Dec. 4, 1951 H. G. FREEMAN 2,577,457

LIQUID MIXING APPARATUS

Filed Oct. 6, 1948

Fig. 1

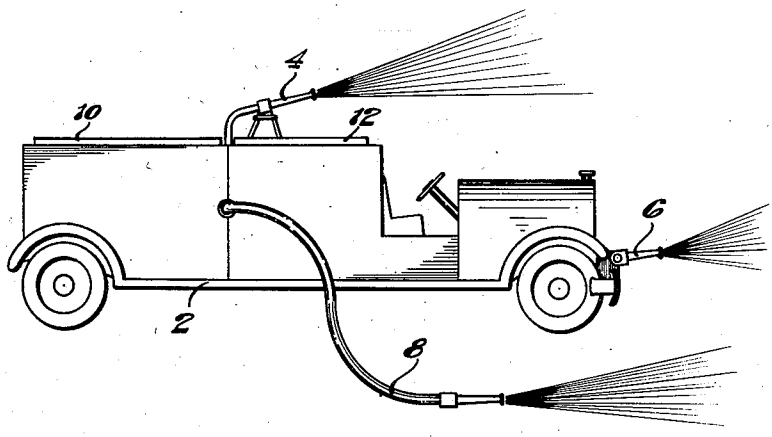


Fig. 2

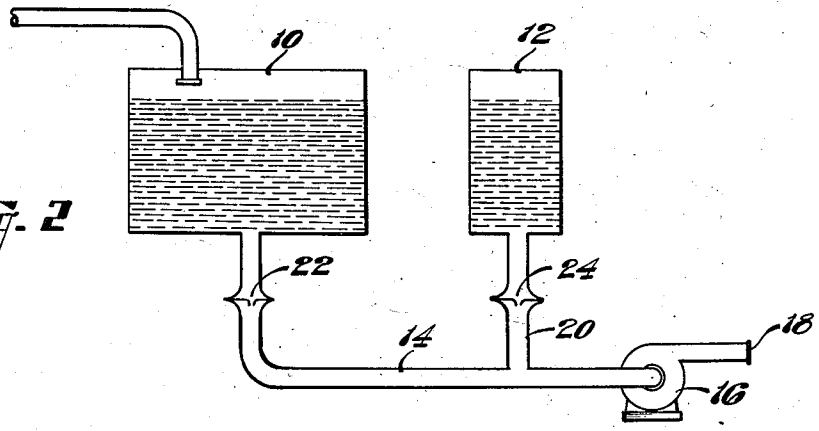
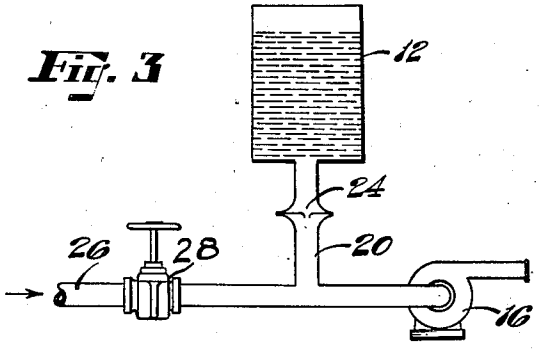


Fig. 3



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LIQUID MIXING APPARATUS

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1 Claim. (Cl. 169—15)

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The present invention relates to liquid mixing apparatus and more particularly to apparatus for proportioning the mixture of two or more liquids and maintaining the proportions substantially uniform under variable flow conditions.

An example of apparatus for proportioning liquids is in the foam equipment for fire fighting. In the portable foam equipment, as in crash trucks for airports, the water and the foam liquid are carried in separate tanks and are mixed at the time the foam is to be thrown on the fire. The truck may carry several hand lines and nozzles, some or all of which may be placed in use at one time. The usual proportioner is what is termed an "across-the-pump" proportioner consisting of a venturi connected between the inlet and discharge of the pump. The venturi is connected with the foam liquid source whereby the foam liquid is drawn into the venturi and discharged into the main stream. One of the disadvantages of this system is that the pressure between the inlet and discharge of the pump is virtually constant, so that a constant flow of foam liquid occurs, in spite of the fact that the volume of water varies in accordance with the number of lines or fire nozzles in operation.

The object of the present invention is to provide simple and effective means for maintaining the proportions of water and foam liquid (or other mixtures of liquids) constant and independent of quantity and pressure of discharge.

To this end the invention comprises liquid mixing apparatus having two sources of liquid which are maintained under equal or nearly equal pressures, together with connections including metering devices which are of relative sizes to determine the desired proportions of the liquids. In the case of portable equipment the two sources preferably comprise tanks which are of such relative sizes that the head of liquid remains the same for both sources as the liquid levels fall. When one or both of the sources consists of supply mains under pressure, suitable arrangements are made for maintenance of substantially uniform pressures on the liquids.

In the accompanying drawings Fig. 1 is a diagram of a portable fire extinguishing unit to which the present invention is applied; Fig. 2 is a diagram of the proportioning system according to the present invention; and Fig. 3 is a diagram of a modified system.

The illustrated embodiment of the invention comprises apparatus for use in a portable truck. The truck is diagrammatically indicated at 2 and may be provided with a suitable fixed nozzle 4,

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a bumper nozzle 6, and several hand lines one of which is indicated at 8. Mounted on the truck are tanks 10 and 12, the tank 10 containing water and the tank 12 containing foam liquid.

A diagram of the proportioning apparatus is given in Fig. 2. The water tank 10 is connected through a pipe 14 with the inlet of a pump 16 having a discharge connection 18, the latter being adapted for connection to the various units 4, 6, 8, etc. shown in Fig. 1. Similarly, the tank 12 is connected through a pipe 20 with the inlet of the pump.

The pipes 14 and 20 are provided with suitable metering devices, indicated as an orifice 22 for the pipe 14 and an orifice 24 for the pipe 20. The orifices are of such size as to maintain the proper desired proportion of liquids. The orifices may if desired be formed simply as holes in a diaphragm but are preferably smoothly curved as indicated in Fig. 2 whereby their contraction coefficients will be practically equal to one, in that efficient flow conditions may be maintained.

The quantity of discharge through an orifice is given by the following formula:

$$Q=cA\sqrt{2gh}$$

where

A=area of orifice.

h=total head of liquid due both to liquid level and to the head produced by the pump.

c=the orifice coefficient.

It will be seen that if for the two sources 10 and 12, the heights of liquid in the tanks are nearly equal, the relative quantities will depend only on the areas of the orifices and will remain substantially constant, regardless of the number of nozzles in service or the fall in liquid levels as the liquids are used. For example, if the desired proportions are 6% foam liquid to 94% water, the orifice areas are in the proportion of 6 to 94.

Since the factor h in the above formula depends on the height of liquid as well as on the pump pressure, the tanks are preferably so proportioned that as the liquid is used up the height of liquid remains constant for both tanks. Accordingly, in the example given, the area of the tank 12 is preferably about six percent of the area of the tank 10. Actually, since the head due to height of liquids is usually small compared to the head produced by the pump, it is not essential to maintain this exact relation of tank areas, since variations in liquid level will be small except at low capacities.

The apparatus may also be used with connection to water mains as indicated in Fig. 3. Un-

der such conditions the pressure existing in the water main 26 is considerably greater than that in the tank 12 in which the foam liquid is stored. Accordingly, the water from the mains may be used to fill the tank 10 in which case suitable means (not shown) may be provided to maintain the liquid level in the tank 10 substantially equal to that in the tank 12 or, if the pump is operated at fairly high pressure, the variation in liquid level may be neglected. On the other hand, a direct connection may be made from the water main as indicated in Fig. 3. A suitable throttling device 28 is introduced to bring the pressure down to substantially the pressure available on a foam liquid. Since the throttling device wastes pressure substantially in accordance with the rate of flow, the device 28 is preferably in the form of an adjustable valve whereby it may be closed off more tightly at low rates of discharge and opened wider at higher discharges. These modifications are used for stationary systems.

It will be understood that the variations in quantity of liquid under changes of pressure are not such as to require an absolute or precise equalizing of pressure. The quantity is proportional to the square root of the pressure across the orifice. Hence substantial variations in pressure may be acceptable without seriously affecting the proportions of liquids. It is, however, desirable to maintain reasonable equality of pressure in order that the foam liquid may be introduced into the water at substantially its optimum proportions regardless of the amount of liquid being discharged at any time.

Having thus described my invention, I claim:

Portable fire extinguishing apparatus comprising a liquid discharge line, a pump in said line, and means both for supplying a plurality of liquids to said line and for maintaining the said liquids in substantially uniform proportions comprising a plurality of tanks each having a uniform cross-sectional area from top to bottom, the tanks being of cross-sections proportional to the desired proportion of fluids, connections from the tanks to the line on the inlet side of the pump, and orifice plates in the said connections, the orifice plates having orifices of sizes likewise proportional to the desired proportion of fluids, whereby operation of the pump to discharge liquid from the said line will draw proportionate amounts from the tanks regardless of rate of flow through the line or available head in the tanks after once starting with the head in the tanks substantially the same.

HOWARD G. FREEMAN.

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