METHOD AND APPARATUS FOR GENERATING FIRE-FIGHTING FOAM

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7 Claims

ABSTRACT OF THE DISCLOSURE

A fire protection method and apparatus for generating high expansion foam. The disclosed apparatus includes an elongated housing having an inlet and an outlet and a perforated member extending across its free passage area. A fan is positioned in the housing and drivenly rotated by impulse nozzles supplied with pressurized liquid foam solution. The nozzles are arranged to provide a relatively uniform wetting of the perforated means while driving the fan in a direction to provide air flow through the housing and against the perforated means at a pressure sufficient to produce high expansion foam bubbles on the downstream side of the perforated means.

This invention relates to fire protection apparatus and more particularly to a fire fighting foam generator for making foam characterized by having a very high air-to-liquid content known as high expansion foam.

This invention will be described with reference to a tubular foam generator having a fan, a readily wettable sieve downstream of the fan, and jet nozzles for dispersing a spray of liquid foam producing solution over the sieve. As air is forced by the fan through the sieve, bubbles of foam are continuously formed and move forwardly as a foam plug into the area to be protected. Obviously the invention has much broader application, however, and may also be used as a smoke or fume evaporator, ventilator or the like.

By high expansion foam as used hereinafter, the meaning is that the foam plug will contain from 50 to 1500 times more air by volume than it does liquid thus distinguishing it from foam generated by turbulent aeration, i.e., where baffles or rotors are employed to beat air and liquid foam solution into a turbulent foam formation.

Hercetofore high expansion foam generators have been operated with electrically powered fans. The employment of such equipment at a fire site is conditioned upon its ability to be moved to the most effective vantage point available to an electrical outlet. Moreover, in fixed installation the electrical wiring must pass certain rigid tests in order to receive an acceptable rating by regulatory and governmental agencies due to the built-in fire hazard of using electricity.

To overcome these and other disadvantages it has been proposed to power the fan hydraulically; and furthermore to power it by means of the same liquid foam solution used to wet the downstream sieve. In a co-pending United States patent application Ser. No. 362,596, filed Apr. 27, 1964, assigned to the assignee of the present invention, such an apparatus is described and claimed. The present invention is a refinement of the invention described in the aforesaid application.

In accordance with the present invention a fire protection apparatus comprises a tubular housing within which is located a fan. A perforated member or sieve covers the free passage area of the housing downstream of the fan. A plurality of jet nozzles attached to the fan and radially positioned relative to the fan axis are angularly directed and mounted so as to rotate therewith. Liquid foam solution under pressure is sprayed by the nozzles causing rotation of the fan in the direction opposite to that at which the nozzles point. The air velocity created by the fan carries the spray downstream against the perforated member for the production of high expansion foam.

In an embodiment of the invention, and particularly where the circumferential force acting on the liquid spray may tend to cause it to deposit largely at the peripheral regions of the perforated member, a second battery of nozzles is positioned radially inwardly of the rotatable nozzles so as to introduce a spray concentrated more along the fan axis and centrally of the perforated member.

As a further aspect of the invention, and especially where the length of the tubular housing is to be minimized, the rotatable nozzles are mounted generally in the plane of the fan are circumferentially positioned between the fan blades.

Further in accordance with the invention, the second battery of nozzles which provide a centrally directed spray when the centrifugal force is high may be eliminated entirely by inclining the rotatable nozzles downwardly toward the fan axis.

Accordingly, it is the main object of the invention to provide fire protection apparatus employing a jet powered fan.

Another object is to provide a high expansion foam generator in which a fan is powered by hydraulic reaction jets which also introduce a spray of foam solution into the air stream created by the fan for wetting a sieve downstream of the fan.

It is a further object of the invention to provide such a foam generator reduced in length so as to be more suitable for installation where space is a problem.

A still further object is to eliminate the safety hazards common to prior art electrically powered generators.

These and other objects and advantages will be more fully appreciated by reference to the following description and drawings wherein:

FIGURE 1 is a side view of one embodiment of the invention;

FIGURE 2 is a front view of the fan embodiment of FIGURE 1 taken along line 2—2;

FIGURE 3 is exemplary of one type of fixed installation window mounting for the invention;

FIGURE 4 is an enlarged fragmentary view of the fan embodiment of FIGURES 1 and 2;

FIGURE 5 is a schematic representation of the reaction jet motor used to drive the fan embodiment of FIGURE 4;

FIGURE 6 is a side view partially broken away to show another fan embodiment of the invention;

FIGURE 7 is a fragmentary front view of the apparatus in FIGURE 6 taken on line 7—7;

FIGURE 8 is an enlarged fragmentary view of the reaction motor embodiment depicted in FIGURE 6; and

FIGURE 9 is a view of still another reaction motor embodiment in accordance with the invention.

Referring now to the drawings wherein the showings are for the purpose of illustrating preferred embodiments of the invention only and not for the purpose of limiting the same, in FIGURES 1 and 2, a foam generator 10 is shown to include a tubular housing 12 having an air intake 13 and outlet 14. A fan 15 mounted within the housing 12 is driven in accordance with the invention by a reaction jet motor generally indicated by the numeral 16 and described more in detail hereinafter. A perforated member or sieve 17 extends across the free passage area of the housing 12 adjacent the outlet 14. A liquid spray of foam solution is introduced by nozzles 20 which is then borne by the velocity of the air stream created by the fan against the sieve 17. The number of foam-forming perforations 22 in the sieve 17 is greatly increased by
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of the zig-zag pattern. The number of bubbles formed, and consequently the volume of foam produced, can be increased, to a degree, by increasing the velocity of the air flow and/or the perforated surface area of the sieve 17. The upper limit on the velocity of the air stream is dependent on various factors such as the surface tension of the foam solution, which affects its ability to bridge across the foam-forming perforations 22, and the size of oil bubble generated.

The housing 12 has a constant diameter portion 23 closely surrounding the blades 19 of fan 15 which is joined by an outwardly tapered section 24 of increasing cross-sectional area, the purpose of which will be explained hereinafter. Foam is produced on the sieve 17 by forcing air through the perforations which have been sprayed with the foam solution from nozzles 20. The principle used is not unlike that of a toy bubble pipe. As the foam is formed on the sieve 17, it continuously detaches itself as new foam is generated and advances forwardly as a foam plug. The higher the expansion ratio, i.e., the ratio of the volume of air present to the volume of liquid foam solution, the quicker the affected space will be filled with foam; however, for some applications wetter foam is used for its greater heat barrier properties. For purposes of discussion, wetter foam refers to foam having an expansion ratio of between 50 and 200 to 1. As a general rule, high expansion foam having an expansion ratio of in the order of 500 to 1 will serve most applications and is preferred.

Referring now particularly to FIGURES 4 and 5, the fan 15 includes a hub 25 journaled on a shaft 27 mounted axially of the housing 12 upon a fan support frame 28. The shaft 27 is hollow and is connected at one end by line 30 communicating with a source of pressurized foam solution which has been referred to herein and generally comprises mostly water with a detergent chemical added of any well-known type in the proper proportions to insure stable high expansion foam. The shaft 27 and bearing 32 have circumferentially spaced ports 34, 34' connecting to a chamber 35 in the fan hub. The fan hub 25 supports a plurality of radially extending pipes 36 each connecting with chamber 35 and spaced circumferentially between the fan blades 19 (FIGURE 2). Each pipe 36 carries a nozzle 20.

Referring now to FIGURE 5 and in accordance with the invention, each nozzle 20 points at an angle to the axis of fan rotation A. Under pressure from line 30, each nozzle introduces a spray jet of foam solution indicated at B. Since the fan hub 25 which supports the nozzles 20 is free to rotate, the combined thrust from each of the nozzles 20 imparts rotation to the fan 15 in the direction of arrow C. Thus the reaction motor assembly 16 is the sole source of power for the fan 15. The angulation of the nozzles 20 with respect to the fan axis A is such that there is a substantial downstream force behind the spray as indicated by the spray jet vector D. The angle which the nozzles 20 make relative to the axis of rotation A may be varied but in most cases will be as great as possible without the jet spray impinging directly upon the fan blades 19. The greater the length of pipes 36, the greater will be the moment arm of the reaction motor 16 for driving the fan 15; however, the point is reached where, in the interest of greater fan velocity, the angulation of the nozzles 20 and the length of the pipes 36 will increase to a point where the spray is greatly influenced by the centrifugal action. At this point, it is deposited largely at the marginal boundaries of the sieve 17.

In this event, and further in accordance with the invention, the movable spray battery 40 may be provided. As shown in FIGURES 2 and 4, the spray battery 40 includes a cross fitting 41 from which extend four pipes 42 on the ends of which are mounted nozzles 21. The fitting 41 communicates through the shaft 27 with the pressure line 30. The nozzles 21 point axially and when under pressure direct a spray of foam solution more or less con-centrated toward the center of the sieve 17 and thus in-sure uniform wetting thereof.

In operating apparatus 10 could be installed as shown for example in FIGURE 3 within an opening 45 of a building so that the inlet 13 is on the outside and the outlet 14 on the inside. It will be understood that a fixed installation as shown in FIGURE 3 is only one application of the invention and that others can be envisioned, particularly mobile mounted fire truck units, since there is no dependence on electrical power. Under pressure in line 30, the fan 15 is rotated by the reaction motor 16 which also introduces the foam solution spray wetting the downstream sieve 17. On high velocity units, the spray battery 40 will insure coverage of the center perforations 22. The quantity of foam generated is largely a function of the total area of sieve 17 within certain velocity limits; that is, if the velocity of the air stream is too high, bubbles will not bridge across the foam-forming perforations 22 and blown out regions will result in which no foam is generated. A certain percentage of the foam solution will merely drain off of the sieve 17 from the blown out regions. The maximum velocity is a balance of various factors but an important part is the shape of the housing 12. As previously noted, the constant diameter portion 23 is joined by an increasing cross-sectional area portion 24. As a result, a significant portion of the velocity head of the air stream is converted into a dynamic pressure head immediately behind the sieve 17. The fan r.p.m.'s can thus be increased. Thus, in accordance with the invention, by merely increasing the pressure of the foam solution, a coordinated action occurs in which the fan increases in speed automatically to increase foam production consistent with the increased volume of spray introduced.

In the preferred embodiment of the invention, the reaction motor 16 is mounted on the fan hub 25 so that the housing 12 can be considerably shortened, as is apparent in FIGURE 1, thus enabling the installation of window type units as shown in FIGURE 3 with a minimum of overhang. In a second embodiment of the invention where the housing can be longer, reference is made to FIGURES 6, 7 and 8. In this embodiment, like parts are identified by like numerals and similar parts by like numerals with the addition of a prime mark. In the modification, a fan 15' is driven by a reaction motor 16' mounted on the fan hub 25'. The reaction motor 16' differs from that in the preferred embodiment in that the pipes 36' are inclined forwardly as shown best in FIGURE 6. The degree of inclination of the nozzles 20' toward the fan axis is sufficient to compensate for the centrifugal force acting on the spray, indicated by the directional arrows V, so that a more uniform distribution of spray is made on the sieve 17. Consequently, a secondary or auxiliary group of spray jets, such as the battery of jets 40 in the preferred embodiment of the invention, is unnecessary in the modification however, if desired, an optional, central nozzle 50 may be provided to introduce a spray directly at the center.

In a further embodiment of the invention (FIGURE 9) the reaction motor 60 is connected to a fan shaft 62 journaled at 63. A hollow shaft 64 supporting the reaction motor 60 connects the chamber 67 thereof with a pressure line 65. Operation is substantially like the embodiment in FIGURES 6–8.

Having thus described my invention, I claim:

1. The method of generating high expansion foam comprising the steps of introducing a high velocity spray of liquid foam solution into a building housing at an angle relative to the housing axis, to produce a jet reaction force, causing rotation of a fan about the housing axis in response to said jet reaction force to thereby cause air to flow through the housing, and depositing the high velocity spray against a perforated member positioned downstream of the fan so as to
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5 close the perforations thereof with a film of liquid foam solution, and forming bubbles of foam on the perforated member as the air becomes trapped in the film, which under the prevailing dynamic pressure head, continuously detach themselves as a high expansion foam plug.

2. The method according to claim 1 wherein the dynamic pressure head is sufficient to form a foam plug having an air to liquid ratio as high as 1500 to 1.

3. A high expansion foam generating fire protection apparatus comprising:
an elongated tubular housing having an inlet end and an outlet end;
fan means positioned within said housing between said inlet end and said outlet end and arranged so that upon rotation in a first direction air is caused to flow from said inlet end to said outlet end;
a perforated member covering the free passage area of said housing downstream of said fan means in the direction of air flow; a plurality of jet spray nozzles positioned within said housing and connected with a source of foam generating liquid solution under pressure, said nozzles being positioned upstream of said perforated means and substantially all of said nozzles being directed generally toward said perforated means and laid out in an arrangement to provide generally uniform wetting of said perforated means by said liquid solution; and,

4. A high expansion foam generating apparatus as defined in claim 3 wherein said rotatably mounted nozzles are carried on elongated arms directly connected to said fan means.

5. A high expansion foam generating apparatus as defined in claim 3 wherein at least one of said nozzles is stationary and positioned generally centrally of said housing.

6. A high expansion foam generating apparatus as defined in claim 3 wherein all of said nozzles are rotatably mounted.

7. A high expansion foam generating apparatus as defined in claim 3 wherein said nozzles are spaced radially and circumferentially of the axis of rotation of said fan.

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