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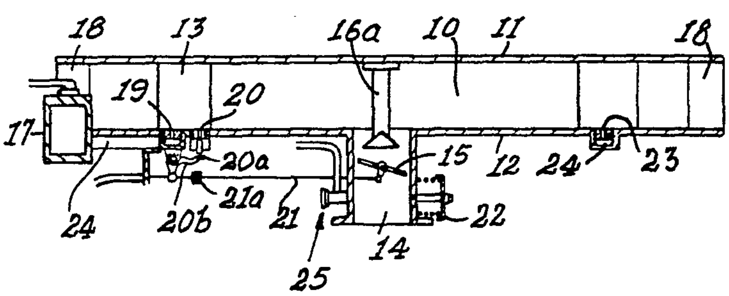
(54) **A carburettor and a method of carburation.**

(57) The invention provides a carburettor for an internal combustion engine, comprising an upper plate element, a lower plate element and a side wall structure which spaces the plate elements from one another to define a mixing chamber within its surround. A tangential inlet to the chamber is defined in the side wall structure while a central outlet from the chamber is provided so that fluid entering the inlet follows a vortical path en route to the outlet. In a preferred arrangement the inlet is provided with a variable throat which includes a hinged flap adapted automatically to open the throat in proportion to air flow therethrough so that velocity through the throat remains substantially constant until the flap is fully open. A fuel jet is disposed a short distance downstream from the free end of the flap so that with the flap partially open, the jet is subjected to a constant pressure differential and in order to compensate for increasing airflow, a number of jets are provided successively upstream from the first jet. Once the flap is fully open, increased air flow results in an increased pressure differential over the jets so that the air fuel ratio remains substantially constant. A feature of the invention is that during low engine speeds, for example, during starting and idling, the air velocity is sufficiently high to effect vaporisation of liquid fuel. While the carburettor is of extremely simple construction, the mixing chamber ensures a high degree of vaporisation of liquid fuel without the application of heat or dependancy upon a manifold for the internal combustion engine.



EP 0 051 992 A2

THIS invention relates to a carburettor for an internal combustion engine.

It is well recognized that with an internal combustion engine good vaporisation of liquid fuel in the combustion air is highly desirable in order to obtain maximum performance, minimum fuel consumption, and minimum polution emission. It is also important to maintain the ratio of fuel to air mass reasonably constant throughout the range of engine speeds to ensure good combustion. In an effort to achieve the above, modern carburettors have become more complex and costly, difficult to adjust, less flexible and bulky.

A further disadvantage associated with conventional carburettors resides therein that at low engine speeds, for example during starting and idling conditions, air velocity through the venturi of the carburettor is insufficient to induce fuel into the airstream. During low engine speeds, therefore, fuel is drawn from an idle jet which is disposed downstream from the throttle control of the carburettor and fuel is introduced directly into the manifold which is often heated to assist vaporisation. It will be appreciated that where the manifold is heated by exhaust gases, the efficiency of the engine will be lowered as a result of a decrease in the density and mass of working fluid. Moreover, where the manifold is relied upon for vaporisation purposes, an excessively rich fuel/air mixture is required during cold conditions which results in liquid fuel entering the engine and causing resultant wear, and also resulting in incomplete combustion and pollution.

Various proposals have been made to improve the vaporisation problem described above. For example, US Patent No 1 642 795 discloses a vaporiser which is in the nature of a vortex chamber heated by exhaust gases, and which is adapted to be disposed intermediate the carburettor and manifold. Similar arrangements are disclosed in British Patent No 413 630, European Patent Application No 0 011 360/A1 and US Patent No 3 336 017. These arrangements all suffer from the disadvantage that they tend to render the fuel supply to the engine more complex and costly.

It is accordingly an object of the present invention to provide a novel carburettor which is of simplified construction and which will perform adequately. A further object of the invention is to provide a carburettor which will perform satisfactorily during start and idling conditions.

According to the invention, a carburettor adapted to provide an air/fuel mixture to an internal combustion engine comprises a mixing chamber, a substantially central outlet therefrom and a substantially peripheral inlet thereto, the chamber defining a vortical pathway from the inlet to the outlet, and means at the zone of the inlet for causing liquid and/or gaseous fuel to be entrained in the airstream, such means comprising a formation adapted to form a zone of reduced pressure relative to ambient pressure in an airstream passing through the inlet and a fuel inlet disposed in such zone so that fuel is emitted from such inlet.

Further according to the invention, the mixing chamber is of substantially circular configuration and the inlet is adapted to direct fluid into the chamber tangentially. In a preferred embodiment, the structure of the carburettor will comprise an upper and a lower plate element spaced from one another by a side wall structure, with the inlet being in the nature of a slot extending through the side wall, while the outlet is provided by a central axial aperture in one of the plate elements. With this arrangement an annular air filter device may be sandwiched between the plate elements with the side wall structure disposed within the surround of the filter device.

It will be appreciated that the plate elements could be contoured to provide a desired configuration to the mixing chamber and in a preferred arrangement one or both plate elements will be of convex profile with the convexity directed towards the chamber so that it has a reduced cross-sectional area in the central zone thereof. Baffles and/or flow directing vanes could also be provided in the chamber to ensure that vortical flow is maintained during reduced flow velocities of the air/fuel mixture.

Also according to the invention, the mixing chamber has a profile such that fluid entering through the inlet is radially more remote from the outlet than fluid which has travelled one or more convolutions in the mixing chamber en route to the outlet.

Further according to the invention, the means for introducing fuel into an airstream passing through the inlet comprises a converging-diverging venturi formed in the side wall structure with a fuel inlet disposed in the zone of the throat of the venturi.

In a preferred arrangement, the means for introducing fuel into an airstream passing through the inlet comprises a variable throat assembly which includes a body member defining a passage therethrough, and a closure member within the passage, the closure member being biased to a position wherein it substantially closes the passage and being adapted to move progressively to open the passage in proportion to air flow therethrough.

Further according to this aspect of the invention, a primary fuel inlet to the passage is in the nature of a jet or the like and is disposed in the zone of the closure member. Preferably the fuel inlet will be disposed a short distance downstream from the closure in its closed position.

In a preferred arrangement, the closure member will be in the nature of a hinged flap element which is pivotally movable progressively to open the passage. The flap element may be biased towards its closed position by means of a spring arrangement but would preferably be biased simply by means of gravity. With this arrangement the fuel inlet will preferably be disposed in substantial alignment to the free end of the flap element remote from its pivot. Thus, during minimal air demand, for example during starting with the flap element only minimally opened, air flow will nevertheless be directed over the fuel inlet to ensure that vaporisation is effected. As air flow is increased the flap element will open progressively so that the pressure differential over the fuel inlet remains substantially constant. It will be appreciated that only when there is an increase in air flow after the closure has been fully opened, will the pressure differential over the fuel inlet increase.

Also according to the invention, one or more additional supplementary fuel inlets are provided in positions upstream from the primary fuel inlet so that a pressure differential is effected across such additional fuel inlet once the closure has been opened at least partially. Preferably additional fuel inlets will be spaced progressively upstream from the closure with a pressure differential being created successively over these as air flow reaches a sufficient velocity. Thus, additional fuel inlets which are disposed in relatively close proximity to the flap element, will be subjected to a pressure differential as a result of the convergence of the airstream in the region of the closure member, while fuel inlets disposed further upstream will be subjected to a lesser pressure differential until a closure element is in its fully opened position.

Still further according to the invention, damping means is provided for the closure member. Such damping means could, for example, be in the nature of a fly wheel adapted to dampen through an inertia effect or an element movable through liquid or the like. In one arrangement, the force of gravity could be utilized to bias the closure element to its closed position or alternatively a spring device which provides a substantially constant biasing force throughout its range of operation could be utilised.

Further still according to the invention, means is provided for progressively increasing the effective cross-sectional area of the inlet to the mixing chamber in proportion to the flow rate through the chamber, so that the velocity of flow through the inlet can be held substantially constant, such means comprising additional inlets to the chamber which are adapted to open successively in accordance with flow through the chamber. In one arrangement, the subsidiary inlets may each be provided with a closure which is biased to a position wherein it closes these inlets, with the biasing force being increased from one to the other so that the inlets open progressively as the depression in the mixing chamber increases. If desirable the subsidiary inlets may be operated by extraneous means such as electro-magnets, a throttle control or the like.

Further included within the scope of the invention, is a method of providing an air/fuel mixture for an internal combustion engine comprising the steps of providing a mixing chamber having a substantially peripheral inlet for air to the chamber, an inlet for fuel in the zone of the air inlet, and a substantially central outlet from the chamber, drawing air into the chamber through a suction at the outlet, causing a zone of reduced pressure relative to ambient to develop in the zone of the fuel inlet so that fuel is emitted from the fuel inlet and entrained in the air, and ducting the air/fuel mixture along a vortical path about the outlet en route thereto.

Further according to this aspect of the invention, the chamber is substantially circular and the fluid is ducted into the chamber substantially tangentially and withdrawn therefrom axially relative to the vortical path.

Still further according to the invention, the method includes the steps of providing a closure in the inlet, the closure being biased to a position wherein it substantially closes the passage and being adapted to move progressively to open the passage in proportion to air flow therethrough, and the method includes the steps of drawing an air/fuel mixture into the chamber by means of suction from the carburettor with the closure member substantially closed so that a mixture of relatively low air/fuel ratio is provided; and thereafter permitting the closure member to open progressively in accordance with air flow so that the pressure differential over the fuel inlet remains substantially constant with the air/fuel ratio increasing progressively as air mass increases.

Yet further according to this aspect of the invention, the method includes the step of permitting the closure to open fully so that the pressure differential across the fuel inlet increases in accordance with the increase of air flow with the air/fuel ratio decreasing gradually as air density decreases.

The method further includes the steps of allowing one or more additional fuel inlets to provide fuel when the closure elements are in a partially opened position and thus to reduce the air/fuel ratio. Preferably a plurality of additional supplementary air/fuel inlets will be brought into operation successively.

In order more clearly to illustrate the invention, some embodiments thereof are described hereunder purely by way of example with reference to the accompanying drawings wherein :

Figure 1 is a schematic sectioned elevation of a first carburettor,

Figure 2 is a schematic plan of the carburettor in Figure 1 without its top lid,

Figure 3 is a schematic enlarged sectioned elevation of part of the left hand portion of the carburettor in Figure 1, showing the main and acceleration jets thereof,

Figure 4 is a further schematic enlarged sectioned plan of the jets in Figure 3 and a venturi inlet,

Figure 5 is an idling jet arrangement of the carburettor in Figure 1 shown in a schematic enlarged form,

Figure 6 is a schematic side view of the arrangement in Figure 5,

Figure 7 is a schematic enlarged sectioned plan of one of the supplementary venturis employed in the carburettor in Figure 1,

Figure 8 is a schematic sectioned elevation of a second carburettor embodiment,

Figure 9 is a schematic enlarged plan of the arrangement in Figure 8 with the top lid removed,

Figure 10 is a schematic enlarged sectioned elevation of the left hand portions of the carburettor in Figure 8, showing inter alia the main and acceleration jets thereof,

Figure 11 is a schematic enlarged sectioned view illustrating the idling jet of the carburettor in Figure 8.

Figure 12 is a schematic sectioned elevation of an inlet for a carburettor in accordance with the invention,

Figure 13 is a schematic sectioned plan of the inlet in Figure 12,

Figure 14 is a schematic sectioned elevation of a different embodiment of an inlet for a carburettor,

Figure 15 is a schematic sectioned plan of the inlet in Figure 14,

Figure 16 is a schematic sectioned elevation of yet a different embodiment of an inlet for a carburettor,

Figure 17 is a schematic sectioned elevation of a third carburettor in accordance with the invention,

Figure 18 is a schematic plan of the carburettor in Figure 17, without a top closure plate therefor,

Figure 19 is a schematic plan of a different embodiment of the third carburettor showing only portion of such carburettor comprising a mixing chamber and a primary and supplementary inlet to such chamber,

Figure 20 is a schematic plan of a supplementary inlet for the carburettor in Figure 19,

Figure 21 is a graph showing the relationship between air velocity through an inlet in accordance with the invention, and the angle of a closure disposed in such inlet,

Figure 22 is a graph showing the relationship between the air/fuel ratio; and air at various engine speeds and throttle conditions,

Figure 23 is a schematic sectioned elevation of portion of a carburettor showing a sample of a side wall structure thereof and venturi formations in such side wall structure,

Figure 24 is a schematic perspective view of portion of the section of the carburettor shown in Figure 23,

Figure 25 is a schematic perspective view of a closure for a venturi formation in the side wall structure in Figure 23,

Figure 26 is an enlarged sectioned elevation of a carburettor in accordance with the invention showing an inlet in the side wall structure thereof and fuel supply to a fuel inlet to the carburettor, and

Figure 27 is a sectioned plan of a carburettor with liquid fuel injection.

As mentioned above, three carburettors are illustrated, the first in Figures 1 to 7, the second in Figures 8 to 11 and the third preferred carburettor in Figures 12 to 22. These carburettors are all based on the same structural concept and also on the same concept of vortical mixing of the air and fuel. It is to be stressed that any number of conventional variations such as idling fuel inlet, accelerating fuel inlets etc. can be incorporated and the examples below serve only to illustrate some of these.

The basic structure of the carburettor comprises a generally circular chamber 10 which is defined between an upper plate-like lid 11 and a lower plate 12 with a central outlet 14 being disposed in the lower plate 12 and adapted to be mounted on a manifold of an internal combustion engine. The chamber 10 is further defined within a circular wall structure 13 which spaces the upper plate 11 from the lower plate 12, and which defines a main substantially tangential inlet 26 therein. Subsidiary inlets may also be disposed in the side wall as will be explained in more detail below. Arranged peripherally about the circular side wall 13 is an air filter element 18 which is also sandwiched between the upper lid 11 and the lower plate 12. One or more fuel inlets which introduce fuel into an airstream passing through the main inlet 26 will in all cases be provided in the zone thereof.

Within the framework of the basic structure described above, various refinements and additions may be incorporated and some of these will be described below. From a structural point of view where the main inlet 26 is adapted to be in the nature of a converging-diverging venturi, the side wall structure 13 could be of the type illustrated in Figures 23 and 24. In this arrangement the side wall structure 13 comprises an inner wall 13a and an outer wall 13b, with the venturi 13c defining the main inlet. The venturi 13c will be profiled for suitable flow characteristics and preferably it will be of lesser height than the side wall structure 13 so that it could readily be closed by means of a closure which will be described in more detail below.

A less complex and preferred wall structure is shown in Figure 18 and Figure 19 and such wall structure is in fact particularly suitable where a flap-type closure is disposed within the inlet as will be more fully set out hereinafter. It will be noted that the wall structure in Figures 18 and 19 is spirally shaped so that fluid rotating in the chamber will not interfere to any significant degree with fluid entering the chamber through the inlet.

A further structural feature of the carburettor comprises a fuel supply to the fuel inlets and such a fuel supply could conveniently be in the form of a conventional float chamber, for example, shown at 17, Figure 1 and at 230, Figure 26. With reference to Figure 26 the float chamber is defined by a housing 234 which houses a float control valve indicated at 235. Preferably the float of the float control 235 will be set so that the level of fuel in the chamber is sufficiently low to prevent flooding when the carburettor is tilted. For some applications it is required that the carburettor be capable of being tilted to about 30° out of the horizontal and the fuel level in the housing can be controlled accordingly. Fuel passages lead from the lower region of the chamber to jets shown at 236, 237 and 238 which are disposed in the throat of a venturi-like main inlet 26. In this arrangement, fuel is induced into the chamber 10 through a pressure differential across the respective fuel inlets. An alternative arrangement, Figure 27, provides for fuel to be injected into the airstream passing through the inlet 26 by means of a suitable injection device shown schematically at 40. The amount of fuel injected into the airstream will be metered in the normal manner and be responsive, for example, to throttle opening, mass flow of air, engine revolutions and high/low demand. With such an arrangement, working fluid may be cooled if necessary at high engine speeds, for example by injecting water into the airstream passing through the inlets 26.

A further structural variation is shown in Figure 26 wherein the top closure plate 11 is provided with a convex formation in its central region at 11b, the convexity being directed towards the outlet 14. It will be appreciated that by reducing the cross-sectional area of the chamber 10 by way of the convexity 11b, the velocity of the working fluid in this zone will be increased.

The abovementioned variations will indicate to persons skilled in the art that the basic structure of the carburettor could be varied to suit requirements.

From a functional point of view, the carburettor operates as follows :

During operation of the internal combustion engine on which the carburettor is mounted, air is drawn into the chamber 10 through the tangential inlet 26 and moves along a vortical path to the outlet 14. Fuel droplets are maintained in the airstream as it moves through the inlet 26 and centrifugal force acting on the droplets will counteract the centripetal air drag and will tend to retain larger particles in rotation at the peripheral zone of the chamber 10 and thus prevent them from passing through the outlet 14. As a result of attrition, vaporisation and impact, the droplets will be substantially fully atomised before passing through the outlet 14 en route to the internal combustion engine.

As previously mentioned, in order to minimize interference between rotating fluid in the chamber 10 and fluid entering the inlet 26, it is preferred that the chamber spirals to a degree towards the outlet 14 so that fluid entering the inlet 26 is radially more remote from the outlet 14 than fluid which is rotating in the chamber 10 as shown in Figure 18. The swirling rotational emotion of the fuel/gas mixture can also be maintained as the mixture moves down the outlet 14 by providing a cone formation 16, Figure 3, at the mouth of the outlet 14, the cone formation 16 being mounted by means of a pillar 16a which extends from the top of the lid 11.

Means for introducing fuel into an airstream passing through the inlet 26 can take on various forms and three examples are discussed below.

Example 1

A first carburettor is illustrated in Figures 1 to 7 and operates on a semi-constant depression principle.

With reference to Figure 2 the inlet 26 which has a venturi-like profile is provided with a main jet 19 and acceleration jet 20 in the throat of the venturi. For idling purposes, an additional fuel inlet 25 is provided in the outlet 14 of the carburettor, downstream from a butterfly-type flow control valve 15. Fuel at a constant head is supplied to the jets 19 and 20 and fuel inlet 25 from a conventional float chamber 17 and fuel pump [not shown].

During starting and idling the butterfly-type valve 15 disposed in the outlet 14 will be substantially closed causing a substantial pressure drop downstream therefrom. As a result of the pressure drop fuel will be drawn from a fuel duct 24 through an idling jet 30. The fuel then moves over a syphon hump 31 which has its upper extremity above the level of fuel in the float chamber 17 and which thus prevents flooding through the inlet 25. Fuel passing over the syphon hump 31 is mixed with air which is drawn in through an air bleed-in jet 32 and the fuel mixture then moves to the inlet 25, via a metering jet 32a and a lead 25b. For mixture adjustment purposes, a tapered needle and seat arrangement 25a is provided, with adjustment being effected by screwing the tapered needle towards or away from the seat.

As the valve 15 is opened the depression downstream therefrom will decrease and the setting of the tapered needle and seat arrangement 25a will be such that supply through the idling inlet 25 will effectively cease and in such condition the main jet 19, Figure 3, will supply fuel to the engine, the fuel being drawn through the main jet 19 from the fuel duct 24. With reference to Figure 4, the main jet 19 is disposed in the throat of the venturi-like inlet 26 and it will be appreciated that as air flow through the inlet 26 increases, the pressure differential over the jet 19 will increase causing increasing amounts of fuel to be drawn therethrough. Disposed adjacent the main jet 19 and downstream therefrom in the inlet 26, is an acceleration jet 20 which is capable of being opened selectively to supply additional fuel to the engine during high load conditions such as during acceleration and hill climbing. A tapered needle

20a will engage in a seat in the acceleration jet 20 and keep such jet closed during normal engine operating conditions, a lever 21b being biased towards the needle 20a and serving to hold such needle in the closed position. A linkage for operating the throttle valve 15 is shown at 21 and a stop member 21a is provided on the linkage 21 as indicated. When the linkage 21 moves to open the valve 15 to a relatively fully opened position, the stop 21a will engage the lever 21b causing it to disengage the needle 20a whereupon the latter will move away from its seat under the influence of or through an internal spring bias, thus opening the acceleration jet 20. Once the linkage 21 moves the valve 15 to a more closed position, the stop 21a will again disengage the lever on 21b which in turn will close the needle and seat arrangement under the influence of a spring bias 21c. It is envisaged that the spring bias 21c will be sufficiently strong to give an indication at the acceleration pedal, when the stop 20a engages the lever 21b. In this way a driver could selectively open the acceleration jet 20 when more power is required from the engine.

An alternative arrangement is illustrated in Figure 26 wherein the idling fuel inlet 25 is dispensed with. In this arrangement an acceleration and starting jet 238 is provided in the inlet 26 and in order to ensure that fuel is drawn from this jet at required times, an aerodynamic constriction 17a is provided in the throat of the passage 26 to increase the velocity of air passing therethrough. It is envisaged that the constriction 17a will be in the nature of an aerodynamically shaped formation which fits into the throat of the venturi 26 to reduce its cross-sectional area. In some cases it may be desirable to increase or reduce the effect of the formation 17a and for this purpose it may be pivotally mounted and movable into and out of the throat of the venturi 26 by suitable adjusting means such as a cable or linkage. With such an arrangement, it has been found that the jet 237 will operate effectively during idling conditions and also act as a main jet during running conditions. The supplementary jet 238 is open during starting and acceleration in the same manner as the jet 20, Figure 3.

With reference to Figure 2 and Figure 7, each supplementary venturi inlet 27 is provided with a jet 28, and a closure 29 which is hinged at 29a for pivotal movement between a closed position as indicated in Figure 7 and an open position indicated by the broken line, each closure 29 is biased towards its closed position by means of a resilient finger element 29b which trails the closure 29a and which contacts an adjustable stop formation 29c. It will be appreciated that the biasing force of the finger 29b will be increased either by reducing the distance between the pivot point 29a and the stop formation 29c or by screwing the stop formation 29c towards the finger 29b to tension the latter. In the arrangement shown in Figure 2 it is envisaged that the biasing strength of the fingers of the respective supplementary inlets 27 will be increased from one to the other so that these openings open progressively as the depression in the chamber 10 becomes greater with increasing engine speeds so that the air velocity through the main opening 26 and supplementary openings 27 remains below a predetermined and desired maximum. In this way the air/fuel ratio of the mixture passing through the outlet 14 will remain within desired limits.

It will be appreciated that the closure 29 could be biased to its closed position in various ways. For example, in Figure 25 the closure which is now shown at 113 is biased to its closed position by means of resilient finger formations 114, and doubtless other variations are possible.

A further feature of the carburettor comprises the provision of a relief valve 22 downstream from the valve 15, Figure 1. When the valve 15, Figure 1, is closed during high engine revolutions, a substantial pressure drop is created downstream therefrom and in such circumstances the relief valve 22 will open to decrease the pressure drop and thus prevent excess fuel from being drawn through the idle inlet 25. It will be appreciated that such a relief valve 22 could be provided in the valve 15. In a further alternative, valve means such as a solenoid operated needle valve could be provided to close the supply line 25b when engine speed rises above idling speed as described hereinafter.

Example 2

A carburettor which operates on a variable depressing principle is indicated in Figures 8 to 11 and where the same numerals are employed, the same or a similar structure or arrangement is indicated. This carburettor differs from the one disclosed in Example 1 in that the main inlet 40 which is provided with a main jet 43 and an acceleration jet 44 in the throat thereof, is supplemented only by a secondary inlet 41 and a tertiary inlet 42. The inner surfaces of the secondary and tertiary inlets 41 and 42 are formed by flap formations 41a and 42a which are respectively hinged at 41b and 42b for movement between a closed position and an opened position as indicated in figure 9. The flaps 41a and 42a are biased towards their closed positions by means of a suitable spring bias 41c and 42c respectively and the force of the spring bias 42c will be greater than that of 41c so that the secondary inlet 41 will open before the tertiary inlet 42 as pressure decreases in the chamber 10 with rising engine speed. If desirable, the closures 29 for the supplementary inlets 27, Figure 7, could be employed instead of the flaps 41a and 42a. Clearly other variations are also possible with regard to the progressive opening of additional inlets to the chamber 10 such as shown in Figures 14, 20, 25 etc. It will be noted that the secondary inlet 41 is provided with a main jet 41d which will feed fuel into the airstream passing through the inlet 41 once this is open. It is believed that no jet will be required in the tertiary inlet 42 but a small jet could be provided if necessary. It will be appreciated that the secondary and tertiary inlets 41 and 42 will serve to maintain air velocity through the inlets below the desired maximum and a constant fuel/air ratio will thus be maintained.

As in the first carburettor described above, a needle and seat valve 20 will be provided to close off fuel supply to the acceleration jet under normal conditions, the needle and seat valve 20 being held in the closed position by means of a lever 21b. As in the previous arrangement a stop 21a on the linkage 21 for the operating valve 15 will contact the lever 21b when the valve moves to its substantially fully opened position. Control of the acceleration jet 44 is thus effected by means of the linkage 21 as in the previous case. In the present example, however, an additional needle valve 45 which is controlled by means of a solenoid 45a is provided to close off fuel supply to the acceleration jet 44 at high engine revolution. It is envisaged that a signal from an engine speed indicator will be utilized to operate the solenoid 45a.

With reference to Figure 11 a solenoid operated needle valve 46 with the solenoid being shown at 46a, is also provided in the fuel supply to an idling jet 47. As with the previous carburettor, a fuel inlet 25 for idling purposes is provided downstream from the valve 15. Fuel is again drawn over a syphon hump 31 with a suitable air bleed-in 48 being provided and in this instance the idling jet 47 is provided downstream from the syphon hump 31 and from the solenoid operated needle valve 46. As with the solenoid 45a, a signal from an engine speed indicator could be utilized to operate the solenoid 46a and it is envisaged that the arrangement will be such that the needle valve 46 closes fuel supply for idling purposes when the engine speed rises above idling speed. With such an arrangement, when the butterfly-type valve 15 is closed at high engine speeds, excess fuel cannot be drawn through the inlet 25.

It will be appreciated that the features of the two carburettors described above will often be interchangeable. Whereas various needle valves have been described above, rotary- or ball-type valves could be employed instead, although needle valves are preferred from a control point of view. Likewise the closure plates 29, figure 2, or the flap formations, figure 9, as the case may be which control flow through the supplementary inlets of the carburettors, could be positively operated by means of vacuum operable devices.

Example 3

A preferred arrangement for inducing fuel into the airstream passing through the inlet 26 is shown in Figures 12 to 18 wherein means for varying the throat of the inlet 26 is provided, such means comprising a closure member 312 which is biased to a position wherein it closes the inlet 26 and which is adapted to open progressively in proportion to air flow through the inlet 26. In the arrangement in Figure 12 and Figure 13 the closure member 312 is in the nature of a weighted flap element pivotally mounted at its one end at 312a for movement about a horizontal axis.

A fuel inlet 315 is disposed slightly downstream from the free end of the flap 312 in its closed position, as illustrated.. A second supplementary fuel inlet 16 is provided upstream from the first inlet 15 and it is envisaged that further additional fuel inlets 318 and 319 may be provided in upstream locations. Further additional fuel inlets could be provided if required.

In the arrangement in Figure 12 the flap 312 is biased towards its closed position by means of gravity. An alternative arrangement is shown in Figure 16 wherein the flap 312 is of relatively light construction with a low mass and is biased towards the closed position by means of a compression spring 340 of the type which provides a constant biasing force throughout the range of its compression. In both Figure 12 and Figure 16 therefore a constant biasing force acts on the flap 12, and if different characteristics are required different biasing devices which, for example, have a biasing force which increases in proportion to compression, could be utilized.

In use fuel is induced into the chamber 10 as follows :

When the throttle 15 , Figure 18, is opened, and the engine turned over for starting purposes, fuel will be drawn from the fuel inlet 315. The flap 312 will also be opened, as a result of the suction, to a small degree and air will flow under its free end at relatively high velocity causing a fair degree of vaporisation of the fuel drawn from the fuel inlet 315. The air/fuel ratio at this stage will be relatively low, and as the engine starts and the engine speed increases, air flow will increase as the flap 312 opens progressively, and the air/fuel ratio will accordingly rise. The proportions of the flap 12 and fuel inlet 315 will preferably be selected to provide a substantially perfect air/fuel ratio, at the idling speed of the engine.

As air flow through the passage 26 increases at higher engine speeds, the flap 312 will open progressively causing the air velocity over the fuel inlet 315 to remain substantially constant, and thus also causing the pressure differential over the fuel inlet 315 to remain substantially constant. Accordingly, as engine speed increases above idling speed, the air/fuel ratio will rise sharply and the mixture become excessively "lean". In order to provide more fuel to the airstream at this stage, it is envisaged that the second upstream inlet 316 will be brought into operation as the air velocity thereover becomes sufficiently high. It will be appreciated that there is a convergence and accordingly an increase in the velocity in the airstream in the region of the flap 312 and the closer the inlet 316 is to the inlet 315, the sooner it will be brought into operation. It is envisaged that a plurality of supplementary fuel inlets 318 and 319 may be provided and these may be spaced progressively from the primary fuel inlet 315. Once the flap 312 is in its fully opened position, the velocity of the airstream through the passage 26 will increase as engine speed increases and accordingly the pressure differential over the primary fuel inlet 315 as well as the supplementary fuel inlets 318 and 319 will increase with an increase in air velocity.

The air/fuel ratio at this stage will therefore remain substantially constant although a progressive decrease in the density of the air will result in a gradual decrease in the air/fuel ratio.

The above effects are graphically illustrated in Figure 22 where the curve at 380 indicates starting conditions, 382 idling conditions, 383 conditions with the throttle partially open, 384 to 385 conditions wherein the flap 312 is partially opened with the throttle fully open, and from 387 onwards conditions wherein the flap 312 is fully opened. As a result of supplementary fuel inlets being brought into operation the curve 386 could remain substantially constant as illustrated between idling speed at 382, to about 2000 RPM. Thereafter, the air/fuel ratio increases gradually until the flap 312 is in a fully opened position at 385.

The broken curve indicated at 381 shows an exaggerated situation where supplementary fuel inlets are brought into operation successively with a sharp drop in the curve and reduction in air/fuel ratio being indicated as each inlet comes into operation. It will be appreciated that by providing sufficient supplementary fuel inlets and varying the proportions of the flap 312 and primary fuel inlet 26, the characteristics of the curve shown in Figure 22 could be altered as desired so that a curve which approached an ideal one shown by full line 386 could be obtained.

Figure 21 illustrates the air velocities below the free end of the flap 312 at various openings. It will be noted that in the graph the closed position is shown at 45° and by varying the angle at which flap 312 is closed different characteristics can again be obtained. Once the flap 312 is fully opened the velocity through the passage 26 will increase in accordance with mass flow, and the velocity will depend upon the constriction provided by the leading end of the flap 312. An additional constriction [not shown] could also be provided in order to obtain the required velocity.

With reference to Figures 17 and 18 a supplementary air inlet is again provided at 337 which is adapted to open when the depression inside the chamber reaches a predetermined value and in order to ensure that air velocity through the primary inlet 26 does not exceed a desired value. A closure 336, Figure 14, Figure 15, may be in the nature of a spring loaded flap with a fuel inlet 335 being provided upstream therefrom. It will be appreciated that the action of the spring loaded flap 336 is different from that of the flap 312 of the main inlet in the sense that the air/fuel mixture provided by the additional inlet 337 will remain substantially constant at least until the flap 336 reaches its fully opened position. Thus, the pressure differential over the inlet 335 will be substantially proportional to air flow as a result of the progressive opening of the flap 336.

As in the previous examples, more than one supplementary inlet 337 could of course be provided. In Figure 17 and Figure 18 the closure 336 is adapted to move vertically to open the inlet 337 and a variation of this arrangement is shown in Figure 19 and Figure 20. In the latter, a supplementary inlet is shown at 341 with a resilient closure therefor and a fuel inlet shown at 340 and 339 respectively, the closure being adapted to move in a horizontal plane as shown in Figures 1 to 9 and 25. In Figure 20 a similar arrangement is shown with a closure being biased to the closed position by means of a resilient finger 342.

It will be appreciated that the simplicity of the carburettor described in Example 3 will carry tremendous cost savings and it has further been found that the carburettor is highly efficient. When accelerating suddenly at any speed no "flat spots" or reduction in power is experienced. This is due partly to a certain reserve of vaporised fuel in the chamber 10 and partly to a temporary enrichment of the mixture caused by the inertia of the flap 312. The weighted flap 312 causes an increased temporary depression downstream therefrom during acceleration as a result of its inertia and accordingly an increase in fuel supply will little increase in air mass. A further advantageous effect experienced with the carburettors described in all three examples above is that the latent heat of vaporisation required to vaporise the liquid fuel results in a substantial temperature drop in the chamber 10 which in turn increases the density and mass of the working fluid and accordingly the volumetric efficiency of the engine. This effect is the opposite of conventional carburettors where the manifold is often heated by exhaust gases to assist in vaporisation.

Clearly further variations of the invention exist which differ in matters of detail only and do not depart from the principles set out in the appended claims. For example, the drawings all show the outlet 14 as being disposed centrally in the chamber, but the outlet could clearly be offset relative to the centre of the chamber without detrimental effect. In particular, the outlet could be moved into closer proximity to the inlet 26, where no supplementary inlets are provided.

CLAIMS

1. A carburettor adapted to provide an air/fuel mixture for an internal combustion engine comprising a mixing chamber, a substantially central outlet therefrom and a substantially peripheral inlet thereto, the chamber defining a vortical pathway from the inlet to the outlet, and means in the zone of the inlet for causing liquid and/or gaseous fuel to be entrained in an airstream passing through the inlet.

2. The carburettor according to Claim 1 wherein the means for causing liquid and/or gaseous fuel to be entrained in the airstream comprises a formation adapted to form a zone of reduced pressure relative to ambient pressure in an airstream passing through the inlet, and a fuel inlet disposed in such zone so that fuel in induced from the inlet.

3. A carburettor according to claim 1 or claim 2, wherein the mixing chamber is of substantially circular configuration and the inlet is adapted to direct fluid into the chamber tangentially.

4. A carburettor according to any one of claims 1 to 3 wherein the structure thereof comprises an upper and lower plate element spaced from one another by a side wall structure with the inlet being formed in the side wall while the outlet is provided by a central axial aperture in one of the plate elements.

5. The carburettor according to any one of claims 1 to 4, wherein the means for introducing fuel into an airstream passing through the inlet comprises a variable throat assembly which includes a body member defining a passage therethrough, and a closure member within the passage, the closure member being biased to a position wherein it substantially closes the passage and being adapted to move progressively to open the passage in proportion to air flow therethrough.

6. The carburettor according to claim 5, wherein a primary fuel inlet is provided in the passage and is disposed in the zone of the closure member.

7. The carburettor according to claim 6, wherein the fuel inlet is disposed a short distance downstream from the closure in its closed position.

8. The carburettor according to any one of claims 5 to 7, wherein the closure member is in the nature of a hinged flap element which is pivotally movable progressively to open the passage.

9. The carburettor according to claim 8, wherein the fuel inlet is disposed in substantial alignment with the free end of the flap element remote from its pivot so that during minimal air demand, for example during starting, with the flap only minimally opened, air flow will be directed over the fuel inlet for purposes of vaporising fuel issuing therefrom, and as air flow is increased the flap element will open grogressively so that the pressure differential over the fuel inlet will remain substantially constant, and so that once the closure is fully opened, the pressure differential across the fuel inlet will increase.

10. The carburettor according to any one of claims 6 to 9, wherein one or more additional supplementary fuel inlets are provided in positions upstream from the primary fuel inlet so that a pressure differential is effected across such additional fuel inlets once the closure has been opened at least partially.

11. The carburettor according to claim 10, wherein the additional supplementary fuel inlets are spaced progressively upstream from the closure with a pressure differential being created successively over these as air flow reaches a sufficient velocity.

12. The carburettor according to any one of claims 1 to 11, wherein means is provided for progressively increasing the effective cross-sectional area of the inlet to the mixing chamber in proportion to the flow through the chamber so that the velocity of flow through the inlet can be held substantially constant, such means comprising additional subsidiary inlets to the chamber which are adapted to open successively in accordance with flow therethrough.

13. A method of providing an air/fuel mixture for an internal combustion engine comprising the steps of providing a mixing chamber having a substantially peripheral air inlet to the chamber, an inlet for fuel in the zone of the air inlet, and a substantially central outlet from the chamber, drawing air into the chamber through a suction at the outlet, causing a zone of reduced pressure relative to ambient to develop in the zone of the fuel inlets so that fuel is emitted from the fuel inlet and entrained in the air, and ducting air/fuel mixture along a vortical path about the outlet en route thereto.

14. The method according to claim 13 including the steps of providing a closure member in the inlet, the closure member being biased to a position wherein it substantially closes the inlet and being adapted to move progressively to open the inlet in proportion to air flow therethrough, and the method including the further steps of drawing an air/fuel mixture into the chamber by means of suction with the inlet substantially closed by the closure member so that a mixture of relatively low air/fuel ratio is provided.

1/12

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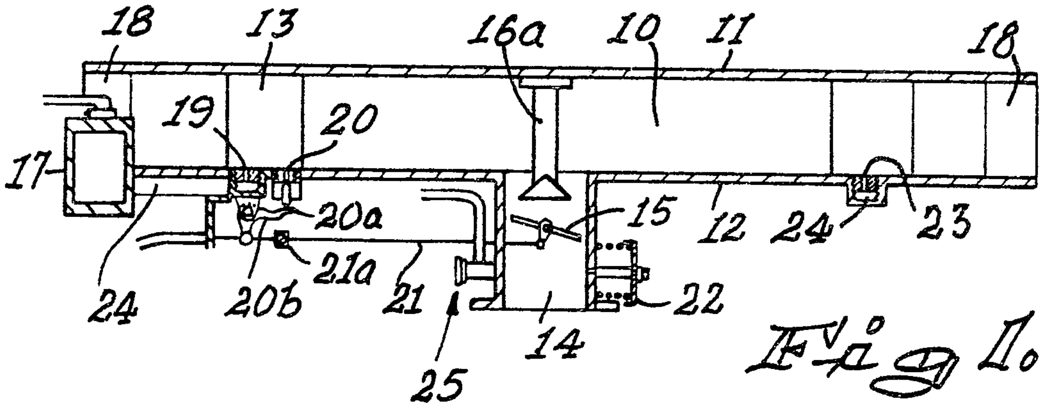


Fig 1.

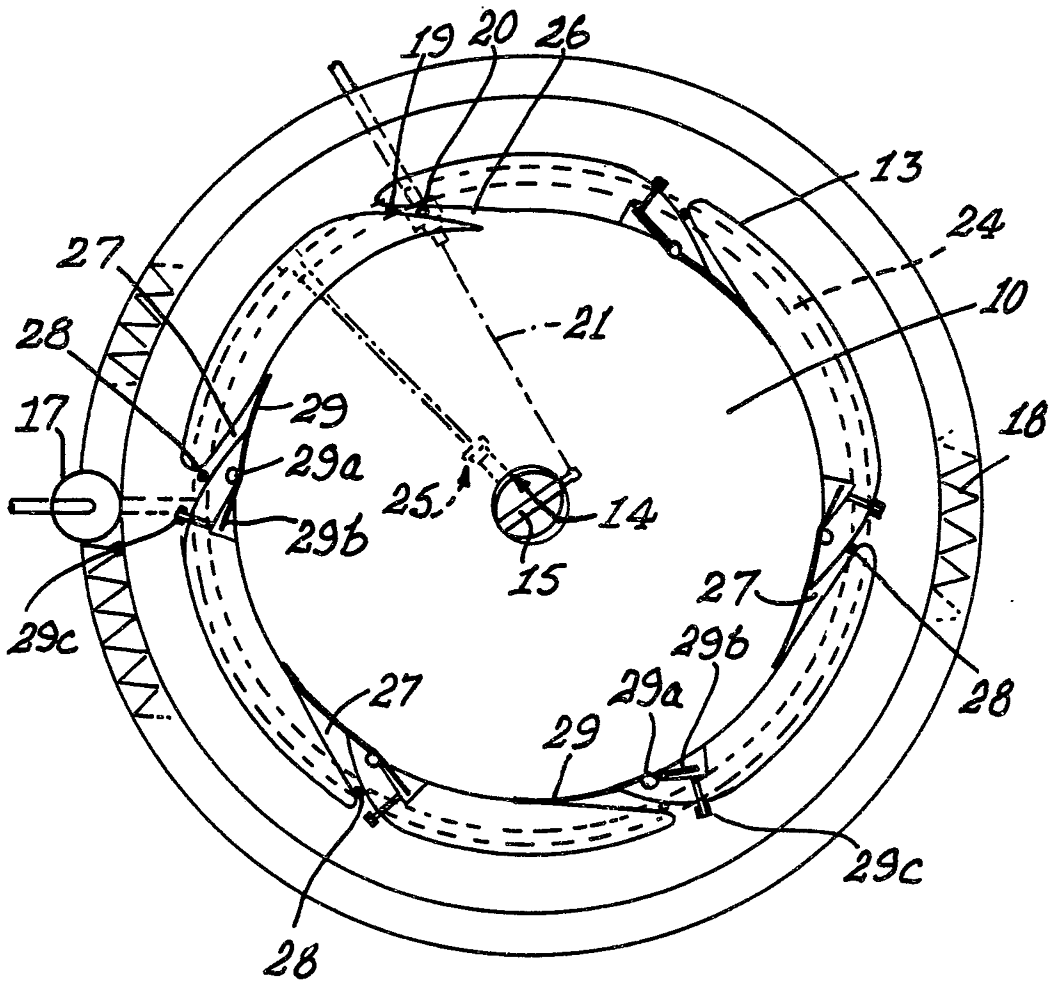
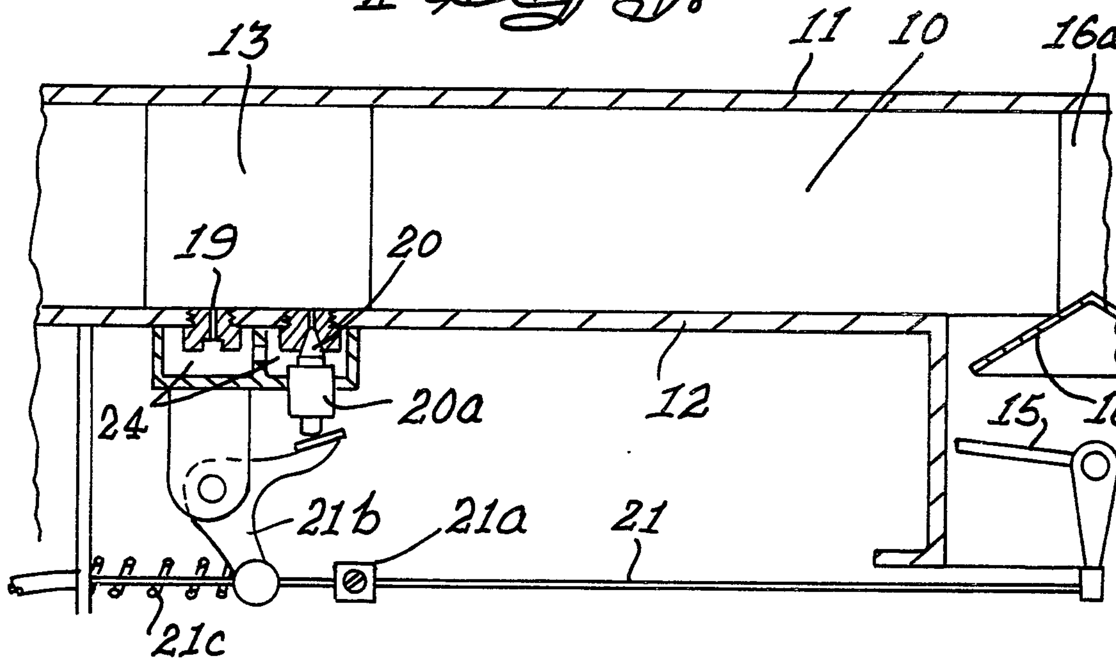


Fig 2.

Fig 3.



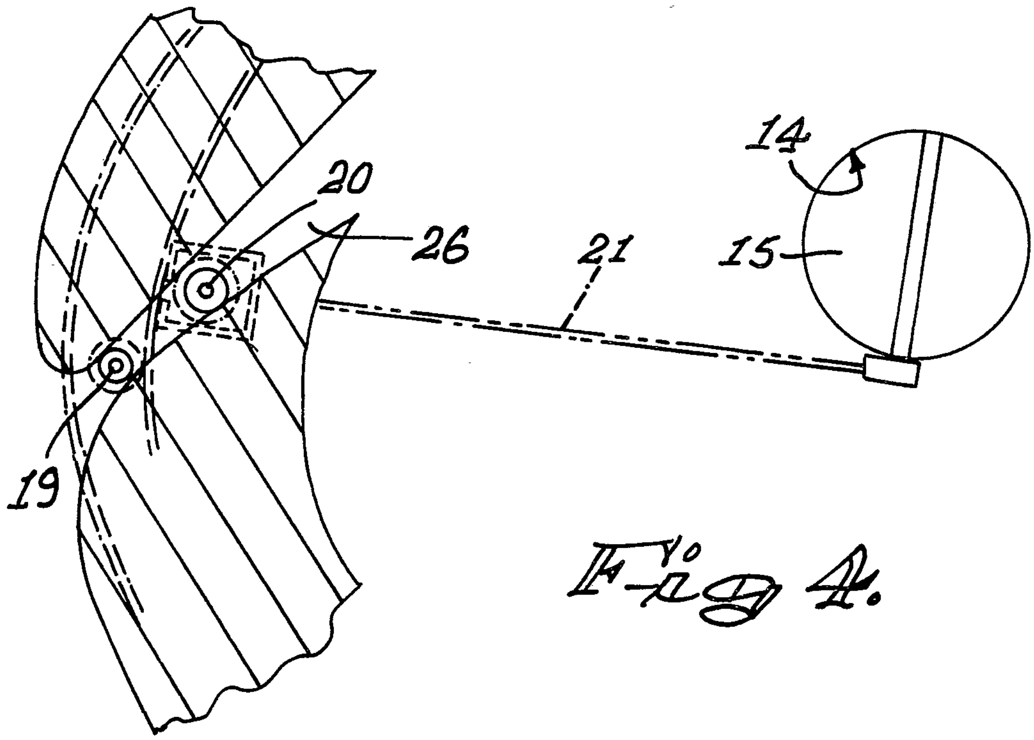


Fig 4.

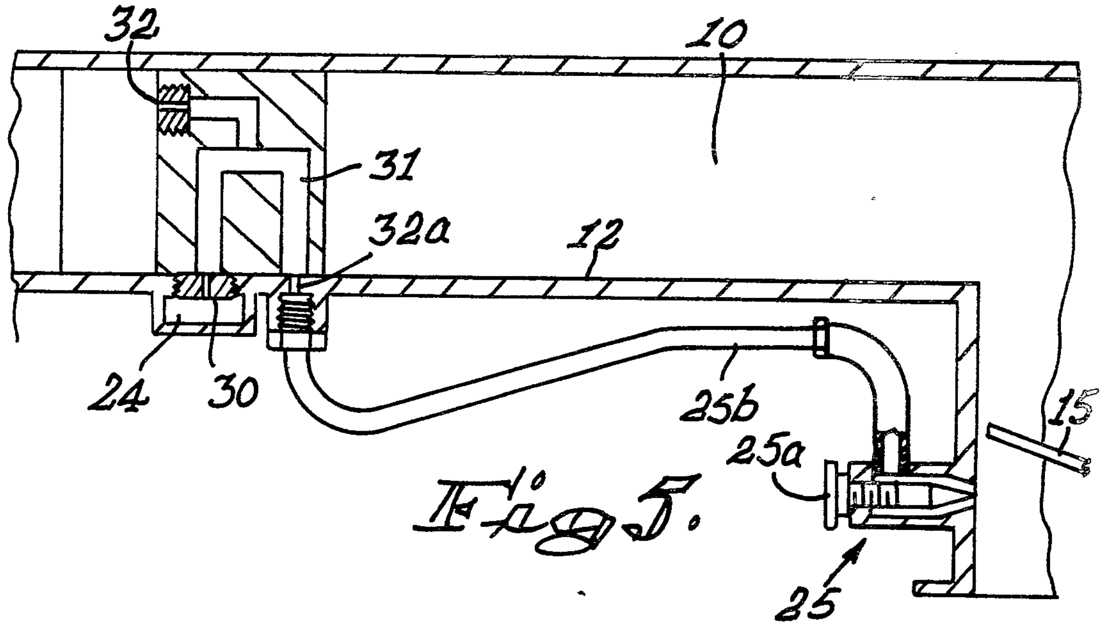
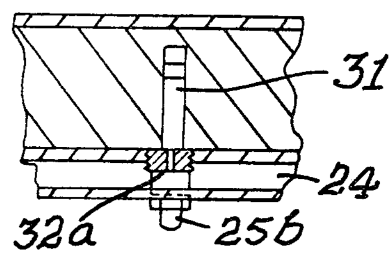


Fig 5.



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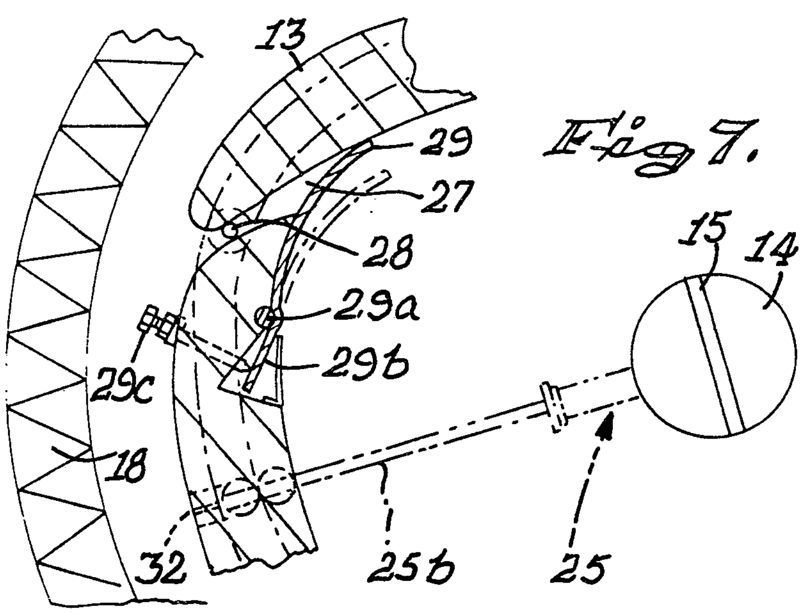

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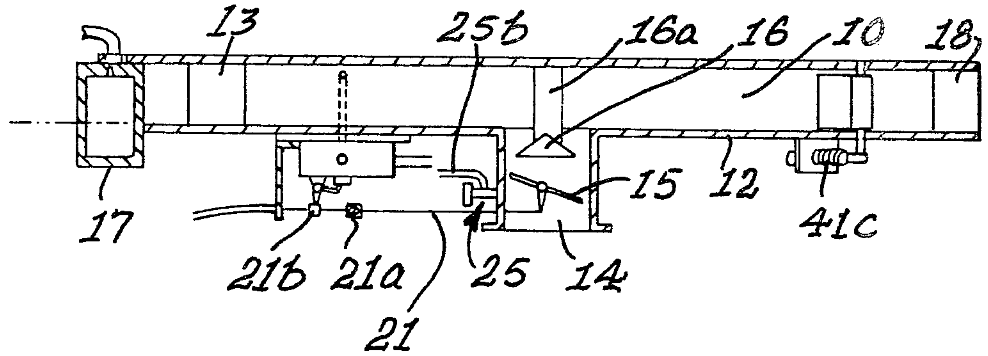
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16
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17
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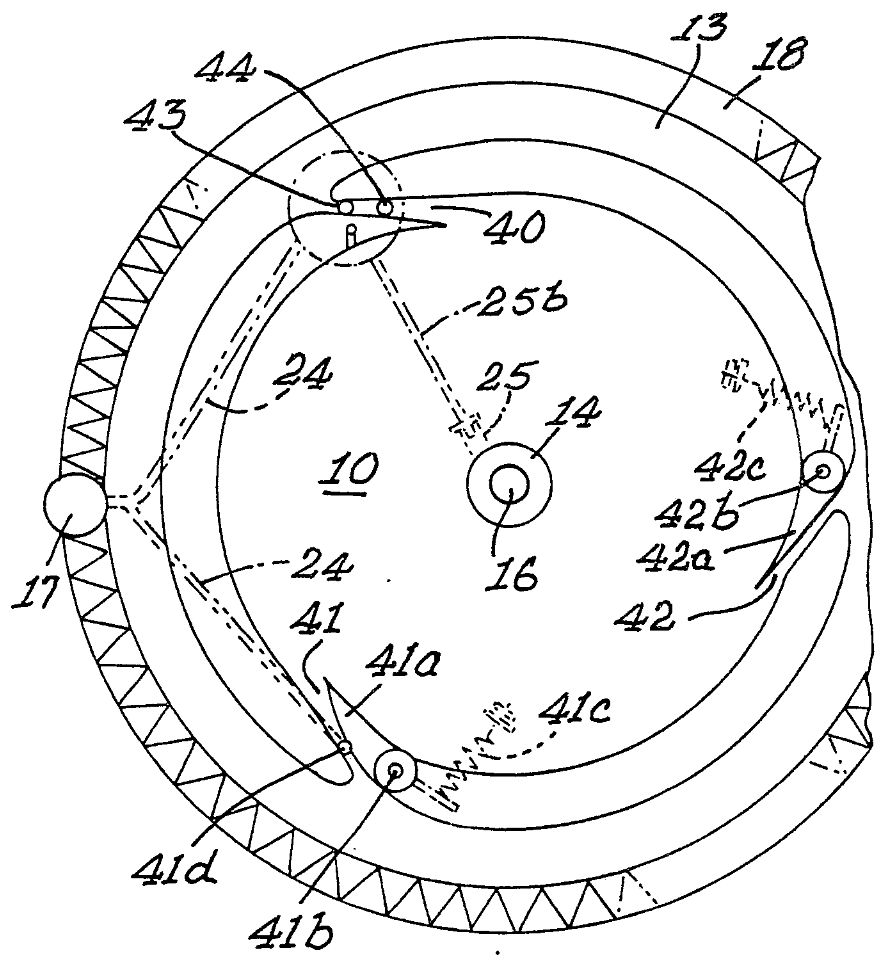
12
41c
21b
21a
25
14
21

Fig 8.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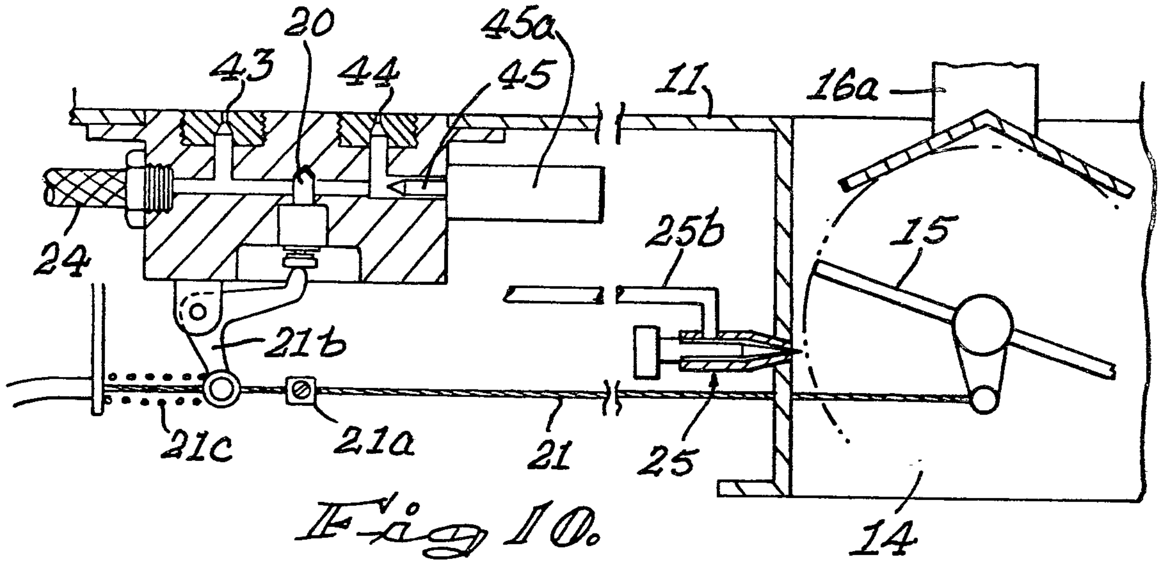
41c
41d
41b

Fig 9.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21c
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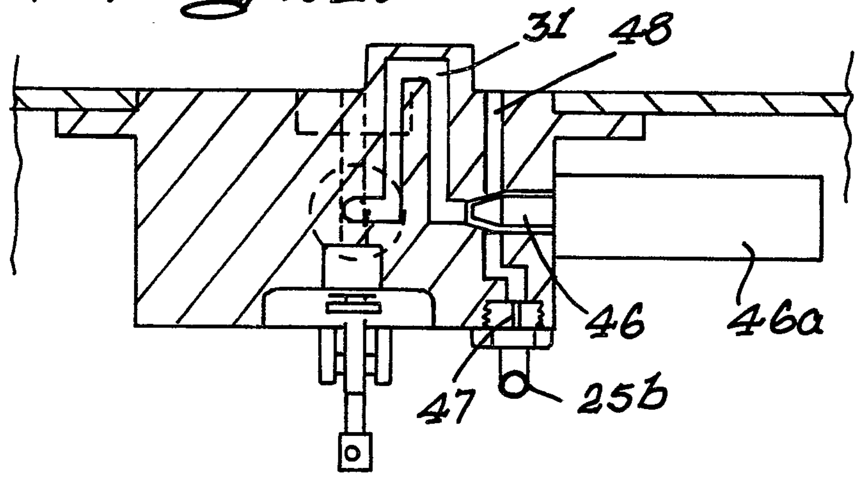
14

Fig 10.

Fig 11.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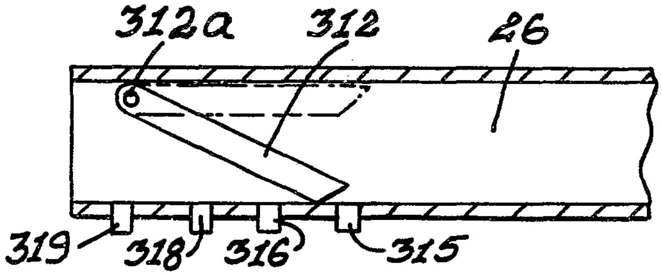
25b



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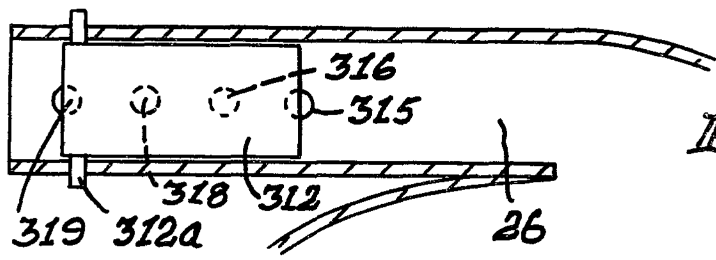


Fig 13.

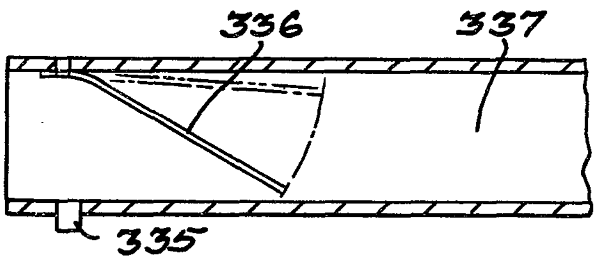
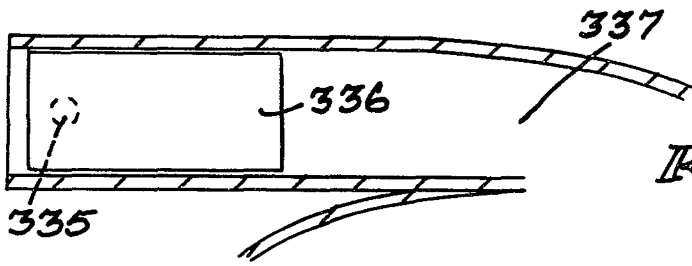


Fig 14.



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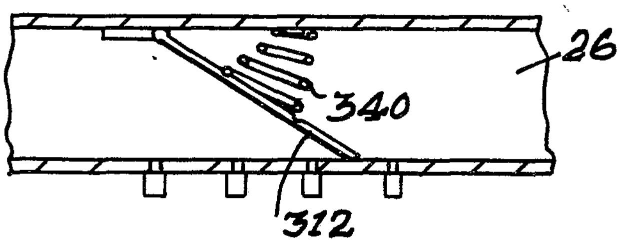

Fig 16.

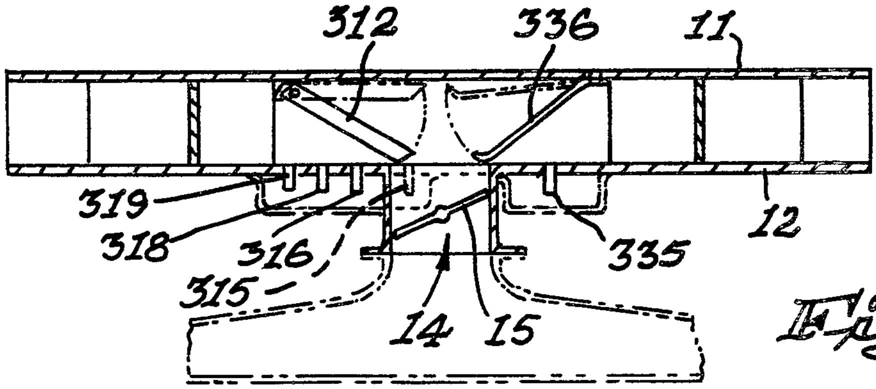
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Fig 17.

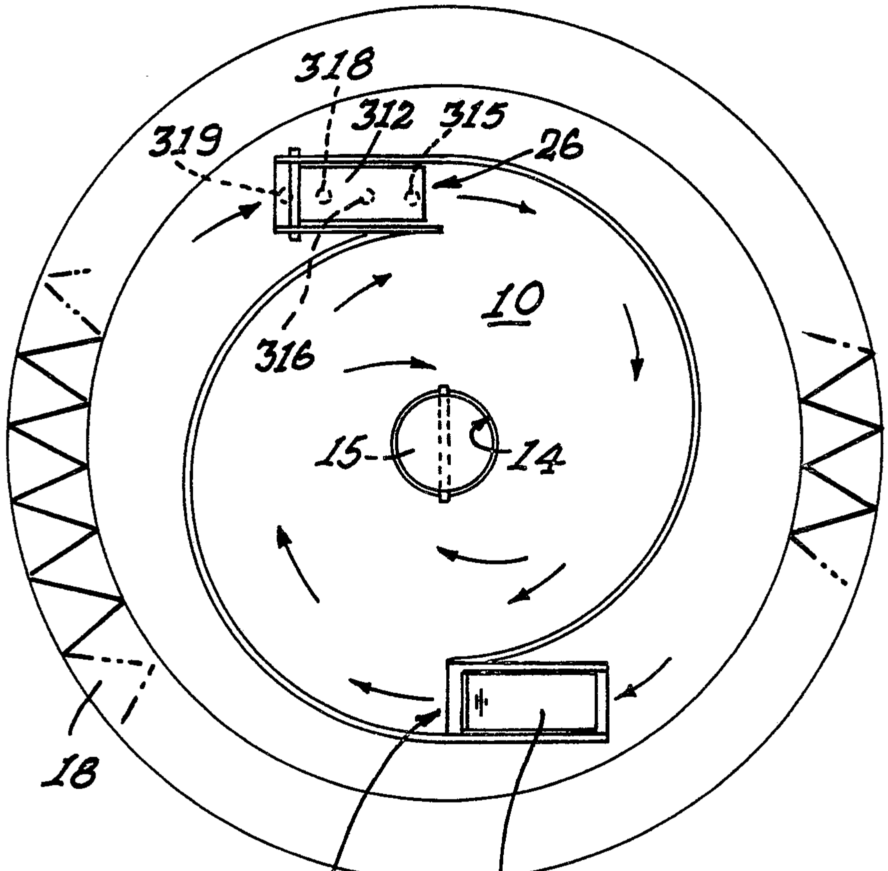
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Fig 18.

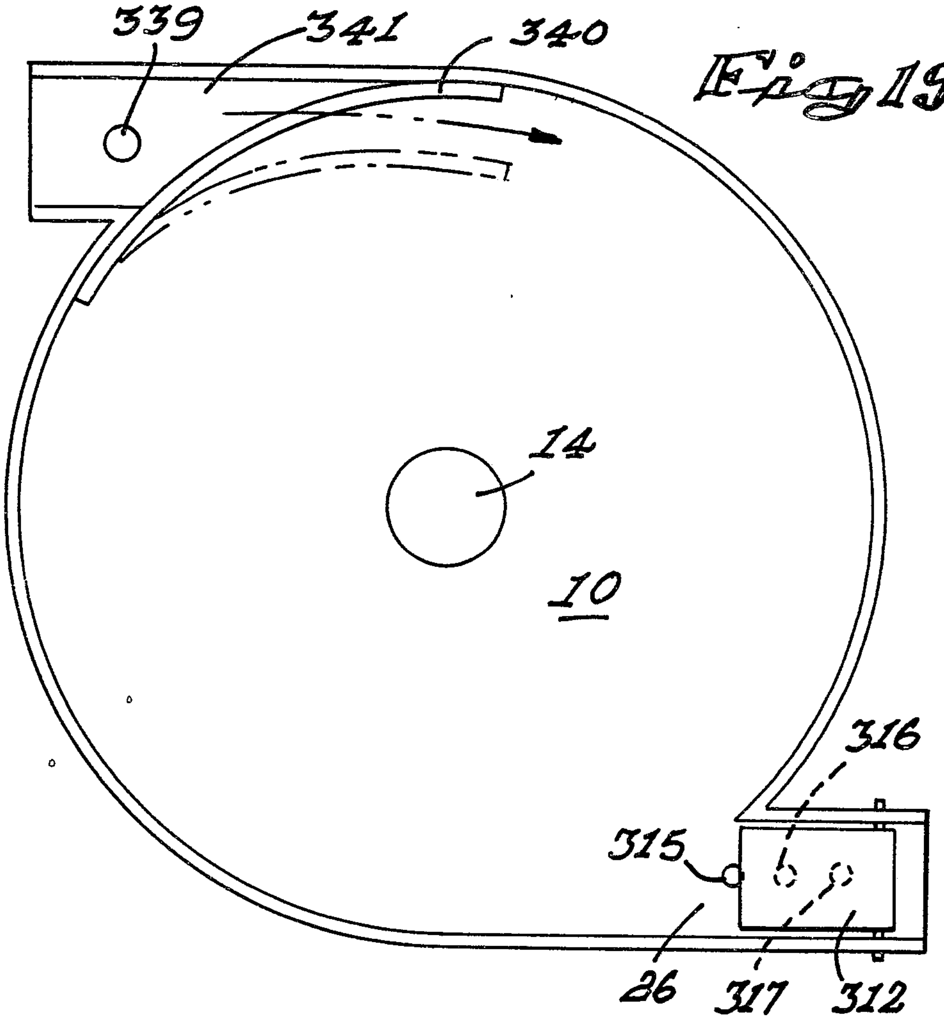

Fig 19.

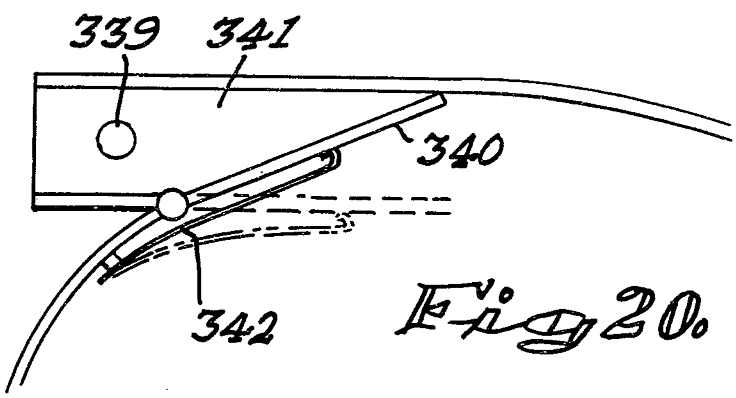

Fig 20.

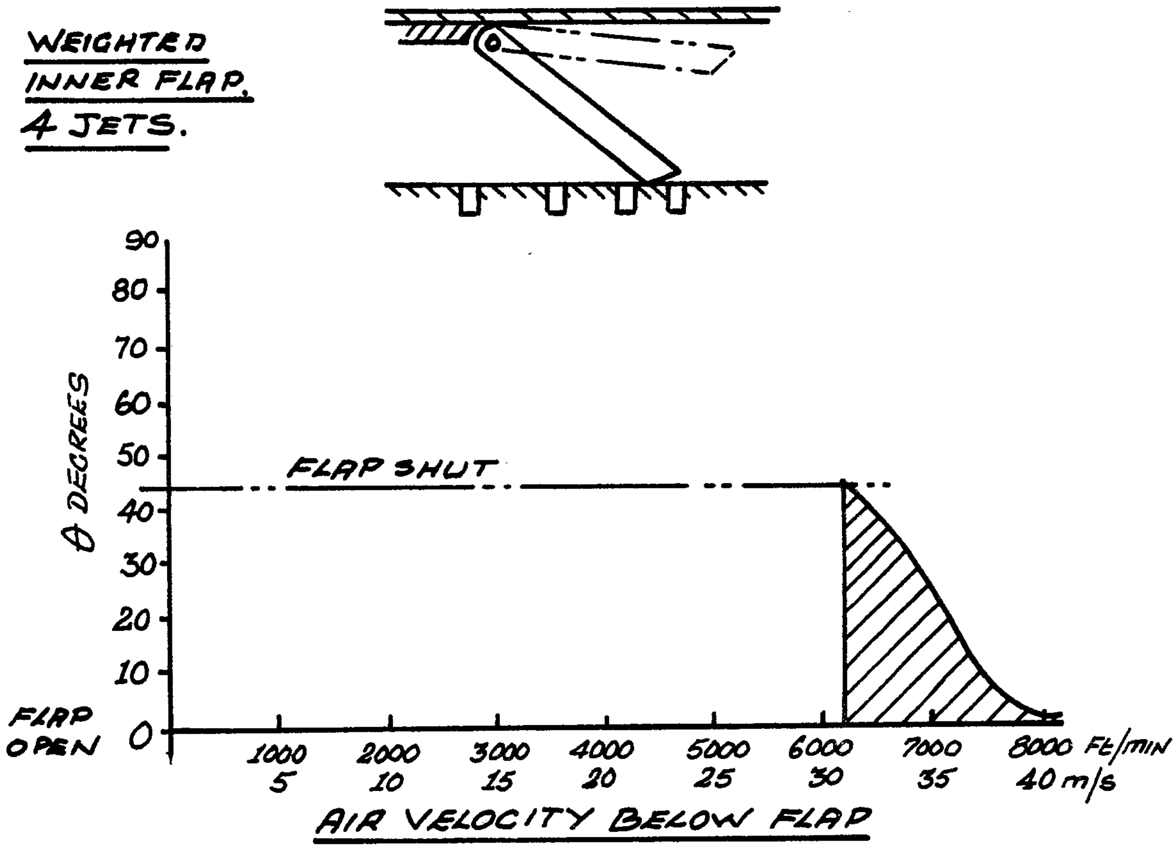
WEIGHTED
INNER FLAP.
4 JETS.
FLAP SHUT
θ DEGREES
90
80
70
60
50
40
30
20
10
0
FLAP OPEN
1000 5
2000 10
3000 15
4000 20
5000 25
6000 30
7000 35
8000 Ft/min 40 m/s
AIR VELOCITY BELOW FLAP

Fig 21.

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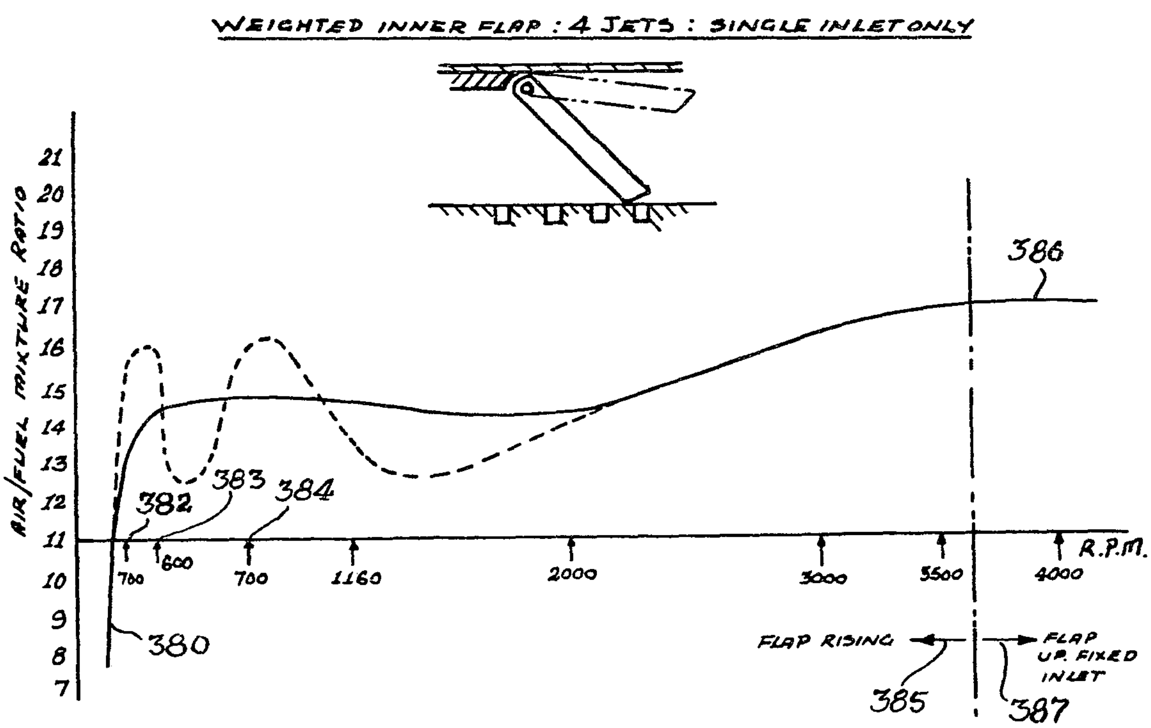
Fig 22.



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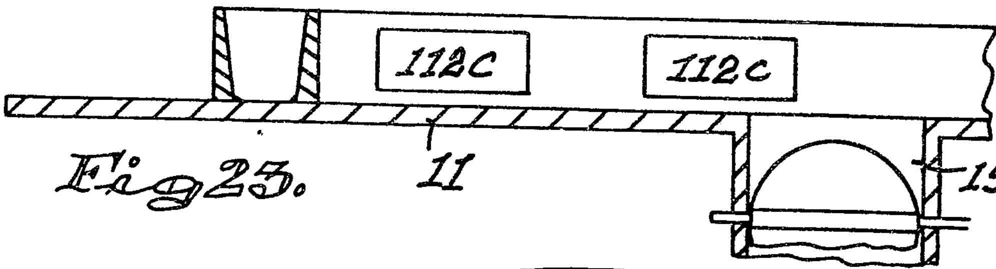

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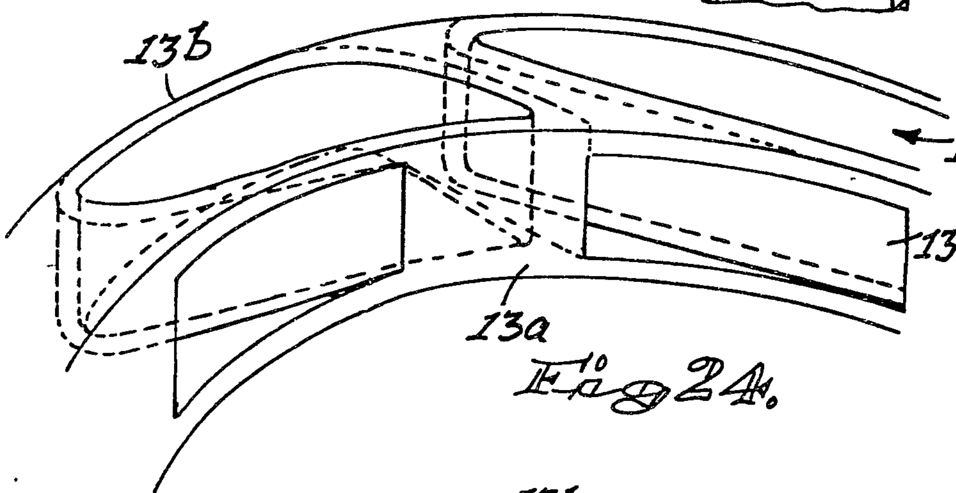

Fig 24.

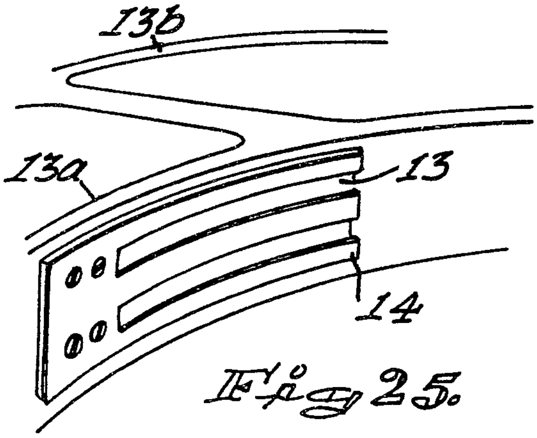

Fig 25.

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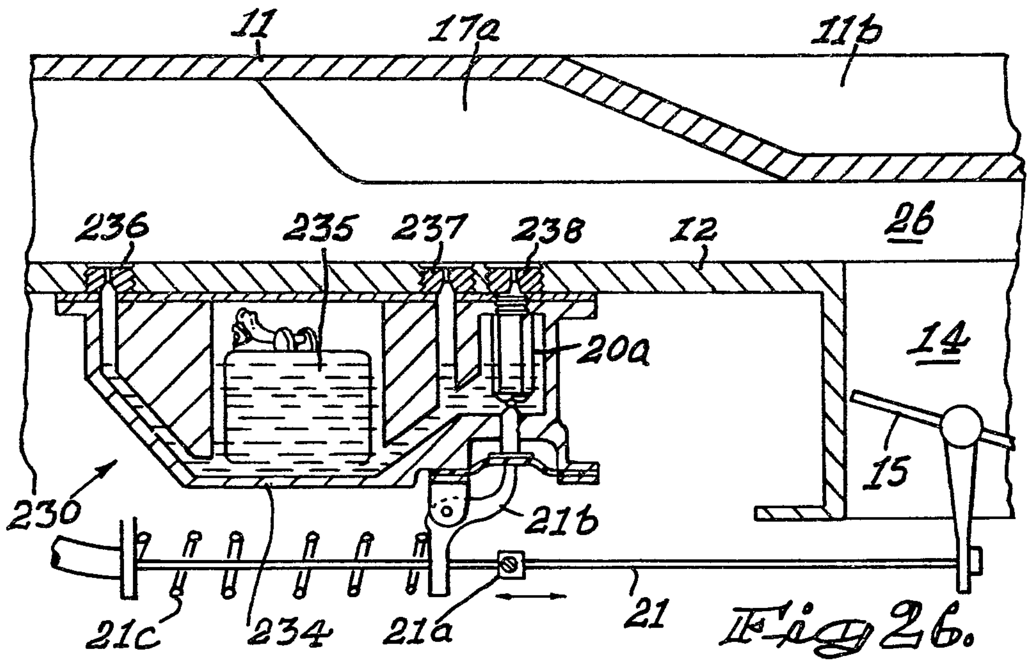

Fig 26.

Fig 27.