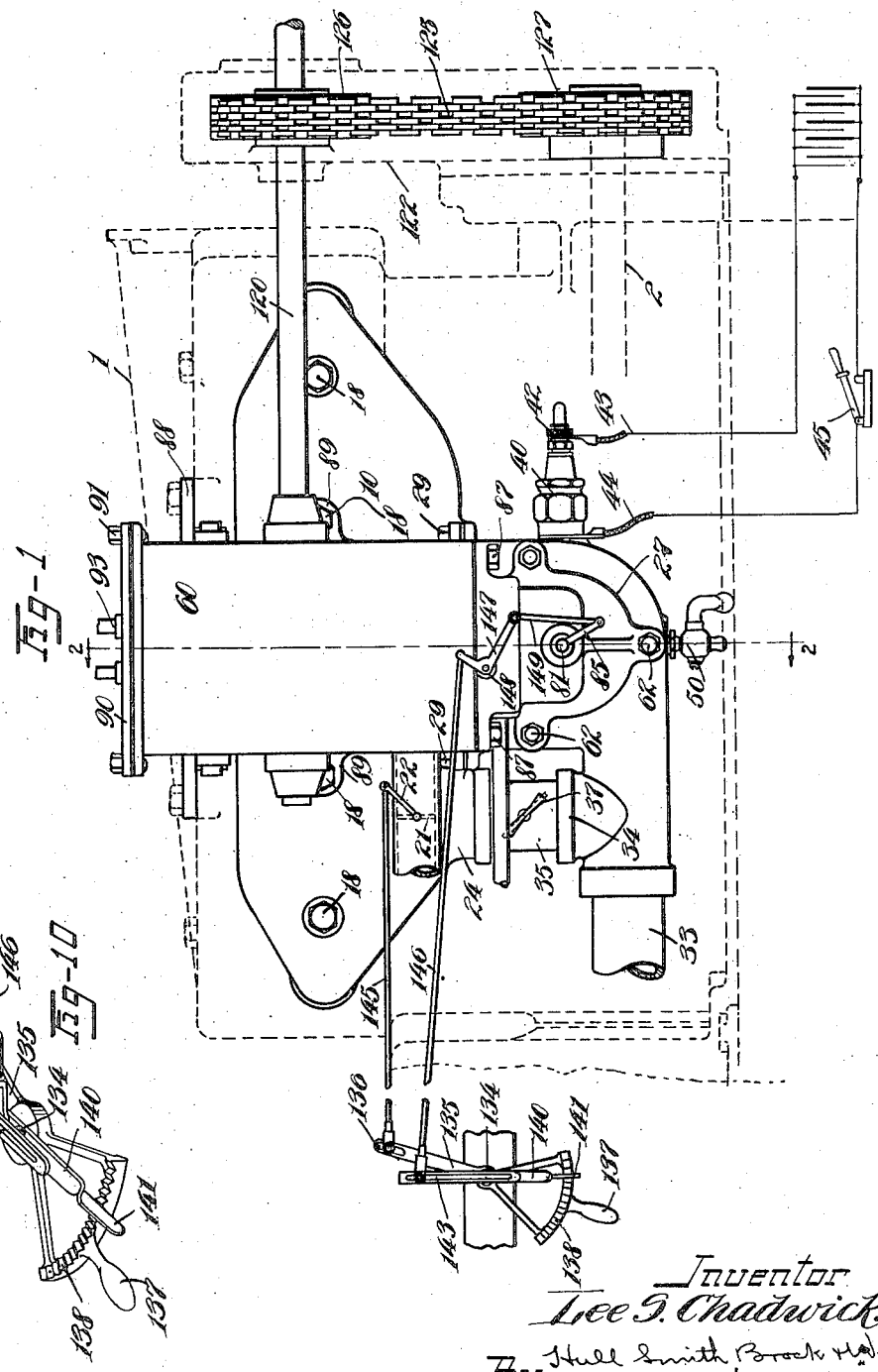


Fig-1

Fig-10

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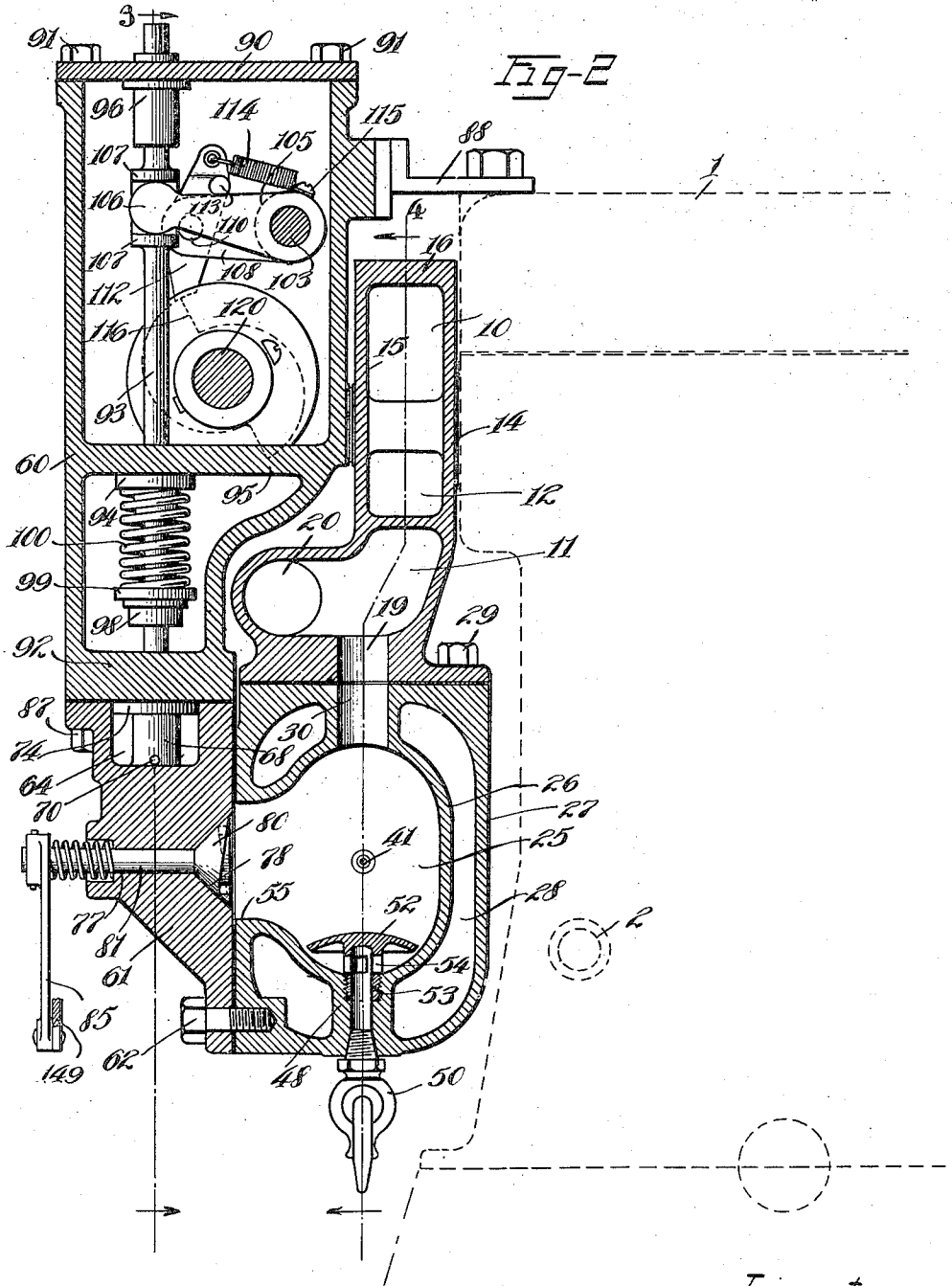
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8 SHEETS-SHEET 2

Fig-2



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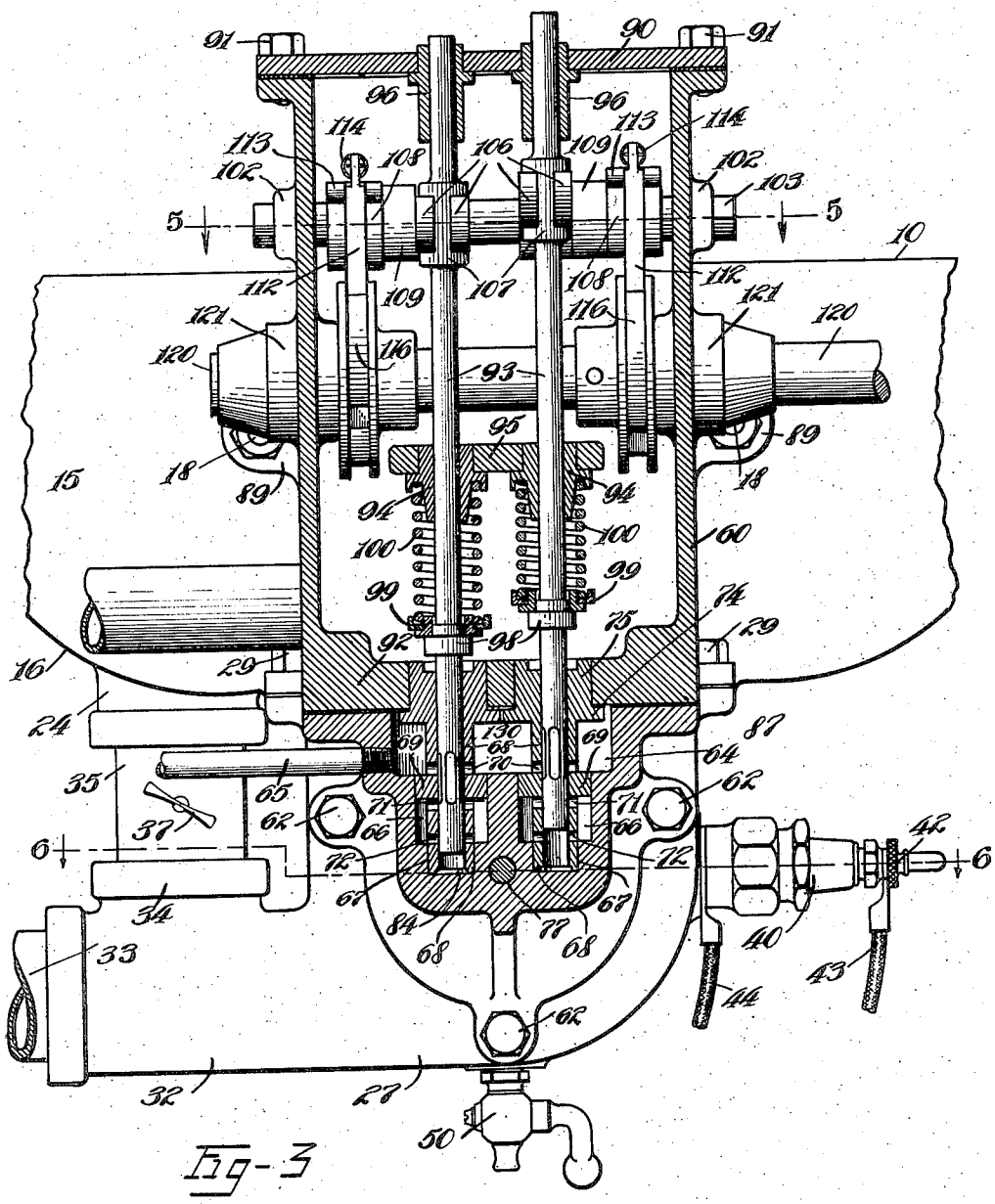


Fig-3

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8 SHEETS-SHEET 4

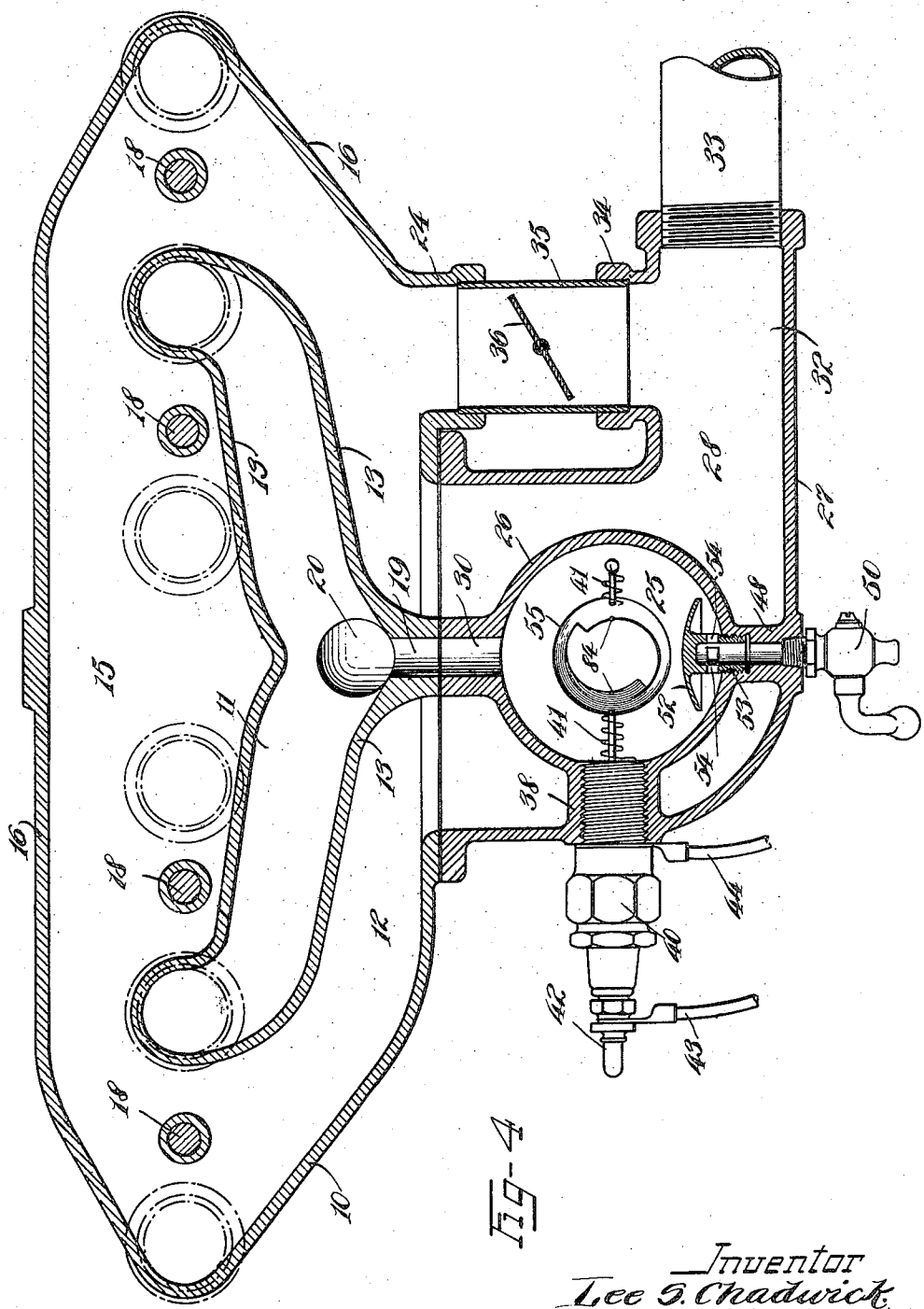


Fig. 4

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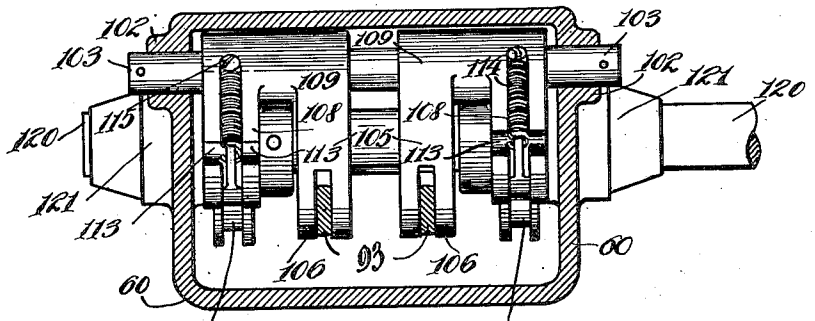


Fig-5

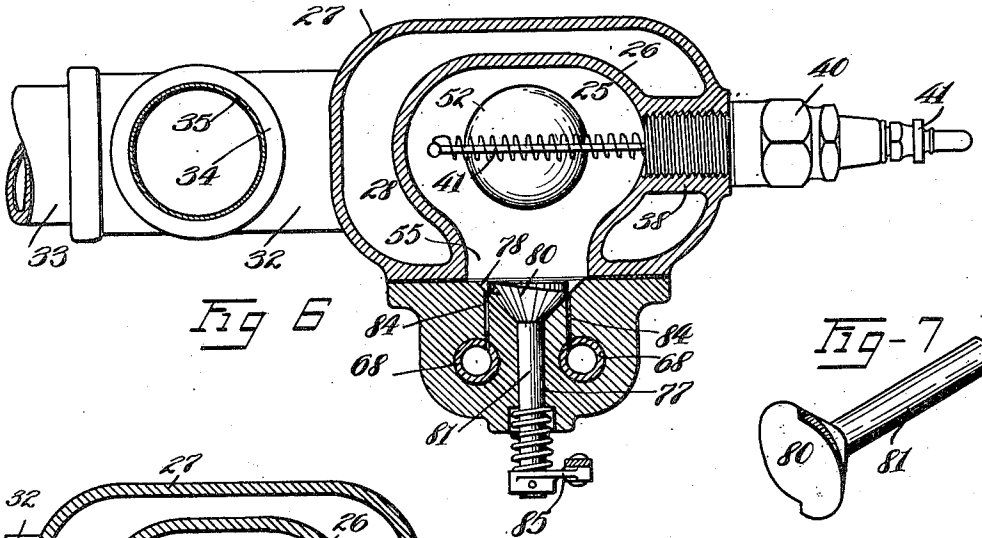


Fig 6

Fig-7

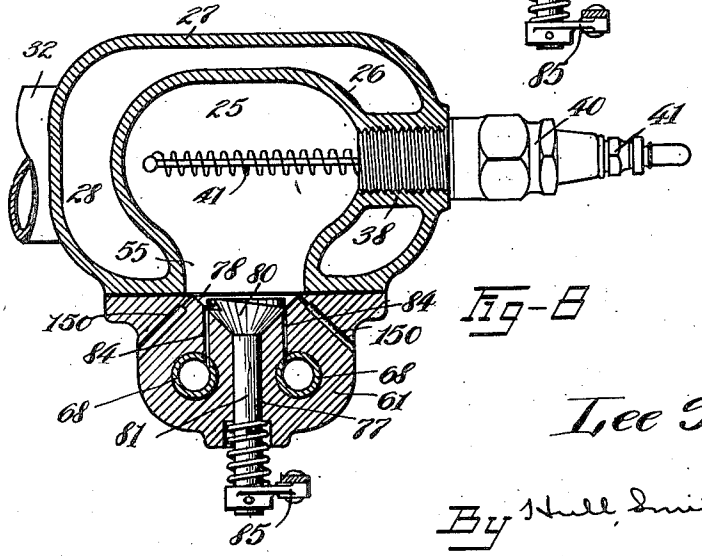


Fig-8

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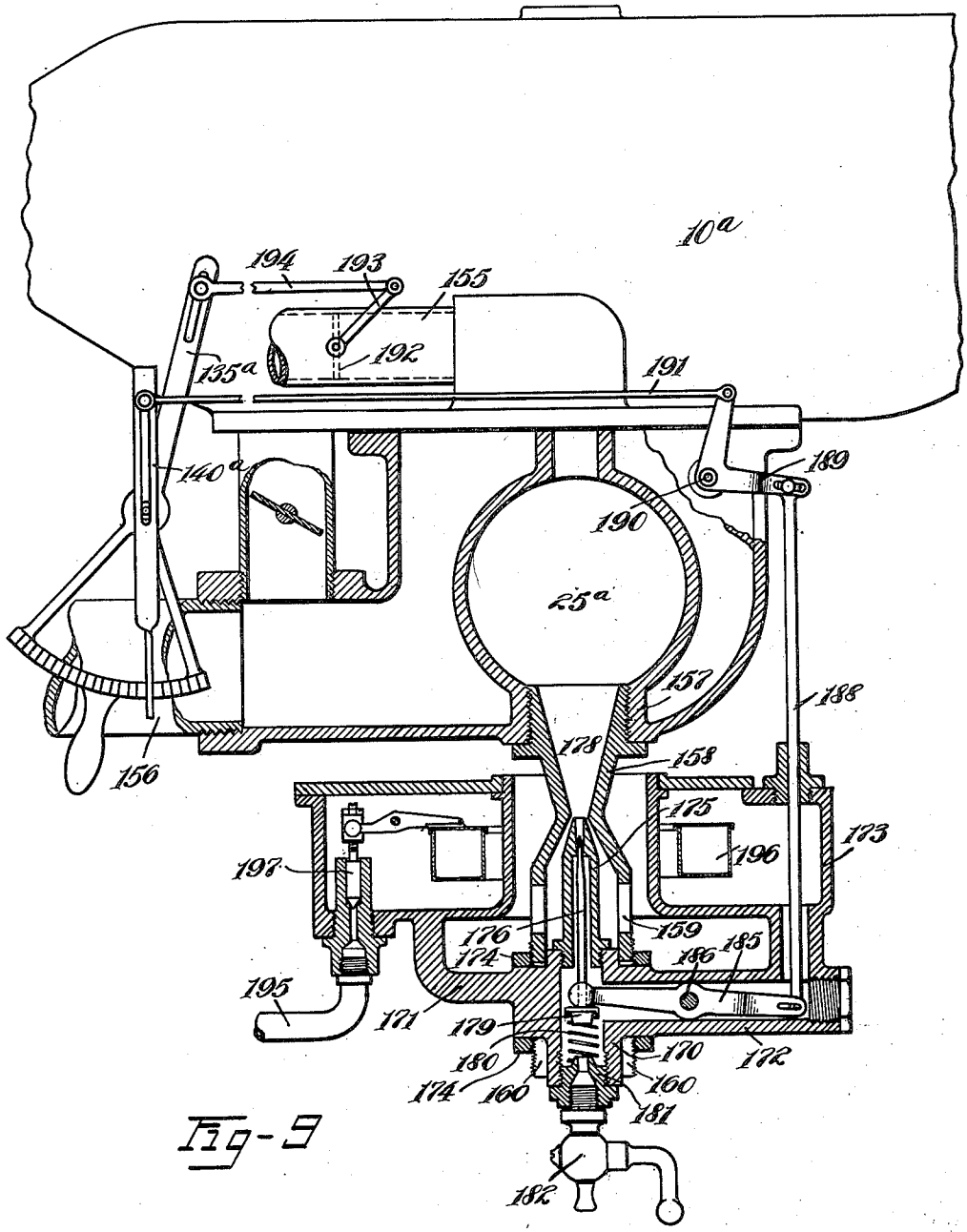


Fig-9

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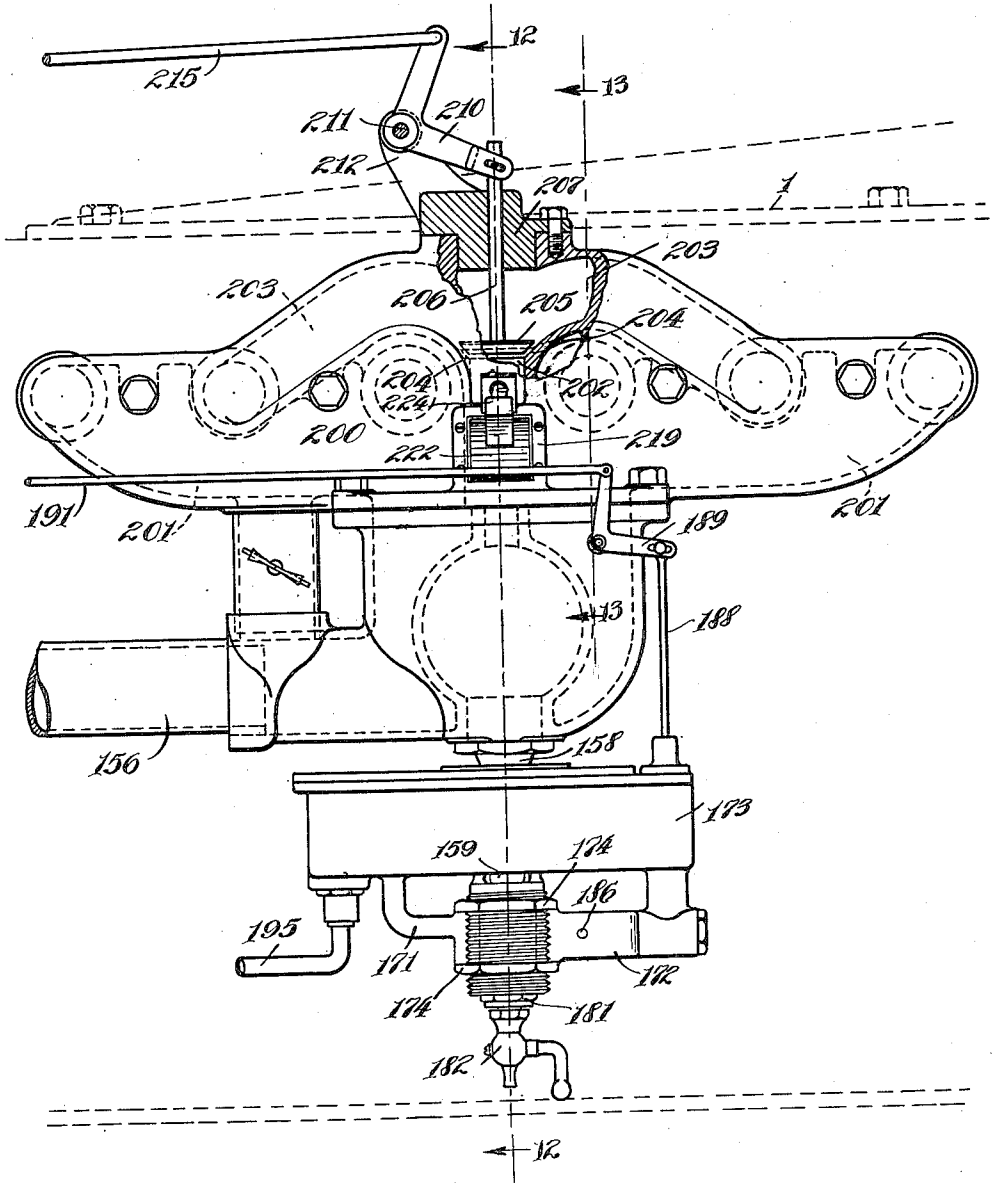


FIG. 11.

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8 SHEETS-SHEET 8

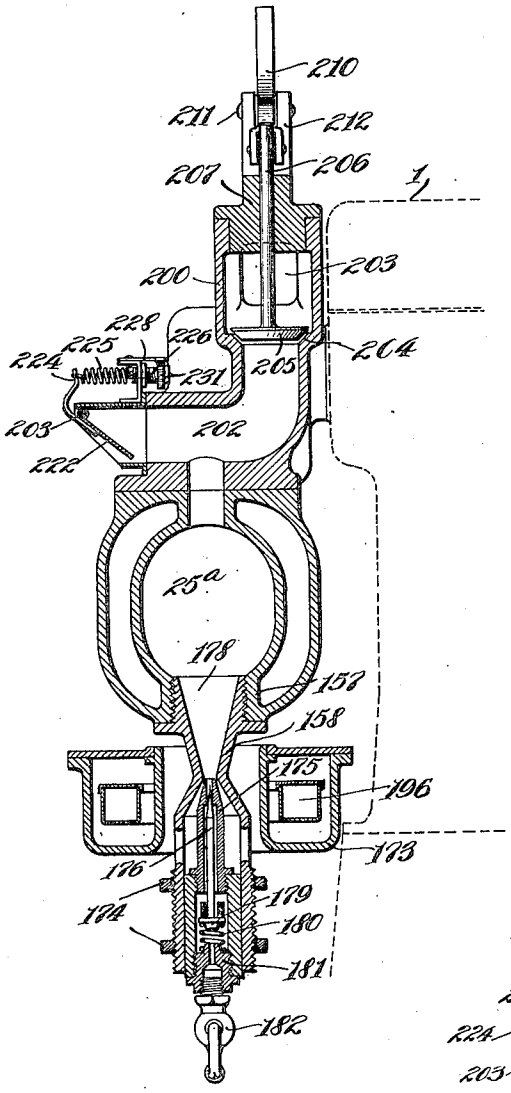
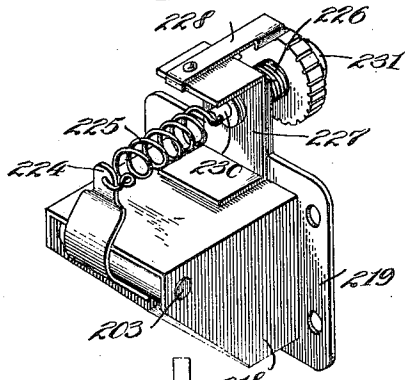


Fig. 12.

Fig. 14.



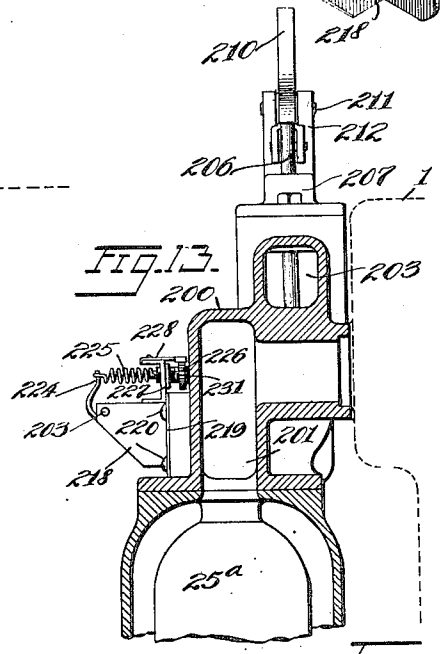


Fig. 13.

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UNITED STATES PATENT OFFICE.

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APPARATUS FOR VAPORIZING LIQUID FUEL.

Application filed July 27, 1917. Serial No. 183,163.

To all whom it may concern:

Be it known that I, LEE S. CHADWICK, a citizen of the United States, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in Apparatus for Vaporizing Liquid Fuel, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

This invention relates to liquid fuel vaporizing apparatus for internal combustion engines, particularly the type of engine used in automobiles.

The invention has for its objects the production of apparatus of the above character adapted for attachment to, or incorporation in, internal combustion engines of prevailing types, enabling the use in such engines of fuels heavier than the usual grade of gasoline, such as kerosene or lower grades of petroleum, and which apparatus may be employed to advantage with gasoline to greatly enhance its vaporization; the provision of apparatus of the character aforesaid involving mechanical means for incipiently breaking up or atomizing the fuel, augmented, if desired, by heating means for thoroughly vaporizing the fuel; the provision of apparatus including an intake conduit that is normally heated by radiation from an exhaust conduit and into which air and vaporized fuel may be injected for mixing; in addition to the last named object, the inclusion of means for atomizing the liquid fuel prior to introducing it into the main body of air; the provision of means for introducing into such atomized fuel sufficient air to maintain it thoroughly broken up and suspended preparatory to injecting it into the main body of air; the provision of means for accurately adjusting the proportions of fuel and air initially mixed; and the provision of comparatively simple mechanism for attaining the foregoing objects in a highly efficient and expeditious manner, and of a design readily adapted to prevailing types of internal combustion engines.

Further objects are the production of a combined inlet and exhaust manifold, preferably integral, wherein the source of exhaust gases is directed about or in very close proximity to the inlet conduit; the provision of a heating chamber adapted for communicative connection with the inlet conduit of the manifold and surrounded by a heating passageway or jacket through which the burned gases may be trained from the exhaust conduit thereby to heat the chamber; and the inclusion of a by-pass between the outlet of the jacket and the exhaust conduit, with a valve in said by-pass, whereby the quantity of exhaust gases passing through the heating jacket may be varied and the temperature of the chamber accordingly altered.

My invention further comprehends a method of producing an explosive mixture which consists in atomizing liquid fuel and subsequently heating the same to thoroughly vaporize it, adding to this vaporized fuel sufficient air to maintain the same suspended but not enough to produce an explosive mixture, and then introducing this premature mixture into a body of air sufficient to render the whole explosive.

In the accompanying drawings I have shown constructions wherein the foregoing objects are attained.

Fig. 1 is a side elevation of an engine (shown in dotted lines) to which my liquid fuel vaporizing apparatus (shown in full lines) is applied; Fig. 2 is a central vertical section through the apparatus, as indicated by the line 2—2 of Fig. 1; Fig. 3 is a vertical section on the line 3—3 of Fig. 2 looking toward the engine; Fig. 4 is a section on the line 4—4 of Fig. 2 looking away from the engine; Figs. 5 and 6 are sections on the lines 5—5 and 6—6, respectively, of Fig. 3 looking in the direction of the arrows associated with the respective lines; Fig. 7 is a perspective view of the liquid fuel valve; Fig. 8 is a view, similar to Fig. 6, of a slightly modified form of the invention; Fig. 9 illustrates a further modification; Fig. 10 (on Sheet 1) is a perspective view illustrating means for actuating in unison and relatively adjusting the fuel valve and air throttle; Fig. 11 is a view, similar to Fig. 1, of a modification wherein the manually actuated throttle is located within the intake manifold beyond the fuel inlet; Figs. 12 and 13 are sections on the lines 12—12 and 13—13 of Fig. 11; and Fig. 14 is a perspective view of the shutter equipment for the main air inlet of the latest modification.

I have shown my invention herein as applied to a very common type of internal combustion engine, the same being designated 1, and having a cam shaft 2; and it may be

explained that in this type of engine the intake and exhaust ports occur on the same side of the engine and in horizontal alignment, the location of the inlet and exhaust ports, with respect to the intake and exhaust manifolds of the apparatus of my invention, being indicated by dot-and dash lines in Fig. 4.

The apparatus comprises three main parts, to-wit:—the intake and exhaust manifold unit, the heating chamber, and the fuel injecting mechanism.

The intake and exhaust manifold unit, shown in Figs. 1 to 4, is designated 10, and preferably consists of an integral casting containing a branched intake conduit 11 and a similar exhaust conduit 12 which are separated from each other by a partition 13 and enclosed by side walls 14 and 15 and a peripheral wall 16. The intake and exhaust conduits have openings which are adapted to register with the respective intake and exhaust ports of the engine when the unit is secured to the side of the engine by such fastening means 18 as studs or screws, the unit having hollow bosses extending between the walls 14 and 15 through which the studs or screws pass. An inlet passageway 19 opens upward through the bottom of the unit into the intake conduit at the crotch of its branches, and adjacent the inlet passageway the conduit is adapted to have communication with the atmosphere through a tubular extension 20, containing a butterfly valve 21 having, exterior of the extension, an operating arm 22. The opposed branches of the exhaust conduit open through the bottom of the unit casting on opposite sides of the inlet passageway 19. A tubular extension 24 opens downward out of one branch of the exhaust conduit and constitutes an auxiliary outlet therefor.

The heating chamber above referred to, and designated 25, is enclosed in a globular inner casing 26 which is surrounded by an outer casing 27, the inner and outer casings being spaced apart to provide therebetween a heating jacket 28 that opens through the top of the casing in communication with the exhaust conduits of the manifold unit when these elements are secured together by screws 29, as indicated in Figs. 1 and 2. The heating chamber 25 communicates with the intake conduit 11 through a passageway 30 and the aforesaid inlet passageway 19 wherewith it registers. An outlet extension 32 leads from the casing 27 and has connection with an exhaust pipe 33, said outlet extension having a lateral branch 34 in axial alignment with the extension 24 of the manifold unit. A by-pass for relieving the heating jacket of some of the products of combustion is provided by the sleeve 35 that is clamped between the extension 24 and branch 34, and is equipped with a damper 36 which may be turned by means of an operating handle 37 exterior of the sleeve to obstruct, more or less, the passage of products through the sleeve. Thus the temperature of the heating chamber may be regulated.

A hollow internally threaded boss 38 extends between the walls of the inner and outer casings 26 and 27 and is arranged to receive the threaded end of an electric heating plug 40, the same being equipped at its inner end with a heating unit 41, and at its outer end with a binding post 42 for the attachment of an electric conductor 43, said conductor constituting one side of an electric circuit, while the other side is made through a conductor 44 which is grounded to the casing of the plug, such being in accordance with well known practice. The circuit, of course, includes a source of electric energy, and when closed by a suitable switch, indicated at 45 in Fig. 1, the current flows continually through the heating element.

Screwed into the lower end of a hollow boss 48 which connects the lower end of the inner casing 26 with the adjacent portion of the outer casing 27, is a valve 50 provided essentially for the purpose of controlling the inlet of air to the heating chamber but serving also as a "drip" for the chamber. A "mushroom" deflector 52 has the end of its tubular stem 53 screwed into the upper end of the boss 48 and functions to deflect air admitted through the valve 50, and which passes upward through the bore of the shank 53 and openings 54 thereof, outward into proximity to the walls of the chamber, to prevent liquid fuel from lodging or condensing upon the walls, or to wipe any off which has been deposited there. The heating chamber opens, at 55, through one side of the outer casing, the wall of the inner casing being flared gradually outward until it joins the outer.

I shall now describe the liquid fuel injecting mechanism. It is composed generally, of a housing 60 containing the actuating mechanism, and the fuel valve casing 61, which is surmounted by the housing 60 and is connected to the outer side of the heating chamber by screws 62 (Figs. 1, 2 and 3). A fuel chamber 64 is formed in the top of the valve casing and receives its supply of fuel through a tube 65 which is shown as screwed into the wall of the chamber. Two fuel wells 66 descend into the body of the casing from the fuel chamber, and at their lower ends are reduced in diameter, as shown at 67. A bushing 68 is set into each well and is mainly of a diameter to fit their reduced portions 67. At the upper ends of the wells the bushings are provided with flanges 69 which effectually close the wells from the fuel chamber. Respectively above and below the flanges 69, the walls of the bushings

have ports 70 and 71; and at the bottom of the enlarged portions of the wells the bushings are provided with ports 72. In the plane of the upper end of the casing 61, the bushings have flanges 74 above which their diameters are materially increased, as shown at 75. Midway between the fuel wells, and substantially coincident with the center of the heating chamber 25, the valve casing is provided with a bore 77 which is flared outward at its inner end as shown at 78, where it opens into the heating chamber, to form a seat for a conical valve 80 whose stem 81 has bearing within the bore 77. In the horizontal plane of the axis of the bore 77, a port 84, (Fig. 6) of comparatively small diameter, leads from the lower end of each fuel well to the heating chamber, each port opening through the aforesaid valve seat, at one end, and extending through the wall of the bushing 68, at the other. As clearly shown in Fig. 4, diametrically opposite portions of the periphery of the valve 80 are cut away enough to uncover the ports 84 (when such cut away portions are adjacent said ports) and these cut-away portions are shown as extending through practically 180 degrees of the valve's circumference, becoming gradually more shallow as they progress thereabout, so that, by turning the valve, the ports 84 may be closed more or less. An arm 85 is secured to the outer end of the stem 81 for the purpose of turning the valve.

The housing 60, above referred to, surmounts and is secured to the fuel valve casing 61 by screws 87. At its upper end, the housing is connected to the engine casing through a bracket 88, while intermediate its ends it has opposed perforated ears 89 which receive two of the studs or screws 18 that secure the manifold unit to the engine.

The open top of the housing is closed by a cover 90, held in place by screws 91, and its lower wall 92 has apertures for the reception of the enlarged upper ends 75 of the bushings 68. The lower ends of plungers 93 slidably fit within the bores of the bushings 68 and are guided within thimbles 94 contained within apertures in a horizontal partition 95 of the housing, and within guides 96 that have their upper ends contained within apertures in the cover 90. A short distance above the bushings 75 the rods have flanges 98 to which are fitted spring seats 99, and compression springs 100 are interposed between these spring seats and seats and flanges of the thimbles 94, the springs tending to force the plungers downward.

Supported within bosses 102 of the opposed side walls of the housing are the ends of a shaft 103 (Figs. 2, 3, and 5). A lifter 105 is associated with each plunger and comprises an arm having a bifurcated end 106 which embraces a flattened portion of the plunger between opposed heads 107, the bifurcated arm having connection with an arm 108 through an elongated hub 109 that is journaled upon the shaft 103. The free ends of the arms 108 are forked and have pivoted between their respective branches upon pins 110, pawls 112 having stops 113 which engage the tops of the arms for preventing undue movement of the pawls in the direction in which they are moved by springs 114, one end of each spring being attached to the upper end of the respective pawl while its opposite end is secured, as by a screw 115, to the hub of the lifter.

The lower end of each pawl 112 is arranged to ride upon a cam 116, secured to a shaft 120 which is journaled within bosses 121 in the opposed side walls of the housing 60 and projects forwardly beyond the front end of the engine where it has bearing in the upper end of a casing 122, the casing enclosing a chain 123 which passes about the pinions 126 and 127 that are secured, respectively, to the shaft 120 and the cam shaft 2 of the engine. As indicated in dotted lines in Fig. 2, each cam 116 comprises two lifting portions extending through 180 degrees each so that upon each rotation of the cam the corresponding lifter 105 is actuated twice.

From the foregoing it will be understood that the shaft 120 is driven constantly while the engine is running so that the plungers 93 are continually reciprocated. Now upon an inspection of Fig. 3, it will be seen that each plunger is provided with a series of comparatively short longitudinal grooves 130 located at substantially the longitudinal center of the portion which occupies the bushing 68. These grooves are of sufficient length to extend between the ports 70 and 71 of the bushings, so that, when the plungers are at an elevation to present their respective grooves simultaneously to the ports 70 and 71, communication is established between the fuel chamber 64 and the enlarged portions of the respective wells 66 and a quantity of fuel is transferred from the chamber to such portions of the wells. Upon the ascent of the lower ends of the plungers above the ports 72, the fuel in the enlarged portions of the wells will gravitate through these ports into the bottoms of the wells. Now, when the pawls 112 drop from the high points of the cams 116, the plungers are impelled downward by the springs 100 thereby to force the fuel then within the lower ends of the wells through the ports 84 into the heating chamber 25. The velocity with which the fuel is ejected from the ports 84 into the heating chamber results in effectually atomizing it; and this atomized fuel is further vaporized by the heat transmitted to the chamber through the

wall of the inner casing 26 from the exhaust gases passing through the heating jacket 28. As previously explained, the quantity of gas passing through this jacket and consequently the temperature of the chamber, may be controlled by the by-pass valve 36. In the instance of starting the engine, when the parts are cool, the temperature of the heating chamber may be raised to the desired degree by energizing the plug 40.

In Fig. 1 I have shown associated with my vaporizing apparatus a controlling means common to the air throttle 21 and the fuel valve 80, the control means being illustrated in perspective in Fig. 10. Pivoted at 134, upon a suitable support within convenient reach of the operator, (although in practice I contemplate incorporating the control means in the steering column of the automobile) is an arm 135 provided with a slot 136 at one end, and with an operating handle 137 at the other, adjacent to which there is a sector 138 having a serrated upper face. Pivoted, preferably upon the same center 134, is a second arm 140 having a portion 141 for cooperation with the serrated face of the sector 138. As shown, the arm 140 has its opposite end turned upward and backward over itself and is provided with a slot 143 which extends from the turned off portion some distance beyond the center 134. One end of a link 145 is adapted to be secured at any point along the slot 136 of the arm 135, the connection being of a pivoted nature, while its opposite end is pivotally connected to the operating arm 22 of the air throttle 21. One end of a second link 146 is likewise connected to the arm 140, and is adjustable along its slot 143, while its opposite end is pivoted to one branch of a bell-crank lever 147, shown as fulcrumed upon a stud 148 projecting from the side of the fuel valve casing, the free end of the other branch of said lever being connected, through a link 149, to the operating arm 85 of the fuel valve 80. Through this construction the fuel valve and air throttle may be opened and closed by swinging the handle 137 to and fro, and relative adjustment between the valve and throttle may be accomplished by shifting the lever 140 with respect to the lever 135, or by adjusting the ends of the links 145 and 146 along the slots of the respective arms 135 and 140. The latter adjustment provides for a very accurate setting of the valves, while the former may be used for altering the mixture from time to time in the driving of the engine to meet various situations as they arise, and is conveniently accomplished by moving the portion 141 along the serrated face of the sector 138.

I have already explained the main function of the valve 50 in the bottom of the heating chamber, as that of controlling the supply of air admitted to the chamber for the purpose of maintaining the atomized fuel in a broken up condition and assisting in carrying the fuel to the intake conduit. Substantially the same end may be accomplished (except for the control afforded by the adjustment of the valve) by providing air ducts 150 (Fig. 8) that lead through the opposite sides of the fuel valve casing 61 and open into the preheating chamber 25.

In Fig. 9 I have shown a modification of my invention which utilizes only the manifold unit and heating chamber of the construction above described and has associated with them a carburetor of usual principle. Here the manifold unit is designated 10^a and the heating chamber 25^a, the former having an air inlet extension 155 and the latter an exhaust pipe connection 156. Into a hollow boss 157 which opens in through the bottom wall of the heating chamber is screwed the upper end of a mixing tube 158 of the carburetor. This tube has air openings 159, and at its lower end is split at 160 on opposite sides to permit of the insertion of a tubular boss 170 which is connected, through arms 171 and 172, to a float chamber 173. The enlarged inner ends of the arms 171 and 172 are clamped between nuts 174 that are threaded upon the lower end of the mixing tube. The latter arm is hollow and affords communication between the float chamber and the interior of the tubular boss 170. A nozzle 175 is screwed into the upper end of the boss 170 and contains a needle valve 176, the upwardly converging end of which is adapted to seat within the lower end of the upwardly diverging orifice 178 of the nozzle. The relation of the end of the nozzle 175 to the restricted zone of the mixing tube (where it converges to its minimum diameter) may be varied by adjusting the nuts 174 to change the area of the air passage about the nozzle. The needle valve 176 has a head 179 at its lower end that is engaged by a spring 180 which is seated upon a thimble 181, screwed into the lower end of the tubular boss; and a drip cock 182 is threaded into the thimble for cleaning out purposes. An arm 185 is pivoted on a pin 186 which extends transversely through the hollow arm 172, and one end of the arm engages the upper surface of the head 179 of the needle valve. The opposite end of the arm has connection, through a link 188, with an arm of a bell-crank lever 189 shown as pivoted at 190 to the casing of the heating chamber while the opposite arm of said lever has connection, through a link 191, with a lever 140^a of a control means identical with that above described in connection with the former modification. The throttle 192 in the air inlet extension 155 has its operating arm 193 connected, through the

link 194, with the arm 135ª of the control means. Thus the fuel valve of this form of my invention may be actuated simultaneously with the air throttle, and a relative adjustment between the throttle and valve may be accomplished in the same manner as that formerly described. Fuel is supplied to the float chamber 173 through a tube 195, and the required level is maintained therein by means of a float 196 which is connected to and controls the inlet valve 197 in the usual well known manner.

In the form of my invention illustrated in Figs. 11 to 14 I have shown a modification of the manifold unit associated with the heating chamber and carburetor of the last described embodiment. Here the manifold unit is designated 200 and houses (preferably within an integral casting) two exhaust conduit sections 201 and an intake conduit. The central branch 202 of the intake conduit separates the exhaust conduit sections, and divides thereabove in two lateral branches 203 which lead downward to the intake ports of the engine. At the junction of the central and lateral branches of the intake conduit, a seat 204 is formed for a valve 205, the stem 206 whereof is guided within a fitting 207 that closes an opening in the top of the manifold through which the valve may be inserted. The angle of a bell-crank lever 210 is fulcrumed upon a pin 211 supported by and extending between the upper ends of arms 212 rising from one side of the fitting. One branch of the lever has connection with the valve stem 206, while the other branch connects, through a rod 215, with a suitable actuating means (not shown) such, for example, as that illustrated in Fig. 10.

The central branch of the intake conduit opens out through the side of the unit and is there provided with the shutter equipment illustrated in perspective in Fig. 14, and shown otherwise in Figs. 11, 12, and 13. This equipment comprises a rectangular housing 218 having a flange 219 at its inner end for attachment to the manifold unit, by screws 220, and having the plane of its outer end inclined downward and inward. A shutter 222, ample in area to close the housing, is hinged upon a pintle 223 along the upper side of the outer end of the housing. A finger 224 extends upward over the hinged side of the shutter and has the end of a spring 225 attached to it, the opposite end of the spring being connected to the end of an adjusting screw 226 threaded through an upward extension 227 of the housing. A spring detent 228, carried by the extension 227, is arranged to engage notches in the periphery of the head of the screw 226 to hold the screw in any adjusted position to which it is turned to create within the spring 225 the desired tension. To allow the screw to be turned without interference with the spring, the connection between the two may be of a swivel nature, produced, in the present instance, by connecting the spring to a pin 230 which extends through a bore in the screw and has a head 231 beyond and for engagement with the head of the screw.

The heating chamber and carburetor, being the same in this modification as in that shown in Fig. 9, bear like reference characters in both exemplifications of the invention.

Having thus described my invention, what I claim is:—

1. The combination, with an engine of the character set forth, of an intake conduit communicating with the intake port of the engine and having an air receiving opening, a vaporizing chamber communicating with the intake conduit, said chamber having an air inlet, a deflector for directing the air into proximity to the wall of the chamber, heating means for the chamber, and means for introducing atomized liquid fuel into the vaporizing chamber.

2. In liquid fuel vaporizing apparatus, means for mechanically atomizing the fuel, means for heating and thus vaporizing the fuel, and means for introducing into the vaporized fuel a quantity of air sufficient to hold the same in suspension and convey it to a subsequent air supply.

3. A carbureting apparatus comprising an intake conduit of an internal combustion engine having a main air inlet, means for mechanically atomizing liquid fuel, means for subsequently heating and thus vaporizing the atomized fuel, means for introducing into the vaporized fuel a quantity of air sufficient to suspend the fuel, and means for delivering the suspended fuel to the intake conduit.

4. The combination, with an internal combustion engine having an air inlet communicating with its cylinder, means for mechanically atomizing liquid fuel, means for heating and thus vaporizing the atomized fuel, means for introducing into the vaporized fuel sufficient air to maintain the fuel suspended, and means for delivering the fuel while thus held in suspension to the engine cylinder.

5. The combination with an engine of the character set forth, of an integral body incorporating an intake manifold and an exhaust manifold communicating respectively with the intake and exhaust ports of the engine, and a second integral body comprising a vaporizing chamber and a heating chamber enveloping the vaporizing chamber, said chambers communicating respectively with the intake and exhaust manifolds, the exhaust manifold and the heating chamber having secondary means of com-

munication, and further means for controlling the passage of exhaust gases through said secondary means of communication.

6. The combination with an engine of the character set forth, of an integral body incorporating an intake manifold opening through the bottom of the body and an exhaust manifold surrounding the intake manifold and opening through the bottom of the body on each side of the opening of the intake manifold, a second integral body incorporating a vaporizing chamber opening through the top of said body for registration with the intake manifold and a heating chamber surrounding the vaporizing chamber and opening through the top of the respective body for registration with the exhaust manifold when said bodies are connected together, said bodies having opposed laterally spaced openings, and a tubular member disposed between said openings.

7. The combination with an engine of the character set forth, of an integral body incorporating an intake manifold opening through the bottom of the body and an exhaust manifold surrounding the intake manifold and opening through the bottom of the body on each side of the opening of the intake manifold, a second integral body incorporating a vaporizing chamber opening through the top of said body for registration with the intake manifold and a heating chamber surrounding the vaporizing chamber and opening through the top of the respective body for registration with the exhaust manifold when said bodies are connected together, said bodies having opposed laterally spaced openings, a tubular member disposed between said openings, and a valve in said member.

8. The combination, with an engine of the character set forth, of an intake conduit communicating with the intake port of the engine and having a fluid receiving opening, a throttle for governing the passage of fluid through said conduit, means for introducing a fuel into the intake conduit, means for controlling the quantity of fuel introduced, an operating device, independent connections between the operating device and each the throttle and controlling means whereby they may be operated in unison, said connections being adjustable one with respect to the other.

9. The combination, with an engine of the character set forth, of an intake conduit communicating with the intake port of the engine and having a fluid receiving opening, a throttle for governing the passage of fluid through said conduit, means for introducing fuel into the intake conduit, means for controlling the quantity of fuel introduced, an operating device, independent connections between the operating device and each the throttle and controlling means whereby they may be operated in unison, and adjusting means incorporated in the operating device so that said connections may be relatively adjusted from the place of operation.

In testimony whereof, I hereunto affix my signature.

LEE S. CHADWICK.