(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 878 212 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
18.11.1998 Bulletin 1998/47

(51) Int. Cl.[6]: **A62C 35/68**

(21) Application number: **98108720.8**

(22) Date of filing: **13.05.1998**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **16.05.1997 US 857546**

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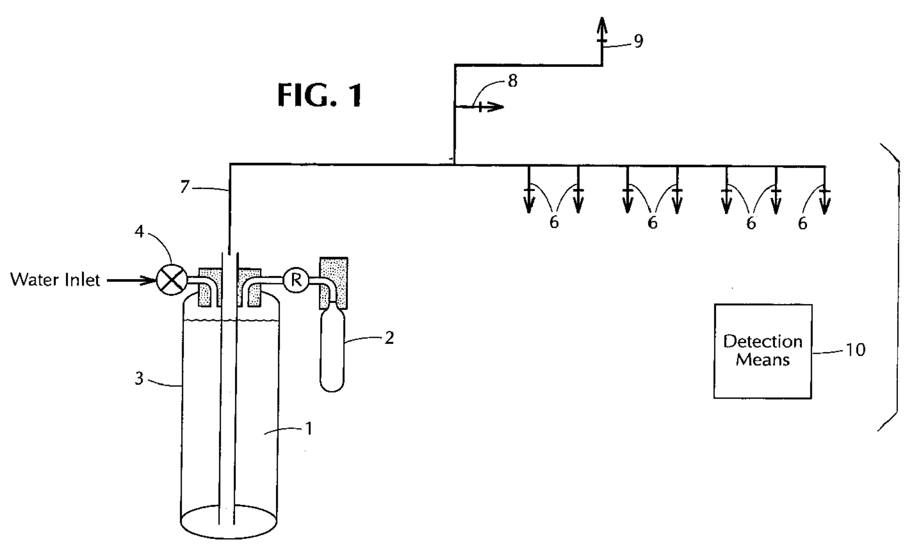
(54) Fire suppression system

(57) The present invention relates to a fire suppression system and method in which an extinguishing agent is automatically discharged from a limited source of supply of the wet chemical extinguishing agent for rapid extinguishment of the fire, followed by water application to the locus of the fire from an unlimited source of supply of water. The subsequent automatic application of water provides rapid cooling of the hot burning material below its reflash temperature. The present hybrid system exploits the best fire suppression properties of both agents against fires i.e. the wet chemical extinguishing agent provides rapid flame extinguishment and water provides rapid cooling following extinguishment. The present hybrid system is significantly more robust (fire test variables are less critical to its fire suppression performance) than current water or wet chemical agent systems.

FIG. 1



EP 0 878 212 A2

Description

Field of the Invention

The present invention relates to a fire suppression system and method for extinguishing fires by dispensing a fire extinguishing composition onto the fire followed by the application of water. The system can utilize a particular extinguishing composition which comprises a unique mixture of at least two salts wherein the mixture exhibits a single minimum melting point.

Background of the Invention

In the fire extinguishing art, fires are divided into four general classes; namely, Class A, Class B, Class C and Class D.

Class A fires are those involving ordinary combustible material such as paper, wood, etc. and can be extinguished by quenching and cooling with large quantities of water or solutions containing a large percentage of water.

Class B fires are those involving shortening, oils, greases, flammable liquids, etc. In this type of fire, the use of water is generally ineffective, because the contact of water with the hot oil causes a great amount of splattering without extinguishing the flames and the hot burning oil or grease may spread the fire. This type of fire is the most difficult to extinguish because of the low auto-ignition points of shortening, oils and greases which are in the range of about 360°C to 380°C. Further, the presence of flammable materials in large quantities makes it extremely important to extinguish the fire as rapidly as possible and also bring the temperature down to prevent any reflash which occurs at a lower temperature of about 337°C.

Class C fires involve electrical equipment. Thus, the electrical conducting property of the extinguishing material is an important consideration. For this reason, it has been found that dry fire extinguishing agents are generally more useful. It has also been found that the fire extinguishing agents useful for Class B fires are generally also useful for Class C fires.

Class D fires involve combustible metals and are extinguished with special dry powders.

Many different fire extinguishing compositions and fire extinguishing systems using such compositions have been developed and are available on the market. However, re-flash or auto- ignition of the hot shortening, oils or greases in Class B fires remains a serious problem. This is true, particularly, when such fires involve large commercial establishments, such as restaurants, cafeterias, mess halls, etc. The potential danger of such fires in these types of establishments is widely recognized.

Prior art systems for extinguishing fires in cooking equipment in a kitchen have utilized a water spray. When such systems are employed, the time to extinguish fat, oil, shortening or grease fires may take up to six minutes. The water spray can cause violent flaming. In such systems, the fat, oil, shortening or grease fire is eventually extinguished because of the cooling action of the applied water on the hot oil or grease. A system which utilizes water spray fire protection for hoods over cooking units is shown in U.S. Pat. No. 4,356,870. Another system which automatically releases a high volume flow of extinguishant over critical areas of a fat or grease fire is disclosed in U.S. Pat. No. 3,584,688.

Various state-of-the-art restaurant fire protection systems use proprietary wet chemical agents to suppress hostile fires in hoods, ducts and cooking appliances. These wet agents are typically aqueous solutions of organic salts specifically formulated to suppress fuel-in-depth grease fires in two distinct phases. During the first phase, the agent is sprayed directly onto the grease fire for rapid extinguishment (approximately 5 seconds) of the flames by chemical reaction. In the second phase, the wet agent continues to be discharged onto the hazard to both cool and combine with the hot grease to generate a protective foam blanket on top of the hot grease. The foam blanket secures the hot grease from reflashing by excluding air until the grease either cools down below its reflash temperature or the foam blanket breaks down from the heat of the hot grease below, or both. The water content in the wet agent is an effective cooling agent (a positive feature) but is offset by the insulating effect of the foam blanket which retards the heat release of the hot grease (a negative feature). When water alone is sprayed onto a grease fire, it has proven to be a poor extinguishing agent but an effective cooling agent, provided it is discharged for an extended period of time (for an average of about 6-9 minutes). In fact, water alone will not extinguish the flames until the hot grease is cooled below its reflash temperature.

It is an object of the present invention to provide a fire suppression system which provides rapid flame knockdown by the application of a wet chemical and which also provides cooling and securement of the hot greases, oils, shortening, fat or flammable liquid (fuels) by further application of an unlimited amount of water.

It is a still further object of the present invention to provide a fire suppression system which gives better coverage over a grease or oil fire and which is easy to install in existing kitchen equipment.

Summary of the Invention

The present invention relates to a fire suppression system and method in which an extinguishing agent is automatically discharged from a limited source of supply of the wet chemical extinguishing agent for rapid extinguishment of the fire, followed by water application to the locus of the fire from an unlimited source of supply of water. The subsequent automatic application of water provides rapid cooling of the hot burning material below its reflash temperature. The protective foam blanket normally generated by an extinguishing agent alone can be negated by water spray dilution in order to maximize the superior cooling effects of the water against the hot burning material such as grease or fat. However, the present hybrid system exploits the best fire suppression properties of both agents against fires i.e. the wet chemical extinguishing agent provides rapid flame extinguishment and water provides rapid cooling following extinguishment. The present hybrid system is significantly more robust (fire test variables are less critical to its fire suppression performance) than current water or wet chemical agent systems.

In the dry pipe embodiment of the present system, an extinguishing agent in liquid form is automatically delivered to a fire by a fire suppression system. The fire suppression system comprises a means for automatic fire detection, a means for automatic actuation of the suppression system, a storage vessel for an extinguishing agent, distribution piping for the extinguishing agent and for water, and nozzles for spraying the wet chemical extinguishing agent and subsequently water onto the fire. The operation of the system is such that, at the completion of the discharge of the extinguishing agent, an automatic switching means provides for the subsequent application of water automatically through the same distribution piping and spray nozzles of the system as are employed to apply the extinguishing agent onto the fire.

The automatic switching means to switch from the flow of extinguishing agent to a flow of water is accomplished by an automatic valve. The automatic switching valve is actuated with either gas or hydraulic pressure, depending on which of three optional valves is used with the dry pipe system, as described in the following section describing the details of the present invention by reference to the figures.

In a wet pipe embodiment of the invention, a liquid extinguishing agent is contained within the distribution piping and is delivered to the fire by a system comprising a means for fire detection, a means for automatic actuation, distribution piping for the extinguishing agent and water, and spray nozzles for dispensing the extinguishing agent and water onto the fire. At the completion of the discharge of the liquid extinguishing agent the subsequent application of water occurs automatically by means of an automatic check valve through the same distribution piping and spray nozzles.

The extinguishing agent can also be stored in solid rather than liquid form within a primary storage means and can be dissolved by the flow of water into the primary storage means. The water flow is automatically actuated by a means for fire detection and a means for automatic actuation. The flow of the extinguishing agent dissolved in water occurs through distribution piping and spray nozzles, with the flow of water continuing after the dissolved extinguishing agent solution is exhausted.

The extinguishing agent can also be in solid form within multiple storage means located directly prior to each spray nozzle and can be dissolved by the flow of water. The flow of water is automatically actuated by a means for fire detection and a means for automatic actuation. The flow of the extinguishing agent dissolved in water occurs through the spray nozzles, with the flow of water continuing after the dissolved salt solution is exhausted.

Brief Description of the Drawings

Fig 1. is a schematic for the dry pipe embodiment of a fire extinguishing system of the present invention.

Fig. 2 is a schematic for the wet pipe embodiment of a fire extinguishing system of the present invention.

Figs. 3a, 3b and 3c are details for one valve option for a dry pipe fire extinguishing system of the invention.

Fig. 4a and 4b are details of a second valve option of a dry pipe fire extinguishing system.

Fig. 5 is a detail of a third valve option of a dry pipe extinguishing system.

Fig. 6 is a detail of a nozzle useful in the present system.

Detailed Description of the Invention

One dry pipe embodiment of the present system is shown in Fig. 1. A tank **3** holding a solution of the fire extinguishing composition **1** is connected through pipes **7** to appliance nozzles **6**, plenum nozzles **8** and duct nozzles **9**. A valve assembly **4** (detail shown in Figs. 4 and 4b) mounted on the tank **3** controls the sequential release of the solution of the fire extinguishing composition followed by water. When a fire is detected by a detection means **10**, a seal in a gas cartridge **2** release is punctured and gas at high pressure is released from the gas cartridge **2**. The high pressure gas simultaneously presses a spring loaded piston against the water inlet valve (not shown) to prevent water from being discharged and forces the solution in the tank to be discharged through the nozzles **6**, **8** and **9**. When the gas pressure is reduced to a particular pressure, such as for example 45 psi, the spring loaded piston of the valve assembly moves to an open position to permit water flow down to the tank **3** and out to the nozzles.

The embodiment shown in Fig. 2 is a wet pipe system. Before system actuation, the storage tank **20** and the distribution piping **21** are filled with wet agent. The tank **20** and distribution piping **21** are under pressure from compressed gas in the top of the agent tank. Discharge nozzle valves **22**, **23**, **24** are closed. When one or more heat-actuated nozzle valves **22**, **23**, **24** opens in response to heat from hostile fire(s) wet agent is automatically expelled from the agent tank **20** and distribution piping **21** through the open nozzles **27**, **28**, **29** by the compressed gas in the tank **20**. When the compressed gas pressure drops below in the water pressure at the water inlet check valve **26**, water will automatically flow through the distribution piping **21** and the same open nozzles **27**, **28**, **29** until the water supply is manually shut off. Only those nozzles **27**, **28**, **29** which open in response to heat from hostile fires will automatically discharge agent and water onto the burning hazards.

Figures 3a, 3b and 3c show cross-sections of one automatic valve option of a dry pipe system. The storage tank **31** is filled with wet chemical agent **32** and is under atmospheric pressure. A valve **33** has a gas inlet port **34** which is connected to a gas pressure regulator (not shown) on the Ansul Automan release assembly (not shown). The gas regulator is connected to an expellant gas cartridge which contains nitrogen or carbon dioxide expellant gas under high pressure. The valve water inlet **35** is connected to a municipal water supply or restaurant wet sprinkler system and is under static water pressure. The double piston assembly **36** is locked in the closed position by the spring-loaded reset pin **37** so that static water pressure will not move the double piston assembly **36**. The valve discharge outlet **38** is piped to multiple discharge nozzles (not shown), each aimed at a potential fire hazard.

When a hostile fire is detected, the spring-loaded release assembly **39** (not shown) automatically actuates to puncture the seal of the expellant gas cartridge (not shown), thereby releasing expellant gas under high pressure through the pressure regulator (not shown), where the pressure is reduced to a lower operating pressure, and thence to the valve **33**. The expellant gas performs two functions in the tank assembly **31**. First, it thrusts the double piston assembly **36** toward the water inlet port **35** to release the spring-loaded reset pin **37**, which retracts into a recess in the valve body as shown in Fig. 3b. Second, the expellant gas is ported through the valve **33** to the top of the tank where it pressurizes the wet agent **32** to force it down the tank, up the pick-up tube **41**, through the valve discharge outlet **38** and out the discharge nozzles (not shown). During wet agent discharge, gas pressure on the piston **42** and liquid pressure from the wet agent on the other piston **43** hold the piston assembly **36** in the unlocked position against the static water pressure.

When the wet agent has been expelled from the tank and the gas pressure decays to a critical level, the net force on the double piston assembly will reverse (force to open from water pressure will be greater than the force to continue closing under decaying gas pressure) and the static water pressure will thrust the piston assembly **36** towards the gas inlet **34** thereby opening the water inlet port **35** to the discharge outlet port, allowing water to flow out the same discharge piping to the discharge nozzles. The water will flow until it is manually shut off upstream of the valve. The check ball **44** prevents water from entering the tank.

The present valve is mechanically activated using cartridge pressure to pneumatically actuate the valve and initiate the flow of the extinguishing agent.

In the event of a fire the actuation cartridge pressure is released to port **34**. The pressure piston releasing the locking/reset pin number **37**. This pin is spring-loaded to pull out away from the piston when the catch is released. Pressure ported through inlet **34** is also directly connected to the head space of the tank where the agent is being pushed out by the gas from the cartridge. When the tank pressure depletes after expelling the wet chemical agent the holding force acting on the piston area decreases allowing the water pressure to shuttle the valve to a water open position. Water then flows through the distribution piping and is applied to the extinguished hazard cooling the grease or cooking surface and preventing reflash from occurring.

Figures 4a and 4b show another automatic valve option of a dry pipe fire protection system. Tank **50** is filled with a wet chemical agent **51** under atmospheric pressure. The water inlet port **52** of the valve assembly **53** is piped to a source of water supply. The valve **53** is closed and is under static water pressure. The connected water line (not shown) includes a check valve (not shown) to prevent backflow when the system is initially actuated. The high pressure gas inlet port **54** of the valve **53** is piped to the high pressure side of the gas pressure regulator (not shown) on the spring-loaded release assembly (not shown) and is under atmospheric pressure until the fire protection system is actuated. The high pressure line (not shown) includes a check valve (not shown) to trap high pressure gas in the line when the system is actuated. As an optional feature, the high pressure gas line may include a bleed orifice so that the high pressure gas is slowly released to allow water pressure to automatically close the valve after the water has discharged for a minimum duration, to minimize flooding. The low pressure gas inlet port **55** on the pick-up tube assembly is piped to the low pressure side of same gas pressure regulator and is also under atmospheric pressure until the system is actuated. The gas pressure regulator (not shown) is piped to a gas cartridge (not shown) a small pressure vessel, which contains a fixed volume of nitrogen or carbon dioxide expellant gas under high pressure. The tank discharge outlet **56** on the pick-up tube assembly **57** is piped to multiple discharge nozzles (not shown), each aimed at a potential fire hazard.

When a hostile fire is detected by the fire protection system, the spring-loaded release assembly (not shown) automatically actuates to puncture the seal of the expellant gas cartridge, thereby releasing gas under high pressure to both the high pressure gas inlet of the valve **54** and the pressure regulator, where the high gas pressure is reduced to a lower operating pressure. The high pressure gas opens the valve **53** to the water supply by thrusting the piston **59** and stem assembly **60** towards the water inlet **52** against the force of the spring **61** and the static water pressure. Once the stem assembly **59** is unseated, the trapped high pressure gas will hold it open until the gas pressure is manually released after the fire event when the system is recharged and reset. The low pressure gas from the regulator enters the top of tank to expel the wet agent **51** from the tank **50** through the tank discharge outlet **56**, discharge piping (not shown) and discharge nozzles (not shown). Once the low pressure gas is flowing, the regulator will feed the low pressure gas into the tank at a constant pressure until the decaying pressure of the gas in the fixed-volume cartridge falls below the preset outlet pressure of the regulator, at which time the gas pressure from the regulator will also decay with time.

Although the valve was opened initially by the high gas pressure, water will not flow into the tank **50** until the water pressure from the water supply overcomes the decaying gas pressure of the low pressure gas in the top of the tank **50**, at which time water will automatically commence flowing through the tank **50**, discharge piping and the discharge nozzles. Water will continue to flow until it is manually shutoff upstream from the valve after the fire event is concluded.

Figure 5 shows a third automatic valve option of the dry pipe system. The automatic remote valve **70** can be located in the agent distribution piping (not shown) of the present fire protection system between the wet agent storage tank (not shown) and the discharge nozzles (not shown). The agent inlet port **71** on top of the valve is piped to the discharge connection on the wet agent storage tank and is under atmospheric pressure until the system is discharged. The discharge outlet **72** on the valve is piped to multiple discharge nozzles (not shown), each aimed at a potential fire hazard. The water inlet port **76** on the bottom of the valve is piped to a water supply source and is under static water pressure. The piston **74** includes two circumferential O-rings (not shown) to seal against hydraulic pressure from either side. The piston **74** is locked in the closed position by the spring-loaded reset pin assembly **75** to resist the static water pressure. Because the reset pin **75** is hooked on the piston, it cannot retract (move to the right) under spring force until the piston is thrust downward during the operating cycle.

When a hostile fire is detected by the system, the spring-loaded release assembly (not shown) automatically actuates to puncture the seal of the expellant gas cartridge (not shown), thereby releasing expellant gas (nitrogen, carbon dioxide, or air) under high pressure through the pressure regulator (not shown), where the pressure is reduced to a lower operating pressure. From the regulator, the gas is routed to the inside of the agent storage tank (not shown) where it forces the wet agent out of the tank, through the normally-open ports in the automatic valve **70** and out the discharge nozzles (not shown). The hydraulic pressure of the wet agent flowing through the automatic valve **70** will thrust the piston **74** down against water pressure to unlatch the reset pin **75** which will then retract under its spring force into the wall of the valve body. While the wet agent is flowing through the valve **70** under maximum regulated gas pressure, the piston **74** will remain in the closed position because the hydraulic pressure of the wet agent against the larger diameter of the piston **74** overcomes the water pressure against the smaller diameter of the piston.

When the wet agent has been expelled from the tank and the gas pressure from the cartridge decays to a critical level, the net force on the piston will reverse (force to open from water pressure will be greater than the force to continue closing the piston under decaying wet agent pressure) and the piston will be thrust up to close the agent inlet port **71** and open the water inlet port **76** to the discharge outlet, allowing water to flow to the discharge nozzles until it is manually shut off.

A particular system nozzle which can be used in the present invention is shown in Figure 6.

The nozzle **80** has a swivel joint **81** so that it rotate up to 30 degrees in any direction from the centerline of the body.

The nozzle **80** also includes a vane **83** which twists or spins the fluid being discharged out of the tip **82** to stabilize the exiting spray cone. The internal bore of the nozzle tip is machined to a configuration which controls both the critical flow and spray angle of the discharge. In the case of the new appliance nozzle, the nominal flow rate will be 1.7 gallons of water per minute (6.4 liters/min) at 80 psi nozzle pressure. Spray angle (included angle of the cone of water being discharged) will be a nominal 60 degrees.

The flow rates and spray angles for the nozzles which protect ventilation hoods and ducts over the appliances are established based on the necessary environmental conditions of the nozzle location and based on the known need of extinguishing agent and water at the nozzle locus. The appliance nozzle has a built-in swivel joint while the hood and duct nozzles do not need to swivel.

The present invention relates to a fire protection system which automatically actuates the sequential discharge of a fire extinguishing composition followed by water. The fire protection system includes novel valve assemblies. The valve assembly may be installed on the top of a tank holding the fire extinguishing composition or the valve assembly may be remote from the tank. Preferred valve assemblies are described herein above.

Fire extinguishing systems for use in a commercial kitchen are usually installed as a part of the exhaust hood over the cooking range.

The instant fire extinguishing system can be employed using various known extinguishing agents. Different types of nozzles with different flow rate controls and different spray angles are required for the different cooking appliances such as deep fryers, griddles and ranges.

A preferred fire extinguishing composition which is disclosed in concurrently filed copending patent application Serial No. ________________ entitled A COMBINATION OF A NOVEL FIRE EXTINGUISHING

COMPOSITION EMPLOYING A EUTECTIC SALT MIXTURE AND WATER AND A METHOD OF USING SAME TO EXTINGUISH FIRES and this preferred composition is especially advantageous in the operation of the present fire suppression system. The copending application is expressly incorporated herein by reference.

The preferred novel fire extinguishing composition comprising a unique mixture of at least two salts I and II, wherein I is selected from the group consisting of a carbonate or bicarbonate of sodium or potassium and II is selected from the group consisting a chloride, sulfate, or tartrate salt of sodium or potassium, and the mixture I and II exhibits a single minimum melting temperature range by DSC. The mixture is particularly effective when applied as a combination with additional water. The characteristic of this unique mixture is analogous to that of a eutectic wherein a mixture of two or more metals or salts exhibit a minimum melting point. I is a salt having the following characteristics: it dissociates to form carbon dioxide when heated, and it is soluble at a range of about 25 g to 150 g/100ml of water. II is a salt or a mixture which when mixed at a particular ratio with I will provide a single minimum melting temperature range. It was found that by adding a small amount from 10 mole% to 20 mole% of II to I, the mixture exhibits a single minimum melting temperature range, lower than that of I alone or II alone. Also, at this temperature, the heat capacity of the mixture, its ability to absorb heat, is at a maximum, a value that is in excess of the heat capacity of the individual components. The single minimum melting temperature range is determinable by the use of differential scanning calorimetry (DSC).

It is found that when the unique mixture is applied as a fire extinguishing agent followed by water, the combination is extremely effective for extinguishing Class B fires involving oils or greases and will prevent reflash/auto-ignition. The mixture may be sprayed onto a fire as a concentrated aqueous solution of about 15%-30% by weight in water, followed by further application of water. The mixture when initially sprayed onto a fire at a flow rate of about 4.5 L/min to 7.5 L/min will generate a thick layer of foam containing carbon dioxide. At these flow rates, the pressure is about 30 psi to 100 psi. This thick layer of foam smothers the burning flame rapidly, within 2-10 seconds. When followed by the application of water, further foaming is generated together with rapid cooling of the hot oil/grease. An application of water for 2 minutes at a similar flow rate of about 4.5 L/min to 7.5 L/min causes more foaming and at the same time reduced the temperature of the hot oil to below 330°C. so that re-ignition is prevented.

Apparently, the unique mixture when applied to the burning oil absorbs a large amount heat from the oil. It has been found that at a flow rate of about 4.5 L/min/nozzle - 7.5 L/min/nozzle, a 2-10 sec. application of a 25 wt% solution of a mixture of potassium bicarbonate with sodium sulfate in a mole% ratio of 85:15 followed by a 2-10 minute application at the same flow rate of water completely extinguishes an actively burning deep fryer containing about 50 L. (13 gal.) of cooking oil. Furthermore, the oil is cooled down to below 330°C to prevent re-flash.

The present system provides various operating options. The extinguishing agent can be any known extinguishant or is preferably the salt mixture disclosed in the copending application discussed hereinabove. The extinguishant can be employed as a liquid solution or the system can be designed to employ an extinguishant in dry solid form which is converted to a liquid solution when the system is activated.

There are also various extinguishing agent storage options. The extinguishing agent can be contained in one or more containers under compressed gas pressure in a dry pipe system. In another embodiment, the extinguishant can be contained in one or more containers under atmospheric pressure in a dry pipe system. In still another embodiment liquid extinguishant can be contained in the discharge piping under compressed gas pressure as a wet pipe system.

There are also various water valve actuation options including:

a) gas pressure;
b) water pressure;
c) spring-loaded trip mechanism;
d) electric solenoid; and
e) a combination of above

Agent expellant options include:

a) gas pressure;
b) water pressure;
c) gas/water pressure combination; and
d) an eductor suction.

Compressed gas storage options include:

a) gas cartridge or
b) agent tank (stored pressure).

Claims

1. A fire suppression system for extinguishing a fire wherein a liquid solution of an extinguishing agent is automatically delivered to the fire by the fire suppression system comprising a means for fire detection, a means for automatic actuation, a storage vessel, distribution piping, and spray nozzles, and wherein the system further comprises a valve means so that after the discharge of the liquid solution the valve automatically switches to allow a subsequent application of water through the same distribution piping and spray nozzles.

2. The system of claim 1 wherein the automatic

switching from the flow of liquid solution to the flow of water is accomplished by a switching valve located at the storage vessel, said valve being actuated by a pressurized gas used to propel the liquid solution, and subsequently allows the flow of water when the pressure of a water supply exceeds the expellant gas pressure.

3. The system of claim 2 wherein the automatic switching from the flow of liquid solution to the flow of water is accomplished by a switching valve located at the storage vessel, which valve is actuated by pressurized gas used to propel the liquid solution, and subsequently allows the flow of water when the pressure of the water supply exceeds the expellant gas pressure, and for which the actuation pressure for the valve is trapped by a check valve to hold the switching valve in the open position, until such time as sufficient pressure is released through an optional bleed port to allow the valve to close after a prescribed period of time.

4. The system of claim 2 wherein the automatic switching from the flow of liquid solution to the flow of water is accomplished by an automatic switching valve located remote from the agent storage tank within the distribution piping; which valve is actuated by the pressure of the initial flow of the liquid salt solution, and subsequently allows the flow of water when the pressure of the water supply exceeds the pressure within the distribution piping.

5. The wet pipe embodiment of claim 1 wherein the liquid solution is contained within the distribution piping and is delivered to the fire by a system comprising a means for automatic fire detection and agent discharge at each nozzle, distribution piping, and automatic spray nozzles, and wherein at the completion of the discharge of the liquid solution, a subsequent application of water occurs automatically through the same distribution piping and spray nozzles.

6. The system of claim 1 wherein the liquid solution is initially in solid form within at least one storage container and the solid is subsequently dissolved by a flow of water, which flow is automatically actuated by a system comprising a means for fire detection and a means for automatic actuation, and for which the flow of the now dissolved solid in water occurs through distribution piping and spray nozzles, with the flow of water continuing after the dissolved solid solution is exhausted.

7. The system of claim 6 wherein the solid is within multiple storage cartridges located directly prior to each spray nozzle and are subsequently dissolved by the flow of water, which flow is automatically actuated by a system comprising a means for fire detection and a means for automatic actuation, and for which the flow of the now dissolved salts in water occurs through the spray nozzles, with the flow of water continuing after the dissolved salt solution is exhausted.

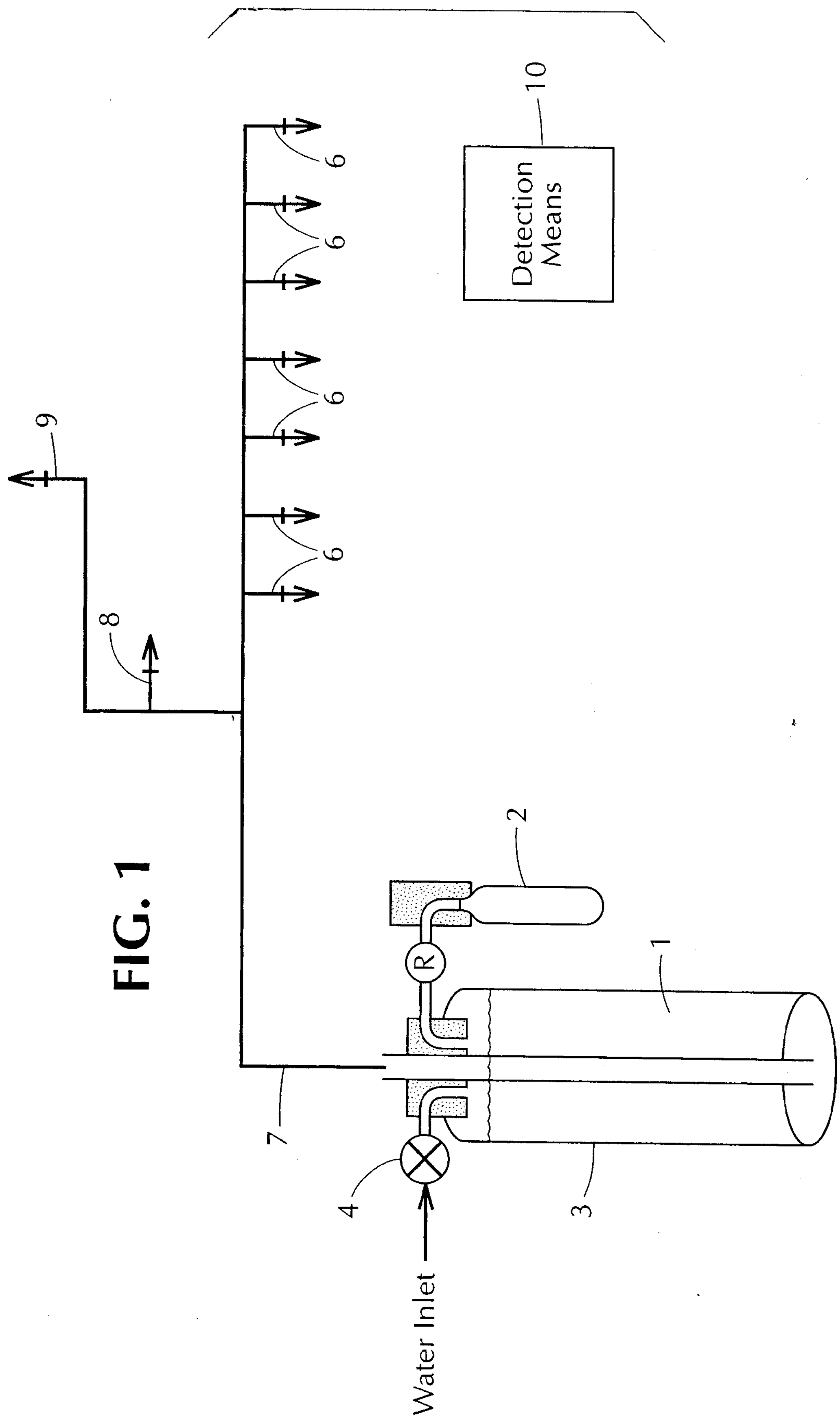


FIG. 1

FIG. 2

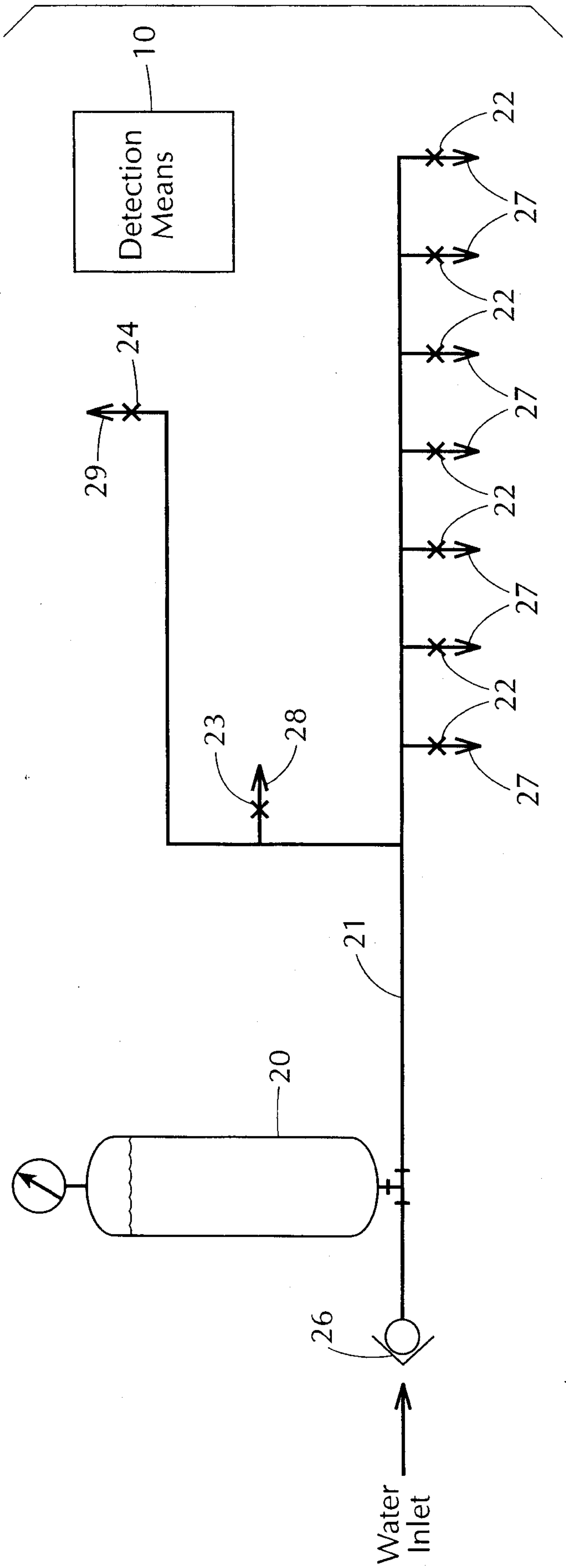


FIG. 3A

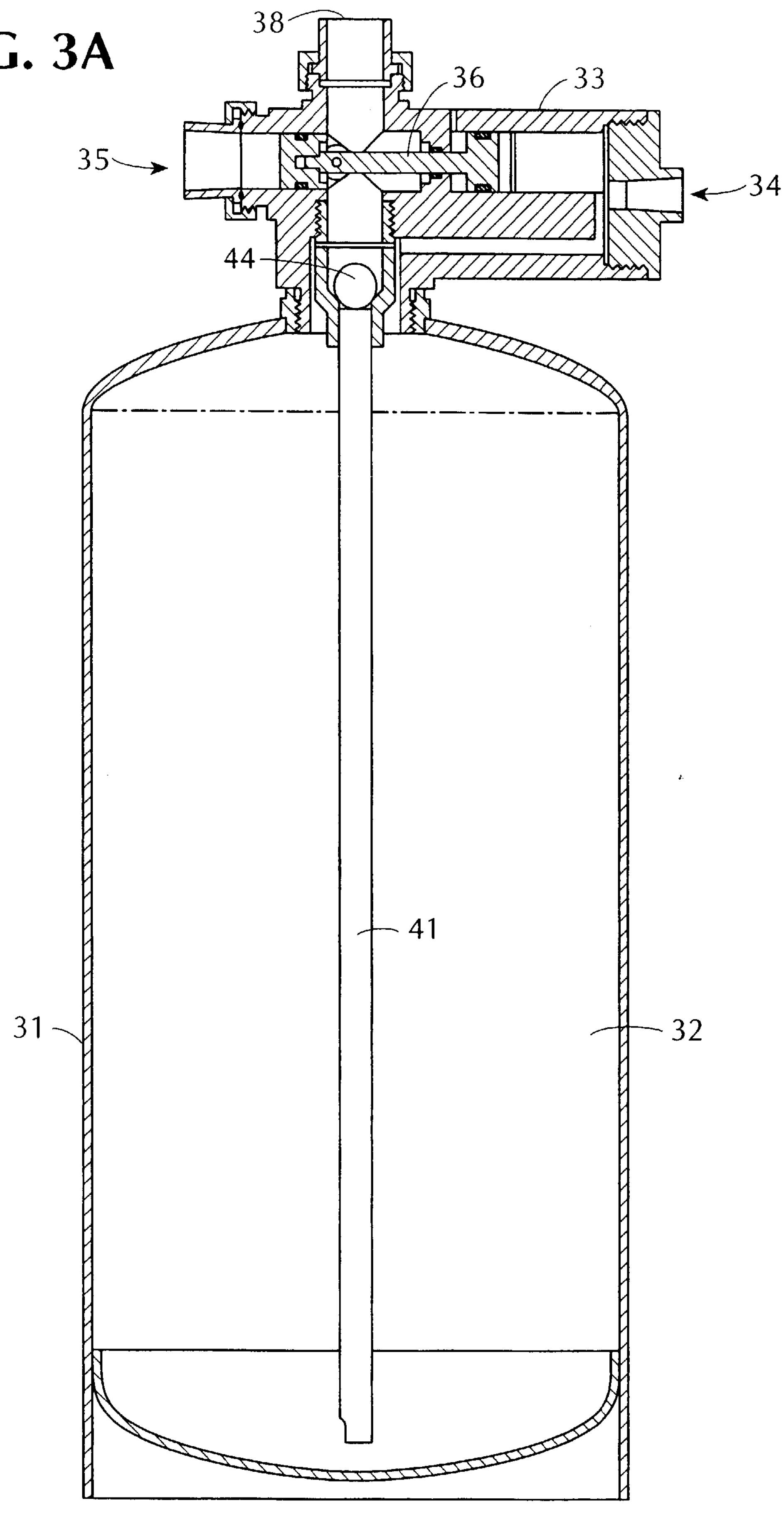


FIG. 3B

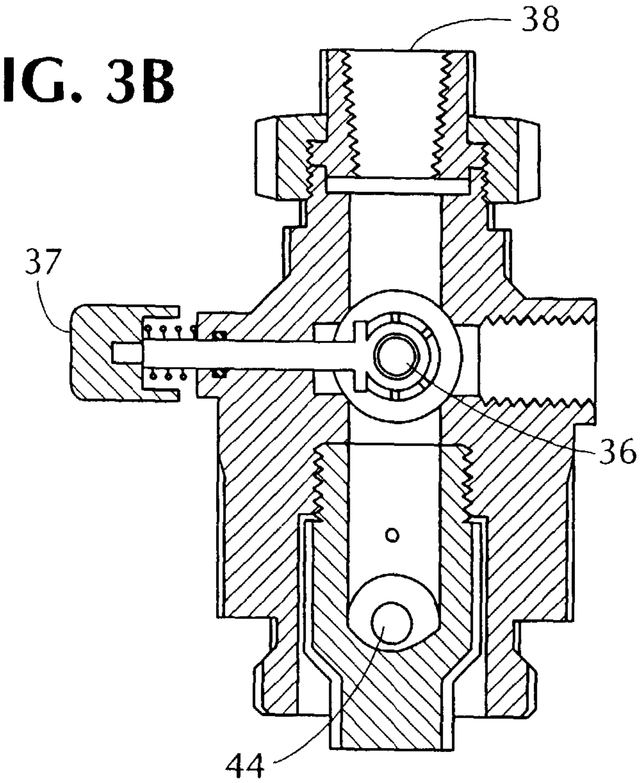


FIG. 3C

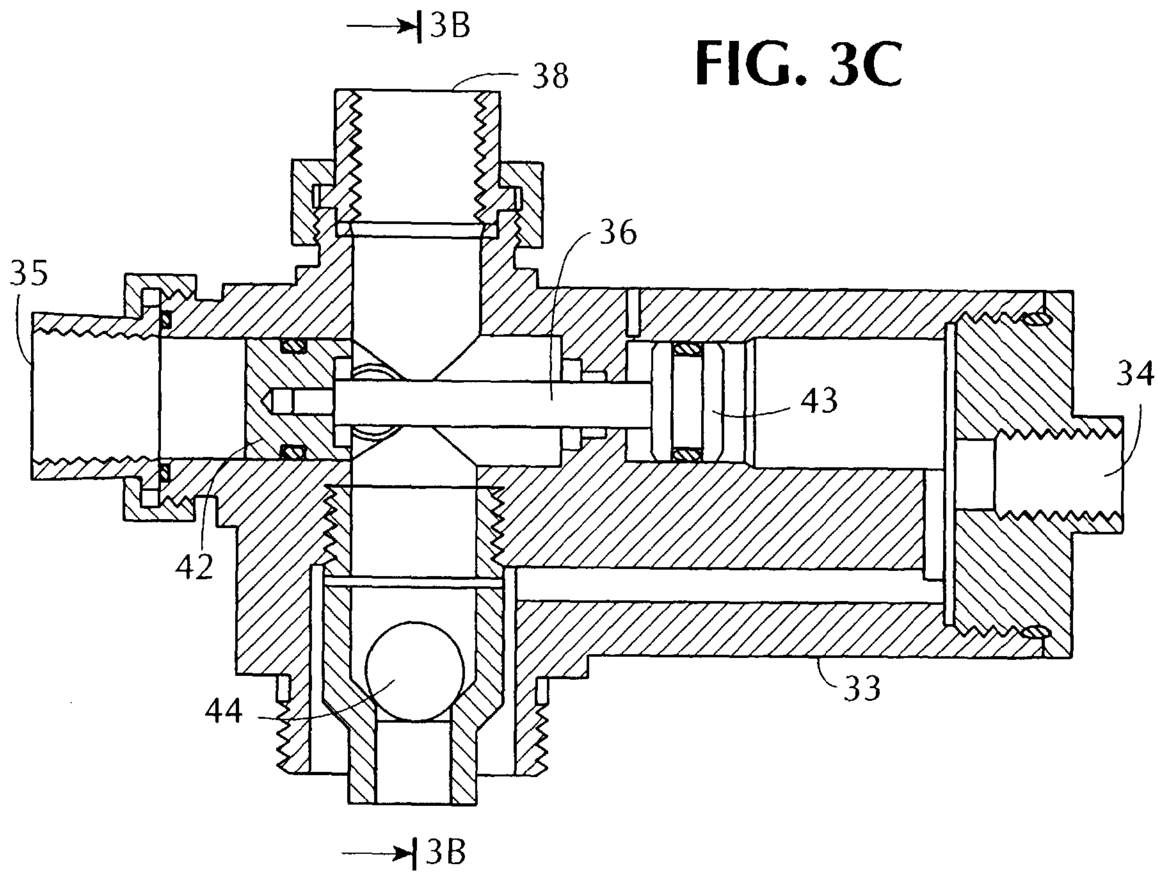


FIG. 4A

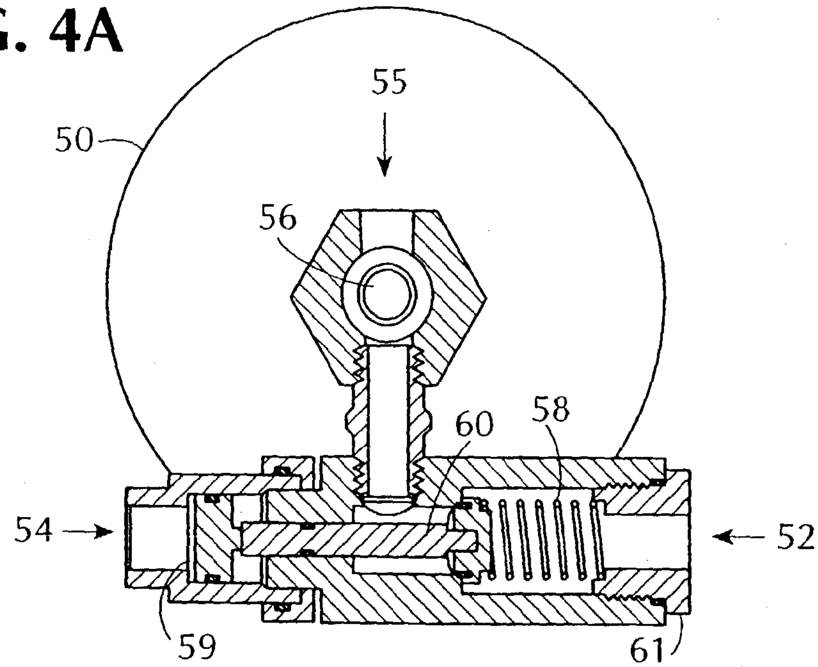


FIG. 4B

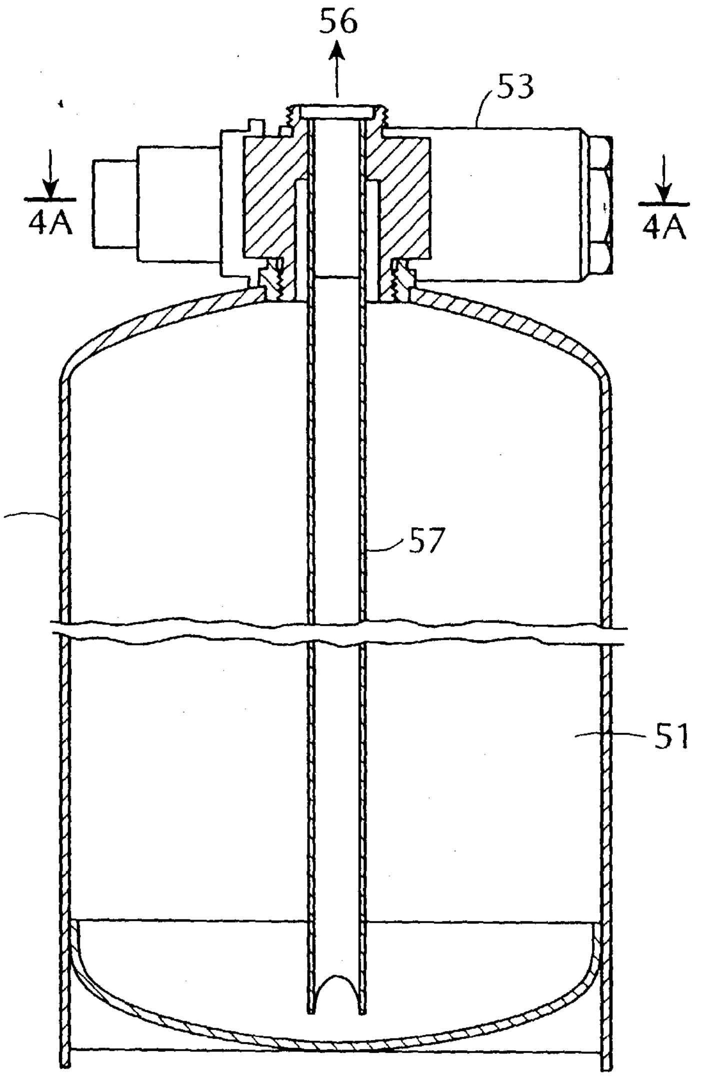


FIG. 5

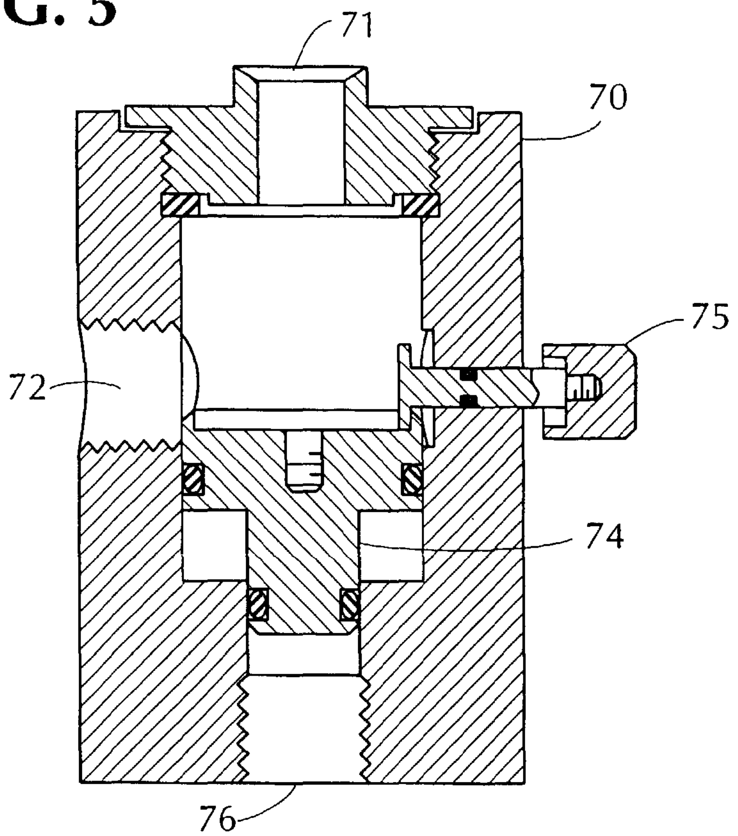


FIG. 6