Oct. 21, 1930. M. R. WOLFARD 1,779,154

THE SLOW FEEDING OF LIQUID

Filed May 27, 1927

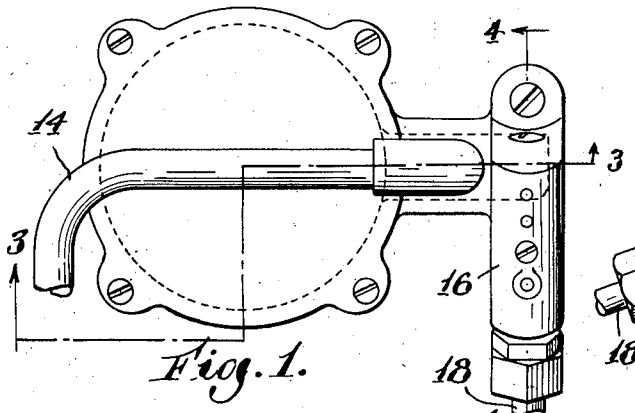


Fig. 1.

Fig. 2.

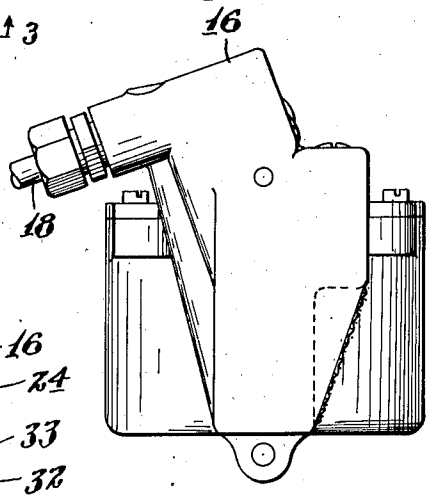


Fig. 3.

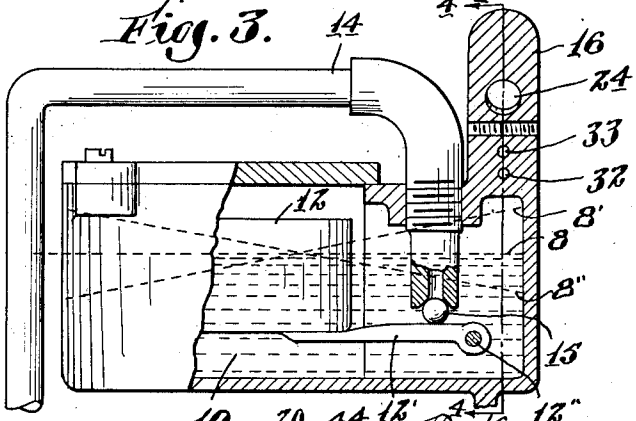
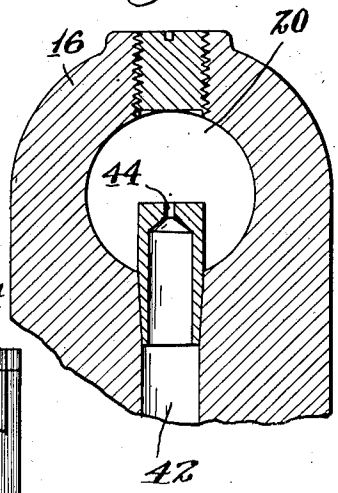


Fig. 5.



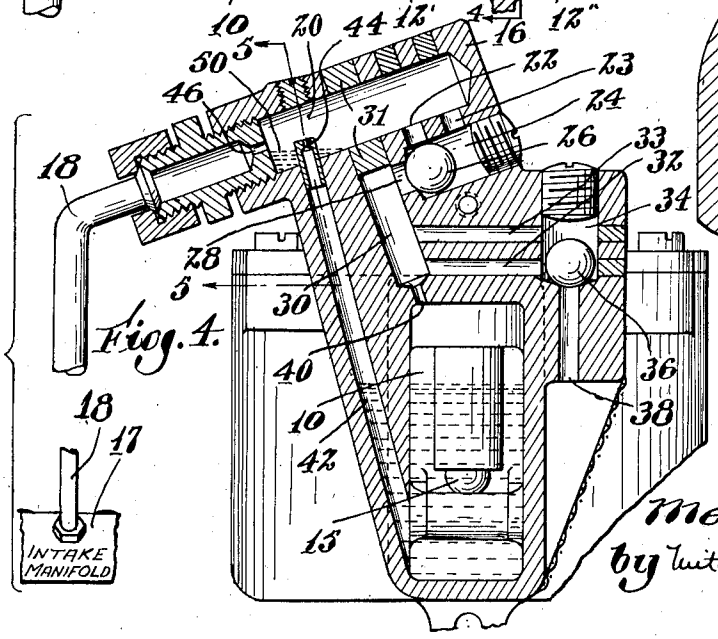


Fig. 4.

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UNITED STATES PATENT OFFICE

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THE SLOW FEEDING OF LIQUID

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This invention relates to improvements in the slow feeding of liquid. More particularly it relates to the making of a predetermined differential of pressure; and specifically to the applying of this differential for feeding a liquid, from a local supply, at a rate which is very low, and which is constant, notwithstanding that the main motivating suction is relatively very high and fluctuates greatly.

The particular utility chosen to illustrate herein an application of the invention is the supplying of a de-detonating liquid to the intake manifold of the internal combustion engine of an automobile. In such a case it is desired that the rate of flow be very small, and that it be not multiplied or magnified when the engine applies a heavy suction, as when idling. A difficulty heretofore has been that the flow of de-detonating liquid could not be satisfactorily controlled, in the minute quantities desired. To limit the flow sufficiently when high suction conditions prevail in the manifold, it has been proposed to have a very small port; but in that case not sufficient would be drawn into the manifold under low suction conditions. And moreover, if the drawing means be the same suction which draws the gasoline, as is desired, viz, the suction in the intake manifold of the engine, the outlet for the de-detonating liquid must be so extremely small, in order not to feed at more than the desired rate, that the said outlet port will be frequently becoming clogged.

It is among the objects of the invention to provide a differential device for these and like purposes; and to provide for a flow of liquid to start and to stop automatically with the suction of air, yet to proceed with substantial uniformity under normal operating conditions even though the suction inducing it fluctuates.

Another object is to provide that the differential of pressure applicable for feeding the liquid is extremely low, in which case the port for outflow of the very small quantity needed may be made large enough to be safe from danger of becoming clogged. Another object is to increase the rate of flow above normal when the main suction becomes very low, the danger of detonation in the engine being then greater; also to diminish the flow below normal when the engine load is light, as in going down a grade.

Another object is to provide for the same apparatus to maintain the local supply replenished by a suction of still a different order of magnitude.

Another important feature is to produce and maintain suctions having these rather complicated relations from a common source by a small, compact, simple and highly efficient device which can be produced at small cost.

These ends and the other advantages which characterize the invention are gained by providing a passage through which the main motivating suction, e. g., that in the intake manifold of an engine, draws air, with an intensity which, due to a restriction in the connection, normally is far below that of the manifold, yet is of an order of magnitude sufficient to lift the de-detonating liquid from its storage reservoir to the local supply. This passage contains a valve which may close it, but which is easily openable by the current of air, when the suction is strong enough, the opening of which determines a drop or differential of pressure between those parts of the passage which are on opposite sides of the valve. Connections from the passage on opposite sides of this valve are open to the places where the differential pressure is to be applied. In the particular application herein illustrated these places are two separated surfaces of the local supply of liquid. The pressure on the upstream side of the restriction is applied to the level of surface of the main body of this local supply, and that of the downstream side is applied to the discharge orifice of a spout leading from this main body to a slightly higher level, so that liquid would rise in the spout to a height corresponding to the differential, if the spout were high enough. As it is not, the liquid in fact flows out through the orifice at a rate depending on how much the equivalent head of the applied differential force exceeds the head of liquid at the orifice, above the main static level. In the instance illus-

trated this differential is normally but a fraction of an inch.

It is a feature of the invention that the restriction producing the drop in the air branch is a ball or other rolling element constituting a practically frictionless valve, opening by being rolled up a slight incline and fitting its raceway with only a necessary minimum of clearance. Because of the incline the opening force need only be strong enough to overcome that portion of the weight of the ball which is determined by the angle of slope. The opening pressure thus predetermined is maintained approximately constant by the constant tendency of the ball to roll back to its seat; but it is slightly less when the ball is remote from its seat, driven wide open by full suction (because the area of the ball, projected, is larger than the area of valve seat opening, and a lower intensity of pressure applied on that larger area will hold it open); and it is slightly greater when a weakness of suction has permitted the ball to roll to nearly closed position. The pressure thus determined is applied to the static liquid surfaces. Having thus been made to overflow through the orifice, the liquid can thence pass by gravity through any passage prepared for it, which is illustrated as being the suction passage leading to the manifold, but which is not necessarily that.

Other features of the invention will appear, dealing with the increasing of the discharge when the engine is running slowly up hill under heavy torque; the replenishment of the local supply of liquid; chattering of valves; and other matters.

The invention may be applied to other uses, one example in connection with an internal combustion engine being the feeding of lubricating oil. Also the invention may be applied to apparatus other than engines; and it is not limited to those cases in which the operative differences of pressure arise from a suction.

It is intended that the patent shall cover, by suitable expression in the appended claims, whatever features of patentable novelty exist in the invention disclosed.

In the drawings:

Figure 1 is a plan of a device embodying the invention, as prepared for feeding a de-detonating liquid into the manifold of an automobile engine;

Figure 2 is an end elevation thereof;

Figure 3 is a side elevation, partly in section on line 3—3 of Figure 1;

Figure 4 is an elevation, in section on line 4—4 of Figures 1 and 3, on a larger scale;

Figure 5 is an enlarged detail, in section, on line 5—5 of Figure 4.

The drawings illustrate a particular apparatus which has been found successful for maintaining a very small and very regular flow of de-detonating liquid from a local supply contained in chamber 10. This has a float 12 attached to a lever 12′ which rotates about a pivot 12″ and acting against a ball 15 maintains in 10 a constant level. The drawing of liquid up to this float chamber through the main feed pipe 14 from a larger supply (not shown) which may be at any convenient place several inches lower, and the simultaneous drawing of the same liquid from this float chamber at the extremely slow rate desired, is accomplished by the suction of the engine manifold 17 acting through the connection pipe 18. While embodiments of the invention may be constructed of various sizes and relative dimensions of parts according to the needs or choice of the designer, it may be helpful to this description to mention that in the embodiment here being set forth the height of parts represented in the main part of Figure 4 of the drawing is about two and a half inches, from which dimension the size and relations of the various passages in this particular instance may be estimated.

A small header 16 located over one end of the float chamber 10 contains the discharge chamber 20 of the device, which chamber is connected through port 46 to tube 18 and thus to the suction manifold 17 of the engine. The connecting port 46 is of such small dimension, and the air inlet to chamber 20 is so relatively free, that the full suction of the manifold is not experienced in this chamber, yet the vacuum experienced therein is arranged to be enough, when transmitted further through the apparatus, to raise the de-detonating liquid as many inches as may be required through pipe 14 from a storage supply at some convenient nearby location, the head for which will ordinarily be several times as great as the differential of pressure which is produced by the apparatus for feeding the same liquid out from the float chamber to which it has thus been raised. The entire passage of which the discharge chamber 20 is a part has an entrance chamber 30 to which there is an air inlet 38 closed by a ball valve 36 which is seated by gravity except as the suction lifts it. The design of this air inlet and valve determine the degree of suction available for lifting liquid through the pipe 14 for supplying the float chamber. Between the entrance chamber 30 and the discharge chamber 20 two passages extend, through both of which the suction is felt, in operation, except that one of them contains a differential ball valve 26, arranged to open with a very slight difference of pressure between chambers 30 and 20; and the other division contains the liquid in the float chamber 10 and its spout or discharge passage 42, so that no air passes, but the liquid is raised in its discharge passage 42

above its level in the float chamber 10 with a force corresponding to the differential of pressure between chambers 30 and 20 introduced by the valve 26. By locating the outlet orifice 44 of the discharge spout 42 at some place between the level in float chamber 10 and the height above that level, of a head of liquid to which this said force is equivalent, the outflow of liquid through the orifice 44 will be at whatever rate corresponds to the portion of said head remaining above the level at which the orifice is set. Preferably the orifice 44 is at the upper end of a plug which projects upward a little distance into the discharge chamber 20, so that liquid which has overflowed through the orifice 44 may gather in a small pool 50 in the chamber 20 till it reaches the level of outlet 46 therefrom, or whatever other outlet for it is provided, out through which it may flow by gravity. The setting of the chamber 20 as a cylindrical bore with axis tipped up from the horizontal and with outlet 46 of small diameter at the axis provides the small pool 50 which is illustrated in Figure 4, but there would ordinarily be no structural or operative objection to arranging the outlet so that the liquid would drain away immediately upon overflowing from the orifice 44 without forming such a pool.

For establishing the differential of pressure between chambers 20 and 30, pressure in the latter being the same as in float chamber 10 because of the connecting port 40, the following arrangements are illustrated. The ball 26 is a valve which seats toward chamber 30 by rolling against an axial opening 28 in the end of a cylindrical raceway 24, from the side of which raceway two ports 22, 23, lead into the discharge chamber 20. The described operation of this valve depends upon its rolling on an incline, rather than on its being a ball; and therefore the valve, valve seat and raceway might have forms other than the ball, circle and cylinder herein illustrated. The ball or other rolling element has a diameter nearly equal to that of its cylindrical raceway 24; and the raceway is set at an incline from the horizontal according to whatever differential pressure is desired to be produced. In the instance illustrated the incline is twenty degrees. Suction failing, the ball 26 rolls down against the port 28, thus closing the air passage. As the ball moves with absence of resistance due to friction, a very slight excess of pressure in chamber 30 over the pressure in chamber 20 can open the valve, if the pitch of the incline be made low; and the opening of this valve fixes the limit of pressure which any suction however great in chamber 20 can apply to the liquid, provided of course that the passages 22, 24, 28 and 30 are adequate in size. The port 22 is located in the raceway wall below where the ball when seated, most nearly fills its raceway; and port 23 is above that place where the ball, when fully lifted, most closely fills the same. The ports 22, 23 should be large enough to make sure that they do not in themselves constitute a restriction to flow so as to introduce an undesired differential of pressure. The port 23 vents the space behind the ball to a suction equal to that in chamber 20, and prevents the possibility of the passage to chamber 20 becoming completely closed. The latter is accomplished by there being two such holes 22, 23, which cannot both be closed by the ball at the same time. Preferably, to prevent chattering they are located so that neither can be closed at any time. Port 23 being large enough, there is no appreciable difference in pressure between chamber 20 and the space in cylinder raceway 24 beyond the ball.

The location and peripheral extent of that part of the port 22 which is closest to the port 28 (the peripheral wall of which port 28 forms the seat for ball valve 26) must be so related to the location of port 28, and so restricted, that during the ordinary running of the automobile the suction produced in the manifold will maintain the ball at such a distance from its seat that the differential pressures acting to lift the ball will be spread over and operate against the full hemispherical surface of the ball 26. When the ball is at its seat the differential pressure is applied to it only over the area of the port 28; and this condition continues, substantially unchanged, if the air escaping between the ball 26 and its seat around port 28 finds free passage into chamber 20. This air does find free passage, if a portion of port 22 extends substantially to the seat of port 28 and has too large a peripheral dimension. That is, the port 22 must be so restricted that the air which has passed the port 28 is yet confined by the port 22, with the effect that the pressure of this confined air is spread over the whole under surface of the ball 26. In that case, considering the difference between the area of projected hemisphere of the ball and the area of the port 28 (and considering that the weight of the ball remains unchanged) it is seen that the intensity of pressure which will support the ball on the inclined race is less when that supporting pressure is spread over the whole half ball, than when spread over only that part of the ball's area which is exposed to the area of the port 28. During ordinary operation this lesser pressure remains approximately constant; no increase in its intensity is required to hold the ball a little higher up, with port 22 thus open wider, and accommodating an increased flow but still maintaining a restriction.

It will be observed that in the drawing the port 22 is a circular drill hole having area about half that of port 28, which, in turn is about half that of the ball 26. Thus air which has flowed through port 28 is nevertheless

held back or restricted in flow by port 22; and because of this restriction it maintains a pressure toward chamber 20 which holds the ball rolled back some distance from its seat. And this pressure is substantially the differential between chambers 30 and 20, and therefore is the differential experience at the liquid orifice 44.

The suction port 46, makes a severe restriction in the air flow passage. In the instance illustrated it has a diameter of only .025 inch. By this the high and fluctuating suction of the intake manifold of the automobile engine is reduced for the chamber 20, and engine pulsations therein are equalized or averaged, so that suction in chamber 20 is relatively constant (at an intensity which is high enough, nevertheless, to raise liquid through pipe 14 to the float chamber). With the arrangements set forth, a pressure equivalent to a head of about one and one-half inches above the main liquid level 8, and one half inch above the discharge orifice 44 may be steadily maintained in chamber 30, whenever the operating suction is large enough for that value to be reached, as is usual during operation, and notwithstanding that the operating suction greatly exceeds such a magnitude. Considering that in an ordinary case there is, in the manifold, a high and fluctuating drop of pressure, below atmosphere, equivalent to a head of water ranging from 150 to 250 inches and falling at times down to fifteen inches, the production thereby of a steady liquid feeding head as low as a half of an inch is an interesting achievement of the invention, particularly when the invention provides for a variation of this small head, independently of variations of the manifold suction, to meet automatically needs for greater or less feed of liquid, and also provides for replenishing the local supply from a reservoir below with a suction head of still a different order, say twelve or fifteen inches. These results follow from the severity of the restriction made by the port 46; the very gentle action of the valve 26; and the moderate resistance with which the intake valve 36 opens.

In dealing with such very small heads a change of a fraction of an inch in head makes considerable difference in the flow of liquid, so that a nice attention to the dimension of the valve seat 28 may become important. It was found for example that with a ball race 24 twenty-one sixty-fourths of an inch in diameter, and with a ball 26 five-sixteenths of an inch in diameter, the making of the valve seat 28 five thirty-seconds of an inch in diameter increased to an undesirable extent the differential head between chambers 30 and 20, while the making of this hole 28 three-sixteenths of an inch in diameter gave a satisfactory increase in differential head.

With the ball 26 maintaining a differential of pressure equivalent to an inch and a half of liquid head, that is, of a liquid having approximately the specific gravity of water, and with the orifice 44 one inch above the main liquid level in float chamber 10, the de-detonating liquid would flow out with a head of one-half inch. But for special occasions when the manifold suction is low, at which times the engine is usually working under heavy load and has greater need of detonating liquid, the apparatus may automatically increase the feed, by increasing the differential pressure or by decreasing the elevation of the orifice 44 above the static liquid level in the float chamber, or both.

The intensity of pressure, in chamber 30, required for rolling valve 26 up its incline, is greatest when that valve is closed, for the area of the valve on which pressure against it can be applied is then smallest; and for a similar reason when the valve is open but a trifle the pressure required to hold it there is larger than when it is open more widely, in which latter case the opening pressure can act upon a larger area of the valve. There is also an effect of momentum of current. Therefore, when the manifold suction falls so low that the valve 26 becomes nearly closed, or so that it repeatedly closes and opens, the actual or average pressure in chamber 30 rises somewhat above that experienced in ordinary running, provided the valve and its seat are designed with suitable ratio, of opening in valve seat to projected area of valve in combination with the position and relative size of port 22. With this ratio in the range between one-third and one-half, the differential has been found to be raised automatically equal to one half an inch of head, by the falling of the suction to an extent such that the valve 26 becomes nearly closed. As this closed condition is approached the pressure conditions approach the situation in which the ball is supported by air on an area approximating the area of port 28, and the intensity of pressure of air supporting it is thereby increased. Under the conditions used for illustration this doubles the head of pressure on through orifice 44 at the very time when more detonating liquid is most needed by the engine.

When an automobile is climbing a hill it may be desirable automatically to increase the flow of de-detonating liquid, since the engine is then most likely to be operating under maximum torque and at slow speed, conditions which produce the greatest tendency to detonation. The invention provides for the setting of the apparatus with the longer dimension of its float chamber 10 extending lengthwise of the automobile. Then, with the center of oscillation of the liquid surface in float chamber 10 forward of the discharge orifice 44, the inclining upward of the forward end of the car for the climbing of the grade will cause the liquid level to stand

higher in the rear of float chamber 10, and therefore nearer to the level of orifice 44, so that a larger proportion of the available head produced by the differential pressure device is available for causing outflow through the orifice 44. This is indicated by the dotted level 8′ seen in Figure 3 which the liquid, having the normal level 8 on a horizontal road, will assume when the car moves up a grade at an angle of ten degrees. Correspondingly when the car goes down a hill the liquid level in the float chamber shifts to that indicated for a ten degree grade by the reference numeral 8″ and the head available for outflow to the orifice 44 is correspondingly diminished, thus conserving de-detonating fluid when it is not needed.

The ball valve 36 has a vertical passage 34 which constitutes its raceway, and has ports 32, 33 above and below the ball. The size of the inlet port 38 in relation to the size and weight of the ball determines the intensity of suction which can exist in the chamber 30 before the ball will be raised by that suction so as to let in air through inlet 38, this intensity becoming greater as the area of valve seat 38 becomes smaller. The passages 38, 32, 33 and 34 co-operate to reduce chattering of the ball in that after the suction has once become large enough to lift the ball from its seat 38 the ball tends to stay open, because the port 33 maintains suction behind the ball 36, aided by the closeness with which that ball fills its raceway 34. The intensity of the main suction, thus determined at the valve 36 applies in the chamber 30, port 40 and float chamber 10, so that, whenever the float 11 descends sufficiently to let the valve 15 open a trifle, that suction will draw liquid through the pipe 14 into the float chamber from whatever lower level is permitted by the intensity of suction thus provided by the valve 36, which indraft of liquid will be stopped whenever sufficient has been drawn in to raise the float valve 11 so as to close the liquid inlet passage at 15.

By the operation of the apparatus the suction of the engine manifold to which the pipe 18 is connected maintains a flow of air through the passages 38, 32, 30 and 28, 22, 20 and 18, with valve 26 steadily held open and with a sufficiency of suction in the float chamber 10 (connected with 30 through port 40) as compared with atmospheric pressure, to maintain the float chamber filled through pipe 14 from a supply at lower level; and with a sufficiently small differential of pressure between float chamber 10 and discharge chamber 20 to produce a constant elevating of liquid from the float chamber, and outflow at a desired very slow rate.

The structural method, by which the various internal passages described are created within a virtually solid block of metal, is that holes are drilled from the outside into a suitably shaped casting, and these open holes later become interior cavities, by having their undesired openings plugged. The chamber 30 is the unfilled remnant of a boring through the chamber 20, the parts at each side of the chamber 20 being plugged, as at 31. While the passages may be otherwise arranged, it is possible to make them all in the same plane, including the offset raceway 24 as illustrated in Figure 4, by drilling directly through the chamber 20 to make the chamber 30, and the port 40 into the float chamber 10.

While the invention has thus been described as it may be applied for feeding a liquid under very low head to the very place whence the suction originates, viz, the manifold, it will be observed that, when the suction is operating in the apparatus described, the differential of pressure is maintained between the chambers 20 and 30, and that this differential may be applied for any other purpose that may be desired, not necessarily having any connection with the source of the suction, nor, indeed, having anything to do with liquid.

I claim:

1. Differential pressure apparatus comprising a suction passage having a valve with inclined raceways whereon gaseous pressure rolls the valve upward for opening the passage; the said raceway being a closed chamber extending with a substantially uniform cross-section, which the valve nearly fills, to a stop to which the valve opens freely; the chamber having two constantly open ports on the down stream side, arranged in its wall, one of the ports being at a place in the wall which is between the valve seat and the point where the maximum cross section of valve lies when the valve is seated, and the other of the ports being at a place in the wall which is beyond the portion occupied by the valve when fully lifted; said port which is located between the valve seat and the valve maximum cross section, being so positioned and restricted in its peripheral dimension that the gaseous pressure which is effective on the valve, after the valve has moved along its raceway a short distance from its seat, remains substantially constant while permitting the volume of flow of gas past said valve to vary over a wide range according to the degree of opening of said port.

2. The combination, with the intake manifold of an engine, of liquid feeding apparatus comprising a passage having its discharge chamber connected to and transmitting suction from the manifold and having two branches leading into the chamber from an earlier part of the passage, one of which branches contains the liquid to be fed, and the other of which is for air to flow and contains a valve seat with rolling valve, opening with

suction in a closely enclosing raceway inclined upward from the seat; there being ports in the wall of said raceway on the down stream side, one of them, located between the valve seat and the valve, being so positioned relative to said seat, and so proportioned in area that the pressure which is effective on the valve, after it has moved along its raceway a short distance from its seat, remains substantially constant while permitting the volume of flow of gas past said valve to vary over a wide range according to the degree of opening of said port whereby a drop of pressure is produced for feeding the liquid in the first mentioned branch into the chamber; there being a ratio between the area of opening of valve seat and the projected area of valve approximating the range of one-third to one-half, whereby the drop increases when the valve is in position near to being seated.

3. The combination, with the intake manifold, for feeding fuel to an internal combustion engine, of a chamber for holding a supply of de-detonating liquid; and means for feeding the liquid slowly to the manifold, comprising a passage having its discharge chamber connected to and transmitting suction from the manifold and having two branches leading from an earlier part of the passage, one of which said branches contains said supply chamber, and the other of which contains a rolling valve with an inclined raceway whereon current rolls the valve upward for opening this branch, thereby making a drop in the suction therein; the said branch passage containing the supply being arranged connecting parts of the other branch which are on opposite sides of said valve; said chamber adapted to contain the body of de-detonating liquid having a spout with discharge orifice at a low level above the static level of liquid in this chamber, less than the hydrostatic head equivalent to the drop in pressure imposed by said valve on said static level of liquid.

4. Means for feeding a liquid, comprising the combination, with an engine intake manifold, of a container for the liquid; a spout rising therefrom and having an orifice at a low elevation above the static level of liquid in the container; means for maintaining said level approximately constant; and means for applying to said static level and to the liquid in said orifice a slight differential of pressure, greater than the head of said orifice above said static level; the last said means comprising a passage having a discharge chamber restrictedly connected to the manifold, into which chamber the said orifice delivers, and also connected to an air intake passage; an approximately frictionless valve located between said chamber and the intake, normally tending to be closed by gravity and capable of being opened by the current drawn by the manifold; the said static level being exposed to the pressure of air in said passage on the intake side of said valve.

5. A device for feeding liquid to an engine, comprising the combination with the intake manifold of the engine of a container for the liquid having a main surface and a discharge surface; and a substantially frictionless valve responsive to the pressure drop in the manifold arranged to apply to those two surfaces a substantially constant differential of pressure of a very small magnitude as compared with the difference in pressure existing between the atmosphere and the manifold during ordinary operating conditions while the manifold pressure remains well below that of the atmosphere, said valve being positioned and adapted to automatically increase said differential of pressure as the manifold pressure approaches and becomes more nearly equal to atmospheric pressure.

6. Apparatus for producing and controlling a slow feed of liquid, comprising a passage, adapted for connection to the intake manifold of an engine and having a rolling valve with inclined raceway arranged for the valve to be opened by suction toward the manifold by being rolled upward on the raceway; said passage including a chamber below the valve, containing the liquid which is to be fed and open to the pressure which is in the passage on the side of the valve remote from the manifold, and also including a chamber above the valve, open to the pressure which is in the passage on the side of the valve toward the manifold; a liquid discharge passage from the lower chamber, having orifice into the upper chamber; and a severe restriction in the passage between said upper chamber and the manifold, the severity of said restriction being such as to reduce the quantity of air thus admitted to operative effect of the suction of the manifold to a diminutive fraction of the quantity of air normally flowing through the manifold.

7. Apparatus for producing and controlling a slow feed of liquid, comprising a passage, adapted for connection to the intake manifold of an engine and having a rolling valve with inclined raceway arranged for the valve to be opened by suction toward the manifold by being rolled upward on the raceway; said passage including a float chamber below the valve, containing the liquid which is to be fed and open to the pressure which is in the passage on the side of the valve remote from the manifold, and also including a chamber above the valve, open to the pressure which is in the passage on the side of the valve toward the manifold; a liquid discharge passage from the rear of the lower chamber, having orifice into the upper chamber; the whole being arranged with the float chamber extending in forward and rear direction of the automobile so that,

with the inclining of the car on a grade, the liquid level in the chamber changes a substantial amount with respect to the delivery level of the discharge orifice from the float chamber; whereby the feeding of liquid therefrom, by head due to pressure differential introduced by the valve, is increased with upward forward inclination of the car.

8. Means for feeding a liquid at an extremely slow rate comprising the combination, with a container for the liquid, of a spout for the container, having discharge orifice at a low elevation above the static level of the liquid in the container; and a substantially frictionless valve arranged to be operated by a varying quantity of flowing air for applying to said static level of liquid a slight air pressure, equivalent to a greater head than the head of said orifice above said static level, said valve being positioned and adapted to maintain said slight air pressure substantially constant during a period of operation when the quantity of flowing air is relatively large, and to automatically increase said slight air pressure during a period of operation when the quantity of flowing air is decreasing and is less than the said relatively large quantity.

9. Means for feeding a liquid at an extremely slow rate comprising the combination, with a container for the liquid, of a spout for the container, having discharge orifice at a low elevation above the static level of the liquid in the container; and means for creating a differential of pressures between said container and said orifice, comprising a passage which communicates with the interior of said container, and into which said orifice leads; and an inclined raceway chamber of substantially uniform cross-section with confined rolling valve arranged in said passage between said container and said orifice; a port in the side of and extending along the chamber; said valve when seated being beside the midst of said port, and said valve when opening on the raceway, moving along said port, whereby the valve opens a direct passage from the valve seat to more or less of the port according as the valve moves along its raceway.

10. A device for feeding de-detonating liquid to an engine, comprising the combination with the intake manifold of the engine of a container for the de-detonating liquid having a main surface and a discharge surface; a passage which communicates with the interior of said container and into which said discharge occurs; and a rolling valve operting in said passage, between said container and said discharge; there being a restriction of said passage just beyond said valve's seat, constantly open but controlled as to degree of opening by movements of said valve toward or from its seat; said passage, in rear of said valve having a valved branch leading from atmosphere.

11. Means for feeding a de-detonating liquid to an automobile internal combustion engine, comprising the combination, with the engine intake manifold, through a connection to the manifold which is restricted so as to supply but a diminutive portion of the quantity of air normally flowing through the manifold, of a supply chamber for the de-detonating liquid, extending in the forward and rear direction of the automobile; a spout from the chamber with discharge orifice at an elevation above the static level of the main body of liquid in the chamber; and means applying pressure to the liquid at the main static level and at the spout, with a differential exceeding the hydrostatic head which liquid at the orifice has above the main static level, comprising a passage which communicates with said supply chamber and into which said spout discharges, and a rolling valve operating in said passage between said chamber and said spout; there being a restriction of the passage beyond the valve's seat, constantly open but controlled as to degree of opening by the movements of said valve toward or away from its seat; the said spout being at the rear of the chamber whereby a forward upward inclination of the car and chamber reduces the hydrostatic head of the orifice above the main static level and thereby increases the differential of pressure which is available for causing outflow of liquid.

Signed at Boston, Massachusetts, this 20th day of May, 1927.

MERL R. WOLFARD.