Aug. 30, 1949. H. V. WILLIAMSON 2,480,391

VENTING MEANS

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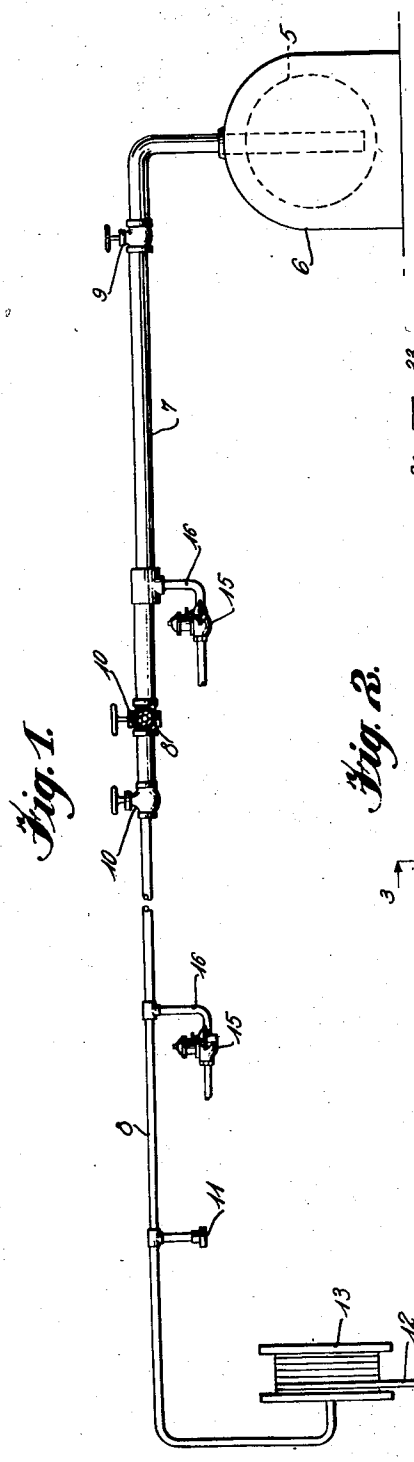


Fig. 1.

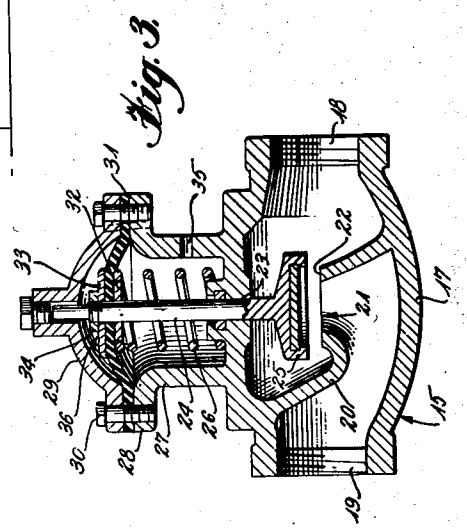


Fig. 3.

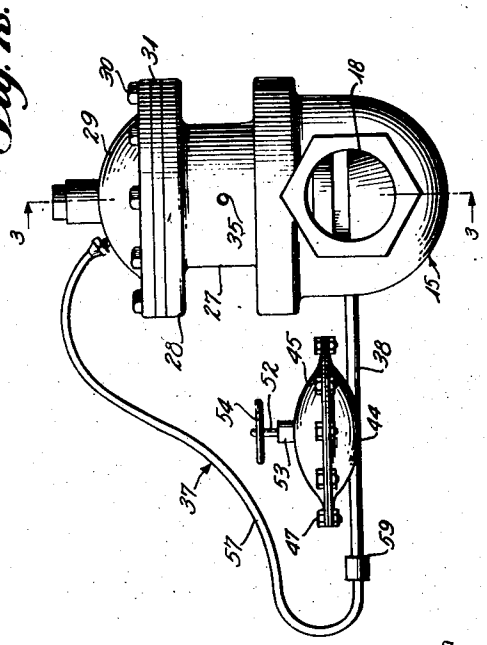


Fig. 2.

Inventor
Hilding V. Williamson

By L. Donald Myers
Attorney

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Fig. 4.

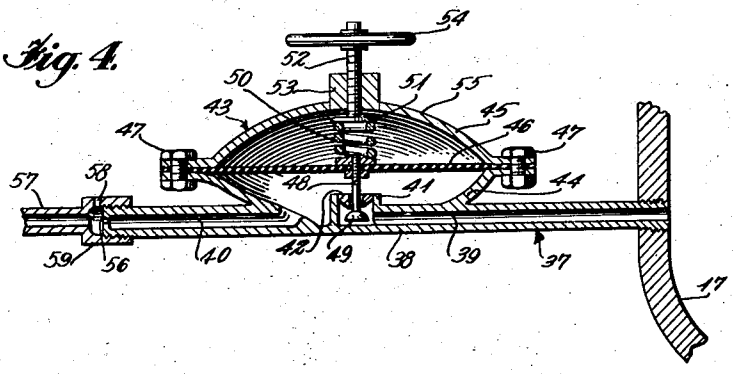


Fig. 5.

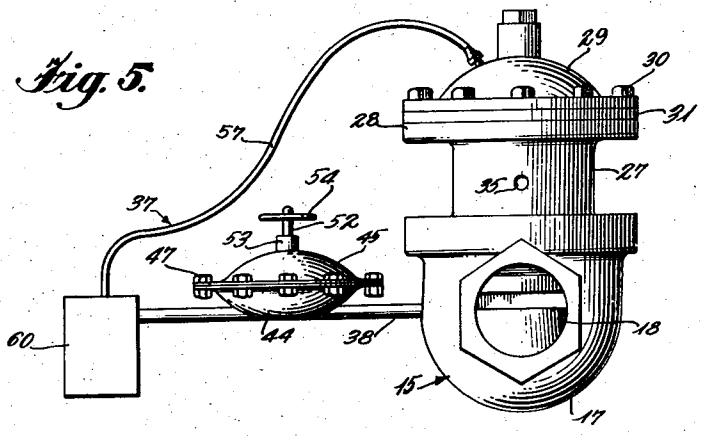
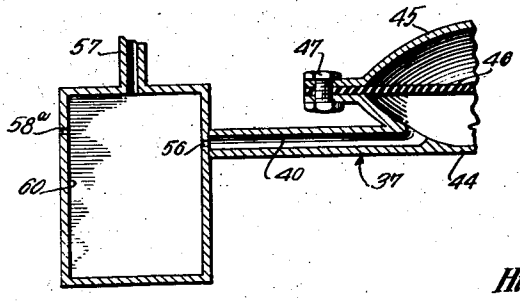


Fig. 6.



Inventor

Hilding V. Williamson

By L. Ronald Myers

Attorney

Patented Aug. 30, 1949 2,480,391

UNITED STATES PATENT OFFICE

2,480,391

VENTING MEANS

Hilding V. Williamson, Chicago, Ill., assignor to Cardox Corporation, Chicago, Ill., a corporation of Illinois

Application February 26, 1947, Serial No. 731,099

12 Claims. (Cl. 62—1)

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This invention relates to new and useful improvements in venting means and relates more specifically to the venting of carbon dioxide vapor from a fire extinguishing system that employs liquid carbon dioxide as the extinguishing medium.

When carbon dioxide is employed for extinguishing a fire by the direct application of the extinguishing medium onto the burning object or material, it is essential that liquid carbon dioxide be delivered to the point or points of discharge if the most efficient extinguishing action is to be obtained. For that reason, the nozzles, or other discharge devices, employed for effecting release of the extinguishing medium are designed especially for handling liquid carbon dioxide and are so positioned relative to the hazard as to make proper use of the snow and vapor type of discharge that results from the release of liquid carbon dioxide to the atmosphere. It will be obvious, therefore, that the delivery of carbon dioxide vapor to such discharge nozzles, or the like, will not help to any material extent in effecting extinguishment of a fire. It further will be realized that the time required to make the liquid carbon dioxide available for discharge at the nozzle is a very important factor in effecting rapid extinguishment of a fire after it is discovered so that property loss will be held to a minimum.

A fairly high percentage of fire extinguishing system installations require relatively long pipe-lines to connect the source of supply of the liquid carbon dioxide to the discharge nozzles that are located at the remotely positioned property to be protected. In other installations, a large capacity piping header must be provided to simultaneously supply the extinguishing medium to a number of discharge nozzles protecting a given hazard, or to a number of branch pipe-lines leading to different hazards that may require protection at the same time.

It is the usual practice to so install carbon dioxide fire extinguishing systems that the liquid carbon dioxide normally is kept confined in a refrigerated storage tank, or in a bank of high pressure cylinders, until a fire occurs and is then admitted to the piping system. Because the long pipe-lines and/or the large capacity piping headers are at atmospheric pressure and are at the temperature of the surrounding atmosphere when the liquid carbon dioxide is admitted thereto, there is considerable evaporation of the liquid carbon dioxide first released into the piping until

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a proper pressure and temperature condition develops in the piping of the systems.

The carbon dioxide vapor that is thus formed in the piping system must be expelled through the nozzles before liquid carbon dioxide can reach the nozzles for discharge onto the fire. Since all nozzle sizes must be established with reference to the piping system so as to maintain a desired back-pressure at the nozzles that is in excess of at least eighty pounds per square inch, absolute, the carbon dioxide vapor is discharged through such nozzles at a much lower rate than the nozzles are capable of discharging liquid carbon dioxide. Another condition that results in a very slow discharge of the carbon dioxide vapor is encountered in installations involving several hazards and including one or more small hazards which are protected by small capacity nozzles receiving their supply of carbon dioxide from large capacity piping headers. In such instances, the relatively large amount of carbon dioxide vapor that is formed in initially filling the headers may require as much, or even more, time to be discharged through the said small capacity nozzles as is required to effect the actual extinguishment of the fire with liquid carbon dioxide after the latter becomes available at the discharge nozzles.

It is the primary object of this invention to provide apparatus for quickly freeing a fire extinguishing piping system of its initial charge of carbon dioxide vapor so as to materially shorten the time required for liquid carbon dioxide to reach the discharge nozzles.

A further important object of the invention is to provide apparatus for quickly expelling the initial charge of carbon dioxide vapor from the portions of the fire extinguishing system piping located in advance of its liquid carbon dioxide discharge nozzles and for automatically stopping the expelling of carbon dioxide vapor after the elapse of a predetermined time interval.

Still another object of the invention is to provide the piping of a liquid carbon dioxide fire extinguishing system with one or more normally open venting valves which will discharge carbon dioxide vapor from the piping for a predetermined length of time after the vapor has first reached said valves and which will then automatically close, whereby the discharge nozzles of the system, which are operable to effect extinguishment of a fire by releasing liquid carbon dioxide to the atmosphere, will be supplied with the required liquid carbon dioxide much

more quickly than would be the case if said venting valves were not employed.

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

In the accompany drawings forming a part of this specification and in which like numerals are employed for designating like parts throughout the same,

Figure 1 is a side elevational view of a fire extinguishing system having carbon dioxide vapor venting valves properly assembled therein,

Figure 2 is a side elevational view of one of the vapor venting valves that are shown assembled in the system of Fig. 1,

Figure 3 is a sectional view taken on line 3—3 of Fig. 2,

Figure 4 is a detail, vertical sectional view showing a pressure regulating valve and a flow throttling device that are connected in a by-pass line shown associated with the vapor venting valve of Figs. 2 and 3,

Figure 5 is a similar view to Fig. 2 but illustrates a slight modification that involves a capacity increasing receiver connected in the by-pass line of the vapor venting valve, and

Figure 6 is a detail, vertical sectional view that more clearly illustrates the construction of the receiver shown in Fig. 5.

In the drawings, wherein for the purpose of illustration are shown the preferred embodiments of this invention, and first particularly referring to Fig. 1, the reference character 5 designates a storage tank in which liquid carbon dioxide is confined at a controlled sub-ambient temperature, and its corresponding vapor pressure, by means of an automatically controlled refrigerating system, not shown. This type of bulk storage for liquid carbon dioxide is more fully illustrated in the Eric Geertz patent, No. 2,143,311, issued January 10, 1939, and No. 2,202,343, issued May 28, 1940. The storage tank 5 is suitably confined in a housing 6 and the space between the housing and the exterior of the tank 5 is filled with a suitable heat insulating material to retard absorption of heat from the surrounding atmosphere by the liquid carbon dioxide stored in the tank.

The tank 5 has suitably connected thereto a relatively large capacity piping header 7 through which the liquid carbon dioxide is to be delivered to any desired number of branch lines 8 of smaller capacity. For the purpose of normally confining the liquid carbon dioxide in the storage tank 5, and for effecting its release into the header 7 when a fire occurs, a suitable master valve 9 is connected to the header 7 at a desired point located relatively close to the tank 5. It will be appreciated that this master valve 9 may be either manually controlled or automatically controlled. If it is automatically controlled, it normally will be opened in response to the automatic detection of a fire at one or more of the hazards being protected by the system.

When the system includes a plurality of branch lines, such as those designated by the reference characters 8, for separately or independently protecting different hazards, the admission of the liquid carbon dioxide from the piping header 7 into the branch pipe-line 8 that leads to the involved hazard is controlled by a valve 10. These are known as selector valves and one such valve is provided for each one of the separate branch lines 8. These selector valves 10 may be either manually controlled or automatically controlled

in the same manner as has been referred to above in connection with the master valve 9.

Each branch line 8 may have connected therein any desired number of liquid carbon dioxide discharge nozzles, or the like. Fig. 1 discloses one of the branch lines 8 as having connected therein a discharge nozzle 11 which will directly apply the discharge of carbon dioxide onto the particular hazard that is to be protected thereby. Additionally, this branch line 8 is illustrated as having connected thereto a hose-line 12, normally wound on the reel 13, and having the discharge nozzle 14 connected to its outer end.

Because the master valve 9 is normally closed, so that the liquid carbon dioxide will be confined in the storage tank 5, the large capacity header 7 normally will be in a non-pressure condition. That is to say, the pressure prevailing in the header 7, between the master valve 9 and the several selector valves 10, will correspond to that of the atmosphere. The header 7, also, will be at ambient temperature. Consequently, when the liquid carbon dioxide is admitted to the header 7, as a result of opening the master valve 9, there will be a substantial drop in pressure of the liquid carbon dioxide that is admitted to the heater. Also, the low temperature liquid carbon dioxide admitted to the header will absorb a substantial amount of heat from the header until the temperature of the header is lowered to that of the carbon dioxide. Because of these two conditions, the liquid carbon dioxide first admitted to the header 7, for the purpose of filling this header, will vaporize and the header will be filled with carbon dioxide vapor. These same two conditions apply to the particular branch line 8 into which the carbon dioxide is released, by the opening of the proper selector valve 10, to effect delivery of the extinguishing medium to the particular hazard that is being consumed by the fire. Consequently, the liquid carbon dioxide that is first admitted to one of the branch lines will flash to vapor.

As has been pointed out above, the discharge nozzles 11 and 14 are designed for extinguishing a fire when liquid carbon dioxide is delivered thereto for release into the surrounding atmosphere. These discharge nozzles, therefore, are not suitable for effecting a rapid liberation of the piping 7—8 of the carbon dioxide vapor that is initially formed therein. Also, the discharge nozzles 11 and 14 cannot be relied upon to effectively attack a fire when carbon dioxide vapor is being discharged therefrom.

Because it is very essential that liquid carbon dioxide be delivered to the discharge nozzles 11 and 14 at the earliest possible moment after a fire is discovered, it becomes imperative that the initial charge of carbon dioxide vapor be expelled from the piping at a more rapid rate than is possible with the discharge nozzles 11 and 14. For that reason, the piping of the system is provided with a suitable number of vapor venting valves which are designated by the reference character 15 in Fig. 1. It will be noted that one of these valves is provided for the large capacity piping header 7 while a second vapor venting valve is provided for the completely illustrated branch line 8. It is to be understood, however, that additional vapor venting valves 15 may be employed and that they may be arranged in any suitable manner in the system to most effectively provide rapid discharge of the carbon dioxide vapor from the piping system.

Each one of the vapor venting valves 15 is il-

lustrated in Fig. 1 as being connected in a length of piping 16 that is coupled to the header 7 or a branch line 8. These pipe-lines 16 are shown as being broken-off beyond the vapor venting valves 15. This is intended to illustrate that these pipes 16 may open to the atmosphere in the vicinity of the piping or they may extend to a suitable point outside of the building provided with this fire extinguishing system so that the vented carbon dioxide vapor may be exhausted to the outside atmosphere.

The detail construction of each one of the carbon dioxide vapor venting valves is clearly illustrated by the disclosures of Figs. 2 to 6 inclusive. Figs. 2 to 4 inclusive illustrate one form of vapor venting valve while Figs. 5 and 6 illustrate a slight modification. These two constructions will be described in detail in connection with these several figures.

First referring to Figs. 2 to 4 inclusive, it will be seen that the vapor venting valve includes a suitable valve housing or body 17 that is provided with an inlet 18 and an outlet 19. Between the inlet and the outlet, the body 17 is provided with a partition 20 that is formed with an opening 21 surrounded by a valve seat 22. In line with the axis of the opening 21, the valve body 7 is provided with a packed opening 23 through which passes the valve stem 24. This stem carries a valve head or member 25 that is adapted to be moved into and out of engagement with the valve seat 22, of the partition 20, for closing and opening the flow path that is provided through the valve body 17.

The valve head or member 25 normally should occupy the unseated position illustrated in Fig. 3 so that the vapor venting valve will be open for the discharge of carbon dioxide vapor from the associated piping. A spring 26 is threaded over the valve stem 24 and is connected, in a manner to be described, to the valve stem for normally holding the valve head or member unseated.

The valve body 17 is provided with a hollow extension 27 that surrounds most of the projecting portions of the valve stem 24 and the spring 26. This hollow extension is flanged at 28 for having connected thereto the outwardly dished cap 29 by means of the screws 30. The cap 29 and the flange 28 have clamped between their opposed surfaces the periphery or margin of the flexible diaphragm 31. The central portion of this diaphragm is connected to the outer end portion of the valve stem 24 by means of the discs 32 and 33 and the lock nut 34. These discs and the diaphragm function to connect the outer end of the spring 26 to the valve stem 24.

The space provided within the hollow extension 27 is vented to the atmosphere by the port 35 so that atmospheric pressure will prevail in this space. The space or chamber that is formed between the diaphragm 31 and the cap 29, which space is designated by the reference character 36, is sealed so as to provide a fluid pressure chamber for the application of fluid pressure to the outer surface of the diaphragm 31. When a suitable working fluid pressure is built-up in the chamber 36 and is applied to the outer face of the diaphragm 31, the force of the spring 26 will be overcome and the diaphragm 31 will be displaced to move the valve head or member 25 against the seat 22 for closing-off the flow path for carbon dioxide vapor that is normally provided through the valve body 17.

Figs. 2, 3 and 4 disclose a by-pass line 37 that communicates at one end with the fluid pressure chamber 36 and communicates at its other end with the interior of the valve body 17 on the inlet side of the partition 20. It is to be understood, however, that the last mentioned end portion of the by-pass line 37 may be connected to the associated length of piping 16, or even to the header 7 or the branch line 8, just so the point of connection is upstream of the venting valve partition 20 and its opening 21.

By referring more specifically to Fig. 4, it will be seen that the portion of the by-pass line 37 that is located adjacent the vapor venting valve consists of a relatively stiff or rigid pipe section 38 that includes a bore portion 39 and a bore portion 40. The bore portion 39 communicates with the interior of the valve casing or housing 17 and terminates at its outer end in an enlarged valve chamber 41. The outlet opening of this valve chamber is partially closed by a valve seat forming disc 42.

This valve seat forming disc 42 constitutes a part of a pressure regulating valve that is designated in its entirety by the reference character 43. This pressure regulating valve specifically includes an inner, dished casing portion 44 and an outer dished casing portion 45. These casing portions are peripherally flanged to permit the peripheral edge portion of the diaphragm 46 to be clamped therebetween when the casing portions 44 and 45 are connected by the bolts and nuts 47.

The diaphragm 46 has the outer end portion of the valve stem 48 suitably connected thereto. This stem carries the valve head 49 that cooperates with the valve seat forming disc 42 and is located on the upstream side thereof. It will be seen, therefore, that when fluid pressure is developed in the space between the inner casing portion 44 and the diaphragm 46, the diaphragm will be flexed outwardly to move the valve head 49 toward or into engagement with the valve seat disc 42.

To properly counteract the fluid pressure that is developed in the casing of the pressure regulating valve 43, or below the diaphragm 46, a spring 50 is arranged so as to bear at one end against the diaphragm 46. A disc 51 is suitably fastened to the outer end of this spring 50 and to the inner end of the adjustment screw 52 that is threaded in the extension 53 formed on the casing portion 45. An operating wheel 54 is attached to the outer end portion of the adjusting screw 52. The space within the casing of the pressure regulator valve, located outwardly of the diaphragm 46, is vented to the atmosphere by the port 55 so that atmospheric pressure will prevail within this portion of the casing.

This pressure regulating valve 43 will function to maintain at a constant pressure value any carbon dioxide vapor that flows through the bore 39 of the length of pipe 38. By adjusting the screw 52, through the medium of the operating wheel 54, the pressure exerted by the spring 50 on the diaphragm 46 may be adjusted or varied to regulate the pressure at which the carbon dioxide vapor is discharged past the valve head 49 and the disc seat 42.

This constant pressure carbon dioxide vapor will flow from the casing of the pressure regulating valve 43 into the bore portion 40 of the length of piping 38 and will be discharged through the throttling orifice 56 that is located at the outer extremity of the bore 40. This orifice 56 is intended to reduce to a desired extent the volume or rate of discharge of the constant pressure carbon

dioxide vapor that is delivered to the bore 40 of the pipe 38. It will be appreciated, therefore, that by regulating to a constant value the pressure of the carbon dioxide vapor that is permitted to flow into the bore 40, and by throttling the rate of discharge of the carbon dioxide vapor from this latter bore, the volume of carbon dioxide vapor that is released through the orifice 56 can be predetermined. Consequently, the length of time required for a given volume of carbon dioxide vapor to be released through the orifice 56 can be accurately measured or predicted.

The measured carbon dioxide vapor that is released through the orifice 56 is delivered to the pressure chamber 36 of the vapor venting valve 15 through the tubing 57 that forms the second part of the by-pass line 37. With the carbon dioxide vapor being delivered to the chamber 36 of the vapor venting valve 15 at a constant, predetermined rate, the amount of time required to build-up the proper working pressure within the chamber 36 can be predetermined. It will be appreciated, therefore, that any desired predetermined length of time may be required to elapse before the development of the work pressure in the chamber 36 that is necessary to move the valve body 25 into engagement with the valve seat 22 for closing-off the vapor flow path through the valve body 17 and the venting pipe-line 16. It will be apparent, therefore, that the vapor venting valve 15 can be caused to operate to vent or exhaust carbon dioxide vapor from the associated header 7 or branch line 8 for a desired length of time and then be stopped by the closing of the vapor venting valve.

After a particular fire has been extinguished, and the master valve 9 and appropriate selector valve 10 have been closed, it becomes necessary to exhaust the carbon dioxide vapor that remains in the inlet portion of the valve body 17, the by-pass line 37, and the pressure chamber 36. The extremely small vapor exhausting port 58 is provided for this purpose. In Fig. 4, this port 58 is illustrated as being formed in the coupling 59 that connects the rigid pipe 38 to the tubing 57. It is to be understood, however, that this exhausting port 58 may be located at any other desired point. It further will be appreciated that the diameter of the exhausting port 58 should be so much smaller than the diameter of the throttling orifice 56 that the rate of release of carbon dioxide vapor through the exhausting port 58 will not affect to a material extent the function performed by the throttling orifice 56.

It will be appreciated that for practical reasons, the volumetric capacity of the pressure chamber 36, provided for each vapor venting valve 15, may be limited. Consequently, if it becomes desirable or necessary to prolong the closing of a vapor venting valve 15 beyond the capacity of its pressure chamber 36, the pressure regulating valve 43, and the throttling orifice 56, it becomes necessary to increase the effective capacity of the pressure chamber 36. This increase in effective capacity can be accomplished in the manner illustrated by the modification shown in Figs. 5 and 6. In this modification, a carbon dioxide vapor receiver 60 is connected in the tubing 57. The volumetric capacity of this receiver 60, therefore, is added to the volumetric capacity of the pressure chamber 36. Of course, the volumetric capacity of the length of tubing 37 can be increased in any other desired manner, such as by materially increasing the length of the tubing, or by materially increasing its diameter.

An extremely small carbon dioxide vapor exhausting port 58a is formed in a wall of the receiver 60. This exhausting port is intended to function in the same manner as the exhausting port 58 illustrated in Fig. 4.

All other elements incorporated in the modification illustrated in Figs. 5 and 6 are the same as those illustrated in detail in Figs. 2 to 4 inclusive. For that reason, the same reference characters will be applied to these elements.

It is to be understood that the forms of this invention herewith shown and described are to be taken as the 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. The combination with a fire extinguishing system comprising a source of supply of liquid carbon dioxide, piping extending from said source of supply to the point or points of discharge, liquid carbon dioxide discharge means connected to the piping at the points of discharge, and valve means in the piping adjacent the source of supply for admitting liquid carbon dioxide into the piping, of a plurality of normally open venting valves connected in the piping at spaced intervals between the said valve means and the discharge means for quickly emptying the piping of the carbon dioxide vapor that is formed therein as a result of flashing of the liquid carbon dioxide initially released into the piping, pressure fluid operated means for closing each venting valve as soon as a proper working pressure of carbon dioxide vapor has been built-up therein, means forming a carbon dioxide flow path between each pressure fluid operated means and the piping upstream of its associated venting valve, means located in said flow path for regulating to a constant pressure the carbon dioxide flowing therethrough, and means located in said flow path downstream of said pressure regulating means for throttling the flow of constant pressure carbon dioxide thereto to provide for the passage of a predetermined interval of time before the said working pressure is developed in said pressure fluid operated means.

2. The combination with a fire extinguishing system comprising a source of supply of liquid carbon dioxide, piping extending from said source of supply to the point or points of discharge, liquid carbon dioxide discharge means connected to the piping at the points of discharge, and valve means in the piping adjacent the source of supply for admitting liquid carbon dioxide into the piping, of a plurality of carbon dioxide vapor venting outlets connected to the piping at spaced intervals between the said valve means and the discharge means through which the carbon dioxide vapor initially formed in the piping is to be quickly discharged, a normally open vent valve controlling each venting outlet, pressure fluid operated means for closing each vent valve, each pressure fluid operated means comprising a fluid chamber having a displaceable wall portion operably connected to its associated vent valve for closing the latter when a proper working pressure of carbon dioxide vapor has been built-up in the fluid chamber, means forming a carbon dioxide flow path between the fluid chamber of each pressure fluid operated means and the piping upstream of its associated vent valve, means located in each flow path for regulating to a constant pressure the carbon dioxide flowing

therethrough, means located in each flow path downstream of said pressure regulating means for throttling the flow of constant pressure carbon dioxide therethrough, and a receiver connected in each flow path between the throttling means and the fluid chamber of the associated pressure fluid operated means to increase the effective volumetric capacity of said fluid chamber so as to delay the development of the working pressure in the fluid chamber.

3. In combination, a pipe-line into which liquid carbon dioxide is released when required for discharge at a point of use served by said pipe-line, a normally open vent valve connected to the pipe-line for releasing to the atmosphere the vapor that is formed in the latter when liquid carbon dioxide is first released into the pipe-line, pressure fluid operated means for closing said vent valve as soon as a proper working pressure of carbon dioxide vapor has been built-up therein, means forming a carbon dioxide flow path between said pressure fluid operated means and the pipe-line upstream of the vent valve, means located in said flow path for regulating to a constant pressure the carbon dioxide flowing therethrough, and means located in said flow path downstream of said pressure regulating means for throttling the flow of the constant pressure carbon dioxide therethrough to provide for the passage of a predetermined interval of time before the said working pressure is developed in said pressure fluid operated means.

4. In combination, a pipe-line into which liquid carbon dioxide is released when required for discharge at a point of use served by said pipe-line, a normally open vent valve connected to the pipe-line for releasing to the atmosphere the vapor that is formed in the latter when liquid carbon dioxide is first released into the pipe-line, pressure fluid operated means for closing said vent valve, said pressure operated means comprising a fluid chamber having a displaceable wall portion operatively connected to the vent valve for closing the latter when a proper working pressure of carbon dioxide vapor has been built-up in the fluid chamber, means forming a carbon dioxide flow path between the fluid chamber and the piping upstream of the vent valve, means located in the flow path for regulating to a constant pressure the carbon dioxide flowing therethrough, means located in the flow path downstream of the pressure regulating means for throttling the flow of constant pressure carbon dioxide therethrough, and a receiver connected in the flow path between the throttling means and said fluid chamber to increase the effective volumetric capacity of said fluid chamber so as to delay the development of the working pressure in the fluid chamber.

5. Means for venting vapor from a pipe-line into which liquid carbon dioxide is occasionally released, comprising a valve body having a carbon dioxide vapor flow path therethrough, a valve member in the valve body movable between two positions for opening and closing said flow path, resilient means normally holding said valve member in its open position, pressure fluid operated means for moving said valve member into its closed position when a predetermined working pressure has been built-up therein, means forming a carbon dioxide vapor by-pass line between the pressure fluid operated means and the said vapor flow path through the valve body, a pressure regulating valve connected in the vapor by-pass line to render constant the pressure of the vapor flowing through said line, and means located in said by-pass line downstream of the pressure regulating valve for throttling the flow of carbon dioxide therethrough to delay the development of the working pressure in the pressure fluid means for a predetermined interval of time after carbon dioxide has been delivered to the flow path through the valve body.

6. The combination with a fire extinguishing system comprising a source of supply of liquid carbon dioxide, piping extending from said source of supply to the point or points of discharge, liquid carbon dioxide discharge means connected to the piping at the points of discharge, and valve means in the piping adjacent the source of supply for admitting liquid carbon dioxide into the piping, of a plurality of normally open venting valves connected in the piping at spaced intervals between the said valve means and the discharge means for quickly emptying the pipe of carbon dioxide vapor that is formed therein as a result of flashing of the liquid carbon dioxide initially released into the piping, pressure fluid operated means for closing each venting valve as soon as a proper working pressure of carbon dioxide vapor has been built-up therein, by-pass means connecting each pressure fluid operated means to the piping upstream of its associated venting valve for delivering to the pressure fluid operated means substantially all of the by-passed carbon dioxide vapor, and means associated with each by-pass means for controlling the by-passed vapor to effect delivery at a slow constant rate to delay the development of said working pressure in the pressure fluid operated means for a predetermined interval of time to prevent premature closing of the venting valve.

7. In combination, a pipe-line into which liquid caron dioxide is released when required for discharge at a point of use served by said pipe-line, a normally open vent valve connected to the pipe-line for releasing to the atmosphere the vapor that is formed when liquid carbon dioxide is first released into the pipe-line, pressure fluid operated means for closing said vent valve as soon as a proper working pressure of carbon dioxide vapor has been built-up therein, and by-pass means connecting the first-mentioned means to the line upstream of the vent valve for delivering to the first-mentioned means substantially all of the by-passed carbon dioxide vapor at a slow constant rate until a predetermined time has elapsed, after liquid carbon dioxide is released into said pipe-line, before the said working pressure is built-up in said pressure fluid operated means.

8. In combination, a pipe-line into which liquid carbon dioxide is released when required for discharge at a point of use served by said pipe-line, a normally open vent valve connected to the pipe-line for releasing to the atmosphere the vapor that is formed in the latter when liquid carbon dioxide is first released into the pipe-line, pressure fluid operated means for closing said vent valve as soon as proper working pressure of carbon dioxide has been built-up therein, by-pass means connecting said pressure fluid operated means to the pipe-line upstream of the vent valve for delivering to said pressure fluid operated means substantially all of the by-passed carbon dioxide vapor, and means associated with said by-pass means for controlling the by-passed vapor to effect delivery at a slow constant rate to provide for the elapse of a predetermined length of time, after liquid carbon dioxide is released

into the pipe-line, before the said working pressure is built-up in said pressure fluid operated means.

9. Means for venting vapor from a pipe-line into which liquid carbon dioxide is occasionally released, comprising a valve body having a carbon dioxide vapor flow path therethrough, a valve member in the valve body movable between two positions for opening and closing said flow path, resilient means normally holding said valve member in its open position, pressure fluid operated means for moving said valve member into its closed position when a predetermined working pressure has been built-up therein, by-pass means connecting said pressure fluid operated means to said vapor flow path through the valve body for delivering to said pressure fluid operated means substantially all of the by-passed carbon dioxide vapor, and means associated with said by-pass means for controlling the by-passed vapor to effect delivery at a slow constant rate to delay the development of the working pressure in the pressure fluid means for a predetermined interval of time after carbon dioxide has been delivered to the flow path through the valve body.

10. Means for venting vapor from a pipe-line into which liquid carbon dioxide is occasionally released, comprising a valve body having a carbon dioxide vapor flow path therethrough, a valve member in the valve body movable between two positions for opening and closing said flow path, resilient means normally holding said valve member in its open position, pressure fluid operated means for moving said valve member into its closed position when a predetermined working pressure has been built-up therein, by-pass means connecting said pressure fluid operated means to said vapor flow path through the valve body for delivering to said pressure fluid operated means substantially all of the by-passed carbon dioxide vapor, means associated with said by-pass means for controlling the by-passed vapor to effect delivery at a slow constant rate to delay the development of the working pressure in the pressure fluid operated means for a predetermined interval of time after carbon dioxide has been delivered to the flow path through the valve body, and a receiver connected in the by-pass line between the means for controlling the by-passed vapor and the pressure fluid operated means to increase the effective volumetric capacity of the pressure fluid operated means to further delay the development of said working pressure in the pressure fluid operated means.

11. Means for venting vapor from a pipe-line into which liquid carbon dioxide is occasionally released, comprising a valve body having a carbon dioxide vapor flow path therethrough, a valve member in the valve body movable between two positions for opening and closing said flow path, resilient means normally holding said valve member in its open position, pressure fluid operated means for moving said valve member into its closed position when a predetermined working pressure has been built-up therein, by-pass means connecting said pressure fluid operated means to said vapor flow path through the valve body for delivering to said pressure fluid operated means substantially all of the by-passed carbon dioxide vapor, means associated with said by-pass means for controlling the by-passed vapor to effect delivery at a slow constant rate to delay the development of the working pressure in the pressure fluid operated means for a predetermined interval of time after carbon dioxide has been delivered to the flow path through the valve body, a receiver connected in the by-pass line between the means for controlling the by-pass vapor and the pressure fluid operated means to increase the effective volumetric capacity of the pressure fluid operated means to further delay the development of said working pressure in the pressure fluid operated means, and means for slowly exhausting the vapor from the pressure fluid operated means, after the release of liquid carbon dioxide into said pipe-line has ceased, to permit the resilient means to return the vent valve member to its open position.

12. Means for venting vapor from a pipe-line into which liquid carbon dioxide is occasionally released, comprising a valve body having a carbon dioxide vapor flow path therethrough, a valve member in the valve body movable between two positions for opening and closing said flow path, resilient means normally holding said valve member in its open position, pressure fluid operated means for moving said valve member into its closed position when a predetermined working pressure has been built-up therein, by-pass means connecting said pressure fluid operated means to said vapor flow path through the valve body for delivering to said pressure fluid operated means substantially all of the by-passed carbon dioxide vapor, means associated with said by-pass means for controlling the by-passed vapor to effect delivery at a slow constant rate to delay the development of the working pressure in the pressure fluid operated means for a predetermined interval of time after carbon dioxide has been delivered to the flow path through the valve body, a receiver connected in the by-pass line between the means for controlling the by-passed vapor and the pressure fluid operated means to increase the effective volumetric capacity of the pressure fluid operated means to further delay the development of said working pressure in the pressure fluid operated means, and means for slowly exhausting the vapor from the pressure fluid operated means, after the release of carbon dioxide into said pipe-line has ceased, to permit the resilient means to return the vent valve member to its open position.

HILDING V. WILLIAMSON.

No references cited.