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2,559,634

DRY POWDER FIRE EXTINGUISHER APPARATUS

Filed Sept. 2, 1947

4 Sheets-Sheet 1

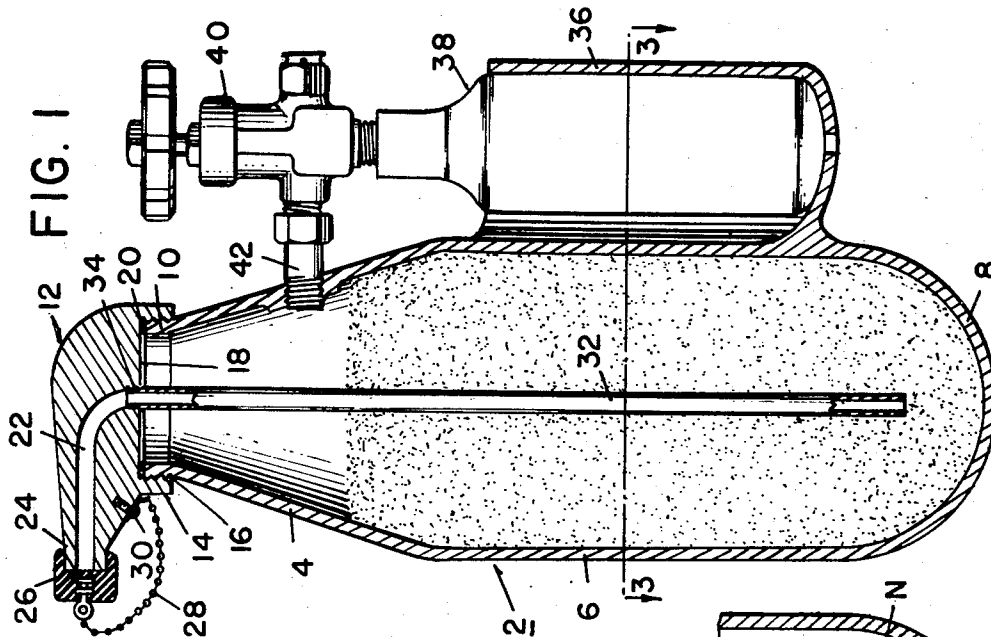
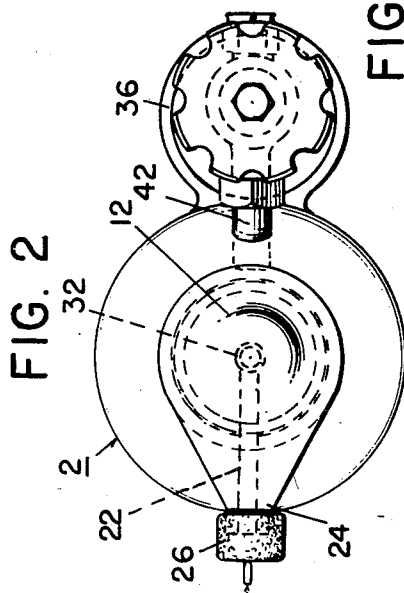
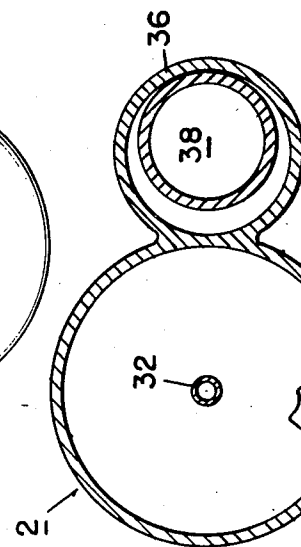
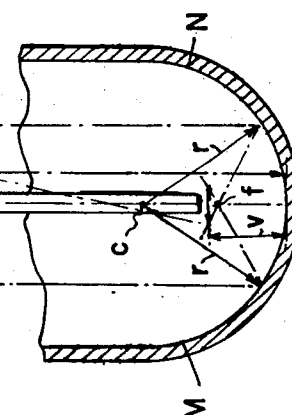


FIG. 4



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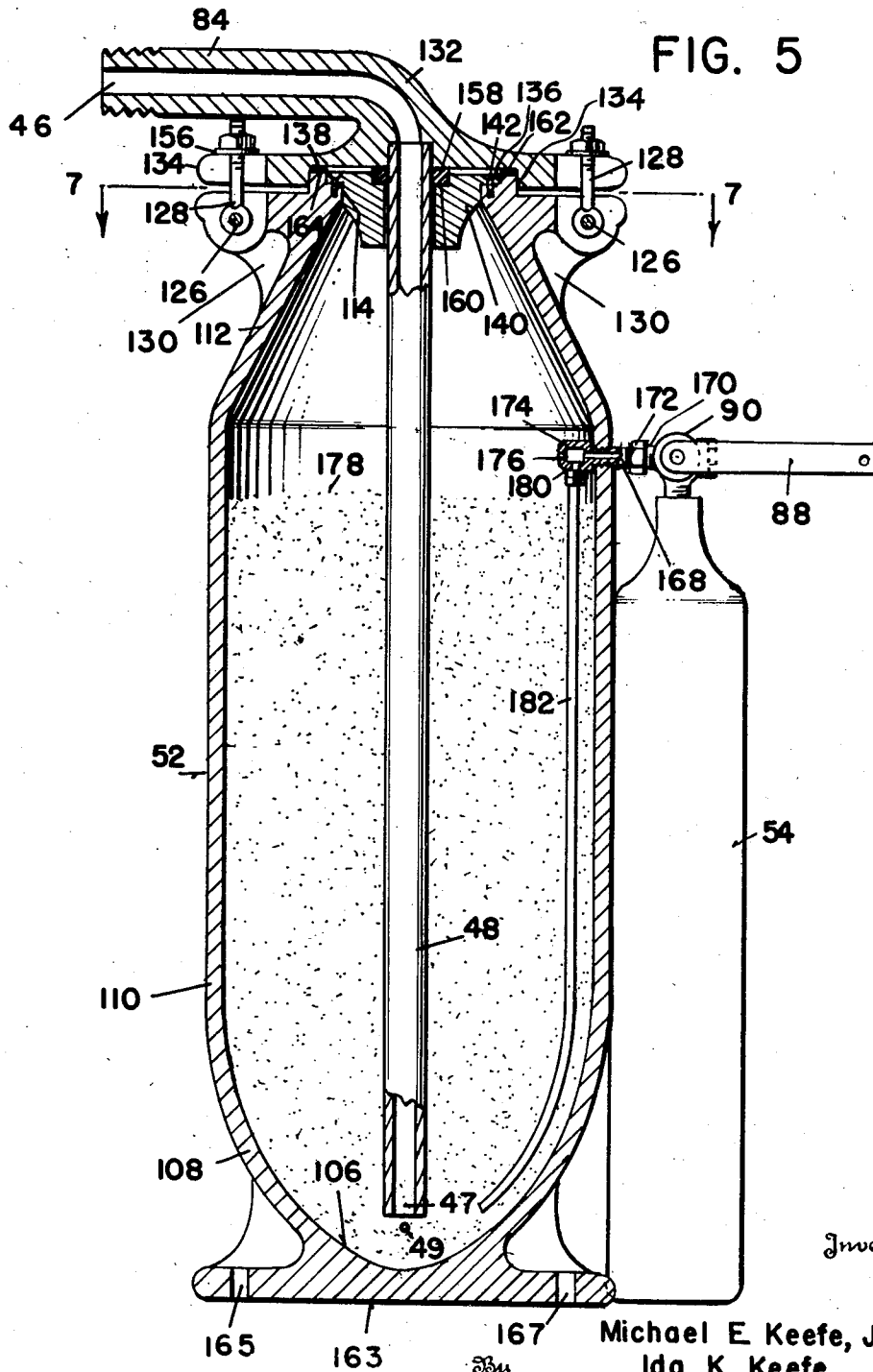
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DRY POWDER FIRE EXTINGUISHER APPARATUS

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FIG. 6

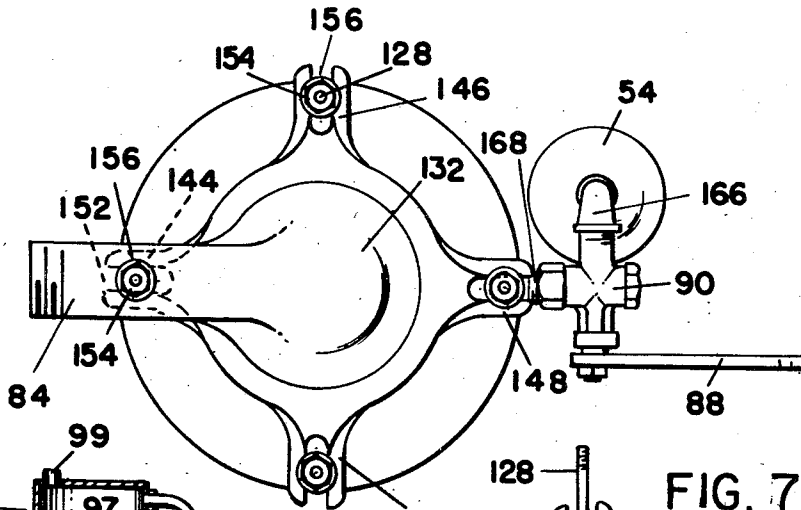


FIG. 7

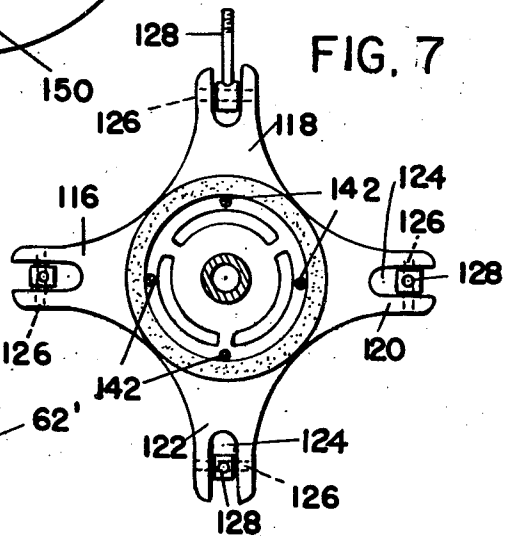
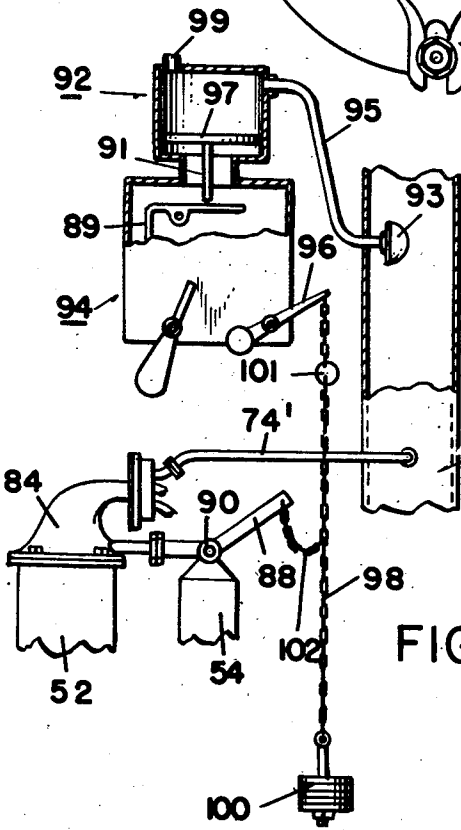


FIG. 10



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DRY POWDER FIRE EXTINGUISHER APPARATUS

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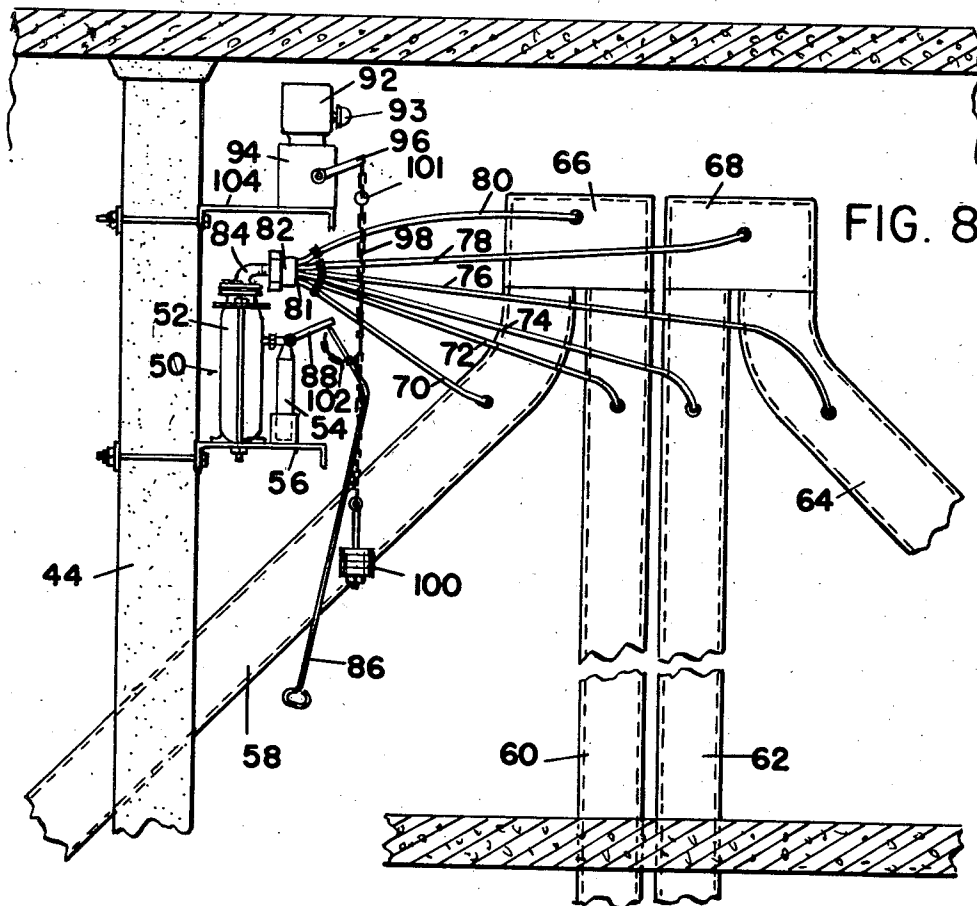


FIG. 8

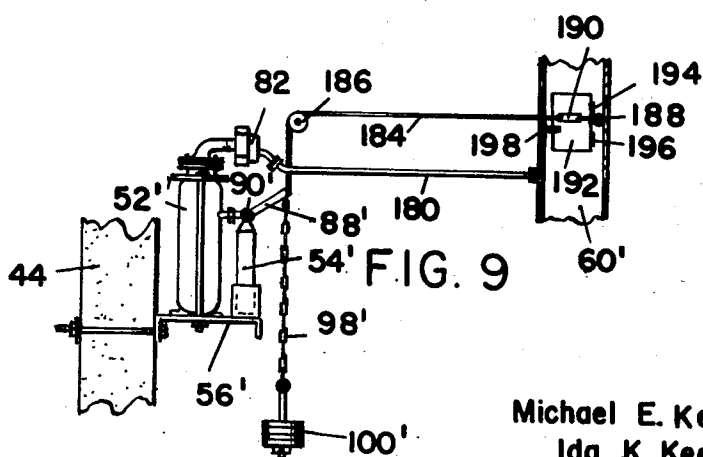


FIG. 9

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UNITED STATES PATENT OFFICE

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DRY POWDER FIRE-EXTINGUISHER
APPARATUS

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22 Claims. (Cl. 169—31)

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The present invention relates to fire extinguishing apparatus and to a method of operation thereof by means of which a fire extinguishing powder is blown upon the fire by the medium of a pressure gas, such as carbon dioxide. More particularly, the invention relates to a fire extinguishing apparatus of the portable form and to a novel method of operation in which the powder to be used is contained within a cylindrical container having a rounded bottom portion and a conical upper portion into which the pressure gas is conducted, the cylindrical container having a central tube extending into the rounded or semi-spherical bottom portion through which the powder is atomized and expelled by means of the pressure gas, as hereinafter more fully described.

The fire extinguisher powder employed must be free-flowing and remain free-flowing over a relatively long period of time during storage or non-use of the apparatus, in order to be satisfactorily operated when put into use. The powder which is preferably employed is mainly sodium bicarbonate, or has a sodium bicarbonate base with modifying agents, which is not a part of the present invention.

In various forms of fire extinguishers heretofore employed, provision is made for the discharge of the powder at the bottom of the powder container through an outlet nozzle connected thereto, the discharge being effected in part by means of a gas discharged through a tube which extends down into the nozzle, and in part by means of the pressure of gas which is applied through branch tubes into the body of the container above the outlet nozzle. This form of fire extinguisher and others have attempted to overcome the tendency of the powder to pack in the container, but heretofore none of these prior devices have been found to operate under all conditions. Failure in operation, or the retarded operation of the apparatus has resulted frequently in additional property loss because of the failure to get the fire under immediate control.

The packing which takes place in powder fire-extinguishing apparatus is apparently due to the continued pressure on standing through the action of gravity, causing congestion and adherence of the particles to each other resulting in partial immobility or caking of the compressed powder at the lower end of the container. Such compression or caking causes interference with discharge or stoppage at the discharge pipe or nozzle, and the packing is increased when the high pressure gas is introduced into the con-

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tainer above the mass of the powder therein, frequently causing clogging at the small orifice at the discharge nozzle at the lowermost end of the apparatus. Furthermore, in such apparatus, providing for discharge of dry powder at the bottom of the fire-extinguisher container, the introduction of high pressure gas has resulted in many instances in forcing the gas through cracks or passageways in the congested or caked mass without entraining the powder required for extinguishing the fire, particularly in connection with the forms of apparatus in which a plurality of internal tubes are used to assist in the discharge of the powder.

Experience with such apparatus has developed the necessity of constructing a dry powder fire-extinguisher having a construction and mode of operation designed to remove the danger of packing of the powder in the container and at the same time to provide for the location of the discharge tube or nozzle in a position in the extinguisher where it will be substantially free from any packing effect to retard or prohibit flow through the discharge tube or nozzle. Such a form of construction requires also that a clear path be provided in the container to the discharge tube or nozzle, in order that the free-flowing quality of the powder shall be protected and preserved for transmission therethrough.

The construction of the fire-extinguishing apparatus of our invention involves the provision that the discharge of dry powder chemical is effected in a direction opposite to the force of gravity, the force of gravity being overcome at the bottom of the container by the movement and force of the pressure gas admitted to the container in a downward direction and then reflected or reversed in direction or movement, coming to a focus at a point corresponding substantially to the focus of the spherical surface at the bottom of the container. By this movement, the powder is entrained in the gas and is withdrawn therewith through an eduction tube, the entrance end of which is located at a point at or immediately above the said principal focus.

Broadly stated, the invention comprises a form of dry chemical extinguisher which is provided with a container for the dry powder having a main cylindrical wall portion, an upper conical portion and a domed bottom portion having an inner concave spherical surface which merges with or tapers to the cylindrical wall portion. The upper conical portion of the container is preferably provided with a form of closure or cap which serves as the outlet tube or outlet

nozzle of the apparatus. Within the container is an eduction tube which passes axially there-through to a point at or immediately above the principal focus of the concave spherical surface of the bottom of the container and may be attached directly to the cap or closure portion of the container, or may be held in place by a separate removable supporting member, as hereinafter more fully described. Means are provided for the introduction of pressure gas, as carbon dioxide, into the dry powder container, preferably to the upper conical portion thereof, from which it expands and passes to the bottom of the container, as above described. The pressure of the gas in the container and the passage of the gas thereinto are controlled by means of a valve connected to the inlet pipe from the gas container to the dry powder container.

The features of construction of the dry-powder extinguisher hereinafter described which are of primary importance are the introduction of pressure gas into the dry powder chamber in the upper portion thereof so as to initially exert a downward pressure on the mass of powder therein in an axial direction, after which it is reflected or diverted from the concave spherical bottom portion to substantially the location of the principal focus thereof in the same manner as occurs in the passage of light axially to a concave mirror of spherical contour. By the passage of the gas in the manner described, the fire extinguisher powder is entrained in the gas and is immediately withdrawn at its point of concentration at substantially the said principal focus through an eduction tube which passes through the container from the point of the said principal focus to the exit tube or discharge nozzle of the container.

In operation, therefore, the combined gas and powder are withdrawn from the container at a point therein corresponding substantially to the position of the principal focus of the concave spherical bottom portion as rapidly as the gas and powder are brought to or concentrated at that point. It has been found in actual practice and commercial operation that the entire mass of 100 pounds of dry extinguisher powder may be discharged by means of 1½ pounds of carbon dioxide, although it is desirable to have from 2½ to 3½ pounds of carbon dioxide in a five-pound cylinder in order to have an excess as an insurance against loss of pressure and also in order to fully clear the dispersal tubes of all residue of powder from the unit when the unit is used to expel powder and gas to a plurality of points at the same time, as will be hereinafter more fully explained.

By means of the construction hereinafter described and by the method of operation involved, as applied to small scale operation, it may be stated that about 1½ ounces of carbon dioxide gas is required to completely discharge 8 pounds of dry powder, mainly sodium bicarbonate, as compared with an approximate requirement of 1½ ounces of carbon dioxide gas under the same pressure, about 900 pounds per square inch, to discharge 3 pounds of the same powder by means of the forms of apparatus heretofore used, having the discharge nozzle at the lower end of the extinguisher, even when the discharge nozzle and the path leading thereto are free from any packing condition and are fully clear.

It will be understood that fire-extinguishers of the dry powder type are particularly useful in extinguishing oil fires, fires of inflammable

liquids in general, electrical fires caused by short circuits, fires on busses, aircraft, boats and other transportation means, fires of illuminating gas, natural gas, and many other types of fires, in most of which the ordinary fire-extinguisher, containing a solution of sodium bicarbonate into which sulphuric acid is introduced when operated, is entirely ineffective. It will also be understood that the dry powder fire-extinguisher operates by the use of sodium bicarbonate as a base in powder form and serves to lay a blanket of sodium bicarbonate over the burning area, and that at a temperature of about 270° C. (518° F.) carbon dioxide is released therefrom which assists in extinguishing the flames, leaving a residue of normal sodium carbonate which forms a smothering blanket over the fire area.

One of the objects of the present invention is to provide a form of dry powder fire-extinguisher adapted to expel the powder in a free flowing stream with carbon dioxide and to discharge the entire powder contents of the extinguisher with a relatively low ratio of the gas to the powder contents expelled.

Another object of the invention is to provide a form of dry powder fire-extinguisher apparatus in which the powder is discharged through an eduction pipe, the inlet of which is located at or immediately above the principal focus of the concave spherical bottom portion of the dry powder container.

Another object of the invention is to provide a form of dry powder fire-extinguisher in which the eduction pipe or outlet pipe serves in the closure of the container as the discharge nozzle of the fire-extinguisher and in which the gas employed in discharging the powder contents is admitted above the mass of the powder and passes with powder entrained therein to substantially the principal focus of the concave spherical bottom portion of the container so as to be withdrawn and expelled by means of an eduction pipe having its entrance end located at substantially the said principal focus.

Another object of the invention is to provide a modified form of dry powder fire-extinguisher apparatus particularly adapted for automatic operation in response to control by a heat activated device by which fires may be extinguished at a plurality of points, such as in ducts in textile mills for conducting away lint, textile fibers, dust or other inflammable small particles, which are apt to be ignited by sparks of static electricity or other means, and which cannot be reached by the usual water sprinkler system for extinguishing the flames.

Another object of the invention is to provide a form of dry powder fire-extinguisher which is relatively simple in form and which may be readily assembled or taken apart, which may be manufactured at a relatively low cost and which may be operated manually or automatically with suitable control devices.

With these and other objects in view, the invention comprises the various features hereinafter more fully described and defined in the annexed claims.

The various features of the invention are illustrated in the accompanying drawings showing the invention in its preferred form and in modifications thereof adapted more particularly for automatic operation, in which:

Fig. 1 is a view in elevation, partly in section, of a dry powder fire-extinguisher of our invention;

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Fig. 2 is a top plan view of the apparatus shown in Fig. 1;

Fig. 3 is a sectional view taken on the section line 3—3 of Fig. 1;

Fig. 4 is a diagrammatic view of a portion of the fire-extinguisher container of Fig. 1, particularly the lower portion including the concave spherical bottom portion and the eduction pipe entrance and lower portion thereof in relation to the principal focus of the spherical bottom portion considered as a mirror;

Fig. 5 is a detailed view in elevation, partly in section, showing a modified form of the invention adapted more particularly for automatic commercial operation in connection with textile mills and other plants employing ducts carrying inflammable material in suspension in or admixed with air;

Fig. 6 is a top plan view of the apparatus shown in Fig. 5;

Fig. 7 is a sectional plan view taken on the section line 7—7 of Fig. 5;

Fig. 8 is a detailed view in elevation showing the invention as applied for automatic operation to a system of ducts as used in textile mills for carrying away lint, fibers, dust and the like with air from various machines.

Fig. 9 is a view in elevation, partly in section, of another modification, and

Fig. 10 is a schematic view of a further modification of the invention.

Referring more in detail to the drawings, the numeral 2 designates a dry powder container having a conical upper portion 4, a main cylindrical portion 6, and a concave semi-spherical bottom portion 8, which merges with the sides of the cylindrical portion of the container. The upper conical portion 4 is provided with an externally threaded collar or neck portion 10 over which a closure cap 12 is adapted to be screwed into position. The screw cap 12 has a downwardly extending flange portion 14 with internal screw threads 16 adapted to fit the screw threads of the collar 10. Between the upper portion of the collar 10 and the seating portion 18 of the closure, a gasket 20 may be provided in order to obtain a tight fit of the closure onto the container so as to prevent the passage of moisture into the container around the collar portion thereof. In the cap or closure 12 is a channel 22, the inner portion of which is curved through substantially a right angle, and the outer portion of which is straight and disposed at an angle of substantially 90° with the longitudinal axis of the container. Over the outlet or nozzle portion 24 of the closure 12 is a rubber closure cap 26, which fits tightly over the outer surface of the nozzle to prevent admission of moisture into the channel 22. In order to prevent the closure cap 26 from being lost when the extinguisher is in use, a chain 28, attached to the cap and secured to the under side of the closure 12 by means of a screw 30, is provided.

Connected to the under portion 18 of the closure 12 is an eduction pipe 32 which is preferably screwed into position by means of screw threads 34 cooperating with similar female threads at the lower end of the channel 22, the threads being accurately positioned so that the eduction pipe 32 passes axially through the upper conical portion 4 and the main cylindrical portion 6 of the container to a point corresponding to substantially the principal focus of the concave semi-spherical bottom portion 8, or immediately above

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the said focus or principal focus point of the surface.

Connected to the powder container 2 is a bracket or frame member 36 adapted to hold a carbon dioxide cylinder or container 38 for pressure gas. The carbon dioxide cylinder is provided with a valve member 40, the outlet of which is securely coupled to an inlet tube 42 which is screwed into the wall of the conical upper portion 4 of the powder container at a point thereof substantially opposite to the position of the outlet nozzle 24.

The theory on which the invention is based in expelling powder from the powder container by means of pressure gas passing downwardly in an axial direction to the bottom of the container may be explained by reference to Fig. 4 of the drawings by analogy to the action of a concave spherical mirror. It is well known that in the operation of a concave spherical mirror, light from a source at a distance u from the concave mirror MN, having a center of curvature at C and a radius r , will come to a focus at a distance v from the mirror, the relation between u , v and r being expressed by the formula:

$$1/u + 1/v = 2/r$$

If the source of light is parallel to the axis of the mirror, so that the distance u is substantially infinity, the value $1/u$ becomes substantially zero, so that the formula becomes:

$$1/v = 2/r, \text{ or } v = r/2$$

V in the formula now represents the principal focal length, generally expressed by f , so that: $f = r/2$, which means that the principal focus of the mirror is located at a point half way between the mirror MN and its center of curvature C on the axis of the mirror. In this connection it may be stated that as a matter of definition, a line drawn through the center of a sphere of which the mirror is a part perpendicular to the plane by which the mirror is cut off from the sphere is called the axis of the mirror. It will be understood also, that in the passage of light to a mirror at any point, the angle of incidence with reference to the normal at that point in the concave spherical surface is equal to the angle of reflection with respect to that normal.

The present invention has been developed on the theory that in the passage of a gas with dry powder entrained therein, to a concave semi-spherical surface, the gas and powder might come to a focus corresponding to the principal focus of a concave spherical mirror of the same curvature, provided that the passage of the gas and powder is in a direction parallel to the axis of the spherical surface or concave mirror and provided also that the powder and gas might be removed at substantially the principal focus so as not to interfere with the gas and powder traveling in the opposite direction, or, in other words, so as to prevent turbulence in the oncoming stream of gas and powder. In order to test out this theory and possible mode of operation, a powder container, having a cylindrical main body portion, a conical upper portion provided with means for introducing a gas therein, and a semi-spherical concave bottom portion merging with the cylindrical main body portion, together with an eduction pipe extending axially through the cylindrical main body portion to a point below the center of curvature of the semi-spherical concave bottom corresponding to the principal focus of the spherical surface, considered as a concave

spherical mirror, was used. By the use of carbon dioxide under a pressure of from about 800 to 900 pounds per square inch, admitted to the container at the conical portion thereof, as above stated, the powder was found to be rapidly ejected in a relatively short interval of time through the eduction pipe, leaving substantially no powder in the powder container when the normal amount, and even in excess of the normal amount of extinguisher powder was used. The powder container was tested also with the inlet to the eduction pipe substantially below the principal focus of the concave spherical surface, that is, somewhat below the distance corresponding to one-half of the radius of curvature of the spherical surface on the axis thereof, but the results showed an incomplete expulsion of the extinguisher powder, which was due, doubtless, to turbulence which was set up and interference with the withdrawal of the powder and gas through the eduction pipe at the same rate that they were brought to a focus at the said principal focus. Tests were also carried out with the eduction pipe passing axially through the cylindrical container to a point slightly above the principal focus of the spherical surface, employing the same apparatus with the same extinguisher powder and the same gas under the same pressure as above stated. A complete discharge of the extinguisher powder was found to take place, and with this construction it was found that it was possible to discharge nearly three times as much powder with the same amount of gas as is possible to discharge with dry powder fire-extinguishers having the outlet nozzle at the bottom of the powder container, heretofore generally used.

It must be considered that in the use of a fire-extinguisher having a concave spherical bottom of large aperture with an eduction pipe axially positioned with respect to the spherical bottom and having an inlet to the eduction pipe at substantially the principal focus of the spherical surface, in substantially the manner illustrated in applicants' drawings, there is a deviation of gas and powder from the principal focus of the concave spherical bottom after passage thereto which is analogous to the effect produced in the passage of light to a concave spherical mirror of large aperture and which in this case is termed "spherical aberration." In accordance with this phenomenon, which apparently takes place in a similar manner in the operation of applicants' apparatus, a part of the gas and powder will be deflected from the spherical bottom to a point slightly below the principal focus, or, in other words, between the principal focus and the spherical bottom axially thereof. It has been found by experiment, however, that irrespective of the spherical aberration effect, the gas and powder appear to be carried bodily with the gas and powder concentrating at the principal focus so as to be expelled completely through the eduction pipe without scattering or loss of portions of the powder, due possibly to a partial vacuum below the principal focus.

The actual size and proportions of the parts of the apparatus which have been found to be most effective are as follows: The cylindrical main body portion 6 may have an internal diameter of $4\frac{1}{2}$ inches and $6\frac{1}{2}$ inches long, the thickness of the container, which may be made of aluminum alloy, being preferably $\frac{3}{8}$ inch. The conical upper portion may be $4\frac{1}{2}$ inches long and the upper portion at the neck 10 may have a diameter of 2 inches, so that the slope of the sides of the conical portion will be at an angle of about 75°

with the horizontal, or inwardly in the upward direction of about 15° with the vertical or axis of the cylindrical container. The bottom concave spherical portion of the container may have a radius of $2\frac{1}{4}$ inches, so that the principal focus of the spherical bottom, considered as a mirror, will be $1\frac{1}{8}$ inches from the center of the bottom, or its lowermost point. The collar portion 10 at the top of the truncated conical portion is preferably $\frac{1}{2}$ inch in height, and the cap member or closure 12 has a flange portion of a height of $\frac{1}{2}$ inch and is internally threaded to cooperate with corresponding threads on the outside of the collar 10, 12 threads per inch being found suitable. The channel 22 through the outlet nozzle 24 may have a diameter of $\frac{1}{8}$ of an inch and the nozzle 24 may have a length of $2\frac{3}{4}$ inches from the center line passing through the base 18 of the closure. The eduction pipe 32 may have an internal diameter of $\frac{1}{8}$ of an inch and is threaded at its upper portion into corresponding female threads in the channel 22 adjacent the under portion 18 of the closure and may be employed with a stop or shoulder portion in the channel 22 so that in screwing the eduction pipe into the channel, the pipe will pass downwardly axially through the container to substantially the principal focus of the spherical surface or slightly above that point. The overall length of the eduction pipe from the surface 18 to its lowermost end may be substantially $12\frac{1}{8}$ inches, or may vary from about 12 inches to $12\frac{1}{2}$ inches. The inlet tube 42 is preferably located with its center about $2\frac{1}{2}$ inches below the upper end of the collar 10 and may have an external diameter of about $\frac{1}{8}$ of an inch and an internal diameter of about $\frac{1}{16}$ of an inch. The shield member 36 may be of any desired form and may, if desired, completely surround the container 2 or the cylindrical main body portion 6 and the carbon dioxide cylinder 38, or may be made to cover both the bottom of the powder container 2 and that of the carbon dioxide cylinder, instead of extending around only a part of the powder container in the manner illustrated in the drawings.

It will be understood that the sizes and proportions of parts above described are merely for the purpose of setting forth the preferred embodiment of the invention, but it will be obvious that details of construction and proportions may be varied without changing the mode of operation, as will be apparent to those skilled in the art. The form thus far described is adapted for small units in which relatively small amounts of the dry powder chemical are used, such as 8 pounds thereof, for example, but it is equally adapted for large units, such as mobile or wheeled units which may carry 100 pounds or more of the dry chemical, and which may be discharged through a hose attached to the discharge outlet. The head, closure or cap 12 may accordingly be furnished with a nozzle, or it may be merely an outlet pipe to which a hose is attached, or it may have a male screw thread to which a hose of any desired length may be attached by means of the usual screw-threaded coupling. The head may be attached to the body of the container by means of screw threads, as has been described, or it may be attached by means of notched lugs and bolt members in the manner hereinafter more fully described, or by other suitable means for securely attaching the closure in place, such as a hinge member together with a spring lever arrangement on the opposite side of the closure, the form of attachment depending on the size of the installation and ease of construction and other fac-

tors as will be understood by those skilled in the art.

A form of apparatus particularly adapted for automatic operation for the protection of ducts carrying inflammable material, as lint, fibers and dust in suspension in air, which serve to withdraw the material from textile machines and the like for the protection of operators, is illustrated and described in connection with Figs. 5, 6, 7 and 8 of the drawings. Such a unit, designated as 50 in Fig. 8 of the drawings, comprising a dry powder container 52 and the carbon dioxide cylinder 54, may be mounted on a bracket member 56, which may in turn be mounted on any suitable form of support, such as the beam 44, for example. A series of ducts to be protected, such as ducts 58, 60, 62 and 64, connected to headers 66 and 68, may conduct suspensions of lint or fibers in air, or other inflammatory material from lint or dust forming machines used for weaving or other textile operations in which it is necessary to protect the operators from the effects of the lint or dust which becomes suspended in the surrounding air. When such suspensions are drawn off through ducts, it frequently happens that a fire occurs in one or more of the ducts or headers, the suspension therein being ignited by static sparks or other means. Such fires are particularly difficult to extinguish by ordinary means, and it frequently occurs that the heat from the ducts caused by the fire sets off the water sprinkling system in the plant, causing considerable damage even without extinguishing the fire in the ducts or headers.

In order to overcome this fire hazard, the dry powder container 52 may be connected to the ducts and headers by means of a series of dispersal tubes 70, 72, 74, 76, 78 and 80 which are adapted to carry the dry powder chemical and inert gas, as carbon dioxide, from the extinguisher system to the ducts or headers when the extinguisher system is operated. In the preferred form of construction, the dispersal tubes are attached to the ducts or headers by the use of a flange affixed to each of the ducts or headers and into which the tubes are inserted through expansion nuts which serve to hold each of the tubes firmly in place. The opposite or entrance ends of the dispersal tubes are preferably held in place by a face plate 81 in the union nut 82, which is affixed to the discharge outlet 84 from the dry powder container 52. The dispersal tubes may be sealed into the nipple or face plate in varying lengths, having affixed to their adjacent ends connecting nuts, by means of which each of the tubes may be extended to any desired length, or the length required by the adjustment of the tubing.

The fire-extinguishing apparatus 52 is provided with a pull rod 86 attached to the operating lever 88, by means of which the apparatus may be manually operated, if desired. The lever 88 for operating the valve 90 of the carbon dioxide cylinder 54 is also operatively connected to a pressure-actuated device 92 which is provided with or connected to a heat-responsive, pressure producing element 93 thereon or connected therewith, which is placed in the fire zone or in a position near the ducts or near the ceiling of the room in which the ducts are located, so as to be directly affected by the temperature of the fire or the heat produced by the fire in the ducts or flues or headers. The element 93 may be connected by tubing to the said-actuated device 92, which contains a flexible diaphragm and a vent or restricted leak (see Fig. 10) which serves to

equalize the pressures which are due to normal atmospheric pressure changes or to normal temperature changes.

The said-actuated device 92 is operatively connected to an automatic release mechanism 94 which is caused to operate only when the temperature adjacent the heat-responsive element rises at an abnormal rate, so that the increase in pressure against the diaphragm in the device 92 is not compensated for by the leakage of air through the vent or restricted leak. An operating lever 96, connected to the release mechanism 94, is normally retained in its upper position, but upon operation of the release mechanism, the lever is turned downwardly, or in a clockwise direction, by which the chain 98, carrying the weight 100, is slipped or disconnected from the end of the lever member 96. The weight member 100 then falls downwardly, producing a pull or jerk on the slack chain section 102, which on straightening out causes a downward pull on the lever 88, turning the operating valve 90 into the position in which carbon dioxide or inert gas is passed from the cylinder 54 into the dry powder container 52. The chain 98 is preferably provided with a fusible link member 101, so that in the event that the automatic release mechanism should fail to operate, the fusing of the link would cause a break in the chain 98, releasing the weight 100 and pulling the chain 102, by which the lever 88 and valve 90 are operated.

Referring to Fig. 5 of the drawings, the dry powder container 52 is preferably constructed for large scale commercial operation with a domed bottom portion 106, which is spherical at the lowermost portion but merges with a tapered portion which gradually merges with the cylindrical side walls 110 of the container. At the upper portion 112, the side walls are tapered or sloped inwardly, leaving an opening or mouth portion 114, through which the dry powder chemical may be filled into the container. The mouth portion 114 is preferably reinforced by means of four equilaterally spaced forked lug members 116, 118, 120 and 122, which serve in connection with the cover member to fasten the cover in place. The arms of the notched lug members are provided with transverse openings 124, into which bolts or pins 126 are adapted to be passed for holding the cap-retaining bolts 128 pivotally in place for pivotal movement for securing the cover in place. The lug members are preferably reinforced by means of webbed lug-reinforcement members 130, as shown more particularly in Fig. 5 of the drawings.

In order to permit rigidly fastening the cap or cover member 132 in place over the mouth portion 114 of the container, the mouth portion is formed with an outer shoulder portion 134 together with an inner recessed shoulder portion 136, providing an annular seat 138 which is adapted to carry an eduction tube supporting member 140, which may be fastened in place thereon by means of set screws 142.

The cap member or closure 132 is preferably constructed in spider form having four equilateral forked side members 144, 146, 148 and 150 and an upwardly and outwardly extending tube member or discharge outlet 84 having a central channel outlet therein, designated as 46. The forked lugs 144, 146, 148 and 150 of the closure member are adapted to register with the corresponding forked lug members 116, 118, 120 and 122 around the seat member or mouth portion 114 when seated thereon in oriented position, so that the cap retaining bolts 128 may be swung around the pivot

members 126 into their upper seated position engaging with the upper notched openings 152, in which the bolts may be fastened in place by means of nuts 154 and the steel washers 156, which serve to prevent "freezing" of the nuts onto the upper surface of the lugs.

Connected to the supporting member 140, preferably brazed thereto, is an eduction pipe 48 which is held axially within the container 52 and extends downwardly therein to a point at substantially the principal focus 49 of the spherical bottom portion 106, or very slightly above the said principal focus so as to withdraw dry powder chemical and carbon dioxide gas admixed therewith through the eduction tube and into the channel 46 of the closure member 132. The eduction tube 48 may extend upwardly a short distance above the upper surface of the supporting member or bracket 140, and a corresponding recess may be provided at the bottom of the closure member adjacent the channel portion 46 so that when the closure member 132 is fastened in place over the opening 114, the opening through the eduction tube will be in registration with the lower portion of the channel 46 in the cap.

In order to prevent leakage of gas between the eduction tube 48, or its supporting member 140, and the closure 132, an inner sealing ring or gasket 158 is employed which is preferably held in a recess 160 in the upper surface of the supporting member. To prevent leakage of gas between the closure and the adjacent upper surface of the container 52, an outer annular sealing ring or gasket 162 is positioned on the upper surface 164 of the annular ring member formed between the shoulder portions 134 and 136. The rings or gaskets 158 and 162 are preferably of a rubber or synthetic rubber composition having the required resiliency and adapted to withstand compression over a long period of time without substantial deterioration.

The bottom or lower portion of the container 52 is preferably provided with a flanged supporting stand 163 having openings 165 and 167 therein by which it may be bolted or otherwise secured to a bracket or other form of support for the apparatus.

The admission of carbon dioxide gas into the dry powder container 52 to operate the fire-extinguisher apparatus is preferably obtained by means of a carbon dioxide cylinder 54, which may be mounted adjacent the dry powder container on the same support or on a separate base, as may be desired. The carbon dioxide cylinder is preferably of a size to hold from 2½ to 3½ pounds of carbon dioxide to each 100 pounds of the dry powder to be discharged. We may employ 2½ pounds of carbon dioxide in a 5-pound cylinder for the discharge of 100 pounds of dry powder chemical in the container 52, the margin above the 1¼ pounds of carbon dioxide necessary for complete discharge serving the purpose of insurance against any loss of pressure, or as a factor of safety, and also to insure that the pressure cylinder shall contain sufficient gas after the complete discharge of the powder from the container 52 to serve the purpose of clearing the dispersal pipes or hose of all the residue of powder from the unit. The carbon dioxide cylinder is preferably of a form constructed to provide a test strength of 3,000 pounds per square inch, in accordance with standard specifications.

The carbon dioxide cylinder 54 is preferably provided with a control valve or operating valve 90 which is preferably of the "diaphragm packless" type generally available on the market, or

may be of the "on and off" form or other suitable or available form. The control valve is preferably connected to the carbon dioxide cylinder by means of a "street L" or "service L" connection 166, by means of which the carbon dioxide valve 90 may be positioned horizontally, instead of in the usual vertical position. The control valve 90 may be operated through a lever 88, which may be manually operated, if desired, by means of a pull rod 86, or it may be operated automatically by heat control means, as through the pressure-actuated device 92, above described, or by other suitable means, such as fusible links in the ducts or places to be protected which are operatively connected to the operating lever 88, as hereinafter described (see Fig. 9).

The control valve 90 is connected by means of an inlet tube 168 to the dry powder container 52, the tube 168 and the threaded pipe 170 of the valve casing being detachably connected by means of a connecting nut 172, as shown in Fig. 5 of the drawings. The inlet tube 168 passes through the adjacent wall of the dry powder container 52 and is connected to a discharge fixture 174, which is preferably screwed into place at the inner end of the inlet tube at the upper portion of the cylinder wall portion 110 of the container. The gas discharge member 174 is provided with a lateral discharge orifice 176, which allows gas passing through the inlet tube 168 to be discharged directly into the powder container above the normal level 178 of the powder contained therein. The lower or underside of the discharge fixture 174 is preferably provided with an opening 180, to which a bleeder tube 182 is connected which passes downwardly through the container adjacent the cylindrical wall portion 110 and the lower tapered wall portion 108 to a point substantially opposite the entrance end 47 of the eduction pipe or tube 48. The lateral discharge orifice 176 may have a diameter about twice that of the bleeder opening 180, such as in the ratio of ½ inch to ¾ inch, for example, although obviously the relative sizes of the openings may be varied with the particular installations.

The purpose of the bleeder tube 182 is mainly to insure that the opening of the valve 90 will be followed substantially immediately with the discharge of the dry chemical powder upwardly through the eduction tube 48. Lag or delayed action in the discharge of the powder may occur when the powder at the bottom portion of the container 52 is packed or congested, as may be caused by long standing in the vertical position of the apparatus without being operated. By the employment of the bleeder tube 182, a small portion of the carbon dioxide gas may be diverted at the beginning of the operation through the tube to near the bottom of the dry powder container adjacent to the entrance of the eduction tube, which unpacks or loosens the dry chemical mass and serves to dislodge a portion of the powder and to initiate the operation by which powder and gas are discharged through the eduction tube. After the initial action loosening the powder, the gas then passes through the inlet tube 168 and through the larger orifice 176 and the flow through the bleeder opening 180 and the bleeder tube is then brought to a minimum, the dry powder being entrained in the gas and passes upwardly through the eduction tube, through the outlet to the dispersal tubes and into the ducts or headers, by which any fire therein is extinguished.

The specific mechanism, detailed structure and mode of operation of the said actuated device 92, heat-responsive element 93 and release mechanism 94 are not specifically a part of the present invention and it is to be understood that any suitable form of mechanism such as various devices well known in the art may be employed for the purpose. The details of construction and the mode of operation of various parts of the mechanism above described in a general way and indicated in the drawings are fully disclosed in the expired Patent No. 1,404,534 to which reference may be made, and further detailed description of the means for automatically operating the lever 96 in response to abnormal heat changes, by which the control valve lever 88 is operated is unnecessary. It is to be understood, however, that in place of the mechanism and detailed structure shown and described in the Patent No. 1,404,534, I may employ the thermally controlled releasing mechanism as shown and described in the Patent No. 1,208,177, except that the cord of the release mechanism is connected to the valve control lever 88 as above described, so that when the weight falls or is released, the control valve 90 will be operated.

In some installations of the invention above described, it may be preferable, because of the distribution of the ducts, headers or flues to be protected, to have the heat-responsive, pressure producing element 93 located directly in the duct or header, as shown in Fig. 10, or a number of the elements 93 may be positioned in a plurality of ducts or headers and connected to a pipe connected to the said actuated device 92, so that if a fire occurs in any one of the ducts or headers in which the device 93 is located, the control valve 90 will be operated and the extinguisher powder and carbon dioxide will be distributed by the various dispersal tubes to the ducts or headers. If desired, a number of dispersal tubes may be connected to the same duct at different elevations, or to a header at different localities, so that the dry powder chemical and inert gas may reach the locality of the fire at the soonest possible moment.

Under conditions in which any combustion in the ducts or passageways to be protected develops an initially high temperature, the ducts or passageways may be protected by one or a plurality of fusible link members in the manner illustrated in Fig. 9 of the drawings. In this figure, the numeral 54' designates a carbon dioxide cylinder connected to the dry powder container 52' as above explained, the carbon dioxide valve 90' being operated by the valve lever 88' through a chain or wire member 98' to which the weight member 100' is connected. Extending upwardly from the lever 88' is a wire or cord 184, which passes over a pulley 186, by which the direction of pull of the wire or cord is changed. The wire 184 passes into the interior of a duct, as 60', and may be attached therein through a fusible link 190 to a hook or connection 188. The duct or flue 60' may contain a door or closure 192 adjacent the point of attachment 188, so that the link 190 may be readily replaced after having been fused, by which the operation of the fire extinguisher has taken place.

The door or closure 192 is preferably mounted on hinges 194 and 196 on one wall of the flue and may be provided with locking means 198, so that the link and wire member are unaccessible except to authorized persons. It is apparent that when combustion takes place in the flue or duct 60',

the wire 184 is released as soon as the fusible link 190 melts, by which the lever 88' is supported in its raised position, and the weight member 100' then drops and exerts a pull on the chain 98', turning the lever 88' downwardly and operates the valve 90' by which carbon dioxide is admitted to the dry powder container 52' which passes to the eduction pipe, entraining dry powder therewith, which passes through the discharge outlet into the dispersal tube or dispersal tubes into the corresponding duct or passageway 60', where-by the fire therein is extinguished.

In the event that two or more similar ducts or flues are to be protected by a mechanism similar to that shown in Fig. 9, the wire 184 may be made to pass in a substantially straight line through the flues, and a separate fusible link, as 190, may be inserted in the wire in each flue, so that when a fire occurs in any one of the flues or ducts, the tension in the wire 184 is released and the weight 100' then operates the lever 88' and the corresponding control valve 90, by which the extinguisher powder and carbon dioxide combination is discharged into each of the ducts or flues through the corresponding eduction pipes.

It is to be understood that various changes or modifications may be made in the forms of apparatus and the mode of operation thereof without departing from the spirit or scope of the invention as set forth in the claims annexed hereto. It will be obvious that the various parts of the fire-extinguisher apparatus may be so proportioned as to obtain substantially any desired rate of evacuation, and the size of the unit employed may be varied with the type of apparatus or devices to be protected, or with the number and size of the dispersal tubes or the lengths required in any particular installation.

Referring to Fig. 10 of the drawings, for example, the heat-responsive element 93 may be located in a duct 62' and is connected by means of a pipe 95 to the pressure-responsive member 92, in which is a diaphragm member or piston 97, which is mounted so as to be deflected by pressure or air from the element 93. A vent or relief valve 99 may be located in the housing of the pressure-actuated element 92, so as to relieve excess pressure produced by normal temperature increase in the heat-responsive element 93, or, if desired, the vent may be located in the pipe 95, or in the casing of the element 93, as may be preferred. The diaphragm or piston 97 may be connected by means of a pin member 91 for engagement with a detent lever 89 of the automatic release mechanism 94 for the operation of the release mechanism, the details of construction and mode of operation of which are fully shown and described in the Patent No. 1,404,534 above referred to, and need not be further described herein.

It will be obvious in connection with Fig. 10 that when a fire occurs in the duct 62', the air in the heat-responsive element 93 expands at a relatively rapid rate and pressure in excess of that relieved by the vent 99 is transmitted to the diaphragm or piston 97, which serves to depress the pin member 91 and to cause actuation of the automatic release mechanism 94, deflecting the lever 96 and causing the chain 98 to be slipped or dropped from the end of the lever, by which the weight member 100 is dropped, producing a pull on the chain section 102, which then pulls the lever 88 into the open position of the control valve 90, admitting carbon dioxide into the dry powder container 52 and causing dry powder and

gas to be blown out through the discharge outlet 84 into the dispersal tube 74' and into the duct 62' for extinguishing the fire therein in substantially the same manner as above explained in connection with Fig. 8 of the drawings.

While the ordinary small scale and commercial forms of the invention have been shown and described in detail herein, it is to be understood that various changes may be made therein as applied specifically for various uses, as for example in connection with its use for mobile units for extinguishing gasoline fires, particularly such as occur in connection with airplanes, oil tankers and other transportation devices, as will be obvious to those skilled in the art.

Having thus described the invention, what is claimed as new is:

1. A dry powder fire-extinguisher adapted for discharge from the upper portion thereof which comprises a container for dry powder having a concave bottom with a spherical surface, a discharge nozzle connected to said container, a discharge tube in said container having an inlet at substantially the principal focus of said spherical surface and an outlet into said nozzle, and means for discharging a pressure gas into the upper portion of said container to cause discharge of dry powder and gas through said discharge tube and said nozzle.

2. A dry powder fire-extinguisher adapted for discharge from the upper portion thereof which comprises a container for holding dry powder having a spherical concave bottom with a spherical surface, a filler opening at the upper portion of said container, a closure cap for said opening having a discharge nozzle therein, a discharge tube in said container extending axially therein, said discharge tube having an inlet immediately above the point corresponding to half the curvature distance from said spherical surface in an axial direction and an outlet into said nozzle and means for discharging an inert gas under pressure into the upper portion of said container to mix with dry powder in the operation thereof to discharge dry powder and gas through said discharge tube and nozzle.

3. A dry powder fire extinguisher adapted for discharge from the upper portion thereof which comprises a container for dry powder having a semi-spherical concave bottom portion, a discharge nozzle connected to said container, a central eduction pipe in said container having an inlet for intake of dry powder and gas immediately above the point corresponding to the principal focus of said semi-spherical concave portion and an outlet into said nozzle and means for discharging an inert gas under pressure into said container to bring dry powder therein and said gas to the said inlet to the eduction pipe for immediate discharge through said nozzle.

4. A dry powder fire-extinguisher adapted for discharge from the upper portion thereof which comprises a container for dry powder having a cylindrical main body portion, a semi-spherical concave bottom portion merging with the periphery of said cylindrical main body portion and an upwardly narrowed truncated cone portion merging with said cylindrical main body portion, a filler opening at the upper portion of said container, a closure cap combined with a discharge nozzle having a channel therethrough, and a central eduction pipe in said container connected to said closure cap for discharge into said channel and extending axially through the container to a point immediately above the principal focus of

said semi-spherical concave bottom portion, whereby when pressure gas is passed into the container through said cylindrical portion thereof, dry powder will be entrained in the gas and discharged through said eduction pipe and said nozzle.

5. A dry powder fire-extinguisher adapted for discharge from the upper portion thereof which comprises a container for dry powder consisting mainly of sodium bicarbonate, said container having a concave bottom with a spherical surface, a discharge nozzle connected to said container, an eduction pipe in said container having an inlet thereto immediately above the principal focus of said spherical surface and an outlet into said nozzle, a container for carbon dioxide under a pressure of from about 800 to 900 pounds per square inch and means for discharging said carbon dioxide from said carbon dioxide container into said dry powder container in a ratio of about $2\frac{1}{2}$ pounds of carbon dioxide to about 100 pounds of said dry powder, thus bringing said powder and gas into the inlet of said eduction pipe and discharging the same through said nozzle.

6. A dry powder fire-extinguisher adapted for discharge through the upper portion thereof in the upright position which comprises a container for dry powder having a concave bottom with a spherical surface, an eduction pipe in said container having an inlet thereto at substantially the principal focus of said spherical surface and extending into the upper surface of the container and means for discharging an inert pressure gas into said container to admix with said dry powder and to concentrate at substantially said inlet of the eduction pipe for discharge.

7. A method of quenching fires by means of a dry powder fire-extinguisher having a concave bottom with a spherical surface and a confined space therein containing dry powder which comprises passing carbon dioxide under a pressure of about from 800 to 900 pounds per square inch into said confined space to expand toward said surface in an axial direction to bring said powder and gas to a focus at substantially the principal focus of said spherical surface in a flowing stream, continuously withdrawing the combined powder and gas through an eduction pipe having an inlet positioned immediately above the principal focus of said spherical surface and expelling the same through said eduction pipe onto the fire.

8. A method of quenching fires by means of a dry powder fire-extinguisher having a concave bottom with a spherical surface and a confined space therein containing dry powder which comprises passing carbon dioxide under a pressure of substantially 800 to 900 pounds per square inch in a ratio of about $2\frac{1}{2}$ pounds of carbon dioxide to 100 pounds of said dry powder toward said semi-spherical bottom in an axial direction to bring the combined powder and gas to a focus at substantially the principal focus of said semi-spherical bottom in a flowing stream, continuously withdrawing the combined powder and gas from the locus of said principal focus through an eduction pipe having an inlet adjacent the said principal focus and continuously expelling the combined powder and gas through the eduction pipe onto a fire.

9. A method for expelling dry powder and gas under pressure from a container having a spherical bottom surface and a conduit axially positioned therein which comprises passing gas under pressure toward the area of the said spherical

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surface and withdrawing combined powder and gas through said conduit having an opening at substantially the principal focus of the said spherical surface and extending away from the said spherical surface.

10. A dry powder fire-extinguisher apparatus which comprises a container for dry powder having a concave spherical bottom portion, an eduction tube in said container having an inlet at substantially the principal focus of said spherical bottom portion, a pipe connected to said dry powder container at a point substantially above the mid portion thereof for admitting an inert gas therinto, a discharge member connected to said pipe having a main discharge orifice to permit gas to be discharged directly into the dry powder container, a bleeder tube connected to said discharge member having a discharge opening at substantially the level of said inlet of the eduction tube by which initial discharge of the dry chemical powder and gas into the said eduction tube is effected, irrespective of packing of the dry powder within the container, and a discharge outlet from said container connected to said eduction tube.

11. A dry powder fire-extinguisher apparatus adapted for discharge in upright position from the upper portion thereof which comprises a container for dry powder having a concave spherical bottom portion, an eduction tube in said container having an inlet at substantially the principal focus of said spherical bottom portion, a carbon dioxide container, a pipe leading from said carbon dioxide container to said dry powder container at a point above the mid portion thereof, a control valve in said pipe, a discharge member connected to said pipe having a lateral discharge opening for normal discharge of carbon dioxide into the dry powder container, a bleeder tube connected to said discharge member having an opening of a diameter substantially half that of said lateral opening, said bleeder tube having a discharge outlet directed toward said spherical body portion and terminating at substantially the level of said principal focus, a passageway to be protected, a dispersal tube leading from said eduction tube to said passageway, a heat-responsive pressure producing element associated with said passageway and adapted to respond to abnormal temperature changes produced by combustion in said passageway, a diaphragm adapted to be actuated by said heat-responsive element, a vent associated with said diaphragm to relieve pressures produced by normal temperature changes in response to corresponding changes in said heat-responsive element, and an automatic release mechanism operatively connected to said diaphragm for opening said control valve in response to abnormal temperature changes affecting said heat-responsive element.

12. A dry powder fire-extinguisher system adapted for automatic operation in response to abnormal temperature increase adjacent ducts and passageways to be protected which comprises a container for dry powder having a concave bottom with a spherical surface, an eduction tube in said container having an inlet thereto at substantially the principal focus of said spherical surface and extending into the upper portion of the container, a carbon dioxide container having carbon dioxide therein at a high pressure, a pipe for the passage of carbon dioxide from the said carbon dioxide container into said dry powder container, a control valve in said pipe, a plurality of dispersal tubes passing from said eduction tube to

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each of the ducts and passageways to be protected, heat responsive, pressure producing means adjacent said ducts and passageways, a release mechanism operatively connected to said control valve so as to cause operation thereof to admit carbon dioxide into said dry powder container in response to abnormal temperature changes and means permitting manual control of said control valve.

13. A dry powder fire-extinguisher system adapted for automatic operation in response to abnormal temperature increases adjacent the ducts and passageways to be protected which comprises a container for dry powder having a concave bottom with a spherical surface, an eduction tube in said dry powder container extending axially of the container and having an inlet at substantially the principal focus of said spherical surface and extending into the upper portion of said dry powder container, a carbon dioxide container adapted to hold carbon dioxide under a high pressure, a pipe connecting said carbon dioxide container to said dry powder container, a control valve in said pipe, a lever connected to said control valve, a plurality of ducts adapted for carrying inflammable air suspensions to be protected, a plurality of dispersal tubes connecting said eduction tube to one of said ducts, a heat responsive, pressure producing means adjacent said ducts, a pressure-actuated device having a diaphragm therein adapted for actuation by pressure from said heat-responsive, pressure producing means with abnormal temperature changes, a vent operatively associated with said diaphragm for equalizing pressures due to normal temperature changes, and an automatic release mechanism operatively connected to said pressure-actuated device adapted to cause turning of said lever for actuation of said control valve, whereby when a fire occurs in one of said ducts, the heat thereby affects said heat-responsive, pressure producing means resulting in operation of said control valve and passage of dry powder and carbon dioxide through said eduction tube and through said dispersal tubes into the ducts connected therewith, by which the fire is extinguished.

14. A dry powder fire-extinguisher system adapted for automatic operation in response to abnormal temperature increase adjacent a duct to be protected by the system which comprises a container for dry powder having a concave bottom with a spherical surface, an eduction tube in said dry powder container extending axially therethrough and having an inlet at substantially the principal focus of said spherical surface, a carbon dioxide container adapted to hold carbon dioxide under a high pressure, a pipe connecting said carbon dioxide container to said dry powder container, a control valve in said pipe to control the passage of carbon dioxide to said dry powder container, lever means connected to said control valve, a duct liable to carry inflammable air mixtures to be protected, a dispersal tube connecting said eduction tube to said duct, a heat-responsive, pressure producing element in said duct, a pressure-actuated device having a diaphragm therein adapted for actuation in response to pressure changes produced by abnormal temperature changes adjacent to said heat-responsive element, a vent associated with said diaphragm to relieve pressures due to normal temperature changes, an automatic release mechanism operatively connected to said diaphragm and having an operating lever normally held in

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raised position, a weight member suspended from said operating lever by releasing means so as to drop the weight member when said operating lever is actuated by said automatic release mechanism and connecting means between said weight member and said control valve lever so as to operate said control valve when the weight member is dropped.

15. A dry powder fire-extinguisher system adapted for automatic operation to quench a fire in a duct, header or passageway conducting inflammable air mixtures and unprotected by the plant automatic water sprinkling apparatus which comprises a container for dry powder having a concave bottom with a spherical surface, a discharge outlet connected to said container, an eduction tube in said container having an inlet thereto immediately above the principal focus of said spherical surface and an outlet into said discharge outlet, a container for carbon dioxide adapted to withstand a pressure of at least 900 pounds per square inch, a pipe connecting said carbon dioxide container with said dry powder container above the mid-portion of said dry powder container, a control valve in said pipe to control the passage of carbon dioxide therethrough, lever means connected to said control valve, a system of ducts and headers adapted for carrying off inflammable material to the atmosphere, a series of dispersal tubes connecting said discharge outlet to the ducts and headers of said system for the discharge of dry powder and carbon dioxide therein when a fire therein is to be extinguished, a heat-responsive, pressure producing element associated with said duct system, a device having a diaphragm adapted for actuation in response to heat changes in said element and having a vent associated therewith to relieve pressure changes on the diaphragm due to normal temperature changes and corresponding pressure changes, an automatic release mechanism operatively associated with said diaphragm, said release mechanism having an operating lever connected thereto, a weight member, suspending means connecting said weight lever to said operating lever so as to release the weight member when the release mechanism is operated in response to abnormal temperature changes affecting said heat-responsive element and connecting means between said control valve lever and said suspending means so as to operate the control valve when the weight member is released by said automatic release mechanism and whereby the dry powder chemical and carbon dioxide are immediately discharged through said dispersal tubes into the ducts, headers and passageways connected thereto.

16. A dry powder fire-extinguisher system adapted for automatic operation in response to abnormally high temperatures in a duct to be protected which comprises a container for dry powder having a concave bottom with a spherical surface, an eduction pipe in said dry powder container extending axially of the container and having an inlet at substantially the principal focus of said spherical surface, a carbon dioxide container adapted to hold carbon dioxide under high pressure, a control valve for controlling admission of carbon dioxide to said dry powder container, a lever connected to said control valve, a duct normally carrying an inflammable mixture to be discharged, a tube connecting said eduction pipe to the interior of said duct, a weight member suspended from said control valve lever, a wire member connected to said control valve

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lever so as to normally retain the control valve in closed position, said wire passing into said duct and connected to the interior wall thereof and a fusible link member in said wire within said duct, whereby when a fire occurs in the duct, the melting of the fusible link releases said wire and said weight member to operate the control valve by which fire-extinguisher powder and gas are injected through said tube into the duct to extinguish the fire therein.

17. A dry powder fire-extinguisher system adapted for automatic operation in response to abnormally high temperatures in any one of a plurality of ducts to be protected which comprises a container for dry powder having a concave bottom with a spherical surface, and eduction pipe in said dry powder container extending axially thereof and having an inlet at substantially the principal focus of said spherical surface, a carbon dioxide container adapted to hold carbon dioxide under a pressure of about 900 pounds per square inch, a control valve for controlling admission of carbon dioxide from the carbon dioxide container to said dry powder container, a lever member connected to said control valve for operating the same, a plurality of ducts normally carrying inflammable mixtures to be discharged, a series of tubes connecting said eduction pipe to each of said ducts for the passage of dry powder chemical and carbon dioxide thereto, a wire member passing through each of said ducts to be protected, a fusible link in each of said ducts inserted in said wire, whereby when a fire occurs in any one of said ducts, the wire will be severed by the melting of the fusible link therein and means connected to said lever member for operating the control valve when said wire becomes severed.

18. A method for expelling dry powder chemical and inert gas under pressure from a fire-extinguisher which comprises passing an inert gas under pressure to a spherical surface, the axis of which is in a substantially vertical position, in a downward direction substantially parallel to the said axis to bring the said powder and gas to a focus at substantially the principal focus of said spherical surface and withdrawing the combined powder and gas in a continuous stream from the point of said principal focus through an eduction pipe having an opening at substantially the said principal focus, the ratio of the size of the opening to the radius of curvature of the said spherical surface being about $\frac{1}{8}$ to $\frac{2}{4}$.

19. A method of quenching fires by means of a dry powder fire-extinguisher having a concave bottom with a spherical surface and a confined space therein containing dry powder which comprises emitting an inert gas under pressure into said confined space to pass toward said spherical surface and to form a free-flowing stream of dry powder and gas converging at substantially the principal focus of said surface, continuously withdrawing dry powder and gas through an eduction tube having an inlet positioned at substantially the said principal focus and continuously expelling the said powder and gas from said eduction tube to the locus of the fire to extinguish the same.

20. A dry powder fire-extinguisher apparatus which comprises a container for dry powder having a concave spherical bottom portion, an eduction pipe in said container having an inlet thereto at substantially the principal focus of said spherical bottom portion, a carbon dioxide container, a pipe leading from said carbon dioxide

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container to said dry powder container at a point above the mid-portion thereof, a control valve in the last-named pipe, a header connected to said eduction pipe at the outlet end thereof, a face plate connected to said header, a series of dispersal tubes anchored in said face plate and leading to a locus to be protected and an operating lever connected to said control valve for releasing carbon dioxide into the said dry powder container to provide operation of the said apparatus.

21. A dry powder fire-extinguisher apparatus which comprises a container for dry powder having a concave spherical bottom portion, an eduction pipe in said container having an inlet thereto at substantially the principal focus of said spherical bottom portion, a carbon dioxide container, a pipe leading from said carbon dioxide container to said dry powder container at a point above the mid-portion thereof, a control valve in the last-named pipe, a header connected to said eduction pipe, a face plate in said header, a series of dispersal tubes anchored in said face plate and leading to ducts to be protected, an operating lever connected to said control valve and means operable with abnormally rapid increase of temperature in one of said ducts for operating said operating lever to provide operation of said apparatus.

22. A dry powder fire-extinguisher apparatus in accordance with claim 21 in which the dispersal tubes are sealed at one end thereof into the face plate through nuts permitting the dis-

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persal tubes to be extended to adjust the lengths thereof and in which the dispersal tubes are attached at the other ends thereof to a duct by means of a flange affixed to the duct, into which the dispersal tubes are inserted through expansion nuts.

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