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(54) **CARBURETORS HAVING FILTER ARRANGEMENTS**

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(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 85 days.

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**F02M 19/06** (2006.01)  
**F02M 9/14** (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.**  
CPC ..... **F02M 19/066** (2013.01); **F02M 9/14** (2013.01)

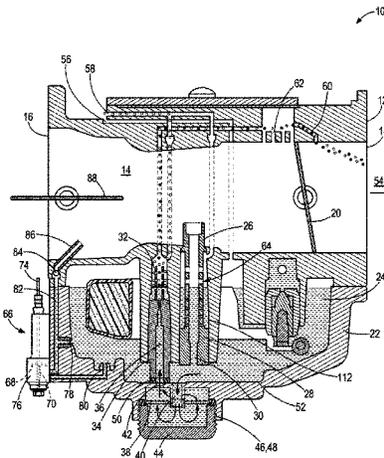
A carburetor has a carburetor body having a venturi passage that conveys air from an air inlet to an air outlet. A throttle valve controls flow of the air in the venturi passage. The throttle valve is movable into a closed position, an open position, and at least one transition position between the closed position and the open position. A fuel bowl holds fuel for mixing with the air in the venturi passage. A main nozzle discharges the fuel from the fuel bowl to the air in the venturi passage when the throttle is in the open position. A secondary circuit that is smaller than the main nozzle discharges fuel from the fuel bowl to the air in the venturi passage when the throttle is in the closed position, the transition position, and the open position. A filter is configured to remove particulate matter from the fuel in the fuel bowl prior to discharge via the secondary circuit. Methods are for making the carburetor and operating the carburetor.

(58) **Field of Classification Search**  
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USPC ..... 123/445; 261/23.2, 36.2, 41.2—41.5  
See application file for complete search history.

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**15 Claims, 7 Drawing Sheets**



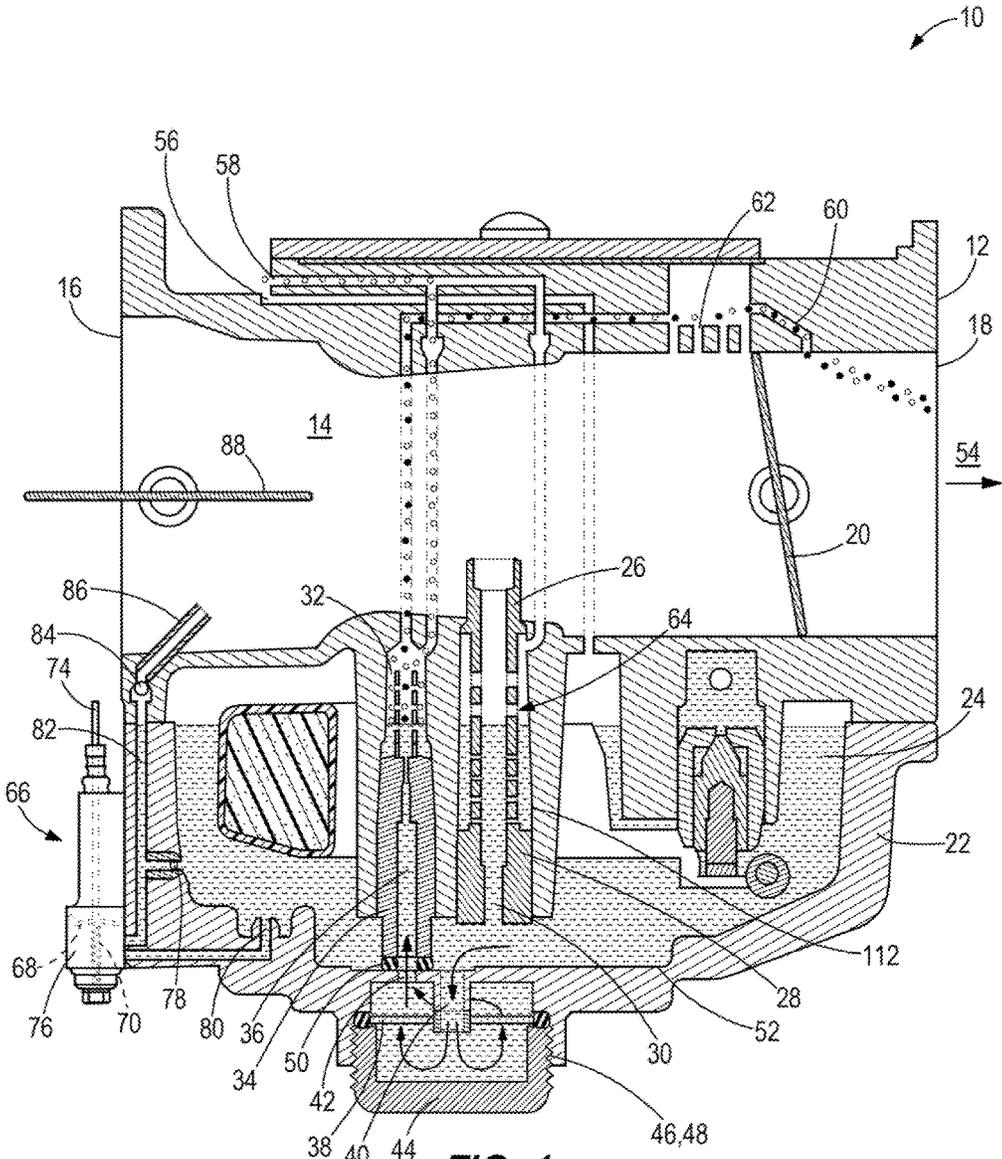
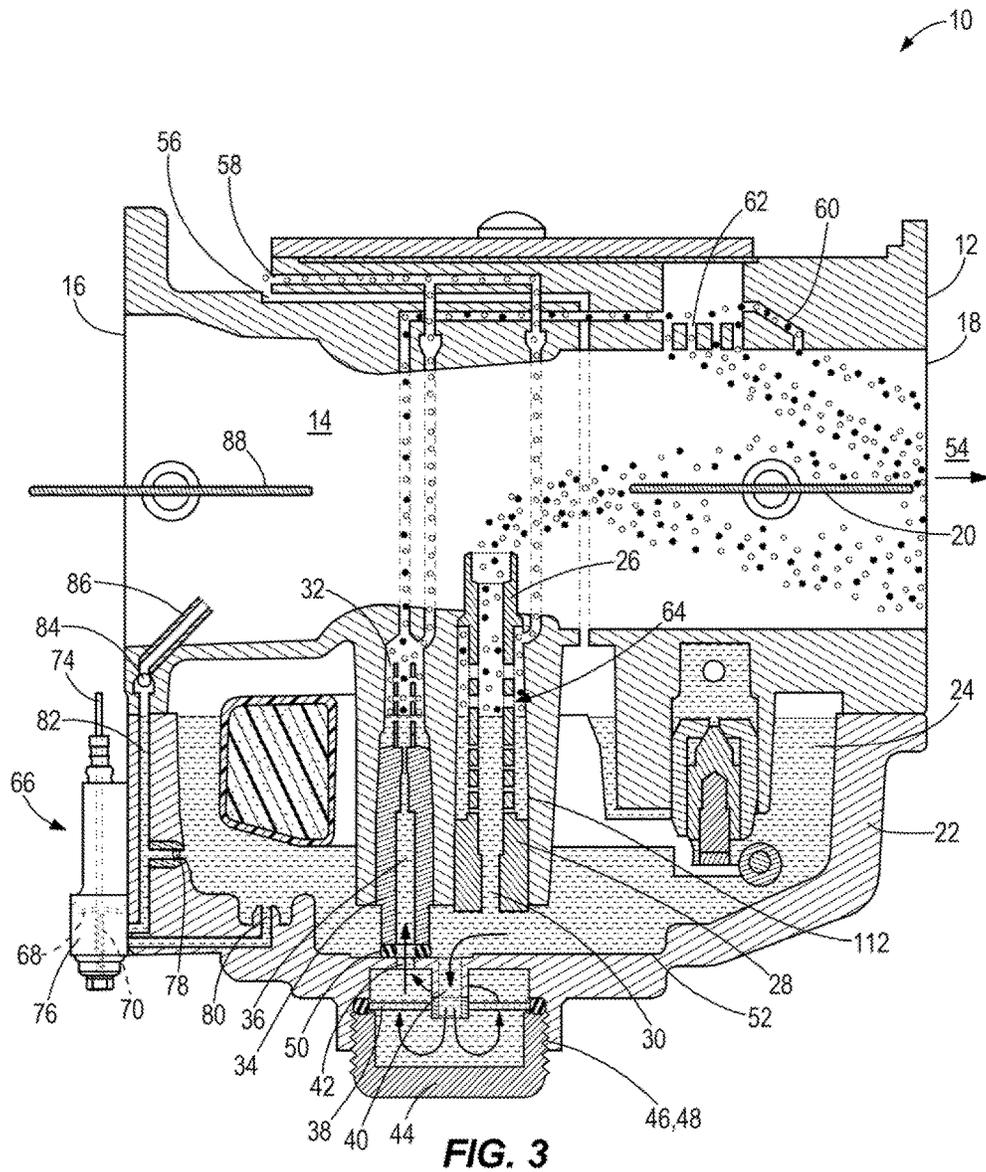
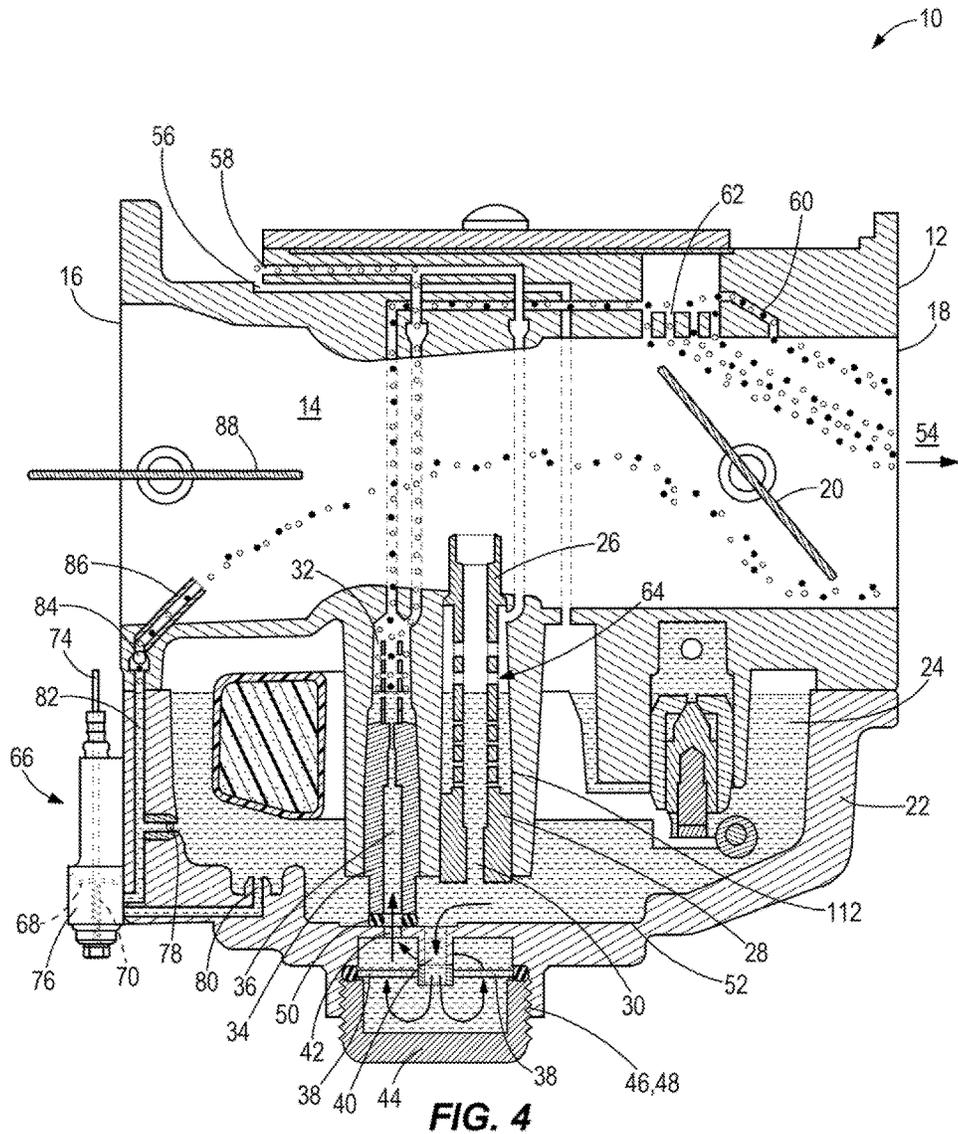
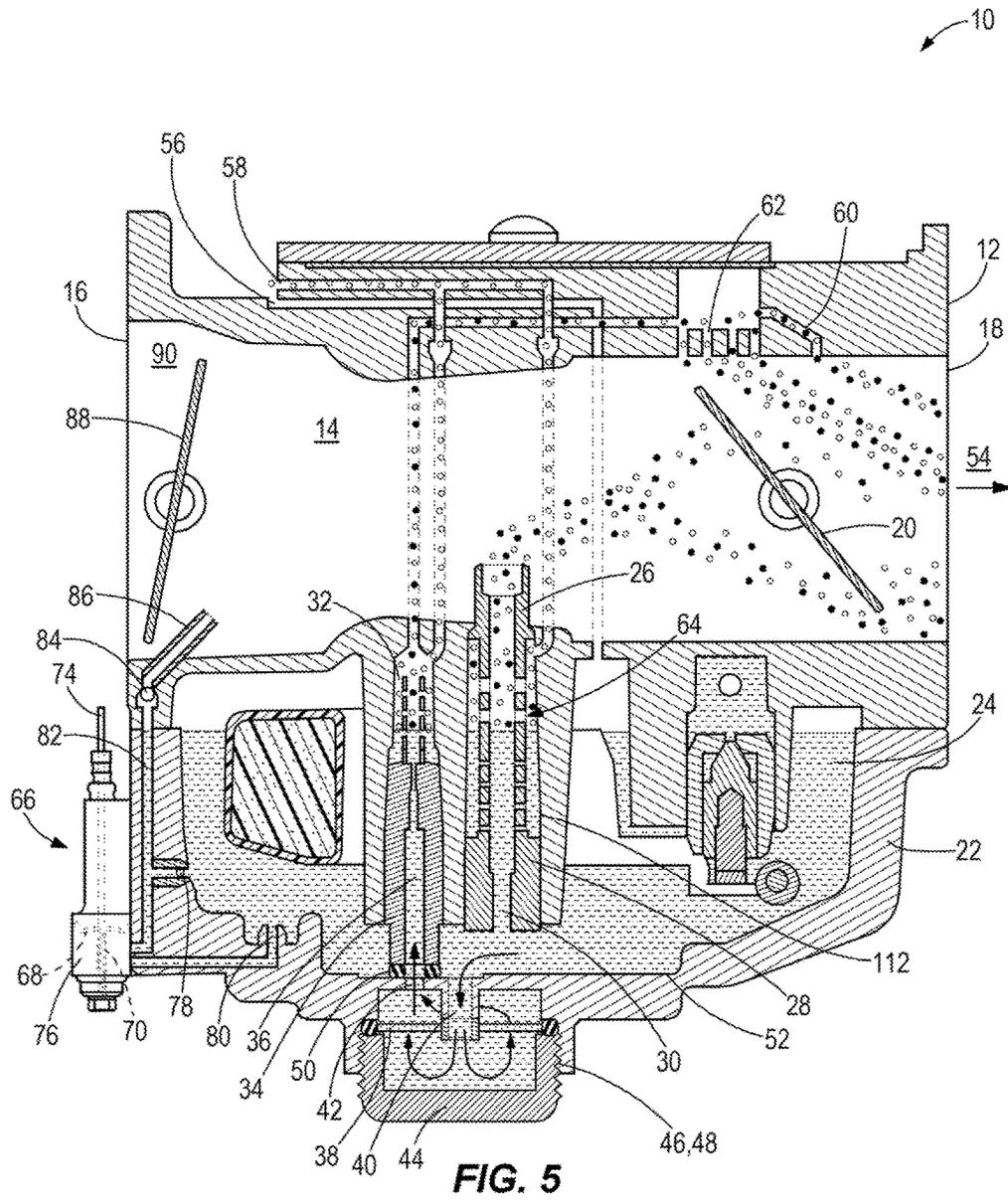


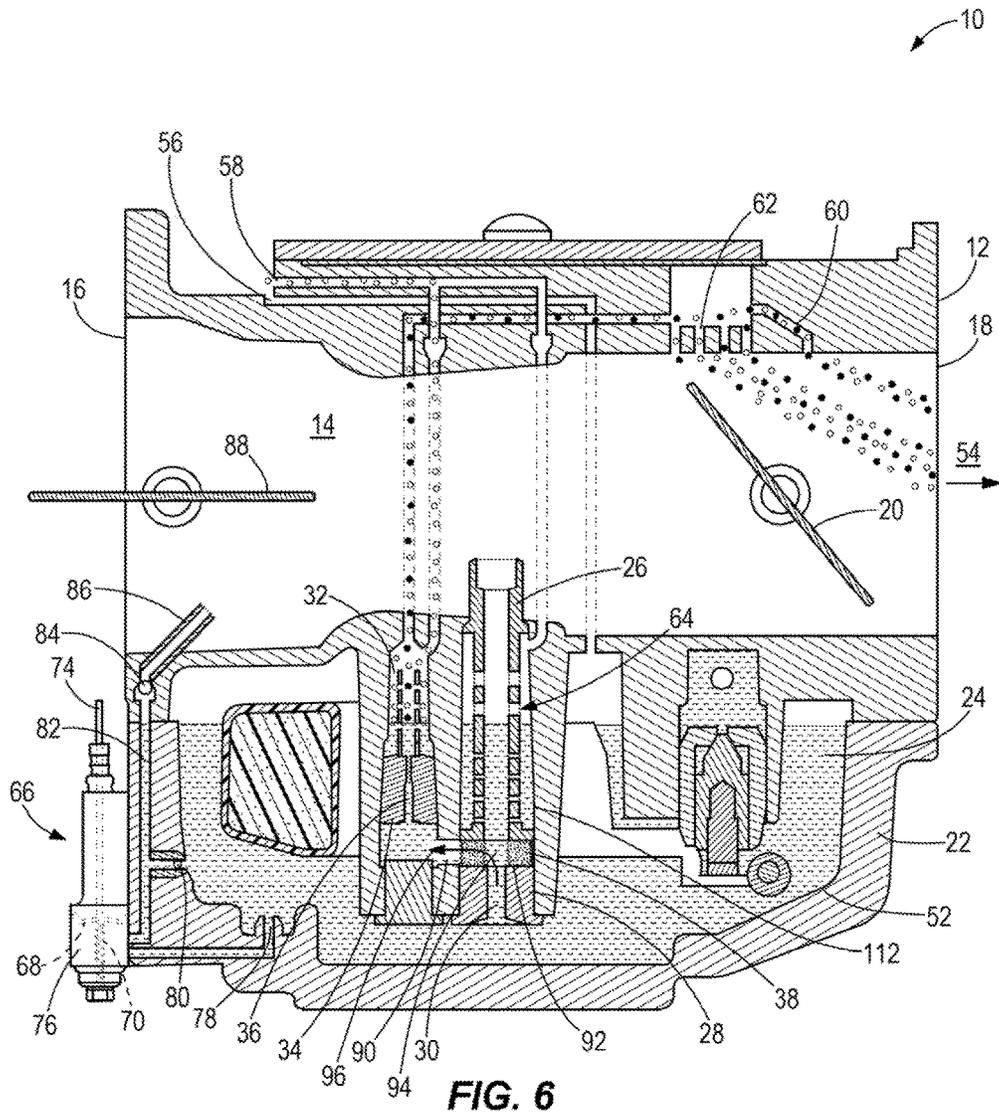
FIG. 1











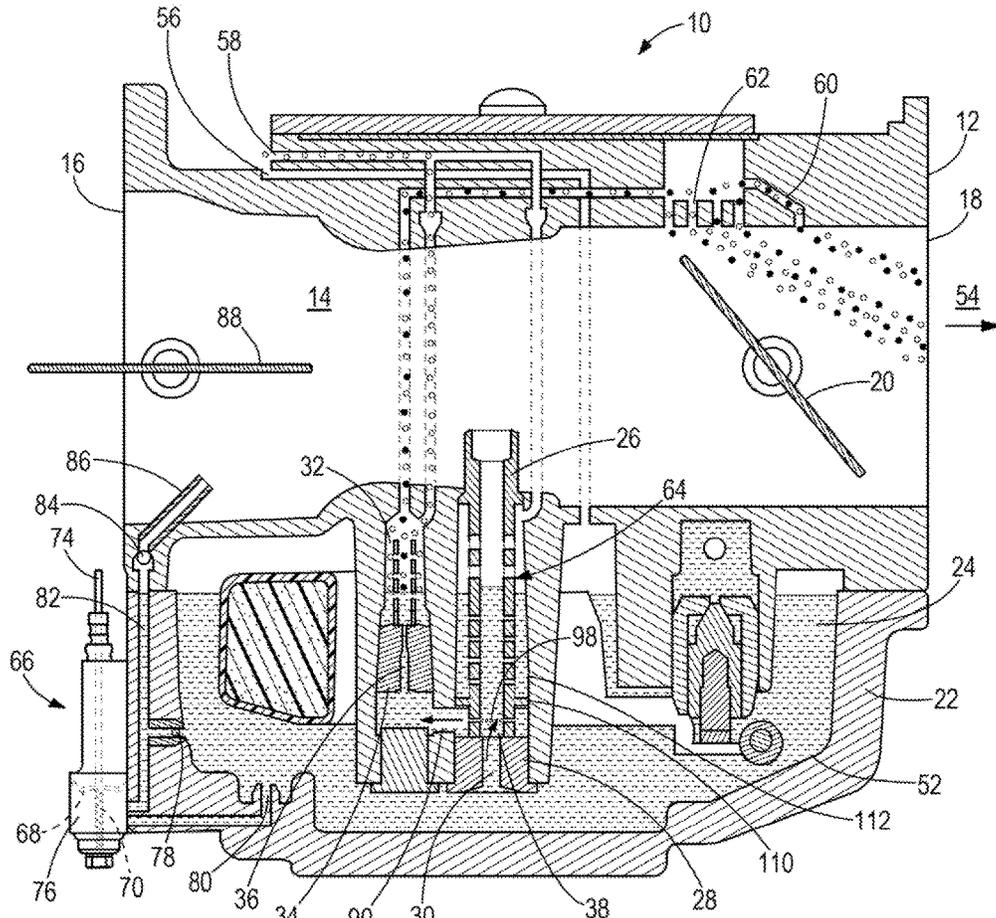


FIG. 7

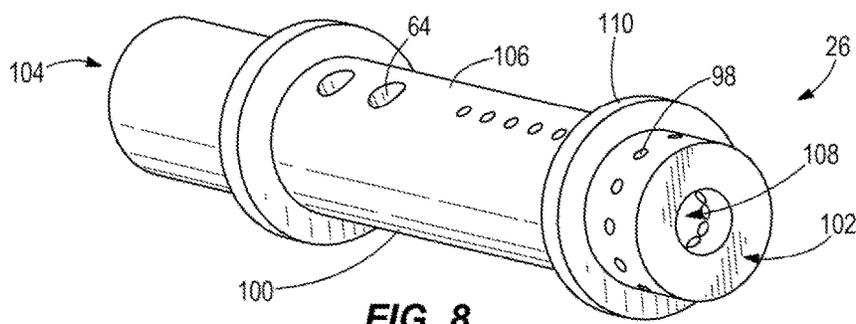


FIG. 8

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## CARBURETORS HAVING FILTER ARRANGEMENTS

### FIELD

The present disclosure relates to carburetors, including carburetors for internal combustion engines on marine vessels.

### BACKGROUND

U.S. Patent Application Publication No. 2009/0130929A1 discloses a water cooled fuel reservoir for a carbureted engine. Water is drawn by a pump from a body of water and caused to flow to a water jacket surrounding a fuel reservoir of the carburetor. The fuel reservoir, or float bowl, stores a quantity of liquid fuel which is cooled by thermal contact with the water in a water jacket of the water reservoir.

U.S. Pat. No. 7,490,584 discloses a fuel enrichment cold start/run circuit and method that pumps fuel from the fuel pump to an enrichment circuit inlet independently of a carburetor float bowl such that the enrichment circuit is supplied with fuel regardless of the orientation of the float bowl, including angular orientation.

U.S. Pat. Nos. 5,854,464 and 5,628,927 disclose a carburetor anti-icing apparatus and method for a marine drive for heating a carburetor to a temperature above that at which ice may form in the idle and progression circuits of the carburetor. Several heaters, heat sources, and methods are disclosed for heating the carburetor. In one embodiment an electrical heating element is mounted to the carburetor body near the fuel orifices which make up the idle and progression circuits. In another embodiment, engine cooling water is circulated through a heater housing mounted to the carburetor body. In yet a further embodiment, engine exhaust from the marine drive is conveyed through the heater housing mounted to the carburetor body. A thermally conductive gasket is used to improve heat transfer.

U.S. Pat. No. 4,905,638 discloses a two stage carburetor for introduction of an air-fuel mixture into the crankcase of a two-stroke marine engine including a carburetor body that defines a pair of throttle bores, one of which has a reduced cross-sectional area. The throttle bores deliver an air-fuel mixture to separate and distinct reed blocks having comparable cross-sectional areas.

### SUMMARY

This Summary is provided to introduce a selection of concepts that are further described below in the Detailed Description. This Summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

In certain examples disclosed herein, a carburetor comprises a carburetor body having a venturi passage that conveys air from an air inlet to an air outlet. A throttle valve controls flow of the air in the venturi passage. The throttle valve is movable into a closed position, an open position, and at least one transition position between the closed position and the open position. A fuel bowl holds fuel for mixing with the air in the venturi passage. A main nozzle discharges the fuel from the fuel bowl to the air in the venturi passage when the throttle is in the open position. A secondary circuit that is smaller than the main nozzle discharges fuel from the fuel bowl to the air in the venturi passage when the throttle is in the closed position, the transition position,

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and the open position. A filter is configured to remove particulate matter from the fuel in the fuel bowl prior to discharge via the secondary circuit. Also disclosed are methods of making the carburetor and methods of operating the carburetor.

### BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure is described with reference to the following Figures. The same numbers are used throughout the Figures to reference like features and like components.

FIG. 1 is a sectional view of a carburetor being operated at an idle speed.

FIG. 2 is a sectional view of the carburetor being operated at an off-idle (transitional) speed.

FIG. 3 is a sectional view of the carburetor being operated at a high speed.

FIG. 4 is a sectional view of the carburetor being operated during acceleration.

FIG. 5 is a sectional view of the carburetor being operated during a choke condition.

FIG. 6 is a sectional view of another example of a carburetor being operated at an off-idle (transitional) speed.

FIG. 7 is a sectional view of another example of a carburetor being operated at an off-idle (transitional) speed.

FIG. 8 is a perspective view of a main nozzle for the carburetor shown in FIG. 7.

### DETAILED DESCRIPTION OF THE DRAWINGS

FIGS. 1-5 depict one example of a carburetor 10 for use in an internal combustion engine. The carburetor 10 has a carburetor body 12 having a venturi passage 14 that conveys air for combustion in the engine. The air travels from an air inlet 16 to an air outlet 18. A throttle valve 20 controls flow of the air through the venturi passage 14. The throttle valve 20 is movable into a closed position (FIG. 1), a wide-open position (FIG. 3), and at least one transition position (FIG. 2) which is located between the closed position and the open position. A fuel bowl 22 holds fuel 24 for mixing with the air in the venturi passage 14. As further described herein below, a main nozzle 26 discharges fuel 24 from the fuel bowl 22 to the air in the venturi passage 14 when the throttle valve 20 is in the open position. A main jet 28 has a through-bore 30 that conveys fuel 24 from the fuel bowl 22 to the main nozzle 26. A secondary (slow speed) circuit 32 is sized smaller than the main nozzle 26 and discharges fuel 24 from the fuel bowl 22 to the air in the venturi passage 14 when the throttle valve in the closed position, the transition position, and the open position. A secondary jet 34 has a through-bore 36 that conveys fuel 24 from the fuel bowl 22 to the secondary circuit 32.

Through research and development, the present inventors have determined that the secondary circuit and related fuel flow passages are susceptible to clogging from debris in the fuel. This has especially been found on carburetors used with four-stroke internal combustion engines, because such carburetors often have a relatively small size jet, nozzle and related passages. Oxygenated fuels can exacerbate the problem. Gum and varnish can quickly form if the fuel 24 is left in the carburetor for even a short period of time (e.g. 1 month). Fuels containing ethanol can cause corrosion, with the by-products getting trapped in the secondary circuit and related passages. Such debris can cause the engine to run lean, resulting in hard starting, rough running, hesitation, and stalling. Even a small amount of debris can cause these problems. Some prior art fuel systems have a fuel filter that

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prevents debris in the fuel from getting into the carburetor. Such systems include fuel filters located in the carburetor and/or externally of the carburetor. However these systems are only capable of capturing existing contaminants in the fuel from entering the carburetor (e.g. via hoses, fuel lines, pumps, etc.). That is the present inventors have realized that such prior art systems do not effectively protect the carburetor against fuel that deteriorates or causes corrosion while inside the carburetor. This can happen due to the operator leaving the fuel in the carburetor without the engine being run for an extended period. The gum, varnish and corrosion by-products that form will accumulate in the fuel bowl and often will eventually get caught in the relatively small passages associated with the secondary circuit.

Accordingly, the present inventors have provided the carburetor 10 with a filter 38 that is configured to remove particulate matter from the fuel 24 in the fuel bowl 22 prior to discharge via the secondary circuit 32.

In the example shown in FIGS. 1-5, the filter 38 is located externally of the fuel bowl 22. The fuel bowl 22 has an outlet passage 40 that drains fuel 24 from the fuel bowl 22 and an inlet passage 42 that conveys the fuel 24 from the outlet passage 40 to the secondary circuit 32 via the secondary jet 34. The filter 38 is located downstream of the outlet passage 40 and upstream of the inlet passage 42. A removable cap 44 is on the filter 38 and has screw threads 46 that mate with screw threads 48 on the carburetor body 12. The secondary jet 34 has an inlet end 50 that is sealed to an interior surface 52 of the fuel bowl 22. As described further herein below, a method according to the present disclosure provides a filter 38 that is configured to remove the noted particulate matter from the fuel 24 in the fuel bowl 22 prior to discharge via the secondary circuit 32. The filter 38 collects the gum, varnish, and corrosion by-products that have accumulated in the fuel bowl 22 and keeps them from getting into the passages associated with the secondary jet 34 and secondary circuit 32. According to the method, the filter 38 can be easily serviced by an operator (e.g. cleaned or replaced) from outside of the carburetor 10 via the removable cap 44.

FIG. 1 depicts the carburetor 10 during operation of the internal combustion engine at idle speed. As the engine rotates, piston travel moves away from an open intake valve. This movement creates a low pressure area behind the throttle valve 20. Atmospheric pressure pushes air through the venturi passage 14, past the throttle valve 20, and into a low pressure area inside the piston-cylinder of the engine, as schematically shown at arrows 54. The low pressure causes air at atmospheric pressure to enter the fuel bowl 22 through the fuel bowl vent inlet 56. This pressure forces the fuel 24 toward the low pressure area behind the throttle valve 20. The fuel 24 flows down through the outlet passage 40, and back up through the filter 38 to the through-bore 36 of the secondary jet 34, and then onto the secondary circuit 32. In the secondary circuit 32, air from the air bleed inlet 58 is mixed with the fuel 24. The mixture of air and fuel 24 is forced through the secondary circuit 32 and into the low pressure area behind the throttle valve 20 via the idle discharge port 60 for downstream combustion by the engine.

Referring to FIG. 2, as engine speed is increased, the throttle valve 20 is rotated past the off-idle ports 62, exposing the off-idle (progression) ports 62 to the low pressure area behind the throttle valve 20. This causes additional fuel 24 to flow through the off-idle ports 62 as the throttle valve 20 continues to rotate.

Referring to FIG. 3, as the throttle valve 20 rotates past the off-idle ports 62, the low pressure area extends to the area of the venturi passage 14 in the carburetor body 12

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wherein the main nozzle 26 is located. In addition, the increased air flow through the venturi passage 14 creates a low pressure area inside the venturi passage 14. These combined forces create a suction force (low pressure) on the main nozzle 26. This causes fuel 24 to flow through the main jet 28, up the main nozzle 26 and into the venturi passage 14. Air from the air bleed inlet 58 mixes with the fuel 24 in the main nozzle 26 via a plurality of air holes 64 in the main nozzle 26. As the throttle valve 20 continues to open, additional fuel 24 is drawn out of the main nozzle 26, exposing additional air holes 64. At full throttle speeds, the mixture of fuel 24 and air is primarily controlled by the size of the main jet 28. Both the secondary circuit 32 and main nozzle 26 will continue to supply fuel 24 to the venturi passage 14 for combustion in the engine.

FIG. 4 depicts the carburetor 10 during a state of engine acceleration, wherein the throttle valve 20 is opened rapidly and the air flow and the pressure change in the venturi passage 14 change almost instantaneously, while supply of fuel 24 tends to lag, behind, thus causing momentary leanness. In this instance, an accelerator pump 66 can be used to provide fuel that is necessary for smooth operation during this time. Fuel for acceleration is supplied by a diaphragm 68 that is spring loaded by a spring 70. The diaphragm 68 is operated by a pump shaft and lever assembly (not shown). The spring 70 provides assistance for the diaphragm 68 to return to the relaxed position shown in FIG. 4. When the throttle valve 20 is opened, the pump plunger 74 is forced downward in a fuel well 76. The downward motion of the pump plunger 74 closes inlet check valves 78, 80, forces fuel into the pump discharge passage 82 and opens the outlet check valve 84. The fuel then passes through the outlet check valve 84 to the pump discharge jet 86 where it sprays into the venturi passage 14. When the pump plunger 74 moves upward, as happens during closing of the throttle valve 20, fuel enters the pump through the inlet check valves 78, 80 and fills the fuel well 76. After discharge of the pump, the outlet check valve 84 closes, thus preventing additional flow of fuel.

FIG. 5 depicts the carburetor 10 during choke condition for cold start of the internal combustion engine. The operator can push in a cold start priming bulb, which forces fuel into the same chamber area and circuitry as the accelerator pump 66. Pushing of the cold start priming bulb closes the inlet check valves 78, 80, forces fuel into the pump discharge passage 82, and opens the outlet check valve 84. Fuel then passes on through the outlet check valve 84 to the pump discharge jet 86 where it sprays into the venturi passage 14. A choke valve 88 can be controlled by the operator via, for example, electric solenoid. When the engine is cold, the operator can activate the solenoid to close the choke valve 88. As the engine is started, a low pressure area develops inside the venturi passage 14. Air at atmospheric pressure flows through the passageway 90 in the choke valve 88 into the low pressure area. Fuel is drawn into the flow of air through the main nozzle 26, off-idle ports 62 and idle discharge port 60. As the engine warms up, the operator can reposition the choke valve 88, as desired. After the engine reaches operating temperature, the choke valve 88 is returned to the full open position, shown in FIG. 1.

FIG. 6 depicts another example of the carburetor 10, wherein the filter 38 is located inside the carburetor body 12. In this example, the filter 38 is located downstream of the through-bore 30 of the main jet 28 and upstream of the through-bore 36 of the secondary jet 34. In this example, a passageway 90 extends between the through-bore 30 of the main jet 28 and the through-bore 36 of the secondary jet 34.

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The filter 38 filters fuel that flows through the passageway 90. The filter 38 includes a filter media 92 that is disposed between the main jet 28 and the main nozzle 26, below the fuel level in the fuel bowl 22. The type of filter media 92 can vary and in some examples includes wire mesh. The filter media 92 has a central opening 94 through which fuel flows from the main jet 28 to the main nozzle 26. The central opening 94 can be sized slightly larger than the through-bore 30 of the main jet 28. This advantageously causes the fuel 24 to clean the filter 38, i.e. the relatively high speed flow of fuel 24 through the central opening 94 to the main jet 28 washes away particulate material on the filter media 92 and carries the particulate matter through to the main nozzle 26. This self-cleaning feature helps avoid the need for periodic cleaning of the filter media 92. Filtered fuel flows radially at arrow 96 through the filter media 92 into the secondary circuit 32.

FIGS. 7 and 8 depict another example of a carburetor 10 wherein the filter 38 is formed by a plurality of fuel holes 98 that are circumferentially spaced around the main nozzle 26. Each fuel hole 98 has a size that is small enough to prevent passage of particulate matter that would otherwise restrict fuel from flowing through the secondary circuit 32. In this example, the main nozzle 26 includes an elongated element 100 having first and second ends 102, 104. The first end 102 receives the fuel from the main jet 28 and the second end 104 discharges the fuel to the venturi passage 14 in the carburetor body 12. The main nozzle 26 includes an outer circumference 106 and an inner passageway 108 extending, from the first end 102 to the second end 104. The fuel holes 98 are disposed around the outer circumference 106 at the first end 102, below the fuel level in the fuel bowl 22. Each fuel hole 98 extends through the elongated element 100 from the outer circumference 106 to the inner passageway 108. The main nozzle 26 includes the plurality of air holes 64, which are configured to aerate and vaporize the fuel in the main nozzle. The fuel holes 98 are located closer to the first end 102 than the air holes 64. The main nozzle 26 includes a flange 110 that is located between the fuel holes 98 and the air holes 64. The flange 110 is configured to stabilize the main nozzle 26 with respect to the carburetor body 12 by engaging with inner walls 112 of the carburetor body 12. The flange 110 also separates the main circuit from the secondary circuit 32. The fuel holes 98 are exposed to the relatively high speed fuel flow through the main nozzle 26, such that the fuel flow cleans the debris from the fuel holes 98 and carries the debris through the main nozzle 26. This provides a self-cleaning feature similar to the self-cleaning feature described herein above regarding FIG. 6.

The present disclosure thus provides methods of making and operating a carburetor, including providing a filter 38 that is configured to remove particulate matter from the fuel 24 in the fuel bowl 22 prior to discharge via the secondary circuit 32.

In the above description, certain terms have been used for brevity, clarity, and understanding. No unnecessary limitations are to be inferred therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes and are intended to be broadly construed. The different systems and method steps described herein may be used alone or in combination with other stems and methods. It is to be expected that various equivalents, alternatives and modifications are possible within the scope of the appended claims.

What is claimed is:

1. A carburetor comprising:

- a carburetor body having a venturi passage that conveys air from an air inlet to an air outlet;
- a throttle valve that controls flow of the air in the venturi passage, wherein the throttle valve is movable into a

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closed position, an open position, and at least one transition position between the closed position and the open position;

- a fuel bowl that holds fuel for mixing with the air in the venturi passage;
- a main nozzle that discharges the fuel from the fuel bowl to the air in the venturi passage when the throttle valve is in the open position;
- a secondary circuit that discharges fuel from the fuel bowl to the air in the venturi passage when the throttle valve is in the closed position, the transition position, and the open position;
- a filter that is configured to remove particulate matter from the fuel in the fuel bowl prior to discharge via the secondary circuit;
- wherein the filter is located externally of the fuel bowl; and

wherein the fuel bowl has an outlet passage that drains the fuel from the fuel bowl and an inlet passage that conveys the fuel from the outlet passage to the secondary circuit, wherein the filter is located downstream of the outlet passage and upstream of the inlet passage.

2. The carburetor according to claim 1, further comprising a removable cap on the filter.

3. The carburetor according to claim 1, further comprising a secondary jet that supports the secondary circuit, wherein the secondary jet has a through-bore that conveys the fuel from the inlet passage to the secondary circuit.

4. The carburetor according to claim 3, wherein the secondary jet has an inlet end that is sealed to an interior surface of the fuel bowl.

5. A carburetor comprising:

- a carburetor body having a venturi passage that conveys air from an air inlet to an air outlet;
- a throttle valve that controls flow of the air in the venturi passage, wherein the throttle valve is movable into a closed position, an open position, and at least one transition position between the closed position and the open position;
- a fuel bowl that holds fuel for mixing with the air in the venturi passage;
- a main nozzle that discharges the fuel from the fuel bowl to the air in the venturi passage when the throttle valve is in the open position;
- a secondary circuit that discharges fuel from the fuel bowl to the air in the venturi passage when the throttle valve is in the closed position, the transition position, and the open position;
- a filter that is configured to remove particulate matter from the fuel in the fuel bowl prior to discharge via the secondary circuit;
- wherein the filter is located inside the carburetor body; and
- a main jet having a through-bore that conveys fuel from fuel bowl to the main nozzle, and
- a secondary jet having a through-bore that conveys fuel from the main nozzle to the secondary circuit, wherein the filter is located downstream of the through-bore of the main jet and upstream of the through-bore of the secondary jet.

6. The carburetor according to claim 5, wherein a passageway extends between the through-bore of the main jet and the through-bore of the secondary jet, and wherein the filter filters fuel that flows through the passageway.

7. The carburetor according to claim 6, wherein the filter comprises a filter media that is between the main jet and the main nozzle.

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8. The carburetor according to claim 6, wherein the filter comprises a plurality of fuel holes that are circumferentially spaced around the main nozzle, each fuel hole in the plurality of fuel holes having a size that is small enough to prevent passage of particulate matter that would otherwise restrict fuel from flowing through the secondary circuit.

9. The carburetor according to claim 8, wherein the main nozzle comprises an elongated element having first and second ends, wherein the first end receives the fuel from the main jet and wherein the second end discharges the fuel to the venturi passage in the carburetor body.

10. The carburetor according to claim 9, wherein the main nozzle comprises an outer circumference and an inner passageway extending from the first end to the second end, and wherein the plurality of fuel holes are disposed around the outer circumference at the first end, and wherein each fuel hole extends through the elongated element from the outer circumference to the inner passageway.

11. The carburetor according to claim 10, wherein the elongated element further comprises a plurality of air holes that are configured to aerate the fuel in the main nozzle, wherein the plurality of fuel holes are located closer to the first end than the plurality of air holes.

12. The carburetor according to claim 11, wherein the elongated element further comprises a flange located between the plurality of fuel holes and the plurality of air holes, and wherein the flange is configured to stabilize the main nozzle with respect to the carburetor body.

13. A method of making a carburetor, the method comprising:

- providing a carburetor body having a venturi passage that conveys air from an air inlet to an air outlet;
- providing a throttle valve that controls flow of the air in the venturi passage, wherein the throttle valve is movable into a closed position, an open position, and at least one transition position between the closed position and the open position;
- providing a fuel bowl that holds fuel for mixing with the air in the venturi passage;
- providing a main nozzle that discharges the fuel from the fuel bowl to the air in the venturi passage when the throttle is in the open position;
- providing a secondary circuit that discharges fuel from the fuel bowl to the air in the venturi passage when the throttle is in the closed position, the transition position, and the open position;

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providing a filter that is configured to remove particulate matter from the fuel in the fuel bowl prior to discharge via the secondary circuit; and

locating the filter externally of the fuel bowl, wherein the fuel bowl has an outlet passage that drains the fuel from the fuel bowl and an inlet passage that conveys the fuel from the outlet passage to the secondary circuit, and further comprising locating the filter downstream of the outlet passage and upstream of the inlet passage.

14. A method of making a carburetor, the method comprising:

- providing a carburetor body having a venturi passage that conveys air from an air inlet to an air outlet;
- providing a throttle valve that controls flow of the air in the venturi passage, wherein the throttle valve is movable into a closed position, an open position, and at least one transition position between the closed position and the open position;
- providing a fuel bowl that holds fuel for mixing with the air in the venturi passage;
- providing a main nozzle that discharges the fuel from the fuel bowl to the air in the venturi passage when the throttle is in the open position;
- providing a secondary circuit that discharges fuel from the fuel bowl to the air in the venturi passage when the throttle is in the closed position, the transition position, and the open position;
- providing a filter that is configured to remove particulate matter from the fuel in the fuel bowl prior to discharge via the secondary circuit; and
- locating the filter inside the carburetor body, and further comprising providing a main jet having a through-bore that conveys fuel from fuel bowl to the main nozzle, providing a secondary jet having a through-bore that conveys fuel from the main nozzle to the secondary circuit, and locating the filter downstream of the through-bore of the main jet and upstream of the through-bore of the secondary jet.

15. The method according to claim 14, comprising forming the filter from a plurality of fuel holes that are circumferentially spaced around the main nozzle, and sizing each fuel hole in the plurality of fuel holes small enough to prevent passage of particulate matter that would otherwise restrict fuel from flowing through the secondary circuit.

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