

[54] APPARATUS FOR ADMIXING FLUIDS IN PREDETERMINED PROPORTIONS

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 [58] Field of Search.....169/5, 15, 13, 16, 19, 20;
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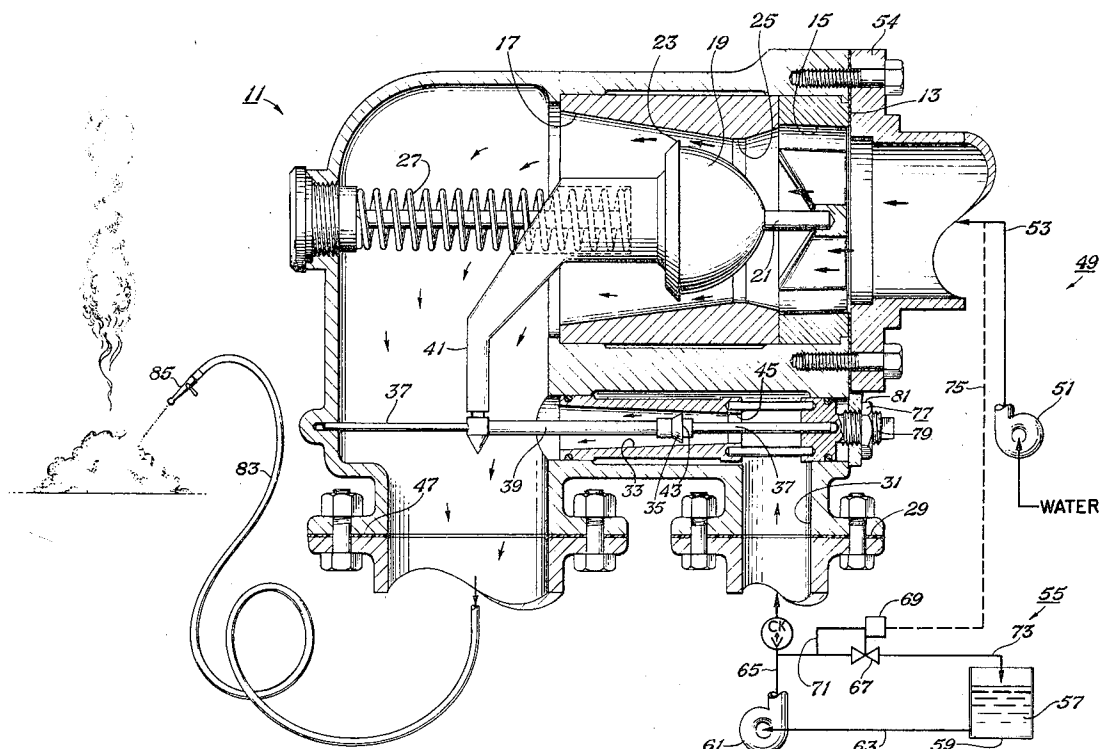
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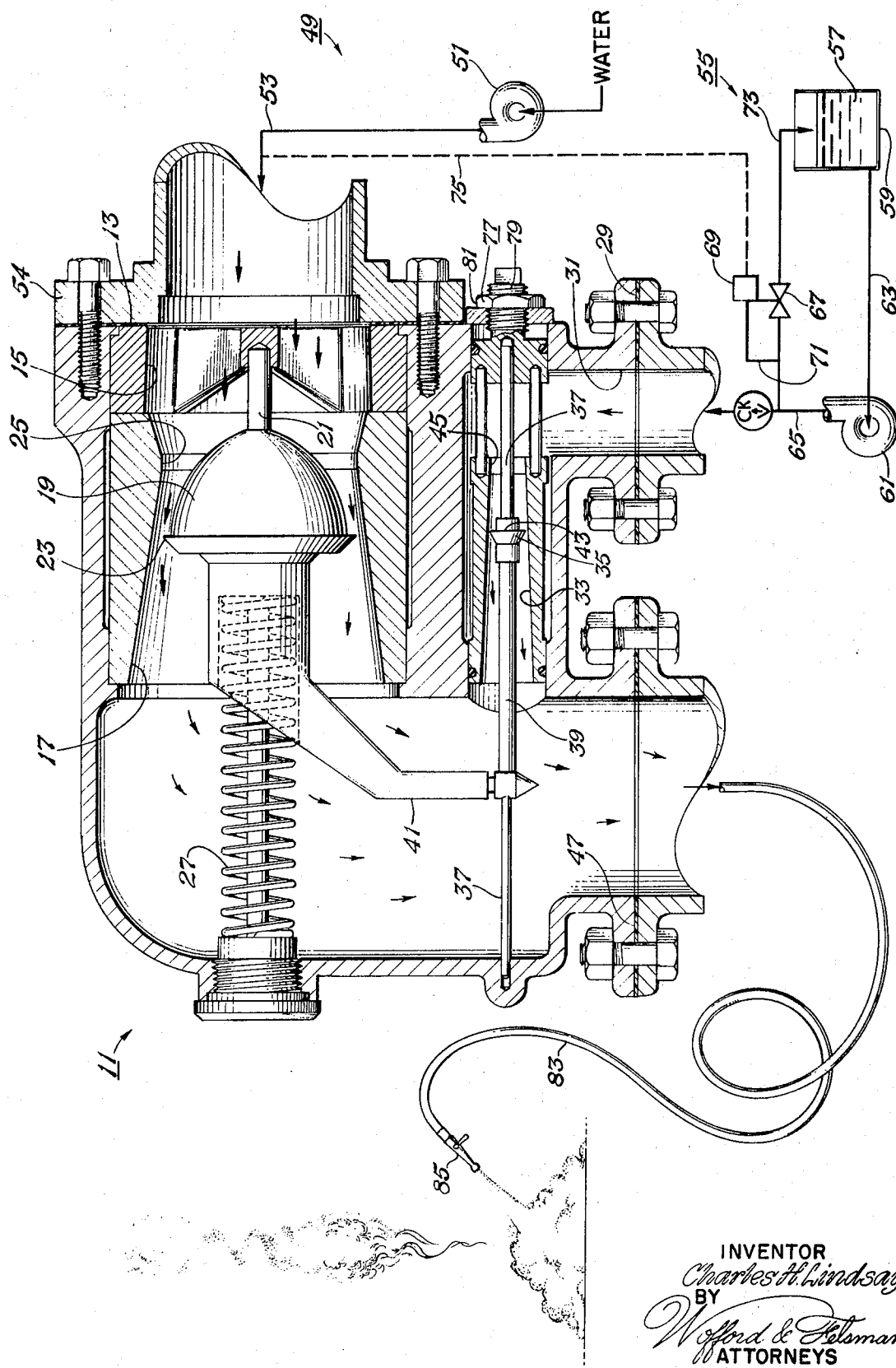
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[57] ABSTRACT

Apparatus for admixing fluids in a predetermined proportion characterized by, inter alia, first and second valves, connected together and disposed in their respective tapered throats and sized to effect the correct proportion of fluid flow therepast; the first valve being biased towards its no flow position by suitable force sufficient to require at least 2.5, and preferably about 5 pounds per square inch (p.s.i.) pressure differential across the valve to open it for flow therepast. Delivery systems are provided for delivering the two fluids to be admixed at about the same inlet pressure. The second throat is movable with respect to the second valve to allow some flexibility in adjusting the proportion of the fluids, although for large variations in proportion, or concentration, of the second fluid, the second throat may be changed out entirely to give a larger or smaller range of areas of flow past the second valve.

16 Claims, 1 Drawing Figure





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APPARATUS FOR ADMIXING FLUIDS IN PREDETERMINED PROPORTIONS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to apparatus for admixing fluids in a predetermined proportion and, in a particular aspect, to demand proportioners.

2. Description of the Prior Art

A variety of apparatus for effecting proportioned flow and subsequent mixing of fluids has been suggested. One of the best known of the apparatus for such admixing of liquids is the proportioner in which water flows through and spins a hydraulic rotor. The hydraulic rotor is tied to a pump that, in turn, pumps a second quantity flow rate of a second fluid to be admixed with the first. Large sums have been spent in perfecting this type of prior art demand proportioner and it works satisfactorily with clear liquids. Even a small amount of solid particles; such as, sand, or welding slag from lines; however, are damaging and adversely affect its operation.

Other methods of effecting a proportionate mixing of fluids is known employing elaborate flowmeters and quantitative controllers in conjunction with quantitative pumping units for the second fluids. These elaborate prior art apparatus for effecting admixture of fluids are initially more expensive than desirable and require skilled operating personnel to keep them properly maintained and operative.

In addition, the prior art apparatus for admixing liquids in a given proportion were operative only over a small range of flow rates or were adapted to a particular flow rate and did not allow wide variations therein.

The prior art devices frequently required too accurate a control over the inlet pressures, in addition to being operative over too limited a range of flow rates, to be practical.

The prior art has not been satisfactory in providing a simple demand proportioner that obviates the disadvantages enumerated hereinbefore and in which two streams can be connected in parallel with any assurance that anything like the proper proportion of admixing will be effected.

BRIEF DESCRIPTION OF THE DRAWING

The figure is a partly cross-sectional and partly schematic view of apparatus in accordance with one embodiment of this invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is a primary object of this invention to provide a simple, economical, and rugged demand proportioner that can be employed to effect admixing of fluids in a predetermined proportion over a wide range of flow rates; for example, from 50 to 1,500 gallons per minute (g.p.m.). In addition, it is also an object of this invention to provide in the foregoing demand proportioner an adjusting means that can be readily adjusted to vary the proportion in which the fluids are admixed.

It is also an object of this invention to provide apparatus for admixing fluids in a predetermined proportion and over a wide range of flow rates that will tolerate variations in inlet pressures of the two fluids of sufficient magnitude to allow employing conventional other apparatus and thus, be commercially feasible.

It is also an object of this invention to provide apparatus for admixing fluids that will tolerate an appreciable amount of solids in the primary fluid without adversely affecting the apparatus or the proportioning and admixing of the fluids.

The invention is illustrated in the figure and described hereinafter specifically with respect to admixing a fluid concentrate; such as, a foam liquid concentrate; and water to produce a fire extinguishing agent; such as, foam; for fighting fires. Any two fluids, including materials like fluidized solids that exhibit the flow characteristics of fluids, may be admixed by apparatus of this invention, however. Referring to the figure, demand proportioner 11 has a first connection means such as flange-receiving plate 13 adjacent passageway 15 for

connection with a supply means for delivering a first fluid such as water. Demand proportioner 11 also includes a first throat means 17 and a first valve means 19 in fluid communication with the first connection means. First valve means 19 is reciprocally movable along guide rod 21. First valve means 19 has a flow control shoulder 23. Shoulder 23 engages seat 25 when first valve means is moved to the right to a zero flow position for restricting flow of the water therepast. First throat means 17 comprises a frustoconical section that diverges outwardly toward its discharge end to effect a first monotonically increasing flow area between the first valve means 19 and first throat means 17 at increasing rates of flow of the water therethrough. The principle is analogous to the principle employed in suspending bobs at heights proportional to rates of flow in rotameters.

First valve means 19 is biased to the right to a closed, or zero flow, position by a biasing means such as spring 27. In my work with this demand proportioner I have found that the biasing means should hold the first valve means 19 in the closed position with a considerable force in order to allow use of commercially available equipment in the remainder of the apparatus and provide an economically feasible embodiment; particularly, in the area of generating foam for fire fighting equipment. Specifically, spring 27 should force first valve means 19 toward the closed position with a force sufficient to require at least 2.5 pounds per square inch (p.s.i.); and, preferably, 5 p.s.i.; pressure differential across the valve means to open it for flow or water therepast. Biasing with a lesser force causes too great a change in proportions of the two liquids with small differences in inlet pressure of the two liquids.

Demand proportioner 11 has a second connection means such as flange receiving plate 29 adjacent passageway 31, for connecting with a second supply means for delivering a second fluid such as a foam liquid concentrate.

Demand proportioner 11 also has a second throat means 33 and a second valve means 35 in fluid communication with the second connection means. Second valve means 35 is reciprocally movable along guide rod 37. Second valve means 35 is connected with first valve means 19 by shaft 39 and arm 41. Thus, shaft 39 and arm 41 serve as means drivingly connecting the first valve means with the second valve means such that the second valve means is moved responsively to and as a second predetermined function of movement of the first valve means. As illustrated, first and second valve means move in unison along their respective guide rods the same lineal distance.

Second valve means 35 also has a flow control shoulder 43 for engaging seat 45 in the zero flow position. Second throat means 33 is adapted to effect a second monotonically increasing flow area between it and second valve means 35 that is a predetermined function of the first monotonically increasing flow area between first throat means 17 and first valve means 19. The predetermined function is that relationship necessary to effect the requisite proportion between the two liquids flowing through their respective throat means.

Demand proportioner 11 also has a discharge means such as flange-receiving plate 47 in fluid communication with the effluent ends of the first and second throat means for admixing the respective fluids flowing therethrough.

As illustrated in the figure, a water supply means 49 is connected with the first connection means for delivering water at a predetermined pressure P_1 . Specifically, a source of water such as a storage tank (not shown) is connected with the intake side of pump 51 and the discharge side of pump 51 is connected by conduit 53 and flange 54 with the first connection means of demand proportioner 11.

Similarly, a foam liquid concentrate supply means 55 is connected with the second connection means for delivering foam liquid concentrate at an inlet pressure P_2 . While some variation between the inlet pressures P_1 and P_2 can be tolerated with this embodiment, it is desirable that they be approximately the same for most nearly accurate proportioning of the

liquids. Accordingly, a relief valve is afforded to maintain pressure P_2 at the proper level and to recycle excess foam liquid concentrate back to a reservoir. Specifically, foam liquid 57 in reservoir, or supply tank, 59 is connected with the intake of pump 61 via conduit 63; and the discharge of pump 61 is connected with second connection means 29 via conduit 65. Pressure relief valve 67, having a controller 69 thereon for positioning the valve in response to back pressure sent via control line 71 vents excess pressure via return conduit 73 back to reservoir 59. Desirably, controller 69 is also connected with and is responsive to pressure P_1 at the inlet of the water at the first connection means in order to control the pressure on the foam liquid concentrate at nearly the same pressure as the water inlet pressure. Such a control line is illustrated by dashed line 75. This arrangement enables more nearly accurate control of the proportionate admixing of the foam liquid concentrate and the water to produce a better foam.

A sleeve adjustment means 77 is provided for moving second throat means 33 longitudinally with respect to second valve means 35 or even completely changing the second throat means 33 for controlling the concentration of the foam liquid being supplied therethrough to be admixed with the water. Sleeve adjustment means 77 includes suitable lineal moving means such as a threaded shaft 79 and locking means such as a locknut 81.

A delivery means such as hose 83 and nozzle 85 is provided for delivering the foam effected by admixture of the foam liquid concentrate with the water. As is well known, the nozzle may be manipulated by any suitable means to direct the foam onto the fire. Suitable means includes manual manipulation or automatically controlled turret manipulation.

In operation, demand proportioner 11 is connected with the respective conduits 53 and 65 and with hose 83 for admixing the water and the foam liquid concentrate to produce foam for being delivered through nozzle 85 via suitable fire fighting equipment (not shown), onto a fire, or the like. Foam liquid concentrate is supplied by pump 61 and bypass valve 67 at pressure P_2 . Water is supplied by pump 51 at the water inlet at a pressure P_1 sufficient to move first valve means 19 to the left against spring 27 for a given rate of flow of water therethrough. The rate of flow may be adjusted by suitable valves (not shown), in conduit 53 from 50 to 1,500 g.p.m. and still effect the requisite concentration of foam liquid concentrate in the water through the metering effect of second valve means 35 in the second throat means 33. Specifically, as first valve means 19 moves to the left against spring 27, an increasing area becomes available for flow of water between first valve means 19 and first throat means 17. Simultaneously, second valve means 35 is moved to the left so that an increasing area becomes available for flow of foam liquid concentrate between second valve means 35 and second throat means 33. Because of the predetermined relationship between the increasing flow areas when the respective valve means move lineally to the left, the proportion of the liquids is maintained to effect the desired mixture and hence, the desired foam.

The resulting foam, effected by the admixture of the liquids and the flow through hose 83, can be delivered onto a fire for its extinction.

If, as is usually the case, pump 61 delivers the foam liquid concentrate at a rate greater than is being flowed through the area between second valve means 35 and second throat means 33, pressure will increase and the increase in pressure will be sensed via control line 71 by controller 69 which will open relief valve 67 to bypass the foam liquid concentrate through return conduit 73 to reservoir 59. The pressure at which controller 69 begins to open relief valve 67, may be controlled in response to the water pressure via a control line 75 in order to keep the inlet pressures nearly the same. Because of the biasing force of spring 27, requiring at least 2.5 p.s.i. to move first valve means 19 to the left, commercially available equipment may be employed to attain economically feasible fire fighting admixture with the demand proportioner of this invention.

This is in contradistinction to some of the prior art apparatus for admixing of liquids in a given proportion which require that the inlet pressures of the two liquids be so nearly identical as to be commercially infeasible.

Sleeve adjusting means 77 allows moving second throat means 33 with respect to valve means 35 for effecting minor adjustments in the concentration of the foam liquid concentrate to be supplied to the water. If large variations in proportions are desired, the sleeve adjustment means may be unlocked and the second throat means replaced with another second throat means having greater or lesser flow area between it and the second valve means 35 to effect a radically different proportion of the second fluid supplied and admixed with the first fluid. For example, in commercially available foam liquid concentrates, viscosities differ greatly such that greater flow areas may be necessary to effect the same concentration of liquid foam concentrate to produce the foam. On the other hand, different suppliers of foam liquid concentrates advocate different concentrations to effect the most advantageous foam. For example, one manufacturer of a commercially available foam liquid concentrate advocates a proportion of about 6 percent of the foam liquid concentrate admixed with water for effecting most nearly optimum foam. Other concentrate manufacturers may advocate greater or lesser proportions, or concentrations, of the foam liquid concentrate in the water.

The biasing means has been discussed hereinbefore as comprising spring 27. The biasing means, however, includes all of the force acting on first valve means 19 to tend to return it to the zero flow position. The weight of the first valve means 19 becomes significant in installations in which the guide rod 21 is vertical, since the differential pressure is proportional to the total force, including the spring force and the force of gravity, opposing the fluid pressure. For example, I have employed a cast brass first valve means 19 that weighed 14 pounds. Such additional weight of first valve means 19 is particularly significant at low rates of flow through the demand proportioner 11.

It may be advantageous to employ a spring and a lightweight first valve means 19 to obtain a response determined substantially entirely by the spring constant irrespective of the position in which the demand proportioner is employed; for example, whether employed with the guide rod 21 vertical or horizontal. By lightweight valve means is meant a hollow valve means, or one formed from a lightweight metal such as aluminum or magnesium, or plastic. On the other hand, it may be advantageous to employ a relatively heavy first valve means in conjunction with a light spring and a vertical guide rod 21 to allow employing a more elongated throat means and longer travel of the first valve means without higher differential pressures across the valve means at higher flow rates.

As noted, the second throat means 33 effects a monotonically increasing flow area between it and second valve means 35 that is a predetermined function of the first monotonically increasing flow area between the first throat means 17 and first valve means 19. The predetermined function may vary, depending upon the flow correlations employed. I have found that a satisfactory empirical solution is achieved when the second throat means employs two frustoconical sections having only a slight change in the degree of taper of the walls of the second throat means 33 to maintain the desired proportion of the second fluid at different rates of flow. For example, I have found that, employing a 6 percent proportion of a foam liquid concentrate admixed with water, increasing the taper from about 3° to about 5° at about the midpoint of the length of the second throat means will effect the desired proportions, as determined by empirical flow curves and proportions.

The respective valve means may be connected in any way that will effect the cooperative movement thereof. For example, they may be connected by lever means across a fulcrum, in which case their movement and associated throat means could be arcuate; or they may be connected by lineal members for movement in opposite directions along suitably disposed throat means and guide rods.

The delivery means illustrated and described hereinbefore is a fire hose and nozzle. The delivery means is meant broadly to include any means for delivering the admixture of fluids; the delivery means including conduits or ducts for delivering or circulating the admixture of fluids.

The standard flow controls and other similar well known equipment are, of course, employed. For example, the check valve in line 65 may be employed to prevent any danger of the water backflowing into line 65. Such well known apparatus are not described herein, since they do not form a part of the invention.

Thus, it can be seen that the invention accomplishes the objects delineated hereinbefore in providing a simple, economical, and rugged demand proportioner that can be employed to effect the admixing of fluids in a predetermined proportion over a wide range of flow rates; and that enables changing the proportion in which the fluids are admixed; and in providing apparatus that will tolerate appreciable solids and variations in inlet pressures without deleteriously altering the proportions of the fluids in the admixture.

Although the invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention.

What is claimed is:

1. Fire fighting apparatus for effecting optimum fire extinguishing agent by admixing a fluid concentrate with water in a predetermined proportion regardless of rate of flow of the water comprising:

- a. a water supply means for delivering water at a predetermined pressure;
 - b. a fluid concentrate supply means for delivering a fluid concentrate and including means for effecting and maintaining the delivery pressure of said fluid concentrate at substantially said predetermined pressure;
 - c. a first elongate throat means and a first valve means in fluid communication with said water supply means, having a zero flow position and adapted to effect a first monotonically increasing flow area between said first valve means and said first throat means at increasing rates of flow of said water therethrough;
 - d. biasing means biasing said valve means toward said zero flow position with a force sufficient to require at least 2.5 pounds per square inch (p.s.i.) pressure differential across said valve means to open it for flow of said water therepast;
 - e. a second elongate throat means and second valve means in fluid communication with said fluid concentrate supply means, having a zero flow position and adapted to effect a second monotonically increasing flow area between said second throat means and said second valve means that is a predetermined function of said first monotonically increasing flow area;
 - f. means drivingly connecting said first valve means with said second valve means such that said second valve means is moved responsively to and as a second predetermined function of movement of said first valve means; said second predetermined function effecting increased flow through said second valve means when said first valve means is moved to effect increased flow therethrough and vice versa; and
 - g. discharge and delivery means in fluid communication with the effluent end of said first and second throats for combining the respective fluids flowing therethrough to form and deliver said fire extinguishing agent onto a target.
2. The apparatus of claim 1 wherein said first and second valve means are connected together to move in unison and in the same direction.
3. The apparatus of claim 1 wherein said second throat means is movably positioned with respect to said second valve

means for adjusting the concentration of said fluid concentrate being admixed with said water to form said fire extinguishing agent.

4. The apparatus of claim 1 wherein said first and second valve means move in the same direction along parallel axes that are also parallel with the axes of the respective throat means.

5. The apparatus of claim 1 wherein said fluid concentrate supply means comprises:

- a. a reservoir;
- b. a pump connected at its intake with said reservoir and at its discharge with the inlet of said second throat means; and
- c. pressure relief means for bypassing said fluid concentrate back to said reservoir when the pressure immediately upstream of said second throat means and said second valve means exceeds the predetermined pressure.

6. The apparatus of claim 5 wherein said pressure relief means is also responsively connected with said water supply means immediately upstream of said first throat and said first valve means for maintaining said predetermined pressure substantially equal for both said water supply means and said fluid concentrate supply means.

7. Apparatus for mixing fluids in a predetermined proportion regardless of rate of flow comprising:

- a. a first fluid supply means for delivering said first fluid at a predetermined pressure;
- b. a second fluid supply means for delivering said second fluid and including means for effecting and maintaining the delivery pressure of said second fluid at substantially said predetermined pressure;
- c. a first elongate throat means and a first valve means in fluid communication with said first fluid supply means, having a zero flow position, and being adapted to effect a first monotonically increasing flow area between said first throat means and said valve means at increasing rates of flow of said first fluid therethrough;
- d. biasing means biasing said first valve means toward said zero flow position with a force sufficient to require at least 2.5 pounds per square inch (p.s.i.) pressure differential across said valve means to open it for flow of said first fluid therepast;
- e. a second elongate throat means and a second valve means in fluid communication with said second fluid supply means, having a zero flow position, and adapted to effect a second monotonically increasing flow area between said second throat means and said second valve means at increasing rates of flow of said second fluid therethrough, said second monotonically increasing flow area being a predetermined function of said first monotonically increasing flow area;
- f. means drivingly connecting said first valve means with said second valve means such that said second valve means is moved responsively to and as a second predetermined function of movement of said first valve means for controlling flow of said second fluid therepast; said second predetermined function effecting increased flow when said first valve means is moved to effect increased flow therethrough and vice versa; and
- g. discharge means in fluid communication with the effluent end of said first and said second throats for admixing the respective fluids flowing therethrough.

8. The apparatus of claim 7 wherein said second throat means is removably and movably positionable with respect to said second valve means for adjusting the relative proportion of the respective fluids being admixed.

9. A demand proportioner that is operable over a wide range of flow rates and effects increased flow of a second fluid concomitantly with increased flow of a first fluid comprising:

- a. first connection means for connecting with a supply means for delivering a first fluid;

- b. a first elongate throat means and a first valve means in fluid communication with said first connection means, having a zero flow position, and adapted to effect a first monotonically increasing flow area between said first valve means and said first throat means at increasing rates of flow of said first fluid therethrough;
- c. biasing means biasing said first valve means toward said zero flow position with a force sufficient to require at least 2.5 pounds per square inch (p.s.i.) pressure differential across said first valve means to open it for flow of said first fluid therethrough;
- d. second connection means for connecting with a second supply means for delivering a second fluid;
- e. a second elongate throat means and second valve means in fluid communication with said second connection means, having a zero flow position, and adapted to effect a second monotonically increasing flow area between said second valve means and said second throat means that is a predetermined function of said first monotonically increasing flow area;
- f. means drivingly connecting said first valve means with said second valve means such that said second valve means is moved responsively to and as a second predetermined function of movement of said first valve means; said second predetermined function effecting increased flow when said first valve means is moved to effect increased flow and vice versa; said first and second throat means being adapted to be operable when said first and second fluids are delivered at substantially equal pressures; and
- g. discharge means in fluid communication with the effluent end of said first and second throat means for admixing the respective fluids flowing therethrough.
10. The demand proportioner of claim 9 wherein said first and second valve means are connected together to move in unison and in the same direction.

11. The demand proportioner of claim 9 wherein said first and second valve means move in the same direction along parallel axes that are also parallel with the axes of the respective throat means.
12. The demand proportioner of claim 9 wherein said second throat means is removably and movably positionable with respect to said second valve means for adjusting the relative proportion of the respective fluids being admixed.
13. The demand proportioner of claim 9 wherein said biasing means biases said first valve means toward said zero flow position with a force sufficient to require 5 pounds per square inch (p.s.i.) pressure differential across said first valve means to open it for flow of said first fluid therepast.
14. The demand proportioner of claim 9 wherein said second throat means is removably and movably positionable with respect to said second valve means for adjusting the relative proportion of respective fluids being flowed therethrough.
15. The demand proportioner of claim 9 wherein said biasing means comprises a spring having a spring constant; and said first valve means is formed as a light weight structure such that response of said first valve means to flow of a fluid therepast is governed substantially entirely by said spring constant, and said demand proportioner may be employed in any position.
16. The demand proportioner of claim 9 wherein said first valve means is retained by a guide rod, is movable longitudinally of said guide rod; said guide rod is employed in a vertical position; said biasing means comprises a spring and the weight of said first valve means; and said first valve means is formed of a heavy material such that the weight of said first valve means is a significant part of said biasing means; whereby said demand proportioner may employ a relatively more elongated throat means for longer travel of said first valve means, without requiring high-pressure drop across said first valve means at high flow rates.

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