

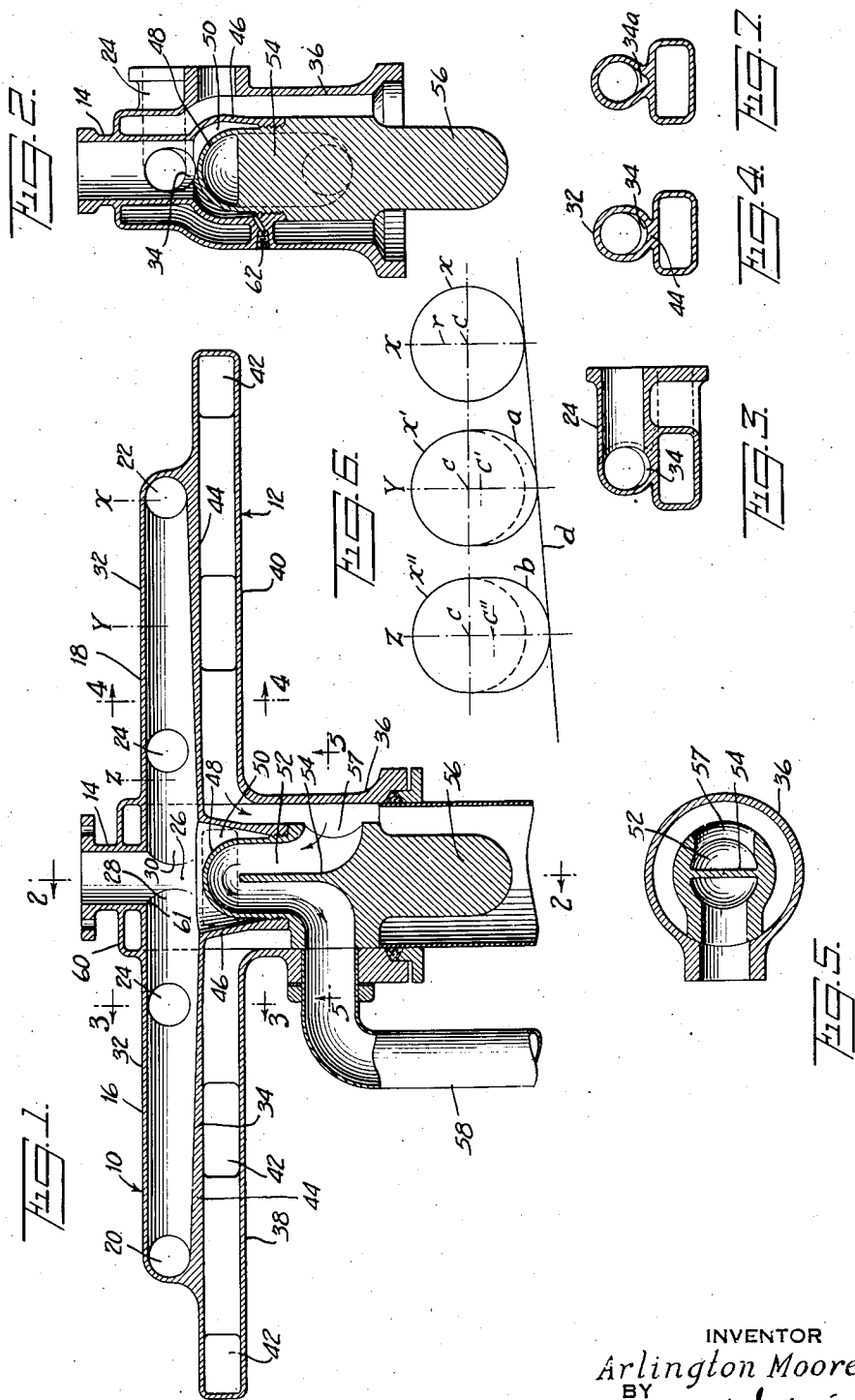
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CHARGE FORMING AND DISTRIBUTING MANIFOLD

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CHARGE FORMING AND DISTRIBUTING
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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 engine 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 central portion of the intake conduit contiguous to the point of subdivision or deflection of the charge stream into the branches for causing the vaporization of fuel particles discharged through or thrown out of the charge stream at said point enroute to the engine cylinders, to render the thermal efficiency of said central heated portion substantially maximum to cause fuel vaporization at a rate to prevent accumulation of fuel in said heated portion and the thermal decomposition of fuel to form tarry products liable to impair the thermal efficiency of the device, to prevent condensation of fuel in the branches enroute to the cylinders by the action of heating or by maintaining charge velocity, or both, and to render the device self draining into said central heated portion 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 drawing:

Fig. 1 is a longitudinal vertical section of one form of device constructed according to and embodying my said invention.

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

Fig. 3 is a transverse vertical section thereof on the line 3—3 of Fig. 1;

Fig. 4 is a transverse vertical section thereof on the line 4—4 of Fig. 1;

Fig. 5 is a horizontal section thereof on the line 5—5, Fig. 1;

Fig. 6 is a diagram illustrating the construction of the intake conduit; and

Fig. 7 is a section showing a slight modification.

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 mixtures containing more volatile fuels, such as gasoline, may be as 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 or 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 distributions to the cylinders renders the use of such fuel oils practicable.

When conventional three port manifolds are employed there is 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 providing a construction similar to the intake manifold described as a modification in my application Ser. No. 234,417, filed November 19, 1927, 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.

Referring to the drawing, 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 branches 16 and 18 and out through the elbow outlets or end portions 20 and 22, the central cylinders being supplied by the outlets or shorter branches 24 communicating with the branches at points outwardly from the central portion of the conduit, so that the charge mixture is supplied there-through after subdivision of the charge by deflection into the branches, the arrangement being conducive to more uniform distribution.

The intake manifold 10 illustrated as one example, is for an eight cylinder engine having four intake ports. With cylinder blocks designed for receiving only two intake manifold branches, the branches 24 are omitted. With the form shown, neck 14 leads downwardly to connect with the manifold at substantially the middle thereof and immediately above the entrances to its branches, and at this point a distributing chamber 26 is provided from which the mixture is supplied to the manifold branches 16 and 18.

The branches 16 and 18 have entrances 28 and 30 thereto from the chamber 26 of enlarged areas as compared to the area of the openings 20, 22 and 24, and their cross-sectional area gradually decreases towards the end portions 20 and 22 to cause an increase in the velocity of the fuel charge as the same approaches the elbows, and in this way the charge mixture can be delivered to the straight-in passages 20 and 22. The cross-sectional area of said branches 16 and 18 at the elbows 20 and 22 is substantially the same as the cross-sectional area of the entrances 24.

The branches 16 and 18 each preferably comprises a semi-cylindrical upper portion 32 of substantially uniform cross-section from the inner end thereof to the elbow thereof, and preferably horizontal, and a lower portion 34 at the base thereof merging into the upper portion 32 and likewise extending from the inner end of the branch into the elbow thereof and gradually decreasing in cross-sectional area or depth towards each elbow, the upper portion 32 forming the major part of the branch and the lower portion 34 the lesser part. The portions 34 jointly with the upper portions 32 form passages providing the relatively large entrances 28 and 30 and gradually decreasing in cross-sectional area to said elbows 20 and 22.

The desired inclination of the floor of the intake conduit branch and the tapering thereof as a whole is obtained as illustrated in Fig. 6, exaggerated in size to make the same clear, and representing successive cross-sections taken on the lines x , y and z of Fig. 1. The cross-section at the elbow is a circle x having a radius r . The cross sections of the upper portion 32 from the elbow inwardly are partial circles x' , x'' having the same radius r , the centers c of the several circles lying on the same horizontal line. The cross

sections x' , x'' however are enlarged progressively towards the inner end of the branch, the lower portion 34 having cross-sections conforming to partial circles a , b , having the same radii r and described about centers c' , c'' located vertically below the centers c and progressively increasing in distance therefrom, the partial circles a , b merging with the partial circles x' , x'' .

By progressively enlarging the general contour of the branch at the bottom, the branch is made to incline downwardly towards the center of the manifold at a substantial angle for drainage purposes, as indicated at d , Fig. 6. At the same time the branch passage as a whole varies in cross section at a rate determined solely by the variations in cross section of the relatively smaller lower portion 34, the rate of variation of the cross sections of the branch passage as a whole being less than the rate of variation in cross-section of the lower portion 34. The lower portions 34 therefore provide relatively steep inclinations for drainage and effect relatively slight progressive restriction of the branches to cause acceleration ratio proportional to distance traveled by the charge materials to effect uniform delivery through all ports.

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 36, the branches 38 and 40 thereof having openings 42 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.

In the present embodiment of the invention the exhaust gas manifold branches and the passages thereof lie entirely below the plane of the intake branches and the passages thereof, the two manifolds being in thermal contact with each other and integrally connected through longitudinal necks or connecting portions 44, which, as shown at Fig. 1, preferably increases in thickness towards the outer ends of the manifold. The amount of heat conducted to the intake at the base or bottom thereof depends on the thickness of the metal in the connecting neck 44. With this construction the intake conduit is substantially entirely exposed to air around the circumference or periphery thereof except for said portion 44.

If so desired the lower portion of the intake branches may be constructed as shown at Fig. 7 in which the circular portion 34 is replaced by a relatively deep groove 34a which tapers towards the outer end of the manifold, like portion 34, to provide heated drainage inclinations and general charge accelerating variation in taper of the branch as a whole.

The intake conduit 10 at the junction of the branches thereof opposite the neck 14 is provided with a tapered wall portion 46 extending downwardly into the exhaust passage coaxially with and in spaced relation to the walls of the outlet 36, 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 46, opens into the intake manifold and the lower end thereof is closed by a dome shaped member or wall portion 48 in spaced relation thereto to form a substantially annular chamber 50 opposite the inlet 14 at the point of subdivision of the charge mixture stream but lying substantially beyond the path of travel thereof, the upper end of the dome 48 preferably lying

entirely below the plane of the intake branches.

The portion 48 is preferably separate from the portion 46, the former preferably being composed of a material of high heat conductivity, such as an alloy composed principally of copper. The interior 52 of the portion or member 48 is exposed to the hot exhaust gases, the member preferably having means formed to insure positive circulation of the hot exhaust gases therethrough.

This means in the present embodiment of the invention includes a deflector or baffle 54 forming an integral extension of the relatively massive lower portion 56 which forms a heat reservoir integral with the dome 48 and lies within the exhaust gas outlet 36. The baffle 54 extends into the chamber 52, substantially bisecting the same and terminating short of the top thereof. This forms a return bend passage having an entrance 57 through which a portion of the hot exhaust gases are bypassed from the outlet portion 36 and directed into contact with the upper portion of the dome. The bypassed exhaust gases pass out directly to atmosphere through a pipe 58 connected with the opposite end of the return bend passage 52, thereby accelerating the circulation and keeping the dome heated to a maximum. The dome 48 may be knurled or roughened to transfer heat to the fuel at maximum rate and reduce film deposits. Live exhaust gas is thus made to positively and continuously flow through the passage 52 to heat the dome 48.

The exhaust manifold 12 is arranged to supply heat to the neck 14 of the intake manifold by surrounding the neck with a jacket extension 60 of the exhaust manifold. The neck 14 is terminated in a sharp angle, as indicated at 61, to shed off any liquid fuel from the neck wall into the air stream.

The diameter of the tubular portion 46 at the entrance thereto is substantially greater than the diameter of the passage in the neck 14 so that the particles entering and escaping from the crucible 50 do not interfere. The walls 46 and 48 provide between them the annular well 50 which is subject on both sides to the most concentrated heat from the exhaust gases. The massive metal member 56 of copper or the like serves as a thermal reservoir for uniform supply of heat to the dome 48 by conduction. Said well 50 is vented to the atmosphere preferably through the passage 62, said passage being also adapted to serve as an orifice for admission of fuel for idling, if so desired.

The air bled through passage 62 serves to agitate the fuel in cup 50 and assist the heating in returning the fuel into the intake during engine operation, or if liquid fuel should accumulate in the well 50 it can run out through the passage 62.

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 condi-

tion—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 60, thus providing a hot surrounding wall adapted 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 50 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 therein.

Inasmuch as the exhaust gas from all the exhaust ports is directed into the vicinity of the crucible 50, 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 the positive deflection of a portion of the exhaust gases into the interior of the dome 48. By disposing the dome 48 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 down-draft 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 62 and moving in the opposite direction.

The temperatures available with my manifold, particularly at the higher speeds, are sufficient 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 50 and the vapor produced is substantially dry and less liable to condense.

Sudden changes from heavy to light loads are accompanied by a flow of heat from the massive member 56 rendering available heat for restabilizing the mixture when inertia effects on fuel

flow are prevalent and particularly when the engine is suddenly brought down to idling from loads.

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 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 on the floor of the intake branches 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.

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

The floors 34 taper from least at the outer ends of the intake manifold branches to largest depth where they lead down into the annular well 50. The decrease in section of the intake manifold speeds up the charge as it travels to the engine cylinders thereby opposing any tendency of fuel particles to deposit on the walls. Any fuel deposit that does take place finds its way by gravitation to the hot floor, where the fuel is immediately vaporized.

By venting the annular well 50 to the atmosphere at its bottom through passage 62 any liquid fuel which may run back from the branches and accumulate in well 50, as for example, at starting, or upon pumping in extra fuel for acceleration, will not simply boil or distill off, but can either run out through such vent, or, in case the intake depression is relatively high, be carried along upwardly as vapor with air admitted through the opening 62.

That the hot wall surfaces 46—48—56 are of sufficient area and mass to supply vaporizing heat to the relatively large quantity of liquid fuel blasted or otherwise projected thereagainst during full power operation insured 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 during idling is lower than at full load, and owing to the heat available upon the walls of the crucible 50, vaporization of fuel is accomplished without the formation of tarry products liable to reduce the thermal efficiency thereof because of the insulating effects of such tarry formations.

The charge so 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.

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 equally efficient, however, with any conventional carburetor, much as those connected below the throttle. The manifold can be adapted to meet any engine or fuel requirement by slight variation in the thermal and other relationships of the parts.

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

1. An intake manifold comprising a hollow member including branches having an intermediate opening for supplying a charge mixture thereto, each of said branches including an upper portion of uniform cross section, and a lower portion extending below the general outline of the upper portion and merging therewith to complete the branch passage, the successive cross-sections of said lower portion having substantially equal radii and being described about centers decreasing in distance below the axis of the upper portion in the direction towards the outer end of the branch.

2. An intake manifold comprising a hollow member including branches having an intermediate opening for supplying a charge mixture thereto, each of said branches including a semi-cylindrical upper portion and a lower portion extending below the general outline of the upper portion and merging therewith to complete the branch passage, the successive cross-sections of said lower portion being substantially semi-circles described about centers of decreasing distance below the axis of the upper portion in the direction towards the outer end of the manifold.

3. An intake manifold comprising a hollow member including branches having an intermediate opening for supplying a charge mixture thereto, each of said branches including a substantially horizontal semi-cylindrical upper portion and a lower portion extending below the general outline of the upper portion and merging therewith to complete the branch passage, the successive cross-sections of said lower portion being substantially semi-circles of radii substantially equal to the radius of the upper portion and described about centers of decreasing distance below the axis of the upper portion in the direction towards the outer end of the manifold.

4. A charge forming and distributing manifold comprising an intake conduit including branches of progressively decreasing cross-section towards the outer ends thereof, and having the lower wall portions inclined downwardly towards the center, and an exhaust conduit formed integrally with the lower wall portions of said branches.

5. A charge forming and distributing manifold

comprising an intake conduit including branches, and an exhaust conduit formed integrally with the lower portions of said branches and extending substantially coextensively therewith, the portions intermediate said conduits progressively increasing in thickness from the inner ends thereof to the outer ends.

6. A charge forming and distributing manifold comprising an integrally formed unit including branched intake and exhaust manifolds having central intake and outlet portions respectively, the lower portions of the intake branches being formed integrally with the upper portions of the exhaust branches, each pair of integral intake and exhaust manifold branches being disposed so that the general outlines thereof are approximately tangential to each other at the juncture thereof, the juncture forming a relatively reduced connecting neck of limited thermal conductivity extending longitudinally of the branches.

7. A charge forming and distributing manifold comprising an integrally formed unit including branched intake and exhaust manifolds having central intake and outlet portions respectively, the lower portions of the intake branches being formed integrally with the upper portions of the exhaust branches, each pair of integral intake and exhaust manifold branches being disposed so that the general outlines thereof are approximately tangential to each other at the juncture thereof, the juncture forming a relatively reduced connecting neck of limited thermal conductivity extending longitudinally of the branches, said neck increasing in thickness progressively from the inner end thereof to the outer end.

8. A charge forming and distributing manifold comprising a hollow member having an opening intermediate the ends thereof for supplying a charge mixture thereto, and including branches open at the outer ends thereof for the egress of the charge mixture, each of said branches including an upper portion forming a part of the branch passage having a substantially uniform cross-sectional area and a lower portion depending below the general outline of the upper portion and merging therewith to form a complementary portion of the branch passage, said last named portion decreasing in cross-sectional area progressively towards the outer end thereof, whereby to decrease said branch passage in cross-sectional area as a whole at a relatively lesser rate than the rate of decrease of the lower passage portion, and an exhaust conduit disposed below and extending along said lower portions in thermo-conductive relation thereto.

9. A charge forming and distributing manifold comprising a hollow member having an opening intermediate the ends thereof for supplying a charge mixture thereto, and including branches open at the outer ends thereof for the egress of the charge mixture, each of said branches including a substantially straight horizontal upper portion forming a part of the branch passage having a substantially uniform cross-sectional area and a lower portion depending below the general outline of the upper portion and merging therewith to form a complementary portion of the branch passage, said last named portion decreasing in depth and cross-sectional area progressively toward the outer end thereof, whereby to provide for drainage towards the center of the manifold and decrease said branch passage in cross-sectional area as a whole at a relatively lesser rate than the rate of decrease of the lower

passage portion, and means for the passage of a heating medium extending along said lower portions in thermo-conductive relation thereto.

10. A charge forming and distributing manifold comprising an intake conduit having lateral branches, the lower portions of said branches being inclined downwardly towards the center relative to the upper portions thereof and forming a passage portion decreasing in cross-sectional area relative to the upper portion in the direction towards the outer ends of the branches for accelerating the charge passing through each branch as a whole, and an exhaust conduit formed integrally with said branches substantially below the plane of the bases thereof and extending along the lower portions for supplying heat primarily thereto.

11. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, lateral branches, and a recessed portion in axial alignment with said inlet portion substantially beyond the path of travel of the charge mixture, the lower portions of the branches substantially from the discharge ends thereof to said recessed portion being inclined to drain liquid fuel into said recessed portion, and means for supplying heat to the exterior of said recessed portion.

12. A charge forming and distributing manifold comprising an intake conduit having a downdraft inlet portion and lateral branches, the lower portions of said branches being inclined downwardly toward the center from substantially the discharge ends thereof, a recessed portion opposite said inlet at the termination of said inclined portions, and means for heating said inclined and recessed portions.

13. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, lateral branches, and a recessed portion in axial alignment with said inlet portion substantially beyond the path of travel of the charge mixture, the lower portions of the branches substantially from the discharge ends thereof to said recessed portion being inclined to drain liquid fuel into said recessed portion, and an exhaust conduit disposed below said inclined portions in thermo-conductive relation thereto and enclosing the outer side of said recessed portion for supplying heat to said portions.

14. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, lateral branches, and a recessed portion in axial alignment with and facing said inlet portion substantially beyond the path of travel of the charge mixture, and an exhaust conduit formed integrally with and in thermo-conductive relation to the lower portions of the branches substantially from the discharge ends thereof to said recessed portion and entirely enclosing the outer sides of the walls of said recessed portion.

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

16. A charge forming and distributing manifold comprising an intake conduit having a downdraft inlet portion, lateral branches, and a recessed portion in axial alignment with and facing

said inlet portion substantially beyond the path of travel of the charge mixture, the lower portions of the branches substantially from the discharge ends thereof to said recessed portion being inclined to drain liquid fuel into said recessed portion, said recessed portion having an opening at the base thereof for bleeding air thereinto and draining fuel therefrom, and means for supplying heat to the exterior of said recessed portion.

17. A charge forming and distributing manifold comprising an intake conduit including a central inlet portion and branches extending therefrom, a recessed portion forming a receptacle for fuel disposed in alignment with said central inlet portion at the juncture of said branches substantially beyond the path of travel of the charge mixture, said receptacle having a vent at the base thereof in communication with the atmosphere for passing air thereinto for agitating fuel therein to assist vaporization, and an exhaust gas conduit entirely enclosing the outer side of the wall of the recessed portion.

18. A charge forming and distributing manifold comprising an intake conduit including a central downdraft inlet portion and branches extending therefrom, a recessed portion forming a fuel receptacle in alignment with said central portion at the juncture of said branches substantially beyond the path of travel of the charge mixture, the lower portions of said branches draining into said recessed portion, a vent at the base of said receptacle in communication with the atmosphere for air agitating the fuel therein to assist vaporization, and for draining said recessed portion, and a branched exhaust conduit disposed below said intake conduit and extending along and formed integrally with the lower portions of the intake branches, said exhaust conduit having a central outlet, and entirely enclosing the outer side of said recessed portion in proximity to the juncture of the branches of the exhaust conduit.

19. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, branches extending therefrom, and an annular chamber in alignment with said inlet portion having an annular mouth opening into said intake conduit, and means disposed at the outside of said chamber for exposing the walls thereof to a heating medium.

20. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, branches extending therefrom, and an annular chamber in alignment with said inlet portion and opening into said intake conduit, and an exhaust gas conduit receiving said annular chamber and substantially entirely enclosing the wall of said chamber at the outside thereof.

21. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, branches extending therefrom, and a fuel receiving chamber in alignment with said inlet portion substantially beyond the path of travel of the charge mixture, said chamber including a peripheral wall portion directed outwardly relative to the inlet portion and a return wall portion disposed within the peripheral wall portion in spaced relation thereto and forming a dome therein facing said inlet portion, and means for exposing the outside of the chamber to a heating medium.

22. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, branches extending therefrom, and

a fuel receiving chamber in alignment with said inlet portion substantially beyond the path of travel of the charge mixture, said chamber including a peripheral wall portion directed outwardly relative to the inlet portion and a return wall portion disposed within the peripheral wall portion in spaced relation thereto and forming a dome therein facing said inlet portion, said dome having a hollow interior, and an exhaust conduit for exposing the outside of the peripheral wall portion and the interior of said dome to heating by exhaust gas.

23. A charge forming and distributing manifold comprising an intake conduit having a chamber for receiving fuel projected out of the air stream, said chamber including a peripheral wall portion directed outwardly and a return wall portion disposed within the peripheral wall portion in spaced relation thereto and forming a hollow dome therein, an exhaust conduit disposed to expose the outside of the chamber to exhaust gas heat, and means for causing a flow of exhaust gas through the hollow dome portion.

24. A charge forming and distributing manifold comprising an intake conduit and a hollow dome portion therein, an exhaust conduit associated with said dome portion, and means for deflecting a portion of the exhaust gas through said dome, said means including an opening for venting the deflected exhaust gas from said dome directly to the atmosphere.

25. A device for supplying heat to charge material for an internal combustion engine comprising an annular well part opening into the intake manifold and having its exterior wall exposed to exhaust gas stream, and means for securing circulation of exhaust gas in contact with the interior walls thereof.

26. A charge forming and distributing manifold comprising an intake conduit having an inlet portion, branches extending therefrom, and an outwardly directed annular portion in alignment with said inlet portion, an exhaust conduit formed integrally with said intake conduit and having a central discharge outlet enclosing said outwardly directed annular portion, and a member composed of material of high heat conductivity having a hollow dome portion closing the outer end of said outwardly directed annular portion and extending into the same in spaced relation thereto to form a chamber therewith, said member having an integral massive portion within the exhaust conduit constituting a heat reservoir and serving to cause flow of exhaust gas through said dome portion.

27. A charge forming and distributing manifold comprising an intake conduit having a downdraft inlet portion, branches extending therefrom and a portion projecting below the conduit in alignment with said inlet portion, an exhaust conduit formed integrally with the lower portion of said intake conduit and having a central discharge outlet concentric with said projecting portion, and a member composed of material of relatively high conductivity having a hollow dome portion closing the outer end of said projecting portion and extending into the same in spaced relation thereto to form a chamber therewith, said member having a depending massive portion within the discharge outlet including a partition extending medially into said dome portion to form a passage there-through, said member serving to positively deflect a portion of the exhaust gas into said passage at one end thereof, and the opposite end of

the passage being vented to atmosphere through an opening separate from said discharge outlet.

28. A charge forming and distributing manifold comprising an intake conduit having an intermediate inlet portion, and a recessed portion in alignment with said inlet portion, and an exhaust conduit having an intermediate outlet portion disposed about said recessed portion, and a jacket disposed about said inlet portion and in communication with the main portion of the exhaust conduit.

29. A charge forming and distributing manifold comprising an exhaust conduit having a central outlet portion and an intake conduit having a central inlet portion, and a recessed portion in alignment therewith beyond the path of travel of the charge through said intake conduit and extending into said exhaust conduit contiguous to the outlet portion thereof, said recessed portion including an exhaust gas heated wall in heat transfer relation to the intake conduit and composed of material of relatively high heat conductivity and including a more massive part of like material integral with said wall and in part spaced therefrom to allow direct contact of the exhaust gas with said wall, said massive part within the exhaust conduit serving to facilitate heat conduction to the wall of said recessed portion.

30. A charge forming and distributing manifold comprising an exhaust conduit, an intake conduit having an inlet portion, a peripheral portion in alignment with said inlet portion extending into the exhaust conduit, and a dome shaped portion having a hollow interior, extending into said peripheral portion to form therewith an annular chamber and including means for directing the exhaust gas into said hollow interior.

31. A charge forming and distributing manifold comprising an exhaust conduit, an intake conduit having a downdraft inlet portion, and a recessed portion below said inlet portion extending into said exhaust conduit, said recessed portion including an exterior wall and an interior dome shaped wall extending into the confines of said first named wall in spaced relation thereto, and means for causing passage of exhaust gas in contact with the dome shaped wall.

32. A charge forming and distributing manifold comprising a downdraft inlet portion, and a convex wall portion disposed within a recess in the manifold at the lower side thereof substantially in alignment with said inlet portion, said convex wall portion being disposed in spaced relation to the wall of said recess and having a hollow interior exposed to the heated exhaust gases.

33. A charge forming and distributing manifold comprising a downdraft inlet portion, and a convex wall portion in alignment with said inlet portion at the lower side of the manifold substantially beyond the path of the charge into the branches, said convex wall portion being composed of a metal of high thermal conductivity, and having a hollow interior, and means for positively circulating exhaust gases through said hollow interior.

34. A charge forming and distributing manifold comprising a convex hollow portion composed of a metal of high thermal conductivity and disposed in the manifold to be impinged by fuel particles contiguous to a point of deflection of the charge in the manifold, said hollow portion having an opening to the interior thereof from the exhaust gas stream, and means disposed me-

dially of said opening and in spaced relation to the closed end of said hollow portion for causing hot exhaust gases to be deflected from said exhaust gas stream through the interior of said hollow portion in contact with the wall thereof.

35. An intake manifold for internal combustion engines comprising a conduit having an angularly related passage portion, and a dome shaped hollow portion disposed within a recess in alignment with said angularly related portion at the opposite side of said conduit substantially beyond the path of travel of the charge therein, the exterior of the dome-shaped portion being disposed to be impinged by fuel particles thrown out by inertia when the charge is deflected, and the interior of said dome-shaped portion being exposed to hot exhaust gases.

36. An intake manifold for internal combustion engines comprising a conduit having a charge inlet portion at one side, said conduit having a recess opening therein at the opposite side thereof in alignment with said charge inlet, and a hollow dome-shaped portion disposed within said recess in spaced relation to the wall thereof, the convex side of the dome being disposed within said recess entirely beyond the plane of said conduit and facing said charge inlet, and the inner side of said dome being exposed to hot exhaust gases.

37. An intake manifold for internal combustion engines comprising a conduit having a charge inlet at one side thereof, and a recess opening into said conduit at the opposite side thereof in alignment with said charge inlet, and a hollow dome-shaped portion disposed within said recess in spaced relation to the wall thereof, the outer side of said dome facing the charge inlet, and the outer side of the wall of said recess and the inner side of said dome being exposed to hot exhaust gases.

38. An intake manifold for internal combustion engines comprising a conduit having an angularly related passage portion at one side thereof, and a recess opening into said conduit at the opposite side thereof in alignment with said angularly related portion, and a hollow dome-shaped portion disposed within said recess in spaced relation to the wall thereof, said dome shaped portion having the outer side thereof facing said inlet portion, and being composed of a metal of relatively high thermal conductivity compared to iron; and means for causing the flow of hot exhaust gases through the interior of said dome in contact with the highly conductive wall thereof.

39. An intake manifold for internal combustion engines comprising a conduit having an angularly related passage portion at one side thereof, and a recess at the opposite side thereof in alignment with said angularly related portion, a hollow member disposed within said recess and having the outer side thereof facing said inlet portion and extending transversely and recessively relative thereto in spaced relation to the wall of said recess to be impinged by fuel particles thrown out by inertia when the charge is deflected, and means for by-passing hot exhaust gases from the exhaust gas stream through the interior of said hollow member.

40. An intake manifold for internal combustion engines comprising a conduit having an angularly related charge inlet portion at one side thereof, and a hollow member at the opposite side of said conduit in alignment with said inlet portion, the outer side of said member facing said inlet portion and extending transversely and re-

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- cessively relative thereto, to be impinged by the fuel particles thrown out by inertia when the charge is deflected, and the inner side of said member being subjected to a flow of hot exhaust gases therethrough, and said member being composed of a metal of relatively high thermal conductivity compared to iron for transferring the heat at a rate producing spheroidal vaporization of the impinging fuel.
- 10 41. An intake manifold for internal combustion engines comprising a conduit having a down-draft intermediate charge inlet portion at one side thereof, and a hollow portion at the opposite side of said conduit in alignment with said inlet portion, the outer side of said hollow portion facing said inlet portion and extending transversely and recessively relative thereto to be impinged by fuel particles thrown out by inertia when the charge is deflected, the wall of said hollow portion being composed of a metal of relatively high thermal conductivity, and means for causing a positive flow of hot exhaust gases through the interior of said hollow portion.
- 15 42. An intake manifold for internal combustion engines comprising a charge conduit having an angularly related passage portion at one side thereof and a hollow portion composed of a metal of high thermal conductivity and disposed within a recess at the opposite side of said conduit in alignment with said angularly related portion, the outer side of said hollow portion extending transversely and recessively relative to said angularly related portion to be impinged by fuel particles thrown out by inertia when the charge is deflected, and means for insuring a positive flow of hot exhaust gases through the interior of said hollow portion, the conductivity of the convex wall and the flow of exhaust gases in contact therewith being coordinated to cause spheroidal vaporization of the impinging fuel.
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- ARLINGTON MOORE.

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