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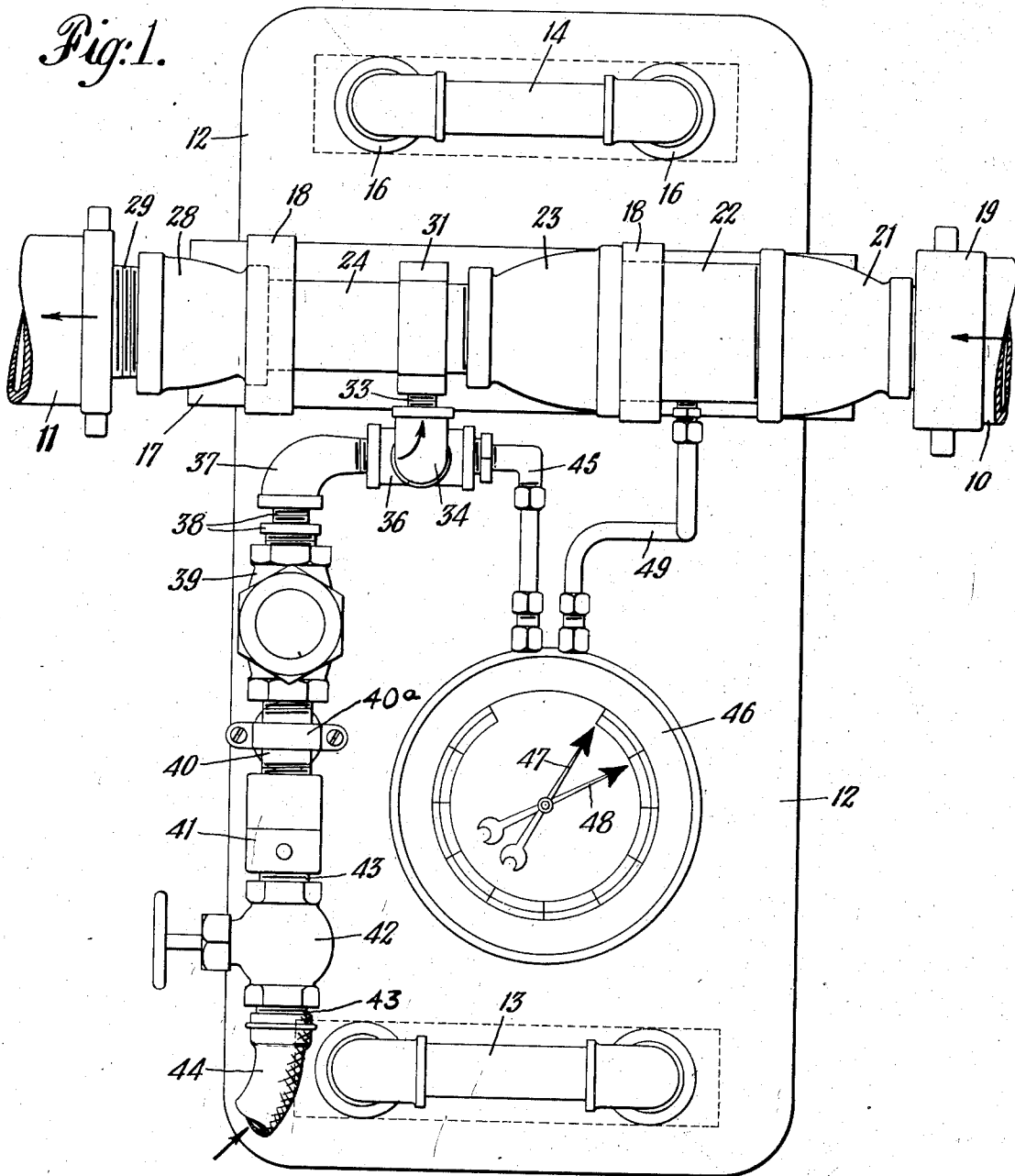
2,356,286

METHOD OF AND APPARATUS FOR PROPORTIONING LIQUIDS

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Fig. 1.



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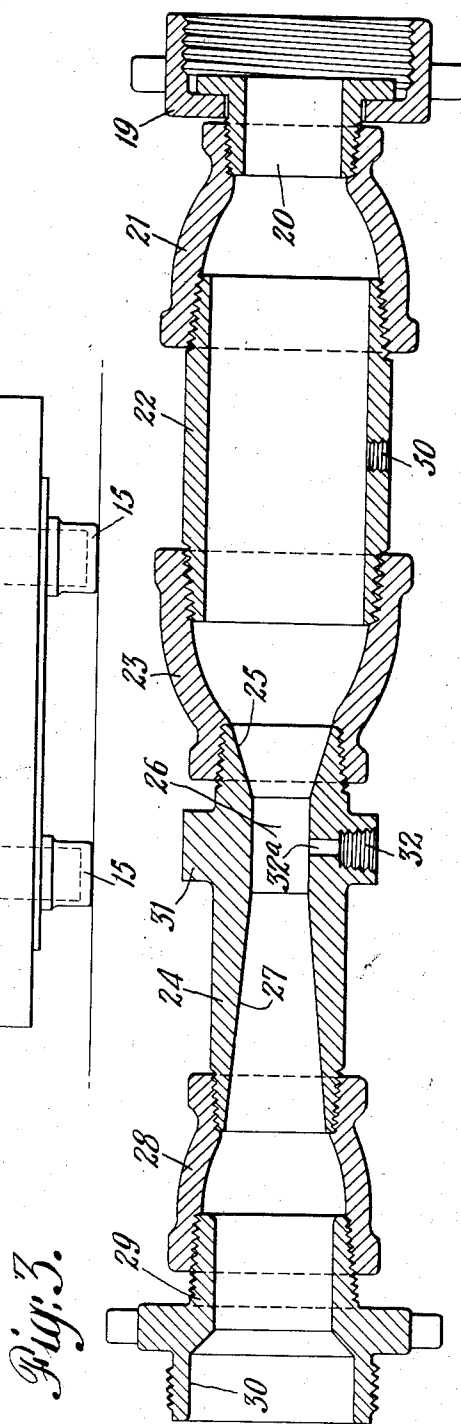
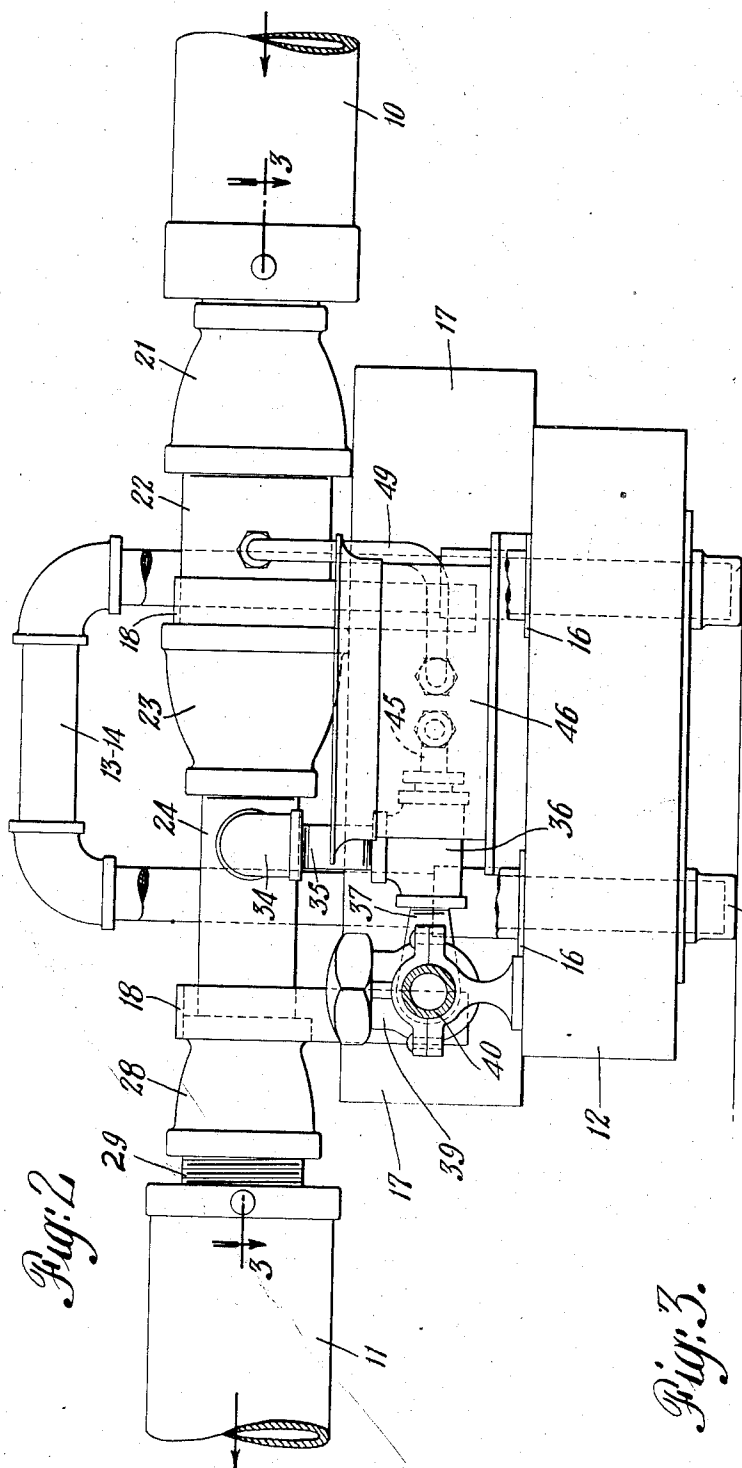
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2 Sheets-Sheet 2



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METHOD OF AND APPARATUS FOR PROPORTIONING LIQUIDS

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13 Claims. (Cl. 299-83)

This invention relates to a method of and apparatus for bringing together or intermingling in correct proportions two liquids from separate sources, under pressure, and for delivering the mixture of the two liquids under pressure to a point of use. It relates particularly to the introduction of a foam stabilizing solution in desired proportions into a stream of water, the mixture to be used in the production of fire extinguishing foam by the subsequent incorporation therein of air or other gas.

Many problems are presented in attempting to produce a substantially uniform mixture of water and foam stabilizing solution for delivery under high pressure to suitable foam-producing equipment which in turn is capable of delivering the foam under pressure to the seat of a fire. The available line pressure in the water mains at a certain point is subject to considerable fluctuation and the volume of water utilized in any given period likewise varies widely. Thus, it frequently happens that additional hose lines and play pipes connected with a particular main are put into use in the course of fighting a fire, or certain lines may be cut out of use, with resultant changes in available pressure. So also, the discharge nozzle for a particular play pipe may be adjusted in the course of use to vary the volume of water or foam being discharged through it. It is difficult, under these conditions, to insure the introduction into the water of just the right amount of foam stabilizer at all times.

For most efficient and effective use of a foam stabilizing solution, it is important to maintain a predetermined proportioning of it to the water into which it is introduced. Regular, commercial foam stabilizing solutions should ordinarily be added to the extent of about 5% of the water, by volume. If a greater proportion is added, there is unnecessary wastage of the stabilizer, while if less is added, a good stable foam is not likely to be produced. Some small variation in the exact proportions used is, of course, permissible without serious harm but the departure from the optimum percentage of foam stabilizer should not be great.

Heretofore various schemes or arrangements have been suggested for insuring the correct proportioning of foam stabilizer to water but these have all been subject to various limitations. Some have been restricted to batch operations of relatively small units, relying upon water and foam stabilizer stored in tanks; others relying upon water under line pressure have utilized an excessive amount of the pressure to bring about

aspiration of the foam stabilizer with the result that insufficient pressure has remained to deliver the mixture any substantial distance to the seat of the fire. Certain of the prior schemes have required location of the pumping or other pressure-creating means in the neighborhood of the fire while others have required a reservoir for the foam solution in close proximity to the nozzle in which the mixture is produced. Various other limitations have also existed in proportioning schemes previously suggested.

A primary object of the present invention has been to provide a simple but effective method and means for insuring the proper proportioning of foam stabilizer to water in a fire foam producing system in which the water and stabilizer are both available under substantial pressure and in which the proportioning and mixing may take place at any convenient point, remote from the sources of both the water and stabilizing solution and from the point of use of the mixture. The arrangement is such that a substantially uniform mixture may be maintained with a minimum of effort and without requiring any special experience or the exercise of any great amount of care or thought. This is of considerable importance since there is usually a great amount of chaos and confusion at the time the foam is being produced to extinguish a fire.

Another object of the invention has been to provide a mixing unit for water and foam stabilizer, which is of portable character, which may be inserted at any convenient point in a line, as at the coupling between two sections of hose, and which may be readily regulated and controlled at said point, in the manner indicated.

Other objects and advantages of the invention will appear from a detailed description of an illustrative form of the same which will now be given in conjunction with the accompanying drawings, in which:

Fig. 1 is a plan view of a portable proportioning unit constructed and adapted to be used in accordance with the invention;

Fig. 2 is an end elevation of the improved unit, and

Fig. 3 is an enlarged cross sectional view through the main conduit of the unit, taken along the line 3-3 of Fig. 2.

The improved proportioner unit is adapted for insertion at any convenient point in a pipe-line or hose-line forming part of the fire extinguishing system for any property or locality. The inlet side of the unit may be connected, for example, with one section of a pipe or hose-line

10 extending from a hydrant or any suitable outlet from a water-main. To the discharge side of the unit there may be connected another section 11 of pipe or hose which is adapted to deliver the mixture of water and foam stabilizer, produced within the unit, to the point of use of the foam. At the discharge end of the hose-line 11 there may suitably be provided a nozzle construction of any of the types illustrated in my pending application Ser. No. 417,220, filed on October 31, 1941, or in my prior Patents No. 2,057,218, granted October 13, 1936, and No. 2,146,605, granted February 7, 1939. Any other suitable means may be employed for introducing the air or other gas into the mixture of water and foam stabilizer to produce the desired foam. To insert the improved proportioning unit in the hose-line 10, 11, it is simply necessary to uncouple the two sections 10 and 11 of the hose and to insert the unit between the free ends of the sections. It will be understood that for the protection of a large area, such as that occupied by an oil refinery, a number of pipe-lines or hose-lines 10, 11 may extend from the same water-main or hydrant to a plurality of different points and each of these lines may have inserted between two of its sections one of the improved units.

Turning now to the construction of the unit, it may suitably be provided with a base 12, preferably in the form of a wood block of appropriate dimensions and having at its opposite ends a pair of handles 13 and 14. Each handle may simply be formed of sections of pipe connected together by elbows, as indicated, to form a U-shaped member. The free ends of the U-shaped member may be passed through suitable holes formed in the wood block and they may be threaded to receive screw-threaded, retaining caps 15. The latter are preferably so formed as to provide spikes or projections adapted for engagement with cinders or soft earth to insure the stability of the unit during operation. Above the upper surface of the block 12 each branch of the U-shaped handle may be provided with a flange or projection 16 suitably secured to the pipe. The block may be clamped between these flanges and the cap members 15. As indicated in Fig. 2, the handles preferably extend upwardly to a point above the other devices mounted on the block so as to facilitate their use and at the same time afford protection for the other devices which will be described.

Adjacent one end of the block 12 there is secured a transversely extending block 17 which carries a pair of straps 18 for holding down the conduit means adapted to be inserted between the hose sections 10 and 11. This conduit means may suitably comprise a union having a coupling element 19 adapted to be connected with the threaded end of the hose section 10. A nipple 20 of reduced diameter, forming part of the union, is connected with an expansion coupling 21. The large end of the expansion coupling is connected by a nipple or pipe section 22 with a reducing coupling 23, which is in turn connected with one end of a Venturi tube 24. At that end of the latter connected with the coupling 23, the inner surface 25 is tapered inwardly to form an extension of the inner surface of the coupling and to gradually reduce the interior diameter of the conduit to the desired extent at the throat portion 26 of the Venturi tube. Beyond this throat section the inner wall 27 of the tube is flared outwardly along a gradual taper, as indicated in Fig.

3. The opposite end of the Venturi tube is connected with an expansion coupling 28, which is in turn connected with the smaller end 29 of a male expansion coupling. At its larger end 30 this male coupling is adapted to receive the coupling element of the hose 11.

In the region of the throat 26 of the Venturi tube the latter is provided with an enlarged flange or projection 31 having a threaded recess 32, in its outer surface, connected through a small passageway 32a with the interior of the tube and adapted to receive a small nipple 33. The latter is connected with an elbow 34 and a small pipe section 35 with a T-member 36. One of the branches of the latter is connected by an elbow 37 and fittings 38 with a check valve 39. The opposite side of the latter is connected by a nipple or pipe section 40 and a union 41 with a suitable source of supply of the foam stabilizer. A pedestal clamp 40a, surrounding the nipple 40, serves to retain the latter and the adjoining parts in proper position on the base. The stabilizer solution is adapted to be delivered, to the connections indicated, under pressure which is subject to regulation or variation at will. This may be accomplished by control of a suitable pump or by the regulation or adjustment of a pressure-reducing valve 42 connected by means of nipples 43 with the union 41 and with a hose 44 through which the foam stabilizer solution is delivered from its source of supply.

The other branch of the T-member 36 is connected by a line 45 with one side of a duplex pressure gauge 46. This gauge may be of any suitable, known construction which is such that two separate pressures may be indicated by two separate hands 47 and 48. The pressure at the T 36 may, for example, be indicated by the hand 47 while the pressure in the large diameter section 22 of the conduit may be indicated by the hand 48. For this purpose, the second pressure-responsive element of the gauge may be connected by a line 49 with a threaded opening 50 through the wall of the section 22.

In the normal operation of the apparatus, water from the main or a fire hydrant is allowed to flow continuously through the conduit inserted between the sections 10 and 11 of the hose. This water may, for example, be under a pressure of 100 lbs./sq. in. at the section 22. However, due to the increased velocity at the throat of the Venturi tube during operation of the equipment, the pressure at this point will be reduced to an extent depending upon the rate of flow. If the flow is at the rate of 100 gallons per minute, the pressure differential between the two points will be about 15 lbs./sq. in. Now, if the pressure of the foam stabilizer at the T 36 is so maintained, by regulation of the valve 42 or the like, as to substantially equal the pressure in the section 22, it will be clear that under the conditions mentioned a 15-lb. differential will exist for the introduction of the foam stabilizer through the restricted passage 32a. By appropriate correlation of the interior diameters of the section 22, throat 26, and passage 32a, correct proportioning of the foam stabilizer to the water may be maintained, under substantially all conditions, likely to be encountered in the operation of a given unit, by simply keeping the indicator hands 47 and 48 of the gauge 46 in approximate coincidence. Thus, an attendant may simply observe the gauge and then regulate the pressure of the foam stabilizer, by adjustment of the valve 42 or the like, to follow the fluctuations in pressure in the section

22. No reference to a chart is necessary to determine what pressure should be maintained on the foam stabilizer to correspond with a given water pressure and rate of flow.

Assuming that the volume of water flowing through the conduit remains substantially the same throughout minor fluctuation of the pressure in the section 22, there will be maintained substantially the same differential between the pressure at the throat 26 and the pressure of the foam stabilizer at the T 36. However, if any substantial change in the volume of flow occurs, either as a result of a change in the pressure of the water in the section 22 or due to manipulation of the play nozzle at the end of the hose-line 11, this variation in flow will be immediately reflected in the pressure differential between the section 22 and throat 26. The relation between flow and pressure differential is indicated by the following data: It has been found that for a pressure of 100 lbs./sq. in. in the section 22, there will be a pressure of 90 lbs./sq. in. at the throat 26 if only 60 gals. per min. are passing through the conduit. The pressure at the throat 26 will drop to about 85 lbs./sq. in. when the rate of flow is increased to 100 gals. per min. and it will drop to about 80 lbs./sq. in. when the rate of flow is 140 gals. per min. and to about 75 lbs./sq. in. when the flow is at the rate of 180 gals. per min. It will be seen, therefore, that as the volume of flow increases, the pressure differential under which the foam stabilizer will be introduced correspondingly increases so as to maintain substantially constant proportioning of the stabilizer to water. If the pressure in the main should vary substantially while the volume of flow remains the same, there would be a change in the pressure drop at the throat 26, i. e. for higher pressures the drop would be greater. But in normal operation, any change in the water pressure in the main will result in a corresponding change in the volume of flow and, therefore, correct proportioning will be maintained.

It will be understood that each unit constructed in accordance with the invention will be so dimensioned, particularly with respect to the interior diameters of the section 22, throat 26 and passage 32a as to insure the introduction of the correct amount of foam stabilizer at a particular normal water pressure. Assuming that it is desired to introduce 5% of foam stabilizer solution into the water, the dimensions indicated will have one relation when the normal water-line pressure is 100 lbs./sq. in. and will have another relation when the normal water-line pressure is, say, 75 lbs./sq. in. or 150 lbs./sq. in. Within reasonable limits of variation from the normal pressure, only slight deviation from the correct proportioning will result from the operation of a particular unit.

As a typical example, it has been found that for a water-line pressure of about 100 lbs./sq. in., the interior diameter of the section 22 should be about $2\frac{1}{2}$ " while the diameter of the throat 26 should be about $\frac{7}{8}$ " and the diameter of the passage 32a should be about $\frac{3}{8}$ ". Thus, the throat has between one-eighth and one-ninth the cross-sectional area of section 22 while passage 32a has about one-tenth the cross-sectional area of the throat 26.

The provision of a large increase in velocity of flow through the throat 26, by having this less than one-fifth and preferably about one-eighth the cross-sectional area of the section 22, insures a substantial pressure drop at the throat and

hence a relatively high head for the introduction of the foam stabilizer. This allows for a substantial, sudden variation in the water-line pressure without danger of causing a reverse flow of water through the passage 32a into the foam stabilizer line. However, if the water-pressure should suddenly increase to a point at which such reverse flow would occur, the check valve 39 would operate to prevent the flow of the water into the foam stabilizer line 44.

It is not essential that a Venturi construction be employed in the conduit inserted between the hose-lines 10 and 11. If desired, an abrupt change in dimension, or a series of shoulders, might be provided at some point between the section 22 and the passage 26 at which the foam stabilizer is introduced. It is primarily important to provide a substantial difference in the velocity of flow at these two points, as above indicated. However, the Venturi construction illustrated in Fig. 3 is the preferred way of accomplishing the result since it does so with the highest efficiency. There is, naturally, some loss in pressure between the inlet and outlet ends of the complete conduit but with the Venturi construction illustrated, the loss in pressure from the hose section 10 to the hose section 11 is not more than about 5%. With other types of construction a substantially greater loss may be encountered.

While an illustrative form of the invention has been described in considerable detail, it will be understood that numerous changes may be made in the construction and arrangement of the various parts of the apparatus and in the mode of operating the same without departing from the general principles and scope of the invention.

I claim:

1. A method of introducing a predetermined proportion of foam stabilizer under variable pressure into a flowing stream of water under pressure which comprises causing the water to flow at greatly increased velocity through a limited space, introducing foam stabilizer under pressure into the water within said limited space, and adjusting the pressure of the foam stabilizer to maintain the same substantially equal to that of the water in advance of said limited space.

2. A method of introducing a predetermined proportion of foam stabilizer under variable pressure into a flowing stream of water under pressure which comprises causing the water to flow at a relatively low velocity through one zone and a relatively high velocity through another zone, introducing foam stabilizer under pressure into the water in the high velocity zone, determining the pressure of the water in the low velocity zone and of the stabilizer at a point in advance of its introduction into the water, and maintaining said pressures substantially equal.

3. In apparatus of the class described a conduit having a portion of reduced cross-sectional area intermediate its ends, means for introducing a liquid into said conduit at one end, means for introducing a second liquid into said conduit at said portion of reduced cross-section, and manually adjustable means for varying the pressure of said second liquid adjacent its point of introduction into said portion of reduced cross-section.

4. In apparatus of the class described a conduit having a portion of reduced cross-sectional area intermediate its ends, means for introducing a liquid into said conduit at one end, means for introducing a second liquid into said conduit

at said portion of reduced cross-section, means for separately indicating the pressures of the two liquids at points adjacent but slightly removed from said portion of reduced cross-sectional area, and manually adjustable means for varying the pressure of said second liquid adjacent its point of introduction into said portion of reduced cross-section.

5. In apparatus of the class described a conduit having a Venturi section intermediate its ends, means for introducing a liquid into said conduit at one end, means for introducing a second liquid into said conduit at the throat of said Venturi section, and manually adjustable means for varying the pressure of said second liquid adjacent its point of introduction into the throat of said Venturi section.

6. A portable unit for proportioning two liquids brought together under pressure which comprises a conduit having a section of relatively small cross-sectional area and a section of substantially greater cross-sectional area, means for connecting said conduit into a line carrying one of said liquids under pressure, means for delivering the other of said liquids under pressure and introducing the same into said conduit at said section of relatively small cross-sectional area, means for regulating the pressure of said other liquid, and pressure gauging means for indicating the pressure of said one liquid at said section of greater cross-sectional area and for indicating the pressure of said other liquid at a point adjacent its point of introduction into said conduit.

7. A portable unit for proportioning two liquids brought together under pressure which comprises a conduit having a section of relatively small cross-sectional area and a section of substantially greater cross-sectional area, means for connecting said conduit into a line carrying one of said liquids under pressure, means for delivering the other of said liquids under pressure and introducing the same into said conduit at said section of relatively small cross-sectional area, means for regulating the pressure of said other liquid, and pressure gauging means having a plurality of juxtaposed indicators for indicating the pressure of said one liquid at said section of greater cross-sectional area and for indicating the pressure of said other liquid at a point adjacent its point of introduction into said conduit.

8. A portable unit for proportioning two liquids brought together under pressure which comprises a conduit having a portion of Venturi form, means for connecting said conduit into a line carrying one of said liquids under pressure, means for delivering the other of said liquids under pressure and introducing the same into said conduit at the throat of said portion of Venturi form, means for regulating the pressure of said other liquid, and pressure gauging means for indicating the pressure of said one liquid at the point of greatest diameter of said portion of Venturi form and for indicating the pressure of said other liquid at a point adjacent its point of introduction into said conduit.

9. A portable unit for introducing a foam stabilizing solution in desired proportion into a stream of water under pressure for the purpose of introducing fire extinguishing foam which comprises, a base, a conduit mounted on said base and having a section of relatively small cross-sectional area and a section having a cross-sectional area at least five times as great as that of the first mentioned section, means for con-

necting said conduit into a high pressure water line, means for delivering a foam stabilizing solution under pressure and introducing the same into said conduit at said section of relatively small cross-sectional area, means for regulating the pressure of said solution, and means on said base for indicating in juxtaposed relation the pressure of the water at said section of relatively large cross-section and the pressure of said solution at a point adjacent its point of introduction into said conduit.

10. A portable unit for introducing a foam stabilizing solution in desired proportion into a stream of water under pressure for the purpose of producing fire extinguishing foam which comprises, a base, a conduit mounted on said base and having a section of relatively small cross-sectional area and a section having a cross-sectional area at least five times as great as that of the first mentioned section, means for connecting said conduit into a high pressure water line, means for delivering a foam stabilizing solution under pressure and introducing the same into said conduit at said section of relatively small cross-sectional area, said delivery means including a restricted passage having less than one-fifth the cross-sectional area of said section of relatively small area, means for regulating the pressure of said solution, and means on said base for indicating in juxtaposed relation the pressure of the water at said section of relatively large cross section and the pressure of said solution at a point adjacent its point of introduction into said conduit.

11. A method of utilizing a conduit having a portion of relatively large cross-section and a following portion of reduced cross-section for bringing together two liquids under independent pressure in predetermined proportions which comprises flowing one of the liquids first through said portion of relatively large cross-section at comparatively low velocity and high pressure and then through said portion of reduced cross-section at higher velocity and lower pressure, introducing the other of said liquids into said conduit at said portion of reduced cross-section, and varying the pressure of said other liquid adjacent its point of introduction to substantially coincide with the pressure of said one of the liquids in said portion of relatively large cross-section in advance of said portion of reduced cross-section.

12. A method of utilizing a conduit having a portion of relatively large cross-section and a following portion of reduced cross-section for bringing together two liquids under independent pressure in predetermined proportions which comprises flowing one of the liquids first through said portion of relatively large cross-section at comparatively low velocity and high pressure and then through said portion of reduced cross-section at higher velocity and lower pressure, introducing the other of said liquids into said conduit at said portion of reduced cross-section, restricting the flow of said other of said liquids in accordance with the desired proportioning of said liquids, and varying the pressure of said other liquid adjacent its point of introduction to substantially coincide with the pressure of said one of the liquids in said portion of relatively large cross-section in advance of said portion of reduced cross-section.

13. A method of utilizing a conduit having a portion of relatively large cross-section and a following portion of reduced cross-section for

bringing together two liquids under independent pressure in predetermined proportions, the conduit having an orifice leading into the same at said portion of reduced cross-section whose area in relation to the area of said reduced cross-section is greater and in relation to the area of said relatively large cross-section is smaller than the desired ratio of the liquid of lesser volume to the liquid of greater volume, which method comprises flowing one of the liquids first through said portion of relatively large cross-section at comparatively low velocity and high pressure and

then through said portion of reduced cross-section at higher velocity and lower pressure, introducing the other of said liquids into said conduit at said portion of reduced cross-section, and varying the pressure of said other liquid adjacent its point of introduction to substantially coincide with the pressure of said one of the liquids in said portion of relatively large cross-section in advance of said portion of reduced cross-section.

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