June 29, 1943. H. V. WILLIAMSON ET AL 2,322,758

FIRE EXTINGUISHING METHOD AND APPARATUS

Filed March 24, 1942

Fig. 1.

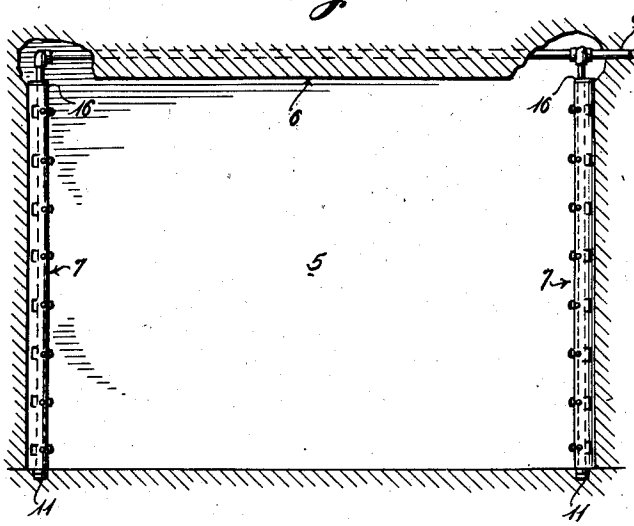


Fig. 2.

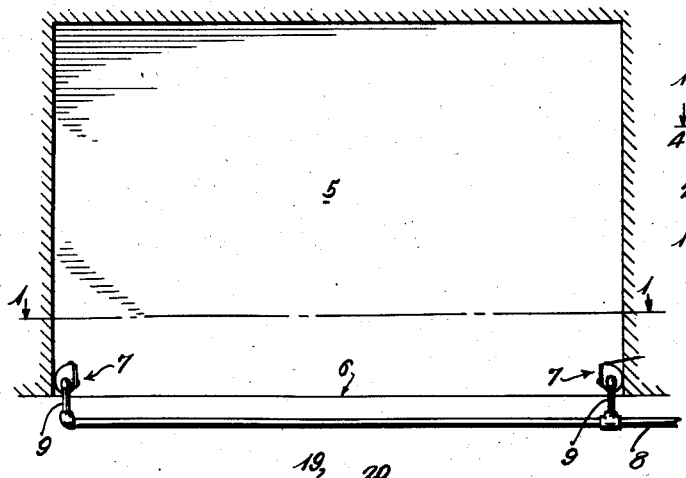


Fig. 3.

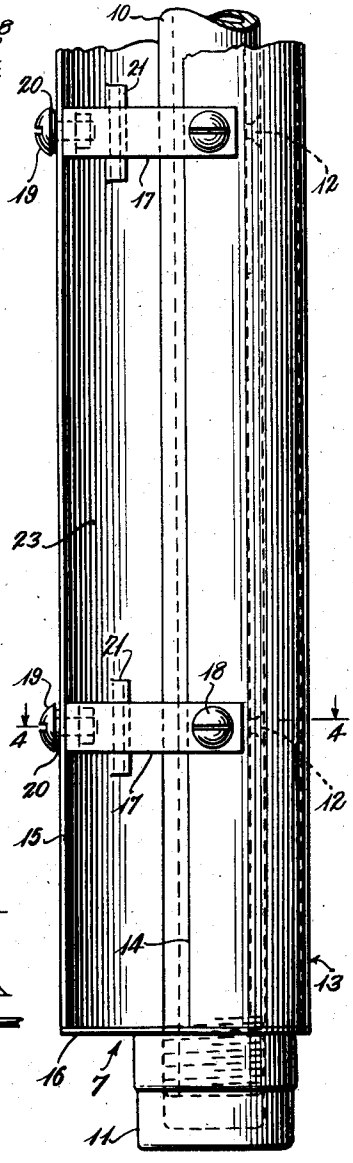
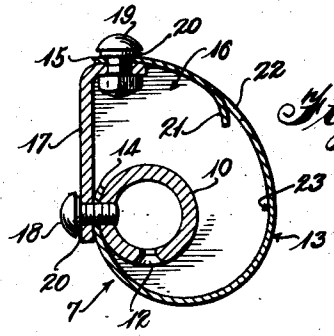


Fig. 4.



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FIRE EXTINGUISHING METHOD AND APPARATUS

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Application March 24, 1942, Serial No. 436,052

20 Claims. (Cl. 169—11)

This invention relates to a method of employing liquid carbon dioxide for extinguishing fires involving enclosures in which certain treatment or process steps, requiring the use of inflammable substances, are performed, and apparatus suitable for carrying out said method.

It is the present practice in numerous industries to subject certain materials, objects, parts, or the like, to one or more process or treatment steps in relatively small enclosures or booths which usually have one wall, or a sizable portion thereof, omitted to provide a permanent opening. These process or treatment steps very often involve the use of highly inflammable fluids, powders, gases, or the like. For that reason, fires are rather easily started and they usually are of such a size that the entire interior of the enclosures is involved. The permanent opening left in each of these enclosures, the readily displaceable character of the inflammable substances employed, and the size or extent of the fire present special extinguishing problems which are difficult to overcome.

If the aforementioned treatment or process steps were carried out in a completely or substantially completely closed off space it would be a comparatively simple matter to flood the same with sufficient carbon dioxide to provide the necessary extinguishing concentration. The provision of a permanent opening, however, allows the extinguishing vapors to escape at such a rapid rate that total flooding of the space in the customary manner can only be accomplished by delivering the vapors at a very rapid rate; i. e., a large volume at a high velocity. This type of discharge of carbon dioxide creates such a powerful blast or draft in the comparatively small enclosure that the flames are blown out through the opening to a distance of several feet. Also, some of the flaming treatment substance occasionally is dislodged and blown through the opening. Naturally, these conditions are very objectionable and may result in spreading the fire to other portions of the building in which the treatment enclosure or booth is located.

Starting with the above premise in mind, experiments were carried out to determine whether extinguishment could be accomplished by discharging the carbon dioxide in such a manner as to simultaneously provide a screen or barrier for the opening and build up the desired concentration within the enclosure. Pipe sections having one or more rows of closely positioned discharge orifices or regular commercial room flooding nozzles were employed for these tests. The pipe sections were located either at the top or at the two side margins of the opening with the orifices or nozzles pointing into the enclosure and/or across the area of the opening.

The positioning of any of the above noted pipe sections along the top margin of the opening proved to be the least effective while positioning such pipes along the opposite side margins provided fairly satisfactory results. Some of the tests employing top marginal pipes failed to effect complete extinguishment because of low, non-uniform concentration of the extinguishing medium. The highest concentration produced by any of these tests was forty percent while the average was approximately twenty-seven percent. The best extinguishment time that could be obtained was ten seconds while the average time was twenty-eight seconds.

No one of these discharge arrangements provided perfect screening for the opening of the enclosure. The top marginal arrangements that failed to effect complete extinguishment caused flames to be blown through the opening during the entire period of discharge of the extinguishing medium. The more favorable tests caused flames to be blown through the opening to distances ranging from ten feet to fifteen feet during approximately the first half of their extinguishment time, or until the fire had partially subsided. The most pronounced blowing was found to occur during the first few seconds of discharge, or during the period before the liquid carbon dioxide reached the orifices or nozzles and when nothing but vapors were being discharged. This delay in the arrival of liquid carbon dioxide at the region of release or discharge is a normal characteristic of carbon dioxide and this initial delay period varies depending on the length of the flow path from the source of supply to the region of release as well as such other factors as the total discharge area provided by the release orifice or orifices. After the liquid reached the orifices or nozzles and was released to create a more dense discharge that was formed of mixed snow and vapors, the blowing of the flames subsided.

The above noted tests established certain facts which were further developed during the subsequent experiments that brought about the creation of the method and apparatus embodying this invention. These facts were:

1. Locating the discharge devices at opposite margins of the opening is essential.

2. Higher concentrations can be developed in the enclosure by discharging the extinguishing

medium both into the enclosure and across the entire area of the opening.

3. The more dense the discharge that produces the screen or barrier for the opening, the less the blowing of flames through the opening.

4. Blowing flames through the opening cannot be prevented if a substantial amount of the extinguishing medium is discharged into the enclosure prior to the development of a dense screen or barrier across the entire area of the opening.

The primary object of this invention is to provide a method and apparatus for employing carbon dioxide to effectively extinguish fires involving partially open enclosures or booths in which are carried out process or treatment steps that require the use of highly inflammable materials.

A further important object of the invention is the provision of a method and apparatus of the above mentioned type which will discharge the extinguishing medium from opposite margins of the enclosure opening; which will create a high concentration of carbon dioxide in the enclosure; which will provide a dense screen or barrier across the entire area of the enclosure opening, and which will produce the aforesaid dense screen or barrier prior to discharging a substantial amount of the extinguishing medium into the enclosure.

Still another object of the invention is the provision of a method and apparatus for creating a screen or barrier across an open area while building up a high fire extinguishing concentration on one side thereof.

Other objects and advantages of the invention will be apparent during the course of the following description.

In the accompanying drawing forming a part of this specification and in which like numerals are employed to designate like parts throughout the same,

Figure 1 is a vertical sectional view of an enclosure, taken on line 1—1 of Fig. 2, and showing the fire extinguishing apparatus embodying this invention in elevation and as viewed from within the enclosure,

Figure 2 is a horizontal sectional view taken through the enclosure and shows the fire extinguishing apparatus in top plan,

Figure 3 is an enlarged, fragmentary view of one of the discharge devices shown in position in Figs. 1 and 2, and

Figure 4 is a transverse sectional view taken on line 4—4 of Fig. 3.

In the drawing, wherein for the purpose of illustration is shown the preferred embodiment of this invention, and first particularly referring to Figs. 1 and 2, the reference character 5 is employed to designate in a general way an enclosure or booth in which certain treatment or process steps, involving the use of highly inflammable substances, are carried out. This enclosure or booth is provided with a permanent opening 6 in one wall thereof. It is to be understood that this illustration of an enclosure or booth is only representative and is not intended to restrict the invention to any particular proportions or dimensions. Additionally, while the permanent opening 6 is shown as extending the full width of the enclosure or booth 5, it is to be understood that the permanent opening need not correspond in either horizontal or vertical dimensions with one side of the enclosure or booth. That is to say, the opening may be smaller than the side of the enclosure or booth in which it is located.

Positioned at the opposite side margins of the opening 6 are the two vertically arranged discharge devices 7. These devices are of sufficient length to extend the full height of the opening. A supply line 8 extends from any suitable source of supply of liquid carbon dioxide, such as the bulk storage tank of Patent No. 2,143,311, issued to Eric Geertz, January 10, 1939, or a bank of high pressure cylinders. This supply line 8 is connected by means of the branch lines 9 to the discharge devices 7 for supplying these devices with the required amount of liquid carbon dioxide. Naturally, any suitable form of automatic or manual control mechanism may be connected in the supply line 8 to determine the time and duration of discharge periods.

The construction of each one of the discharge devices 7 will be described in detail in connection with the disclosures provided by Figs. 3 and 4. Each one of these devices includes a discharge pipe 10 which is connected at its upper end to one of the branch pipes 9 and is threaded at its lower end into a combined cap and floor anchor 11. This element 11 may be embedded in a concrete floor or otherwise suitably anchored to prevent movement of the device during discharge of the carbon dioxide. At suitably spaced intervals the discharge pipe is provided with the well known Camus type of discharge orifice 12. The counter-bored or re-entering formation of these orifices prevents them from plugging up with snow when the carbon dioxide is discharged therethrough.

A merging and segregating chamber 13 is provided for the discharge pipe 10 and is arranged to enclose the latter throughout its length, or throughout the length of the pipe that corresponds with the height of the opening 6. By inspecting the sectional view of Fig. 4, it will be seen that this chamber is substantially of half-heart shape. The two longitudinal edges 14 and 15 terminate in spaced relation to each other to provide a discharge opening which extends the length of the chamber. The opposite ends of the chamber are closed by the walls 16 which are welded in place in any suitable manner.

For the purpose of anchoring the discharge pipe 10 to the edge portion 14 of the chamber and to brace and reinforce the chamber and its discharge opening throughout their length, straps 17 are provided. These straps are each fastened at one end by a screw 18 which passes through the strap, the edge portion 14 of the chamber 13 and the discharge pipe 10 with the screw being threaded into the opening formed in the pipe. The remaining end of each strap is anchored to the edge portion 15 of the chamber 13 by a bolt and nut assembly 19. Suitable lock washers 20 are provided for both of these types of securing elements 18 and 19 to prevent loosening of the same.

In circumferential alignment with each one of the orifices 12 the wall of the chamber 13 is provided with a struck-in tongue 21. The forming of these tongues leaves a slot or opening 22 through which a portion of the carbon dioxide will be discharged in a manner to be described in detail at a later point. The tongues 21 cooperate with these slots or openings 22 by acting as scoops or deflectors which guide the extinguishing medium to and through the slots or openings.

By again inspecting Fig. 4, it will be seen that the cross sectional shape of the chamber 13 pro-

vides an inner surface 23 which is curved throughout the circumferential extent of the chamber. That is to say, the inner surface 23 of the chamber wall is curved transversely of the chamber. This figure also shows the longitudinal series of orifices 12 as pointing or facing in the direction of the curved surface 23 of the chamber so as to intersect the latter relatively close to the edge 14 of the chamber. The longitudinal series of discharge slots or openings 22, with their struck-in tongues 21, are arranged relatively close to the longitudinal edge 15 of the chamber wall. It will be seen, therefore, that any material which is discharged from the pipe 10 through the series of orifices 12 will be compelled to travel along the interior curved surface 23 of the chamber to reach the discharge opening that is defined by the chamber edges 14 and 15 and this material, therefore, will be compelled to partake of curvilinear motion instead of the straight line motion that will exist between each one of the orifices 12 and the opposing zone of the internal curved surface 23 of the chamber. That is to say, the curved surface of the chamber will deflect the discharged medium from its straight line path of movement and will force the medium to flow through a curved path until it arrives at the longitudinal discharge opening of the chamber. Because the interior of the chamber is not obstructed throughout its length, the extinguishing medium discharged through the several orifices 12 will be permitted to spread longitudinally of the chamber and merge into a continuous mass before arriving at the discharge opening of the chamber.

By comparing the disclosure of Fig. 4 with the disclosure of Fig. 2, it will be seen that each discharge device is arranged so that its chamber discharge opening faces or points across the area of the opening 6 for the enclosure or booth 5. Therefore, the extinguishing medium that is expelled through the two chamber openings will travel across the enclosure opening 6 to meet at approximately the vertical medial line of this opening. The extinguishing medium discharged from the two devices 7, therefore, will provide a screen or barrier that will completely close off the opening 6 of the enclosure or booth 5. A comparison of these last two mentioned figures also shows that the two discharge devices are arranged so that any material which is released through the longitudinal series of openings or slots 22 will be directed into the enclosure or booth 5 inwardly of the screen or barrier that is provided by the main discharges from the two devices 7.

The mode of operation of this fire extinguishing apparatus now will be described. Liquid carbon dioxide is delivered to the discharge pipes 10 of the two devices 7 by means of the main pipe line 8 and its two branches 9. This liquid is released through the orifices 12 and, as a result of this sudden expansion of the liquid and the accompanying drop in pressure, the jets or streams of liquid carbon dioxide will be immediately converted to mixtures of snow and vapors. The jets of snow and vapor released from the orifices 12 will partake of straight line motion until they arrive at the opposed zones of the interior curved surface of the associated chamber 13. The mixture will then be compelled to partake of curvilinear motion as a result of flowing over the chamber surface 23. Because the snow portion of the mixture is many times more dense than the vapor portion, centrifugal force will compel the snow to seek the outer portion of the curvilinear path, or to force its way toward the curved surface 23. As a result of this movement of the snow particles, the vapors are crowded or forced away from the curved surface 23, or away from the peripheral margin of the curvilinear path. Therefore, by the time the snow and vapors reach the discharge opening of the chamber 13, the snow has formed a layer that lies adjacent the inner surface of the chamber while the vapors form a layer that is superimposed with respect to the snow layer, or which lies closer to the longitudinal axis of the chamber. The final discharge through the opening of the chamber, which is defined by the longitudinal edges 14 and 15, has its snow segregated in one layer and its vapors segregated in another layer. Due to the arrangement of the discharge devices 7 with respect to the opening 6 of the enclosure or booth 5, the vapor layer of each discharge will be arranged on the outer side of the stream while the snow layer will be arranged on the inner side. The vapor layers of the two opposed discharges, therefore, will shield the snow layers from the atmosphere outside of the enclosure opening 6.

These two opposed streams will be equal in width to the length of each chamber 13 or to the height of the enclosure opening 6. The thickness of each one of these two streams will correspond with the combined thickness of the layers of segregated snow and vapors discharged by each device 7. These two wide and relatively thin streams will meet or impinge against each other at approximately the vertical medial line of the enclosure opening 6 to provide a continuous, dense screen or barrier across the entire area of this opening. As these two streams will travel in the same vertical plane, their impingement will cause the materials of the two streams to be deflected in opposite horizontal directions. That is to say, each stream will be split along a vertical line so that one part of the stream will flow or be deflected into the enclosure or booth 5 while the other portion will be deflected outwardly. This vertical line of cleavage will be located approximately at the region where the snow layer blends into the vapor layer with the result that the snow particles will be deflected into the enclosure or booth 5 while the vapors will be deflected outwardly to create a cloud in front of the opening 6.

By the time the discharges from the several orifices 12 have traveled over the curved surfaces 23 of the chambers 13 from the points of first contact with this surface to the locations of the tongues 21 and openings or slots 22, the snow and vapors have been segregated to a considerable extent. The tongues 21 will terminate within the depth of the snow layer and, therefore, will function to scoop or deflect snow outwardly through the openings or slots 22 into the interior of the enclosure or booth 5. The snow discharged through the openings or slots 22 and the snow deflected inwardly by the impingement of the two main streams from the discharge devices 7 will sublime within the enclosure or booth to create the desired high extinguishing concentration. It will be appreciated that prior to impingement of the streams at the vertical medial line of the opening 6, the concentrating of the snow of both of these streams into layers will provide a very dense screen or barrier for the opening.

In the introductory portion of this specification

the statement is made that a considerable amount of the extinguishing medium should not be discharged into the enclosure or booth prior to the creation of a dense screen or barrier across the opening of the enclosure or blowing of flame through the opening would result. This statement had reference to the initial period of discharge when nothing but carbon dioxide vapors are discharged by the devices 7, prior to the arrival of liquid carbon dioxide in substantial amounts at the discharge orifices 12. This desired result is obtained with the discharge devices 7 notwithstanding the provision of the slots or openings 22 and the tongues 21. When nothing but vapors are being discharged through the orifices 12, the volume of flow is not as great as when liquid is released through the orifices 12. Therefore, the density, per unit of volume, of the material flowing through the chamber 13 is not as great. Additionally, the density of the vapors is not of such a value as to compel the vapors to crowd or pack tightly against the inner curved surface 23 of the chamber 13. As a result of these two factors, a comparatively small amount of carbon dioxide vapors will be discharged into the interior of the enclosure or booth 5 during this initial period of discharge of the carbon dioxide vapors. After the liquid reaches the orifices 12, the release of the same through the orifices will provide snow as well as vapors and the screen or barrier formed across the opening 6 of the enclosure will be sufficiently dense to permit a greater volume of carbon dioxide to be expelled into the enclosure or booth.

Extensive tests carried on with the discharge apparatus of this invention clearly prove its effectiveness to completely extinguish fires involving the highly inflammable substances that are used in these treatment or process enclosures or booths. No blowing of flames through the opening 6 occur during the entire extinguishment period. Carbon dioxide fire extinguishing concentrations of forty-five percent or more can be created within the enclosure or booth 5 with this apparatus. Fires involving the entire interior of the enclosure or booth have been extinguished in as short a time as four seconds. The average extinguishment time for all of the tests conducted with this apparatus was seven seconds. By comparing the figures obtained from the tests made with this apparatus with the figures obtained during the tests referred to in the introduction of this specification, it will be seen that considerably improved extinguishment is provided.

Although the disclosure given above specifically referred to the extinguishment of fires involving partially open processing enclosures or booths, persons skilled in the art to which this invention relates will readily appreciate that the method and apparatus can be employed just as effectively to provide screens or barriers for the openings of other types of enclosures while building up a fire extinguishing concentration in the latter and that the method and apparatus can even be employed for creating a screen or barrier across the entire area of a tunnel, a passageway in a coal mine, or the like.

It is to be understood that the form of this invention herewith shown and described is to be taken as a preferred example of the same, and that various changes in the shape, size, and arrangement of parts may be resorted to without departing from the spirit of the invention or the scope of the subjoined claims.

Having thus described the invention, we claim:

1. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the length of opposed margins of said opening, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining in confinement the snow and vapors until the separate discharges of the same merge throughout the length of each of said margins, causing the snow and vapors to partake of curvilinear motion while thus confined so that the difference in density of the snow and the vapors will effect segregation of these components, discharging a part of the segregated snow from both of the margins into the interior of the enclosure, and discharging the remaining snow and the vapors from both of said margins toward each other to form a screen or barrier across the entire area of said opening.

2. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the length of opposed margins of said opening, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into streams of snow and vapors, uniformly deflecting the flowing snow and vapor streams from their normal straight line paths of movement while allowing them to merge lengthwise of each of said margins, maintaining the flowing snow and vapors under the influence of the force producing said deflection until their difference in density effects a substantial segregation of these components, discharging a part of the segregated snow from both of the margins into the interior of the enclosure, and discharging the remaining snow and the vapors from both of said margins toward each other to form a screen or barrier across the entire area of the opening.

3. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the length of opposed margins of said opening, discharging the liquid at each of said regions through spaced constricted orifices into a chamber that extends lengthwise of said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, causing the flowing snow and vapors to merge throughout the length of each chamber and to partake of curvilinear motion while flowing through the chamber to effect substantial segregation of these components, discharging a part of the segregated snow from both of the margins into the interior of the enclosure, and discharging the remaining snow and the vapors from both of said margins toward each other to form a screen or barrier across the entire area of said opening.

4. A method of employing liquid carbon dioxide for creating a screen or barrier entirely across an open area and developing a fire extinguishing concentration on one side thereof, comprising conducting liquid carbon dioxide to regions of release arranged in a common plane and extend-

ing the length of opposite margins of said area, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining in confinement the snow and vapors until the separate discharges of the same merge throughout the length of each of said margins, causing the snow and vapors to partake of curvilinear motion while thus confined so that the difference in density of the snow and vapors will effect segregation of these components, discharging a part of the segregated snow from both of the margins to one side of the said common plane of both of said regions, and discharging the remaining snow and the vapors from both of said margins toward each other to form a screen or barrier entirely across said area and in said common plane.

5. A method of employing liquid carbon dioxide for creating a screen or barrier entirely across an open area and developing a fire extinguishing concentration on one side thereof, comprising conducting liquid carbon dioxide to regions of release arranged in a common plane and extending the length of opposed margins of said area, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into streams of snow and vapors, uniformly deflecting the flowing snow and vapor streams from their normal straight line paths of movement while allowing them to merge lengthwise of each of said margins, maintaining the flowing snow and vapors under the influence of the force producing said deflection until their difference in density effects a substantial segregation of these components, discharging a part of the segregated snow from both of the margins to one side of said common plane of both of said regions, and discharging the remaining snow and the vapors from both of said margins toward each other to form a screen or barrier entirely across said area and in said common plane.

6. A method of employing liquid carbon dioxide for creating a screen or barrier entirely across an open area and developing a fire extinguishing concentration on one side thereof, comprising conducting liquid carbon dioxide to regions of release arranged in a common plane and extending the length of opposed margins of said area, discharging the liquid at each of said regions through spaced constricted orifices into a chamber that extends lengthwise of said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, causing the flowing snow and vapors to merge throughout the length of each chamber and to partake of curvilinear motion while flowing through the chamber to effect substantial segregation of these components, discharging a part of the segregated snow from both of the chambers to one side of the said common plane of both of said regions, and discharging the remaining snow and the vapors from both of said chambers toward each other to form a screen or barrier entirely across said area and in said common plane.

7. A method of employing liquid cabon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the lengths of opposed margins of said opening, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining in confinement the snow and vapors until the separate discharges of the same merge throughout the length of each of said margins, discharging a part of the carbon dioxide from both of the margins into the interior of the enclosure, and discharging the remaining carbon dioxide from both of said margins toward each other to form a screen or barrier across the entire area of the opening.

8. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the lengths of opposed margins of said opening, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into streams of snow and vapors, permitting said flowing snow and vapor streams to merge lengthwise of each of said margins into a continuous mass equal in length to said margin, discharging a part of the carbon dioxide from both of the margins into the interior of the enclosure, and discharging the remaining carbon from both of said margins toward each other to form a screen or barrier across the entire area of said opening.

9. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the lengths of opposed margins of said opening, discharging the liquid at each of said regions through spaced constricted orifices into a chamber that extends lengthwise of said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, causing the flowing snow and vapors to merge lengthwise of each chamber, discharging a part of the carbon dioxide from both of the chambers into the interior of the enclosure, and discharging the remaining carbon dioxide from both of the chambers toward each other to form a screen or barrier across the entire area of said opening.

10. A method of employing liquid carbon dioxide for creating a screen or barrier entirely across an open area and developing a fire extinguishing concentration on one side thereof, comprising conducting liquid carbon dioxide to regions of release arranged in a common plane and extending the lengths of opposed margins of said area, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining in confinement the snow and vapors until the separate discharges of the same merge throughout the length of each of said margins, discharging a part of the carbon dioxide from both of the margins to one side of the said common plane of both of said regions, and discharging the remaining snow and vapors from both of the margins toward each other to form a screen or barrier entirely across said area and in said common plane.

11. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the lengths of opposed margins of said opening, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to per-

mit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining in confinement the snow and vapors until the separate discharges of the same merge throughout the length of each of said margins, causing the snow and vapors to partake of curvilinear motion while thus confined so that the difference in density of the snow and the vapors will effect segregation of these components into superimposed layers, discharging a part of the snow layer from both of the margins into the interior of the enclosure, and discharging the vapor layer and the remainder of the snow layer from both of said margins toward each other to form a screen or barrier across the entire area of said opening with the snow layer arranged on the enclosure side of the screen or barrier so as to be shielded from the atmosphere outside of the enclosure by the vapor layer.

12. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the lengths of opposed margins of said opening, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into streams of snow and vapors, uniformly deflecting the flowing snow and vapor streams from their normal straight line paths of movement while allowing them to merge lengthwise of each of said margins, maintaining the flowing snow and vapors under the influence of the force producing said deflection until their difference in density effects a substantial segregation of these components into superimposed layers, discharging a part of the snow layer from both of the margins into the interior of the enclosure, and discharging the vapor layer and the remainder of the snow layer from both of said margins toward each other to form a screen or barrier across the entire area of said opening with the snow layer arranged on the enclosure side of the screen or barrier so as to be shielded by the vapor layer from the atmosphere outside the enclosure.

13. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising conducting liquid carbon dioxide to regions of release extending the lengths of opposed margins of said opening, discharging the liquid at each of said regions through spaced constricted orifices into a chamber that extends lengthwise of said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, causing the flowing snow and vapors to merge throughout the length of each chamber and to partake of curvilinear motion while flowing through the chamber to effect substantial segregation of these components into superimposed layers, discharging a part of the snow layer from both of the chambers into the interior of the enclosure, and discharging the vapor layer and the remainder of the snow layer from both of said chambers toward each other to form a screen or barrier across the entire area of said opening with the snow layer arranged on the enclosure side of the screen or barrier so as to be shielded by the vapor layer from the atmosphere outside the enclosure.

14. A method of employing liquid carbon dioxide for creating a screen or barrier entirely across an open area and developing a fire extinguishing concentration on one side thereof, comprising conducting liquid carbon dioxide to regions of release arranged in a common plane and extending the lengths of opposed margins of said area, discharging said liquid through constricted orifices spaced at suitable intervals along each of said regions to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining in confinement the snow and vapors until the separate discharges of the same merge throughout the length of each of said margins, causing the snow and vapors to partake of curvilinear motion while thus confined so that the difference in density of the snow and vapors will effect segregation of these components into superimposed layers, discharging a part of the snow layer from both of the margins into the interior of the enclosure, and discharging the vapor layer and the remainder of the snow layer from both of said margins toward each other to form a screen or barrier across the entire area of said opening with the snow layer arranged on the enclosure side of the screen or barrier so as to be shielded by the vapor layer from the atmosphere outside the enclosure.

15. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising effecting sudden release of the liquid along regions extending the lengths of opposite margins of said opening to lower its pressure sufficiently to form snow and vapors, effecting segregation of the snow and vapors, discharging a part of the segregated snow from both of said margins into the interior of the enclosure, and discharging from both of said margins the remaining segregated snow and the segregated vapors as superimposed layers to form a screen or barrier across the entire area of said opening.

16. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising effecting sudden release of the liquid along regions extending the lengths of opposite margins of said opening to lower its pressure sufficiently to form snow and vapors, effecting segregation of the snow and vapors, discharging a part of the segregated snow from both of said margins into the interior of the enclosure, and discharging from both of said margins the remaining segregated snow and the segregated vapors as superimposed layers to form a screen or barrier across the entire area of said opening with the snow layer arranged on the enclosure side of the screen or barrier so as to be shielded by the vapor layer from the atmosphere outside the enclosure.

17. A method of employing liquid carbon dioxide for extinguishing a fire involving an enclosure having an opening in a wall thereof, comprising effecting sudden release of the liquid along regions extending the lengths of opposite margins of said opening to lower its pressure sufficiently to form snow and vapors, effecting segregation of the snow and vapors, discharging a part of the carbon dioxide from both of said margins into the interior of the enclosure, and discharging the remainder of the carbon dioxide from both of the margins to form a screen or barrier across the entire area of said opening.

18. Fire extinguishing apparatus for discharging liquid carbon dioxide to effect extinguishment of a fire involving an enclosure having an opening in a wall thereof, comprising a vertically elongated chamber extending the height of each

of said side margins of the enclosure opening, each of said chambers having a main discharge opening extending the length thereof and facing toward the other of said chambers and a longitudinal series of secondary openings facing inwardly of said enclosure, and a discharge pipe extending lengthwise of each chamber and having a longitudinal series of orifices through which liquid carbon dioxide is released into the chamber to form snow and vapors which will be discharged through said main and secondary openings.

19. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising an elongated chamber having a main discharge opening extending the length thereof and a longitudinal series of secondary openings facing at an angle to the main discharge opening, and a discharge pipe extending lengthwise of said chamber and having a longitudinal series of orifices through which liquid carbon dioxide is released into the chamber to form snow and vapors which will be discharged through said main and secondary openings.

20. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising an elongated chamber having a main discharge opening extending the length thereof, the wall of said chamber being curved throughout its entire periphery from one margin to the other of said main discharge opening, said chamber wall having a longitudinal series of tongues struck inwardly thereof to provide a series of secondary openings arranged adjacent to and parallel with one of the longitudinal margins of the main discharge opening, and a discharge pipe extending lengthwise of the chamber and having a longitudinal series of orifices through which liquid carbon dioxide is released into the chamber to form snow and vapors, said release orifices facing toward the curved wall of said chamber so that the snow and vapors will contact the latter adjacent the other of the marginal edges of said main discharge opening so that the snow and vapors will be caused to travel a curvilinear path while flowing from the orifices to the main discharge opening, said curvilinear motion of the snow and vapors causing segregation of these components as a result of the more dense snow seeking a path of flow adjacent the inner surface of the curved chamber wall, said series of tongues operating to deflect some of the segregated snow through the series of secondary openings.

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