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ELECTRONIC ACTUATOR FOR FIRE PROTECTION SYSTEMS

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Fig. 2

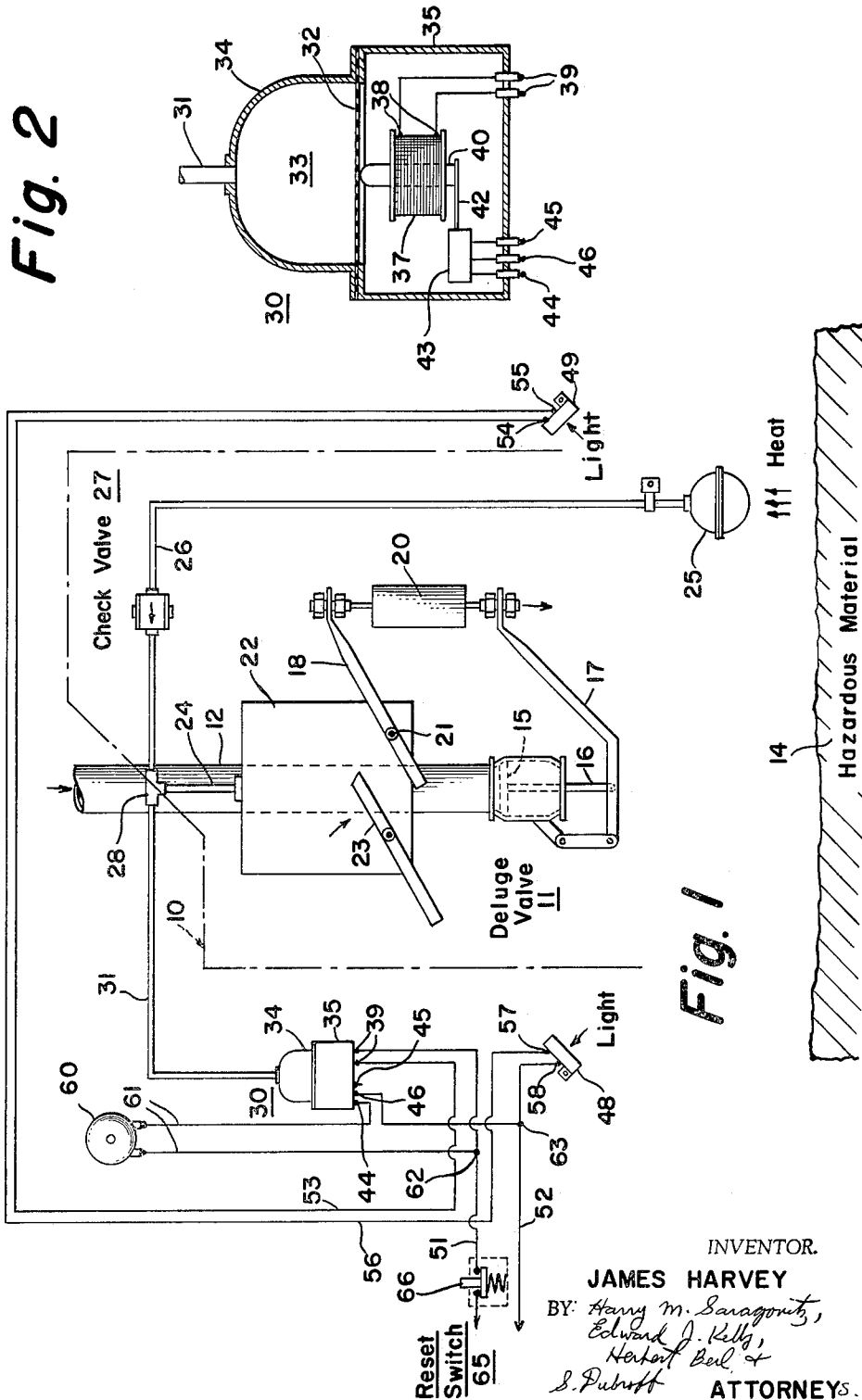


Fig. 1

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**ELECTRONIC ACTUATOR FOR FIRE
PROTECTION SYSTEMS**

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8 Claims. (Cl. 169-19)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment to me of any royalty thereon.

The present invention relates to fire protection systems of the heat-responsive air-operated type for releasing a deluge of water or other extinguishing agent on fires in fast-burning and other hazardous materials. Heat from the fire expands the air in a low-pressure air system to give an increase in pressure which is transmitted therethrough to a release mechanism for the extinguishing agent.

Fire protection systems of this type are in extensive use and have a high degree of reliability. However such systems inherently must operate with some degree of delay between the breaking out of a fire and the application of resultant increased air pressure to the release mechanism. For ordinary materials the slight delay does not create any problems with regard to the protection the system provides. For the effective control of fires in fast-burning materials, such as gun powders, pyrotechnic powders, blank-cartridge powders, and other hazardous materials, it is vital that the fire protection system be extremely fast-acting while retaining its reliability.

Accordingly, it is an object of this invention to provide an improved fire protection system of the type referred to, which gives increased speed of operation without interfering with its normal method of operation and basic protective features.

It is also an object of this invention to provide an improved fire protection system of the type referred to, which operates to supplement the heat-responsive action with substantially instantaneous light-responsive action, without introducing any additional hazards for the protection from fire of fast-burning and hazardous materials, such as gun powders and others referred to.

Advantage is taken of the fact that a protective system can be made faster acting in response to light or a flash from a fire or flame than from the slower build-up of heat therefrom. In accordance with the invention, the flash or light response is provided in addition and supplemental to the existing heat-responsive and low-pressure air-operated release means for the extinguishing agent, rather than as a replacement therefor. This is accomplished by the addition of relatively simple and effective flash-responsive electronic actuator means to the existing heat-responsive system in any installation, and without interfering with its original cost or normal operation in any way.

Heretofore two main and different approaches have been made to solving the problem of applying the extinguishing agent to a fire involving fast-burning or hazardous materials. The first utilizes a photocell to detect the flash or light from the flame. The current from the photocell operates a sensitive meter movement which, in turn, actuates a relay to provide current to an electrically operated water valve. This system is generally complex and relatively slow in operation. The second system is faster acting but can introduce additional hazards. A photocell detector again is used, but indirectly operates to detonate an explosive charge which opens a water valve over the fire. The dangers inherent in an explosive charge are not desirable in hazardous areas.

In a protective system in accordance with the invention, a light-sensitive transistor, having a high degree of

response in the frequency range of light generated by fast-burning materials, controls a solenoid-operated pressure diaphragm to apply air pressure to an extension of the heat-responsive low-pressure air system already provided, whereby it is actuated more rapidly if a flash or flame occurs and without interfering with its normal protective action in response to heat.

The invention will further be understood from the following description when considered with reference to the accompanying drawing, and its scope is pointed out in the appended claims.

In the drawing:

FIG. 1 is a schematic layout and circuit diagram of a fire protection system embodying the invention, and

FIG. 2 is a cross-sectional view in elevation, of a modified apparatus structure adapted for use in the system of FIG. 1.

Referring to the drawing, wherein like parts in the two figures are designated by like reference numerals, a conventional heat-responsive fire protective system 10, as indicated within the dash-and-dot line, is positioned to apply water, as the extinguishing agent, through a deluge or tup valve 11 which terminates a large capacity water supply pipe 12 over relatively large storage pile or body 14 of fast-burning or hazardous material, such as bulk gun powder for example.

The valve element or gate 15 of the valve 11 is of the plunger or stopper type, held closed against the inlet side of the valve by a valve rod or stem 16 connected with a pivoted operating lever 17. The latter is held or supported and locked in the valve-closed position shown, by a latched arm or release lever 18 with which it is connected through an elongated operating weight 20. The release lever or arm 18 is mounted to rotate downwardly or clockwise from the position shown, on a pivot shaft 21 which is connected internally with a conventional release mechanism (not shown) of a weight release device 22 of which it is a part. This type of device is available commercially from different sources. The device 22 as shown may be considered to be a weight release device as supplied to the market by the Automatic Sprinkler Corporation, and is satisfactory for the purposes and generally used throughout the industry.

Like all commercial devices of this type, the device 22 responds to an increase in pressure from a closed low-pressure air system, connected with an inlet pipe or conduit 24 therefor, to release the latched arm or lever 18, thereby permitting the weight 20 to fall and move the lever 17 to abruptly and positively open the deluge valve 11. The arm is reset to close the valve by operating a pivoted reset lever 23 and lifting the weight 20. The arm 18 is then latched and ready for release upon receiving increased pressure on the device 22 from the low-pressure air or conduit system.

This system includes a heat-responsive source for the increased air pressure located in the fire zone as a heat detector. This is a hollow metallic ball or casing, as indicated at 25, generally of copper or brass, with the interior connected into the conduit system. The latter includes a connecting air supply pipe or conduit 26 connected through a check valve 27, and a pipe-T or branch connector 28, with the inlet pipe or conduit 24. Because of the low pressure involved, the entire conduit system may be provided by small tubing of any suitable material such as copper, for example.

The T-connector and the check valve 27, which provides for air flow from, but not to, the ball or detector 25 as indicated by the arrow, are added to the conventional low-pressure air system as here provided in connection with the automatic release device 22. These are part of the means for adapting the system to further respond substantially instantly, in accordance with the invention,

to strong light and light flashes resulting from combustion in fast-burning and hazardous materials. This provides the added protection by reason of the increased speed of operation without interfering with its normal method of operation and basic protective features as referred to hereinbefore.

Thus, further in accordance with the invention, the heat-responsive air-operated protection system 10 as described, is extended to apply the increased operating air pressure thereto for releasing the extinguishing agent in response to the initial light or light flash resulting from the flash combustion in fast-burning and hazardous materials for which the added protection is necessary.

For this purpose a second source of operating air pressure is provided by an electric current-responsive variable-pressure diaphragm or bellows device 30 having a second air supply pipe or conduit 31 connected through the T-connector 28, as a second branch with the inlet pipe or conduit 24 for the release device 22. The device 30, as shown more fully in FIG. 2, is provided with a flexible diaphragm 32 as one wall of an air chamber 33 between it and a dome-shaped cover 34 for the device. The cover is seated to clamp the outer edges of the diaphragm and hold it against a flanged open casing 35 which houses the electrical pressure operating means for the diaphragm. The pipe 31 is connected with the cover 34 and communicates with the chamber 33 for transmitting changes in pressure therein to the inlet pipe 24 and the device 22. The check valve prevents flow of air to the heat detector ball 25.

The electrical operating means preferably is a simple solenoid magnet or winding 37 having terminals 38 connected to external terminals 39 and having a movable solenoid plunger or core element 40 in contact with the diaphragm to compress it when the coil is energized. This may be provided by a device available on the commercial market as an Agastat Ne-11, modified to provide the conduit connection with the dome cover instead of a calibrated air-escape valve usually provided.

The solenoid plunger may be arranged, as shown, also to operate the lever 42 of a microswitch 43, of like auxiliary switch means for controlling alarm and other external signal circuits in response to operation of the device 30. A two-point switch is provided, by way of example, having external terminals 44 and 45 with which a common terminal 46 is closed, respectively, when the solenoid is energized and deenergized.

As shown further in the circuit diagram portions of FIG. 1, two spaced light-sensitive switches or switch elements 48 and 49 are located sufficiently near and facing the fire zone or body of hazardous material, represented by the outline 14, to operate or go into conduction in response to relatively high or strong illumination or light flash therefrom resulting from rapid or flash combustion or burning of the material. These devices may be of the type known commercially as General Electric light-sensitive transistors, Type ZJ235, for example.

A power supply circuit comprising two supply leads or conductors 51 and 52 may be connected with any suitable source such as a conventional 117-volt A.C. outlet (not shown). However low-voltage direct-current is preferred for use with the type of light-sensitive switches above indicated, and in the present example may be considered to be 24 volts D.C. One supply lead 51 is connected through the solenoid 37 at the terminals 39 to a circuit lead 53 which extends to the second switch 49 and one terminal 54 thereof. From the second terminal 55, the control circuit being outlined extends through a return lead 56 to one terminal 57 of the first switch 48 and thence, from the second terminal 58 to the other supply lead 52. Thus a series control circuit for the solenoid and the switches is provided.

In the present system, use is made of the control switch 43 to operate an electrical buzzer or alarm unit 60 connected through circuit leads 61, and the switch terminals

44 and 46, to the supply leads 51 and 52 as indicated at 62 and 63 respectively. This causes the alarm to sound when the solenoid is energized and the plunger 40 moves against the diaphragm to permit the switch to close the connection between the terminals 44 and 46.

A reset switch 65 of the closed-contact type, having a pushbutton 66 for momentarily opening the contacts, is connected serially in the supply lead 51 to momentarily remove the operating current from the transistor devices or switches 48 and 49 once they have gone into conduction, to restore them to the non-conducting or open circuit condition, while also resetting the release device 22 and reclosing the valve 11.

The system described provides a fast-acting electronic actuator for slower-acting heat-responsive low-pressure air-operated fire protection systems, whereby such systems may be better adapted to handle flash-fires in fast-burning and hazardous materials in large storage bodies. It taps onto the existing low-pressure air system. The materials referred to presently generally burn with an orange or red light on a frequency spectrum to which transistor switches of the General Electric ZJ235 type are sensitive and respond with a large current flow in the range of several hundred milliamperes. Therefore the current magnitude, without relays, is sufficient to operate an air pressure generating device such as the diaphragm-and-solenoid operated device 30 in the present example.

At the same time the transistor devices or switches do not respond to normal daylight as being too low in intensity. Ordinarily a relatively heavy concentration of about 80 foot-candles of illumination is required to set off conduction or closing of the switches. Both must be closed by strong light from the common fire zone to which they are directed, and hence neither one alone can set off the fire protection operation of the system if a flash-light or the light of a match is applied directly thereto. Thus the use of two switches serially in the safety control circuit is desirable for protection against such accidental operation, and is a feature of the improved system in accordance with the invention.

The present system provides means for operating an existing fire protection system of the type referred to without interfering with its normal method of operation. It can operate in the matter of milliseconds in time and does not introduce any additional hazards. Any fire in the protected material, with a light output sufficient to cause conduction in the light-sensitive transistor switch means will cause heavy current flow in the series control circuit through the solenoid 37 to apply pressure to the diaphragm element 32 and increase the air pressure on the release mechanism 22 to actuate it. This causes the arm or lever 18 to be released thereby dropping the weight 20 and open the deluge valve 11.

The system will fail safe since if the electrical circuits become deenergized for any reason before the solenoid is operated, the heat from the fire will expand the air in the ball 25 to given the increased air pressure for actuating the release mechanism 22.

I claim:

1. In a fire protection system having an air-pressure responsive operated release mechanism for an extinguishing agent, the combination with air-expansion means of the heat detector type for applying air pressure to said release mechanism to operate it in delayed response to heat from a fire to be extinguished, of additional means for applying air pressure to said release mechanism to operate it in rapid response to light from said fire, said two pressure-applying means having a common air conduit connection with said release mechanism thereby to operate said mechanism independently one of the other, and said additional pressure-applying means including two series-connected transistor switches having a high degree of sensitivity in the frequency range of light generated by fast-burning materials and an electric current operated pressure-generating device having said air conduit

connection with said release mechanism and connected in circuit therewith for control thereby.

2. In a fire protection system having an air-pressure operated release mechanism for an extinguishing agent, the combination as defined in claim 1, wherein the heat-responsive means includes a hollow metallic casing providing an air chamber in communication with said common air conduit connection, and wherein the electrical pressure generating device includes a second air chamber in communication with said common air conduit connection and a solenoid-operated pressure diaphragm providing a flexible wall for said air chamber to effect air compression therein and operation of said release mechanism by air pressure conduction therefrom through said air conduit connection.

3. In a heat-actuated fire protection system, the combination with a low-pressure air-operated release device for controlling the application of an extinguishing agent in a fire zone and heat-responsive means connected through a low-pressure conduit system for applying increased air pressure to operate said device, of means providing an air chamber in communication with said conduit system, means responsive to electric operating current for increasing the air pressure in said chamber and said conduit system effective to actuate said release device, and transistor switch means responsive to relatively high-intensity light from said fire zone connected in circuit with said current-responsive means for applying said operating current thereto.

4. In a fire protection system, the combination as defined in claim 3, wherein the current-responsive means for increasing said air-pressure includes a flexible diaphragm providing one wall of said air chamber and a solenoid having a core element movable to compress said diaphragm and increase the air pressure in the chamber when energized.

5. In a fire protection system, the combination as defined in claim 4, wherein auxiliary switch means is provided in connection with and operated by said solenoid core element, and wherein an external control circuit in connection with said switch is provided for external apparatus operation.

6. In a fire protection system, the combination as defined in claim 3, wherein the transistor switch means includes two spaced light-responsive current-controlling switch elements positioned for receiving light simultaneously from said fire zone and individually for incidental illumination from other sources, and connected serially in circuit with each other for joint control of said current-responsive means.

7. In a heat actuated fire protection system having an air-pressure responsive mechanism and means for releasing an extinguishing agent, the combination with heat-responsive air-expansion means connected to apply air pressure to said release mechanism and effect operation thereof to release said agent in inherently delayed response to heat from a fire to be extinguished and in the effective zone of which said heat-responsive means is

located, of additional means connected to apply air pressure to said release mechanism and effect operation thereof and release of said agent without delay in response to light from said fire, said two pressure-applying means having a common air conduit connection with said release mechanism thereby to operate said mechanism independently one of the other, and said additional pressure-applying means including at least two series-connected light-sensitive transistor switches positioned in said fire zone in spaced relation to each other to be operated in response to the light flash of combustion therein and an electrical pressure generating device connected serially in circuit therewith for response to joint switch operation to apply substantially instantaneous operating pressure to said release mechanism through said conduit connection, thereby to provide rapid release of said agent in advance of its release by said heat-responsive means.

8. In a fire protection system, of the relatively slow-acting heat-responsive type having an air-pressure responsive release mechanism for an extinguishing agent and means for directing a deluge of released agent on a predetermined fire zone which may include stored fast-burning and hazardous materials, the combination with heat detector means in said fire zone providing a heat-responsive source of operating air pressure for said pressure-responsive release mechanism and deluge means and having a supply conduit connection therewith to apply operating pressure thereto with a time delay due to its inherent slow-acting heat response, of means providing a relatively fast-acting electric current responsive source of operating air pressure for said pressure-responsive release mechanism and deluge means, said last named means having a supply conduit connection with said mechanism and deluge means in common with said first conduit connection for independent pressure control thereof and rapid response to operating current, and at least two light-sensitive switch means located in spaced relation to each other adjacent to said fire zone and the material to be protected and connected serially in circuit with said current-responsive source of operating pressure to jointly and cooperatively apply operating current thereto in response to light in said fire zone such as a light flash of combustion, thereby to provide instant operation of said release mechanism and deluge means in advance of the inherently slow acting heat-responsive control thereof.

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