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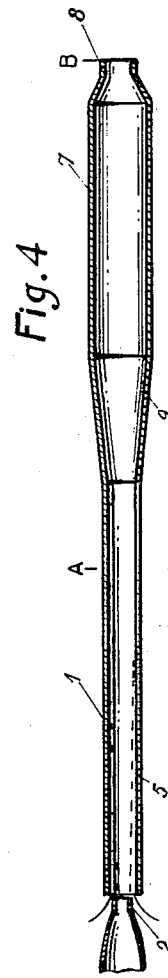
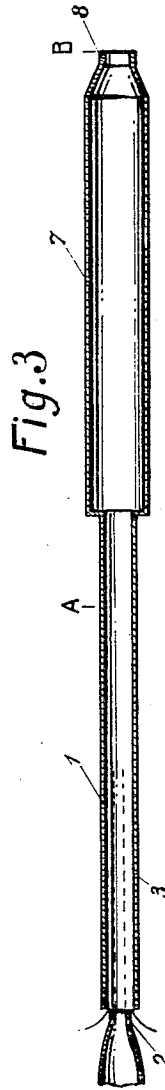
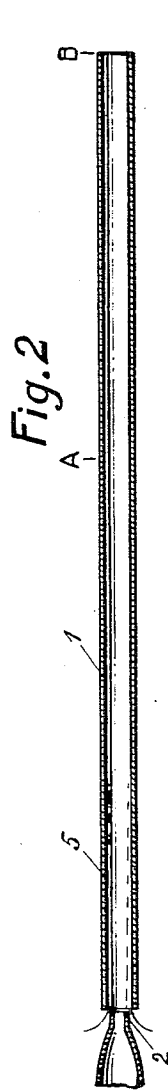
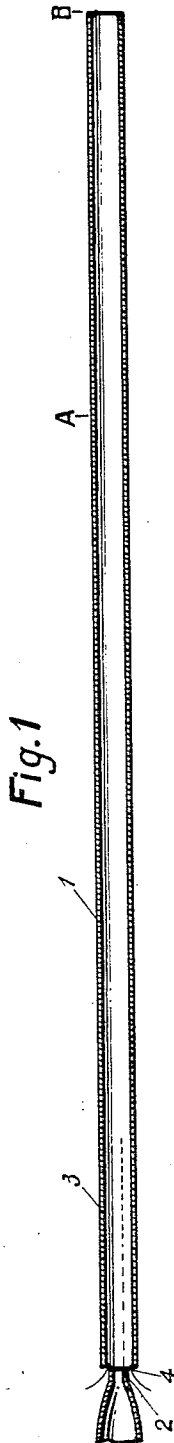
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APPARATUS FOR THE PRODUCTION OF EXTINGUISHING FOAM

Filed Oct. 30, 1951

2 Sheets-Sheet 1



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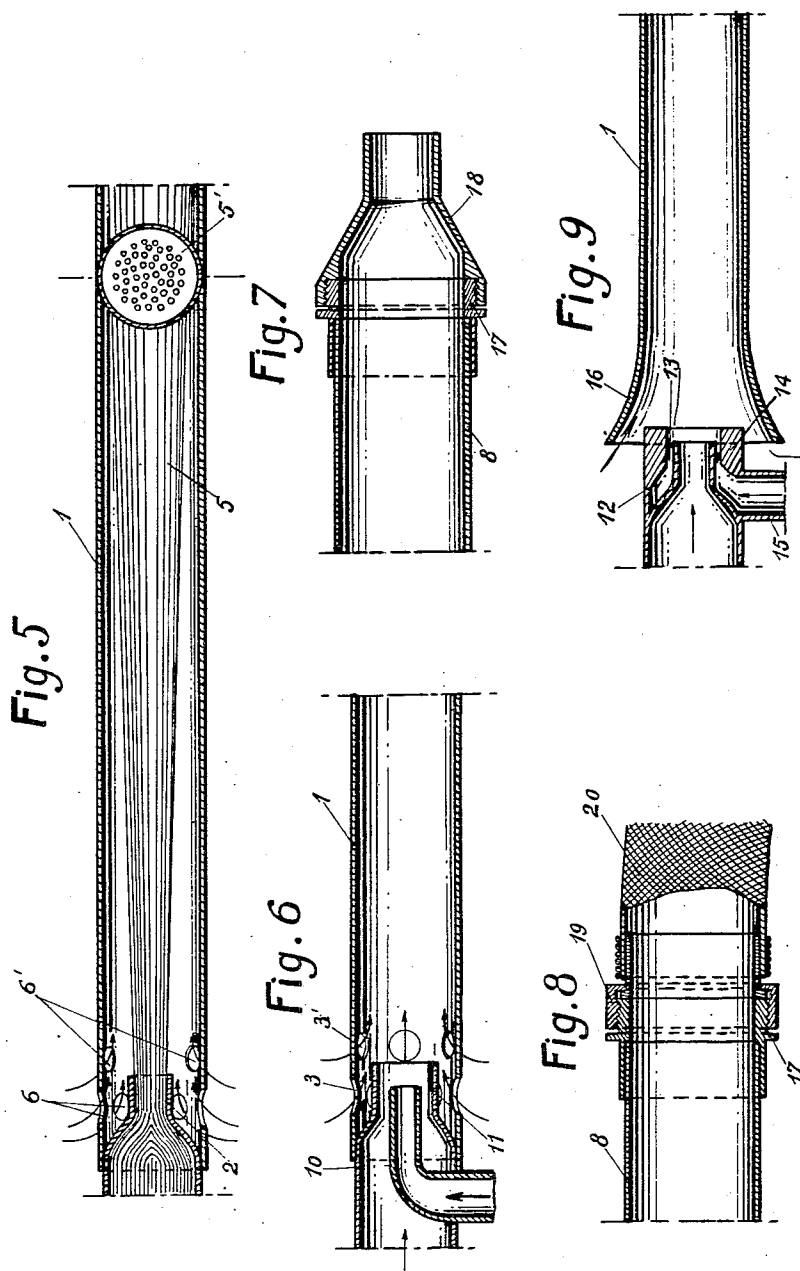
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2 Sheets-Sheet 2



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1

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## APPARATUS FOR THE PRODUCTION OF EXTINGUISHING FOAM

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Claims priority, application France May 9, 1951

4 Claims. (Cl. 169—15)

The present invention relates to apparatus for the production of fire extinguishing air foam, such apparatus comprising a mixing tube provided at one end with injector means fed with a foam forming liquid under pressure and with means for admitting air into said mixing tube arranged adjacent to the injector means, the foam forming liquid being either an aqueous solution of an emulsifying agent or a separate emulsifying agent which is mixed with water in the mixing tube.

Prior art apparatus for the production of this air foam have been based on the assumption that, to obtain a stable foam, in other words a very fine emulsion of the foam forming liquid and air, it is required to very finely divide, up to a spray condition, the jet of said liquid when entering the mixing tube in which it is mixed with air. Prior art apparatus built on this principle include therefore either a number of fine water jets which are parallel to or cross one another; or a revolving jet, the rotary motion of which is obtained through oblique guiding blades; or several jets, approximately parallel, offering some dispersion to give rise to a turbulent flow when said dispersion brings them into contact. Nevertheless, this more or less accentuated division of the liquid into jets or the imparting of rotary motion to the liquid will result in an important loss of energy, with the result that these apparatus, when used like a waterhose nozzle for direct projection in to the open air will not have an adequate range or, if they are connected with a flexible or rigid piping having a hose nozzle at its discharge end will not allow a discharge of the foam to an adequate height and distance.

The object of the present invention is the production of a finer and more stable foam than that obtained in the known extinguishing air-foam devices.

A further object of the invention is to increase the distance and/or the height over which the air-foam might be conveyed under its own pressure.

Still another object of the invention is to provide in the mixing tube a turbulent flow of the emulsion formed by the foam forming liquid and the air, without the necessity of finely dividing the liquid as it is injected into the mixing tube.

A further object of the invention is to provide a turbulent flow of the foam over a path forming an important fraction of the total length of the mixing tube.

With these objects in view, the apparatus according to the invention comprises a single slightly divergent injector nozzle arranged coaxially at the inlet end of the mixing tube, whereby a single divergent central jet having a density substantially uniformly distributed over its cross-section is obtained causing the cross section of the mixing tube to be entirely filled with a compact flow of a large bubble primary foam, at a point distant from the discharge end of said tube.

The inventor has ascertained that, if a turbulent flow is propitious to the formation of a fine foam, it is not absolutely necessary to rely on rotation or on spraying to very finely divide the jet of liquid under pressure; when

2

the liquid jet, driving along the air and forming large bubbles which can be called primary foam entirely fills the cross sectional area of the pipe, the primary foam will flow in a full jet and as the Reynolds number for the mixture of the aqueous solution of the emulsifying agent with the air, is very much greater than the limit number, the flow will not be laminar but turbulent; in this connection, it is advisable to point out that, for the known apparatus above mentioned in which a rotary motion is imparted to the liquid jet entering the mixing tube, favorable conditions are not created for the formation of a primary foam inasmuch as the rotary motion gives rise to a hollow divergent jet, the liquid being distributed in the form of a conical sheet.

In a similar manner, turbulent flow facilitating the formation of stable foam is not obtained in devices of another known type wherein the injector means are arranged to produce a hollow cylindrical or tapered jet by means of an annular injecting nozzle fed with the foam forming liquid.

The length of the pipe, starting from the cross section which is entirely filled by the primary foam is about eight times its diameter. To obtain an adequate proportion of air and of liquid (from six to nine volumes of air to one volume of liquid), corresponding to a foam of good quality, the total cross section of the pipe should be about seven to ten times greater than the area of the nozzle port of the single central jet of liquid: this port may have a diameter as large as desired, according to the output required from the apparatus, and for instance may be 25 mm. and even greater. In the case of a cylindrical jet, the total length of the pipe should be equal to from 20 to 60 times its diameter, said length being possibly reduced in a marked way when a divergent nozzle is used, as this kind of nozzle brings the section where the primary-foam entirely fills the pipe nearer to the inlet end of said pipe.

Other means to reduce the total length of the pipe and which can also be used simultaneously with a divergent nozzle consists in enlarging the cross sectional area of the pipe along that portion of the pipe in which the said portion is completely filled by the liquid jet, said enlarged cross-sectional portion of the pipe being preferably connected with a first portion which has a smaller diameter, through a tapered tube portion, to avoid energy losses resulting from a sudden change in cross section. Because of the speed decrease of the foam which accumulates in the enlarged portion, its loss of kinetic energy results in increased pressure; this pressure increase reacts back on the primary-foam contained in the portion having a smaller diameter resulting in that the section starting from which the primary-foam entirely fills the cross section of the pipe, is brought nearer to the inlet end of the pipe. Thus the total length of the pipe may be reduced accordingly. The enlarged portion of the pipe may be connected either with a flexible piping, or provided with a convergent nozzle to be used like a water hose nozzle.

By roughening the inner wall of the pipe, the setting up of rotational movement of the liquid jet is reduced and thus the length of the pipe may be further reduced.

By way of example, several embodiments of the apparatus of the present invention are described hereafter and illustrated in the accompanying drawings.

Figure 1 shows an axial section of an apparatus including a cylindrical nozzle and a pipe having a constant cross section.

Figure 2 is an axial section of another embodiment having a divergent nozzle.

Figure 3 shows an apparatus including a cylindrical nozzle and a pipe including an enlarged portion.

Figure 4 shows an axial section of an apparatus includ-

3

ing a divergent nozzle and also a pipe ending in an enlarged portion.

Figure 5 shows on an enlarged scale an axial section of a pipe equipped with a divergent nozzle and a cross section of the conical jet thus produced.

Figure 6 shows an axial section of an alternative embodiment of the device used to inject the water and the emulsifying agent.

Figure 7 shows the outlet end of a pipe used like a hose nozzle.

Figure 8 shows the connection of the apparatus with a flexible delivery hose.

Figure 9 is an axial section of another alternate embodiment of the injecting device.

As shown in Figure 1, the apparatus includes a cylindrical pipe 1 having a constant cross section and a total length of at least 20 times its diameter. This pipe is fed at one end through a single central cylindrical nozzle 2 which injects into the pipe an aqueous solution of the foam generating agent, the air being sucked by the central jet 3 through the annular opening 4 surrounding the nozzle. This central jet forms, in the first portion of its flow, an emulsion having large bubbles (above designated as primary foam), which starts at the section designated as A to entirely fill the cross sectional area of the pipe 1. The total length of the pipe is so chosen that the remaining portion, from A to B will permit the turbulent flow arising in said portion to change the primary foam into a fine and stable emulsion which will be ejected into the open air at the end B in the shape of a powerful and far reaching jet. In the embodiment of Figure 2, the nozzle 2 is slightly divergent and the section A in the pipe 1 at which the primary foam 5 will entirely fill the cross section of the pipe, is nearer to the injector with the result that, as the length of the second portion, A to B of the pipe remains unchanged, the total length of the pipe is reduced. As shown in Figure 5, the divergent jet 5, contrary to what happens in the case of a rotary jet, is not hollow and forms a conical beam constituted by a great number of thin jets, more or less evenly distributed through the cross-section of the jet, as shown at 5' in the cross sectional view at the right in Figure 5. In the said Figure 5, the air is sucked into the pipe 1 through two series of staggered ports 6 and 6' arranged near the inlet of the pipe in two circular rows.

In order to shorten the overall length of the delivery tube the apparatus according to the invention shown in Figure 3, comprising a pipe 1, with a cylindrical nozzle 2, is provided in the second portion A to B in which the flow starts to be turbulent, with a chamber 7, having a larger diameter and ending, when the foam is to be ejected directly in the open air, in a convergent nozzle. For the above mentioned reasons, the pressure increase in the enlarged chamber results in bringing nearer to the pipe inlet the section A in which the sectional area of the pipe is entirely filled by the primary foam, so that the total length can be reduced approximately to the same value as for the pipe bearing a divergent nozzle of Figure 2.

In Figure 4, the means used in Figures 2 and 3 are combined and the apparatus includes both a divergent nozzle 2, and an enlarged chamber 7, thus allowing even more of the total length of the pipe to be reduced with the benefit of an important decrease of the bulkiness and the weight of the apparatus. To reduce energy losses, the portions 1 and 7 of the pipe having various diameters are connected, as shown in Figure 4, through a conical portion 9 thereby obtaining a gradual and slow increase of the cross sectional area so that the foaming jet will not break away from contact with the wall of the pipe.

Of course, instead of injecting an aqueous solution of the foam producing agent into the pipe of the apparatus, it is possible to produce the solution within the apparatus itself, as shown in Figure 6: the foam producing agent is sucked through the central nozzle 10 by wafer injected through the annular opening between the nozzles 10 and

4

11, the nozzle 11 being cylindrical or divergent as desired, and the air being sucked, as in Figure 5, through the rows of ports 3, 3'. It is also possible, as in Figure 9, to inject the water through a central divergent nozzle 12, to introduce the emulsifying agent through the piping 15 and through an annular opening 13 formed between the central nozzle 12 and a concentric ring 14, whilst the air is sucked through the wide mouthed piping 16.

As shown in Figures 7 and 8, the end 8 of the pipe 1 may be equipped with a threaded tip 17 on which is screwed, as shown in Figure 7, a convergent nozzle 18 to eject the foam directly into the open air by a long range jet, or the connection 19 and a flexible hose 20 allowing the foam to be conveyed over a rather large distance and height.

What I claim is:

1. In an apparatus for the production of air-foam a mixing tube comprising a first cylindrical portion provided at one of its ends with injector means for introducing a foam forming liquid into said tube, said means comprising a single slightly divergent nozzle arranged coaxially with said tube and adapted to produce a single central divergent jet having a density substantially uniformly distributed over its cross section and causing the cross section of said first part of the mixing tube to be entirely filled before its discharge end, said mixing tube further comprising a second tapered portion connected to the first cylindrical portion and having progressively increasing diameter, and a third enlarged cylindrical terminal portion connected to said tapered portion.

2. In an apparatus for the production of air-foam a mixing tube comprising a first cylindrical portion provided at one of its ends with injector means for introducing a foam forming liquid into said tube, said means comprising a single slightly divergent nozzle arranged coaxially with said tube and adapted to produce a single central divergent jet having a density substantially uniformly distributed over its cross section and causing the cross section of said first part of the mixing tube to be entirely filled before its discharge end, said mixing tube further comprising a second tapered portion connected to the first cylindrical portion and having progressively increasing diameter, and a third enlarged cylindrical terminal portion connected to said tapered portion and provided at its discharge end with a convergent nozzle.

3. In an apparatus for the production of air-foam a mixing tube comprising a first cylindrical portion provided at one of its ends with injector means for introducing a foam forming liquid into said tube, said means comprising a single slightly divergent nozzle arranged coaxially with said tube and adapted to produce a single central divergent jet having a density substantially uniformly distributed over its cross section and causing the cross section of said first part of the mixing tube to be entirely filled before its discharge end, the said cylindrical portion having a cross section of about seven to ten times greater than the area of the outlet of the divergent nozzle, and a length at most equal to twelve times the diameter thereof, said mixing tube further comprising a second tapered portion connected to the first cylindrical portion and having a progressively increasing diameter, and a third enlarged cylindrical terminal portion connected to said tapered portion, the total length of the tapered portion and of the enlarged cylindrical terminal portion being approximately equal to eight times the diameter of the first cylindrical portion of the mixing tube.

4. In an apparatus for the production of air-foam a mixing tube comprising a first cylindrical portion provided at one of its ends with injector means for introducing a foam forming liquid into said tube, said means comprising a single slightly divergent nozzle arranged coaxially with said tube and adapted to produce a single central divergent jet having a density substantially uniformly distributed over its cross section and causing the cross section of said first part of the mixing tube to be entirely

5

filled before its discharge end, the said cylindrical portion having a cross section of about seven to ten times greater than the area of the outlet of the divergent nozzle, and a length at most equal to twelve times the diameter thereof, said mixing tube further comprising a second tapered portion connected to the first cylindrical portion and having a progressively increasing diameter, and a third enlarged cylindrical terminal portion connected to said tapered portion, the total length of the tapered portion and of the enlarged cylindrical terminal portion being approximately equal to eight times the diameter of the first cylindrical portion of the mixing tube, a conver-

6

gent nozzle provided at the discharge end of the enlarged terminal portion of the mixing tube.

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