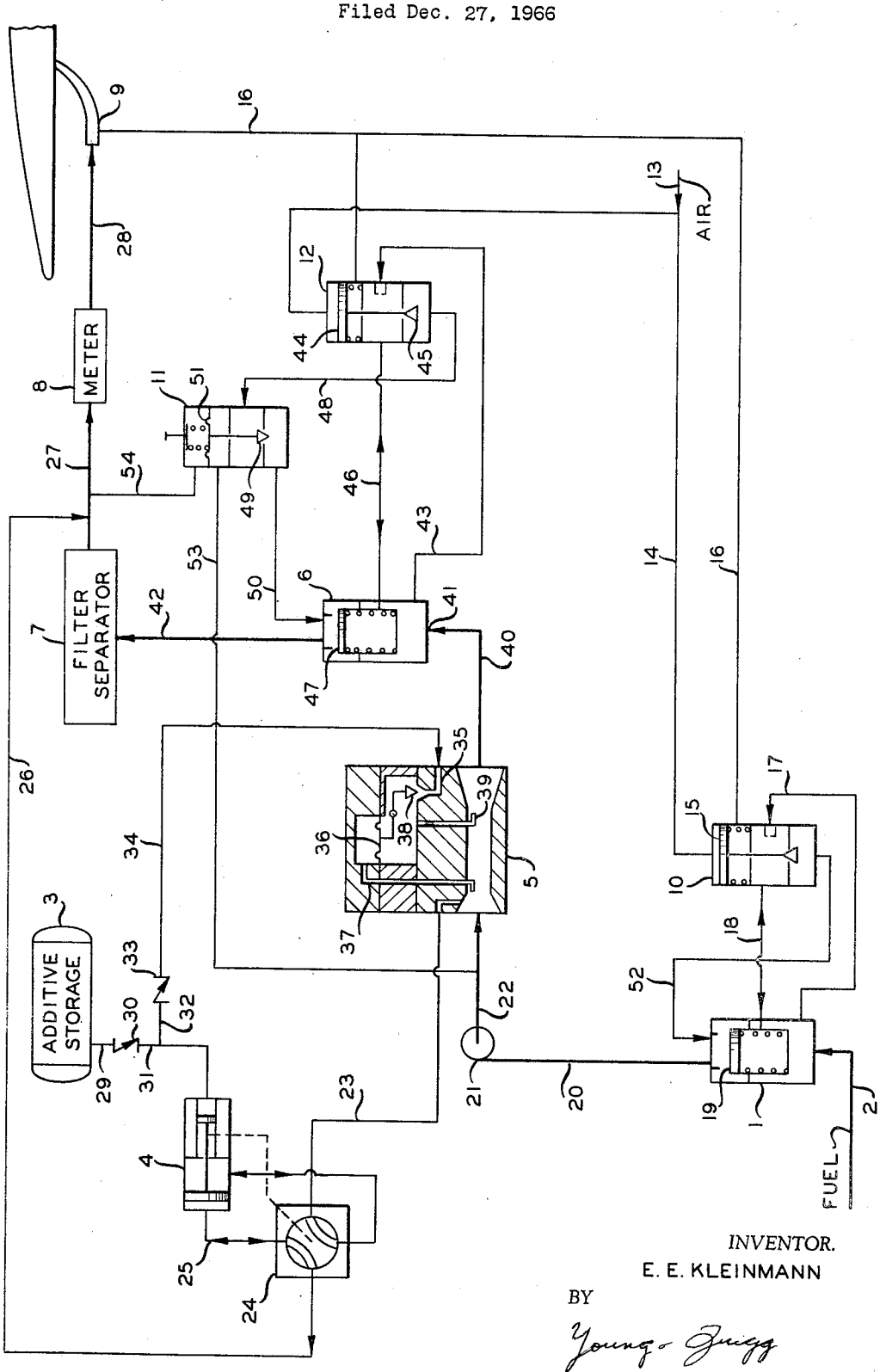
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USING FLUID TO WHICH SUBSTANCE IS ADDED TO MOTIVATE ADDITIVE

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USING FLUID TO WHICH A SUBSTANCE IS ADDED TO MOTIVATE ADDITIVE

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ABSTRACT OF THE DISCLOSURE

Method and apparatus for dosing a material into a fluid and for feeding the dosed fluid at a substantial, constant, predetermined pressure, but at varying rates of flow, and using said fluid for motivating an additive injection which doses said additive into said fluid. In one embodiment, an anti-icing and anti-microbial additive is blended into a jet fuel by passing the same through a primary valve, controlled responsive to pressure at the discharge end of the blending system. Means are provided for maintaining between said valve and the end of the system a pressure drop zone. An additive injection means is motivated by the fluid which has entered the blending system and fluid, which has been used to motivate said injection system, is discharged from the injection system to a point downstream from said pressure drop zone. Various controls and interrelated pressure and flow means are provided.

This invention relates to the supply of a fluid into which another material or fluid or additive is dosed. In one of its aspects, the invention relates to a method for supplying, at rates which can vary, a dosed fluid from a system across which there is maintained a constant pressure differential and in which a portion of the fluid is used to energize an additive injection or dosing agency or pump. In another of its aspects, the invention relates to an apparatus which will supply at a constant, predetermined pressure, but at variable rates, a fluid into which it will dose a predetermined proportion of a modifier or additive fluid or material.

In a specific embodiment of the invention, it is particularly advantageously applicable to the blending of an additive having anti-icing properties, as well as other properties, such as anti-microbial properties into or with an aviation fuel, for example, a jet fuel. U.S. Patents 2,952,121, Bill Mitacek, issued Sept. 12, 1960; 3,032,971, James A. Shotton, issued May 8, 1962; 3,270,497, Emil A. Malick, issued Sept. 6, 1966; and copending application Ser. No. 277,702, filed May 3, 1963, Emil A. Malick, relate to such additives and respectively dislose and claim a method of operating a jet engine, an anti-icing additive suitable for use in a liquid hydrocarbon fuel; a liquid hydrocarbon fuel containing the anti-icing additive and a method of operating a jet engine; a method of operating a jet engine in which an additive for anti-icing is used; and a method of inhibiting microbial attack of liquid hydrocarbon fuel and metal.

In one of its concepts, the invention provides an arrangement of valves and operational connections of flows and transmssion of pressures, comprising in a now more refined and therefore preferred form a primary valve responsive to the pressure difference between a controlled air supply and that prevailing at or near the discharge end from the arrangement or system. In another of its concepts correlated with the first-mentioned concept, the invention provides, within the arrangement, an additive or injection pump operated by a portion of the fluid which has passed through said primary valve and a secondary

valve downstream from a point at which additive is admixed with the fluid; a secondary valve which maintains a desired difference in pressure between a point downstream therefrom and a point upstream therefrom such that the fluid powering the additive pump or agency after use can be reabsorbed into the main stream of fluid before it is discharged from the arrangement; said secondary valve being positioned between the point at which the pump receives said portion of fluid and a point to which said portion of fluid, after use to energize said pump, is passed in the system or arrangement. In a still further concept of the invention, there is provided a constant pressure differential across the system, and also within the system, between said last two points, while flow through the system can vary and while the pressure drop across, say a filter or separator zone through which the fluid is passed before discharge from the system, also varies, thus allowing for re-entry into the main stream of fluid of the portion which has been diverted for use to energize the pump.

I have conceived of a method for the supply at a substantially constant predetermined pressure, but at possibly varying rates of flow, a fluid which is dosed employing a pump or other agency energized by a portion of said fluid, which method comprises the steps of maintaining a constant difference in pressure between the upstream end of a dosing or additive injection zone and a point at the discharge end of said zone, providing an additive injection section in said zone, said section being interposed between said upstream end and said discharge end of said zone, and comprising, in order of flow of fluid through said zone, an additive injection station comprising an additive injection pump and an additive admixing point, and maintaining within said zone a constant difference in pressure between a point downstream from said upstream end, but upstream from said additive injection section; and a point upstream from said discharge end, but downstream from said additive injection section, employing a portion of the fluid passing through said zone as motive fluid for said additive injection pump and passing used motive fluid to a point upstream from said discharge end, but downstream from said additive injection section.

In a now less preferred, yet entirely operative embodiment of the invention, there is simply maintained a substantially constant difference in pressure between the upstream end of the dosing zone and a point at the discharge end of the zone, yet while the pressure of the supply of fluid to the zone is varied.

An objective of this invention is to provide a method for injecting or dosing an additive or modified into a fluid being supplied. Another object of the invention is to provide a method for feeding, at variable rates to a desired point, a fluid which is being dosed with a predetermined proportion of a material or substance. Still a further object of the invention is to provide a method for feeding at a substantially constant predetermined pressure a dosed fluid, while employing a portion of the fluid being dosed as motive power to operate a dosing station, or section, yet delivering the used motive fluid together with, or as a part of, the dosed fluid. A further object of the invention is to provide a method as described wherein a purification zone exists and wherein as the method is in operation, the pressure drop across said zone can vary due to accumulation of impurities therein, yet the desired delivery pressure and varying rates of delivery can be had. Another object of the invention is to provide an apparatus or means which will feed automatically at a predetermined pressure a dosed fluid, and which will dose an ingredient into said fluid employing some of said fluid to motivate the dosing means, yet delivering the fluid used to motivate the dosing means together with the

dosed fluid. Still another object of the invention is to provide an apparatus comprising valves, pilot valves, a dosing agency or pump, a mixing device, and piping and other correlated means so arranged as to provide an overall means for delivering a dosed fluid to a desired point at a desired pressure at possibly varying rates; the apparatus employing a portion of the fluid to be dosed to operate said agency and combining fluid used in said agency with the dosed fluid for its delivery therewith. A still further object of the invention is to provide an apparatus as described, said apparatus including a purification or filtering means, the pressure drop across which will vary as impurities are accumulated therein, yet the apparatus nevertheless will deliver the dosed fluid at said desired predetermined pressure and at said variable rates. A still further object of the invention is to provide a movable combination adapted to take a supply of a movable material from a fixed source and to dose and to deliver said material as herein described. Yet another object of the invention is to provide a combination of a movable supply of such a material or fluid and means for dosing and delivering the same as herein described.

Other concepts, objects, and the several advantages of the invention are apparent from a study of this disclosure, the drawing and the appended claims.

According to the present invention, there is provided a method for supplying a fluid to which has been blended a movable material which comprises supplying to a discharge at a substantially constant pressure, but at rates which can vary, said fluid by receiving said fluid into a fluid blending zone, employing a portion of said fluid as motive fluid for an additive injection section located in said zone, maintaining downstream of said blending zone but upstream from said discharge place, in line of flow from said discharge blending zone to said place, a predetermined substantially constant pressure drop and passing used motive fluid to another place in said line of flow beyond said pressure drop but ahead of said discharge place.

Still according to the invention, there is provided an apparatus comprising, for its essential components, a fluid-operated additive injection means, a pressure drop maintaining means, and an additive blending fluid discharge means, said pressure drop maintaining means being interposed in a line of flow between said fluid-operated additive injection means and said discharge means, and means for conveying fluid used to motivate said injection means to a place in line of flow interposed between said pressure drop maintaining means and said discharge means.

Still according to the invention and in a now preferred form, the method comprises maintaining a substantially constant pressure across the operation from a point at the supply of fluid to the discharge end. Still further according to the invention, the apparatus is combined with a pressure regulating means which is responsive to regulate the pressure of inflowing fluid relative to the pressure in the discharge means so as to maintain a substantially constant pressure drop across the overall apparatus or system regardless of change in rates of flow into and from the system, and changes in the pressure of the fluid supply to the system.

Referring now to the drawing, there is shown a dosed fuel fueling system according to the invention wherein additive is dosed into a fuel. Generally, there is shown a primary valve **1** through which is fed by **2**, to and through the system, a fuel, for example, an aviation kerosene available at a pressure of, say, 140–105 p.s.i., into which is to be dosed an additive, such as an anti-icing additive, for example, that disclosed and claimed in said patents and application, from an additive storage tank **3**. Further, the additive is supplied by way of additive pump **4** to venturi injector **5** to which fuel entering the system through primary valve **1** is also supplied. The additive pump in this embodiment is a reciprocating pump having the usual valving, for supply of its motive fluid, actuated by its own operation.

The venturi injector can be suitably a Hoffman-Taff injector, the entire system can be mounted upon a cart or truck so that it can be attached to a fuel hydrant in the field; it can be mounted in a fueling vehicle or airplane, or ship or otherwise as desired for use in any place as may be desired, even in space. Further, it will be evident that the invention lends itself to portable as well as fixed use and that its method and apparatus can be reasonably varied or modified to suit the particular use for which these are intended.

Fuel into which additive has been dosed is now passed by way of secondary valve **6** to filter separator **7**, through meter **8** and supplied, as to an aircraft, through conduits, or nozzles **9**. There are operated in conjunction with the mentioned valves pilot valve **10**, operatively connected with primary valve **1**; pilot valve **11** operatively connected to secondary valve **6**; and pilot valve **12** operatively connected also to secondary valve **6** and to controled air supply **13** which is also connected to pilot valve **10** of primary valve **1**. According to this embodiment of the invention, a discharge pressure at nozzle **9** of about 40 p.s.i. is desirably maintained. The air supply pressure at **13** is approximately 45 p.s.i. and is controlled to about 40 p.s.i. and supplied by pipe **14** to above the piston **15** in pilot valve **10**. The pressure at nozzle **9** is supplied by **16** to below the piston **15** of pilot valve **10**. As the pressure at **9** is tending to increase, piston **15** in pilot valve **10** will tend to close said pilot valve, whereupon the fuel pressure **2** will pass by way of primary valve body **1**, and **17** by way of pilot valve **10**, and **18** to below piston **19** in primary valve **1**, tending to close primary valve **1** and therefore to reduce flow from this valve into the system by **20**, reel **21**, and **22**. A portion of the fuel is passed by **23** and control valve **24** into additive pump **4** and from additive pump **4** by **25** and **26** to **27** and through meter **8** and **28** to nozzle **9** to be delivered by nozzle **9** together with dosed fuel. The fuel in passing through additive pump **4** activates this pump which draws additive from additive storage **3** by **29**, check valve **30** and **31**, discharging additive through **32**, check valve **33** and **34** into passageway **35** of venturi injector **5**. In this injector, diaphragm **36** is arranged to operate responsive to the pressure of the fuel upstream of the venturi injector communicated by passageway **37** to above the diaphragm and responsive to the pressure of the additive coming from additive pump **4** by way of passageway **35** to control the degree of opening of the valve **38** in the discharge end of passageway **35**. Additive is discharged into the venturi throat by way of conduit **39**. The differential pressure across venturi injector **5** will be of the order of about 2 p.s.i. and the dosed fuel passes by **40** into the upstream end **41** of secondary valve **6** and generally through the valve and by **42** to filter separator **7** and by **27** to the meter **8** and ultimately to nozzle **9**. The pressure from inlet end **41** of secondary valve **6** is transmitted by the fuel passing by **43** into the body of pilot valve **12** equipped with piston **44** and pilot valve member **45**. It will be seen that the fuel pressure is regulably metered from pilot valve **12** by **46** to below piston **47** of secondary valve **6**, and also by **48** into and through diaphragm-operated valve member **49** in pilot valve **11**, thence by **50** into the discharge or downstream end of secondary valve **6**.

The piston **44** in pilot valve **12** is responsive to the pressure difference between nozzle **9** and the controlled air supply **13**. Diaphragm **51** in pilot valve **11** is responsive to the pressure differential between that at **22** by way of **53** just ahead of the venturi injector, and that downstream from secondary valve **6**, in this embodiment at **27** just ahead of meter **8**.

The primary valve **1** is the valve which creates the principal pressure drop in the system. Its inlet pressure is 140–105 p.s.i.g. approximately, depending on the flow

rate in the hydrant system ahead of the primary valve **1**. An air pressure is applied to the top of the piston in the pilot valve shown adjacent to valve **1** and the opposite side of the piston is subject to the fuel pressure near the inlet to the hoses connecting to the airplane. The fuel pressure at the latter point is about 40 p.s.i.

Venturi injector **5** is shown in the main fuel line. It receives additive which is pumped from the additive storage tank **3** into the venturi injector **5** and proportions the additive into the fuel passing through the injector. Movement of the diaphragm **36** shown in the injector moves a lever and attached valve head **38** to control rate of flow of additive into the fuel in response to the flowing pressure of said fuel. It will be noted that a small stream of fuel is taken off at **23** upstream of the injector to drive the additive pump **4**. This stream experiences a pressure drop of 10 p.s.i. and subsequently re-enters the main fuel stream **27** just upstream of meter **8**.

Secondary valve **6** is like primary valve **1** and acts to control pressure in the line near the final hoses in the event that valve **1** fails. Normally, pilot valve **12** stands with the valve head fully open because of air pressure on top of the piston which is about 5 pounds higher than the air pressure applied to the piston of the pilot valve for primary valve **1**. Thus, fuel under pressure from the the upstream end of valve **6** by **43** passes into valve **12** and on out through the bottom outlet **45** of valve **12** through line **48** to valve **11**, maintaining by way of **46** pressure under the piston in secondary valve **6**. Differential pilot valve **11** senses the pressure upstream of venturi injector **5** and the pressure just upsteam of meter **8** and is intended to maintain a fixed pressure difference of about 10 p.s.i. between these two points. When the pressure upstream of meter **8** and the spring pressure on the top of the diaphragm **51** in valve **11** exceed pressure under the diaphragm, the valve head moves to restrict flow through line **48**, thereby causing an increase of the pressure under the piston in the secondary valve **6** and tending to close the valve. This action will increase the pressure drop through valve **6** and the pressure differential sensed by valve **11**.

Should primary valve **1** fail, valve **12** will act to operate secondary valve **6** to maintain the desired pressure at the hoses downstream of meter **8**. In this situation, the pressure drop through valve **6** is increased considerably.

The difference in pressure across filter separator **7** varies with any contaminant build up and can be of the order of about 3 p.s.i. when the filter is clean, and as high as a pressure of the order of 15 p.s.i. and even higher when the filter has been in use for some time. By the arrangement of this invention as a feature thereof, the arrangement of the dosed fuel fueling system, making use of the specific combination of known type valves but so arranged and so communicating, i.e., so disposed and so piped, as to accomplish the overall objectives of the invention is that automatically the desired pressure at **9** and subsidiary desired pressure throughout the system are maintained in spite of variation of pressure drop across the filter, yet conveniently and smoothly delivering together with the dosed fuel the portion of fuel used to operate the additive pump.

The drawing, as one skilled in the art in possession of and having studied the same, will readily understand, indicates in a simple manner the arrangement and piping in an operational sense rather than in a detailed constructional sense. He will routinely supply refinements or modifications and details of construction wherewith the embodiment, the method, and apparatus concepts of the invention are employed.

The actual pieces of apparatus employed in the combination of steps effected according to the claimed invention and, of course, in the construction of the apparatus in connection with which it will now be described are available commercially. The concept of the invention in the method and the concept of the invention in the apparatus, which is one form of apparatus by which the invention can be executed, is primarily in the arrangement of the component parts and in the way they are to function relative to each other to yield the substantially predetermined constant pressure discharge from the system in spite of variation in flow, variation in supply pressure, etc., yet nevertheless to maintain the pressure drop permitting the smooth reabsorption, as it were, into the main stream of the fluid or fuel as the case may be, of that portion of it which has been utilized to motivate the dosing or injection operation.

It is to be understood by those skilled in the art having considered this disclosure that such details as are evident from the drawing and others as well as any equivalents thereto have not been described in mechanical detail since these will be obviously supplied as needed. For example, the flow reducing orifices as in pilot valve **10**, in pipe **39** of venturi injector **5**, and in pilot valve **12** have not been noted in detail since one experienced in the valving and control art will routinely supply the required or desired items.

The pressures or pressure differentials indicated at the various places in the drawing show operational conditions for the illustrated embodiment. It should be understood that departure from these pressures can be had in several instances without abandoning the basic concepts evident from the disclosure and to which the claims are limited.

In a specific embodiment of the invention, in which the component parts and piping diagram in an operational sense are used, there are pumped 50 gallons of fuel at one moment of operation of the system, and at a later moment of operation of the system, 600 gallons of fuel per minute. Thus, one of more fuel tanks may be filled simultaneously with the system which maintains a constant pressure differential between the two sensing points on the main fuel line, that is, at **22** and at **27**, all the while dosing additive into the fuel employing a portion of the fuel as motive fluid for so doing and recovering the used motive fluid as a portion of the ultimate dosed fuel discharged from the system.

As noted, the invention though described in a now preferred embodiment relates to the variable supply at a constant pressure differential of a dosed fuel, is applicable to other fluids into which can be fed additive or other material such as a flowable or dosable material or fluid or fluidized material.

It will be seen that a concept of the invention is in the provision of pressure-responsive secondary valve **6** to, in effect, cause a pressure back-up so that the motive fluid used emanating from the additive pump can work its way back at a downstream point. Thus, this valve is responsive to maintaining differential pressure between a point ahead of itself and a downstream portion of the system, and is positioned downstream from the injector so that this valve, which is responsive to pressure sensed at suitable points in the system, will maintain a differential pressure so that the motive fluid emanating from the additive pump operating in conjunction with the injector can be made conveniently and smoothly to re-enter into the main stream of dosed fluid before this stream is fed from the system, as to an air craft tank. The invention allows injection of the additive as and whenever desired albeit different tanks may be filled or fueled from a common hydrant system.

The invention has been described in a preferred form in which there is employed a primary valve which is arranged to maintain a substantially constant delivery pressure at the outlet of the system. However, whenever a source of supply is available at a usable pressure, it is possible to operate the invention without recourse to the primary valve. Thus, although best results and, therefore, now preferred results are obtained using a primary valve as described herein more particularly in connection

with the drawing, it is within the scope of the broader claims to omit the primary valve. Thus, the system automatically compensates without the primary valve for a reasonable wide variation in fluid supply pressure.

Thus, by maintaining a predetermined or fixed pressure differential between two points in a line, a point being ahead of the injector or secondary valve **6** and a point being beyond it, it is possible to accomplish the smooth and constant reintroduction of the fluid or fuel discharged from the dosing pump.

By the selection of the two points for sensing the differential pressure, the secondary pressure control valve, for example **6**, not only maintains the differential pressure between the two points with varying pressure drop with varying flow within the piping components of the system, but also compensates for pressure drop due to contaminant collection within the filter separator when one is employed. Still further, the inventive system will maintain a constant pressure difference between two remote points in the system, as distinguished from constant rate of flow.

For convenience, the following tabulation is given:

As flow from system increases—
Secondary valve **6** opens
Pilot valve **11** opens

As flow from system decreases—
Secondary valve **6** closes
Pilot valve **11** closes

The invention is applied with considerable advantage to the fueling of aircraft. It is possible, depending upon the size and the number of fuel tanks to be fueled, to employ the invention to receive fuel from a hydrant or other supply thereof and to fuel a tank at, say 150 gallons per minute, while another tank on the same or different aircraft may be fueled at a substantially higher or lower rate. The shutting off or adjusting of any nozzle opening will cause functioning of the invention to maintain the desired discharge pressure, to maintain the desired proportion of dosing, and in general to maintain the efficiency and desirability of the operation. The claimed invention is also applicable for fueling of chemical reaction tanks or storage tanks with chemicals, or for blending chemicals or other fluids or a movable material with suitable adjustment which can be routinely accomplished by one skilled in the art in possession of this disclosure and having studied the same and having selected the materials to be blended. The proportions of materials blended together can be varied widely and here too, one can routinely determine the relative sizes and desirable pressures and flow rates to be accomplished within the various steps or component parts of the invention.

It is within the scope of the claims to employ more than one or more of the steps or components which have been set forth to accomplish different rates or proportions of flow and also to effect a greater degree of accuracy thereof, for example, depending upon the overall or maximum rate of discharge of blended fluid more than one additive pump may be called into place simultaneously or subsequently and removed as rates increase or decrease respectively. Further, more than one primary valve and/or secondary valve may be employed and these may be employed as may other components either in parallel or in series to accomplish desired regulation and ultimate results. While a specific venturi injector additive pump combination has been set forth, other such devices are within the scope of the claims. While anti-icing additive has been given as an example of an additive, other additives added to fuels or to other liquids as these may be pumped to immediate utilization or to storage are within the scope of the claims.

Generally, the method and apparatus of the invention dealing with the physical handling of movable materials, the essential concepts thereof are physical in character and have wide application.

Reasonable variation and modification are possible in the scope of the foregoing disclosure, the drawings and the appended claims to the invention, the essence of which is that there have been provided a method for delivering at a substantially constant predetermined pressure, but at rates which can vary, a dosed fluid employing at least a portion of the fluid to be dosed or blended as motive power to motivate a blending zone and providing for a pressure drop between the point at which said portion of fluid is taken to be used and a point at which the fluid which has been used is recombined for delivery and that an apparatus comprising a primary valve, a fluid motivated blending station, a secondary valve; optionally, a filtering station and a delivery means or nozzle, in the order recited, piped together with pilot valves, etc., as described herein, have been set forth, the apparatus comprising in a broad form thereof for its essential components a fluid operated additive injection means, a pressure drop maintaining means, and an additive blending fluid discharge means, the pressure drop maintaining means being interposed in a line of flow between said fluid operated additive injection means and said discharge means and means for conveying fluid used to motivate said injection means to a place in line of flow interposed between said pressure drop maintaining means and said discharge means; the apparatus in a further limited, but broader form than that described in connection with the detailed drawing, comprising means responsive to the pressure of fluid at said discharge means and to the rate of flow therethrough to adjust said pressure drop maintaining means accordingly so as to maintain a predetermined pressure at said discharge means independently from rate of flow therethrough.

I claim:

1. A method for dosing a material into a fluid and for feeding dosed fluid at a substantially constant predetermined pressure but at possibly varying rates of flow by discharging dosed fluid from an additive injection zone which comprises the steps of maintaining an overall constant difference in pressure between the upstream end of a dosing or additive injection zone and a first point at the discharge end of said zone, providing an additive injection section in said zone, said section being interposed between said upstream end and said first point at said discharge end of said zone, and comprising an additive injection pump and an additive admixing place, maintaining within said additive injection zone a constant difference in pressure between a second point, downstream from said upstream end but upstream from said additive injection section, and a third point upstream from said discharge end, but downstream from said additive injection section, passing said fluid to be dosed into the upstream end of said additive injection zone, thence to and through said additive injection section and thence to a point downstream of said third point and thence to and through said discharge end of said zone, employing in said injection section a portion of the fluid passing therethrough as motive fluid therein for said additive injection pump and then passing said portion of fluid which has been used as motive fluid to a point upstream from said discharge end but downstream from said third point for discharge with the fluid discharged from said additive injection zone.

2. An apparatus system useful for feeding at a predetermined pressure and at varying rates of flow, a fluid which has been dosed or combined with another material or fluid within the system which comprises in combination:

(a) a first means (**1**) for receiving from a supply source (**2**) said fluid into said system;

(b) a second means (**9**) for discharging from said system said fluid, now dosed or combined with said another material, at a constant discharge pressure regardless of change in rate of its flow;

(c) a third means (**4, 5**) intermediate said first and second means, in line of flow of said fluid from said

first means (1) to said second means (9), rendered operative by flow of a portion (23) of said fluid generally flowing through said third means (4, 5), said third means (4, 5) being adapted to admix with said fluid, said another material or fluid (29), said third means (4, 5) discharging therefrom said portion of fluid (25, 26), at a lower pressure;

(d) a fourth means (6, 11, 12) positioned, in line of flow of fluid through said system, between said third means (4, 5) and said second means (9), said fourth means (6, 11, 12) being adapted to maintain a predetermined pressure drop of the fluid flowing therethrough;

(e) a fifth means (26) adapted to conduct said portion (23) of fluid from said third means (4, 5) to a point (27) in line of flow of said fluid intermediate said fourth means (6, 11, 12) and said second means (9) for admixture of said portion (26) of said fluid and for discharge of said portion from said system intermingled with said fluid.

3. An apparatus system according to claim 2 wherein said first means (1) is adapted to feed said fluid at a substantially constant predetermined pressure but at rates which can vary further into said system and wherein sixth means (10) are provided responsive to the difference between a standard pressure and said discharge pressure at said second means (9) for controlling said first means (1).

4. An apparatus system according to claim 3 wherein seventh means (12) are provided responsive to the difference in pressure of said fluid just prior to discharge from said second means (9) and a standard pressure to control flow of said fluid from a point intermediate said third means (5) and said fourth means (6) into said fourth means to activate said fourth means (6) to maintain said pressure drop and to pass fluid from said seventh means (12) to a point intermediate said fourth means (6) and said second means (9).

5. An apparatus system according to claim 4 wherein eighth means (11) are provided responsive to the difference of pressure of said fluid as fed into the system by said first means and the pressure of said fluid at a point intermediate said fourth means (6) and said second means (9) to control flow of fluid from said seventh means (12) to and through said eighth means (11) and thence to a point intermediate said fourth means (6) and said second means (9).

6. An apparatus according to claim 5 wherein there is provided intermediate said fourth means (6) and said second means (9) a fluid purification means (7) which, as the operation progresses, tends to cause an increase in the pressure drop through it owing to retention therein of impurities.

7. An apparatus according to claim 2 comprising in combination the following component means interconnected for operation as later herein described:

(a) a pilot-valve-responsive primary valve (1) connected to a fluid supply source (2);

(b) a pressure-differential-responsive first pilot valve (10) operatively connected to said primary valve (1) to open, close, and adjust the setting of the same;

(c) a standard pressure source (13);

(d) means (14) to convey said standard pressure to said first pilot valve (10) as one pressure operative to create said pressure differential;

(e) means (16) to convey the pressure of said fluid just prior to its discharge from said second means (9) to said first pilot valve (10) as another pressure employed to create said pressure differential;

(f) said first pilot valve (10) responsive to said pressure differential operatively connected (17, 18) to convey fluid from upstream of the primary valve (1), responsive to said pressure differential into (19) said primary valve (1) to close the same whenever the pressure just prior to said second means (9) is tending to undesirably increase, and to release fluid from the same, tending to open the same whenever the pressure just prior to said second means (9) is tending to decrease, and to convey (52) as required to accomplish its function from said first pilot valve (10) to downstream of said primary valve (1) and increase supply of said fluid when said pressure just prior to said second means (9) tends to fall;

(g) a conduit (20, 22, 40, 42, 27, 28) communicating fluid discharged from or at the downstream end of said primary valve (1) to said second means (9);

(h) a venturi injector (5) and an additive pump (4) constituting said third means interposed in said conduit;

(i) a secondary valve (6) also interposed in said conduit downstream from said venturi injector and upstream from said second means (9), said secondary valve (6) being so operated and connected that it will maintain in the system upstream from it a pressure substantially higher than that downstream from it;

(j) said additive pump (4) being operatively connected to an additive storage (3, 29, 30, 31) to receive additive from said storage and to said venturi injector (5, 32, 33, 34, 35) to discharge additive into said venturi injector and to a point in said conduit up stream (23) of the venturi of said injector to convey a portion of said fluid to said additive pump as motive fluid therefor, said additive pump also being operatively connected (25, 24, 26) to said conduit downstream from said secondary valve (6) to discharge into said conduit fluid which has been used as motive fluid for said additive pump;

(k) a pressure-differential-responsive second pilot valve (12) operatively connected to said secondary valve (43, 46) to a standard pressure supply (13) and to said pressure just prior to said second means (9), said standard pressure and said pressure just prior to said second means being employed to create the pressure differential to which said second pilot valve (12) is responsive, said second pilot valve (12) conveying (43, 46) from said conduit from a point in said conduit downstream from said venturi injector (5) but upstream of said secondary valve (6) fluid into said secondary valve (47) when the pressure just prior to said second means (9) tends to rise, thus tending to close said secondary valve and vice versa when said pressure jut prior to said second means tends to fall;

(l) a third pressure-differential-responsive third pilot valve (11);

(m) said second pilot valve (12) being connected (48) to convey fluid from upstream of said secondary valve (6) and from within said secondary valve through said third pilot valve (11) to downstream of said secondary valve (6);

(n) said third pilot valve (11) being connected (53) to be responsive to the pressure of the fluid in said conduit downstream from said primary valve (1) and upstream from said venturi inpector (5) for one source of pressure to create the pressure differential to which it is responsive and to said conduit (54) at a point intermediate said secondary valve (6) and said second means to supply a second pressure creating thte pressure differential to which it is responsive, the operation of said third pilot valve (11) acting to throttle flow from upstream of said secondary valve to the downstream of said secondary valve (6) whenever the pressure in said conduit downstream from said secondary valve but upstream from said second means tends to increase and vice versa.

8. An apparatus according to claim 6 wherein there is interposed in said conduit a prification means (7), the pressure drop across which tends to vary with respect to

changes in flow rate and through and/or when said purification means tends to retain impurities therein.

9. An apparatus system according to claim 8 wherein the system is constructed upon a movable base.

10. An apparatus system according to claim 9 wherein the movable base is a portion of a movable storage facility.

11. A method according to claim 1 wherein said constant difference in pressure between said upstream end and said point at the discharge end of said zone is maintained by providing a pressure-regulating zone responsive to the pressure at said point at said discharge end of said zone to regulate responsive to said last mentioned pressure the pressure of fluid supplied to said upstream end of said additive injection zone.

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