

[54] **PLATELET-VENTURI CARBURETOR FOR COMBUSTION ENGINE**[75] Inventors: **David L. Kors**, El Dorado Hills;
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261/118[51] Int. Cl.² **F02M 19/10**; F02C 3/24[58] Field of Search 239/555; 261/118, 23 A,
261/23 R, 41 C; 60/39.74 R, 39.74 A[56] **References Cited****UNITED STATES PATENTS**

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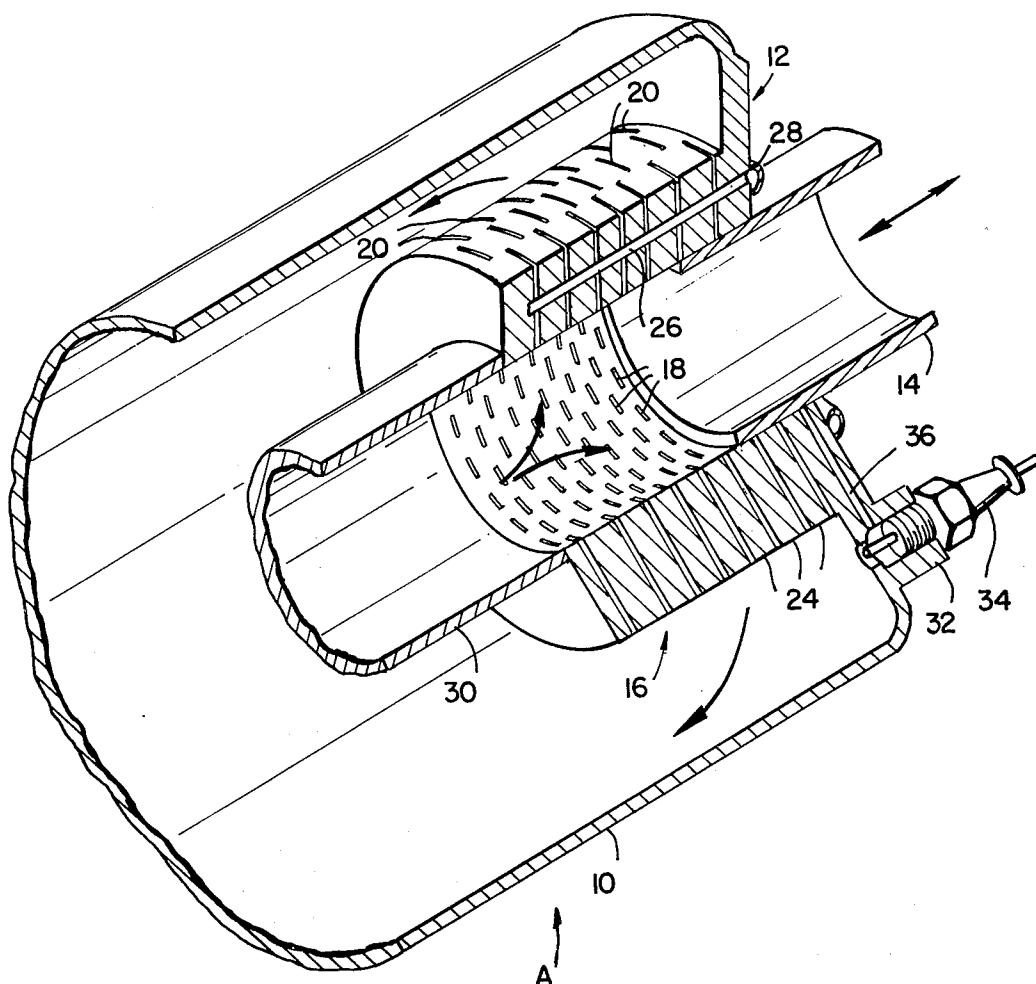
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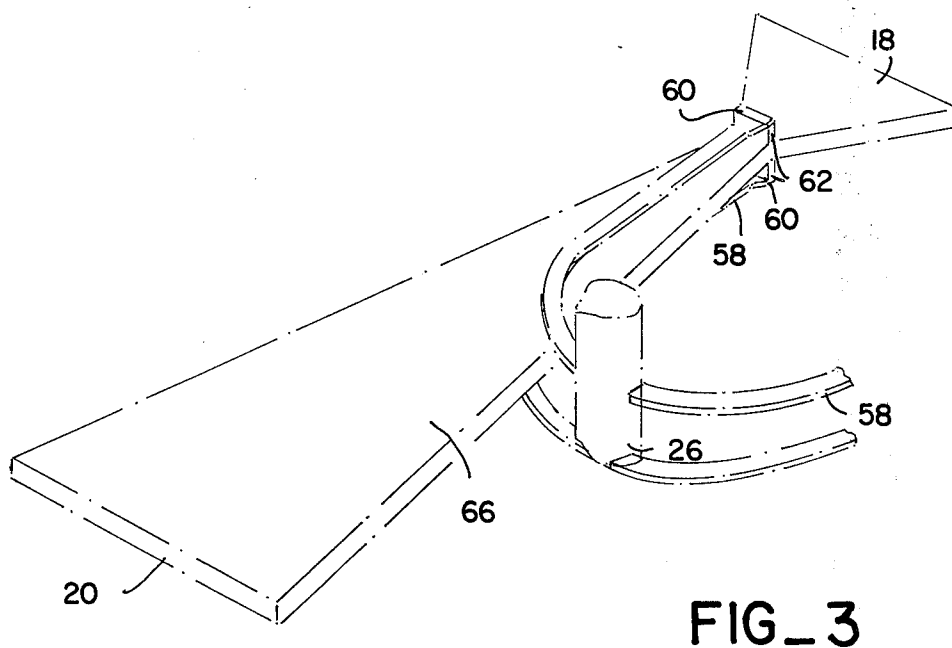
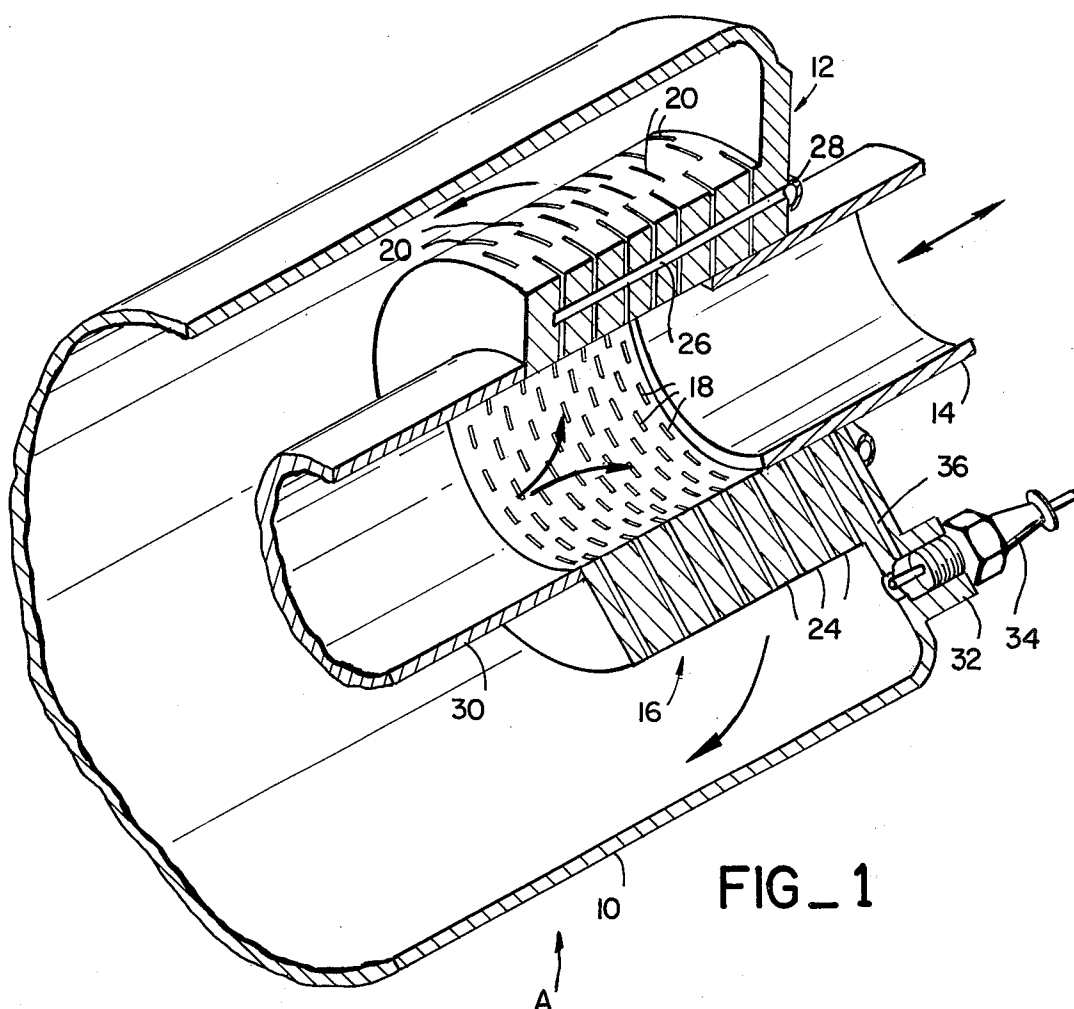
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[57] **ABSTRACT**

A carburetor for combustion engines having a large number of small venturis to accomplish atomization, vaporization and mixing of the fuel with air. The venturis are formed by an assembly or stack of platelets having fine orifices and complex channel shapes defined therein. The fuel can be either aspirated into the venturis by the difference in static pressure between the venturis and the fuel feed source, or it can be injected under pressure. The fine orifices produce droplets significantly smaller than prior art devices, and thus result in more rapid vaporization, finer atomization and better dispersing and mixing of the fuel-air mixture.

18 Claims, 3 Drawing Figures



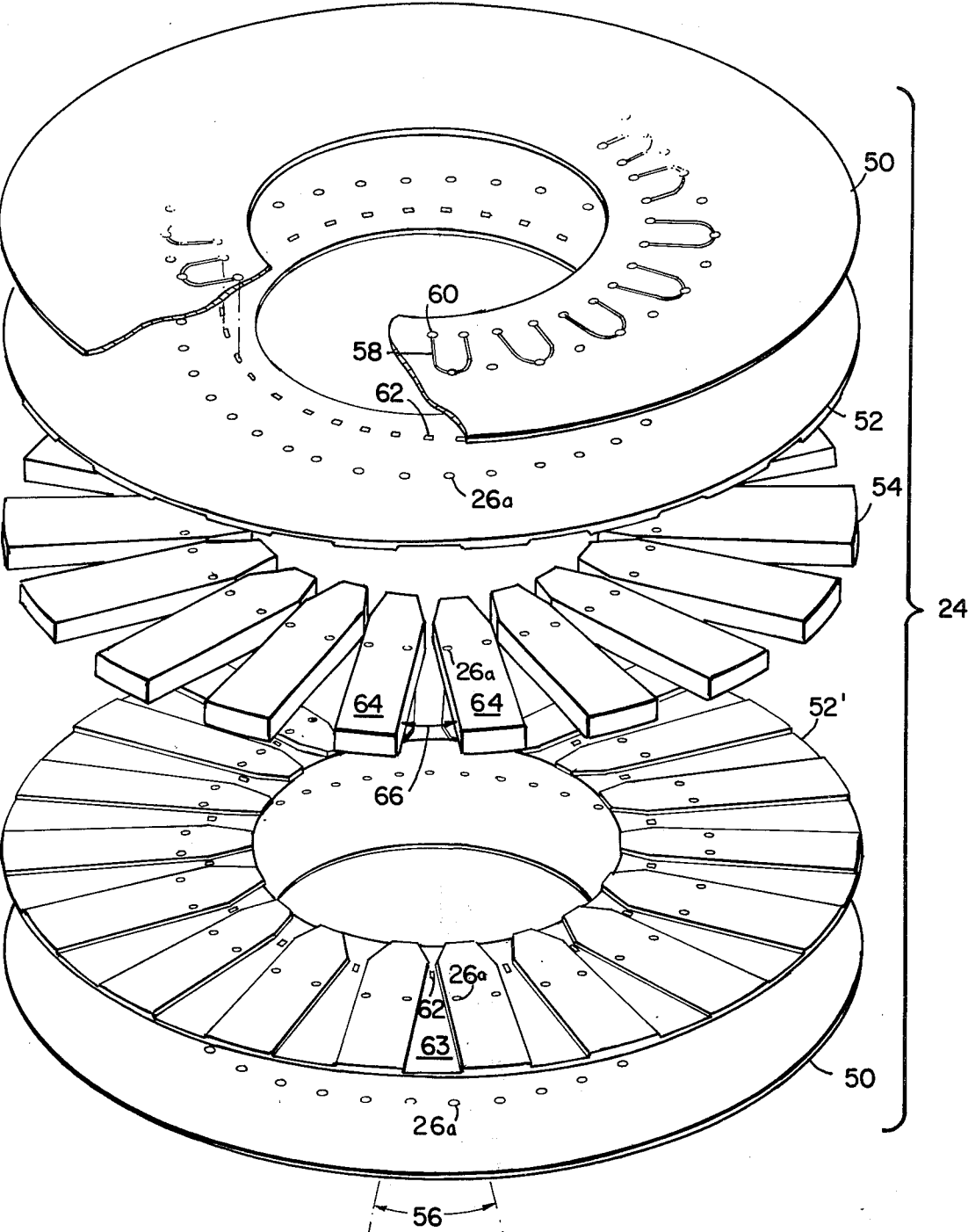


FIG. 2

PLATELET-VENTURI CARBURETOR FOR COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

This invention relates to carburetor or burner devices for external or internal combustion engines.

The dual requirements of lower allowable combustion exhaust emission levels established by Government and high combustion efficiency required by industry impose design criteria which state of the art internal or external combustion engines cannot meet. The platelet-venturi carburetor herein described will provide the carburetion capability for an external combustion engine to meet the anticipated emission and performance criteria.

The platelet-venturi carburetor will provide fuel metering, fine atomization and vaporization, and premixing of the vaporized fuel with the air. Mixing is accomplished on a fine enough scale that mixture gradients will not occur in the combustor. The platelet-venturi carburetor provides such finely atomized and vaporized fuel mixtures that droplet sizes do not exceed 20 microns. It has been established that diffusion droplet burning with its inherent near stoichiometric temperature flame front and local mixture ratio maldistributions which permit near stoichiometric combustion locally are major factors in the production of excessive NOx emissions. The fine vaporization and uniform mixing provided by the platelet-venturi carburetor will thus significantly reduce the NOx emission in external combustors.

The combustion preparation requirements, namely, vaporization and premixing, must be effected without allowing chemical reaction to occur within the venturi. Consequently, the platelet-venturi carburetor includes a flame quench capability to prevent flashback and reaction within the carburetor itself.

SUMMARY OF THE INVENTION

The platelet-venturi carburetor device is basically a carburetor which employs the venturi principle for fuel injection, atomization and mixing. The platelet-venturi carburetor actually consists of hundreds of small venturis which provides superior atomization and mixing characteristics.

The conventional carburetor throttles by controlling the mixture down stream of the venturi. The platelet-venturi carburetor is throttled by controlling the speed of the blower which provides the flow of air there-through. Fuel is introduced into the venturis at some point upstream or at the throat (i.e. point of minimum cross-sectional area). The exact point of injection is determined by required mixture ratio control over the throttle range. The fuel can be either aspirated into the venturi by the difference in static pressure between the venturi and the fuel feed source, or it can be injected under pressure. Generally, aspiration of the fuel is preferred.

The large velocity difference (approximately 500 to 1000 feet per second) between the air and fuel causes the fine atomization and dispersion of the fuel droplets. Lateral pressures within the diffuser further acts to disperse the droplets such that a uniform mixture of vaporized fuel and air is produced at the venturi exit. Flame quenching is provided by dimensioning the venturi flow sections smaller than the quench distance.

The capability of the platelet-venturi carburetor to produce fine scale atomization and mixing is a direct result of the platelet design and the photoetch fabrication process which allows precise location of the extremely fine orifices and complex channel shapes. These are the key features which permit the platelet-venturi carburetor approach to overcome the present carburetor design inadequacies. The fine orifices produce small droplets and hence more rapid vaporization, which leads to the complete combustion in short lengths required for low NOx emission levels. The orifices, being small, can be packed very close together, thus, improving heat transfer consideration conditions which effect burner face cooling and droplet vaporization. The precise location of each orifice and a large quantity of elements per unit area result in excellent mass and mixture ratio control across the burner face. The lack of restrictions on distribution complexity due to the photoetch technique permits flexibility of the design to meet a wide variety of shapes and envelope requirements.

Further reduction in the emission levels can be achieved by complete vaporization of the fuel within the platelet-venturi carburetor. The heat transfer necessary to achieve complete vaporization of the fuel can be either by conduction through the heated platelets or by direct mixing of the exhaust gases with the fuel.

The photoetch platelet concept is particularly well adapted to low cost mass production techniques. Once the basic art work and negatives have been made, the manufacture of the platelets is a repetitive process requiring little supervision. The quality control requirement is almost non-existent as each platelet is a faithful reproduction of the photographic negative. The assembly of the sequenced numbered platelets is almost fool-proof and can be rapidly accomplished by low-cost labor. The final assembled product is readily inspected by visual methods for acceptability.

These and other objects, features and advantages of the present invention will be more readily apparent from the following detailed description, wherein reference is made to the accompanying drawings, in which:

FIG. 1 is a cutaway perspective view of a preferred embodiment of the carburetor according to the present invention when used with an external combustion engine;

FIG. 2 is an exploded perspective view, partially in cutaway, of one of the platelet assemblies of the apparatus depicted in FIG. 1; and

FIG. 3 is a phantom perspective view of one of the venturis of the apparatus depicted in FIG. 2.

Referring initially to FIG. 1, there is depicted, generally at A, a carburetor or burner which, for purposes of illustration, is used with an external combustion engine. Carburetor A generally comprises a cylindrical housing 10 having an end wall 12. End wall 12 includes a central circular opening communicating with a cylindrical air inlet passage 14. The other end of housing 10 generally comprises the throat portion of the carburetor or burner A, and thus communicates with the combustion chamber of an external combustion engine.

The present invention is widely applicable to external and internal combustion engines of varying types. Typically, the throat of carburetor A may communicate directly with the combustion engine. Alternatively, a heat exchanger may be disposed adjacent the throat of car-

buretor A to extract the thermal energy of the combustion.

Disposed within housing 10 adjacent end wall 12 is a multi-venturi assembly 16 which functions to mix and vaporize fuel with the incoming air for combustion. In the depicted embodiment, multi-venturi assembly 16 is generally tubular and is disposed coaxially and adjacent with inlet air passage 14. Thus, incoming air is directed to the interior of the tubular multi-venturi assembly 16. As will be described in greater detail hereinafter, a plurality of venturi inlet ports 18 are formed on the interior surface of multi-venturi assembly 16. Inlet ports 18 communicate with a plurality of venturis which extend radially and terminate in a plurality of venturi exit ports 20 on the outer surface of the multi-venturi assembly 16.

Fuel is supplied to the venturis from an annular fuel manifold 28 which communicates with a plurality of fuel passageways 26 interior of multi-venturi assembly 16. As will be described in greater detail hereinafter, the fuel is thus fed to the venturis where it is vaporized and mixed with air. The vaporized fuel-air mixture exits from venturi exit ports 20 into the interior of housing 10 for combustion. This path is generally shown by the arrows in FIG. 1.

A secondary air inlet passage 30 is provided concentric with the bore of multi-venturi assembly 16 extending therebeyond into the interior of housing 10.

To achieve ignition of the fuel-air mixture, a threaded aperture 32 receiving a spark plug 34 is provided on end wall 12 of housing 10. A pilot fuel passage 36 is provided between fuel manifold 28 and spark plug 32 to insure an adequate supply of fuel at the spark plug for ignition.

Referring now to FIG. 2, the construction of multi-venturi assembly 16 will now be described in greater detail. The multi-venturi assembly 16 comprises an assembly or stack of platelets in the form of circular discs with central openings. Each row of venturis 24 generally comprises a stack of four platelets. There is provided a first platelet 50 which functions to distribute the fuel from the passages 26 to the venturis, second and fourth platelets 52 and 52' which form the upper and lower venturi closures respectively and third platelet 54 which defines the body of the venturi.

The platelets 50, 52, 54 and 52' may be considered as having angular sectors 56 which define a single venturi. Thus, the configuration of the platelets will now be described in greater detail with reference to a particular sector 56, it being expressly understood that the channels and passageways to be described are repetitively formed in the various sectors of the platelets to form a plurality of radially directed venturis in each stack 24 of four platelets.

Initially, it is to be noted that all of the platelets 50, 52, 54, and 52' include, in each sector 56, a hole or aperture 26a. When the platelets are assembled, apertures 26a align to define fuel passages 26 directed axially with respect to the tubular multi-venturi assembly 16.

Fuel metering platelet 50, as its name implies, functions to distribute and meter fuel from the fuel passages 26 to the venturis. To this end, there are provided through fuel metering platelet 50 a plurality of holes or apertures 60 aligned with the throats of the venturis. A channel or passage 58 is provided on fuel metering platelet 50 communicating between apertures 60 and

26a. In the embodiment depicted in FIG. 2, the venturi throats are angularly offset and radially inward from the fuel passages 26. Thus, aperture 60 is correspondingly radially and angularly offset from aperture 26a, and channel 58 traverses a J-shaped path therebetween.

Venturi closure platelets 52 and 52' are mirror images forming the upper and lower venturi closure, respectively. Each of the venturi closure platelets 52 and 52' include, in each sector 56, an aperture or hole 62 disposed in registration with aperture 60 on fuel metering platelet 50. Thus, aperture 62 is disposed at the point of fuel introduction to the venturi, i.e. at the throat or at some desired point upstream thereof. The path of fuel to the venturi is thus through passage 26a, channel 58, aperture 60 and aperture 62.

Since venturi closure platelets 52 and 52' are provided on both sides of the venturi, it is apparent that fuel is introduced into the venturi at corresponding locations on both sides thereof. To this end, the fuel metering platelet 50 of the next adjacent row 24 feeds fuel to lower venturi closure 52. It is thus apparent that each metering platelet 50 feeds the bottom of the venturi above it and the top of the venturi below it. Thus, such a second metering platelet 50 is depicted in FIG. 2 below lower closure platelet 52'.

Venturi closure platelets 52 and 52' include, in each sector 56, a venturi shaped depression 63 which cooperates with venturi body platelet 54 to define the venturi. Specifically, venturi body platelet 54 generally comprises a plurality of radially directed fingers 64 having venturi shaped spaces 66 therebetween. Spaces 66 are disposed in registration with depressions 63, and thus cooperate to form the venturi shaped passageway.

The platelets 50, 52, 54 and 52' are thus stacked in repeating sequence until the required number of rows of venturis 24 have been formed. The repetitive sequence of platelets may be offset circumferentially so that the venturi exit pattern for each row of venturis 24 may be staggered vertically. This offset provides a more uniform injection pattern and face configuration. A blank closure platelet is provided at the bottom of the stack to complete the assembly.

The fastening of the platelets may be accomplished in numerous ways. For applications where minor leakage is of no great consequence and differential pressures are low, a simple, bolted assembly is adequate. This, of course, facilitates disassembly for servicing. An alternate approach is the use of adhesives operable within the operating temperatures of the carburetor. Diffusion brazing is a feasible alternative where leakage illimation is required and temperatures prevent use of adhesives.

Referring now to FIG. 3, which is a phantom illustration of the passageways associated with one venturi element, the venturi elements will now be described in greater detail. As is apparent from FIG. 3, each venturi is substantially two-dimensional. The venturi is provided with a small expansion angle to insure maximum pressure recovery, consistent with reasonable platelet length. The length of the diffuser is selected to maximize pressure recovery and to insure adequate residence time for vaporization. The venturi height is based upon the maximum safe passage width permissible with assurance of flame quenching to prevent flame flashback into the carburetor.

To summarize the operation of the venturi, with reference to FIG. 3, it is apparent that fuel from fuel passage 26 is conducted to the throat of the venturi via channel 58 and apertures 60 and 62. As described hereinbefore, these passageways are duplicated on the opposite face of the venturi so that fuel is introduced into the venturi at corresponding points on the top and bottom thereof. The fuel can be either aspirated into the venturi by the difference in static pressure between the venturi and the fuel feed source, or it can be injected under pressure. Generally, aspiration of the fuel is preferred.

Air is forced into the venturi inlet 18 from the air supply or blower. The inhaled air passes through the venturi restriction where it is mixed with the fuel. The fuel-air mixture exits the venturi through venturi exit port 20. Since the venturis and the associated passages and orifices are substantially smaller than those found in conventional devices, smaller droplets, resulting in better vaporization, atomization and mixing are produced.

What is claimed is:

1. A carburetor comprising: a housing having an air inlet and a fuel inlet, and a platelet stack in said housing defining a plurality of venturis, said venturis being defined in planes parallel to the platelets of said stack, said stack having a plurality of fuel passages placing said fuel inlet in fluid communication with respective venturis, said platelet stack being disposed with the inlets of said venturis communicating with said air inlet.

2. A carburetor comprising: a housing having an air inlet and a fuel inlet, and a tubular platelet stack in said housing defining a plurality of venturis extending radially therethrough, said stack having a plurality of fuel passages placing said fuel inlet in fluid communication with respective venturis, said platelet stack being disposed with the inlets of said venturis communicating with said air inlet.

3. Apparatus according to claim 2, wherein said fuel passages are perpendicular to said platelets.

4. In a combustion engine carburetor having a housing provided with an air inlet and a fuel inlet, the improvement comprising: a platelet stack having a plurality of venturis defined therein and a plurality of fuel passages adapted to place said fuel inlet in fluid communication with said venturis, said venturis being defined by venturi body platelets having a plurality of fingers defining venturi shaped spaces therebetween and pairs of venturi closure platelets respectively disposed on opposite faces of said venturi body platelets, said platelet stack adapted to be disposed in said housing with the inlets of said venturis communicating with said air inlet.

5. Apparatus according to claim 4, wherein at least one of each of said pairs of venturi closure platelets includes apertures respectively adjacent the throat of said venturis communicating with said fuel passages.

6. A carburetor comprising: a housing having an air inlet and a fuel inlet and a stack of circular platelets having central circular apertures aligned to define a central tubular opening communicating with said air inlet, said stack having a plurality of venturis defined therein directed substantially radially with the venturi inlets on said central tubular opening, each of said

platelets having apertures aligned in registration defining fuel passages communicating fuel from said fuel inlet to said venturis.

7. Apparatus according to claim 6, wherein said venturis are defined by venturi body platelets having a plurality of radially directed fingers defining venturi shaped spaces therebetween and pairs of venturi closure platelets respectively disposed on opposite faces of said venturi body platelets.

8. Apparatus according to claim 7, wherein at least one of each of said pairs of venturi closure platelets includes apertures respectively adjacent the throats of said venturis communicating with said fuel passages.

9. In a combustion engine carburetor having a housing provided with an air inlet and a fuel inlet, the improvement comprising: a tubular platelet stack having a plurality of venturis defined therein and extending radially therethrough and a plurality of fuel passages adapted to place said fuel inlet in fluid communication with said venturis, said platelet stack adapted to be disposed in said housing with the inlets of said venturis communicating with said air inlet.

10. Apparatus according to claim 9, wherein each venturi has a pair of fuel passages communicating therewith on opposite sides thereof.

11. Apparatus according to claim 9, wherein each of said platelets includes apertures aligned in registration defining said fuel passages.

12. A carburetor comprising: a housing having an air inlet and a fuel inlet, and a platelet stack in said housing defining a plurality of venturis, said venturis being defined by venturi body platelets having a plurality of fingers defining venturi shaped spaces therebetween and pairs of venturi closure platelets respectively disposed on opposite faces of said venturi body platelets, said stack having a plurality of fuel passages placing said fuel inlet in fluid communication with respective venturis, said platelet stack being disposed with the inlets of said venturis communicating with said air inlet.

13. Apparatus according to claim 12, wherein said plurality of venturis are in substantial parallel orientation in said platelet stack.

14. Apparatus according to claim 12, wherein said platelet stack is tubular and said venturis extend radially therethrough.

15. Apparatus according to claim 12, wherein the thickness of said venturi body platelet is less than the flame quenching distance to prevent flame flashback into the platelet stack.

16. Apparatus according to claim 12, wherein at least one of each of said pairs of venturi closure platelets includes apertures respectively adjacent the throats of said venturis communicating with said fuel passages.

17. Apparatus according to claim 16, comprising a fuel metering platelet adjacent said at least one venturi closure platelet, said metering platelet including an aperture in registration with said aperture in said venturi closure platelet and a channel connecting said aperture and said fuel passage.

18. Apparatus according to claim 17, wherein each of said platelets include apertures aligned in registration defining said fuel passages.

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