March 11, 1958 L. G. A. ERIKSSON 2,826,399

FOAM SPRINKLER

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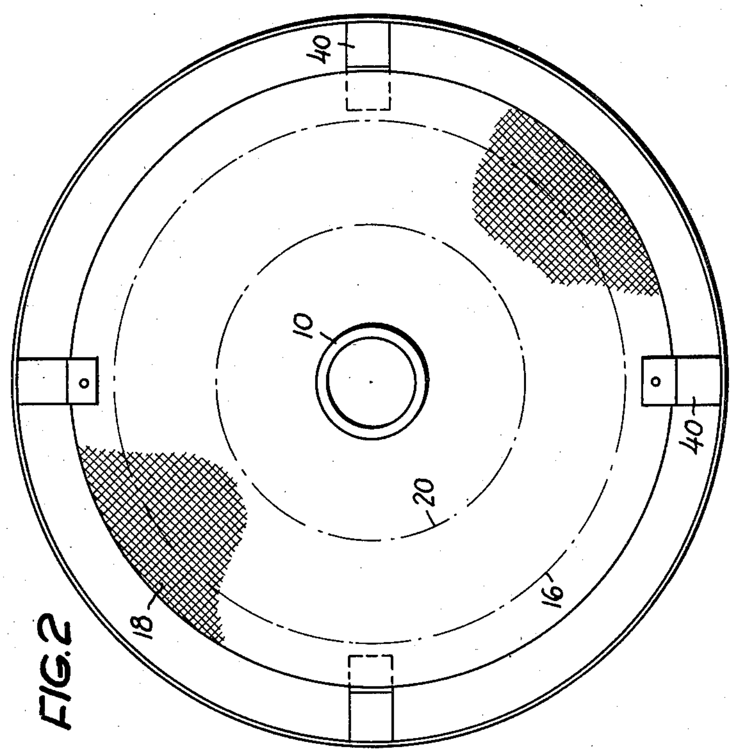

FIG. 2

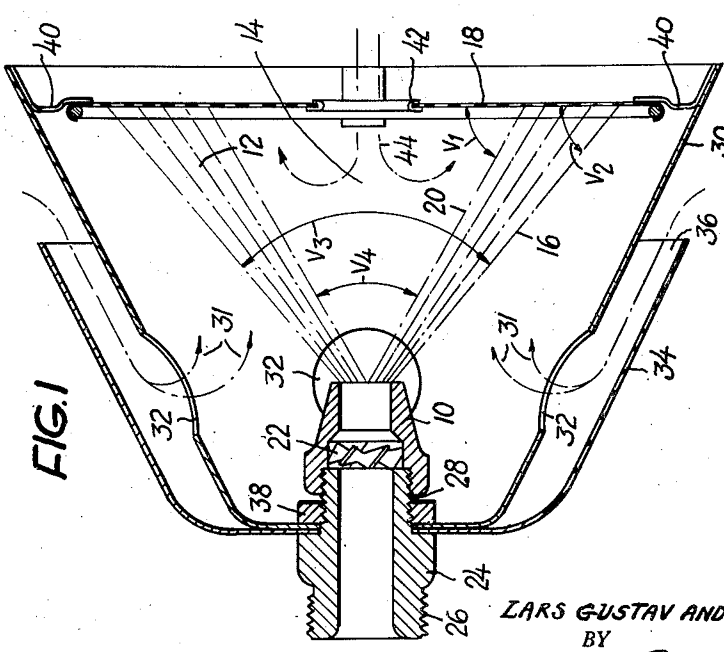

FIG. 1

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FIG.3

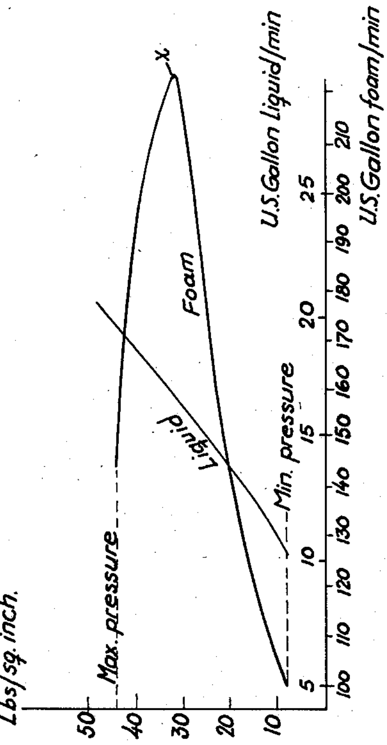
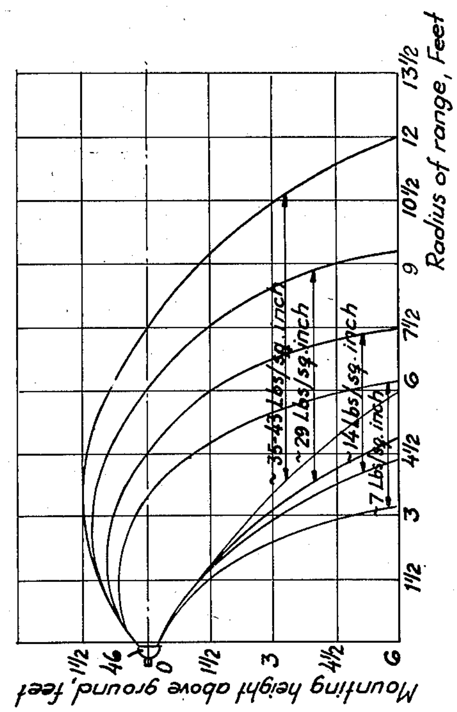


FIG.5



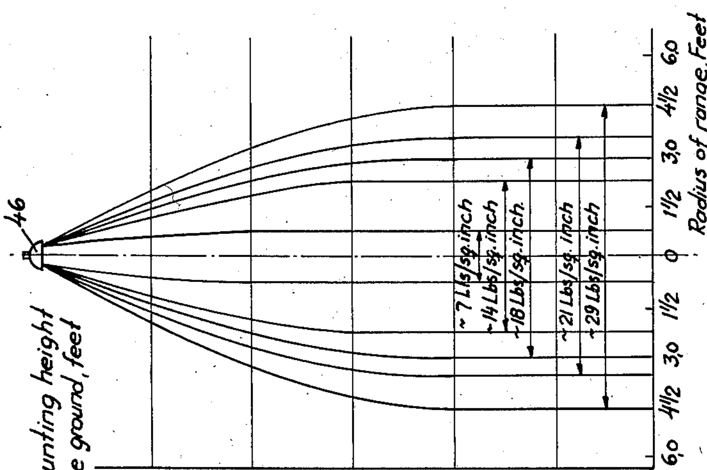


FIG.4

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FOAM SPRINKLER

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Application July 7, 1955, Serial No. 520,581

1 Claim. (Cl. 261—76)

This application is a continuation in part replacing my copending application Serial No. 225.887, filed May 11, 1951, now abandoned, and, as to all common subject matter relates back to application Serial No. 225,887, and to foreign applications corresponding thereto for all dates and rights incident to the filing thereof.

In carrying out my original method I employed an atomizing nozzle for spraying a foam generating liquid against a perforate contrivance such as a wire net or screen to form liquid films in the perforations of said contrivance, while maintaining a low pressure of the order 0.5–3.0 kilograms per square centimeter in the liquid in said member, and forcing a flow of air against the contrivance to expand the liquid fibres and to form bubbles thereof filled with air. Though the atomizing nozzle could be used under certain conditions it proved inadequate from other points of view. Thus, the size of the liquid drops became so small and so little energy-carrying that their velocity when striking against the net was unsatisfactory. Furthermore, the small dimensions of the drops resulted in that too great a proportion of them could pass through the openings of the net without forming the necessary liquid films, particularly so because the impact of the drops took place at right angles to the surface of the net.

The entirely filled and very wide jet cone issued from the original nozzle brought about disturbing and uncontrolled air currents, which reduced the possible quantity of bubbles forming still more.

The main object of the present invention is to improve the method and the apparatus to obtain a more efficient foam generation.

A particular object is to obtain a suitable nozzle for spraying the foam liquid against the perforate contrivance, said nozzle being able to direct substantially all liquid drops of the spray obliquely toward the contrivance.

A further object is to find a suitable range of pressure in the liquid nozzle, within which there is an optimum for the foam generation. The liquid film generation in the perforate contrivance has proved dependent upon the velocity at which the liquid droplets approach the contrivance, and this velocity in turn depends upon the pressure in the nozzle. Thus, it is an object of the invention to find the pressure yielding the most favourable foam generation.

Still further objects of the invention will appear from the following description of an embodiment of the invention, reference being had to the accompanying drawings, in which

Fig. 1 is an axial section of an apparatus of the foam sprinkler type, embodying the invention,

Fig. 2 is a front view of the apparatus illustrated in Fig. 1,

Fig. 3 is a graph illustrating the relation between the foam generation and liquid consumption of an apparatus according to Figs. 1 and 2 on one hand and the pressure in the nozzle on the other hand.

Fig. 4 is a graph illustrating the range covered by a sprinkler mounted with vertical axis, and

Fig. 5 is a graph similar to that shown in Fig. 4 but illustrating a horizontal sprinkler.

The design of the nozzle is of particular importance, and in the most advantageous form the nozzle should deliver a spray or jet in which all liquid particles are directed obliquely toward the net or screen. This has been accomplished in the embodiment shown in Figs. 1–2 by a nozzle 10, from which the liquid is ejected like a conical spray 12, as indicated with chain-dotted lines in Fig. 1, said spray having a central cavity 14 substantially free from liquid drops. The outer conical boundary surface 16 of said spray, which is directed toward a net or screen 18, forms an angle v_1 of about 45–55° with said net or screen, and the inner boundary surface 20 forms an angle v_2 of about 55–65°. In a preferred embodiment yielding the most efficient foam generation the angles v_1, v_2 between said boundary surfaces 16, 20 and the screen 18 is 50° and 60°, respectively. The apex angle v_3 of the outer cone may be 75–85°, preferably 80°, and that v_4 of the inner cone 55–65°, preferably 60° as indicated in Fig. 1.

The spray with the central cavity can be obtained by an open nozzle with a preferably stationary "propeller" 22 which acts as a turbulence whirler. The "propeller" 22 may have, for example, six equidistant blades, whereby the spray will have six sections, in the central portions of which passes an increased quantity of liquid. Through this division into sections the size of the drops may be increased to the required extent, so that they will still have the desired energy contents when striking against the net while also bringing air along with them at a controlled flow.

The use of the non-filled spray or shower jet also brings the advantage that the net or wire screen 18 can be made entirely plane, whereby all of the liquid drops hit the net obliquely, such as at an angle of 60–50° and are thus forced to become flattened on the side of the net facing the nozzle and will thus form the desired liquid films.

By an alteration of the liquid nozzle and of the angle between the direction of flow and the net the losses through drops passing freely through the net have been eliminated almost entirely, as long as the pressure of the liquid in the nozzle is kept within certain limits.

It has been established, furthermore, that the yield of foam relatively to the liquid quantity supplied increases rapidly up to a liquid pressure of 30 lbs. per square inch, after which the yield again decreases just as rapidly. This circumstance depends on the fact that the liquid films formed are capable of enduring, up to this liquid pressure that increase of the air pressure which results from the increase of the velocity of the liquid drops as an increase to said pressure. At a further increase of the pressure, that is to say of the velocity of the drops, the air pressure becomes so great as to cause bursting of the liquid films without any films being formed, while the impact force of the drops also becomes so great that a proportion of their contents is shattered and thrown through the net, whereby the formation of films is also rendered more difficult or ceases.

Every increase of the pressure above 30 lbs. per square inch thus involves an increase of the consumption of energy and liquid but a rapid decrease of the yield of foam. For practical reasons the protection of the invention may thus be set to obtain within the pressure range of 7.1–30 lbs. per square inch.

The quantity of foam generated by a practical sprinkler according to the invention at various pressures in the nozzle is illustrated by Fig. 3, in which pressure in lbs. per square inch is scaled on the ordinate and the generated foam quantity in U. S. gallons per minute is scaled on the abscissa. The characteristic point x at which the foam curve "turns" is of particular interest. The pressure is 29.15/square inch, and the quantity of foam generated at this pressure is about 220 gallons per minute. The straight line designated "Liquid" shows the consumption of water and foam-generating liquid at the various pressures. A scale for this consumption is indicated on the abscissa.

Since the decrease in velocity of the drops is dependent on the distance between the nozzle and the net, a limitation of the pressure range will also involve a limitation of this distance, and practical experiments have shown that an advantageous distance falls within a range of approximately 2" to 3", and preferably amounts to 2.4".

The regularity of these circumstances also influences the selection as a type of perforate contrivance to be employed. Preferably, said contrivance consists of a wire screen, and the number of meshes therein and the thickness of the wires forming the screen is of a certain importance.

If the openings of the screen become too large, very great drops will be required to prevent them from passing through the screen without hitting the wires, that is to say, from causing losses of liquid. Furthermore, a considerable admixture of surface tension reducers, such as foam liquid to the water supplied to the nozzle is required to permit an expansion of liquid films of this magnitude. If the screen openings are too small, the liquid films first formed become so strong as to prevent the available air pressure from bulging them out into bubbles adapted to tie off the films.

Experiments have shown that a number of meshes of about 24–25 per 1" and a wire thickness of 0.4 millimetre give the best yield in the form of a prepared foam, which is also serviceable for fire extinguishing purposes.

In the art of fire extinction the ratio between the generated quantity of foam and the quantity of liquid contained in said foam is defined as the "foam number." Generally, one counts at present with foam numbers of 6–14. The upper limit for the attainment of a foam of such specific gravity that the foam is able to sink down toward the seat of fire against the rising hot gas currents is approximately 16.

If all desiderata relative to a good fire extinguishing foam are taken into consideration, the foam number should be 6–8 times the quantity of liquid.

From the annexed graph, Fig. 3, it will be seen that at a liquid pressure of 7.1 lbs./sq. inch, the formation of foam is 9.8 times the quantity of water, at 14 lbs./sq. inch 9.9, at 20 lbs./sq. inch 10.8, at 30 lbs./sq. inch 13.3, and at the "turning point" 29.15 lbs./sq. inch 13.9 times the quantity of liquid.

These values are within the acceptable limits, and the foam sprinklers according to the present invention are well adapted to the practical desiderata for a fire-extinguishing foam.

In addition to the regularity of the foam generation it is to be noted that the foam bubbles become 2.5–3 times larger in diameter than the openings of the screen, in which the liquid films are generated.

Since foam from a foam sprinkler according to the present invention is not formed by any whipping-in operation and an intense mixing as in normal apparatus for the production of foam for fire extinguishing purposes, for instance in foam nozzles according to the injector principle, foam fog nozzles with a high velocity turbulence according to Freemen or foam pumps according to Schroder and van Deurs or Ellehammer, but is formed on the principle of expanded and tied-off liquid films at very low pressures or velocities, this involves that the bubbles become large and thick-walled so that they will give off their water relatively rapidly.

A normal fire extinguishing foam according to modern principles gives off half of its liquid quantity during a time of up to 60 minutes, whereas foam from the foam sprinklers gives off half of its liquid quantity within a time of 10–15 minutes.

The large bubbles in the foam sprinkler foam and the rapid separation of the liquid act highly reducing on the heat constancy and gas density of the foam, but since the foam sprinkler requires only a low pressure and gives a large foam yield relatively to the quantity of liquid, every plant can be made for previously inconceivably large quantities of foam. The large quantity of foam which is supplied at the same time over the whole of the protected surface gives a rapid so-called shock extinction, whereby the normal demand for the life of the foam can be largely reduced.

Therefore, the foam sprinkler is preferably used in the form of a fixed installation for example in hangars, garages, and chemical-technical industries, where the fire risks are known and where the equipment can thus be adapted directly in the most suitable manner.

In the installation in practice, the foam sprinkler comprises an inlet tube **24** which may have screw threads **26**, **28** at both ends, one for the connection to a supply of water and foam-generating liquid under pressure and the other for the attachment of the nozzle **10** as shown in Fig. 1. Further, the tube **24** may carry a substantially conical frustum-shaped casing **30**, having lateral apertures **32** for the admission of air as indicated at **31**, and also a wind shield **34** surrounding the rear portion of the casing **30** but in laterally spaced relation thereto to form a passage for air. The casing **30** and wind shield **34** are held in place by a nut **38** screwed onto the fore end of the tube **24**. The screen **18** is carried by brackets **40** in the open front of the casing **30**, and it has a central aperture **42** forming a passage for air sucked thereinto by the spray **12** as indicated by the arrows **44**.

In operation, when liquid is supplied to the nozzle **10** at the suitable pressure, the flow of liquid is rotated by the impeller **22** whereby the liquid delivered by the nozzle will form a conical spray or jet with a central cavity as described hereinbefore. Air is entrained by said spray and additional air is continuously sucked into the casing through the lateral apertures **32** and through the central aperture **42**. The liquid droplets reaching the screen hit the wires thereof but are prevented from passing freely through the openings therebetween because their directions of flow are oblique to the plane of the screen. Thus, substantially the entire liquid contents are able to contribute to generation of liquid films over the openings of the screen. These films are expanded by the flow of air and form bubbles which are advanced from the screen as foam.

The foam sprinkler described above has a certain spreading effect on the foam ejected therefrom, and the area to be covered with foam depends upon the pressure in the nozzle. This is illustrated by Figs. 4 and 5 for a sprinkler **46** mounted vertically, for example under the roof of a hangar, or horizontally, respectively. The values are indicated in the graphs by way of example. The curves represent the boundary surfaces of the foam spray. The scale on the ordinate indicates the height at which the sprinkler is mounted above the area to be covered by foam.

In the embodiment described the screen is located at right angles to the axis of the nozzle but the invention also includes embodiments in which the screen is oblique to said axis.

What I claim is:

A foam sprinkler of the character described comprising a central bushing threaded at both ends; an outer frustum-shaped cone having a flat, closed top with a central hole, said cone being mounted with said central hole, upon the forward threaded part of said central bushing and with its open bell mouth away from same; an inner, similar, frustum-shaped cone having a flat top of smaller diameter than that of said first cone, but being considerably longer than same and having a plurality of lateral air intakes around its sides, said second cone being nested concentrically inside said first cone and having its bell mouth extend forward a distance beyond the open end of said first outer cone, said lateral air intakes in said inner cone being adapted to draw a strong stream of air rearwardly from the open bell mouth of said outer cone; a nut fastening said two cones together upon the forward threaded end of said central bushing; a flat circular screen having a large central aperture closing the forward bell mouth of said second cone; a whirler being placed concentrically upon the forward end of said central bushing, and a spray nozzle member having a nozzle mouth and a rearward integral nut capping said whirler and the forward end of said central bushing, said nozzle in cooperation with said whirler being adapted to produce a liquid spray of a hollow conical shape, whereby when said spray is being thrown against said flat circular screen it mixes both with the

air drawn rearwardly through said large central aperture in said screen and with the strong stream of air drawn through said lateral apertures in said inner cone, whereby a larger amount of air is mixed with said liquid and a larger amount of foam is produced.

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