Feb. 9, 1943. G. SCHAAF 2,310,552

FIRE EXTINGUISHING METHOD AND MEANS

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FIG. 1.

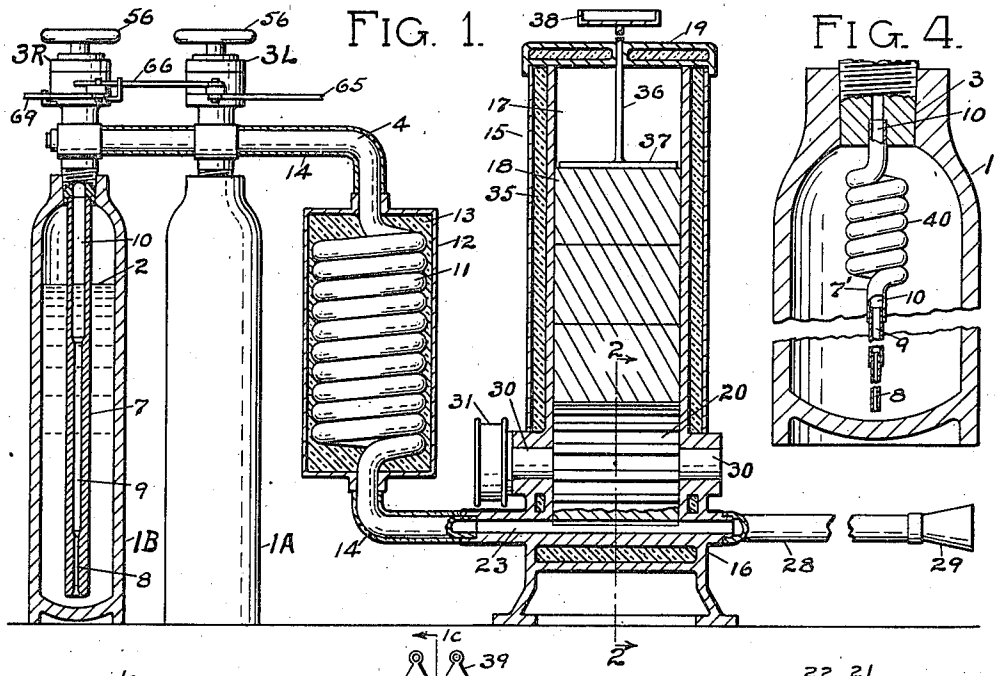


FIG. 4.

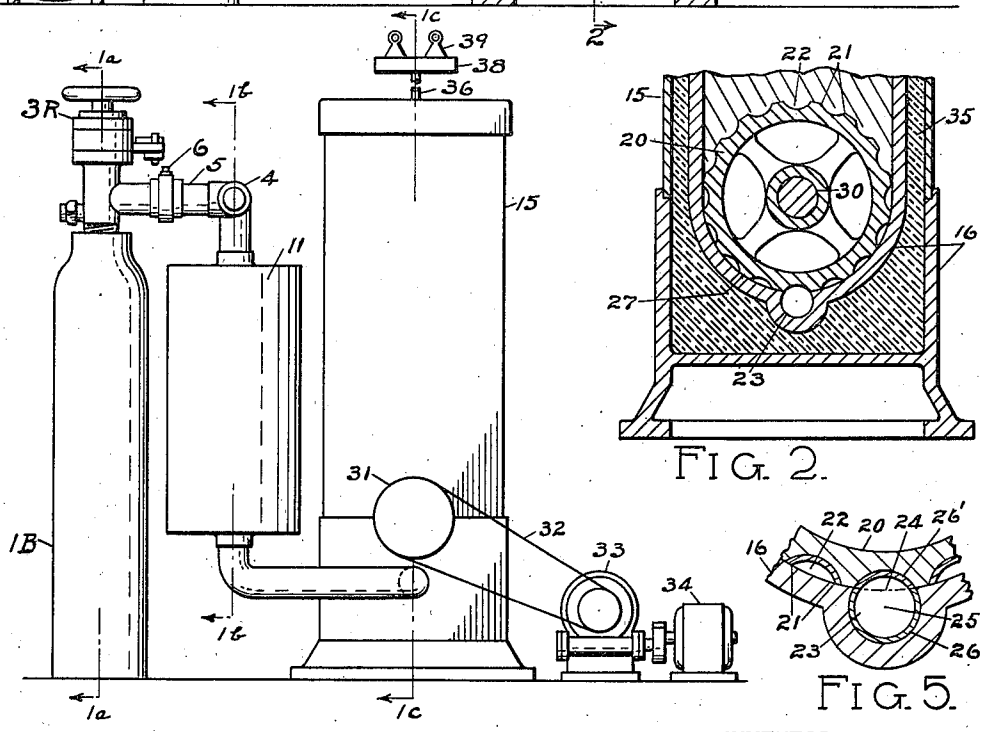


FIG. 3.

FIG. 2.

FIG. 5.

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FIG. 6.

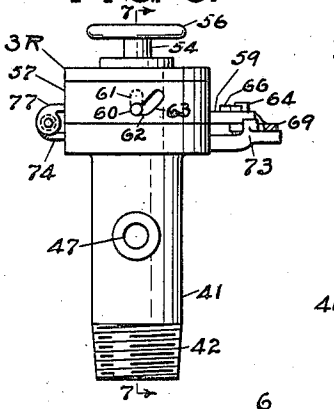


FIG. 7.

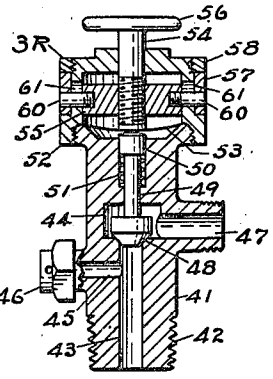
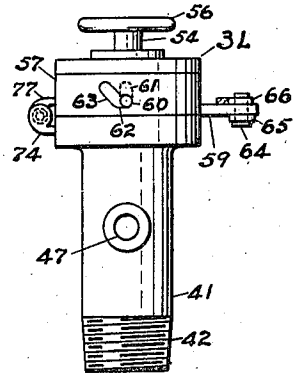


FIG. 8.



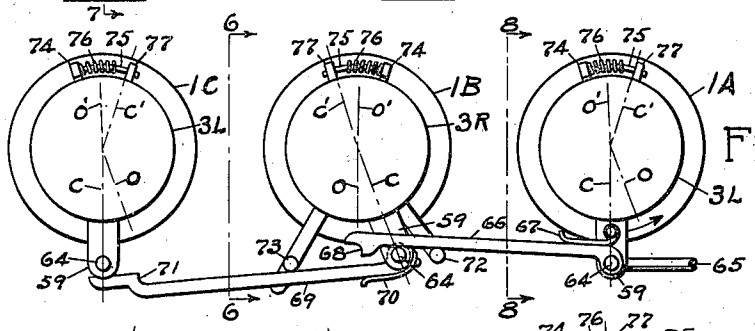


FIG. 9.

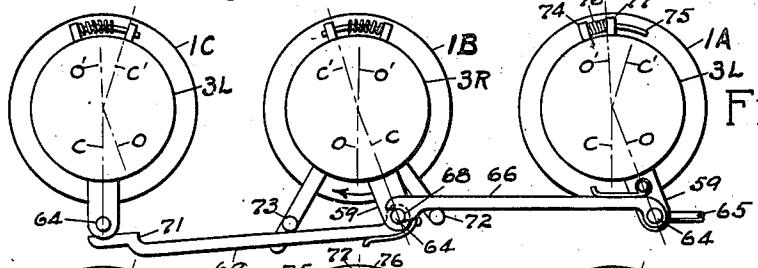


FIG. 10.

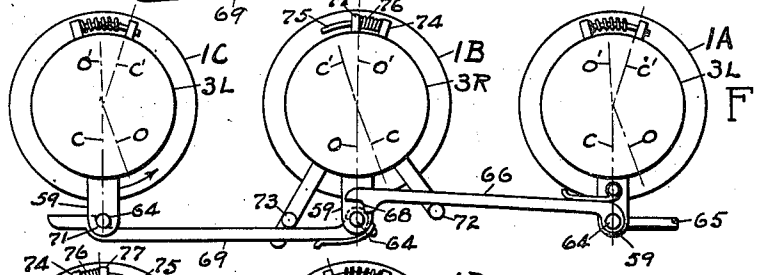


FIG. 11.

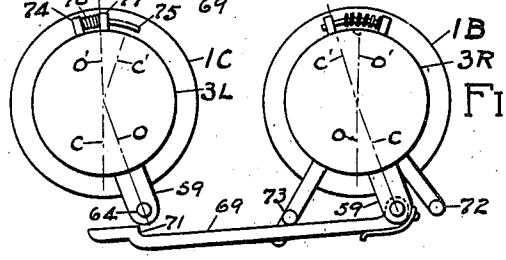


FIG. 12.

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FIG. 13.

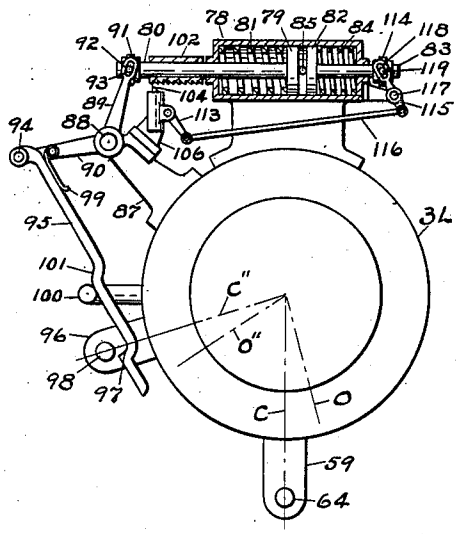
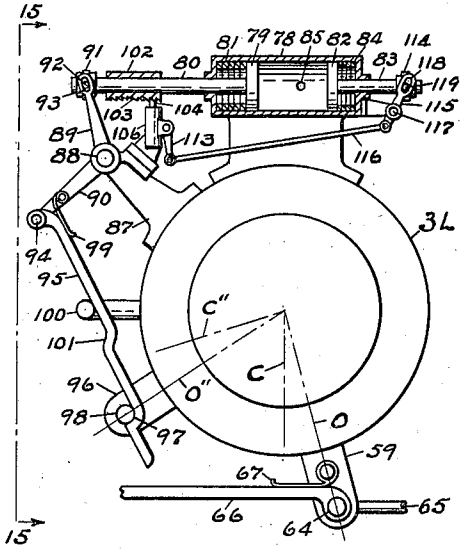


FIG. 14.



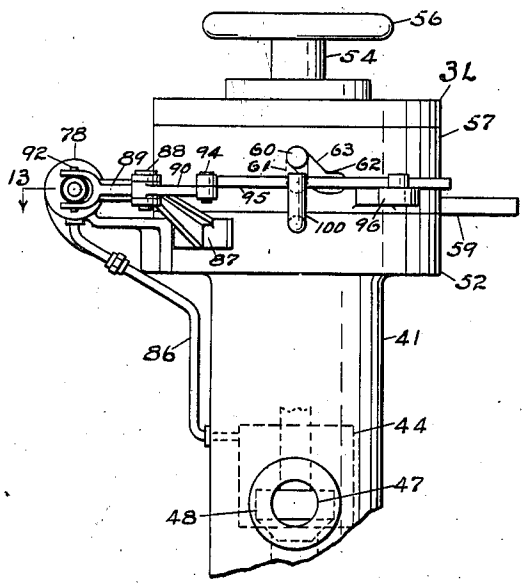


FIG. 15.

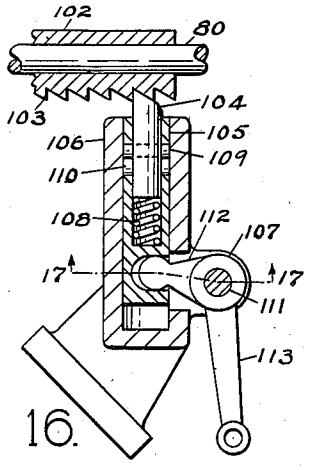


FIG. 16.

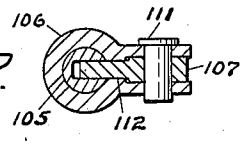


FIG. 17.

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Patented Feb. 9, 1943 2,310,552

UNITED STATES PATENT OFFICE

2,310,552

FIRE EXTINGUISHING METHOD AND MEANS

George Schaaf, Buffalo, N. Y.

Application August 15, 1941, Serial No. 407,029

20 Claims. (Cl. 169—11)

This invention relates in general to a method and means for using carbon dioxide to extinguish fires and especially to distribute carbon dioxide snow by the fluid pressure from a tank or container of liquid carbon dioxide under high pressure.

As ordinarily used for fire extinguishing purposes, the carbon dioxide is maintained under high pressure in a container and at ordinary temperatures this carbon dioxide is in liquid form. Suitable means are then provided for discharging the carbon dioxide fluid from the container to be carried by piping or hose and discharged in a stream to blanket and extinguish a fire. When the stream is discharged into the atmosphere the liquid takes, largely, a gaseous form and under certain conditions a portion of said stream of gas will form a carbon dioxide snow.

As is now well known CO_2 snow is a desirable form to better lower the temperature and blanket and so extinguish a flame and various means have been devised to create as much snow as possible from the discharging stream of fluid from a high pressure container.

Another method of using CO_2 as a fire extinguishing medium is to maintain a quantity in a large tank at a low pressure so a large amount of CO_2 can be discharged, principally as a gas, in a short time on to a fire. With this method the temperature of the CO_2 is controlled and maintained near zero by a refrigerating system to avoid high pressures and heavy and expensive containers.

The amount of snow obtainable from liquid CO_2 when discharged from a container is limited, so as a means of obtaining as much snow as is practically possible, in my present method I convert commercial CO_2 into a snow by shaving it from blocks of dry ice and carry it in the stream of fluid flowing from a container of liquid CO_2 to discharge and spread it onto a fire. In this way I utilize all of the commercial dry ice as a snow and without first liquefying and then losing a certain amount of snow in its discharge, and at the same time utilize whatever snow may be obtained from the liquid CO_2. In other words, if the practical limit of snow obtainable from a quantity of liquid CO_2 is one-third or 33% snow, then discharging a fifty pound container of liquid CO_2 about seventeen pounds of snow may be obtainable, while by my method of using a twenty five pound container of liquid CO_2 and a twenty five pound block of dry ice shaved into snow and discharged with the liquid, I obtain a 50% discharge of snow and disregarding any snow obtainable from the liquid. This amount of snow can be increased by discharging fifty pounds of dry ice as snow with twenty five pounds of liquid to obtain a 66% proportion of snow.

The handling of CO_2 as dry ice has been made convenient by being packed in balsa containers and it is easily insulated to prevent handling loss as it has a property of forming a fog to help protect its surface where exposed. A blanket thrown over an open container will help prevent dissipation of the protecting layer of fog while in process of transporting and handling. However, sufficient insulation will reduce all loss to a minimum and for extended storage an insulated subterranean storage space answers all requirements.

There is always a loss in converting a substance from one form into another and my method avoids these losses as far as the dry ice used. My method is suitable for permanent installations and is especially adaptable for use on a mobile unit, as a truck, for fire fighting. The loss in handling, transporting and storing dry ice by sublimation can be made small and, compared to the liquid form, is also compensated for, by the ease in handling, the original cost and avoidance of expensive containers.

One of the objects of this invention is to provide a method of using CO_2 dry ice as a snow to extinguish a fire.

Another object is to provide a means of holding CO_2 in its commercial form and converting it into snow to be discharged on to a fire by a stream of fluid from a container of liquid CO_2.

Another object is to provide means to reduce and regulate the pressure of fluid from the container to a shaver.

Another object is to provide means to discharge one container at a time in a series of connected containers.

With the foregoing and other objects in view which will appear as the description proceeds, the invention consists in certain features of novelty in the method and in the construction, combination and arrangement of parts by which the said objects are attained, the invention being more particularly pointed out in the claims.

In the accompanying drawings,

Figure 1 is a front elevation of means embodying my invention and shown partly in section on lines 1*a*—1*a*, 1*b*—1*b* and 1*c*—1*c* of Fig. 3.

Fig. 2 is an enlarged view of an elevation of a portion of the shaver on line 2—2 of Fig. 1.

Fig. 3 is an end elevation of my apparatus as in Fig. 1, showing the arrangement of parts with a motor and variable speed gear box.

Fig. 4 is an enlarged view of a sectional elevation of a carbon dioxide container with a fluid expanding siphon tube as in Fig. 1 but formed into a coil for additional expansion into the discharge line.

Fig. 5 is an enlarged view of a portion of the shaver at the discharge passage through said shaver as in Fig. 2, to show lining.

Fig. 6 is a side elevation of a quick acting discharge valve to be operated by a right hand rotated sleeve and shown in place on sectioned container 1B in Fig. 1.

Fig. 7 is a sectional elevation on line 7—7 of Fig. 6.

Fig. 8 is a side elevation of a valve as in Fig. 6 but operated by a left hand rotated sleeve and shown in place on container 1A in Fig. 1.

Fig. 9 is a plan view of three valves as located on three containers connected in series and with the mechanism for operating said valves to discharge the containers in succession and one at a time.

Figs. 10, 11 and 12 are plan views of the valves, as in Fig. 9, to show the different positions of the valve discharge mechanism when said valves are operated.

Figs. 13 and 14 are plan views of a valve in closed and open position, as in Figs. 9 and 10 respectively, but with a modified control mechanism partly in section on line 13 of Fig. 15.

Fig. 15 is a side elevation of a portion of the valve in Fig. 14 as indicated by line 15—15.

Fig. 16 is an enlarged sectional view of the ratchet mechanism of Fig. 14.

Fig. 17 is a sectional view on line 17—17 of Fig. 16.

Referring to the drawings of my fire extinguishing apparatus, one or more containers or tanks 1A, 1B, etc. of the usual steel cylinder construction and charged with carbon dioxide under pressure, can be used. 2 represents the liquid carbon dioxide and is shown in sectioned container 1B. Each container has a discharge valve fastened into its top as by screw threads.

In the present construction, and as a convenient method of operation, to release the carbon dioxide from a series of containers one at a time in succession, a left hand operated sleeve to discharge valve 3L is provided for the first container 1A, the third container 1C, etc. The second and fourth containers 1B, 1D, etc., are provided with a right hand operated sleeeve to discharge valves 3R.

In Fig. 1 is shown an outfit for stationary use or a mobile truck unit but with only two containers 1A and 1B as sufficient to illustrate them with their operating valves 3L and 3R. In Figs. 9 to 12 are shown valves 3L, 3R, 3L, in order as they would be located on a series of three containers, to be repeated as desired.

The discharge valves 3L and 3R are preferably of a quick release type which can be operated individually and when connected in series, as shown in Figs. 1 and 9, can be operated in succession one after the other to discharge the CO_2 from one container at a time. That is, the valve 3L of the first container 1A is opened and as soon as container 1A is emptied, the valve 3R of the second container 1B is opened by the valve 3L, and so on with each of the containers connected in series.

This action of using the contents of only one container at a time has the advantage that only the containers, wholly or partly, discharged in extinguishing a fire have to be recharged. Where the valves of all containers are opened at the same time, all of the containers are discharging at once and so all containers have to be disconnected and recharged, while the amount of carbon dioxide used may only equal the contents of one container. This latter method is illustrated in the patent to Freygand, June 19, 1928, Number 1,674,427.

In Figs. 1 and 3, two containers 1A and 1B are shown connected into a main pipe 4 by branch pipes 5. Each branch pipe 5 has a check valve 6 which allows the carbon dioxide to flow freely from the container to the main pipe 4 but prevents the fluid flowing in a reverse direction, i. e. from the main line 4 into a container. In Fig. 1 container 1B, shown in section, has a siphon tube 7 extending from the top of said container to near the bottom in the liquid carbon dioxide 2. The siphon tube 7 has a small passage 8 at the bottom, with a graduated opening into said passage 8, and a passage which increases in size by successive steps as 9 and 10 to the top.

In this way a partial expansion of the fluid occurs in the siphon tube 7, depending on the amount of increase in size from the bottom to the top. In my Patent No. 2,143,635 I have a similar siphon tube but as an additional means for increasing and controlling the expansion of the fluid in the discharge system, I employ an expansion coil 11. Coil 11 is shown in Figs. 1 and 3 in the main pipe line 4 and acts as a common expansion coil for all of the containers. 12 is a housing for coil 11 with insulation 13. The branch lines 5 and the main line 4 are insulated by 14.

A shaver 15 having a body 16 with a chamber 17 is provided for holding blocks of dry ice 18 which are loaded into said chamber 17 through a removable insulated cover 19 at the top. As commercial dry ice comes in blocks the shaver chamber 17 is of a square section and a size to accommodate the desired number of blocks to be used. The CO_2, or dry ice 18, rests on a horizontally disposed rotating cylindrical cutter 20 with suitable cutting edges 21 which are formed about the periphery of said cutter by horizontally formed grooves 22 which are spaced apart and extend from end to end of said cutter 20. The ends of cutter 20 fits two sides of chamber 17 and the bottom of said chamber is formed into a half circle to fit the periphery of the lower half of cutter 20 (shown in section in Fig. 2).

A passage 23, formed in body 16 and circular in section, extends horizontally through shaver 15 and is located in relation to the periphery of cutter 20 so that the grooves 22 of said cutter form a portion of said passage 23 when in register therewith. (Figs. 2 and 5.) The proportion of the area of a groove 22 to that of the passage 23 can be a small or a large percentage as desired. That is, the path 24 of the periphery of cutter 20 can pass across or below the center 25 of passage 23, instead of above said center, as shown, in Fig. 5. The passage 23 is lined with Lucite or other satisfactory material 26 to prevent the shaved dry ice or snow from sticking in said passage as it has a tendency to do on metal surface. The lining in the grooves 22 are indicated as 26'.

The ends of cutter 20 and the portions 27 of the periphery of cutter 20 between the grooves 22 serve to seal the passage 23 where it passes said cutter. Passage 23 is continued from shaver 15, through a hose 28, of suitable length with dis-

charge nozzle or horn 29, and of the same size or larger as shown.

Cutter 20 is rotated by its shaft 30, pulley 31, belt 32, variable speed gear 33 and motor 34.

The shaver 15 and its cover 19 have suitable insulation 35. Through the cover 19 is shown the stem 36 of a plate 37 which rests on the top of the dry ice 18 and having a cup 38 for holding weights 39 to regulate the feed of the blocks of said dry ice on the cutter 20.

In Fig. 4 is shown an expansion coil 40 as a part of the siphon tube 7' to be used individually with a single container 1, or with containers 1A, 1B, etc. connected in series, in place of the common coil 11, or to supplement said coil 11. Siphon tube 7' has a small passage 8 at the bottom, an intermediate passage 9 and its largest passage 10 through coil 40 into the valve 3. The action of the siphon 7' with its coil 40 is to reduce the pressure of the fluid from container 1, which will ordinarily be about 800 pounds per square inch, to approximately 400 pounds or less as it leaves the valve 3 and so helps to prevent recoil of the container. Recoil prevention becomes more important with the higher pressures and also when the containers are manually handled. The action of the siphon 7' with its coil 40 is, also, to provide a safety device to reduce the pressure in the container when conditions of outside temperature have increased the pressure to such an extent that the opening of valve 3 will rupture the pipe or hose connected to said valve, as sometimes happens where the container pressure is carried through connections to a restricted discharge opening. And this condition is approached by loading the discharge passage with snow.

The function of coil 11, used either singly or with coil 40 as desired, is to reduce the fluid pressure in the discharge system to the desired point at the passage 23 of shaver 15 so as to discharge fire extinguishing snow and fluid a proper distance from nozzle 29.

In Figs. 6, 7 and 8 is shown a valve for discharging fluid from high pressure containers, as 1A and 1B of Fig. 1. The valves of Figs. 6 and 8 are called right hand and left hand valves, respectively, and are identical in construction except for the releasing means which operate in a right hand and left hand direction, as explained presently. The valve of Fig. 6 is therefore referred to as 3R and of Fig. 8 as 3L.

In the sectional view of 3R of Fig. 7, 41 is a body threaded at 42 for fastening into a container and having an inlet passage 43 extending up into a valve chamber 44. A laterally extending boss with passage 45 communicating with passage 43, provides means for holding a nut 46 with a safety disk in the usual manner. Another laterally extending boss has a discharge passage 47 from chamber 44 and is externally threaded for a pipe or hose connection. The opening and closing of passage 43 is controlled by a valve 48 having a stem 49 and a nut 50 with a compression spring 51 bearing against the bottom of said nut 50.

52 is a hollow bonnet threaded onto body 41 to inclose a diaphragm 53 which is clamped, top and bottom around its edge, between said bonnet and body, as shown, to prevent leakage from said body 41 and at the same time allow for operation of the valve 48 by means external to said diaphragm by flexing the central part of said diaphragm. Contacting with the top center of diaphragm 53 is a screw 54 carried by a crosshead 55 through which it is threaded. Crosshead 55 has sliding contact with the cylindrical chamber in bonnet 52 while screw 54 slides through the top of bonnet 52 for quick opening of valve 43. Turning screw 54 by handwheel 56 provides for opening or closing valve 43 independently of crosshead 55. 57 is a sleeve mounted on bonnet 52 with a limited rotative movement thereon and guided between a shoulder on said bonnet and a bonnet nut 58. Rotative movement is imparted to sleeve 57 by a handle 59. Two crosshead pins 60 extend through vertical slots 61 in bonnet 52 and the compound slots in sleeve 57. Said compound slots have a horizontal part 62 for locking crosshead 55 in its lowest position and a diagonal part 63 in which said pins 60 travel when sleeve 57 is partly rotated by means of handle 59.

In the position shown in Figs. 6, 7 and 8 the crosshead 55 is locked in its lowest position by pins 60 in horizontal slots 62. Rotating sleeve 57 by means of handle 59 unlocks pins 60 from slots 62 and allows them to rise in diagonal slots 63 in said sleeve 57 and in vertical slots 61 in bonnet 52 when the crosshead 55 moves upward under action of valve spring 51 and the pressure in a container to open the valve 43. The spring 51 is preferably of sufficient strength to overcome the weight of valve 43 and to also balance the pressure of a ratchet operating spring 84 described later in a modified control construction, as the fluid pressure in a container will open the valve.

Means for opening the valves in succession to discharge contents of containers 1A, 1B and 1C, one at a time, is shown in Figs. 9 to 12. Extending through each handle 59 is a pivot pin 64. Valve 3L on container 1A has a pull rod 65 connected to pin 64 and also a push rod 66 with a control spring 67 and a hook 68 for operative contact with pivot pin 64 of valve 3R on container 1B. Also pivoted to pin 64 of 3R on container 1B is a pull rod 69 with a control spring 70 and a hook 71 for operative contact with pivot pin 64 of valve 3L of container 1C. 72 and 73 are guide pins for rods 66 and 69, respectively, and attached to the bonnet 52 of 3L (see also Fig. 6).

Means for closing each valve after its container contents are discharged, and so opening the valve of the succeeding container, is as follows: 74 is a pin, fastened into bonnet 52, and with a suitable arc shaped rod 75, as shown, for holding a coil spring 76. Spring 76 is compressed by a pin 77, fastened into sleeve 57, and sliding over rod 75 when said sleeve is rotated.

Closed and open positions of valve 43, as shown by the position of sleeve 57, are indicated by radial line C for closed position, and by radial line O for open position, of handle 59, while radial lines C' and O' are closed and open positions of pin 77. The arrow in each case shows direction of movement of handle 59 to open valve 43.

The operation of the valves is as follows: In Fig. 9 all valves are closed and pulling rod 65 rotates sleeve 57 by handle 59, of valve 3L on container 1A, from C to O to unlock and release pins 60 from horizontal slots 62 (Fig. 8) when the valve 43 (Fig. 7) is raised and held open by the pressure in container 1A until the CO_2 is exhausted therefrom. When handle 59 moves from C to O, pin 77 moves from C' to O'. Pin 77 contacts with spring 76, as the pins 60 (Fig. 8) are unlocked from and leave horizontal slots

62, and the raising of valve 48 by its container pressure compresses and holds spring 76 compressed (Fig. 10) until the fluid pressure is exhausted, when the spring 76 rotates sleeve 57 back to its closed position C (Fig. 11) depressing crosshead 55 and closing valve 48.

When valve handle 59 of container 1A is moved from position C of Fig. 9 to position O of Fig. 10, hook 68 of rod 66 engages handle pin 64 of valve 3R on container 1B and when the pressure of 1A is exhausted and spring 76 rotates handle 59 of 1A from O (Fig. 10) to C (Fig. 11), rod 66 pushes handle 59 of 1B from position C (Fig. 10) to position O (Fig. 11) opening valve 3R to discharge container 1B. The fluid pressure of container 1B in opening valve 3R compresses its spring 76 (Fig. 11) while hook 71 of pull rod 69 engages with handle pivot pin 64 of the valve 3L of container 1C. Then the exhausting of fluid pressure in container 1B, by the discharge of its contents, will release spring 76 of 3R to move its handle 59 from position O (Fig. 11) to position C (Fig. 12), closing the valve 3R of 1B and opening the valve 3L of 1C by moving handle 59 of 1C from C (Fig. 11) to O (Fig. 12) by means of rod 69. Thus any number of containers in series can be discharged one at a time.

It will be noted that in the operation of opening a valve, the sleeve 57 has only to be rotated a portion of its travel to unlock and release pins 60 from horizontal slots 62, when the fluid pressure in a container will operate the valve to full open position. A spring 76 is therefore not compressed until the valve is released to allow fluid pressure to compress said spring. Also the compressed spring has only to release a succeeding valve in the first portion of its travel and close its own valve by the balance of said travel.

The guide pin 72 is located to disengage the hook 68 of rod 66 from handle pin 64 near the end of its travel from its position in Fig. 10 to that of Fig. 11, so that when handle 59 of 3R on container 1B is in an open position O (Fig. 11) it can move to a closed position C as in Figs. 12 and 9 without operating valve 3L of 1A.

In the same way guide pin 73 is located to disengage the hook 71 of rod 69 from the handle pin 64 near the end of its travel from its position in Fig. 11 to that of Fig. 12, so when the handle 59 on container 1C is in an open position O (Fig. 12) it can move to a closed position C, as in Fig. 9, without operating valve 3R of container 1B.

Figs. 13 to 17 show modified control means for closing the valves of a series of containers in place of the spring 76 in Figs. 9 to 12. The valve shown in Figs. 13, 14 and 15 is the valve 3L of Fig. 8 and the parts are the same as shown in section of Fig. 7. Mounted on the bonnet 52 is a cylinder 78 having a piston 79 with a piston rod 80 for compressing a heavy spring 81 and an oppositely disposed piston 82 with a piston rod 83 for compressing a light spring 84. Between pistons 79 and 82 is a port 85 which communicates with the valve chamber 44 by means of pipe 86.

Also mounted on the bonnet 52 is a bracket 87 with a pivot pin 88 for pivoting a bell crank having arms 89 and 90. Bell crank arm 89 is forked on the end and connected to the piston rod 80 by means of a nut 91 having two oppositely disposed pins 92 adapted to operate in slots 93 in the forked ends of said arm 89. Bell crank arm 90 is pivoted by pin 94 to a pull rod 95 resting on arm 96 which is connected to the sleeve 57. Pull rod 95 has a hook 97 for engaging with a pin 98 attached to arm 96. 99 is a spring on crank arm 90 to insure engagement of rod 95 with a guide pin 100 which is attached to bonnet 52. Rod 95 is formed, as shown, with a bend 101 for engagement with guide pin 100 to release hook 97 from pin 98 when in the position shown in Fig. 13.

On piston rod 80 is fastened a sleeve 102 having ratchet teeth 103 for engagement with a ratchet pin 104 which is carried in a piston 105 (Fig. 16) and reciprocated with said piston 105 in a housing 106 by means of a bell crank 107. Ratchet pin 104 has a reciprocating movement in piston 105 and actuated outwardly by a spring 108 to engage ratchet teeth 103 when in the position shown in Fig. 16 and in Fig. 14. A pin 109, fastened transversely through ratchet pin 104, and sliding in slots 110 of piston 105, limits the travel of pin 104 and prevents it from rotating.

Bell crank 107, pivoted on pin 111, has one arm 112 for operating piston 105 and another arm 113 connected to, and operated by, piston 82 in cylinder 78 through the medium of a nut 114 on piston rod 83, a lever 115 and a rod 116. The lever 115 is pivoted on pin 117 intermediate of its ends. One end of lever 115 is pivoted to rod 116 and its opposite end is forked and with slots 118 for sliding connection with two oppositely disposed pins 119 in nut 114.

As explained in reference to Figs. 9 to 12, closed and open positions of valve 48, as shown in the position of sleeve 57 by its handle 59, are indicated by radial line C for closed position, and radial line O for open position, while radial lines C'' and O'' are closed and open positions of arm 96.

The operation of the modified control means just described is as follows: Valve 3L is operated to discharge the contents of a container, as 1A (Fig. 9) to which it is attached, by pulling handle 59 from closed position C, Fig. 13, to open position O, Fig. 14, by means of rod 65. As soon as sleeve 57 is rotated sufficiently to release pins 60 from the horizontal slots 62, the valve 48 will be opened by the pressure from the container and discharge the CO_2 from said container. The fluid pressure in valve chamber 44 now flows through pipe 86 and port 85 into cylinder 78 and moves piston 82 from its position in Fig. 13 to its position in Fig. 14 to compress spring 84 and at the same time move ratchet pin 104 into engagement with ratchet teeth 103 on sleeve 102. This fluid pressure will also move piston 79, from its position in Fig. 13 to its position in Fig. 14, to compress spring 81 where it is held by the ratchet pin 104 and ratchet teeth 103. The movement of piston rod 80 operates the bell crank arms 89 and 90 and the pull rod 95 from their positions in Fig. 13 to their positions in Fig. 14, to engage the hook 97 of said rod 95 with the pin 98 on arm 96.

When the pressure is exhausted from the container it will also be exhausted from cylinder 78 and allow spring 84 to move piston 82 from its open position in Fig. 14 to its closed position in Fig. 13. The closing movement of piston 82 will withdraw ratchet pin 104 from ratchet teeth 103 and allow spring 81 to move piston 79 from its open position in Fig. 14 to its closed position in Fig. 13. The closing movement of piston 79 pulls rod 95 to rotate sleeve 57 by arm 96 from its position in Fig. 14 to its position in Fig. 13 and close valve 48 when the pins 60 move downward in slots 63 and 61. The diagonal slots 63 move the pins 60 and the crosshead 55 downward, to close

the valve 48, by the rotative movement of sleeve 57. Locking the heavier operating spring 81 in an open position insures the valve 48 being maintained fully open without restriction, during discharge.

In the operation of the apparatus shown in Figs. 1 to 5, a shaver 15 having a charge of dry ice 18, produces a CO_2 snow by shaving it from the bottom of the charge of said dry ice when the cutter 20 is rotated by the motor 34 through the medium of belt 32 and variable speed gear 33. The variable speed gear 33 regulates the speed of said cutter 20, while the weights 39 provide means for regulating the depth of cut by the cutting edges 21 of cutter 20. Cutter 20 is adapted to be rotated in either a forward or a backward direction so that both edges 21 of grooves 22 can be used as cutting edges.

The operation of my apparatus is to first open container 1A by pulling rod 65 to open valve 3L on said container and discharge its contents through pipe 4, expansion coil 11, passage 23, hose 28 and directed on to a fire by nozzle 29. At the same time the shaver 15 is started and the CO_2 snow fed into passage 23 is discharged with the fluid stream from the container. The fluid pressure in the container is reduced to the desired amount at the passage 23 of shaver 15 to propel stream issuing from nozzle 29 the proper distance, by expansion in siphon tube 7 and coil 11, or by a siphon tube 7' and its coil 40, when used.

When container 1A is exhausted the control mechanism, as of Figs. 9 to 12 or Figs. 13 to 17, operates to close valve 3L and open valve 3R of container 1B by means of rod 66. Other containers connected in series are opened, as before explained, by the closing of the preceding exhausted container, as container 1C by rod 69. On extinguishment of a fire any container, which is being discharged, can be closed by turning its handwheel 56 to seat its valve 48.

Having thus described my invention, I claim:

1. A method of extinguishing a fire by a liquefied gas which is maintained at a high pressure, comprising passing the gas in a stream through stages of expansion to a pressure above the triple point, shaving dry ice to a snow, introducing said snow into said stream and discharging said stream of fluid and snow onto a fire.

2. A method of extinguishing a fire by a liquefied gas which is maintained at a high pressure at ordinary temperatures, comprising passing the gas in a stream through stages of expansion to a pressure above 78 pounds per square inch, maintaining dry ice in an insulated container, shaving said dry ice to a snow, introducing said snow into said stream and discharging said stream of fluid and snow onto a fire.

3. A method of extinguishing a fire which comprises maintaining liquefied gas at a high pressure at ordinary temperatures, releasing said gas and carrying it in a stream to be discharged from a nozzle onto a fire, producing a snow from dry ice and introducing said snow into said stream to be discharged therewith through said nozzle.

4. A method of extinguishing a fire by producing a stream of fire extinguishing fluid containing a percentage of carbon dioxide snow in excess of the amount of snow produced from liquid CO_2 and comprising maintaining a quantity of liquefied gas at a high pressure at ordinary temperatures, releasing said liquefied gas and carrying the fluid in a stream to a point of discharge from which it can be spread onto a fire, partially expanding said stream of fluid from the original quantity to the point of release to reduce the original pressure approximately one-half, producing a snow from dry ice and introducing said snow into said stream.

5. Apparatus for extinguishing a fire, comprising a container for holding a liquefied gas under high pressure, means for holding dry ice in its commercial form, means connected with said dry ice holding means for shaving snow from said commercial dry ice, means having a passage to convey said liquefied gas from its container to a discharge nozzle and means to introduce said snow into said passage conveying means.

6. Apparatus for extinguishing a fire, comprising a container for holding a liquefied gas under pressure, means for holding a quantity of dry ice, means for converting said dry ice into a snow, means having a passage to convey said liquefied gas in a stream from its container to a discharge nozzle, quick opening valve means to release said liquefied gas from said container into said conveying means and means to introduce said snow into said stream of liquefied gas to be discharged therewith from said nozzle.

7. Apparatus for extinguishing a fire, comprising a container for holding a liquefied gas under pressure, a valve to discharge the fluid from said container, means having a passage to convey the fluid from said container in a stream to a nozzle, chamber means for holding a quantity of dry ice and means for shaving said dry ice into a snow, said shaving means including a cutter to convey said snow into said stream and seal said chamber from said stream.

8. Apparatus for extinguishing a fire, comprising a container for holding a liquefied gas under pressure, a siphon in said container leading from near the bottom thereof, means having a passage to convey the fluid from said container in a stream to a nozzle, a valve to discharge the fluid from said container through said siphon and conveying means, means to form a snow external to said conveying means and means to introduce said snow into said stream intermediate of said siphon and said nozzle, said snow forming means including an insulated dry ice chamber, a cylindrical cutter having grooves in its surface forming double cutting edges therewith, and snow repellent lining means in said grooves and contiguous passage means, said grooves forming a portion of said passage means when in register therewith.

9. Apparatus for extinguishing a fire, comprising a container for holding a liquefied gas under pressure, a siphon in said container having passage means leading from near the bottom to the top thereof, means having a passage to convey the fluid from said container in a stream to a discharge nozzle, means for producing a dry ice snow, means to introduce said snow into said fluid stream, a valve to release the fluid from said container and a coil as a part of said passage means.

10. In means to prevent recoil at the container and excessive shock to the discharge system from the high pressure container of a CO_2 fire extinguishing apparatus, the combination of a container for holding liquefied CO_2 at high pressure, a discharge system from said container to a discharge nozzle, a quick acting valve to release said CO_2 into said discharge system and means in said discharge system to reduce the

container pressure to said valve, said reducing means including a siphon in said container leading from near the bottom to the top thereof, and said siphon having a portion with a passage increasing in size from its inlet to a portion with a passage of constant size to its outlet, said latter portion being formed into a coil.

11. Apparatus for extinguishing a fire, comprising two or more containers for holding liquefied gas under pressure, a discharge system from said containers to a nozzle, said discharge system including a main line and a branch line from each container to the said main line, a check valve in each branch line, a quick opening valve in each container, a sleeve on each valve, a spring connected to each sleeve, means to release the valve of the first container and discharge the fluid from said container into said main line, means operated by the fluid pressure of the released valve to rotate its sleeve and compress its connected spring and means to operatively connect said sleeves so the compressed spring of a released valve will release a succeeding valve.

12. In apparatus for extinguishing a fire, comprising two containers for holding liquefied gas under pressure, a discharge system from said containers to a nozzle and means to discharge said containers one at a time into said discharge sytem, said discharge means including a quick opening valve in each container, means to lock each valve in its closed position, means to release the lock means of each valve and discharge the fluid from its respective container, resilient means operated by the pressure of the fluid discharged from one of said containers, and means operated by said resilient means to discharge the fluid from the other of said containers.

13. In apparatus for extinguishing a fire, comprising two containers for holding liquefied gas under pressure, a discharge system form said containers to a nozzle and means to discharge said containers one at a time into said discharge system, said discharge means including a quick opening valve in each container, means to open the valve of each container to discharge its fluid contents, means to operatively connect said valve opening means and means actuated in the absence of pressure of the fluid after it has discharged from the first of said containers to operate the valve opening means of the second container to open the valve and discharge the contents of the second container.

14. Apparatus for extinguishing a fire, comprising two or more containers for holding liquefied gas under pressure and a discharge system from said containers, means to discharge said containers one at a time, said discharge means including a quick opening valve for each container, means to open each of said valves and resilient means for each valve, said resilient means operated by the fluid pressure during discharge of its container and said resilient means operating the opening means of a succeeding valve when released by the drop of said fluid pressure on completion of said discharge.

15. Apparatus for extinguishing a fire, comprising two or more containers for holding liquefied gas under pressure, a discharge system and means to discharge said containers one at a time into said discharge system, said discharge means including a quick opening valve in each container, means to open each valve and release the fluid contents of its container, resilient means on each valve, means to operatively connect said resilient means of one valve and the valve opening means of a succeeding valve, said resilient means operated by the pressure of the fluid released from its container and means to lock said resilient means in an operated position, said locking means held in a locking position by the fluid pressure during discharge of its container and released from said locking position by the drop of said fluid pressure on completion of said discharge.

16. Apparatus for extinguishing a fire, comprising two or more containers for holding liquefied gas under pressure, a discharge system from said containers to a discharge nozzle and means to discharge said containers one at a time into said discharge system, said discharge means including a quick opening valve in each container, means to open the valve of each container to discharge its fluid contents, said valve opening means including a rotating sleeve for each valve, sleeve operating rod means between each two valves pivoted to the sleeve of one valve and normally out of operative position with the sleeve of an adjacent valve, guide means for the free end of said rod means to direct said rod means into operative position with the sleeve of said adjacent valve whereby the rotation of the sleeve in opening the first valve will place the free end of said rod means in operative position with the sleeve of a succeeding valve and whereby the rotation of the sleeve in closing said first valve will rotate the sleeve and open said succeeding valve, and resilient means for each of said valve sleeves, said resilient means operated by the pressure of the fluid released from a container, and said operated resilient means rotating the sleeve and closing the valve of said container when its contents have been discharged.

17. Apparatus for extinguishing a fire, comprising containers for holding liquefied gas under pressure, a discharge system from said containers to a discharge nozzle and means to discharge said containers one at a time into said discharge system, said discharge means including a quick opening valve in each container, means to open the valve of each container to discharge its fluid contents, said valve opening means including a rotating sleeve for each valve, sleeve operating rod means between each two valves, one end of said rod means pivoted to the sleeve of the first valve and the other end of said rod means normally out of operative position with the sleeve of an adjacent valve, guide means to direct the free end of said rod means into operative position with its adjacent valve sleeve when said first sleeve is rotated to open its valve, said guide means directing the free end of said rod means out of operating position with said adjacent valve sleeve during the final part of the movement of said adjacent valve sleeve while said adjacent valve sleeve is being rotated to open its valve.

18. In means to discharge a series of containers holding liquefied gas under pressure into a discharge system one at a time, the combination therewith of a quick opening valve in each container, means to open each valve to discharge the fluid contents of its container, said valve opening means including a rotating sleeve, means to operatively connect adjacent sleeves during the opening of one of two adjacent valves and disconnect said sleeves on the closing of said opened valve, resilient means for each of said valve sleeves, means to compress the resilient means of an opened valve by the pressure of the fluid released from a container by said opened valve, said resilient compressing means operatively con-

nected to the sleeve of said opened valve to close said opened valve by the extending of said resilient means at the drop of said fluid pressure on the completion of the discharge from said container and to open its adjacent valve.

19. In means to discharge a series of containers holding liquefied gas under pressure into a discharge system one at a time, the combination therewith of a quick opening valve in each container, means to open each valve to discharge the fluid contents of its container, said valve opening means including a rotating sleeve, means to operatively connect adjacent sleeves during the opening of one of two adjacent valves and disconnect said sleeves on the closing of said opened valve, resilient means for said valve sleeves, a piston to compress said resilient means, means to operatively connect said piston with the sleeve of an opened valve, means to convey fluid pressure from the container of said opened valve to operate said piston and compress said resilient means, ratchet means to lock said piston in its position of compressing said resilient means and means to release said ratchet means on completion of the fluid discharge from the container of said opened valve.

20. In means to discharge a series of containers holding liquefied gas under pressure one at a time, the combination therewith of a quick opening valve in each container, a rotating sleeve for each valve, means to operatively connect adjacent sleeves, means to rotate a sleeve in one direction to open a valve and discharge the fluid contents of a container and means to rotate said sleeve in the opposite direction to close said opened valve and release the valve of a succeeding container, said means to close an opened valve including a cylinder, two pistons in said cylinder, a spring for each piston, means to convey fluid pressure from said discharging container to said cylinder to operate said pistons and compress their respective springs, means to connect the first piston to the sleeve of said opened valve, ratchet means to hold said first piston in its spring compressing position and means connecting the other of said pistons and said ratchet means, said other piston operated by its spring when released by the drop in fluid pressure from said discharging container to release said ratchet means and allow said first piston to be operated by its spring to close said opened valve.

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