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(73) Proprietor: Ellison, Benjamin Lynn
13115 N.E. 33rd
Bellevue Washington 98005 (US)

(72) Inventor: Ellison, Benjamin Lynn
13115 N.E. 33rd
Bellevue Washington 98005 (US)

(74) Representative: Shindler, Nigel et al
BATCHELLOR, KIRK & EYLES 2 Pear Tree Court
Farringdon Road
London EC1R 0DS (GB)

Courier Press, Leamington Spa, England.

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Description

This invention relates to a carburetor having a fuel metering system for supplying a homogeneous mixture of fuel and air across the throttle opening of the carburetor while precisely controlling fuel and air flow rates.

For so long as internal combustion engines have been in existence, various carburetors have been developed to supply a required air-fuel mixture to the engine to promote proper and efficient combustion. Although myriads of carburetion schemes and devices have been developed, a continuing problem has been metering of the air-fuel mixture in a consistently homogeneous blend such that the air-fuel mixture received by each cylinder of the internal combustion engine is the same as that supplied to each other cylinder.

In addition, not only is it important to control the homogeneity of the fuel-air mixture, it is also important to control the actual quantity of the fuel injected into the air stream in relation to the density of the air passing through the carburetor. Thus, when the air density decreases, it is important to also reduce the fuel flow rate so that the air-fuel blend supplied to the internal combustion engine is not fuel rich. This is particularly important in aircraft, where at high altitudes, the air density is considerably reduced. A commensurate reduction in the flow rate of the fuel must be made in order to properly lean the mixture to avoid fuel waste or possible engine flooding.

In conventional carburetors or fuel injection systems, the velocity of the air passing through a venturi portion is assumed to correspond directly to the air mass flow. This assumption remains correct so long as there is no change in air density. If the ambient air temperature or pressure does change, then the resultant change in density invalidates this assumption and the carburetor or injection system experiences a change in air-fuel ratio. If the air density increases, then the air-fuel ratio becomes leaner and if the air density decreases, then the air-fuel ratio becomes richer. In most carburetor applications except aircraft the recent low cost of fuel has made mixture control not cost effective. In aircraft, where density-related mixture changes due to altitude result in large power reductions, mixture control has always been a necessary feature.

The venturi system of measuring air flow and metering fuel is based upon the Bernoulli principle as expressed by the Bernoulli equation as follows:

$$1/2\ V^2+P/l=\text{Constant}$$

Where P=Pressure, V=airflow velocity, l=air density

As the Bernoulli equation applies to air flow in a venturi, it can be rewritten as follows:

$$1/2\ (V_2^2-V_1^2)+\frac{P_2-P_1}{l}=0$$

or

$$1/2\ (V_2^2-V_1^2)=\frac{P_1-P_2}{l}$$

with the subscripts 1 and 2 referring to different axial locations in the flow tube. If the velocity at location 2 is high (such as occurs at the throat of a venturi) the pressure is lower than the pressure at a location where the velocity is low. From the Bernoulli equation, it is seen that the amount of pressure difference is much greater than the velocity difference because the velocities in the equation are squared.

The pressure that is sensed in a direction perpendicular to the direction of local flow in a venturi is the static pressure and is equal to that which would be sensed by a pressure instrument moving with the air flow. The pressure that is sensed by a probe inserted in the flow path and oriented with its opening, facing the oncoming air is defined as the total pressure. The difference between the total pressure and the static pressure is the dynamic pressure and is related to the flow velocity be Bernoulli's equation as follows:

$$P_T-P_S=1/2l\ V^2$$

In the absence of friction, the total pressure remains constant along the length of a flow tube or venturi. In an areas where the flow velocity increases due to a constriction in flow area, the static pressure commensurately low.

Slide-type carburetors consisting of an air passage and a throttle plate movable to provide an adjustable throttle opening to alterably constrict the air passageway have been in existence for some time, as evidenced by U.S. Patents No. 3,709,469 and 3,957,930. Such devices provide for throttling of the air flow in combination with mechanical control of the fuel quantities added to the carburetor. However, because fuel is injected into one side of the throttle opening in either of these devices, they suffer from an inability to supply a homogenous air-fuel mixture across the throttle opening and do not permit a full range of air-fuel mixture control.

Other devices are known for metering fuel flow across the throat of a carburettor, as evidenced by U.S. Patents No. 1,142,763 and 4,205,024. While such devices do permit fuel distribution effectively across the carburettor, it is difficult with such devices to adjust the air-fuel mixture as the carburettor air passageway is throttled.

British Patent Specification No. 131,079 discloses a carburettor having an air fluid passageway, and a throttle valve having an adjustable throttle aperture. A fuel supply tube extends across the throttle aperture, and has a distribution outlet extending across the throttle opening. The distribution outlet has a number of openings to meter the flow of fuel into the air passageway. The effective size of the openings can vary along the distribution outlet. Also, adjustment of the throttle aperture changes the effective length of the distribution outlet, by exposing more or fewer of the openings.

In GB—A—536549 an apparatus for creating a fuel-rich premixture is described. Air and fuel are mixed in a side passageway, off the main air passageway, by means of a rotatable fuel supply tube. The fuel-rich mixture is heated before being admixed with the air in the main air passageway.

According to the invention there is provided a carburettor comprising: an air passageway; a throttle valve slideably mounted across the air passageway to adjust a throttle aperture, a fuel supply tube connected to a fuel metering tube which extends across the throttle aperture and has along its length a fuel flow outlet to distribute and to meter the flow of fuel into the air passageway, the size of the fuel flow outlet varying along the metering tube, and the slideable throttle valve changing the effective length of the fuel flow outlet, characterised in that the size of the fuel flow outlet increases continually along the metering tube in the direction in which the throttle valve slides to open the throttle aperture, so that air-fuel ratio is maintained substantially constant at a certain air ambient pressure independent of throttle valve shifting and in that means are provided for adjusting the air fuel ratio by adjusting the pressure difference between the fuel pressure upstream of the fuel flow outlet and the air pressure at the fuel flow outlet, the pressure difference being adjusted by means of an air pressure of the air passageway which is adjustable between the total air pressure and the static (air) pressure of the air passageway in the region of the fuel metering tube, the means for adjusting the air fuel ratio having means for supplying fuel to the fuel metering tube at a pressure no greater than the total air pressure in the air passageway.

In one embodiment of the invention, the adjustment means alters the flow of fuel through the distribution outlet by changing the orientation of the fuel metering tube from a maximum lean position, where fuel flow may be essentially eliminated, to a full fuel flow position, thereby providing the richest possible air-fuel mixture.

In this embodiment, in order to alter the flow of fuel through the fuel distribution outlet, the fuel metering tube preferably is rotatable about its longitudinal axis to change the circumferential location of the distribution outlet. The outlet is positionable between a maximum lean condition facing upstream in the direction of air passage, and a maximum rich condition 90 degrees therefrom in which the distribution outlet faces across the path of air flow.

In another embodiment of the invention, the fuel supply comprises a fixed metering tube having its distribution outlet extending along one side and oriented perpendicular to air flow through the throat of the carburetor. In order to control the fuel flow, a pressure detecting tube is located in communication with the air passageway to sense a portion of the dynamic pressure of the air as it passes through the carburetor. This detected pressure is then used to maintain the pressure of the fuel at the detected pressure as the fuel is introduced into the fixed metering tube.

In this second embodiment of the invention, the detecting tube has an inlet in one side and is very similar to the fuel metering tube of the first embodiment of the invention. The detecting tube is rotatable to change the circumferential location of the inlet and therefore change the amount of dynamic air pressure that is sensed. Therefore, because of the rotatable nature of the detecting tube, the tube can be made to sense any pressure between the total pressure and the static pressure of the air flow.

In order to control the fuel flow in this embodiment of the invention, the invention includes a balancing regulator which is regulated by the sensed pressure. The balancing regulator has an inlet on one side for the fuel, and includes a control responsive to the sensed pressure and operable to permit the flow of fuel through the fuel inlet at such a rate so as to maintain equality between fuel pressure and the sensed pressure.

In another embodiment of the invention, the fuel metering tube is also fixed with the distribution outlet extending perpendicular to the air flow. A pressure transmitting tube having one end extending into the air flow is oriented to detect the total pressure of the air. A second pressure transmitting tube has one end extending into the air at the throttle passageway in order to detect the static pressure of the air passing therethrough. The tubes are joined at their other ends and a third pressure transmitting tube leads from this junction to a balancing regulator to control pressure of the fuel. The second pressure transmitting tube has a valve operable to permit a portion of the total pressure in the first pressure transmitting tube to bleed into the second pressure transmitting tube, leaving a resultant differential pressure in the third pressure transmitting tube. The resultant differential pressure is used to control the pressure of the fuel as it is introduced into the fuel outlet.

In this embodiment of the invention, a balancing regulator is again used to control the fuel flow. The balancing regulator senses the differential pressure and has an inlet for the fuel. The regulator includes a fuel control responsive to the sensed differential pressure and operable to permit flow of fuel through the fuel inlet at such a rate so as to maintain equality of pressure between the fuel and the sensed differential pressure.

In both latter embodiments of the invention, the fuel is delivered to the inlet of the balancing regulator from some external source such as a fuel pump or elevated fuel reservoir. The balancing regulator therefore is used to reduce the pressure of the fuel to the required pressure before fuel is permitted to enter the fuel metering tube.

In one form, the distribution outlet in the fuel metering tube comprises a plurality of apertures spaced axially along one side of the metering tube. In another form, the distribution outlet comprises an axial slot along one side of the metering tube. In all cases, the metering tube preferably is positioned in registration with the throttle valve and extends through a complimentary lateral aperture in the throttle valve. The throttle valve is slidable upon the metering tube to adjust the throttle opening and change the effective length of the fuel distribution outlet. Therefore, no matter how large the throttle opening, a uniform distribution of fuel is maintained across the throttle opening.

The throttle valve is adjustable between limits to provide a maximum throttle opening and a minimum throttle opening. In order to precisely control the fuel-air mixture at the minimum throttle opening, the axial location of the fuel metering tube can be adjusted. Thus, a greater or lesser portion of the distribution outlet can be presented across the throttle opening at its minimum setting.

Brief description of the drawings

The above features of the invention, and others, are described in greater detail in the following description of a number of preferred embodiments, where reference is made to the accompanying drawings, in which:

Figure 1 is an exploded illustration of the invention, with some parts omitted and other parts in cross-section to permit illustration of the primary components of the invention.

Figure 2 is a cross-sectional illustration of the assembled invention, illustrating the throttle valve closed to a minimal throttle opening.

Figure 3 is an illustration similar to Figure 2, but with the throttle valve translated sufficiently to provide a partial throttle opening.

Figure 4 is a view similar to Figure 2 but with the throttle valve being withdrawn sufficiently to provide a full throttle opening.

Fig. 5 is an enlarged cross-sectional illustration taken along lines 5—5 of Figure 4.

Figure 6 is an enlarged cross-sectional illustration taken along lines 6—6 of Figure 2.

Figure 7 is an enlarged cross-sectional illustration taken along lines 7—7 of Figure 4.

Figure 8 is an enlarged, partially truncated view of one embodiment of the fuel metering tube according to the invention.

Figure 9 is an elongated cross-sectional illustration taken along lines 9—9 of Figure 8.

Figure 10 is a truncated top plan view of an alternative embodiment of the fuel metering tube according to the invention.

Figures 11 through 13 illustrate rotation of the fuel metering tube respectively between a lean mixture setting, and a rich mixture setting.

Figures 14 illustrates, in cross section, a modified embodiment of the invention.

Figure 15 illustrates a modification of the embodiment of Figure 14, showing another form of the fuel metering system.

Figure 15a through 15c illustrate a partial cross-section taken along lines 15a—15a of Figure 15, with Figures 15b and 15c showing rotation of the pressure detecting tube.

Figure 16 illustrates a further modification of the embodiment of Figure 14, showing yet another form of the fuel metering system.

Figure 17 illustrates a further modification of the embodiment of Figure 14, showing a final form of the fuel metering system.

Description of the preferred embodiments

A fluid mixing device according to the invention, in the form of a carburetor, is shown in assembly fashion in Figure 1. Primary components of the carburetor include a top plate 10, a bottom plate 12, a throttle valve 14. Although the top plate 10 and bottom plate 12 are delineated as such, it should be obvious that the designations "top" and "bottom" are for the purposes of explanation only, and the respective roles of the plates 10 and 12 can be reversed as necessary. In addition, the top plate 10 has been shown in cross-section for the purposes of description, and would include a second half complementary to that shown in Figure 1.

The top plate 10 includes an air inlet 16. The bottom plate 12 includes an air-fuel outlet 18 located in concentric registration with the air inlet 16. The inlet 16 and outlet 18 are preferably of equal diameter.

When the carburetor is assembled, the throttle valve 14 is sandwiched between the top plate 10 and the bottom plate 12 for sliding movement between the two plates. The plates 10 and 12 are suitably fixed together as by means of a plurality of screws 20 passing through apertures 22 in the bottom plate 12 and engaging corresponding threaded apertures 24 in the top plate 10.

Although, as indicated above, the throttle valve 14 is situated between the plates 10 and 12 for sliding movement, the throttle valve 14 is dimensioned for a close fit in the aperture formed between the plates 10 and 12 when assembled. The throttle valve 14 may be formed of a material susceptible to forming a seal, such as Teflon, while the plates 10 and 12 may be formed of aluminum, steel or other relatively stiff material. Other materials may be used as desired.

As best shown in Figure 1, the throttle valve 14 includes a throttle aperture 26. The cross sectional dimension of the aperture 26 is the same as the diameters of the inlet 16 and outlet 18 so that if the inlet 16, opening 26 and outlet 18 are aligned, an uninhibited throttle opening or bore is formed through the carburetor. At this position, as described in greater detail below, air flow is maximum and, as is well known, the carburetor is at its full throttle position.

As best shown in Figures 2 through 4, the position of the throttle valve 14 between the sandwiched plates 10 and 12 is determined by means of a control rod 28. The rod 28 is secured within a bore 30 formed in the throttle valve 14 and passes through an aligned aperture 32 formed in the sidewall of the top plate 10. A pin or set screw 34, passing through a hole 36 in the rod 28 and lodged within a hole 38 formed in the throttle valve 14, secures the control rod 28 within the throttle valve 14.

For fuel metering, the carburetor includes a fuel metering tube 40 which passes longitudinally through the entire throttle valve 14 and extends through apertures 42 and 44 at opposite ends of the top plate 10. The throttle valve 14 includes a close-fitting longitudinal aperture 46 through which the fuel metering tube 40 passes and upon which the throttle valve 14 is mounted for sliding between the extreme location shown in Figures 2 through 4. The longer bore of the longitudinal aperture 46 may include sealing rings or the like (not illustrated) to assure a fluid-tight seal between the fuel metering tube 40 and the aperture 46.

The aperture 44 is threaded, as illustrated. A fuel connection nipple 48 is engaged on the threads of the aperture 44 and is shaped for connection to an external fuel source (not illustrated) in a well known manner not further described herein. The fuel connection nipple 48 may include a sealing ring or some similar device to provide a fluid tight seal between the nipple 48 and the fuel metering tube 40.

The fuel metering tube 40 is rotatable about its longitudinal axis to control the fuel-air ratio. Rotation is controlled by means of an arm 50 attached to the end of the fuel metering tube 40 opposite to that of the connection nipple 48. The arm 50 sealingly closes the tube 40 at its point of connection, and is controlled for rotation by suitable means (not illustrated), such as a control cable which may be clamped to the arm 50 through a bore 52 by a bolt 54.

Immediately adjacent the arm 50, a collar 56 is permanently secured to the fuel metering tube 40. A keeper screw 58, threadedly secured within the top plate 10, engages a circumferential channel 60 formed in the collar 56. Thus, the keeper screw 58 maintains precise axial alignment of the fuel metering tube 40. By suitable adjustment of the keeper screw 58, the axial position of the fuel metering tube 40 may be altered for purposes described in greater detail below.

As best shown in Figures 1 and 4, the fuel metering tube 40 includes a distribution outlet 62 extending across the entire width of the throttle aperture 26 when the throttle valve 14 is in the full throttle position. Thus, with the axial alignment of the fuel metering tube 40 being fixed by the keeper screw 58, no matter what position of the throttle valve 14 between the top and bottom plates 10 and 12, the fuel is dispensed across the entire width of the effective throttle opening.

As shown in enlarged fashion in Figures 8 and 9, in this first embodiment, the distribution outlet 62 is composed of a plurality of holes 64 spaced axially along one side of the fuel metering tube 40. As shown in Figure 8, the holes 64 have been gathered in three groups 66, 68 and 70 in order to overcome the reduction of the fuel flow rate over the length of the distribution outlet 62.

Figure 10 illustrates an alternative embodiment of the distribution outlet, designated as 62′. In this embodiment, the holes 64 are eliminated and instead the distribution outlet 62′ comprises an axial slot opening along one side of the metering tube 40. In the same manner as grouping of the holes 64 in the distribution outlet 62, the slot of the distribution outlet 62′ is formed in an increasing taper fashion, as illustrated, in order to maintain constant fuel outlet flow through the distribution outlet 62′.

As is well known, depending on the position of the throttle valve 14 and therefore the cross sectional dimension of the throttle opening through the carburetor, air flow through the carburetor is controlled. With the throttle valve 14 in the position illustrated in Figures 4, 5 and 7, maximum air flow is permitted and therefore the carburetor is at full throttle. With the throttle valve 14 at the position indicated in Figures 2 and 6, the carburetor is at its throttle closed position. The location shown in Figure 3 is a mid-throttle position. As shown in Figure 2, the maximum closure of the throttle valve 14 is determined by a set screw 72. With the set screw 72 adjusted to the position shown in Figure 2, a minimum air passageway 74 is formed. As shown in the drawings, the dimension of minimum air passageway 74 can be increased or decreased as desired by adjustment of the set screw 72. In fact, if desired, the minimum air passageway 74 can be omitted completely, although such a situation is not normally acceptable.

Also as shown in Figure 2, only a very small portion of the distribution outlet 62 extends into the minimum air passageway 74. If desired, a greater portion of the distribution outlet can extend into the minimum air passageway 74 by adjustment of the keeper screw 58. Assuming that, in the position shown in Figure 2, a single hole 64 (Figure 8) of the distribution outlet 62 extends into the minimum air passageway 74, by suitable adjustment of the keeper screw 58 a greater portion of the distribution outlet 62 can appear in the minimum air passageway 74, allowing one or more additional holes 64 to inject fuel into the minimum air passageway. Thus, by adjustment of the set screw 72 and the keeper screw 58, the dimensions of the minimum air passageway 74 are dictated, and also the fuel metering capacity at this minimum setting is determined.

In many carburetors, such as an aircraft carburetor of the nature of the invention, fuel pressure entering the carburetor fuel metering section is essentially equal to ambient pressure. Therefore, fuel is aspirated from the distribution outlet 62 of the fuel metering tube 40 by pressure differences created within the effective air passageway. In many situations, and in particular in an aircraft, the carburetor must have the capability of reducing the fuel flow as increases in aircraft altitude reduce the density of the air entering the air inlet 16 of the carburetor. Changes in the air-fuel mixture are effected by rotation of the fuel metering tube 40, as best shown diagrammatically in Figures 11 through 13. With the fuel metering tube 40 in the position shown in Figure 11, the distribution outlet is aimed upstream directly toward the air inlet 16, and the carburetor is in the "idle cutoff" position. When the fuel pressure in the metering tube is regulated in such a way so as to be maintained approximately equal to the total pressure of the air, the dynamic air pressure within the air inlet 16 completely inhibits the flow of fuel, causing the engine to stop.

In the position shown in Figure 13, the distribution outlet 62 is turned at 90 degrees to the airflow. This is the position for providing the richest possible air-fuel mixture such as is normally required at low altitudes. In this position, the fuel flow from the distribution outlet is being aspirated into the air passageway by the difference in pressure between the fuel inside the fuel metering tube 40 and the static air pressure outside of the distribution outlet 62 which is reduced below ambient pressure in accordance with the Bernoulli equation.

To adjust the carburetor to a leaner air-fuel mixture as would be required at higher altitudes, the fuel metering tube 40 is rotated to a mid-way orientation such as that shown in Figure 12. In this position, the air pressure outside of the fuel distribution outlet 62 is increased by a dynamic component of the velocity of the air entering the air inlet 16. This reduces the differential between the static and dynamic pressures which aspirates the fuel from the distribution outlet 62, and therefore reduces the fuel flow rate from that of the orientation shown in Figure 13. Consequently, a leaner fuel mixture is attained without fuel flow cutoff as shown in Figure 11.

Therefore, the invention achieves an even fuel distribution with precise air-fuel mixing to enable the carburetor to control an engine no matter what ambient conditions may be encountered. Not only does the throttle valve 14 control the air flow through the carburetor, but also the throttle valve 14, when sliding along the fuel metering tube 40 across the distribution outlet 62, maintains the air-fuel mixture constant no matter what the throttle position, contrary to conventional carburetors. In addition, by rotation of the fuel metering tube 40, the richness of the air-fuel mixture can be precisely controlled to account for changes in ambient air density.

Figure 14 illustrates an alternative embodiment of the invention having modification of the throttle valve and fuel system leading to the fuel inlet tube 40. Other components of the invention remain the same and therefore bear the same reference numerals. Since these elements were described above, further description is omitted.

As illustrated, the throttle valve 14′ in Figure 14 is truncated, omitting a portion of the throttle valve 14 which is unnecessary. As shown, the throttle valve 14′ includes a throttle aperture 26′ having a diameter equal to that of the air-fuel mixture outlet 18 so that, in a full throttle open position (such as that illustrated in Figure 4), there is no obstruction to flow by the throttle valve 14′.

In this embodiment, the invention includes a balancing regulator 90 operable to control fuel pressure in the fuel inlet tube 40 to ambient pressure. The balancing regulator 90 has an inlet 92 for fuel under pressure. The inlet 92 leads to a nipple 94 which may be connected to a source of fuel (not illustrated).

The inlet 92 is terminated by a fluid control ball valve 96 or by a conventional needle valve and seat assembly (not illustrated). The valve 96 has an internal orifice 98 which may be closed by a pair of balls 100. An arm 102, pivotally connected in its mid-section at 104 to the balancing regulator 90, has one end which bears against the larger of the balls 100. The other end of the arm 102 bears against a biasing compression spring 106 which in turn bears against a screw 108 threaded into the body of the top plate 10. Depending on the compression strength of the spring 106, the spring normally pivots the arm about the pivot 104, urging the balls 100 into the orifice 98 to preclude fuel flow through the inlet 92 into the interior of the balancing regulator 90 and from there into the fuel inlet tube 40. Fine adjustment of the compression strength of the spring 106 with the screw 108 to achieve this end is well-known.

The balancing regulator 90 also includes a movable diaphragm 110 having a central contact 112 in alignment with one end of the arm 102. The balancing regulator 90 also includes an opening 114 to the ambient surroundings.

The metering system of the balancing regulator 90 operates in a well-known manner. Since the opening 114 is to the ambient pressure which is usually equal to the airflow total pressure, the ambient pressure normally urges the contact 112 against the arm 102, permitting fuel to enter the regulator 90 through the inlet 92. Not only does the entering fuel flow through the fuel inlet tube 40 and exit through the distribution outlet 62, the fuel also bears against the opposite side of the diaphragm 110 from that open to the ambient pressure experienced through the opening 114. If the fuel pressure is higher than the ambient pressure, the increased pressure of the fuel tends to urge the contact 112 away from the arm 102, permitting the spring 106 to pivot the arm about the pivot 104, urging the balls 100 into the closed position. Therefore, the diaphragm 110 always positions itself as necessary to equalize the fuel pressure on the fuel side of the diaphragm with the ambient air pressure on the air side of the diaphragm. Thus, the fuel pressure in the inlet tube 40 is always maintained at approximately the same pressure as the ambient air pressure surrounding the carburetor.

Figure 15 illustrates a modified version of the invention in which fuel flow is controlled totally by air pressure and the fuel inlet tube 40 is fixed with the inlet 62 oriented so as to sense static pressure, in this embodiment perpendicular to the direction of air flow through the carburetor.

As seen in Figure 15, the opening 114 of the balancing regulator 90 is not opened to ambient pressure. Rather, a conduit 116 leads from the opening 114 to a pressure detecting tube 118 extending across the air inlet 16. The tube 118 must be immediately adjacent the fuel distribution outlet 62, and is shown directly above the tube 40 in Figure 15. The detecting tube 118 includes an aperture 120 therein, thus permitting the tube 118 to sense the air pressure in the air inlet 16. The tube 118 is axially rotatable as shown in Figure 15 and in Figures 15a—15c in order to permit altering the circumferential location of the aperture and therefore vary the percentage of the dynamic pressure that is sensed.

Since the distribution outlet 62 of the fuel inlet tube 40 is fixed at an orientation perpendicular to the air flow through the carburetor, the distribution outlet 62 experiences only the static component of the total air pressure in the carburetor at its particular location. So long as the fuel introduced into the inlet tube 40 is at a pressure greater than the static pressure existing at the distribution outlet 62, fuel will flow from the distribution outlet and be mixed with the incoming ambient air.

The pressure balancing function of the balancing regulator 90 causes the pressure in the metering tube 40 to be equal to the pressure sensed by the pressure detecting tube 118. With the orientation of the aperture 120 shown in Figure 15 and Figure 15a (open to the air flow), the aperture 120 detects the total pressure of the air at this location. The balancing regulator adjusts the fuel pressure in the metering tube 40 to equal the total pressure sensed by the aperture 120. Since the pressure at the fuel outlet 62 is equal to the static pressure, fuel flow occurs through the fuel outlet 62.

If, on the otherhand, the aperture 120 is oriented as shown in Figure 15b, the aperture 120 senses a lower pressure that is equal to the static pressure plus a lesser dynamic component that depends on the upstream orientation of the aperture 120. This lower pressure is transmitted through the conduit 116 to the diaphragm 110. The diaphragm 110 positions itself such that the ball valve 96 admits fuel to the fuel side of the diaphragm 110 at such a rate so as to make the fuel pressure in the metering tube 40 equal to the air pressure sensed by the aperture 120 in the pressure detecting tube 118.

When the pressure sensing aperture is oriented as shown in Figure 15c, the resulting pressure in the fuel metering tube 40 is equal to the static pressure existing at the outlet 62. With the orientation shown in Figure 15c, no fuel would flow.

Figure 16 illustrates a modification of the system for injecting fuel into the carburetor. A portion of the air inlet 16 of the top plate 10 is shown superimposed above the cross-sectional illustration of the carburetor as depicted and described in Figure 14. In this embodiment, a first pressure transmitting tube 122 leads from the air inlet 16 and joins a second pressure transmitting 124 leading from the mixture outlet 18. A third pressure transmitting tube 126 leads from the juncture of the tubes 122 and 124 to the opening 114 of the balancing regulator 90. As shown, the end 128 of the tube 122 in the air inlet 16 faces upstream and therefore senses the total air pressure in the air inlet 16. The tube 124 is introduced at the side of the mixture outlet 18, and therefore detects the static pressure at that location. An adjustable needle valve 130 is located in the tube 124 and may be adjusted to close the tube 124 completely, or permit any opening required.

Because the end 128 of the tube 122 is opened to the total pressure, and because the tube 124 is opened to the lower static pressure, if the needle valve 130 is opened slightly, a portion of the total pressure in the tube 122 is bled through the needle valve 130 into the tube 124. This leaves a resultant differential pressure in the tube 126, which is directed through the opening 114 to the interior of the balancing regulator 90. Thus, by judicious adjustment of the needle valve 130, the differential pressure experienced by the balancing regulator 90 may be adjusted as desired. Since the distribution outlet 62 of the fuel inlet tube 40 is oriented perpendicular to the flow direction, and therefore experiences only the static pressure of the flow, the balancing regulator 90 is operated as described above and fuel is driven through the outlet 62 by the difference between the differential pressure within the tube 126 and the static pressure at the distribution outlet 62. So long as the differential pressure is greater than the static pressure, fuel will flow.

Figure 17 illustrates another embodiment of the invention having modification of the throttle valve and fuel system leading to the fuel inlet tube 40. Components which have been described above bear the same reference numerals and perform the same functions. Further description, therefore, is omitted.

In this embodiment, the invention includes a fuel metering float regulator 140 operable to maintain fuel pressure in the fuel inlet tube 40 at ambient pressure. The float regulator 140 includes the fluid control ball valve 96 and associated component described above. The arm 102 of the prior embodiments of Figures 14 through 16 is replaced with an arm 142 which is pivotally connected in its mid-section at 144. One end of the arm 142 bears against the larger of the balls 100. The other end of the arm 142 is connected to a float 146 maintained within a fuel reservoir 148 of the float regulator 140. The float 146 is situated such that during normal operation, the level of the fuel 150 within the fuel reservoir 148 is sufficient to allow fuel to enter the fuel inlet tube 40. If the pressure of the fuel 150 within the reservoir 148 is greater than the air pressure experienced at the distribution outlet 62 of the inlet tube 40, fuel will flow from the distribution outlet. Conversely, if the air pressure is the same as or higher than the fuel pressure, no fuel will flow from the distribution outlet 62.

As shown diagrammatically, the fuel reservoir 148 includes an aperture 152 open to the ambient surroundings. Therefore, the fuel 150 within the reservoir 148 is maintained at ambient pressure.

The metering system of the float regulator 140 operates in a known manner. Since the aperture 152 is opened to ambient pressure, and assuming fuel pressure in the inlet 92 is greater than ambient pressure, fuel enters the reservoir 148 from the inlet 92 and maintains a level permitted by the float 146. The fuel 150, at ambient pressure, also enters the fuel inlet tube 40, and is present at the distribution outlet 62. With the distribution outlet aimed upstream in the orientation illustrated in Figure 17, the total pressure is experienced. Since the total pressure equals the ambient pressure, at the orientation illustrated, fuel flow through the outlet 62 will be prevented. However, if the fuel inlet tube 40 is rotated slightly, the pressure experienced at the distribution outlet will be less than the total pressure. Thus, fuel will flow from the distribution outlet 62. The fuel/air mixture is therefore controlled by the rotational orientation of the fuel inlet tube 40, in the same manner as described above with regard to prior embodiments.

In this embodiment of the invention, fuel will enter the reservoir 148 from the inlet 92 so long as the fuel in the inlet 92 is under pressure. Therefore, when an internal combustion engine incorporating the invention is stopped, operation of the pump (not illustrated) supplying fuel to the inlet 92 must also be stopped. The fuel 150 contained within the reservoir 148 will, therefore, at maximum drain to a lower level where no fuel enters the inlet tube 40.

The invention provides a novel, precise system for metering fluid flow and mixing of two fluids. By appropriate orientation of the fuel outlet 62 of the fuel inlet tube 40 in combination with regulated fuel pressure and appropriate adjustment of the throttle valve 14, optimum fuel/air ratio can be provided over the full range of engine power and operating environment.

Because no obstructions exist downstream of the fuel outlet, the carburetor according to the invention is non-icing. This feature is quite advantageous particularly in aircraft which operate at altitudes or temperatures where icing can occur in conventional carburetors.

Conventional carburetors which are used in automotive applications require a choke valve of some nature to provide extra richness for engine starting. No choke valve is required in the present invention since the required richness for starting can be obtained by the combination of the fuel inlet tube 40, throttle valve 14, and pressure and outlet rate of the fuel within the inlet tube 40.

With the exception of the embodiment of Figure 17, the invention can be used at any attitude orientation, and also with the exception of the embodiment of Figure 17 can be used in any condition of horizontal or vertical acceleration. Conventional carburetors having a float system for fuel metering require a substantially consistant orientation to prevent fuel starvation or flooding in the carburetor.

Claims

1. A carburettor comprising: an air passageway (16, 18); a throttle valve (14) slideably mounted across the air passageway (16, 18) to adjust a throttle aperture (26), a fuel supply tube connected to a fuel metering tube (40) which extends across the throttle aperture (26) and has along its length a fuel flow outlet (62) to distribute and to meter the flow of fuel into the air passageway (16, 18), the size of the fuel flow outlet (62) varying along the metering tube (40), and the slideable throttle valve changing the effective length of the fuel flow outlet (62), characterised in that the size of the fuel flow outlet (62) increases continually along the metering tube (40) in the direction in which the throttle valve slides to open the throttle aperture, so that air-fuel ratio is maintained substantially constant at a certain air ambient pressure independent of throttle valve shifting and in that means (40, 52; 124, 130; 114, 120) are provided for adjusting the air fuel ratio by adjusting the pressure difference between the fuel pressure upstream of the fuel flow outlet and the air pressure at the fuel flow outlet (62), the pressure difference being adjusted by means of an air pressure of the air passageway (16, 18) which is adjustable between the total air pressure and the static (air) pressure of the air passageway in the region of the fuel metering tube (40), the means for adjusting the air fuel ratio having means for supplying fuel to the fuel metering tube at a pressure no greater than the total air pressure in the air passageway.

2. A carburettor according to claim 1, in which the fuel flow outlet comprises a plurality of apertures (Figure 8) spaced axially along at least one side of the fuel metering tube.

3. A carburettor according to claim 1, in which said fuel flow outlet comprises at least one axial slot (Figure 10) extending along one side of the fuel supply tube.

4. A carburettor according to claim 1, 2 or 3, in which the fuel metering tube (40) extends through a complementary longitudinal aperture (46) in the throttle valve (14), and the throttle valve (14) is slidable upon the metering tube to adjust the throttle opening and change the effective length of the fuel flow outlet (62).

5. A carburettor according to claim 1, 2, 3 or 4, including means (58, 60) to adjust the axial location of the fuel metering tube.

6. A carburettor according to any preceding claim, in which the throttle valve (14) is adjustable between limits to provide a maximum throttle opening and a minimum throttle opening, and further including means (72) to set the minimum throttle opening.

7. A carburettor according to any preceding claim, in which the adjusting means comprises means (50—60) to rotate the fuel supply tube about its longitudinal axis to change the circumferential location of fuel flow outlet (62).

8. A carburettor according to any one of claims 1 to 6, in which the adjustment means comprises

a pressure detecting tube (118) in the air passageway (16, 18), and means (90, 114—116) to control the fuel pressure using the detected pressure.

9. A carburettor according to claim 8, in which there is an inlet in one side of the detecting tube, and the detecting tube is rotatable to change the circumferential location of the inlet and thereby change the pressure which is sensed.

10. A carburettor according to claim 8 or 9, in which the control means comprises a balancing regulator (90) regulated by the sensed pressure, the balancing regulator having a fuel inlet controlling fuel pressure responsive to the sensed pressure and operable to permit flow of fuel through the fuel inlet at such a rate so as to cause substantial equality of pressure between the fuel and the sensed pressure.

11. A carburettor according to any one of claims 1 to 6, in which the adjustment means comprises a first pressure transmitting tube (122) having one end oriented so as to detect high air pressure and a second pressure transmitting tube (124) having one end positioned so as to detect a lower pressure, the tubes being joined at their other ends and having a third pressure transmitting tube (126) leading therefrom, the second pressure transmitting tube having valve means (130) therein operable to permit a portion of the higher pressure in the first pressure transmitting tube (122) to bleed into the second pressure transmitting tube (124), leaving a resultant differential pressure in the third pressure transmitting tube (126), and the adjustment means having means (90) to control the pressure of the fuel at substantially said differential pressure.

12. A carburettor according to claim 11, in which the control means comprises a balancing regulator (90) regulated by the differential pressure, the balancing regulator having a fuel inlet (96) being responsive to said differential pressure and operable to permit flow of fuel through fuel inlet at such a rate so as to maintain substantial equality of pressure between the fuel and said differential pressure.

Patentansprüche

1. Vergaser mit: einem Luftkanal (16, 18); einem Drosselventil (14), das über den Luftkanal (16, 18) schiebbar montiert ist, um eine Drosselöffnung (26) einzustellen, eine Brennstoff-Zuführleitung, die an eine Brennstoffmeßleitung (40) angeschlossen ist, welche sich über die Drosselöffnung (26) erstreckt und entlang ihrer Länge einen Brennstoffauslaß (62) hat, um den Brennstoffstrom in den Luftkanal (16, 18) zu verteilen und abzumessen, wobei die Größe des Brennstoffauslasses (62) entlang der Meßleitung (40) variiert, und wobei das verschiebbare Drosselventil die wirksame Länge des Brennstoffauslasses (62) verändert, dadurch gekennzeichnet, daß die Größe des Brennstoffauslasses (62) kontinuierlich entlang der Meßleitung (40) in der Richtung zunimmt, in der das Drosselventil zum Öffnen der Drosselöffnung gleitet, so daß das Brennstoff-Luftverhältnis bei einem bestimmten Umgebungsluftdruck unabhängig von einer Drosselventilverschiebung im wesentlichen konstant gehalten wird und daß Mittel (40, 52; 124, 130; 114, 120) vorgesehen sind, um das Brennstoff-Luftverhältnis durch Einstellen der Druckdifferenz zwischen dem Brennstoffdruck stromaufwärts von dem Brennstoffauslaß und dem Luftdruck am Brennstoffauslaß (62) einzustellen, wobei die Druckdifferenz durch einen Luftdruck im Luftkanal (16, 18), der zwischen dem Gesamtluftdruck und dem statischen (Luft)Druck im Luftkanal im Bereich der Brennstoffmeßleitung (40) einstellbar ist, eingestellt wird, wobei die Mittel zum Einstellen des Brennstoff-Luftverhältnisses Mittel zum Zuführen von Brennstoff zu der Brennstoffmeßleitung bei einem Druck besitzen, der nicht größer als der gesamte Luftdruck in dem Luftkanal ist.

2. Vergaser nach Anspruch 1, wobei der Brennstoffauslaß eine Anzahl von Öffnungen (Figur 8) aufweist, die axial entlang von zumindest einer Seite der Brennstoffmeßleitung beabstandet sind.

3. Vergaser nach Anspruch 1, wobei der Brennstoffauslaß zumindest einen axialen Schlitz (Figur 10) aufweist, der sich entlang einer Seite der Brennstoffzuführleitung erstreckt.

4. Vergaser nach Anspruch 1, 2 oder 3, wobei sich die Brennstoffmeßleitung (40) durch eine komplementäre Längsoffnung (46) in dem Drosselventil (14) erstreckt und das Drosselventil (14) auf der Meßleitung verschiebbar ist, um die Drosselöffnung einzustellen und die wirksame Länge des Brennstoffauslasses (62) zu verändern.

5. Vergaser nach Anspruch 1, 2, 3 oder 4, mit Mitteln (58, 60) zum Einstellen der axialen Anordnung der Brennstoffmeßleitung.

6. Vergaser nach einem der vorhergehenden Ansprüche, bei dem das Drosselventil (14) zwischen Grenzwerten einstellbar ist, um eine maximale Drosselöffnung und eine minimale Drosselöffnung zu schaffen, und ferner mit Mitteln (72) zum Einstellen der minimalen Drosselöffnung.

7. Vergaser nach einem der vorhergehenden Ansprüche, wobei das Einstellmittel Mittel (50—60) aufweist, um die Brennstoffzuführleitung um ihre Längsachse zu drehen, um die Umfangsanordnung des Brennstoffauslasses (62) zu verändern.

8. Vergaser nach einem der Ansprüche 1 bis 6, wobei das Einstellmittel eine Druckmeßleitung (118) in dem Luftkanal (16, 18) aufweist, und wobei Mittel (90, 114—116) vorgesehen sind, um den Brennstoffdruck unter Verwendung des gemessenen Drucks zu steuern.

9. Vergaser nach Anspruch 8, bei dem an einer Seite der Meßleitung ein Einlaß vorgesehen ist und wobei die Meßleitung drehbar ist, um den Umfangsort des Einlasses und dadurch den gemessenen Druck zu verändern.

10. Vergaser nach Anspruch 8 oder 9, wobei das Steuermittel einen Ausgleichsregler (90) aufweist, der von dem gemessenen Druck geregelt wird, wobei der Ausgleichsregler einen Brennstoffeinlaß besitzt, der den Brennstoffdruck in Abhängig-

keit von dem gemessenen Druck regelt und der so betreibbar ist, daß er eine Brennstoffströmung durch den Brennstoffeinlaß mit einer Rate zuläßt, die einen wesentlichen Druckausgleich zwischen dem Brennstoff und dem gemessenen Druck bewirkt.

11. Vergaser nach einem der Ansprüche 1 bis 6, wobei das Einstellmittel eine erste Druckübertragungsleitung (122) aufweist, von der ein Ende so ausgerichtet ist, daß es hohen Luftdruck mißt und wobei eine zweite Druckübertragungsleitung (124) mit einem Ende so positioniert ist, daß ein tieferer Druck gemessen wird, wobei die beiden Leitungen mit ihren anderen Enden verbunden sind und davon eine dritte Druckübertragungsleitung (126) abzweigt, wobei die zweite Druckübertragungsleitung eine Ventileinrichtung (130) enthält, die so betreibbar ist, daß ein Teil des höheren Drucks in der ersten Druckübertragungsleitung (122) in die zweite Druckübertragungsleitung (124) abgelassen wird, was zu einem Differenzdruck in der dritten Druckübertragungsleitung (126) führt, und wobei das Einstellmittel Mittel (90) zum Steuern des Brennstoffdruckes bei im wesentlichen diesem Differenzdruck aufweist.

12. Vergaser nach Anspruch 11, bei dem das Steuermittel einen Ausgleichsregler (90) aufweist, der durch den Differenzdruck geregelt wird, wobei der Ausgleichsregler einen Brennstoffeinlaß (96) besitzt, der auf den Differenzdruck anspricht und der so betreibbar ist, daß er eine Brennstoffströmung durch den Brennstoffeinlaß mit einer solchen Rate zuläßt, daß im wesentlichen Druckgleichgewicht zwischen dem Brennstoff- und dem Differenzdruck aufrechterhalten wird.

Revendications

1. Un carburateur comprenant: un passage d'air (16, 18), une soupape d'étranglement (14) montée coulissante à travers le passage d'air (16, 18) pour régler une ouverture d'étranglement (26), un tube d'alimentation en carburant connecté à un tube de mesure de carburant (40) qui s'étend à travers l'ouverture d'étranglement (26) et a dans sa longueur une sortie de débit de carburant (62) pour distribuer et mesurer le débit de carburant dans le passage d'air (16, 18), la taille de la sortie de débit de carburant (62) variant le long du tube de mesure (40), et la soupape d'étranglement coulissante modifiant la longueur effective de la sortie de débit de carburant (62), caractérisé en ce que la taille de la sortie de débit de carburant (62) croît de façon continue le long du tube de mesure (40) dans la direction où la soupape d'étranglement coulisse pour ouvrir l'ouverture d'étranglement, de façon à ce que le taux air-carburant soit maintenu essentiellement constant à une certaine pression de l'air ambiant indépendamment du changement de la soupape d'étanglement et pour cela des moyens (40, 52, 124, 130, 114, 120) sont fournie pour régler le taux air-carburant en réglant la différence de pression entre la pression du carburant en amont de la sortie de débit du carburant et la pression d'air à la sortie de débit du carburant (62), la différence de pression étant réglée au moyen d'une pression d'air du passage d'air (16, 18) qui est réglable entre la pression d'air totale et la pression (d'air) statique du passage d'air dans la partie du tube de mesure du carburant (40), les moyens pour régler le taux air-carburant possédant les moyens pour fournir du carburant au tube de mesure de carburant à une pression qui ne soit pas plus élevée que la pression d'air totale dans le passage d'air.

2. Carburateur selon la revendication 1, caractérisé en ce que la sortie de débit de carburant comprend une pluralité d'ouvertures (figure 8) espacées axialement) le long au moins d'un côté du tube de mesure du carburant.

3. Carburateur selon la revendication 1, caractérisé en ce que la sortie de débit de carburant comprend au moins une fente axiale (figure 10) s'étendant le long d'un côté du tube d'alimentation en carburant.

4. Carburateur selon la revendication 1, 2 ou 3, caractérisé en ce que le tube de mesure de carburant (40) s'étend à traverse une ouverture complémentaire longitudinale (46) dans la soupape d'étranglement (14), et la soupape d'étranglement (14) est coulissable sur le tube de mesure pour régler l'ouverture d'étranglement et changer la longueur effective de la sortie de débit de carburant (62).

5. Carburateur selon la revendication 1, 2, 3 ou 4, caractérisé en ce qu'il comprend des moyens (58, 60) pour régler la position axiale du tube de mesure du carburant.

6. Carburateur selon l'une quelconque des revendications précédentes, caractérisé en ce que la soupape d'étranglement (14) est réglable dans certaines limites pour ménager une ouverture d'étranglement maximum et une ouverture d'étranglement minimum, et comprend en outre un moyen (72) pour fixer l'ouverture minimum d'étranglement.

7. Carburateur selon l'une quelconque des revendications précédentes, caractérisé en ce que le moyen de réglage comprend des moyens (50, 60) pour faire tourner le tube d'alimentation en carburant sur son axe longitudinal pour changer la position périphérique de la sortie de débit de carburant (62).

8. Carburateur selon l'une quelconque des revendications 1 à 6, caractérisé en ce que le moyen de réglage comprend un tube détecteur de pression (118) dans le passage d'air (16, 18) et des moyens (90, 114—116) pour régler la pression de carburant en utilisant la pression détectée.

9. Carburateur selon la revendication 8, caractérisé en ce qu'il y a une entrée sur un côté du tube détecteur, et le tube détecteur est rotatif pour changer la position périphérique de l'entrée et ainsi changer la pression qui est captée.

10. Carburateur selon la revendication 8 ou 9, caractérisé en ce que le moyen de contrôle comprend un régulateur d'équilibre (90) régulé par la pression captée, le régulateur d'équilibre possédant une entrée de carburant contrôlant la pres-

sion de carburant sensible à la pression captée et actionnable pour permettre le débit de carburant à travers l'entrée de carburant à un taux tel qu'une égalité de pression essentielle soit obtenue entre le carburant et la pression captée.

11. Carburateur selon l'une quelconque des revendications 1 à 6, caractérisé en ce que le moyen de réglage comprend un premier tube transmetteur de pression (122) possédant une extrémité orientée de façon à détecter une pression d'air élevée et un second tube transmetteur de pression (124) possédant une extrémité placée de façon à détecter une pression plus basse, les tubes étant joints à leurs autres extrémités et possédant un troisième tube transmetteur de pression (126) partant de là, le second tube transmetteur de pression possédant un moyen de soupape (130) actionnable pour permettre à une partie de la pression plus élevée dans le premier tube transmetteur de pression (122) de s'écouler dans le second tube transmetteur de pression (124), laissant apparaître une pression résultante différentielle dans le troisième tube transmetteur de pression (126), et le moyen de réglage possédant un moyen (90) pour commander la pression du carburant essentiellement à la valeur de la pression différentielle.

12. Carburateur selon la revendication 11, caractérisé en ce que le moyen de contrôle comprend un régulateur d'équilibre (90) régulé par la pression différentielle, le régulateur d'équilibre possédant une entrée de carburant (96) sensible à ladite pression différentielle et actionnable pour permettre l'écoulement de carburant à travers l'entrée de carburant à un taux capable de maintenir une égalité essentielle de pression entre le carburant et la pression différentielle.

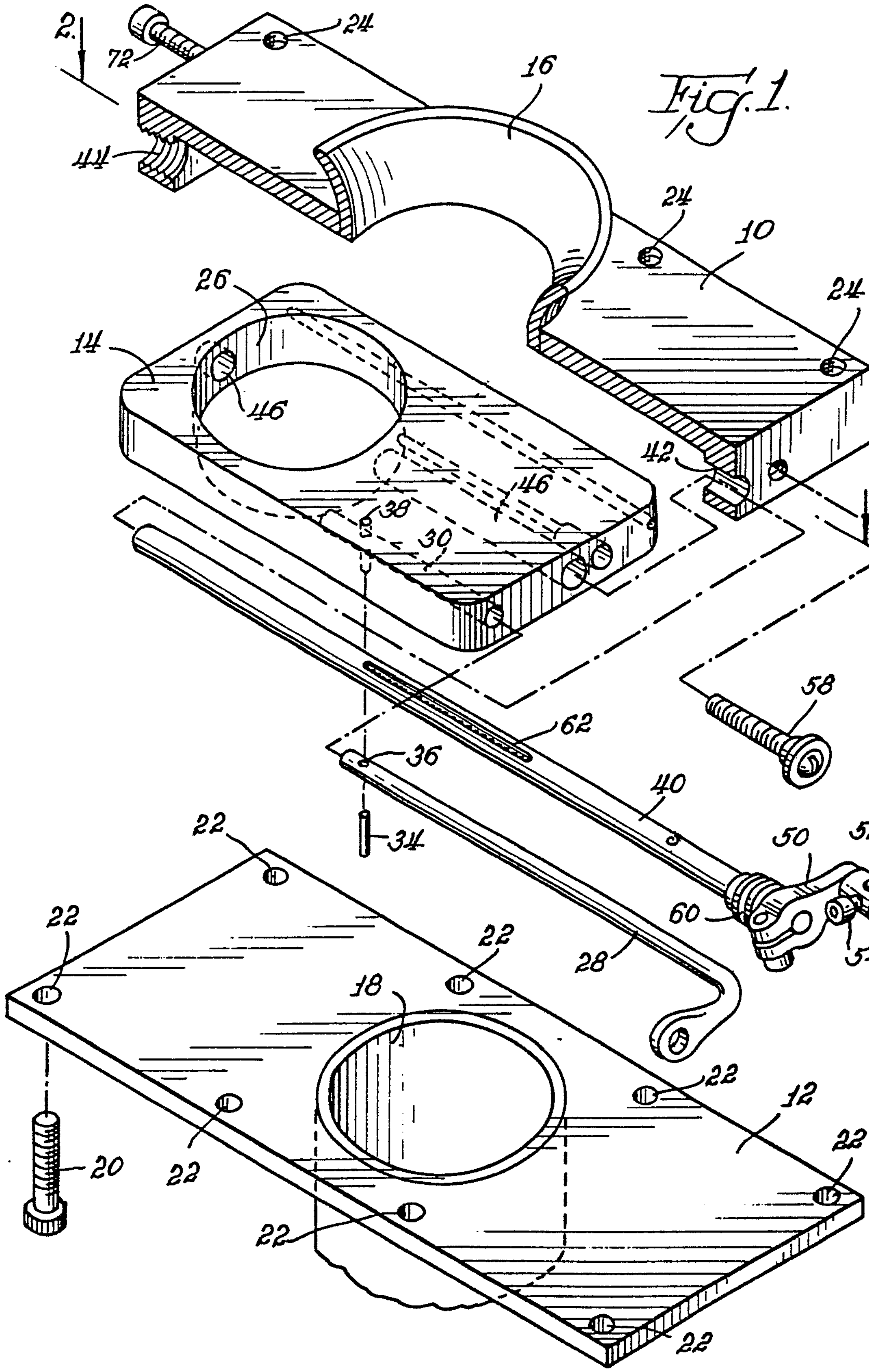
Fig. 1.
2.
72
24
16
44
24
10
24
26
14
46
42
46
38
30
2.
58
62
36
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34
50
52
60
54
22
22
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18
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12
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20
22
22
22

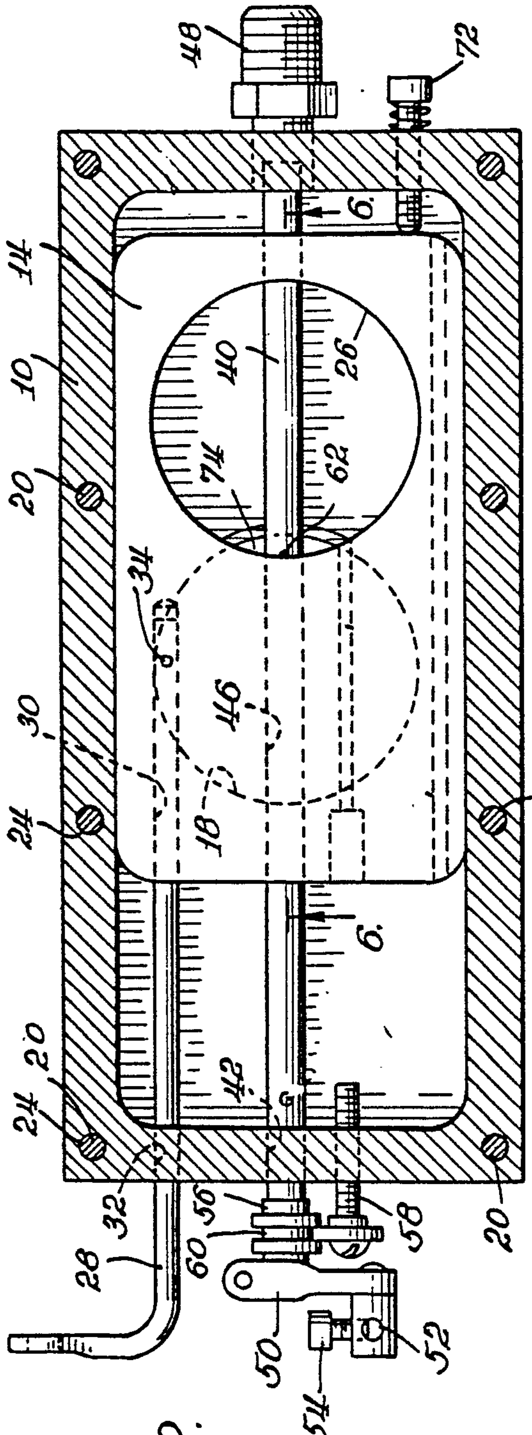


Fig. 2.

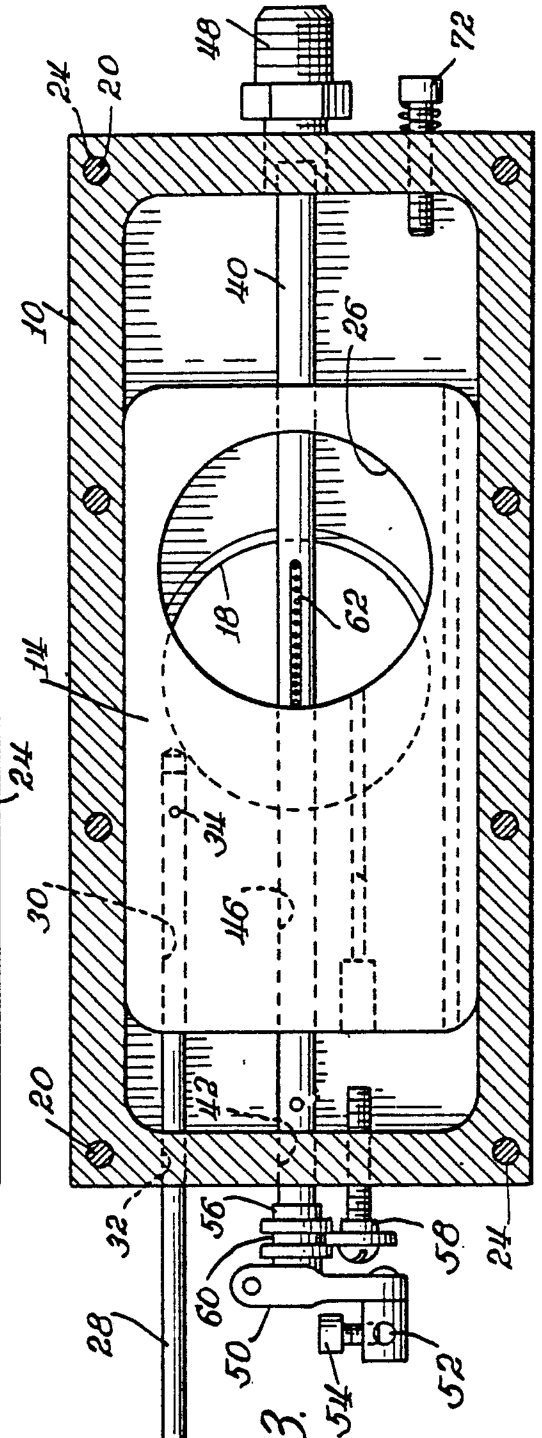


Fig. 3.

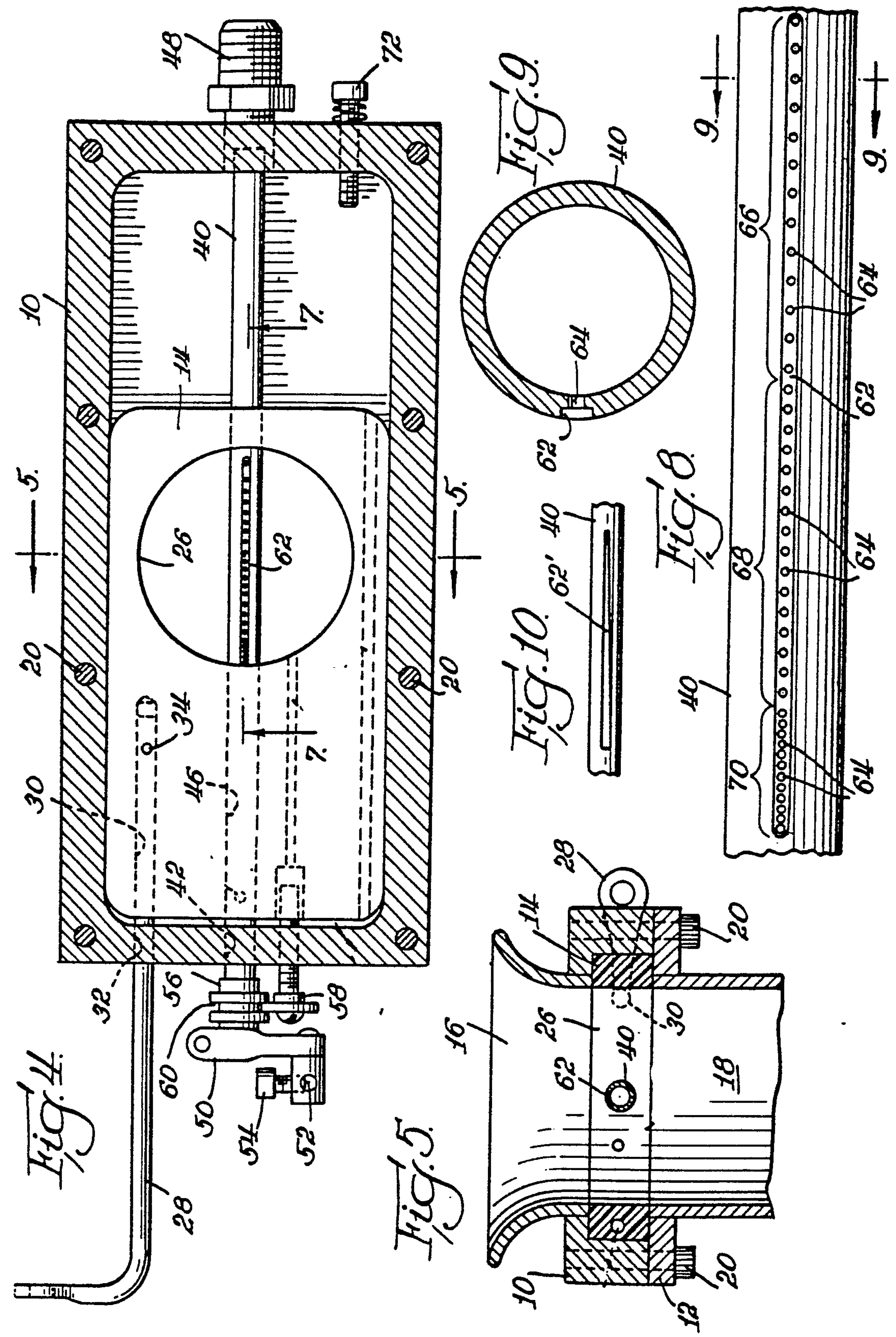


Fig. 4.
Fig. 5.
Fig. 8.
Fig. 9.
Fig. 10.

Fig. 13.

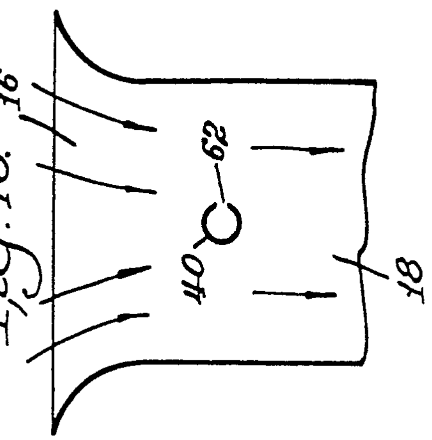


Fig. 12.

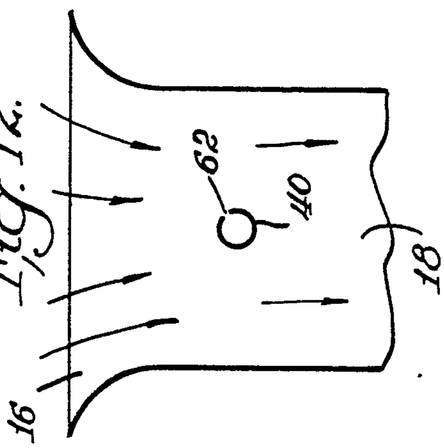


Fig. 11.

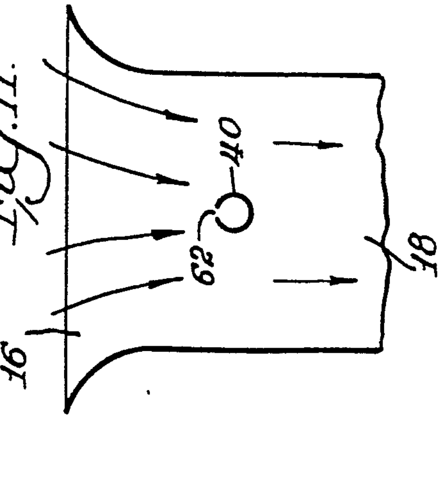


Fig. 7.

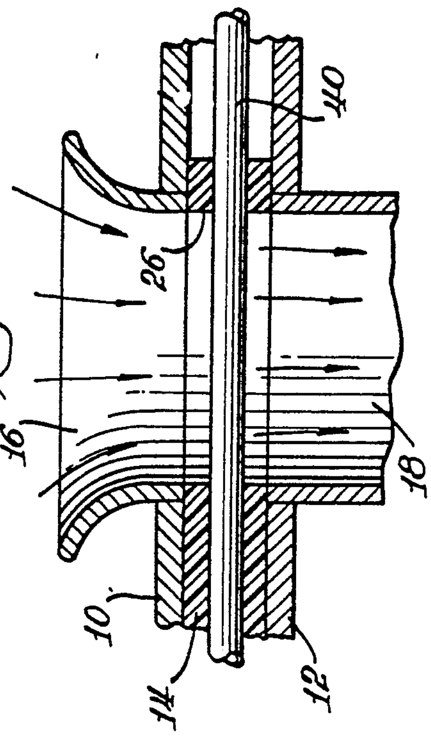


Fig. 6.

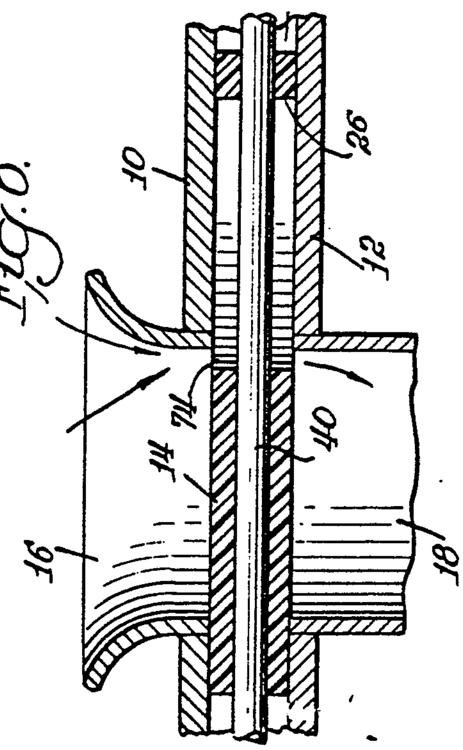


Fig. 14

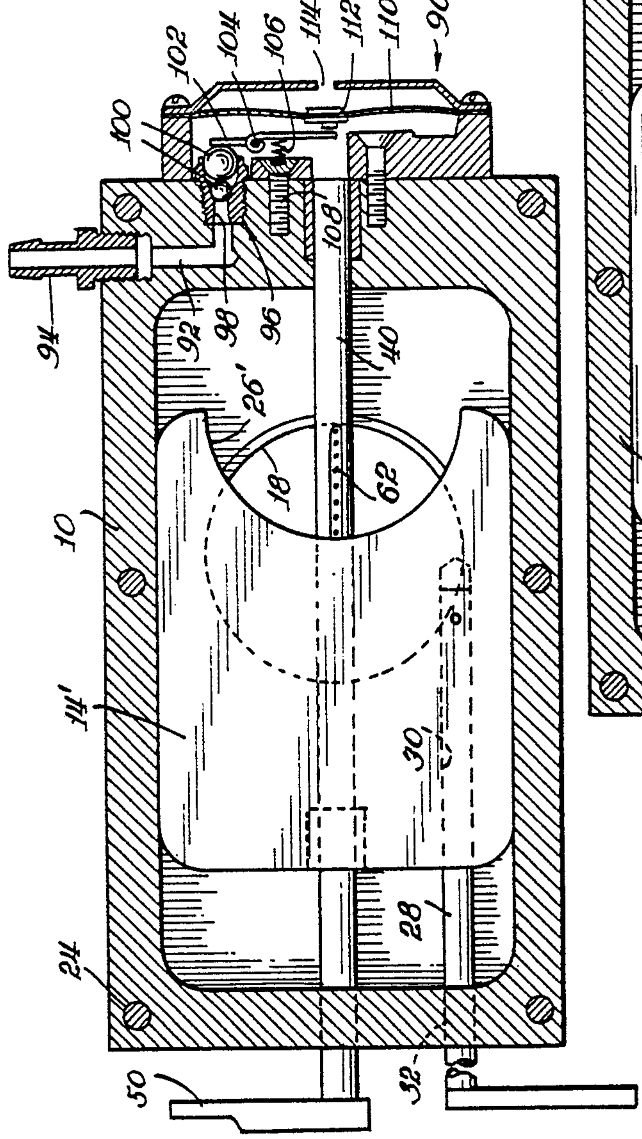
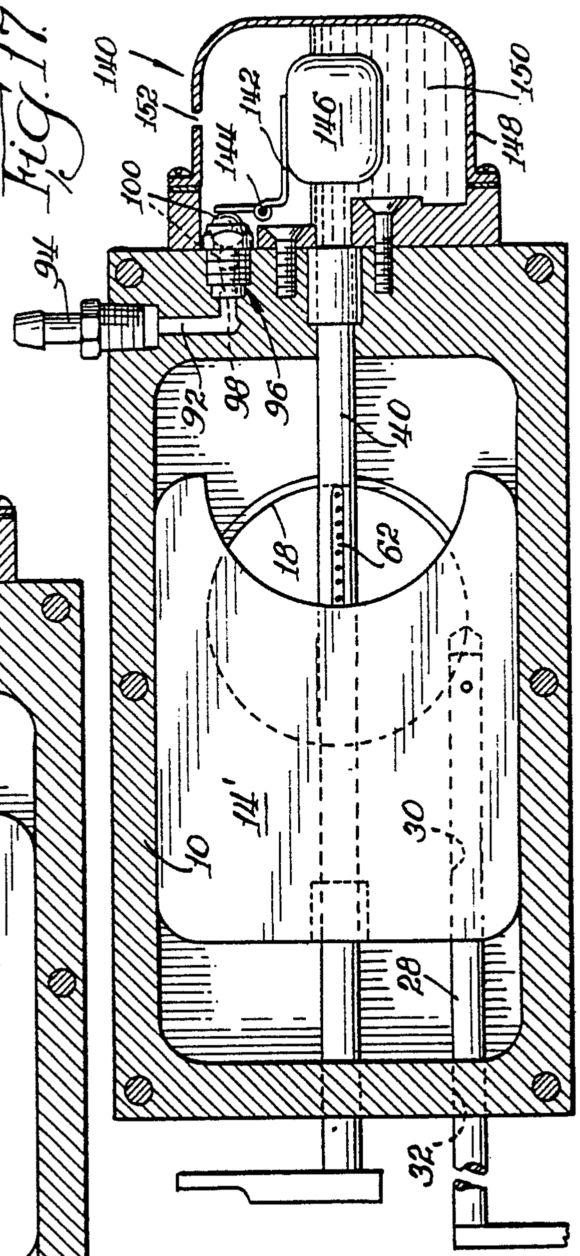

100
102
104
106
114
112
110
90
94
92
98
96
108
40
26'
18
62
10
14'
30
28
24
50
32

Fig. 17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150
144
100
94
92
98
96
40
18
62
10
14'
30
28
32

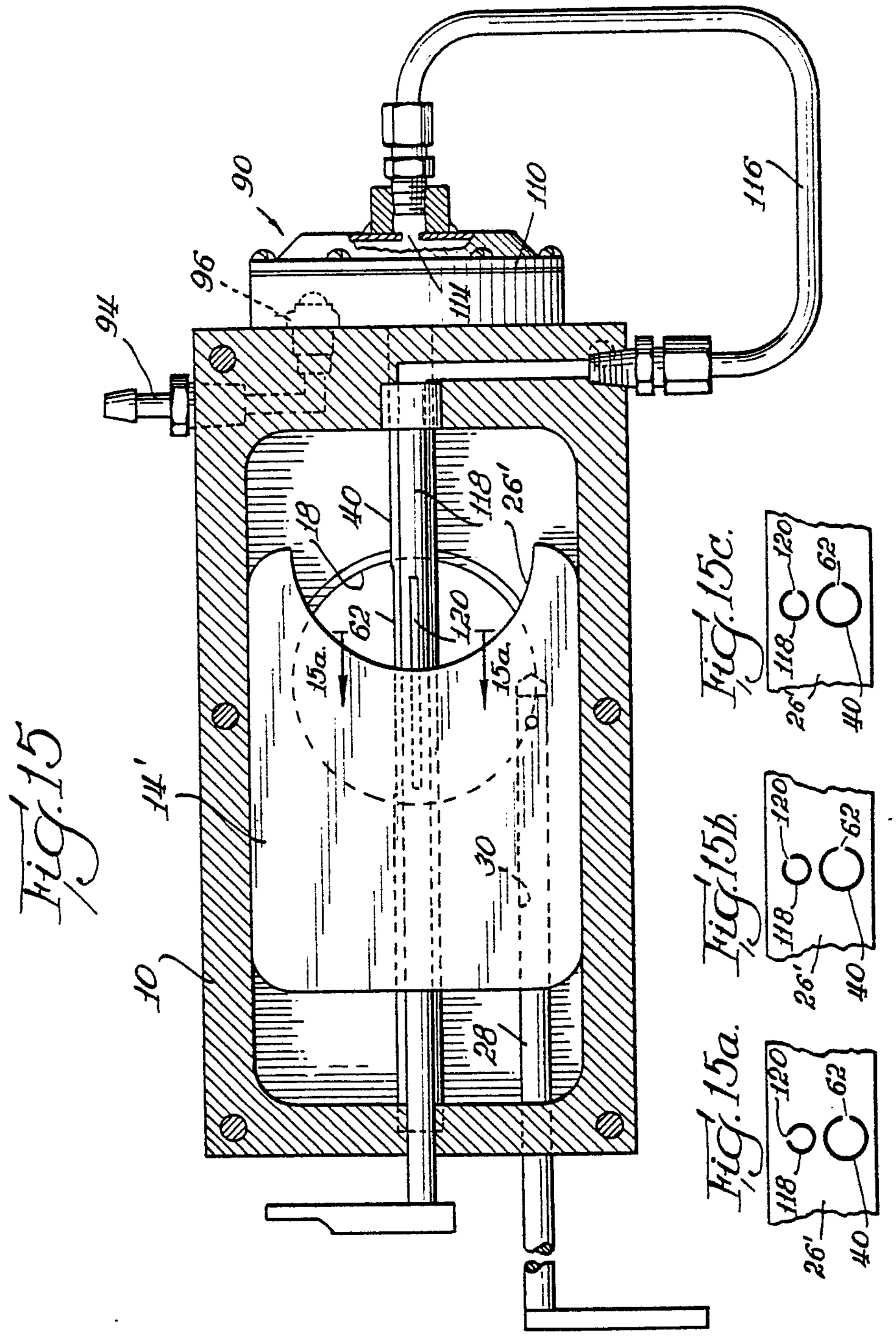
Fig. 15
Fig. 15a.
Fig. 15b.
Fig. 15c.
90
94
96
110
114
116
10
14'
18
26'
28
30
40
62
118
120
15a.

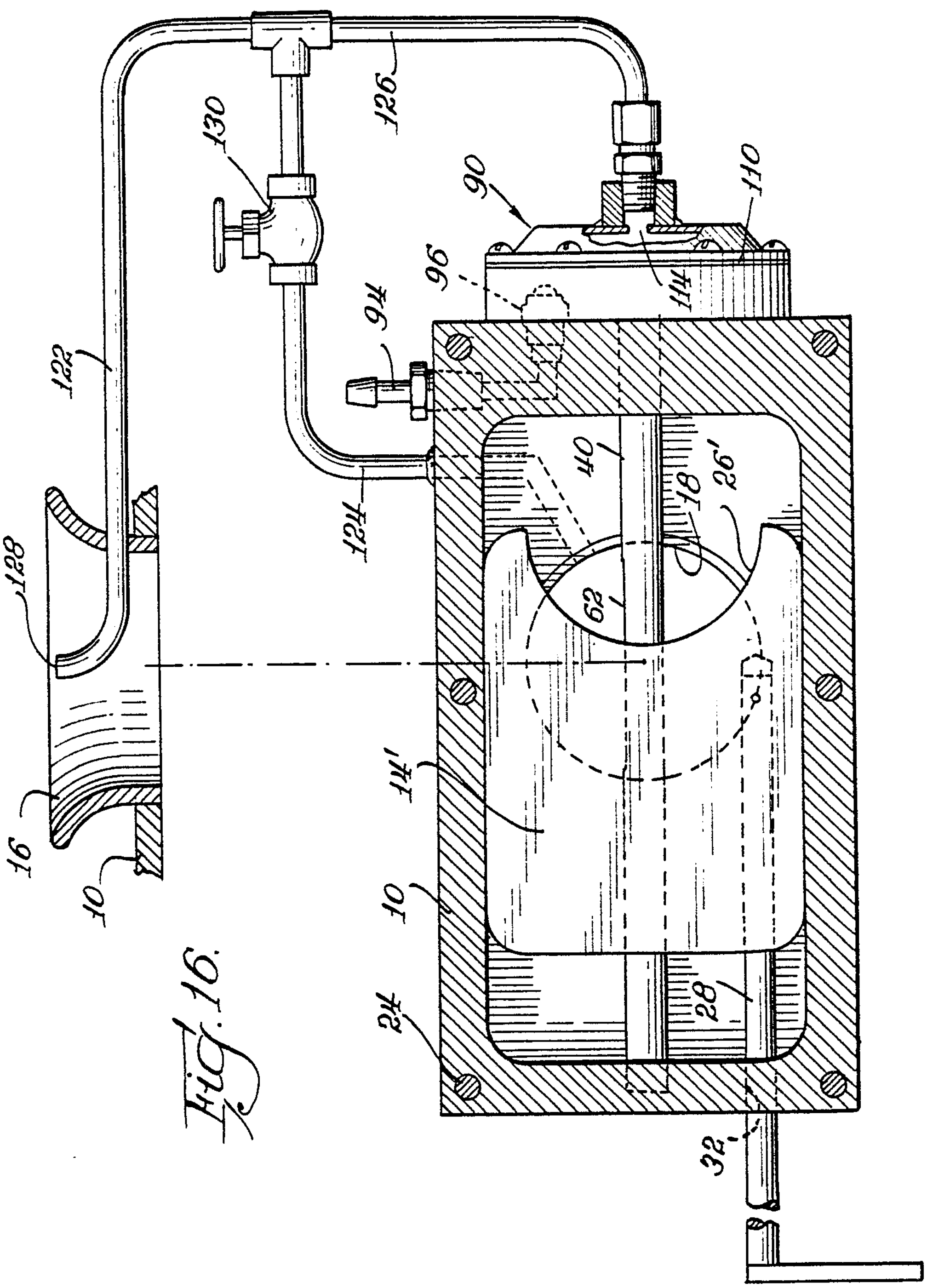

Fig. 16.