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FUEL RECLAIMING SYSTEM FOR COMBUSTION ENGINES

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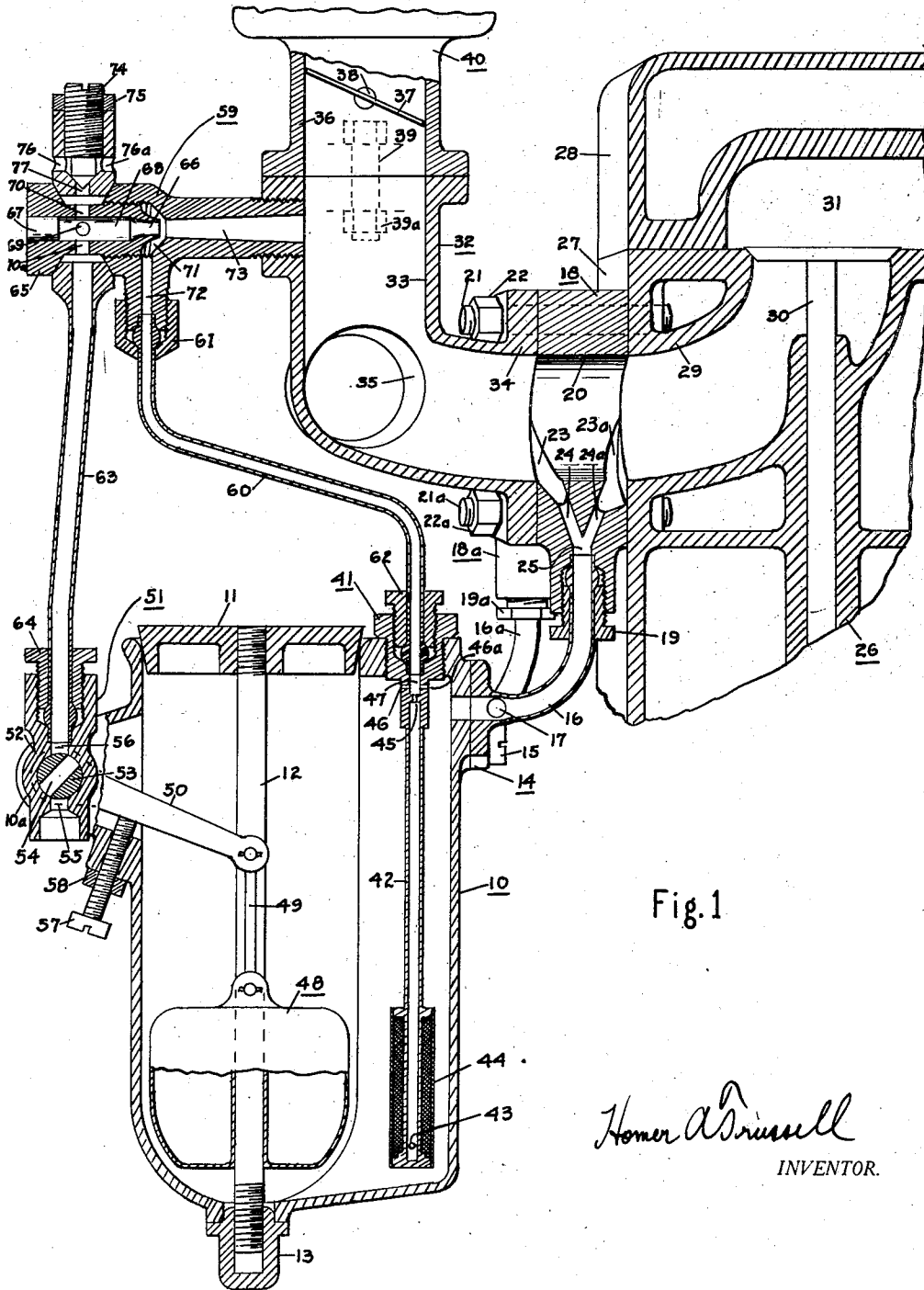


Fig. 1

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FUEL RECLAIMING SYSTEM FOR COMBUSTION ENGINES

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This invention relates to combustion engines, and more particularly, to a new and improved fuel system for such, said system comprising a reclaimer and certain other elements, the structure and function of which is made clear in the following specification.

Automotive engineers of the present day have developed high speed, high compression motors, to meet modern needs, and in so doing have brought to light many new factors in this field; the volume and quality of fuel required for such an engine under the wide range of operating requirements to which it is subject, at once suggesting the magnitude and scope of the problem. For instance, it is apparent that when employing down-draft carburetion, which is now so popular with the automotive industry, fuel is literally being poured into the engine, the volume of such fuel reaching tremendous proportions at high speeds, and while the choke is being employed, as in starting; yet a considerable portion of said fuel, in spite of all modern refinements in carburetion, being unfit to enter the combustion chambers of the engine. That is, the charge as formed invariably contains unvaporized liquid fuel in particles, said particles for the most part representing surplus over what is properly required for mixture strength, and taking the form of raw gasoline under certain conditions such as low temperature operation, improper design or adjustment of the engine and/or its accessories, or the employment of fuel of low volatility.

What has been said concerning down-draft carburetion is likewise applicable to up-draft, cross-draft, or any other system now known or used, the essential point and fact for the purpose of this discussion being that liquid fuel does get into the induction conduits of present day engines in extraordinary quantities, whether from causes previously stated or from flooding or leakage of the carburetor, difficulties encountered in starting the engine from any cause, or for other reasons.

Several conventional methods exist for handling liquid fuel thus accumulated. For instance, it may be forced on into the engine. This is the most obvious means of getting rid of such fuel, but is wasteful of gasoline, causes excessive wear of engine parts by diluting the lubricating oil, washing oil from the cylinder walls and various moving parts of the motor, causing valves to stick, and generating carbon, all of which constitutes unnecessary abuse of the engine. Another method, popular in recent years, of at-

tempting to get rid of this liquid fuel is to apply excessive heat to the induction conduit. Such an expedient as forming hot spots or hot walls is rapidly losing favor, however, since it has the same objections as to the first method while the engine is cold (that is, until sufficient time has elapsed to heat the walls); and contributes to the loss of volumetric, fuel, and thermal efficiencies, while the engine is hot. In addition, such a system is not entirely effective even for the primary purpose intended, in view of the tendency of fuel globules to bounce off a hot surface much as does water from a heated stove top, the result of such action being that the liquid fuel is carried into the motor with attendant undesirable consequences as heretofore described. A third method of partially disposing of liquid fuel accumulating in induction systems consists of letting such fuel run out onto the ground after the engine has stopped, a check valve being employed for this purpose; such an expedient having gained rapid favor in recent months. This has the same evils as the first system described though, while the motor is running, the fuel then being drawn thereinto in the usual manner; while if the engine is stopped, or otherwise stalls from too great a burden of accumulated fuel, raw gasoline is permitted to drain out on the ground, thereby creating a dangerous and unnecessary fire hazard, the system merely amounting to the trading of one evil for another.

An object of this invention is to provide a means for returning liquid fuel drained from the induction conduits of a combustion engine, to the working charge in combustible form through the employment of auxiliary air.

Another object is to provide a means of reclaiming liquid fuel that would otherwise be wasted.

Another object is to provide a reclaimer that will return fuel to the working fluid most rapidly when it is most needed there.

A still further object is to provide a reclaimer of the foregoing character which will return combustible fuel to the working fluid, of a richness in keeping with the requirements of varying operating conditions.

Another object is to provide a fuel reclaiming construction which may operate without any moving parts, and yet be capable of varying the reclaimed fuel-air mixture inversely to induction suction variations; that is, so that the proportion of fuel in said mixture reduces as induction suction increases.

Another object of this invention is to provide a draining adapter which materially aids in draining liquid fuel from the induction system, and in preventing its being drawn back thereinto during normal phases of engine operation.

Another object is to provide automatic means for accomplishing the foregoing.

Taken broadly, the objects of my invention are to provide means for improving engine operation and efficiency; insure greater power and flexibility; secure greater longevity; and effect substantial savings in fuel by employment of the fuel system described herein.

These and other objects made apparent throughout the further progress of this specification are accomplished by means of the instant invention, a full and complete understanding of which is made possible by reference to the drawing herein, in which:

The single figure is a view substantially in vertical cross-section of my fuel system as applied to a combustion engine.

Referring now to the drawing, 10 represents a liquid fuel accumulator, fabricated from suitable material, and of a desired size and shape, provided with a tightly fitting cover 11 held in place by a retaining stud 12, said stud engaging a drain nut 13 at one end, which arrangement seals the device against admission of air thereinto at these points. Adjoining accumulator 10 is a drain manifold 14 held in place by a retaining screw 15, and emptying into which is a series of drain tubes 16 and 16a having outlets such as at 17, and being connected at their opposite ends to a series of draining adapters 18 and 18a by means of packing glands 19 and 19a.

Attention is now directed to adapter 18, which consists of a block of metal having a working fluid conduit 20 therein to conform to the inner dimensions of the outlet branch of the induction manifold with which it is associated, and being mounted between such branch and the engine by means of induction manifold retaining studs 21 and 21a and retaining nuts 22 and 22a. Adapter 18 is provided with one or more drain grooves 23 and 23a, preferably draining from opposite directions and being united by holes 24 and 24a to form drain outlet 25, such an arrangement insuring that fluid flowing either way to the adapter will encounter an acute edge and a draining path in the direction of flow and down with gravity.

In the drawing, 26 represents an engine fragment, 27 the cylinder block, 28 the cylinder head, 29 an intake port, 30 the intake valve, and 31 a combustion chamber. 32 refers to the working fluid induction manifold, which has an inlet conduit 33 and outlet branches 34 and 35. 36 is the carburetor working fluid delivery conduit, in which operates throttle valve 37 upon shaft 38, while retaining bolt 39 and nut 39a unite carburetor 40, (shown in fragmentary form) with the induction manifold.

Carburetor 40 is not illustrated in detail for the reason that any conventional carburetor that will deliver a combustible working charge is suitable for the purposes of the instant system.

Situated within accumulator 10 is a primary vaporizer 41, said vaporizer having an intake tube 42 provided with a fuel inlet aperture 43 and surrounded by a metal strainer 44 which may consist of a gauze cylinder, the function of which is to keep particles of foreign matter draining from the induction manifold, from returning thereto and clogging other parts in so doing. Vaporizer 41 has a fuel metering aperture 45 in its upper

portion, air or vapor metering apertures and vents, 46 and 46a, for the fuel accumulator, and a mixing chamber and outlet 47.

A float 48 is positioned within 10, pivoted to the top of which float is a connecting rod 49 which is in turn pivotally mounted with the operating lever 50 of auxiliary air inlet control 51, said control comprising a valve housing 52, control key 53, having an aperture 54; and control valve inlet aperture 55 and outlet aperture 56; control 51 being housed within an extension 10a of liquid fuel accumulator 10, as indicated in the drawing. An adjusting stop screw 57 in conjunction with nut 58 engages operating lever 50 in a manner and for a purpose described in greater detail elsewhere herein.

Attention is now directed to secondary vaporizer 59, which is connected with primary vaporizer 41 by means of hollow tube 60 and packing glands 61 and 62, and to auxiliary air inlet control 51 by means of tube 63 and packing gland 64. Vaporizer 59 may consist of an auxiliary air nozzle 65 having an outlet 66 and a plug 67 which closes the opposite end of said nozzle; a conduit 68 having air inlets 69, 70 and 70a; a fuel feeding chamber 71, a fuel inlet aperture 72, and a delivery venturi 73.

Secondary vaporizer 59 is surmounted by an initial air inlet adjusting screw 74 cooperating with a lock-nut 75, and controlling admission of air through apertures 76 and 76a, air passing into 59 through outlet aperture 77.

In operation my fuel system works as follows: Carburetor 40 delivers a working charge to working fluid induction manifold 32, from which it passes to the inlet conduit 33 and to various outlet branches such as 34 and 35 illustrated in the drawing. During this operation, liquid fuel forms in the induction system, for any of the reasons previously set forth herein, or for other causes, which fuel, instead of being forced into the engine as in the case of conventional systems now in use, encounters the sharp edges of draining grooves 23 or 23a and aided by the force of gravity and certain other factors discussed elsewhere herein, passes downwardly through holes 24 and 24a into drain outlet 25 and hence through tube 16 and drain manifold 14 into fuel accumulator 10, the fluid entering said accumulator through a passageway substantially at right angles to an upright position, this latter preventing excessive agitation of liquid in 10 upon a surge of fluid thereto concurrently with a sudden increase of pressure in the induction conduit.

While a series of individual draining adapters is indicated herein on the theory that each induction conduit outlet branch may best be drained separately, it is obvious that the induction manifold may be constructed to drain at a single point.

As liquid fuel accumulates in 10, it is now lifted in metered quantities through aperture 43 of intake tube 42 into primary vaporizer 41 where it mixes with air or vapor entering through vents 46 and 46a, and hence passes through tube 60 as a very rich mixture to secondary vaporizer 59, where it is compounded with an auxiliary air blast from nozzle 65 and then sprayed directly into the induction manifold 32 at a point near carburetor 40. Summarized, the system permits fuel to be drained from points close to the engine, accumulated at another point, and sprayed directly into the induction conduit at a third point close to the carburetor.

With the accumulation of liquid fuel in 10, float 48 rises, carrying with it connecting rod 49 75

which in turn actuates operating lever 50 of auxiliary air inlet 51.

Thus it is apparent that as float 48 rises, the inlet aperture 54 of control valve 53 is increasingly brought into registry with the inlet aperture 55 of 51, thus bringing an increasing volume of auxiliary air to the vaporizers with an increase of liquid in the accumulator; and conversely, reduces such supply as the supply of liquid diminishes. Screw 57 may readily be adjusted to vary the low opening of 51, or to permit it to close entirely. Further, screw 74 may be adjusted to prevent air from entering through 77, or to vary the amount of air admitted independently of 51. It is apparent that the lower the float is suspended in 10, the less fluid will have to accumulate therein before an increase in air delivery occurs.

The arrangement shown provides for an increasing volume of reclaimed fuel delivery to the induction conduit as the height of fuel in 10 increases, and may serve as a fast idling means which permits the engine to return to normal idle when the level of the accumulated fuel recedes to a given height. The use of control 51 has the additional advantage of varying the activity of the vaporizers so the liquid fuel gets back into the working fluid more rapidly while it is needed most, the phase of engine operation which results in the most rapid accumulation of liquid fuel naturally being the one which most needs the help of the vaporizers, and consequently there is less liquid fuel remaining to be returned after the engine is warm enough to have less need of the fuel, the foregoing being accomplished without feeding a surplus of auxiliary air while the engine is normally warm and liquid fuel is low or exhausted. In this connection however it is to be noted that my system operates satisfactorily without any moving parts or adjustments, as by eliminating 51 entirely and making the aperture 66 of nozzle 65 the desired size, and calibrating the remainder of vaporizers 41 and 59 according to the characteristics desired, liquid fuel from the induction system being handled without upsetting the working fluid supplied by 40.

As a matter of fact, engine performance is actually improved with the foregoing arrangement, even when starting cold, since liquid fuel is kept from entering the combustion chambers, and the exceptionally powerful vaporizing action of the device guarantees the delivery to the induction manifold of a highly combustible mixture.

My fuel reclaiming system has the unique characteristic of being susceptible of a calibration which will feed a richer reclaimed fuel mixture to the induction manifold when the suction therein is reduced concurrently with an increase in the opening of the throttle 37, or with a reduction in engine speed for a given opening of said throttle, thereby using the accumulated fuel available, to the best advantage in developing power, and still providing for a mixture strength suitable for low throttle and high suction operation. The foregoing characteristic enables more accumulated fuel to be returned to the induction system with less auxiliary air in a given length of operation than would be possible if the ratio of these two fluids were constant, or nearly so, or changing inversely, as is the case where the conventional arrangement for fuel feeding, that is a fuel jet in an air venturi, is used, during induction suction variations.

The desirability of this characteristic is at once apparent when considering the fact that while

the engine is operating at sub-normal temperature, the draining of liquid fuel from the induction conduit is greater, and hence the need of assistance from the additional vaporizers is likewise greater, it being therefore desirable to have these vaporizers active enough to use as much as possible of the supply of accumulated fuel during this period, without having the auxiliary air delivery large enough to result in insufficiently rich mixtures for this period; or in excessive engine speed for given throttle openings.

Again, a ratio of reclaimed fuel and air desirable, particularly in the case of a cold engine, for operation resulting in low induction suction, would otherwise be too rich for idling and other high induction suction operation.

A still further advantage of this characteristic lies in the fact that fuel can be reclaimed fast enough for satisfactory operation with auxiliary air admitted through an aperture as small as a pin hole, and even without the aid of control 51 or any other means of increasing this air. With such a small amount of auxiliary air, little or no change is necessary in the initial carburetor adjustment, even though no means be used to reduce this air when the engine is idling. Experimentation has shown that even with such a small amount of auxiliary air present for feeding and vaporizing the liquid fuel, kerosene or distillate can be handled by auxiliary vaporizers 41 and 59; and at freezing temperatures, which fact is particularly significant in view of the modern trend towards cold carburetion.

Attention is now directed to a unique and outstanding feature of the instant invention, the advantages of which are obvious. It is apparent that secondary vaporizer 59 must increase suction in fuel inlet aperture 72 over that existing in accumulator 10 in order to lift liquid through fuel metering aperture 45 of primary vaporizer 41, and that the higher the ratio of suction in 72 to that of 10, the greater will be the flow at 72. The arrangement of the component parts of the device, if not the ratio of dimensions shown, may result in a suction ratio which increases to the advantage of fuel lifting as the induction suction reduces. Suction reduces in 72 while suction reduces in the working fluid induction manifold, and likewise reduces in accumulator 10, since the suction in 10 is substantially equal to that in the induction manifold, but the reduction in 72 may be proportionately slower than in 10, so the net suction available for lifting fuel will be greater at lowered induction suction.

Such a condition results in a richer reclaimed fuel-air mixture due to a decreased flow of auxiliary air and an increased, or relatively increased, flow of accumulated fuel to the vaporizers. The foregoing action may be altered for the various degrees of suction by changing the size, shape, and/or relative positions of the parts of the vaporizers, particularly those of secondary vaporizer 59; and may actually be increased to the point of causing a reversal of flow of fluid through 72 and mixing chamber outlet 47 at a predetermined high degree of induction suction, which effect may be used advantageously in conserving accumulated fuel while induction suction is above that occurring during normal engine operation, as when an automobile is coasting with the engine in gear and the fuel throttle in low position.

Although my invention has been described herein in connection with a system employing atmospheric pressure feeding, it is apparent that it is equally applicable to systems using supercharg-

ing, or any other suitable means of feeding fuel to an engine.

A distinctive feature of my fuel system is the increasing of the suction in accumulator 10 to draw fluid thereinto by means of additional suction created by the reclaiming vaporizer 59. In this regard it is to be noted that while it is preferable to drain liquid from each induction conduit close to the engine, and to have the drain arranged so that the liquid fuel gravitates into a receptacle in spaced relation to the working fluid induction conduit, liquid fuel may be removed from the working fluid in any desired manner, and accumulator 10 may be placed in any desired elevation, because the increased suction therein, brought about by the action of 59, will lift fuel into 10 against gravity.

In connection with adapters 18 it is to be noted that these elements are suitable for installation between a conventional induction manifold and conventional engine intake ports, by installing longer studs (21 and 21a) with inclined, horizontal, or declined intake port passageways. While it may seem that there would be no tendency for fluid to flow back to the adapters where horizontal or declined ports are served, the fact is that there is a pronounced reversal of flow here also, particularly at low engine speeds, because of pumping action due to the conventional early opening and late closing of the intake valves, and, at higher speeds, due to increased pressure in the port after the valve closes. In view of this tendency, the importance of the to and fro draining action and of the increased suction described above, are obvious. Similar adapters may also be used for induction conduits with up-draft or cross-draft inlets, which, like the down-draft type, may also be adapted to drain in any desired manner at one or more points.

If desired, vaporizers 41 and 59 may be directly connected, without tube 60, and accumulator 10 may be brought up to correspond to the position shown for 59 in the drawing; or the unit composed of 10, primary vaporizer 41 and secondary vaporizer 59 may be placed in any desired position with 59 connected for delivery to the induction conduit by tubing if necessary, depending upon the position chosen. Again, in any combination of positions of 10 and 59, the float controlled valve 51 may be eliminated, and the capacity of 41 and 59 altered as desired, in which case it may be best to reduce their maximum capacity under that permissible with 51 adapted to reduce the volume delivered by 41 and 59 concurrently with a reduction in the quantity of accumulated fuel, as shown in the drawing.

For a construction which has no moving parts, I prefer to have the reclaimed fuel mixture composed of about one part of fuel to four parts of air (about four times normal mixture strength) as a maximum during operation resulting in high induction suction, or low induction pressure, this ratio of fuel to air automatically increasing predeterminedly for lower induction suction, or higher induction pressures. The fuel should be fed at a rate which normally will balance the rate of accumulation of liquid in the tank (cause the level of the accumulating fuel to stop rising) within a few minutes after the engine is started at freezing temperatures.

If desired, 51 and 59 may be united, and if 10 and 59 be in spaced relation, the movement of float 48 may be transmitted to control valve inlet aperture 55 by means of a simple mechanism readily devised by any mechanic. In the con-

struction shown in the drawing, some engineers may elect to use some auxiliary air during all phases of engine operation and to have this auxiliary air increased upon an increase in the amount of liquid fuel accumulated, in which case it may be preferable to adjust screw 74 accordingly, or to eliminate it and make aperture 77 the proper size to supply the desired minimum amount of air while allowing control key 53 to close when the float is in its lowermost position. Such would be preferable to having all of the auxiliary air handled by 51, because 53 would then increase the amount of auxiliary air admitted, upon a smaller increase in the quantity of liquid fuel accumulated.

My fuel reclaiming system has the unique operating characteristics of making the main fuel mixture over-rich with fuel, most of which would otherwise be wasted, while an over-rich mixture is urgently needed, concurrently with the fastest accumulation of liquid fuel; of withholding for subsequent use liquid fuel which is removed from the working fluid induction conduit faster than it is desirable to return it with so simple a device or while the engine is stopped; of decreasing the mixture richness as the accumulated quantity of liquid fuel becomes reduced, concurrently with increased operating temperatures; and of increasing the proportion of fuel to air being delivered by the reclaiming vaporizers upon a decrease in induction suction, or an increase in induction pressure, concurrently with an increase in throttle opening or a drop in engine speed (or relatively slow engine speed) for a given throttle opening.

It will be understood that liquid fuel accumulates very rapidly when a cold engine is first started, and decreases in rate of accumulation as the operating temperature increases. With my device, the engine starts right off firing on all of its cylinders and continues to fire regularly, even in zero weather, most of the gasoline fed by the carburetor during the first few minutes of the critical operation resulting from this low temperature (or, in other words, during the time that about a quart of gasoline is being fed by the carburetor) going through the reclaiming process. Part of said liquid temporarily remains in the accumulator tank, because the rate of accumulation, particularly while about the first pint is being fed by the carburetor, is greatly in excess of the desirable rate of vaporization and delivery of this liquid to the working fluid.

It is to be noted that my fuel system makes provision for control of time and rate of returning liquid fuel compounded with auxiliary air, to the working fluid, the operation being governed by the quantity of accumulated fuel. Also, that provision is made for admitting auxiliary air, only when there is liquid fuel accumulated, and independently of any other control. An additional advantage of not withholding accumulated fuel from returning to the working fluid during low throttle operation is that extended low throttle operation, particularly in cold weather and before the engine has been brought to normal temperature, might otherwise result in excessive accumulation in 10.

The system is automatic, independent of any connection with the initial carburetor throttle, may admit auxiliary air or not as desired, when and if the engine induction conduit be warm enough to prevent accumulation of liquid fuel; and has a simplified cover construction without gaskets, screws, nuts or washers excepting the

single stud and its nut, which also serves as a drain plug.

While I have herein described in considerable detail a specific embodiment of my invention, and suggested certain modifications thereto, it will be apparent to those skilled in the art that numerous changes in structural arrangement might be made without departure from the spirit of my invention and within the scope of the appended claims.

I claim:

1. In a fuel reclaimer, means for lifting liquid fuel in metered quantities against induction suction, means for vaporizing said fuel thus lifted with air also drawn against induction suction, and means for compounding said vaporized fuel with an auxiliary air blast.

2. In a fuel reclaiming system for a combustion engine, an accumulating chamber for liquid fuel received from the working fluid, a float in said chamber, and an air valve controlled by said float, said valve being adapted to feed auxiliary air to said working fluid whenever a predetermined amount of said liquid has accumulated.

3. In a fuel system for a combustion engine, means for delivering auxiliary air to the working fluid at all times, means utilizing said auxiliary air for directly vaporizing liquid fuel encountered in the working fluid, and means for automatically increasing the volume of said air delivered upon a predetermined increase in the amount of said liquid fuel encountered.

4. In a fuel reclaiming system for a combustion engine, an accumulator for liquid fuel encountered in the working fluid, means for controlling the incidence and the rate of return of said liquid to said working fluid, said means being independently governed by the quantity of said fuel accumulated; said liquid fuel being returned with auxiliary air to said working fluid; and means for controlling the ratio of said fuel and said air, said last mentioned means being governed by induction suction values.

5. In a fuel system for a combustion engine, a temporary fast idling device for use during cold engine operation, means for utilizing liquid fuel, which tends to accumulate in the working fluid during cold operation, to form additional working fluid, said device being governed by liquid fuel in the working fluid in such a manner that the low volume of working fluid admitted from the initial source during idling operation is materially increased while said liquid fuel is present.

6. In a fuel reclaimer, means for reclaiming liquid fuel and mixing it with air in predetermined ratios to form working fluid, and means governed by the quantity of liquid fuel available

for reclaiming, to control the quantity of working fluid delivered by said device.

7. In a fuel reclaiming system for a combustion engine, a plurality of vaporizers in series for liquid fuel being reclaimed, said vaporizers being situated in spaced relation to each other, the fuel available to the first stage of this series of vaporizers and the conduit to which the last of said series of vaporizers is adapted to deliver, being at substantially equal pressure.

8. In a fuel system for a combustion engine, an initial working fluid induction conduit, a liquid fuel drain in said conduit, adjacent the combustion chamber inlet, an accumulator for said liquid, situated in spaced relation to said drain, and a vaporizer for delivering said liquid from said accumulator to said working fluid, said vaporizer being situated in spaced relation to said drain and to said accumulator, and said accumulator being adapted to receive and deliver or withhold said liquid at pressures substantially equal to those at said inlet.

9. In a fuel system for a combustion engine, an auxiliary air inlet with an adjustment adapted to provide various fixed capacities of or to entirely close said inlet; and an auxiliary air inlet valve controlled by liquid fuel drained from the working fluid, said valve being adapted to prevent the entry of auxiliary air, or to reduce it predeterminedly while little or none of said liquid is being drained.

10. In a fuel system for a combustion engine, means using auxiliary air to form a reclaimed fuel charge, and means for increasing said auxiliary air automatically as the supply of liquid fuel to be reclaimed increases.

11. In a fuel reclaiming system for a combustion engine, a liquid fuel accumulator in two separable parts, said parts being held together by a single stud with a retaining nut serving also as a drain plug, said parts being air sealed by a tapered joint at their junction, and adapted to permit the removal of the upper of said parts without moving the other part.

12. In a fuel system for a combustion engine, an adapter between the working fluid induction conduit and the combustion chamber inlet port, for the purpose of removing liquid from said conduit, said adapter providing an unobstructed path for working fluid there-through; said adapter having two grooves for collecting liquid flowing in opposite directions in said conduit, and having an outlet duct for each of said grooves so arranged that fluid draining through either duct assists fluid to drain through the other.

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