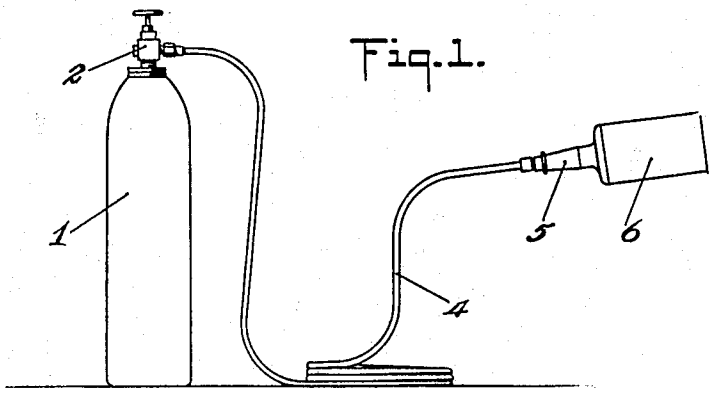
April 3, 1951 J. E. KUCHER 2,547,018

FIRE EXTINGUISHING MEDIUM DISCHARGE METHOD AND APPARATUS

Filed June 7, 1947

Fig. 1.



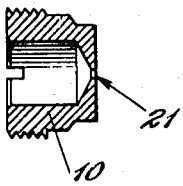


Fig. 4.

Fig. 2.

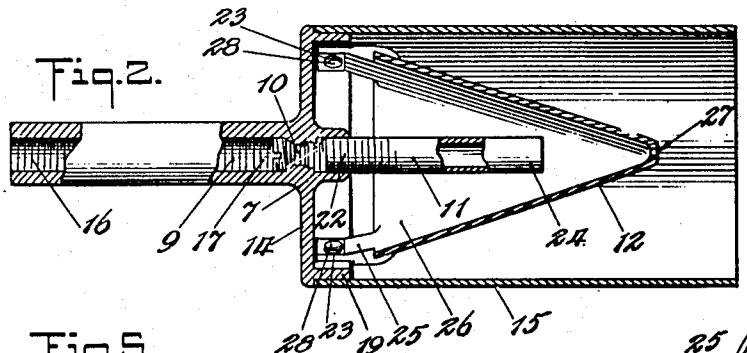


Fig. 3.

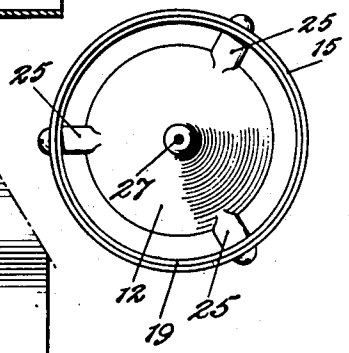


Fig. 5.

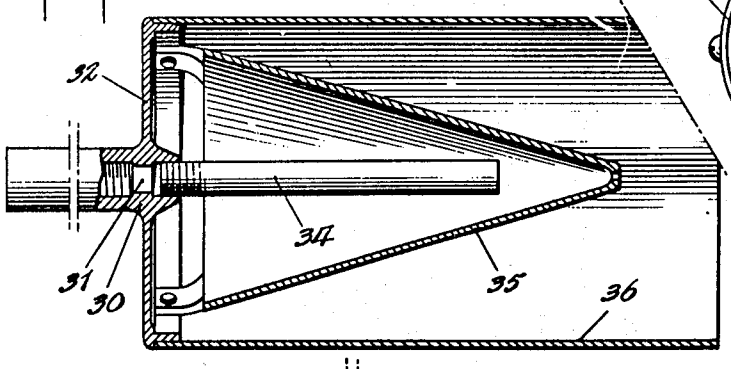


Fig. 6.

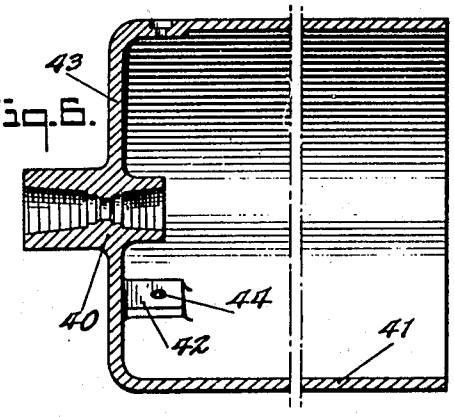
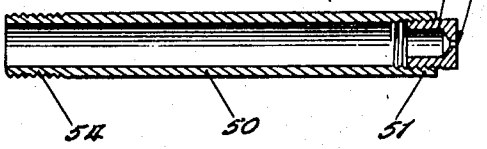


Fig. 7.



INVENTOR.
JOSEPH E. KUCHER
BY Edward T. Connors

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FIRE EXTINGUISHING MEDIUM DISCHARGE METHOD AND APPARATUS

Joseph E. Kucher, Lyndhurst, N. J., assignor to C-O-Two Fire Equipment Company, Newark, N. J., a corporation of Delaware

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13 Claims. (Cl. 169—9)

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This invention relates to an improved method and apparatus for discharging fire extinguishing medium.

The effectiveness of carbon dioxide as a fire extinguishing agent is increased by converting a large portion of the discharged fluid into carbon dioxide snow. Discharge devices heretofore constructed have, in some cases, utilized a horn into which a jet of carbon dioxide is liberated. This device has been termed the "horn type" discharge horn. The horn serves as a shield for the nozzle to prevent the entrainment of air until the velocity of the flow has been reduced to the extent that a negligible amount of air will be entrained. The back pressure in the horn results in the formation of carbon dioxide snow. Because of the length and size of the horn required for large capacity discharges of carbon dioxide, this device is not wholly satisfactory. Other devices have depended upon means to break up the stream of carbon dioxide adjacent the orifice and to provide a zone of low temperature resulting in the production of carbon dioxide snow. A device of this type is shown and described in U. S. Patent No. 1,993,696, issued on March 5, 1935, to S. E. Allen et al. This device has been generally satisfactory for discharges of carbon dioxide, because the horn may be made comparatively short as compared with the "horn type" of discharge device.

The present invention is still further an improvement over the invention disclosed in the Allen patent and enables the production of carbon dioxide snow of better carrying quality.

An object of the present invention is to provide an improved method of and device for discharging carbon dioxide in which the stream of carbon dioxide issuing from the orifice or jet is expanded in a region of extremely low temperature so that the expanding fluid is prevented from absorbing heat during the initial period of its expansion.

Another object of the invention is to provide an improved method of and a device for converting liquid carbon dioxide into carbon dioxide snow and gas for use as a fire extinguishing medium in a simple and economical manner.

Another object of the invention is to provide an improved device for discharging carbon dioxide that is small, compact and light in weight.

In accordance with the invention, the foregoing objects are accomplished by providing a method of and a device for discharging the liquified fluid in which the fluid is expanded and deflected back over itself under a certain amount

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of back pressure so that the initially expanding fluid is completely surrounded by further expanding fluid of extremely low temperature.

This method is advantageous in that the initially expanding fluid is prevented from absorbing heat from the atmosphere or from adjacent portions of the discharge device and thus an increased amount of snow results. Due to the absence of heat, the temperature of the expanding fluid immediately drops to a value at which snow is readily formed in a large proportion to the amount of fluid discharged. A secondary result is that the turbulence caused by the reversed flow produces larger particles of snow which have better carrying properties in the discharged stream. The larger particles also evaporate into gas at a proportionately slower rate and thus are more effective as a fire extinguishing agent.

Other objects and advantages of the invention will be apparent from the following description of forms of the invention, throughout which description reference is had to the accompanying drawing in which:

Fig. 1 is an elevational view illustrating an embodiment of the invention connected with apparatus with which it may be used.

Fig. 2 is a view partly in elevation and partly in longitudinal section of a discharge device in accordance with the invention.

Fig. 3 is an end view of the device shown in Fig. 2.

Fig. 4 is a view in longitudinal section on an enlarged scale of an orifice used in the device shown in Fig. 2.

Fig. 5 is a view in longitudinal section of a modified form of discharge device.

Fig. 6 is a view in longitudinal section of a modified construction of the housing or body of the device.

Fig. 7 is a view in longitudinal section of a modified construction of a portion of the device showing an alternative position for the orifice.

Referring to the drawing, there is shown in Fig. 1 a discharge nozzle in accordance with the invention connected with a container 1 for storing a fire extinguishing fluid liquidifiable under pressure such as carbon dioxide. The fluid is releasably confined in the container 1 by a valve 2 having connected thereto a hose or flexible conduit 4 having a rigid extension or handle 5. A discharge device 6 is connected to the extension for delivering the discharged fluid to a fire. Although shown as portable extinguishing apparatus, it is to be understood that the invention is equally applicable to "built-in" or stationary sys-

tems including several containers manifolded to a common discharge conduit as well as to portable apparatus. Further, the invention is also applicable to lightweight portable extinguishers such as those having the discharge nozzle mounted adjacent the valve for the container.

The discharge device 6 shown in Fig. 2 includes a body 7 adapted to be connected to the handle 5 and having a fluid passage 9, an orifice plug 10 in the fluid passage for restricting the flow of fluid therethrough, a tubular extension 11 for the fluid passage, a cone-shaped deflecting member 12 for directing a stream of fluid issuing from the tubular extension back over itself, a radial flange 14 extending from the body 7, and a directing tube 15. The discharge device may be made of any suitable material such as metal or plastic material, or some parts may be made of one material and other parts of another material.

The body 7 may be varied in shape as desired. For example, the outer contour of the body and flange 14 may be stream-lined, or the body may be combined with handle 5 to provide an integral unit to be attached to the flexible conduit 4. The fluid passage 9 extends through the body 7 and is shown as being threaded at its inlet end 16 for connection with handle 5 and also threaded at its outlet end 17 for connection of the extension tube 11. The radial flange 14 extends around the body 7 and is provided with a cylindrical flange 19 to support the tube or shield 15.

The orifice plug 10 shown in detail in Fig. 4 is formed of a threaded plug having an aperture or orifice 21 to restrict the fluid flow therethrough. The plug is adapted to be positioned in the threaded portion of the inlet end 16 of the fluid passage. However, as will hereafter appear the position of the orifice along the fluid passage is not critical and it may be placed at any convenient position. The size of the orifice is varied depending upon the rate of discharge desired. It is used to provide a restriction in the fluid passage to cause the flowing stream to build up back pressure on the fluid in the conduit 4. The back pressure prevents expansion of the fluid which might lead to freezing of the fluid and blocking of the conduit under conditions such as intermittent operation at low temperature.

The tubular extension 11 preferably has an internal diameter approximately the same as, or slightly less, than the internal diameter of the conduit 4. However, the ratio of the diameter of the tubular extension to that of the conduit is not critical. If desired, the diameter of the tubular extension may be made slightly greater than that of the conduit to provide some expansion of the fluid so that it will have a lower temperature upon its discharge at the end of the tubular extension. The length of the tubular extension is preferably such that it extends into the cone-shaped member 12 at least half way along the axis of the cone. End 22 of the tubular extension is shown as threaded to be retained in the outlet end 17 of the body. The outer end 24 of the tubular extension is cut off square with the edges thereof slightly rounded.

The cone shaped member 12 by reason of its shape and arrangement provides a rearwardly extending passageway between the inner surface of the cone and the tubular extension 11, and also a forwardly extending passageway between the outer surface of the cone and the inner surface of the directing tube 15. Thus the cone not only reverses the direction of the flow of the stream of fluid producing turbulence, but also provides for a continual expansion of the stream with a directing tube comparatively short in length. The stream expands as it flows rearwardly past the diverging wall of the cone which provides a passageway of continually increasing cross section, and the stream is expanded still further as it flows forwardly past the converging wall of the cone which provides, with the tube, a passageway of continually increasing cross section.

Further the cone-shaped member 12 reverses the flow of the stream of fluid issuing from the tubular extension 11 back over itself so that the issuing fluid expands while surrounded on all sides with partially expanded fluid of extremely low temperature which is still further expanding. The issuing fluid is thus prevented from absorbing heat from the atmosphere or adjacent parts of the discharge nozzle and consequently a large amount of snow is formed. The cone-shaped member 12 is hollow with walls of sufficient thickness to provide a rugged construction. Extending portions 25 of the wide end 26 of the cone are shown perforated and attached to the cylindrical flange 19 of the body member 7 thus providing the expansion chamber between the cone and the radial flange 14 and extending the expansion chamber formed between the narrow end of the cone and the tubular extension 11. The space between the end 26 of the cone and the flange 14 provides the passage for the fluid into the directing member 15. The means for attaching the cone 12 to the flange 19 is shown as by screws 23 extending through perforations in the directing tube 15 and through the cylindrical flange 19 into threaded openings 28 in the extending portions 25 of the cone. The dimensions of the cone are capable of considerable variation and are determined initially by experiment depending to a large extent upon the desired characteristics of the discharge stream. The spacing of the wide end 26 of the cone from the radial flange 14 is also subject to variation. However, the spacing should be preferably such as to provide a slight amount of back pressure in the cone from the flow of the fluid as such back pressure aids in the snow formation. An aperture 27 is provided at the apex of the cone in order to prevent the accumulation of snow and to improve the characteristics of the discharge stream issuing from the directing member. It has been found that if the aperture is omitted the discharge stream narrows in diameter a short distance beyond the end of the directing member and at this point considerable air is entrained by the discharge stream. By providing the aperture a portion of the stream of expanding gas issuing from the jet is allowed to escape without being deflected by the cone-shaped member resulting in the elimination of the narrowed portion of the discharge stream and in preventing the resultant entrainment of air. A certain amount of thrust is also provided resulting in an increased throw of snow over a device without the aperture.

The directing tube 15 may be made of metal or plastic material and is preferably cylindrical in shape. The tube is held in place on the cylindrical flange 19 by the screws 23 engaging in the flange or any other suitable fastening means may be used. The length of the tube is made such that the direction of the flow of the turbulent stream of fluid issuing from the cone-shaped member 12 is straightened out to produce a discharge with the desired amount of travel. The length of the tube depends to a considerable ex-

tent upon the desired characteristics of the discharge stream.

In use, the discharge device may be attached to the apparatus as shown in Fig. 1. Liquid carbon dioxide is releasably contained in the container 1 by the valve 2. The container is connected to the discharge device by the conduit 4 having the handle 5 for attachment to the inlet end 10 of the discharge device. In operation, the valve 2 is opened releasing the carbon dioxide from the container 1 through the conduit or hose 4 to the fluid passage 9 of the discharge device. The fluid then passes through the orifice plug 10 and the tubular extension 11 where it issues and suddenly expands within the cone-shaped member 12. The sudden release of pressure results in a considerable drop in temperature of the fluid and the medium changes from the liquid phase to a mixture of solid and gas, the solid portion being in the form of the so-called "snow." The stream then strikes the end of the cone-shaped member and is deflected back over the portion of fluid then issuing from the tubular extension so that the later issuing fluid is expanded in an atmosphere of extremely low temperature under a back pressure from the early issuing fluid. By reason of the cone shape of the deflecting member, the fluid is continuously expanded while being reversed in direction. The combination of the low temperature, back pressure and turbulence is especially conducive to the formation of snow, and, accordingly, a high proportion of the issuing fluid is transformed into snow. The mixture of gaseous medium and snow then contacts the radial flange 14 where it is again reversed in direction and increased in turbulence so that the snow particles are packed together to form larger flakes, the stream of medium is then further expanded and directed outwardly by the directing member or tube 15.

The form of the invention disclosed in Fig. 5 is advantageous for use in connection with large capacity fluid discharges. This nozzle differs from that previously described in that the orifice as such is omitted and the fluid flow is dependent upon the size of the supply conduit. The device comprises a body 30 having a fluid passage 31, a radial flange 32, a tubular extension 34, a cone-shaped member 35, and a directing member 36. In lieu of the orifice, the tubular extension 34 is preferably formed with an internal diameter slightly less than the diameter of the supply conduit 4. As may be seen from the drawing the ratio of the diameter of the base of the cone 35 to the axial length thereof is somewhat smaller than in the embodiment shown in Fig. 2. By this means a proportionately larger space is provided between the cone 35 and the radial flange 32 which has been found to be more satisfactory for discharges of larger capacity.

The housing or body 40 disclosed in Fig. 6 is adaptable to be used alternately in either of the previously disclosed constructions. In this form the body 40 and directing member or shield 41 are formed in one integral unit. This construction lends itself somewhat more readily to the smaller units and is somewhat more economical to manufacture in large quantity production. In order to provide means for attaching the cone-shaped member to the body 40, thickened portions 42 are provided in end 43 of the shield 41. As shown the thickened portions are perforated at 44 and threaded to receive the screws to hold the cone-shaped member in place.

In Fig. 7 there is shown a modified construction in which the tubular extension 50 is shown as internally threaded at its discharge end 51 to receive a threaded plug 52 having an orifice 53. The inlet end 54 is shown threaded to connect with the fluid passage of a housing or body as previously described. It has been found that the position of the orifice along the fluid passage of the discharge nozzle is immaterial insofar as the operation of the device is concerned. In some cases it may be preferable to insert the orifice plug as shown in Fig. 2 in the inlet end of the fluid passage, while in other cases it may be preferable to insert the orifice plug as shown in Fig. 7. The construction shown in Fig. 7 is advantageous in that the orifice plug is readily available for inspection.

From the preceding description it will be seen that the present invention provides an improved method and apparatus for discharging fire extinguishing medium which utilizes a compact directing member in which the stream of fluid issuing from the jet or orifice is expanded in a region of extremely low temperature and is prevented from absorbing heat during the initial period of its expansion so that the fluid is converted into carbon dioxide snow and gas in a simple and economical manner.

While the invention has been described and illustrated with reference to specific embodiments thereof, it will be understood that other embodiments may be resorted to without departing from the invention. For example, while several of the parts have been illustrated as being attached together by means of threaded connections, it is obvious that other means of attachment might be used such as riveted, welded or pressed fit connections. Further, while the directing member or tube has been shown as in line with the axis of the fluid passage in the discharge nozzle, it is understood that the directing member might be made in a curved form, or that the cone-shaped member and the directing tube might be shaped in a somewhat different manner so as to fit in built-in installations in which space limitations necessitates such construction. Further, although the fluid passageway is annular in shape in the form shown it is understood that other arrangements are possible. While the deflecting member has been shown and described as cone-shaped other somewhat similar shapes may be used such as an elongated cup-shaped member, or members of hyperboloid or ellipsoid shape, or the like, in which the issuing fluid is deflected back over itself while being expanded. Therefore, the form of the invention set out above should be considered as illustrative and not as limiting the scope of the following claims.

What I claim and desire to secure by Letters Patent is:

1. The method of discharging a fire extinguishing fluid liquified under pressure comprising expanding the fluid, directing the expanded fluid back over the expanding fluid in a heat exchange relationship and thereafter directing the expanded fluid into a desired direction.

2. The method of discharging a fire extinguishing fluid liquified under pressure comprising expanding the fluid, reversing the direction of the fluid back over itself in a heat exchange relationship while increasing the cross-sectional

area thereof, and thereafter directing the expanded fluid in a desired direction.

3. The method of discharging a fire extinguishing fluid liquified under pressure comprising expanding the fluid, reversing the direction of the fluid back over itself in a heat exchange relationship while increasing the cross-sectional area thereof, thereafter directing the expanded fluid in a desired direction, and further expanding the fluid as it flows in the desired direction.

4. The method of discharging a fire extinguishing fluid liquified under pressure comprising expanding the fluid at an orifice, directing the expanded fluid back over itself in a heat exchange relationship so that the stream of fluid issuing from the orifice is surrounding by the fluid flowing in the reverse direction and thereafter directing the expanded fluid into a desired direction.

5. The method of discharging a fire extinguishing fluid liquified under pressure comprising expanding the fluid, directing the expanded fluid back over itself in a heat exchange relationship while restricting the expansion of the fluid with back pressure greater than atmospheric pressure yet less than the pressure of liquification of the fluid, and thereafter directing the expanded fluid in a desired direction.

6. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a housing having an inlet passage and an outlet passage, means positioned opposite the outlet passage and spaced therefrom so that the fluid may expand therebetween and shaped to reverse the stream of expanded fluid issuing from the outlet passage back over itself in a heat exchange relationship, and means to direct the deflected stream into a desired direction.

7. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a housing having an inlet passage and an outlet passage, means positioned opposite the outlet passage and spaced therefrom so that the fluid may expand therebetween, the means having a surface facing the outlet passage, said surface diverging away from the axial line of the outlet passage in the direction towards the outlet.

8. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a housing having an inlet passage and an outlet passage, a hollow cone-shaped member having its longitudinal axis in alignment with the axis of the outlet and spaced therefrom so that the fluid may expand therebetween, the apex of the cone-shaped member being pointed away from the outlet of the housing so that a passageway is defined between the inside of the cone-shaped member and the outside of the outlet to reverse the direction of the fluid passing therethrough while continually allowing the expansion of the fluid.

9. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a housing having an inlet passage and an outlet passage, a hollow cone-shaped member having its longitudinal axis in alignment with the axis of the outlet and spaced therefrom so that the fluid may expand therebetween in a heat exchange relationship, the apex of the cone-shaped member pointed away from the outlet, the cone-shaped member having an aperture in its apex.

10. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a housing having an inlet passage and an outlet passage, an extension for the outlet passage, and a hollow cone-shaped member having its base positioned about the outlet extension and spaced therefrom whereby a stream of fluid issuing from the outlet is expanded and directed back over itself from the inside of the cone-shaped member in a heat exchange relationship.

11. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a housing having an inlet passage and an outlet passage for the fluid, a hollow cone-shaped member adapted to receive the fluid from the outlet and direct it back over itself in a heat exchange relationship, the housing having an annular wall spaced from and forming with the cone-shaped member an expansion chamber, and means adapted to direct the discharge from the expansion chamber.

12. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a housing having inlet and outlet passages for the fluid, a hollow cone-shaped member having an aperture at its apex, the base of the cone-shaped member positioned about the outlet so as to receive fluid discharged therefrom and deflect one portion of said fluid back over itself and to pass another portion of said fluid through said aperture, and fluid directing means positioned about said outlet and said cone-shaped member.

13. A discharge nozzle for fire extinguishing fluid liquified under pressure comprising a body having a passage therethrough for the fluid, a tubular extension for said passage defining an outlet, a hollow cone-shaped member positioned to receive the tubular extension therein and spaced therefrom to form an expansion chamber about the outlet for the fluid, deflecting means for the fluid spaced from the cone-shaped member to reverse the direction of the expanded fluid back over itself in a heat exchange relationship, and a tube to redirect the expanded fluid.

JOSEPH E. KUCHER.

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