Jan. 17, 1967 R. L. ANDERSON 3,298,677

THROTTLE VALVE FOR INTERNAL COMBUSTION ENGINES

Filed April 20, 1964

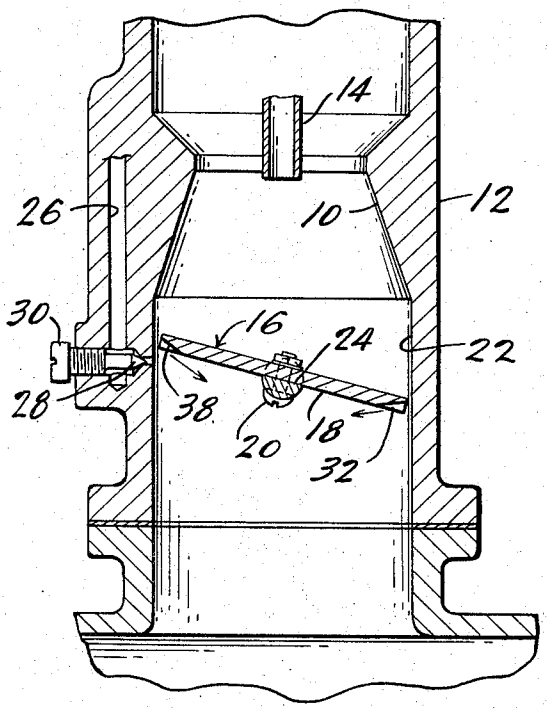


FIG-1-

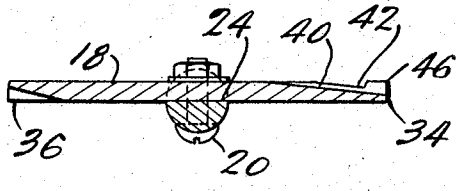


FIG-6-

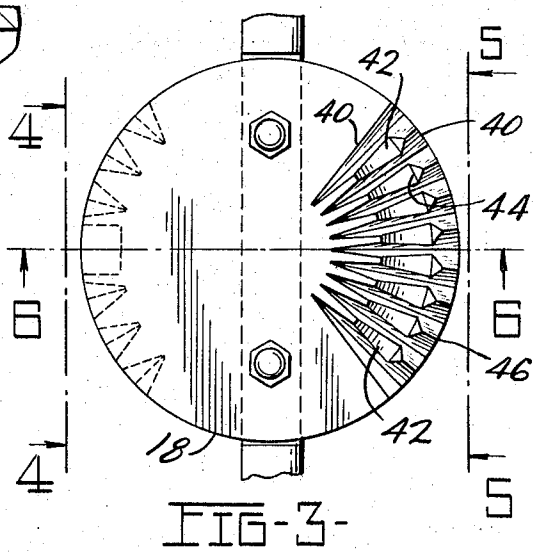


FIG-3-

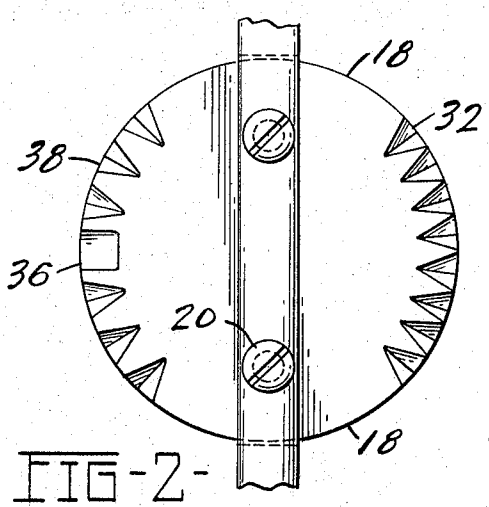


FIG-2-

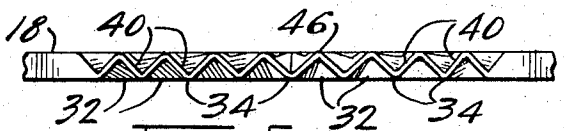


FIG-5-

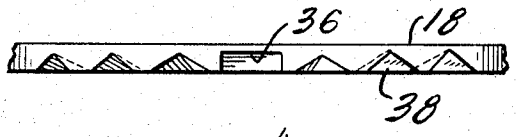


FIG-4-

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THROTTLE VALVE FOR INTERNAL COMBUSTION ENGINES

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5 Claims. (Cl. 261—62)

The present invention relates to butterfly valves for use in controlling the flow of gases having entrained droplets of liquid therein; and, more particularly, to a throttle valve for controlling the flow of a fuel-air mixture from the carburetor to the cylinders of gasoline engines.

Conventional carburetors that are used to mix gasoline with the air that is fed to gasoline engines, utilize a venturi through which the air passes. The venturi produces a drop in pressure which is a function of the rate of air flow to the engine, and this drop in pressure is utilized to control the amount of gasoline that is fed to the air. Gasoline is made up of a mixture of hydrocarbons, about 90 percent of which boil at temperatures below 140° C. In order to increase the anti-knock properties of gasoline, a minor proportion of tetraethyl lead is added. Tetraethyl lead has a boiling point of approximately 200° C., and, in addition, ethylenedibromide which has a boiling point of approximately 130° C. is added to the gasoline, as a lead scavenger agent. The "light ends" of the gasoline, and the ethylenedibromide therefore are usually vaporized shortly after leaving the carburetor, while the heavier hydrocarbons and a major amount of the tetraethyl lead are carried along through the manifold leading to the internal combustion chambers as a dispersion of fine droplets.

The quantity of air and fuel which is fed to the internal combustion engine is regulated by means of a butterfly valve which is positioned downstream of the carburetor fuel metering elements, and upon the upstream face of which any unvaporized droplets of heavy hydrocarbons and tetraethyl lead impinge. At all but wide open throttle settings, the butterfly valve extends partially crosswise to the flow, so that the heavy hydrocarbons and tetraethyl lead coalesce upon the face of the butterfly and drip off the downstream edge of the butterfly as large droplets. These droplets then impinge upon downstream surfaces of the manifold and run along the manifold until they reach the first branch connection leading to one of the cylinders. This cylinder, therefore, receives a considerably greater amount of the heavy ends and the tetraethyl lead than do the other cylinders, and at the same time receive less than the desired proportion of the lead scavenger agent which is carried with the lighter fractions. This results in an accumulation of lead deposits on the spark plug of the cylinder or cylinders which receive the unvaporized liquids from the manifold.

Impingement of the droplets of heavy ends and tetraethyl lead on the upstream face of the butterfly valve occurs, at least to some degree, at all power settings except the closed or idling position of the butterfly valve. During idling conditions, such a small amount of air passes through the venturi of the carburetor that its drop in pressure will not meter the correct amount of fuel to the airflow to the engine, so that during idling, the vacuum which is created on the downstream side of the closed butterfly is used to suck a metered amount of fuel through an idling jet. These jets are usually positioned adjacent one of the opposite edges of the butterfly valve when in its closed position because this is the region of highest air velocity in the air intake passages during idling conditions. Usually only one idling jet is used, so that the air which passes the opposite side of conventional butterfly valves does not directly receive a stream of fuel.

The principal object of the present invention is the provision of a new and improved butterfly valve for the throttle of gasoline engines which will disperse droplets of the heavy ends and tetraethyl lead throughout the body of airflow during idling conditions and intermediate power settings.

Another object of the invention is the provision of a new and improved butterfly valve which will cause fuel injected into the sides of the air passage opposite the adjacent substantially closed edge of the butterfly to be dispersed into the center of the airflow passage downstream of the valve.

A further object of the invention is the provision of a new and improved butterfly of the above described type in which the air passing the opposite side of the substantially closed butterfly is also directed inwardly to mix with the air coming from the side which contains the fuel.

A still further object of the invention is the provision of a new and improved butterfly valve which causes the droplets of liquid which impinge upon the butterfly plate to be evenly distributed as droplets throughout the gases leaving the valve.

Further objects and advantages will become apparent to those skilled in the art to which it relates from the following description of a preferred embodiment described with reference to the accompanying drawing forming a part of this specification, and in which:

FIGURE 1 is a fragmentary sectional view of the throttle body and butterfly valve of a "gasoline" engine;

FIGURE 2 is a bottom view of the butterfly plate and shaft shown in FIGURE 1;

FIGURE 3 is a plan view of the butterfly plate and shaft down in FIGURE 1;

FIGURE 4 is an edge view taken from the position indicated by the lines **4—4** of FIGURE 3;

FIGURE 5 is an edge view of the butterfly plate taken from the position indicated by the line **5—5** of FIGURE 3; and

FIGURE 6 is a sectional view taken approximately along the line **6—6** of FIGURE 3.

FIGURE 1 of the drawing shows a carburetor venturi **10**, and a throttle body **12** of a fuel-air intake system of a gasoline engine. The view also shows the lower end of a gasoline metering jet **14**, as well as a butterfly valve **16** positioned within the throttle body **12** beneath the metering jet **14**. The butterfly valve **16** comprises a butterfly plate **18** that is bolted to a cross shaft **20** which extends across the center of the air passageway **22**. The opposite ends of the cross shaft **20** are journalled in the side walls of the throttle body **12**, and the top half of the shaft **20** which extends between the opposite surfaces of the side walls of the throttle body is machined away to provide a flat surface **24** upon which the bottom of the butterfly plate **18** rests.

Although the air passageway **22** may be of any suitable shape, such as rectangular, square, etc., they are generally cylidnrically shaped. The present invention will have advantages in butterfly valves of any configuration, and has particular advantages when used in butterfly valves for air passages of circular cross section. Accordingly the air passageway shown in the drawing is circular in shape, and the butterfly plate **18** is also generally circularly shaped so that it will substantially close off the passageway **22** when in the generally horizontal position shown in FIGURE 1.

As previously indicated, an object of the present invention is to provide a butterfly valve which will distribute droplets of liquid throughout the air passing through the valve both during idling conditions and at intermediate throttle settings. In the structure shown in FIGURE 1, a passageway **26** is provided in the throttle body for conducting gasoline to an adjustable throttling jet **28** that is positioned in the portion of the throttle body **12** opposite

the radially outer edge of the butterfly plate 18 when in its substantially closed or idling position. Regulation of fuel flow through the jet 28 is accomplished by a needle valve 30 that is threaded into the outer end of the throttle body 12.

While it is considered preferable to introduce the stream of gasoline used for idling of the engine adjacent the radially outer edge of the portion of the butterfly plate 18 which lies upstream of the shaft 20, it will be understood that the invention will also have advantages when used in arrangements where the stream of fuel used during idling of the engine is introduced adjacent the outer edge of the butterfly plate 18 that lies downstream of the shaft 20.

According to the invention, the downstream edge of the portion of the butterfly plate 18 that is downstream of the shaft 20 in the closed position of the valve is provided with a plurality of notches 32 which cause air flowing past the edge of the plate to expand toward the center of the air passage 22. The portions of the edge of the plate between the notches 32 form drip edges 34 the downstream edges of which are positioned inwardly from the sidewalls of the passage 22. The butterfly plate 18 is usually inclined relative to a plane normal to the central axis of the passageway 22, so that the drip edges 34 will be spaced from the sidewalls of the air passage 22 even though the upstream edge of the plate 18 may abut the sidewalls of the passageway 22. Air therefore not only flows between the drip edges 34 and the sidewalls of the passage 22, but also flows through the notches 32 and around opposite sides of the liquid flowing off of the drip edges 34. It will therefore be seen that the notches 32 cause air to flow around at least three sides of the liquid which runs off the drip edges 34 of the butterfly plate 18, and further directs the droplets toward the center of the passage 22. Even during idling when no liquid flows over the drip edges 34 the notches 32 serve the desirable function of causing air to proceed away from the sidewalls of the passage 22 toward the center of the air passage 22 to cause mixing as will further be explained.

In the embodiment shown in the drawing, the idling jet 28 is positioned opposite the upstream edge of the butterfly plate 18, and the edge of the butterfly plate 18 opposite the jet 28 is provided with a center groove 36. The groove 36 allows fluid from the idling jet 28 to squirt radially inwardly as well as to allow air to flow radially inwardly around the stream of idling fluid and mix therewith. The butterfly plate 18 also has notches 38 on either side of the groove 36 which allow air to flow radially inwardly to mix with flow from the groove 36, and thereafter further mix with the air that has passed through the notches 32. Inasmuch as the butterfly plate 18 is circular, in the preferred embodiment the notches 36 and 32 are preferably arranged to extend radially inwardly of the edges of the plate so as to cause air flow to converge upon the center of the passage 22. In partially open positions of the butterfly valve 16, when substantially no flow enters through the idling jet 28, and most of the fuel enters by way of the metering jet 14, the fuel will be directed inwardly by the air flow around the notches 32 to be mixed with air flowing inwardly through the groove 36 and notches 38 on the upstream portion of the butterfly plate 18.

The notches 32, groove 36, and notches 38 can be of various configurations. A generally triangular cross section has proven most effective for the notches 32 and 38, while a generally rectangular-shaped groove has proven to be desirable for the groove 36. The notches 32 and 38 as well as the groove 36, of course, become shallower as they proceed toward the center of the plate 18, and terminate when their deepest portion intersects the downstream surface of the plate.

To further improve upon the effectiveness of the drip edges 34 on the downstream edge of the butterfly plate 18, the upstream face of the butterfly plate 18 is provided with a plurality of grooves 40 each one of which communicates with one of the drip edges 34. The grooves 40 cause the accumulation of liquid on the upstream face of the butterfly plate 18 to break up into channels in the grooves 40, each one of which feeds one of the drip edges 34, so that air will be caused to flow around three sides of substantially all of the fluid which flows off of the downstream edge of the butterfly plate 18. As previously indicatetd, the butterfly plate 18 is circular. The grooves 40, therefore, preferably extend radially from the drip edges 34 toward the center of the plate 18 to cause the liquid which flows down the upstream face of the plate 18 to spread out radically across the downstream edge and be evenly distributed to each of the drip edges 34. While it may not be necessary in all instances, the preferred embodiment also has the portions of the upstream surface of the plate between the grooves 40 partially removed as at 42 in a circularly shaped band which intersects the upstream surface of the plate adjacent the radially inner ends of the grooves 40 and which is approximately one-half the depth of the grooves 40 at a position 44 spaced approximately $\frac{3}{16}$ of an inch inwardly from the outer edge of the plate. The band of removed metal 42 terminates just radially outwardly of its deepest portion 44 so that lips 46 are provided which divert any accumulation of liquid laterally into the lower end of the grooves 40 which communicate with the drip edges 34.

In the idling position of the butterfly valve 16 shown in the drawing, a large vacuum is created downstream of the butterfly valve 16 which draws gasoline through the passage 26 and jet 28 to cause a small stream of gasoline to be directed radially inwardly adjacent the downstream surface of the butterfly plate 18. The groove 36 allows air to flow around the small jet of gasoline as it proceeds toward the center of the passage 22, and the notches 38 cause additional streams of air to converge toward the center of the passage 22 and become mixed with the fuel flowing through the groove 36. At the same time, air is caused to be diverted inwardly of the passage 22 through the notches 32 to meet and mix with the fuel and air that has come from the opposite side of the butterfly plate 18. The grooves 36 and 32, as well as the notches 38, therefore cause the air which flows past the side edges of the butterfly plate 18 to flow toward the center of the passageway 22 with induced tubulence rather than proceed downwardly along the sidewalls of the passage 22 in a sheath.

When the butterfly valve 16 is opened to an intermediate throttle setting, gasoline enters through the metering jet 14. The lighter ends and the ethylenedibromide, lead scavenger agent, vaporize almost immediately while the "heavy ends" and tetraethyl lead accumulate as droplets upon the upstream surface of the butterfly plate 18. These "heavy ends" and tetraethyl lead flow in the direction of air flow along the upstream surface of the plate until the liquid intercepts the grooves 40. whereupon it is caused to diverge radially outwardly and is fed to the drip edges 34. The drip edges 34 are V-shaped and have notches 42 on either side which cause air to flow inwardly past the side edges of liquid falling off of the drip edges 34, so that air flows around at least three sides of all of the droplets of liquid which leave the downstream edge of the butterfly plate 18. In addition, the notches 32 cause the air flow to proceed toward the center of the passage 22 and away from the sidewalls of the passage 22 where it becomes mixed with air that has passed through and around the upstream side of the butterfly plate 18. The butterfly plate 18 of the preferred embodiment therefore not only helps to keep the "heavy ends" and the tetraethyl lead off of the sidewalls of the passage 22, but also causes a more thorough mixing and finer dispersion of droplets and, in turn, a more complete vaporization of the heavy ends and tetraethyl lead than do the butterfly valves of the prior art. Although the in-

vention has been described as embodied in a valve for controlling flow that proceeds downwardly through a conduit, it will be understood that it can also be used to control flow upwardly through passages where the vertical gas velocity is great enough to cause the liquid particles to flow upwardly, or can be used where the carburetor is mounted in horizontal conduits.

While the invention has been described in considerable detail, it is not desired that it should be limited to the particular embodiments shown and described, and it is intended to cover hereby all novel adaptations, modifications, and arrangements thereof which come within the practice of those skilled in the art to which the invention relates.

What I claim is:

1. Fluid mixing means, comprising, in combination, a conduit having a passageway of predetermined cross section for conducting gases containing entrained droplets of liquid in a predetermined direction, a butterfly plate in said conduit rotatable about an axis passing through said passageway, said butterfly plate being rotatable in a given direction from a position substantially closing off said passageway to an open position extending generally lengthwise of said passageway, one portion of said plate on one side of said axis moving upstream while the other portion on the other side of said axis moving downstream as said valve is opened, the downstream edges of both of said portions having a plurality of spaced apart notches extending from said edges inwardly and terminating prior to reaching the center of said plate to provide air passages for communicating gases toward the center of said passageway to direct droplets of liquid leaving said plate toward the center of said passageway and provide mixing of the gases and droplets, and the upstream face of said other portion having a plurality of grooves therein communicating with the downstream edge thereof between said notches.

2. The fluid mixing means defined by claim 1 wherein said grooves in the upstream face of said other portion have a generally V-shaped configuration and extend inwardly from the outer edge of said plate, decrease in depth in an inward direction and terminate prior to reaching the center of said plate.

3. The fluid mixing means defined by claim 1 which further includes a relieved area in the upstream face of said other portion, said relieved area extending over inner portions of said grooves to provide surfaces between said grooves substantially parallel to the upstream face of said plate intermediate said upstream face in the bottom of said grooves.

4. Fluid mixing means, comprising, in combination, a conduit having a passageway of circular cross section for conducting gases containing entrained droplets of liquid in a predetermined direction, a generally circular butterfly plate in said conduit rotatable about an axis passing through said passageway, said butterfly plate being rotatable in a given direction from a position substantially closing off said passageway to an open position extending generally lengthwise of said passageway, one portion of said plate on one side of said axis moving upstream while the other portion on the other side of said axis moving downstream as said valve is opened, the downstream edges of both of said portions having a plurality of spaced apart notches extending from said edges radially inwardly and terminating prior to reaching the center of said plate to provide air passages for communicating gases toward the center of said passageway to direct droplets of liquid leaving said plate toward the center of said passageway any provide mixing of the gases and droplets, and the upstream face of said other portion having a plurality of radially extending grooves therein communicating with the downstream edge thereof between said notches.

5. Fliud mixing means, comprising, in combination, a conduit having a passageway of predetermined cross section through which gases containing entrained droplets of liquid pass in a predetermined direction, a butterfly plate in said conduit rotatable about an axis passing through said passageway, said butterfly plate being rotatable in a given direction from a position substantially closing off said passageway to an open position extending generally lengthwise of said passageway one portion of said plate on one side of said axis moving upstream while the other portion on the other side of said axis moving downstream as said valve is opened, the downstream edge of said other portion having a plurality of spaced apart notches extending from said said edge inwardly and terminating prior to reaching the center of said plate to provide air passages for communicating gases toward the center of said passageway to direct droplets of liquid leaving said plate toward the center of said passageway and provide mixing of the gases and droplets, and the upstream face of said other portion having a plurality of grooves therein communicating with the downstream edge thereof between said notches.

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T. R. MILES, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,298,677 January 17, 1967

Rolland L. Anderson

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 32, for "down" read -- shown --; line 56, for "cylidnrically" read -- cylindrically --; column 4, line 9, for "indicatetd" read -- indicated --; line 13, for "radically" read -- radially --; line 60, for "42" read -- 32 --; column 6, line 14, for "any" read -- and --; line 19, for "Fliud" read -- Fluid --; line 32, for "said", second occurrence, read -- side --.

Signed and sealed this 24th day of October 1967.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents