Nov. 7, 1972 W. L. LIVINGSTON ET AL 3,702,158

FIXED FIRE EXTINGUISHING SYSTEM USING DELAYED ADDITIVE INJECTION

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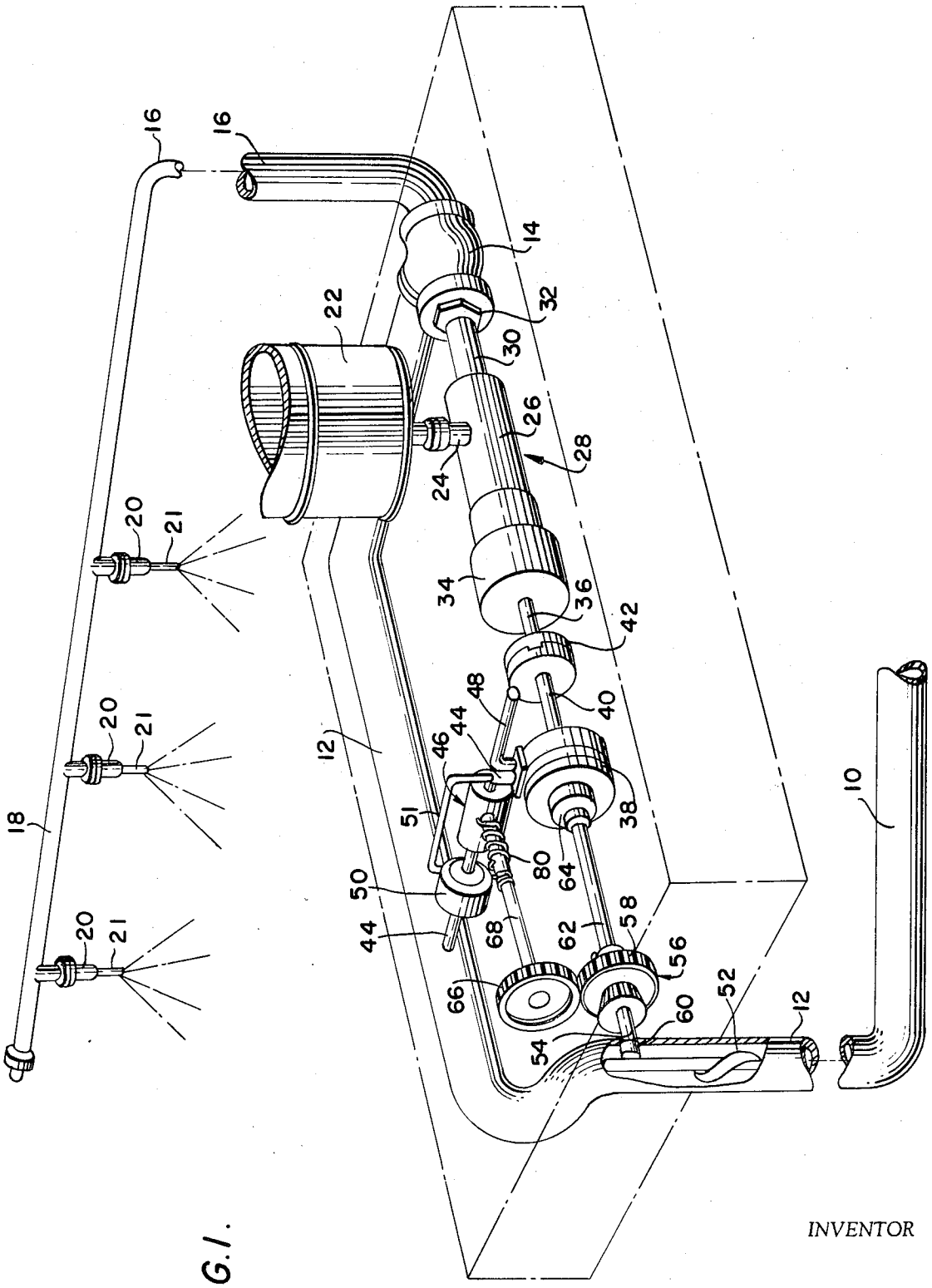


FIG. 1.

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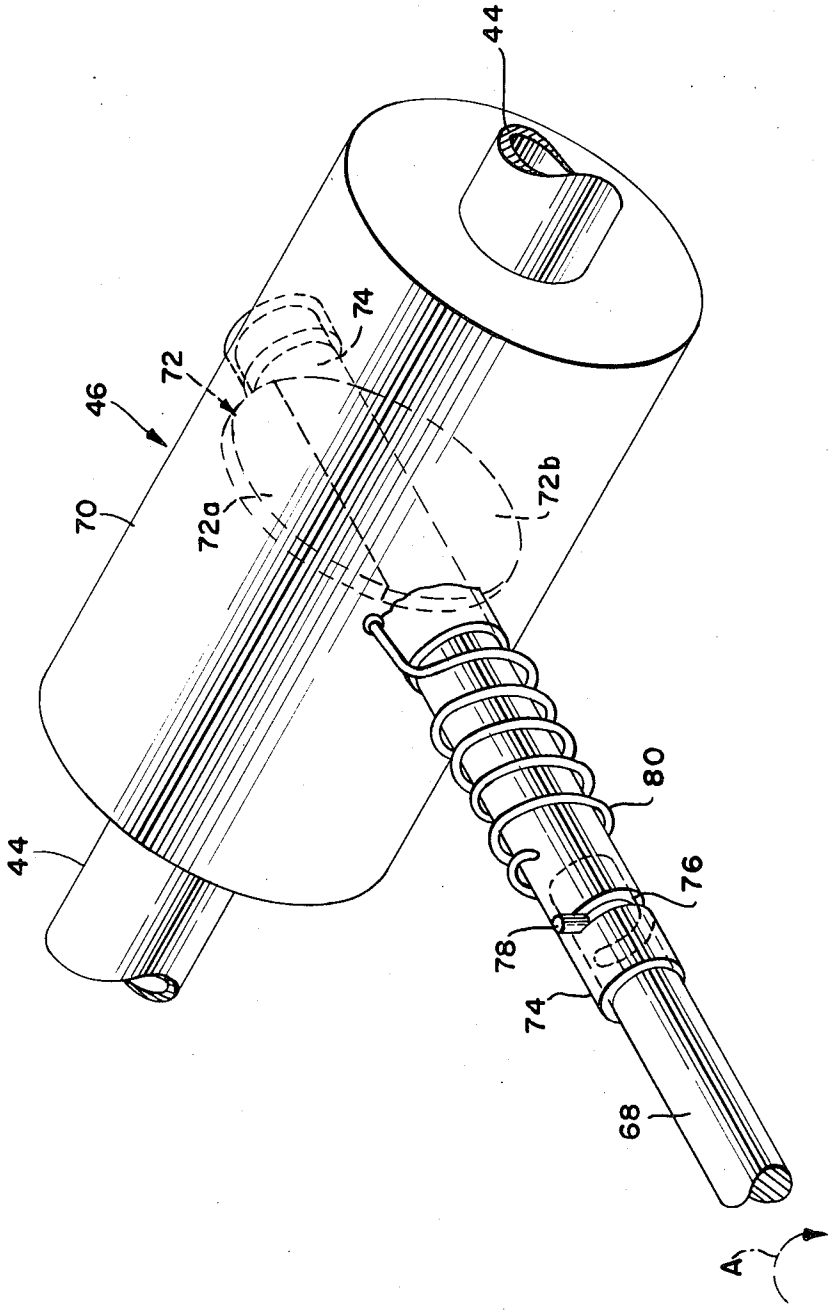
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FIG. 2.



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3,702,158

FIXED FIRE EXTINGUISHING SYSTEM USING DELAYED ADDITIVE INJECTION

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Int. Cl. A62c 35/00
U.S. Cl. 169—15 10 Claims

ABSTRACT OF THE DISCLOSURE

A fixed fire extinguishing system in which one or more discharge heads are adapted to be actuated in response to a fire condition to disperse a fluid supplied thereto by a fluid flow line. After a predetermined amount of fluid is discharged through the heads, an injector introduces an additive to the line in proportion to the fluid flow through the line to improve the fire fighting characteristics of the fluid.

BACKGROUND OF THE INVENTION

This invention relates to a fixed fire extinguishing system, and, more particularly, to a system for discharging an extinguishant from an elevated position relative to a structure to be protected from fire in response to a predetermined fire condition.

In a copending application entitled "Method of Controlling Fire," Ser. No. 776,475, now Pat. No. 3,605,900, filed Oct. 10, 1968, by William L. Livingston and Russell W. Pierce and assigned to the assignee of the present invention, a method of fire protection is disclosed in which a gelling agent in the form of a swellable polymer is injected into a flowing stream of fluid, such as water, which is supplied to the sprinkler heads of a fixed extinguishing system upon actuation of the heads, to put out a fire in the structure protected by the system. The ablative gel has excellent thermal absorption characteristics and, equally as important, is highly viscous and thus tends to cling to the surfaces on which it is sprayed. As a result, a relatively low quantity of ablative extinguishant is required to put out a fire, thereby enabling the system to be designed with a low flow capacity. Also, the ablative gel reduces the water damage to the space being protected.

In a copending application entitled "Additive Injection System," Ser. No. 125,635, filed Mar. 18, 1971, by William L. Livingston and assigned to the assignee of the present invention, a system is disclosed which is adapted to inject the additive into the water line in an efficient and reliable manner. In general, this system employs a hydraulic motor driven by water tapped at line pressure from the main conduit supplying the fire extinguishing system. The motor drives an injection pump by which the additive is introduced into the flow line in direct proportion to the water flow rate through the line, with the increase of injection with increasing flow rates being terminated after a predetermined flow rate is attained.

In this system, the additive is introduced into the flow line immediately after actuation of one or more of the heads. Although this proved to be an extremely effective system for combating the spread of fire, it was later discovered that in the early fire stages there are advantages to discharging plain water, rather than water with the additive. One advantage is that the discharge of plain water through the nozzles at a very high pressure produces a very fine high-impact spray which is not possible if additive is added to the water. This spray, due to its fineness and tight packing, will induce the gaseous products of combustion of the fire to be cycled back to the fire to aid in smothering the fire. Also, the fireball will often blow a large portion of the fine droplets of the spray against the ceiling of the structure which cools and wets the ceiling directly above the fireball and therefore provides added protection. Another advantage of the initial discharge of plain water is that it conserves the additive until the later stages of the fire, when it is more useful.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a fixed fire extinguishing system in which a fluid, such as plain water, is initially discharged towards the fire, followed by an injection of additive into the water after a predetermined amount of water is discharged.

Toward the fulfillment of this and other objects, the system of the present invention comprises a plurality of discharge heads adapted to be sequentially actuated by fire temperatures to discharge an extinguishant, a conduit for supplying water to said heads, and injection means for introducing an additive to said conduit in direct proportion to the water flow therethrough after a predetermined amount of water is discharged.

BRIEF DESCRIPTION OF THE DRAWING

Reference is now made to the accompanying drawings for a better understanding of the nature and objects of the present invention. The drawings illustrate the best mode presently contemplated for carrying out the objects of the invention and are not to be construed as a restriction or limitation of its scope. In the drawings:

FIG. 1 is a schematic view illustrating the additive injection system of the present invention employed in a fixed fire extinguishing system; and

FIG. 2 is an enlarged perspective view of the control valve used in the system of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The fixed fire extinguishing system of the present invention is shown in general in FIG. 1 and includes a source **10** of fluid, such as water, connected to a main feed conduit **12** which in turn is connected by means of a T-coupling **14** to a riser **16**. In accordance with conventional practice, the riser **16** extends upwardly to one or more branch conduits **18** having a plurality of discharge heads **20** depending therefrom. Also in accordance with conventional practice, each of the heads **20** is provided with temperature responsive release means **21** so that upon the development of a fire in the vicinity of one or more of the heads, the system is activated automatically to supply water from the main conduit **12** through the riser **16**, the branch conduit **18**, and out of the heads **20**.

An injection apparatus is connected between the vertical leg of the main feed conduit **12** and the riser **16**. Although the specific details of every component of the injection apparatus have been omitted from FIG. 1 for

the convenience of presentation, the general organization of the apparatus is shown to include a storage tank **22** for a gel additive slurry preferably of the type described above. The tank **22** is connected at its lower end by means of a discharge conduit **24** to the intake **26** of a peristalic pump **28**. The latter pump is described in detail in the second of the above-cited applications, and has a idscharge tube **30** which is coupled by a reducer **32** to the T-coupling **14**. At the opposite end of the pump **28** from the tube **30** is a gear box and bearing assembly **34** for transmitting torque from an input shaft **36** which, in turn, is drivably connected to a hydraulic motor **38** by a motor output shaft **40** and a slip-impact clutch **42**.

The motor **38** is preferably of a positive displacement piston type designed to develop full torque at relatively low speeds and is in communication with the main conduit **12** by way of a tap line **44** having a fluid flow control valve **46** connected therein. An exhaust pipe **48** is provided on the motor **38** and is connected to a drain system, or the like (not shown). A differential pressure regulator **50** is connected in the line **44** upstream of the control valve **46** and has a flow sensing line **51** connected in the line **44** downstream of the control valve. Further details of the control valve **46** and the regulator **50** will be described later.

As a result of the above arrangement, the introduction of water under line pressure into and through the line **44**, the regulator **50**, the valve **46**, the motor **38**, and out through the exhaust pipe **48**, will effect rotation of the motor and correspondingly drive the output shaft **40** at speeds controlled by the valve **46** in a manner well known to those familiar with such motors.

Because of the high reactive character of the contemplated additive, it is imperative that the rate of injection be controlled in a manner to avoid overinjection and preferably by means having an underinjection or no-injection failure mode. To this end, a servomechanism is provided to regulate the control valve **46** to insure that the pump **28** will be operated in conformity to flow rates in the conduit **12**. The servomechanism includes a flow-responsive device in the form of a rotatable screw **52** supported in the main conduit **12**. Rotation of the screw **52** is transmitted by means, including a shaft **54**, to one end input of a conventional differential gear **56** having output ring gear **58**. The shaft **54** is connected to the sensing screw **52** by a one-way torque transmitting device **64** on the motor **38**.

As a result of the above arrangement, the ring gear **58** will be driven in accordance with the differential input from the shafts **54** and **62**. The ring gear **58** is in mesh with a gear **66** keyed to one end of a shaft **68** connected at its opposite end with the valve **46**. Hence, with the shaft **62** stationary, rotation of the screw **52** as a result of water flow through the main conduit **12** will effect rotation of the shaft **54** to develop a differential output rotation of the ring gear **58**. The ring gear **58** in turn rotates the gear **66** and therefore the shaft **68**. The rotation of the shaft **68** operates to control the position of the valve **46**, and therefore the amount of flow through the line **44** and to the motor **38**.

The control valve **46** is shown in detail in FIG. 2 and comprises a cylindrical hollow housing **70**, each end of which registers with the line **44** to control the flow of fluid through the line. A conventional butterfly-type valve **72** is rotatably mounted in the housing **70**, and consists of two semicircular portions **72***a* and **72***b*, the outer edges of which correspond in size to the shape of the inner wall of the housing **70**. In this manner, when the valve **72** attains a vertical position within the housing **70** as shown in FIG. 2, it blocks the flow of water through the line **44**.

The valve portions **72***a* and **72***b* are mounted on diametrically opposite portions of a hollow control shaft **74** which is journaled through two opposite walls of the

housing **70** in a manner to permit rotation of the shaft **74** relative to the housing **70**. One end portion of the shaft **68** extends within the control shaft **74**, and is adapted to drive same in a manner to be described.

As stated above, it is desirable to delay the injection of the additive into the fluid flow line until a predetermined amount of fluid is discharged from the heads **20**. This is achieved by utilizing the valve **72** to prevent flow of fluid through the line **44**, which prevents actuation of the injector motor **38**, until a predetermined amount of water has passed through the system via the conduit **12**, the riser **16**, and the conduit **18**. To this end, a slot **76** is provided in the control shaft **74** which extends for approximately 270°. A radially extending pin **78** is fixed to the shaft **68** and extends through the slot **76**. A helical coil spring **80** is wrapped around the control shaft **74**, with its ends being attached to the control shaft and to the housing **70**, respectively.

When there is no flow of water through the system as a result of no heads **20** being actuated, the shafts **68** and **74** take the approximate position shown in FIG. 2, with the pin **78** engaging one end portion of the slot **76**. When the shaft **68** rotates in the direction indicated by the arrow A in FIG. 2 in response to an input from the servomechanism, caused by a rotation of the screw **52** in response to an opening of one or more heads **20** and a resultant water flow through the system, the pin **78** moves for approximately 270° from the position shown in FIG. 2 to a position whereby it engages the other end of the slot **76**. Further movement of the shaft **68** in the same direction results in a torgue being applied to the shaft **74** by the pin **78**, which rotates the shaft **74** and opens the butterfly valve **72**, permitting fluid flow through the line **44**.

This movement of the shaft **68** also loads the spring **80** in a manner so that it applies a reverse torque to the shaft **74** in a direction opposite to the direction of the torque applied by the shaft **68**. As a result, upon cessation of the rotation of the shaft **68**, or upon rotation of the shaft in a direction opposite to the direction indicated by the arrow A in FIG. 2 in response to a corresponding signal from the servomechanism, the pin **78** will ride in the slot in the opposite direction, and the spring **80** will rotate the shaft in this opposite direction.

Inasmuch as the screw **52** is rotated at a rate directly proportional to the flow rate of water through the main conduit **12**, and the valve **46**, once opened, controls the flow of water through the line **44** in this same proportion, it becomes apparent that the motor **38**, and therefore the pump **28**, is regulated to operate at speeds directly proportional to the flow rate of water through the main conduit **12**.

As emphasized in the second application cited above, after a predetermined upper limit of the water flow rate is exceeded, it becomes desirable to terminate the increase of additive injection with increases in the water flow rate. To this end, the differential pressure regulator **50** is employed to control the pressure differential across the valve **46**. As disclosed in the latter application, the regulator **50** may be of a conventional design and in general, comprises a spring-loaded modulating valve member (not shown) cooperating with a valve seat disposed in the line **44**. The valve member is adapted to act against the pressure in the upstream portion of the line **44** and the flow sensing line **51** is connected to the regulator **50** at a point whereby it also acts against this pressure.

The above-mentioned spring loaded valve member of the regulator **50** can be adjusted so that the pressure upstream of the valve **46** will be such that the pressure differential across the valve **46** will not exceed a predetermined value. Since the flow through the valve **46** in its full open position will be directly proportional to the pressure, and since the latter is regulated by the regu-

lator **50**, it follows that once the valve **46** is completely opened and the predetermined maximum pressure differential across the valve is reached, any additional increases in the water flow through the valve will be terminated despite further increases in the water pressure and in the flow rate in the conduit **12**. This, of course, establishes an upper limit that the speed of the motor **38**, and therefore the pump **28**, can attain, and terminates the increase of the additive injection after a predetermined water flow rate is reached.

Summarizing the operation of the entire system of the present invention, it will be apparent that upon the opening of any of the heads **20**, water will pass through the main conduit **12**, thus rotating the screw **52** and causing a corresponding rotation of the shaft **68** by way of the servomechanism, as described above. Plain water will be discharged from the opened head or heads **20** until the pin **78** reaches the opposite end of the slot **76** from that shown in FIG. 2. Further rotation of the shaft **68** will cause the butterfly valve member **72** to open and thus permit fluid flow through the line **44** which drives the injector motor **38**. As soon as the motor **38** has developed its operating output torque, the shaft **40** will be coupled with the drive shaft **36** of the pump **28** by way of the slip-impact clutch **42** to initiate rotation of the pump rotor. The gel additive slurry, which is passed by gravity from the tank **22** through the discharge pipe **24** into the pump feed chamber **26**, will be pumped through the tube **30** and into the riser **16** to be mixed with the flowing stream of water.

As soon as the servomechanism moves the valve **46** to a fully opened position and as soon as a predetermined pressure differential is established across the valve, the regulator **50** comes into operation by limiting any further water flow through the valve by virtue of maintaining the predetermined pressure differential across the valve, as described above. As a result, plain water will be initially discharged through the opened heads, followed by an injection of additive into the line **16** in direct proportion to the fluid flow as sensed by the screw **52**. The injection continues until a predetermined flow rate through the conduit **12** has been attained, at which time there will be no further increases in additive injection in direct proportion to any further increases in the flow rates.

It is understood that the other components mentioned in the second of the above-mentioned applications, but not described above, may be incorporated in the system of the present invention. For example, a baffle or eddy plate can be disposed in the riser **16** to achieve uniform mixing of the additive with the flowing stream of water. As disclosed in the above application, this eddy plate is preferably formed of material which is flexible so that under conditions where the gel is being introduced, thereby developing lower system flow rates due to the formation of the ablative fluid extinguishant in the system, the eddy plate functions to develop the necessary mixing flow paths and turbulence. Where, however, the injection system fails upon the demand for extinguishant by the heads in the fire extinguishing system, significantly greater flow rates are required by the system as a result of the relatively low viscosity of plain water. The eddy plate responds to these greater flow rates by flexing so that the increased flow rates needed by the heads of the system are not impeded by the eddy plate.

Also, a frangible cap may be provided over the open end of the pump **28** to provide a positive seal between the additive and water within the conduit **12** in order to prevent inadvertent discharge of the additive into the riser **16**.

It is contemplated that numerous other variations may be made in the injection apparatus depicted by the disclosed embodiments, which variations fall within the scope of the present invention. For example, the arcuate length of the slot **76** can be varied in the event it is desired to change the point at which the additive injection is to begin or end. Also, the injection of additive may be delayed by other means such as by requiring a predetermined rotation of the screw **52** before it actuates the shaft **54**, or by delaying the injection until a set number of heads are actuated, etc.

Other means may also be provided to stop the increase of additive injection with increasing flow rates after a predetermined flow rate has been attained. For example, the pump **28** may be provided with a governor, or an overspeed clutch may be provided which is connected to the pump so that once a predetermined pumping speed is attained, it will not be increased. Further, although water and a water swellable gelling agent were disclosed above as examples of a fluid and an additive which together form an extinguishant, it is contemplated that other fluids and additives may be utilized in the system of the present invention without departing from the scope thereof.

Still other variations of the specific construction and arrangement of the additive injection system disclosed above can be made by those skilled in the art without departing from the invention as defined in the appended claims.

We claim:

1. A fixed fire extinguishing system comprising a plurality of discharge heads mounted in an elevated position in the space to be protected from fire, means for supplying a mixture of additive and water to said heads and for supplying water without said additive to said heads, means responsive to a predetermined fire condition in said space for actuating said heads to discharge said mixture or said water without said additive, and control means for controlling said supplying means in a manner so that water without said additive is initially discharged from said heads after actuation thereof and said mixture is discharged from said heads after a predetermined discharge of water without said additive.

2. The system of claim **1** wherein said actuating means is adapted to sequentially actuate said heads according to their proximity to said fire.

3. The system of claim **1** wherein said heads are in the form of direct discharge nozzles.

4. The system of claim **1** wherein said supplying means comprises a conduit system connecting said heads to a source of water.

5. The system of claim **4** wherein said supplying means further comprises means for injecting said additive into water flowing in said conduit system.

6. The system of claim **5** wherein said control means controls said additive injection means in a manner whereby it injects said additive after a predetermined water flow is attained through said conduit system.

7. The system of claim **5** wherein said additive injection means comprises a pump having intake means to receive said additive and discharge means opening into said conduit system, and drive means to said pump to inject said additive.

8. The system of claim **7** wherein said drive means comprises a hydraulic motor connected to said conduit system and driven by said water.

9. The system of claim **8** wherein said control means comprises valve means connected in said conduit sytsem upstream of said motor, said valve means being normally closed and adapted to open to control the water flow rate to said motor.

10. The system of claim **9** further comprising flow sensing means disposed in said conduit system, and lost motion connecting means for operatively connecting said sensing means to said valve means so that said valve means is adapted to prevent water flow to said motor until a predetermined water flow is attained in said conduit system.

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U.S. Cl. X.R.

169—16

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3, 702,158 Dated November 7, 1972

Inventor(s) William L. Livingston & Carl Marshall Munson

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 58, "and drive means to said pump" should read --and drive means to drive said pump--.

Signed and sealed this 1st day of May 1973.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents