

Aug. 29, 1944.

H. V. WILLIAMSON

2,357,040

FIRE EXTINGUISHING METHOD AND APPARATUS

Filed March 13, 1942

Fig. 1.

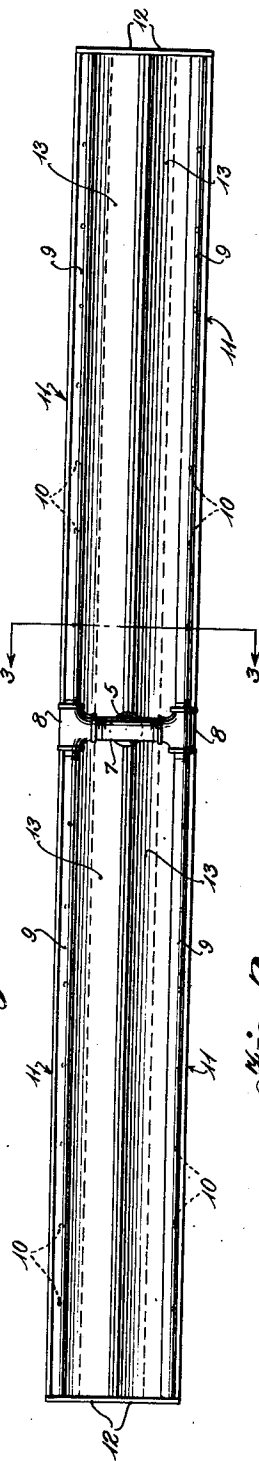


Fig. 2.

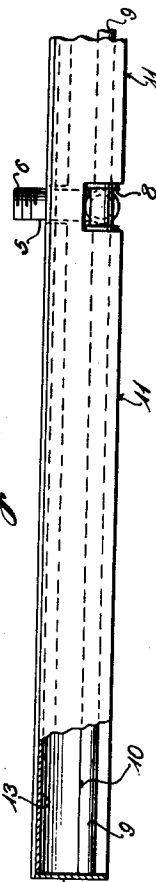


Fig. 4.

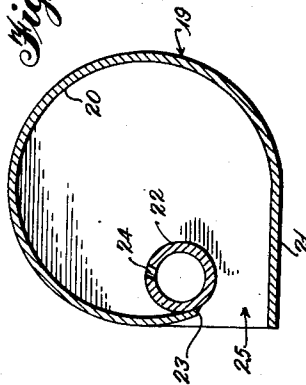
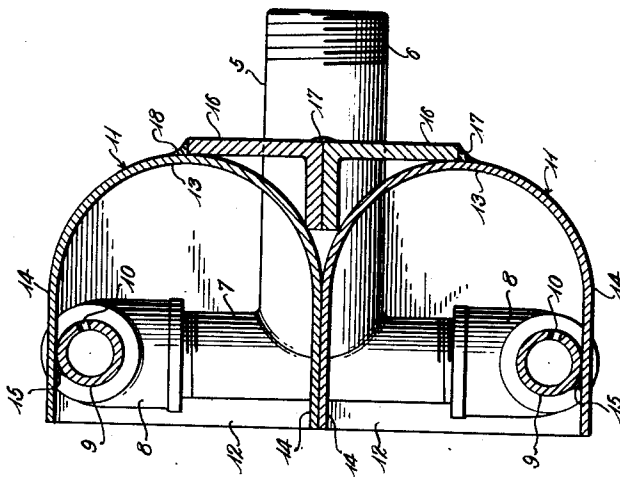


Fig. 3.



Inventor

Hilding V. Williamson

334 L. Donald Meyer Attorney

UNITED STATES PATENT OFFICE

2,357,040

FIRE EXTINGUISHING METHOD AND APPARATUS

Hilding V. Williamson, Chicago, Ill., assignor, by mesne assignments, to Reconstruction Finance Corporation, Chicago, Ill., a corporation of the United States

Application March 13, 1942, Serial No. 434,556

31 Claims. (Cl. 62—1)

This invention relates to methods of discharging liquid carbon dioxide for extinguishing fires and apparatus for carrying out said methods.

In my copending application, Serial No. 425,568, filed January 3, 1942, I have disclosed and claimed a method and apparatus for extinguishing outdoor fires by the direct application of the extinguishing medium. The method of the aforesaid application has for its primary object to increase the effective range and penetrating characteristics of a discharge of carbon dioxide by segregating or separating the snow and vapors and arranging these components, prior to being released to the atmosphere, so that the vapors of the discharge will act as a shield for the snow to lessen the effect of air resistance on the snow and to retard the rate of snow sublimation.

The specific discharge devices illustrated in the aforesaid application for carrying out the method are of the type that must be freely movable to extinguish a fire which involves a relatively large area. That is to say, the cross sectional dimensions of the discharged stream are such that only a relatively small field of application, or area of direct impingement, of the extinguishing medium is provided for any given position of the discharge device. Therefore, when such a device is employed for extinguishing a fire involving a large area, it must be capable of universal movement so that the field of application, or area of direct impingement, will be caused to traverse the involved area throughout both its length and its breadth. This kind of manipulation can best be accomplished by attaching the discharge device to a play pipe that is connected to the end of a hose line for direct manipulation by firemen, or by attaching the device to a pipe which is connected to the supply line by a suitable universal joint so that mechanical actuating means may be employed.

There are certain types of hazards, however, which can be given more efficient fire protection if a method of and apparatus for effecting discharge of liquid carbon dioxide is employed which provide a stream having a field of application, or area of direct impingement that is large enough to permit the point of discharge to be fixed relative to the hazard or to require the point of discharge to be moved to only a limited extent relative to the hazard. When these types of hazards are located out of doors where they may be subjected to high velocity natural winds during a fire, or when other circumstances make such requirements necessary, it is essential that the discharged stream possess highly effective range and pene-

trating characteristics as well as a large field of application of the extinguishing medium.

It is the primary object of this invention to provide a method of and apparatus for effecting discharge of liquid carbon dioxide in such a manner that the resultant stream of snow and vapors will possess highly effective range and penetrating characteristics as well as a large field of application or area of direct impingement.

Another important object of the invention is the production of a discharge stream of carbon dioxide snow and vapors which will be extremely effective in extinguishing fires under difficult conditions of application because of its abnormally large cross sectional area and the segregation of the snow and vapor components in a stream of such large dimensions.

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 front elevational view of one form of carbon dioxide discharge apparatus embodying this invention,

Figure 2 is a fragmentary plan view, partly broken away, of the discharge apparatus shown in Fig. 1,

Figure 3 is a transverse sectional view taken on line 3—3 of Fig. 1, and

Figure 4 is a transverse sectional view of a modified form of carbon dioxide discharge apparatus.

In the drawing, wherein for the purpose of illustration are shown the preferred embodiments of this invention, and first particularly referring to Figs. 1 to 3 inclusive, the reference character 5 designates a pipe which is employed for supplying

the liquid carbon dioxide to the discharge apparatus. This pipe may be considered as representing the piping which leads from the discharge apparatus to the source of supply which may be either a storage container of the type disclosed in

Patent No. 2,143,311, issued to Eric Geertz, in which the liquid carbon dioxide is maintained at a constant subatmospheric temperature, and its corresponding vapor pressure, or a bank of cylinders, in which the liquid carbon dioxide is confined at the changing high vapor pressures which correspond with the prevailing temperatures of the surrounding atmosphere. While the discharge apparatus embodying this invention can be made in sufficiently small sizes to permit them to be employed on the ends of hose lines for direct

manual manipulation, the full benefits to be derived from discharge devices of this character can best be obtained when the devices are made of such sizes as will require them to be employed as a part of a fixed extinguishing system or to permit them to be mounted on some form of wheeled vehicle or carriage which is movable to permit the field of application of the extinguishing medium to traverse the involved area.

This pipe section 5 may be considered as constituting the stem or shank of the discharge device. It is threaded at 6 for connection with the proper supply line. The remaining end of the stem or shank is suitably connected to the right angularly arranged pipe section or manifold 7 that extends in opposite directions. T-couplings 8 are threaded on the opposite ends of the manifold pipe 7 and the aligned branches of each one of these couplings have threaded therein the apertured discharge pipes 9. By inspecting Fig. 1, it will be seen that four of these discharge pipes are provided and are arranged in parallel pairs on opposite sides of the manifold 7 and its couplings 8. Each one of these discharge pipes 9 is suitably closed at its outer end and is provided with a longitudinally arranged series of apertures 10. These apertures may be spaced at suitable intervals and they will face in a general rearward direction, rather than a forward direction.

Each one of these discharge pipes 9 is suitably arranged within a merging and segregating chamber 11. The chambers 11 for the oppositely directed discharge pipes that are united to a single coupling 8 communicate with each other at their inner ends so that they will in effect constitute one long chamber. It will be seen from inspecting Fig. 1, therefore, that there are really provided two merging and segregating chambers which are arranged in parallelism with each other and each one of these two large chambers has arranged therein the two discharge pipes 9 which are connected to the associated coupling 8. The outer ends of the chambers 11 are provided with closure walls 12.

Each one of these merging and segregating chambers 11 is provided with a curved rear wall 13 that is joined to the side walls 14. Each chamber is entirely open at its front, or opposite to its curved rear wall 13. The discharge pipes 9 are disclosed as being welded at 15 to the outer side walls 14. The remaining or inner side walls of the parallel chambers bear against each other and they may be directly connected if desired. By inspecting Fig. 3, it will be seen that the longitudinal series of discharge apertures or orifices point or face toward the zone where its associated rear chamber wall 13 merges with the outer side chamber wall.

To provide the desired amount of rigidity or strength for the discharge device, a pair of angle irons 16 is employed. These angle irons are welded together at 17 and to the outer surfaces of the rear walls 13 of the chambers at 18. The pair of bracing angle irons has a three point engagement with its associated pair of chambers 11 as a result of the contacting branches of the angle irons entering the valley that is formed by the adjacent chamber walls. These angle irons may be continuous throughout the length of the discharge device and provided with an opening for the passage of the stem or shank 5 or two pairs of angle irons may be provided and arranged so that they will terminate at their

inner ends in contact with the stem or shank. As the use of continuous angle irons will provide greater strength, this structure is preferred.

The mode of operation of this form of discharge apparatus or nozzle now will be described. Liquid carbon dioxide of any desired temperature will flow under its own vapor pressure through the bore of the stem or shank from the associated supply line or pipe, not shown. This liquid carbon dioxide will pass into the manifold 7 and will flow in opposite directions through this manifold into the T-couplings 8 from which it will be delivered to the four discharge pipes 9. The liquid carbon dioxide in the discharge pipes 15 will be released to the interior of the chambers 11 through the constricted orifices or apertures 10. Due to the sudden drop in pressure which occurs as a result of releasing the carbon dioxide in this manner, the liquid will be converted to a mixture of snow particles and vapors. Each aperture or orifice 10 will provide a separate jet or stream of the carbon dioxide mixture. These jets or streams will partake of straight line motion until their paths are obstructed by the inner surfaces of the chambers 11. The curved surface of each chamber rear wall will cause the flowing mixtures of carbon dioxide snow and vapors to be deflected so that the normal straight line motion will be converted to a curvilinear motion. In addition to partaking of this curvilinear motion, the snow and vapors of the several streams or jets released into each one of the two long chambers will be permitted to spread longitudinally of the chamber with the result that the various mixtures will merge to form a continuous mass equal in length to each continuous or two-part chamber.

I pointed out in my aforementioned copending application that it is a well recognized law or principle of physics that any object or material which is set in motion will travel in a straight line unless some force is applied thereto which will deflect it from such a path of movement. Additionally, the force required to deflect the object or material from its straight line motion depends on the velocity and the mass or density of the object or material being deflected.

The curved inner surfaces of the rear walls 13 of the chambers have been referred to above as functioning to accomplish this change in direction of motion of the released carbon dioxide snow and vapors. These curved chamber wall surfaces, therefore, provide the opposing force referred to in the above noted principle of physics. As the carbon dioxide snow of the mixture is many times more dense than the carbon dioxide vapors, and as the velocity of both of these components is the same, the snow offers more resistance to the deflecting force provided by the rear chamber walls. The snow, therefore, will force its way to the outer side of the curvilinear path of flow of the material with the result that it will displace the vapors, forcing them to seek a path of flow away from the inner surface of the chamber wall. The difference in density of the snow as compared to the vapors, therefore, brings about a segregation of these two components. That is to say, the snow will form a flowing layer in contact with the inner wall surface of the chamber while the vapors form a superimposed layer spaced from the surface of the chamber wall.

In further explanation of this segregating action, it will be understood that this classifying or segregating of the snow and vapors will not

be complete for a small amount of vapors will be trapped by the snow particles and be compelled to flow therewith while a certain minor portion of the lighter, smaller snow particles will be carried along with the vapors. Furthermore, there will be a merging or blending zone between the concentrated layer of snow and the displaced layer of vapors. That is to say, the snow and vapors will not be sharply defined into two clearly distinguishable layers or strata so that these latter terms are not 100% correct. It is believed, however, that these terms can be employed to distinguish between the segregated snow and vapor components by keeping the above explanation in mind.

The desired segregation of the snow and vapors is accomplished by the time the discharge reaches the open front of each chamber. The snow layer will be adjacent the inner side wall 14 while the vapor layer will be arranged outwardly of the snow layer or adjacent the discharge pipes 9. The final fire extinguishing stream will be formed by the segregated discharges from the two full length, parallel chambers. The snow layers from the two charges will lie adjacent to each other and will immediately merge. The vapor layers of the two discharges will be located outwardly of the snow layers and will sandwich the snow layers therebetween. It will be appreciated, therefore, that the final discharge will consist of a core that is formed by the two merged snow layers with the vapor layers shielding the snow core from the atmosphere. This final discharge stream will have a width which corresponds with the length of each chamber while the depth or thickness of the stream will be approximately equal to the distance between the adjacent sides of the discharge pipes 9.

The carbon dioxide discharge obtained by means of this apparatus has been found to be extremely effective in combating outdoor fires that are burning in the presence of high velocity natural winds. Although the field of application, or area of direct impingement, of the stream is very large, the concentrating of the dense snow in the core of the stream and the shielding of this snow from the surrounding atmosphere by the vapors makes it possible to project the stream a considerable distance while maintaining an entirely effective extinguishing concentration. One type of use for which this discharge device is particularly adapted is the extinguishment of ground fires. When used for that purpose, the discharge device may be several feet in length and be carried by a suitable form of wheeled vehicle, such as a crash truck.

There is one peculiar characteristic possessed by the discharge device of Figs. 1 to 3 inclusive which is believed to be worthy of special mention. It was determined by actual tests that causing the discharges from the two chambers to merge prior to reaching the open discharge side of the apparatus materially reduced the effective range and caused the discharge stream to spread very soon after leaving the device. In making this experiment, the two chambers were terminated on their adjacent sides approximately at the point where the two curved rear walls contact each other. In other words, the two inner side walls 14 were omitted. The reduction in range and increase in spread of the final discharge of this type of structure apparently was due to the fact that the flowing material in the two chambers merged while traveling through two converging paths with the result that the two dense

snow layers deflected each other as a result of the impact. By employing the two inner side walls 14, the discharges from the two chambers are permitted to merge while traveling in the same direction and without any appreciable amount of impact.

It will be appreciated that with certain forms of hazards it is not necessary to shield both sides of the snow from the surrounding atmosphere. The discharge device may be so arranged with respect to such hazards that the hazard itself will shield one side of the discharge. It is not necessary in such cases to use the double chamber type of apparatus. In other words, one of the chambers 11, and its associated discharge pipes 9, may be dispensed with to provide a final discharge which is made up of one layer of snow and one layer of vapors. The layer of snow in such a discharge will be presented to a suitable surface of the hazard while the layer of vapors will shield the snow from the surrounding atmosphere.

Fig. 4 is presented with a double purpose in mind. First, it discloses a single chamber type of discharge apparatus. Secondly, two structures of the type shown in Fig. 4 may be assembled in the manner illustrated in Figs. 1 to 3 inclusive for producing a double chamber type of device.

This Fig. 4 apparatus includes a chamber 19 that is formed with a curved wall 20 which is more than 270° of a circle when viewed in cross section. This chamber terminates in a discharge lip or side wall 21 that is tangentially arranged with respect to the remaining wall portion. The apertured discharge pipe 22 is attached to the chamber wall 20 adjacent its longitudinal edge 23. The discharge orifices or apertures 24 may be arranged so that projections of the same will intersect the curved wall 20 at any desired point. This point of intersection will depend on the degree of segregation of the snow and vapors that is desired. The greater the length of the curved path through which the discharged snow and vapors pass, the greater the degree of segregation of these two components. It will be appreciated, therefore, that the apertures 24 of this discharge device may be arranged so that the released snow and vapors will be compelled to travel a longer curvilinear path than is possible to provide with the chambers 11 of Figs. 1 to 3 inclusive.

Another distinction between the chamber structure of Fig. 4 and the chamber structure of Figs. 1 to 3 inclusive is the difference in the depth or thickness of the discharge opening. In the structure of Fig. 4, a relatively narrow discharge 25 is provided. With this type of discharge, the resultant stream will be more condensed and will possess a relatively high velocity. With the chamber structure of Figs. 1 to 3 inclusive, the discharge opening is formed by the inner side of the discharge pipe 9 and the opposing side wall 14 of the chamber. Therefore, for the same rate and volume of discharge, the velocity of the resultant stream will be less than that of the Fig. 4 apparatus. Except for these distinctions, the discharge device of Fig. 4 will operate in the same manner as the discharge device of Figs. 1 to 3 inclusive.

It is to be understood that the forms of this invention herewith shown and described are to be taken as preferred examples 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, I claim:

1. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to a relatively long region of release, discharging the liquid through a plurality of constricted orifices arranged along said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors in confinement until they merge along the length of said region, 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, and finally discharging to the atmosphere along the length of said region the thus segregated snow and vapors.

2. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to an elongated region of release, discharging the liquid through a plurality of constricted orifices arranged along said region 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 path of movement while allowing them to merge lengthwise of said region, continuing the deflection of the flowing snow and vapors until the difference in density of the snow and the vapors has effected a substantial segregation of components, and finally discharging to the atmosphere along the length of said region the segregated snow and vapors as a single stream having a considerably greater width than thickness.

3. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to an elongated region of release, discharging the liquid at said region through a plurality of spaced constricted orifices into a chamber that extends lengthwise of said region to permit sudden expansion of the liquid to effect its conversion into streams of snow and vapors, causing the flowing streams of snow and vapors to merge and to partake of curvilinear motion while flowing through the chamber to effect substantial segregation of the snow and vapors, and finally discharging to the atmosphere throughout the length of said chamber the segregated snow and vapors as a single stream.

4. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to a relatively long region of release, discharging the liquid through a plurality of constricted orifices arranged along said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors in confinement until they merge along the length of said region, 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, and finally discharging the segregated snow and vapors to the atmosphere in the form of a relatively thin stream having a width substantially corresponding to the length of said region.

5. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to a relatively long region of release, discharging the liquid through a plurality of constricted orifices arranged along said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors in con-

finement until they merge along the length of said region, 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, and finally discharging the segregated snow and vapors to the atmosphere in the form of a stream having a width substantially corresponding to the length of said region and with the snow and vapor layers collectively providing the stream thickness.

6. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to a relatively long region of release, discharging the liquid through a plurality of constricted orifices arranged along said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors in confinement until they merge along the length of the said region, 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, and finally discharging the segregated snow and vapors to the atmosphere in the form of a stream having a width substantially corresponding to the length of said region and with the snow layer defining one surface of the stream while the vapor layer defines the other surface.

7. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to a relatively long region of release, discharging the liquid through a plurality of constricted orifices arranged along said region to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors in confinement until they merge along the length of said region, 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, and finally discharging the segregated snow and vapors to the atmosphere in the form of a stream having a width substantially corresponding to the length of said region and with the snow and vapor layers arranged in the stream so that the vapors will shield the snow from the surrounding atmosphere.

8. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to an elongated region of release, discharging the liquid through a plurality of constricted orifices arranged along said region 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 said region, continuing the deflection of the flowing snow and vapors until the difference in density of the snow and the vapors has effected a substantial segregation of these components, and finally discharging the segregated snow and vapors to the atmosphere in the form of a stream having a width substantially corresponding to the length of said region and with the snow and vapor layers collectively producing the stream thickness.

9. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to an elongated region of release, discharging the liquid through a plurality of constricted orifices arranged along said region

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 said region, continuing the deflection of the flowing snow and vapors until the difference in density of the snow and the vapors has effected a substantial segregation of these components, and finally discharging the segregated snow and vapors to the atmosphere in the form of a stream having a width substantially corresponding to the length of said region and with the snow layer defining one surface of the stream while the vapor layer defines the other surface.

10. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to an elongated region of release, discharging the liquid through a plurality of constricted orifices arranged along said region 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 said region, continuing the deflection of the flowing snow and vapors until the difference in density of the snow and vapors has effected a substantial segregation of these components, and finally discharging the segregated snow and vapors to the atmosphere in the form of a stream having a width substantially corresponding to the length of said region with the snow and vapor layers arranged in the stream so that the vapors will shield the snow from the atmosphere.

11. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to an elongated region of release, discharging the liquid at said region through a plurality of spaced constricted orifices into a chamber that extends lengthwise of said region to permit sudden expansion of the liquid to effect its conversion into streams of snow and vapors, causing the flowing streams of snow and vapors to merge and to partake of curvilinear motion while flowing through the chamber to effect substantial segregation of the snow and vapors, and finally discharging to the atmosphere throughout the length of said chamber the segregated snow and vapors as a single stream with the snow and vapor layers collectively providing the stream thickness.

12. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid to an elongated region of release, discharging the liquid at said region through a plurality of spaced constricted orifices into a chamber that extends lengthwise of said region to permit sudden expansion of the liquid to effect its conversion into streams of snow and vapors, causing the flowing streams of snow and vapors to merge and to partake of curvilinear motion while flowing through the chamber to effect substantial segregation of the snow and vapors, and finally discharging to the atmosphere throughout the length of said chamber the segregated snow and vapors as a single stream with snow and vapor layers respectively defining opposite outer surfaces of the stream.

13. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid through spaced parallel flow paths extending longitudinally of a relatively long region of release, discharging the liquid through a plurality of constricted orifices

arranged along each flow path to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors for each flow path in a separate zone of confinement until they merge lengthwise of their zone, causing the snow and vapors in each zone 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, and finally discharging to the atmosphere from said zones their segregated snow and vapors as a merged composite stream.

14. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid through spaced parallel flow paths extending longitudinally of a relatively long region of release, discharging the liquid through a plurality of constricted orifices arranged along each flow path to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors for each flow path in a separate zone of confinement until they merge lengthwise of their zone, causing the snow and vapors in each zone 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, and finally discharging to the atmosphere from said zones their segregated snow and vapors as a merged composite stream having a width substantially corresponding to the length of said region and with the snow and vapor layers collectively providing the stream thickness.

15. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising conducting the liquid through spaced parallel flow paths extending longitudinally of a relatively long region of release, discharging the liquid through a plurality of constricted orifices arranged along each flow path to permit sudden expansion of the liquid to effect its conversion into snow and vapors, maintaining the flowing snow and vapors for each flow path in a separate zone of confinement until they merge lengthwise of their zone, causing the snow and vapors in each zone 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, and finally discharging to the atmosphere from said zones their segregated snow and vapors as a merged composite stream having a width substantially corresponding to the length of said region and with the layers of the segregated snow and vapors arranged in the stream so that the vapors will shield the snow from the surrounding atmosphere.

16. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along a curvilinear path arranged transversely of an elongated discharge zone to effect segregation of these components, and forming the snow and vapor layers resulting from said segregation into a stream by discharging the same from the zone with the width of the stream substantially corresponding to the length of the discharge zone and with the snow and vapor layers collectively providing the stream thickness.

17. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising an elongated chamber having a discharge opening extending the length thereof and a transversely

curved wall lying opposite said opening, and means for releasing into said chamber a plurality of longitudinally spaced jets of carbon dioxide snow and vapors with the jets so directed that the snow and vapors will be caused to flow over said curved wall in reaching the discharge opening whereby the snow and vapors will be segregated into different portions of the stream discharged through the chamber opening.

18. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising an elongated chamber having a discharge opening extending the length thereof and a transversely curved wall lying opposite said opening, and a discharge pipe extending the length of said chamber and having a plurality of longitudinally spaced orifices through which liquid carbon dioxide is released to convert it to snow and vapors, said discharge orifices being so arranged that the snow and vapors will be caused to flow over said curved wall in reaching the discharge opening whereby the snow and vapors will be segregated into different portions of the stream discharged through the chamber opening.

19. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising two parallel elongated chambers arranged adjacent each other, each one of said chambers having a discharge opening extending the length thereof and a transversely curved wall lying opposite said opening, and means in each chamber for releasing a plurality of longitudinally spaced jets of carbon dioxide snow and vapors with the jets so directed that the snow and vapors will be caused to flow over said curved wall in reaching the discharge opening whereby the snow and vapors will be segregated into different portions of the discharges through the chamber openings.

20. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising two parallel elongated chambers arranged in contact with each other, said chambers having closely positioned openings extending the length thereof with each chamber having a transversely curved wall lying opposite its opening, and a discharge pipe extending lengthwise of each chamber adjacent its outer side and having a plurality of longitudinally spaced orifices through which liquid carbon dioxide is released to convert it to snow and vapors, said pipe orifices being so directed that the snow and vapors will be caused to flow over said curved walls in reaching the discharge openings of the chambers whereby the snow and vapors will be segregated into different portions of the discharges through the chamber openings.

21. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along a curvilinear path arranged to terminate in an elongated discharge zone to effect segregation of these components, and forming the segregated snow and vapor components into a stream discharging from the entire length of the elongated discharge zone.

22. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along a curvilinear path arranged to terminate in an elongated discharge zone to effect segregation of these components, and forming the segregated snow and

vapor components into a stream having a width substantially corresponding with the length of the elongated discharge zone and with the segregated snow defining one surface of the stream while the segregated vapors define the other surface.

23. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along a curvilinear path arranged to terminate in an elongated discharge zone to effect segregation of these components, and forming the segregated snow and vapor components into a stream having a width substantially corresponding to the length of the elongated discharge zone and with the snow and vapor segregations arranged in the stream so that the vapors will shield the snow from the surrounding atmosphere.

24. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along parallel curvilinear paths arranged to terminate in an elongated discharge zone to effect segregation of these components as a result of their difference in density, and forming the segregated snow and vapor components of said parallel paths into a single stream discharging from the entire length of the elongated discharge zone.

25. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along parallel curvilinear paths arranged to terminate in an elongated discharge zone to effect segregation of these components as a result of their difference in density, and forming the segregated snow and vapor components of said parallel paths into a single stream having a greater width than thickness.

26. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along parallel curvilinear paths arranged to terminate in an elongated discharge zone to effect segregation of these components as a result of their difference in density, and forming the segregated snow and vapor components of said parallel paths into a single stream having a width substantially corresponding to the length of the elongated discharge zone and with the snow and vapor segregations collectively providing the stream thickness.

27. A method of discharging liquid carbon dioxide for fire extinguishing purposes, comprising effecting sudden release of the liquid to lower its pressure sufficiently to form snow and vapors, flowing said snow and vapors along parallel curvilinear paths arranged to terminate in an elongated discharge zone to effect segregation of these components as a result of their difference in density, and forming the segregated snow and vapor components of said parallel paths into a single stream having a width substantially corresponding to the length of the elongated discharge zone and with the snow and vapor segregations so arranged in the stream that the vapors will shield the snow from the surrounding atmosphere.

28. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising an elongated chamber having a discharge opening extending the length thereof and a transversely curved wall lying opposite said opening, and means for releasing into the length of said chamber carbon dioxide snow and vapors in such a manner as to cause the snow and vapors to flow over said curved wall in reaching the discharge opening whereby the snow and vapors will be segregated into different portions of the stream discharged through the chamber opening.

29. Fire extinguishing apparatus for discharging liquid carbon dioxide, comprising parallel elongated chambers arranged adjacent each other, each of said chambers having a discharge opening extending the length thereof and a transversely curved wall lying opposite said opening, and means in each chamber for releasing into the length thereof carbon dioxide snow and vapors in such a manner as to cause the snow and vapors to flow over said curved wall in reaching the discharge opening whereby the snow and vapors of each chamber will be segregated into different portions of the stream discharging through the chamber opening.

30. Fire extinguishing apparatus, comprising means for releasing liquid carbon dioxide to produce a mixed snow and vapor flow of elongated shape in cross section, means for causing the snow and vapor of the flow to travel a curvilinear path of sufficient length to effect substantial segregation of the snow and vapor components, and means for effecting discharge of the snow and vapor components to the atmosphere in their segregated condition and as a stream of elongated cross section.

31. Fire extinguishing apparatus, comprising means for releasing liquid carbon dioxide to produce mixed snow and vapor and form it into two parallel flows each of which is of elongated shape in cross section, means for causing the snow and vapor of each flow to travel a curvilinear path of sufficient length to effect substantial segregation of the snow and vapor components, and means for effecting discharge of the snow and vapor components of both flows to the atmosphere in their segregated conditions but as a single stream of elongated cross section.

HILDING V. WILLIAMSON.