

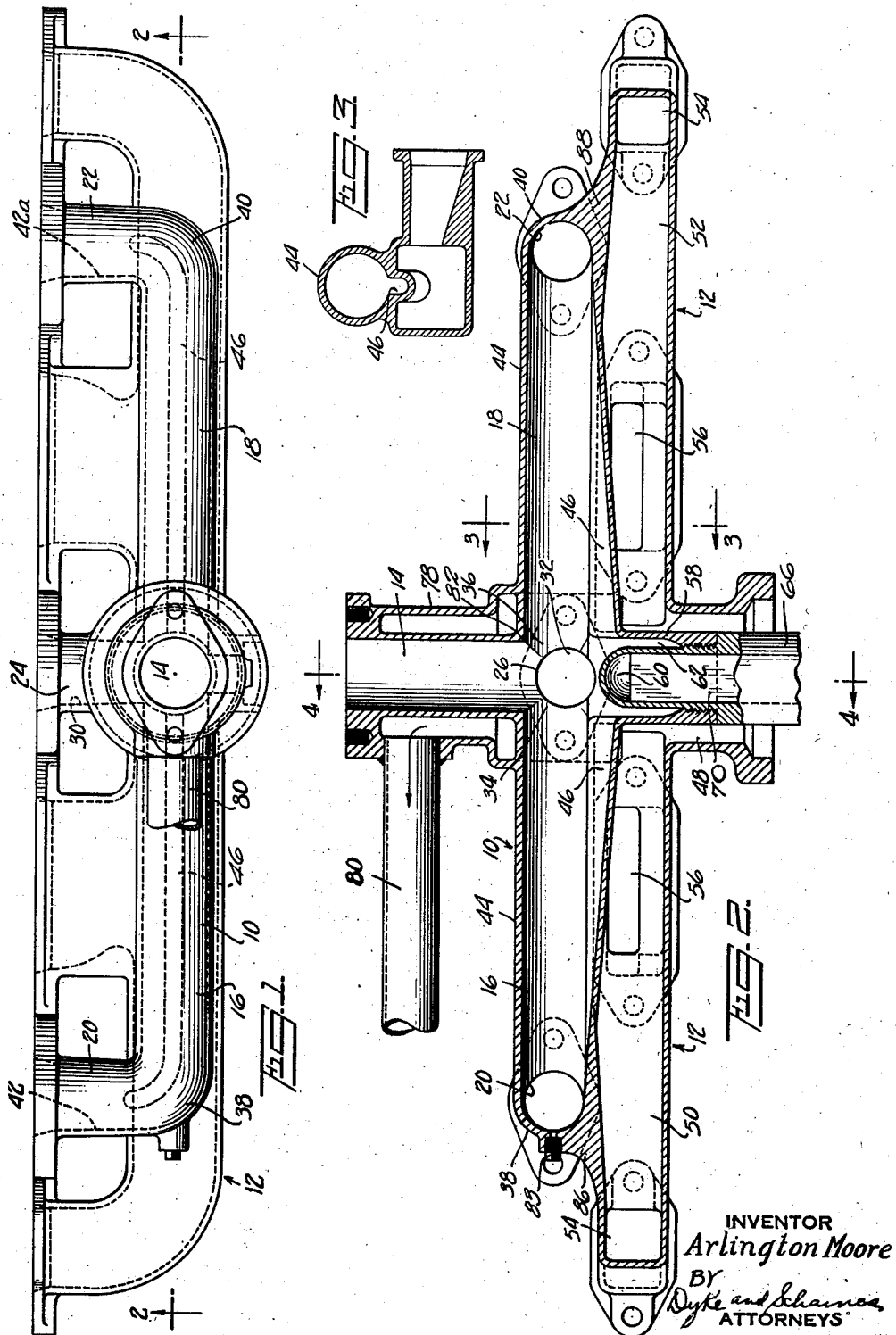
Feb. 12, 1935.

A. MOORE

1,990,662

CHARGE FORMING AND DISTRIBUTING MANIFOLD

Original Filed Feb. 7, 1931 2 Sheets-Sheet 1



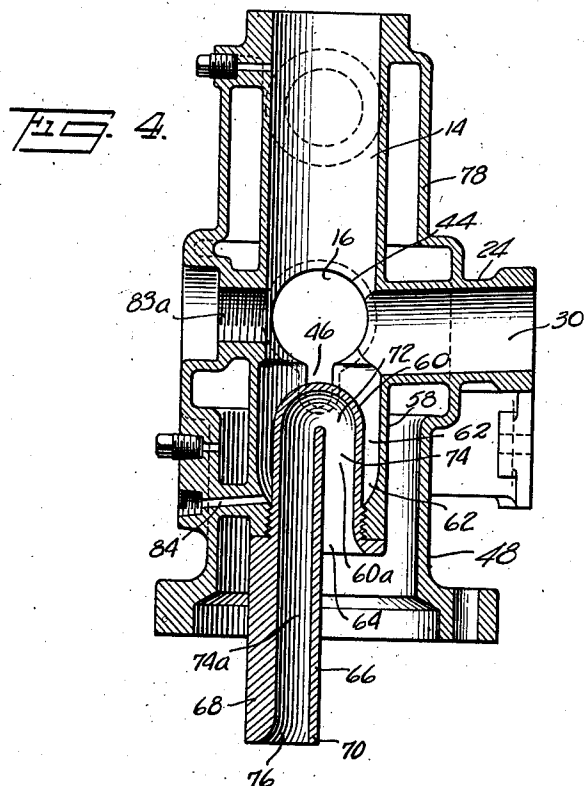
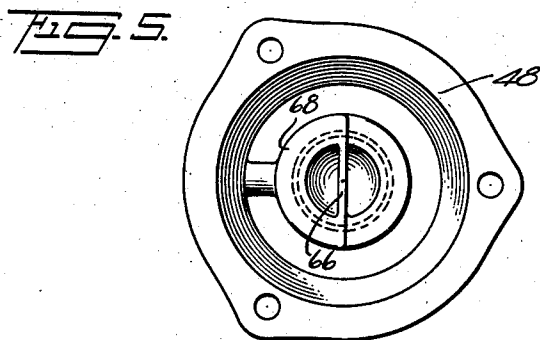
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## UNITED STATES PATENT OFFICE

1,990,662

CHARGE FORMING AND DISTRIBUTING  
MANIFOLDArlington Moore, New York, N. Y., assignor, by  
mesne assignments, to Maxmoor Corporation,  
New York, N. Y., a corporation of DelawareApplication February 7, 1931, Serial No. 514,105  
Renewed July 12, 1933

11 Claims. (Cl. 123—122)

My invention relates to means for uniform distribution of charge materials to the cylinders of an internal combustion engine, and the same has for its object to provide a simple, efficient and compact device which serves to vaporize the fuel component and which is constructed to maintain adequate charge velocity for stable entrainment of the fuel components without sacrifice of volumetric efficiency, resulting in homogeneous charges being introduced into the cylinders and providing adequate facilities for drainage of the branches during initial operation.

The invention also has for its objects to heat the charge distributing manifold or conduit so as to effect complete vaporization of the fuel enroute to the cylinders and maintain the same in such condition without affecting the volumetric efficiency, to concentrate substantially the hottest portion of the exhaust gas stream on a portion of the intake conduit contiguous to the point of subdivision of the air stream or deflection thereof for causing the vaporization of fuel particles discharged through or thrown out of the air stream at said point enroute to the engine cylinders, to render the thermal efficiency of said heated portion substantially maximum to cause fuel vaporization at a rate to prevent accumulation of fuel in said heated portion and thermal decomposition of fuel to form tarry products liable to impair the thermal efficiency of the device, to prevent condensation of fuel enroute to the cylinders by the action of heating or charge velocity, or both, and to render the device self draining into the central heated portions to prevent accumulation of fuel in the branches or the wetting down of the walls thereof.

Other objects will in part be obvious and in part be pointed out hereinafter.

In the accompanying drawings:

Fig. 1 is a plan of one form of device constructed according to and embodying my said invention;

Fig. 2 is a section thereof on the line 2—2 of Fig. 1;

Fig. 3 is a section thereof on the line 3—3 of Fig. 2;

Fig. 4 is a section thereof on the line 4—4 of Fig. 2; and Fig. 5 is a bottom plan of the central portion of the device.

The fuel vaporizing and charge distributing device embodying my said invention is adapted for use with carburetors or fuel supplying devices of various types such as with the apparatus disclosed in my copending application Serial No. 472,310, filed August 1, 1930, and while the device

is particularly adapted for distributing charge mixtures containing fuel of low volatility, charge mixture containing more volatile fuels, such as gasoline, may be effectively distributed thereby in homogeneous admixture with the air.

The low fuel cost and substantial freedom from fire hazard to be obtained with fuel oil, for example, fuel oil of 28° to 40° Baumé, makes the utilization of fuel of low volatility a matter of great advantage for the operation of internal combustion engines, particularly automotive or marine engines.

The use, however, of such fuel has heretofore not been found practical, except in engines of the Diesel and solid fuel injection types, particularly because of the incapacity to vaporize the heavy fuel and prevent heterogeneous formations. The present manifold producing and maintaining homogeneous charge distribution to the cylinders renders the use of such fuel oils practicable.

When conventional three port manifolds are employed there is a tendency for the center port to receive a lean charge whereas the end ports receive a rich charge. This condition is aggravated because the incoming charge picks up condensed fuel from the intake manifold walls, and particularly in the longer branches where the tendency to condense is greater. The condensation or loading up of fuel in the intake manifold takes place principally during periods of low speed operation, and this would be particularly true where the heavier fuels are used. The accumulated or condensed fuel swept into the engine cylinders, especially when the throttle is opened for acceleration, causes waste of fuel, oil dilution, non-uniform distribution with temporary over-richness of the mixture in certain of the cylinders, and other detrimental effects. While various expedients have been resorted to in order to obviate these defects, none of them has proved very successful.

In my invention I do not rely on wasteful, uneconomical and inefficient wetting down of the walls of the intake conduit by fuel in order to insure an accumulation of fuel on the intake walls adapted to be picked up to form the enriched mixture required for acceleration. By suitably distributing heat along the intake conduit the fuel component of the charge is completely vaporized and maintained vaporized enroute to the intake ports, and the maintenance of this condition is preferably supplemented or helped by also constructing the intake manifold in accordance with the invention set forth in my application Ser. No. 234,417, filed November 19, 1927, now Patent

No. 1,901,763, thereby promoting uniform distribution to the intake ports with resulting smooth engine operation, the invention being adapted for two, three or more branched intake manifolds.

5 Referring to the drawings, the intake manifold 10 (the form illustrated being of the downdraft type) is preferably formed integrally with the exhaust manifold 12. The charge mixture passes into the manifold through the central neck portion or descender 14 and into the longer branches 16 and 18 and out through the elbow outlets 20 and 22 and intermediate outlet or shorter branch 24.

The intake manifold 10 illustrated as one example, is for a six cylinder engine having intake ports in sets of pairs in the cylinder block. With cylinder blocks designed for receiving only two intake manifold branches, the center branch 24 is omitted. With the form shown, neck 14 leads 20 downwardly to connect with the manifold at substantially the middle thereof and immediately above the entrances to its several branches, and at this point a distributing chamber 26 is provided from which the mixture is supplied to all 25 the manifold branches 16, 18 and 24.

The straight-in passage 30 of the branch 24 has an opening or entrance 32 thereto from chamber 26. The branches 16 and 18 going to the end cylinders have entrances 34 and 36 thereto from the chamber 26 of enlarged areas as compared to the area of the opening 32 to the middle branch 24, and their cross-sectional area gradually decreases towards the elbow turns 38, 40 in such branches to cause an increase in the velocity of the fuel charge as the same approaches said elbows 38, 40, and in this way the charge mixture can be delivered to the elbows 38, 40, which constitute secondary entrances to the straight-in passages 42, 42a leading to the end pairs of 40 cylinders.

The cross-sectional area of said branches 16 and 18 at the elbows 38 and 40 is substantially the same as the cross-sectional area of the entrance 32 to the central branch 24, and the portions 42 and 45 42a similar in construction, function, and size to the branch 24, provide outlets from the manifold substantially equal in area to the opening at the outer end of the branch 24.

The branches 16 and 18 each preferably comprises a semi-cylindrical upper portion 44 of substantially uniform cross-section from the inner end thereof to the elbow thereof, and a relatively constricted channel portion 46 at the base thereof merging into the upper portion 44 and likewise extending from the inner end of the branch into the elbow thereof and gradually decreasing in cross-sectional area towards each elbow. The channel portions 46 jointly with the upper portions 44 form passages providing the relatively 60 large entrances 34 and 36 and gradually decreasing in cross-sectional area to said elbows 38 and 40.

The exhaust manifold 12 is preferably of the type in which the exhaust gases are conducted from the cylinders toward the middle and out through a central outlet 48, the branches 50 and 52 thereof having openings 54 and 56 adapted to register with the exhaust passages of the cylinder block. The exhaust manifold is located below the intake manifold and is preferably formed integrally therewith, the two manifolds having the grooved wall portions 46 in common so that the grooves or canals project into and are exposed to the hot exhaust gases.

The intake conduit 10 at the junction of the 75 branches thereof opposite the neck 14 is provided

with a cylindrical wall portion 58 extending downwardly into the exhaust passage coaxially with and in spaced relation to the walls of the outlet 48, i. e., substantially at the point where the two exhaust gas streams unite which is substantially the hottest part of the exhaust gas. The upper end of the portion 58 is open and in communication with the intake manifold and the lower end thereof is closed by a dome-shaped wall portion 60 disposed 10 within the confines of the cylindrical portion in spaced relation thereto to form an annular chamber 62 opposite the inlet 14 at the point of subdivision of the charge mixture stream but lying substantially beyond the path of travel thereof, the 15 upper end of the dome 60 preferably lying entirely below the cylindrical portions 44 of the intake branches and below the port 32 to prevent splashing of fuel thereinto. The portion 60 is preferably separate from the portion 58, the former 20 preferably being composed of a material of high heat conductivity, such as copper. The interior 60a of the portion or member 60 is exposed to the hot exhaust gases, the member being open at its lower end as indicated at 64. In order to promote circulation of exhaust gas through the interior 60a, the member 60 at one side is provided with an integral tubular extension or skirt 66 projecting downwardly into the exhaust gas stream substantially beyond the outlet 64, one 30 wall 68 of the projecting portion being thickened to increase the thermal effect. The other wall 70 of the projecting portion 64 extends into the dome 60 to form a partition therein substantially bisecting the same and terminating short of the top thereof to provide a return bend passage 72 having a relatively short arm 74 opening at 64 into the exhaust outlet and a relatively longer arm 74a open at its lower end 76 and communicating with the exhaust gas conduit at a point substantially below the opening 64. The arrangement because of temperature differences causes a circulation of exhaust gas into and through the dome 60 to supply heat thereto.

The exhaust manifold 12 is arranged to supply 45 heat to the intake manifold by surrounding the neck 14 of the intake conduit with a jacket extension 78 of the exhaust manifold vented to the air through the outlet pipe 80, and by forming the floor and ends of the intake manifold 22 integral with the adjacent top portion of the exhaust manifold. The neck 14 is terminated in a sharp angle, as indicated at 82, to shed off any liquid fuel from the neck wall into the air stream, and this arrangement is especially desirable when the intake is constructed with a central outlet 32 as in the structure illustrated herein, which could be directly entered by liquid fuel running down the manifold wall. At 83 is indicated an opening at one end of an intake branch adapted to receive a fuel injecting device for supplying fuel for preheating the intake. At 83a is another opening adjacent the juncture of the branches adapted to receive a spark plug for igniting the preheating charge. 65

The supply of heat from the exhaust to the under side of the intake manifold is concentrated at a region opposite the intake manifold neck 14 by conducting the exhaust gas from the exhaust ports towards the central outlet 48 into contact with the cup or crucible extension 58—60 projecting downwardly into the exhaust conduit and outlet 48 from the intake manifold floor, the diameter of the tubular portion 58 being slightly greater than the diameter of the passage in the 75

neck 14 so that the incoming and outgoing fuel particles do not interfere. The walls 58 and 60 provide between them the annular well 62, subject to the most concentrated heat from the exhaust gases on both sides. The massive metal member 66 of copper or the like serves as a thermal reservoir for uniform supply of heat to the dome 60 by conduction.

The well 62 is vented to the atmosphere preferably through the passage 84, said passage being also adapted to serve as an orifice for admission of fuel for idling, if so desired.

The air bled in through passage 84, serves to agitate the fuel in cup 62 and assist the heating in returning the fuel into the intake during engine operation, or if liquid fuel should accumulate in the well 62 by drainage from troughs 46, as for example, upon starting or pumping in fuel for rapid acceleration, it will not simply boil or distill off, but can either run out through the passage 84, or, in case the intake depression is relatively high, can be carried along upwardly as vapor with air admitted through opening 84.

The fuel, when gaseous injection is employed for blasting the same into and through the air stream in neck 14, is very thoroughly pulverized by reason of its greater velocity and by reason of its resulting great surface exposure to the air absorbs heat therefrom very rapidly. Rapidity of heat absorption is of utmost importance because of the extremely short interval of time available and which is longest with the slow charge travel during engine idling and shortest with the high speed charge travel encountered at full power operation. Heavy fuel when used is capable of taking up more heat than on operation with lighter and more volatile fuels. The heat of the charge is thus reduced so as to favor having high density charge productive of good volumetric efficiency, and the fuel is in large part put into such condition—gasified and/or vaporized and/or in fogged or like highly divided state,—that it is suspended in and carried along with the air stream without condensation or deposition on the conduit walls as the air stream branches or changes direction on its way to the engine cylinders.

The stream of blasted fuel or fuel carried by the air from an ordinary carburetor usually contains some fuel portions or droplets heavy enough to continue their substantially straight line travel without material deflection with the moving air. Unless given a liberal application of heat, this fuel portion would wet and load up the walls of the intake manifold.

By changing the direction of the intake manifold passage in the neighborhood where the blasted or inertia impelled heavier fuel particles strike the conduit walls, I can carry the lighter fuel particles thoroughly suspended in the air stream towards the engine cylinders with the air stream, and by applying heat of the exhaust gases to the intake conduit walls which would otherwise be wetted by deposited fuel droplets, I am enabled to secure a selective application of heat to vaporize and suspend this fuel without undesirably heating the air of the charge.

The illustrated mode of securing such effect is by directing the fuel blast or fuel charge mixture downwardly in the intake manifold neck 14, which at the bottom branches to each side, while applying heat of exhaust gas without such neck by surrounding it with the exhaust gas chamber 78 vented to the atmosphere by the outlet pipe 80, thus providing a hot surrounding wall adapt-

ed to be contacted by and apply heat to the heavy particles of fuel spreading to the outer region of the blast fuel stream, and by providing the hot cup or crucible 62 in line with the discharge end of the neck 14, where the heated portion is struck by and supplies vaporizing heat to the heavy fuel particles projected thereinto. When lighter fuels such as gasoline are employed less heat is required, and the passage of exhaust gas through jacket 78 can be prevented by closing outlet 80.

Inasmuch as the exhaust gas from all the exhaust ports is directed into the vicinity of the crucible 62, the crucible is subjected to the maximum temperature available. The annular crucible is in contact at both sides with the exhaust gas, and provides a doubly extended surface, compared to the surface of an ordinary non-annular cup, for heating the projected fuel, the heating effect being augmented by causing a flow of a portion of the exhaust gases into the interior of the dome 60. By disposing the dome in the path of the projected fuel, the impact of the fuel particles thereon cause the particles to dance thereon or rebound therefrom without tending to conglomerate, an extended surface being provided along which the fuel particles may gravitate, thereby enhancing vaporization or fuel nebulizing and preventing the accumulation of liquid fuel in the bottom of the crucible. The vaporizing effect is also assisted by the provision of a downdraft manifold in which the fuel particles gravitate into the crucible and onto the dome, the incoming particles being subjected to air passing through the opening 84 and moving in the opposite direction. The surface of the dome 60 at the intake side may be knurled or roughened to assist vaporizing.

By the combined effect of the contact of the fuel particles upon these wall surfaces, and the efficient application of heat thereto, the homogeneous suspension of the fuel in the air is completed, without undue air heating and loss of volumetric efficiency through air heating and charge density reduction.

To maintain the homogeneous suspension of the fuel in the air so attained, I keep the sectional area of the intake manifold, and, therefore, of the moving charge stream as low as practicable without unduly restricting charge flow through the manifold, thus keeping the charge moving rapidly and avoiding any slowing up or expansion of the charge material on its way to the engine cylinders, which would be productive of condensation, and I also preferably progressively increase the charge velocity during such travel, as by progressive reduction of the cross-sectional area of the manifold branches from the common neck portion thereof to the engine cylinders, and supply heat to the lower parts 46 of the intake manifold wall which are most readily wet by particles of fuel from the charge stream. The construction above described also delivers the fuel charge to the portions 20, 22 and 24 at substantially the same velocity and in substantially the same quantities.

The charge mixture moving in the opposite direction over condensed fuel in canals 46, produces a surface vaporizing effect on the condensed fuel and causes the same to be delivered as part of the vaporized charge to the proper cylinders, thereby further assisting in preventing fuel from persisting in a liquid and unvaporized state. The floors of all the straight-in branch portions 20, 22, and 24 also preferably slope back from the valve ports toward their inlets so as to drain

back any condensed liquid into the canals 46 and well 62.

The result is that the charge is delivered to the straight-in parts 20 and 22 of the lateral branches 5 16 and 18 as effectively as the delivery thereof to the middle branch 24, the charge being uniformly distributed to the cylinders in substantially the proportions for which the carburetor or other fuel supplying device is set.

10 The troughs 46 taper from least at the outer ends of the intake manifold branches to largest area where they lead down into the annular well 62. This decrease in section of the intake manifold speeds up the charge as it travels to the engine cylinders thereby opposing any tendency 15 of fuel particles to deposit on the walls. Any fuel deposit that does take place finds its way by gravitation to the hot floor trough, where the fuel is immediately vaporized; and any heavy fuel particles traveling in straight lines lengthwise of 20 the intake manifold branches contact with the thickened heated ends 86 and 88 of the intake branches and are flashed into vapor. The troughs 46 serve also as a sort of anti-rifling device 25 to prevent spiraling of the charge in the branches which is desirably to be avoided since it would give increased length of travel for any fuel particles and increase wall contact and liability of coalescence of fine fuel particles into 30 larger particles or droplets, which, when formed, could be deposited on the conduit walls.

In the construction of manifold disclosed the uniform portions 44 preferably extend substantially horizontal and form the major part of the branches while the lower portions 46, forming 35 relatively smaller parts of the branches decrease in cross-sectional area or depth by relatively large increments, the progressive decrease in cross-section as a whole of each branch towards the elbow being determined solely by the variations 40 in the lower portion 46. The lower portions 46 provide relatively steep inclinations for drainage towards the center of the manifold and effect relatively slight progressive restriction of the branches to cause acceleration ratio proportional 45 to distance traveled by the charge materials to effect uniform delivery through all ports.

That the hot wall surfaces 58—60 are of sufficient area and mass to supply vaporizing heat to the relatively large quantity of liquid fuel blasted 50 or otherwise projected thereagainst during full power operation insures plenty of heat being available when the same walls are used for communicating heat to the small quantity of idling fuel, even though the temperature of such walls 55 during idling is lower than at full load, and owing to the heat available upon the walls of the crucible 60, vaporization of fuel is accomplished without the formation of tarry products liable to reduce the thermal efficiency of the heated portion because of the insulating effects of such 60 tarry formations.

The temperatures available with my manifold, particularly at the higher speeds, are sufficient 65 to cause the fuel particles to assume the spheroidal state, evidenced by the fact that the fuel does not form tarry or other solid precipitates within the crucible 62 and the vapor produced is substantially dry and less liable to condense.

70 The charge produced in passing to the cylinders takes up heat from the hot floor and ends of the intake passage and upon delivery to the engine cylinders is and remains in condition for efficient, clean and smokeless burning.

75 The thermal vaporizing effect of the manifold

may be augmented by discharge of the fuel into the region of intake depression at the engine side of the throttle as set forth in my said application Serial No. 472,310, the manifold being 5 equally efficient, however, with any conventional carburetor, such as those connected below the throttle. The manifold can be adapted to suit any engine or fuel requirement by slight variation in the thermal and other relationships of the parts. 10

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. A manifold comprising an annular well opening into the same, means for exposing the walls 15 of said well to the heat of the exhaust gas stream, and means dependent upon thermal and/or pressure difference at spaced points of the exhaust gas stream for inducing a flow of exhaust gas past the interior wall of said well.

2. A manifold comprising an annular well opening into the same, means for exposing the walls 20 of said well to the heat of the exhaust gas stream, and means for promoting flow of exhaust gas over the interior wall of said well, said means including a short passage having an entrance thereto 25 from the exhaust gas stream and a relatively longer return passage having an outlet into the exhaust gas stream.

3. A manifold comprising a fuel chamber opening thereto and including a hollow dome extending into said chamber, and means dividing 30 said dome to form a U passage therethrough communicating at both ends with the exhaust gas stream, the discharge portion of said passage being relatively longer than the entrance portion thereof. 35

4. A manifold comprising a hollow dome facing the interior of the manifold, and means dividing 40 said dome to form a U passage therethrough communicating at both ends with the exhaust gas stream, the discharge portion of said passage being relatively longer than the entrance portion thereof. 40

5. A manifold comprising a hollow dome facing the interior of the manifold, and means dividing 45 said dome to form a passage therein having an entrance portion and a relatively longer return discharge portion opening at the ends thereof into the exhaust gas stream, the wall of the projecting portion of the longer passage being relatively massive and extending into the exhaust gas 50 stream. 50

6. A manifold comprising an outwardly directed open ended portion forming a fuel chamber opening 55 into the manifold, and a member composed of a material of relatively high heat conductivity, closing the end of said outwardly directed portion, and including a hollow dome extending into 60 said chamber in spaced relation to the wall thereof, said member having a portion dividing said dome into a passage having an entrance portion and a return discharge portion communicating 65 at the ends with the exhaust gas stream, the wall of said discharge portion being relatively massive and projecting beyond said dome into the exhaust gas stream. 65

7. A manifold comprising an inlet portion, branches extending therefrom, and an annular well disposed in alignment with said inlet portion 70 substantially beyond the path of travel of the charge mixture, and means dependent upon differences in temperature and/or pressure at spaced points of the exhaust gas stream for promoting 75 flow thereof over the interior wall of said well. 75

8. A manifold comprising an inlet portion, branches extending therefrom, and a fuel heating chamber in alignment with said inlet portion including an outwardly directed peripheral portion and a return dome portion disposed within the peripheral portion in spaced relation thereto, the interior of said dome portion being divided into a U passage communicating at the ends with the exhaust gas stream, the discharge portion of said passage being relatively longer than the entrance portion thereof.

9. A manifold comprising an inlet portion, branches extending therefrom, and a fuel heating chamber in alignment with said inlet portion including an outwardly directed peripheral portion and a return dome portion disposed within said peripheral portion in spaced relation thereto, an exhaust conduit having a central discharge outlet enclosing said chamber, and means forming a return passage through said dome having a short entrance portion and a relatively longer discharge portion projecting into the exhaust gas stream, the ends of said passage portions communicating with the exhaust gas stream at spaced points.

10. A charge forming and distributing mani-

fold comprising an intake conduit having down-draft inlet portion and branches extending therefrom, and a fuel heating chamber having a dome therein, disposed in alignment with said inlet portion and projecting below the intake conduit, an exhaust gas conduit disposed below the intake conduit and having an intermediate discharge outlet surrounding said chamber, and means for promoting flow of exhaust gas through said dome including a portion forming a passage through said dome communicating with the exhaust gas stream, said passage including a short entrance portion and a longer return discharge portion projecting beyond the dome into the exhaust gas stream.

11. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, lateral branches having relatively reduced trough portions, and a recessed portion in alignment with and facing said inlet portion substantially beyond the path of travel of the charge mixture, and communicating with said trough portions, said recessed portion being provided with a normally open vent, and means for supplying heat to the exterior of said recessed portion.

ARLINGTON MOORE.