June 3, 1969 J. HARVEY 3,447,609

FAST-ACTING DELUGE-TYPE FIRE EXTINGUISHER SYSTEM

Filed Aug. 31, 1967 Sheet 1 of 2

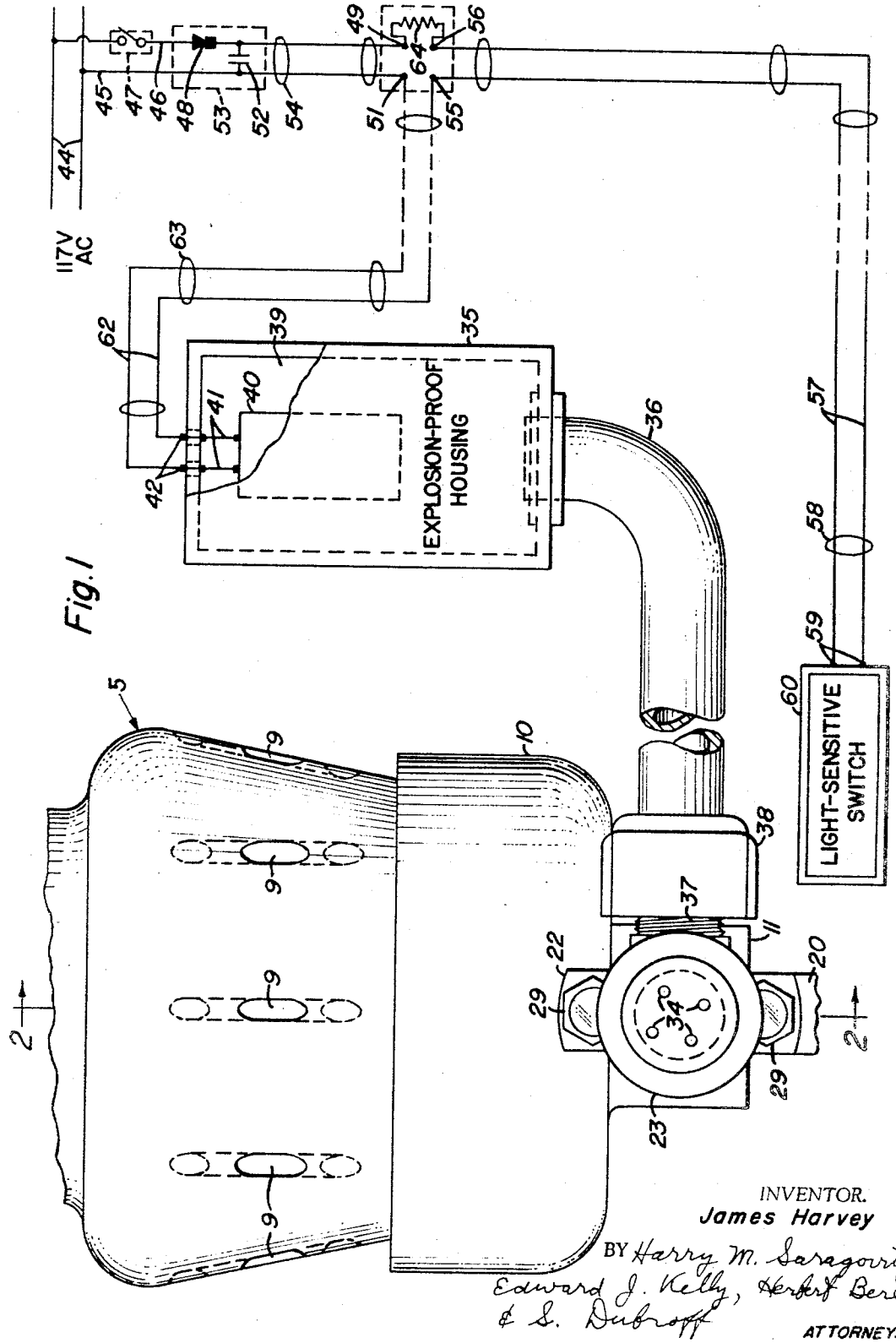

Fig. 1

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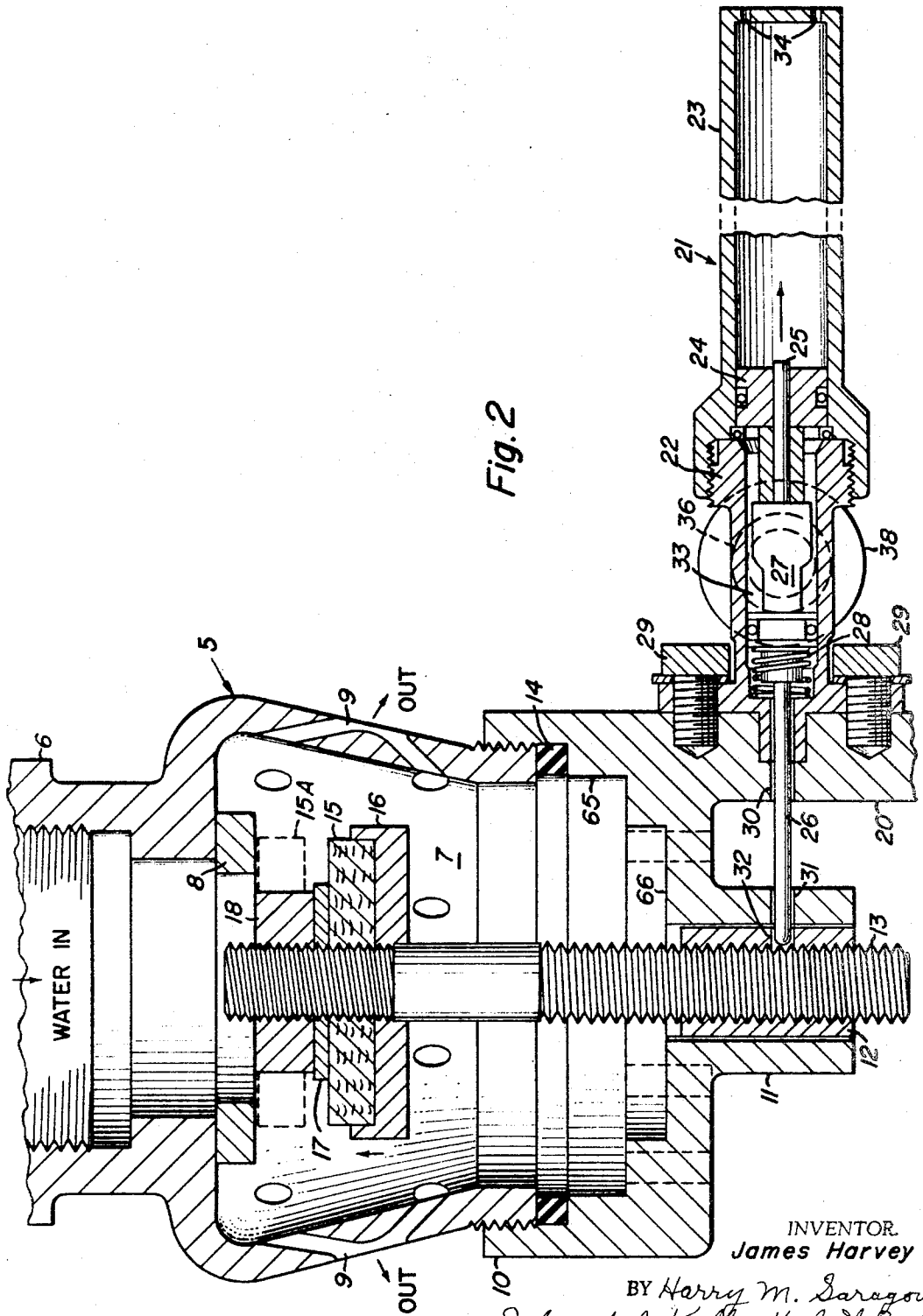
Fig. 2



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FAST-ACTING DELUGE-TYPE FIRE EXTINGUISHER SYSTEM

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ABSTRACT OF THE DISCLOSURE

A fire extinguisher deluge-type valve head at one or more places over a fire hazard area involving highly-explosive and incendiary materials is provided with a gas-actuated firing-pin release mechanism in connection generally through a high-pressure tubing line, with an explosion-proof housing containing an electric detonator cartridge as a source of high-pressure gas for instant operation on firing. The firing current from a rectified A-C source or an existing D-C source, is applied through a modern fast-acting light-sensitive switch located near the hazard area and the potential fire source. The firing current is limited in magnitude by series resistance means. The system operates instantly after light activation by the first incendiary flash, and is effective to provide complete extinguishment of such materials in a few milliseconds.

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

The present invention relates more particularly to a system for applying a spray or stream of water or other extinguishing agent to a potential fire source at the first flash of combustion and represents a new approach to the problem of accomplishing this function in a fraction of a second. This speed is vital to the control of fires in fast-burning materials, such as propellant and pyrotechnic powders, and like explosives and incendiary materials. This problem has existed for many years.

In the past there have been several approaches to the problem of high-speed operation for extinguishing fast-burning materials of the type referred to, and particularly in the handling of ammunition supplies. For this purpose in the past a device has been provided which uses a photo-electric cell to detect the flash of the fire and the current generated serves to operate a meter movement or the like, with contacts which, in turn, control a relay to provide current to an electrically-operated water valve or the like. This system has been found to be complex and relatively-slow in operation, whereby it is noted adapted for the control of fast-burning materials which have become ignited.

A second approach to the problem is found in commercially available devices which utilize a photo-cell type of detector or the like to indirectly actuate an explosive charge. This charge opens a nozzle over the fire by blowing off a sealing element. These and other systems now in use are relatively hazardous and not fast acting enough to prevent the spread of a rapid-burning fire into areas which may cause excessive damage such as in an ammunition or powder-supply bin or chamber.

The system of the present invention is primarily adapted to apply water or other extinguishing agent rapidly to

powder fires in cartridge charging machines and the like, and to provide a fast deluge system for like applications. The system is adapted to apply the extinguishing agent to a fire area in a matter of a few milliseconds and provides an ultra-fast powder-actuated deluge system for applying an extinguishing agent to a fire source of fast-burning powder or like incendiary material. It is operated by a light-sensitive switch, which is of modern design and relatively fast acting, in connection with an electric-current-activated detonator for applying gas pressure to release a modified deluge valve at the fire area or source. Its operation on incendiary powders such as military IM144 has been very satisfactory. Over 60% of an original supply or body of powder remained unburned after extinguishment by this system. Actuation time was less than 20 milliseconds with complete extinguishment in less than 80 milliseconds. The system does not introduce any appreciable hazard, is very simple to operate, and requires very little maintenance.

In accordance with one form of the invention, a deluge-type water or extinguishing agent delivery valve is provided above the fire area and is modified to be held in the closed position by a central sleeve which, in turn, is locked in place by a firing pin of a gas-actuated firing-pin release mechanism, such as military type M1–A1. This includes a gas-operated piston in a cylinder with the piston connected to a firing pin through an extension and spring connected release mechanism. The operating side of the piston is connected through a high-pressure tubing with an explosion-proof housing which receives an explosive force and develops a gas pressure which may reach over 1000 pounds per square inch, from an electric current-activated initiator containing an explosive charge therein. The initiator is fired by operation of a relatively-modern light-sensitive switch in circuit therewith to control the application of firing current thereto from a suitable source of direct current, which is preferably rectified alternating current from a commercial supply circuit. The firing current is applied through limiting resistor means which limits the magnitude thereof to a normal operating level, and is further controlled by a control switch connecting the system with the main line or supply line.

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

In the drawings, FIG. 1 is a fragmentary view, in elevation, of a deluge-type fire extinguisher valve in connection with operating means, and control circuits therefor schematically shown, to provide a fast-acting deluge-type fire extinguisher system in accordance with the invention, and

FIG. 2 is a cross-sectional view of the deluge valve of FIG. 1 and a portion of the operating means therefor taken on the section line 2—2, showing further details thereof in accordance with the invention.

Referring to the drawings, wherein like reference characters indicate like parts in both figures, a fire extinguishing sprinkler head 5 of the deluge type is shown as presently best suited for the use with the fire extinguishing system of the invention. This head is of circular configuration having a flanged open upper end 6 for receiving water or other extinguishing agent under pressure and having a hollow inner chamber 7 which is separated from the inlet end by a circular central valve seat 8. The chamber 7 is in communication with a plurality of uniformly spaced

outlet ports 9 around the outer periphery of the valve casing for the delivery of the water or other extinguishing agent from the sprinkler head over a fire area below.

The sprinkler-head valve casing 5 and the interior chamber 7 is closed by a circular screw threaded base 10 which has a central depending boss 11 as shown more clearly in FIG. 2. The boss 11 is centrally bored to receive a slidable elongated holding sleeve or plug 12. The latter is centrally drilled and threaded to receive a threaded valve stem 13 on the inner end of which is seated the valve or valve disk 15 supported by a flanged washer 16 and clamped thereon by a clamping nut and washer 17 and 18, respectively, as shown more clearly in FIG. 2. The valve is moved to the closed position 15A, as indicated in dotted outline, by rotation of the valve stem 13 through the elongated holding sleeve 12. This is in the upward direction as viewed in FIG. 2. A sealing ring 14 is provided between the sprinkler head or valve casing 5 and the base 10, also as shown more clearly in FIG. 2.

A narrow depending bracket 20 is provided on one side of the circular base 10 as a support for a radially-extending gas-actuated firing-pin release mechanism 21 comprising a hollow tubular base element 22 having a screwed-threaded outer end for seating an outer cylinder element 23 thereon in axial extension thereof, as indicated in FIG. 2. The base element 22 is held in place on the bracket 20 by mounting bolts 29.

A piston 24 operating in the cylinder 23, from a normally-retracted position as indicated in FIG. 2, is provided with a central piston rod 25 connected therewith and extending rearwardly into the tubular base element 22. This is connected with an elongated firing pin 26 through a round guide and packing element 27 in the tubular base element 22, also as shown more clearly in FIG. 2. The piston 24 is held in the retracted position by a retracting spring 28 in the base element 22. An opening 30 is provided in the bracket 20 for the firing pin 26 and likewise, in alignment therewith, a second opening 31 is provided in the boss 11 for the firing pin 26 so that it may extend normally into an engagement with the inner sleeve element or holding plug 12 which holds the valve stem 13 and valve 15 in place. For this purpose a lock hole or opening 32 is provided in the sleeve or holding plug 12 for receiving the operating end of the firing pin 26, as shown in FIG. 2. With the piston retracted as shown in FIG. 2 the firing pin 26 is normally in engagement with the locking opening 32 in the sleeve 12 as shown.

Between the piston 24 and the central guide and packing element 27 in the base element 22, is an annular gas inlet chamber 33 for receiving a high-pressure explosive-gas discharge in rear of the piston to drive it forward or in a direction to the right, as viewed in FIG. 2 thereby abruptly to withdraw the firing pin from the opening 32. Air inlet and outlet openings 34 are provided in the outer free end of the cylinder 23 to provide for free movement for the piston as when driven by gas pressure in rear thereof in the annular chamber 33.

Gas pressure is applied to the chamber 33 from an explosive proof housing 35 through a flexible tubular high-pressure conduit or connection line 36, the delivery end of which is connected to a threaded inlet tube 37 forming part of the tubular base element of the firing pin release mechanism 21. The threaded inlet tube 37 extends outwardly from the tubular base element 22 and substantially at a right angle to the axis thereof and is coupled to the free end of the line 36 by a threaded coupling unit 38 which is adapted to be fitted over the threaded inlet tube 37, as indicated in FIG. 1. This serves to draw the end of the tubing into contact with the end of the inlet tube 37, thereby establishing a tight connection. The connection line 36 is preferably of flexible aircraft tubing adapted to withstand pressures over 10,000 pounds per square inch and it may be extended as indicated by the break shown, to a considerable distance from the hazardous area surrounding the sprinkler head 5 to a safer operating and control area.

The explosion-proof housing 35 includes an interior chamber 39 with relatively heavy walls adapted to withstand pressures equal to that of the connection line 36. As a source of high-pressure gas for operating the firing-pin release mechanism 21 in accordance with the invention, the chamber 39 includes a fast-acting source of explosive pressure such as a detonator 40 adapted to be electrically activated through connection leads 41 having terminals 42 extending through the casing walls and insulated therefrom as indicated. The detonator may be any suitable powder-actuated device which provides a pressure on detonation sufficient to reach a maximum of over 1000 pounds per square inch, in the present example, and substantially instant delivery through the conduit 36 and into the annular chamber 33 of the mechanism 21. This serves to drive the piston 24 forward at a high rate of accelaration and substantially instantly, due to the rapid pressure rise in the chamber 39 of the relatively small explosion-proof housing and through the conduit system.

Further in accordance with the invention, direct current is used to actuate the detonator 40 and may be derived from any suitable source. In the present example it is derived from 117-volt alternating-current lines indicated at 44 through supply leads 45 and 46 connected therewith. A control switch 47 is connected in circuit with the lead 46. As indicated, the lead 46 is connected through a rectifier 48 to a terminal 49 in a terminal or junction box 50 and the lead 45 is connected with a terminal 51 in the same box. A smoothing capacitor 52 is connected between the lines 45 and 46 following the rectifier 48, and the rectifier and the capacitor are included in a suitable rectifier unit 53. From the junction box 50 to the rectifier unit 53 the leads 45 and 46 are enclosed in a suitable cable 54 which may be of the explosion-proof type preferably.

Two additional terminals 55 and 56 in the box 50 are connected through a pair of leads 57 also enclosed in an explosion-proof cable 58, with the terminals 59 of a light sensitive switch 60. The switch 60 may be of the silicon controlled rectifier type, known commercially as a General Electric GE–L7 light-sensitive switch. It is fast acting and responds instantly to a flash of light to provide closure of the circuit between the leads 57. The operation will further be described hereinafter.

The terminals 51 and 55 of the junction box 50 are connected through leads 62 with the terminals 42 of the explosion-proof housing 35. Here, likewise, the leads are enclosed in an explosion-proof cable 63. The terminals 49 and 56 are connected through a control resistor 64 thus completing a series circuit from the lead 46 through the rectifier 48 to the terminal 49 and thence through the resistor 64, the terminal 56 and the leads 57, through the light-sensitive switch 60, and back to the terminal 55. From the terminal 55 the circuit follows through the leads 62 and the detonator 40 by way of the terminals 42, back to the terminal 51, and thence through the lead 45 back to the source. Thus a series operating circuit for the detonator 40 is provided from the supply source 44 through the rectifier unit 53 and the control resistor 64 under the control of the light-sensitive switch 60 which is serially in circuit with the detonator. As indicated by the dotted section of the leads 62 and 57, the latter may be extended a considerable distance from the explosion-proof housing for connection with the supply source.

The light-sensitive switch 60 is placed substantially in the relation indicated, that is, below the operating valve 6 and to one side thereof in the hazard area, to receive the first flash of combustion of the explosive material to be protected by the system. It may be and generally is, located just outside the deluge area if possible but without endangering the protection by having the flash of ignition of the explosive material shielded therefrom in any way, as immediate response must be obtained for the first and slightest ignition of the protected material.

The sprinkler head or valve **5** may be of any suitable type such as a modified Rockwood Sprinkler Corp. deluge head. This is the type shown in the present example. The modification consists of replacing the smooth valve stem with a threaded valve stem **13** as described, boring out the base of the head, which is the boss **11** and inserting therein a threaded stainless-steel holding sleeve which is the sleeve or plug **12** of the present example. Thus by turning the base of the valve stem **13**, the valve **15** may be seated to the closed position in readiness for operation. The gas actuated firing pin release mechanism **21** is fastened to the valve body by the two small bolts **29** and the firing pin **26** is inserted through the openings **30** and **31** into the locking hole **32** of the sleeve **12** also as shown. The device **21** may be of the type known as a military M1–A1 actuator. The detonator **40** may also be of a military type known as an M–5 detonator.

From the foregoing description it will be seen that the interior chamber **39** of the explosion-proof housing **35** is in full and direct communication, through the tubing **36**, with the annular chamber **33** within the gas-actuated firing-pin release mechanism **21**, and directly behind the withdrawn or retracted piston **24**. With the switch **47** closed to energize the system, a flash of light as from a detonating or rapidly-burning body of highly-combustible material, such as a propellant powder or a pyrotechnic powder for example, will instantly cause the light sensitive switch **60** to close, thereby applying operating current through the rectifier **48** and the control resistor **64** to the electrical detonating element of the detonator **40** through the input leads **41**.

The instant explosion of the detonator causes a powder-generated gas pressure to build up rapidly in the chamber **39** and to travel through the tubing **36** into the annular chamber **33** to drive the piston **24** forward and release the firing pin **26** from the locking hole **32**. When the gas pressure within the release mechanism **21** forces the operating piston **24** back, the locking pin **26** in the deluge body being attached thereto, moves therewith and is withdrawn from the stainless-steel holding sleeve **12** and the valve stem **13** thus drops, pulling the valve **15** from its seat **8** and permitting the water or other extinguishing agent to flow through the sprinkler head onto the source of the fire. A well **65** below the line of outlet openings is provided centrally of the valve casing and below the packing ring **14** below the well **65** is a central recess **66** into which the valve washer **16** and the valve **15** may drop to come to a full seated position entirely clear of the chamber **7**.

Because of the instant detonation of the powder charge in the chamber **39** and the instant high-pressure build up through the system, the operation of the piston is instantaneous following the first flash of light from the danger source. Upon recession of the pressure in the chamber **39** and the line **36** the piston **24** is withdrawn to the ready position shown in FIG. 2 by the retracting spring **28**, in preparation for resetting the valve after the fire is extenguished.

As hereinbefore noted, a direct-current source of energy is preferable to operate the present system, and this is for the further reason that the conduction characteristics of the light-sensitive switch **60**, particularly the SCR or GE–L7 series of silicon controlled rectifier switches are such that a delay in response time of up to 12 milliseconds may be introduced if 60 cycle alternating current is used as a sup ply source. Furthermore, the supply source **44** must provide a high and steady operating voltage not subject to falling off below normal in order to provide for sure and rapid ignition of the detonator at all times.

From the foregoing description it will be seen that a fast-acting deluge-type fire extinguisher system has been provided which is adapted to apply an extinguishing agent to a fire in a matter of a few milliseconds. The system is ultra fast in operation and powder-actuated to provide a deluge fire extinguishing agent through a rapidly-opening and simplified valve structure adapted for cartridge and gas-fired operation. The system is further adapted for operation by a light-sensitive switch device by reason of the fact that the gas-producing powder exploding element or detonator is adapted to be electrically activated.

The system of the present invention provides an ultra-fast powder or detonator-actuated deluge system for applying an extinguishing agent to a fire source of fast-burning materials. It incorporates a light-sensitive switch of modern design in connection with an electric current-activated detonator for applying gas pressure to release the piston element. The explosion-proof housing, conduit and annular chamber in rear of the piston are all adapted for operating pressures well above 1000 pounds per-square-inch. This high operating pressure and rapid detonation of the charge in the chamber insures instantaneous operation of the system. As pointed out hereinbefore, in operation with highly-sensitive incendiary and like powders a major portion of a detonated body thereof, under control of the present system always remains unburned after the extinguishing operation. In most tests of this type, the actuation time is found to be less than 20 milliseconds and complete extinguishment is generally accomplished in less than 80 milliseconds. With fast detonating mixtures, such as LBB types, in the detonator, the rise time is fast and an actuation time of less than 5 milliseconds can be attained.

It is obvious that to cover a large area, a plurality of spaced deluge-type sprinkler heads may be provided and connected for control in the same manner as in the present example, since a plurality of detonating devices may be fired, as is well known, from a common driving or activation circuit.

I claim:

1. A fast-acting deluge-type fire extinguisher system comprising in combination, a circular deluge-type valve casing having an inner chamber and a plurality of outlet ports communicating therewith for delivery of extinguisher agent therefrom over a protection area about said casing, a circular disk valve element in said chamber seated in a normally closed position to cut off the flow of said agent into said chamber, a central threaded valve stem for said valve extending axially therefrom, a closed circular base for said casing through which said valve stem extends coaxially therewith, a slidable holding sleeve surrounding said valve stem in threaded engagement therewith within said base and having a locking opening therein, a releasable firing pin extending through said base and into said locking opening to hold said sleeve and valve stem fixed in position against longitudinal movement and said valve in the closed position, a gas actuated firing-pin release mechanism for said firing pin, a gas-actuated piston in said mechanism connected with said valve stem and held in a retracted position with the firing pin in engagement with said locking opening, a relatively-small explosion-proof housing connected with said release mechanism to apply an explosive high-pressure force to said piston to move said firing pin from said opening thereby to release said valve, an electrically-activated detonator element in said explosion-proof housing for creating said explosive high-pressure force for application to said piston, a fast acting light-sensitive switch associated with the protection area for receiving light from flash ignition of protected material in said area, and a direct-current supply circuit connected through said switch with said detonator for activation thereof in response to operation of said switch, thereby to provide instantaneous release of said valve and the application of extinguishing agent to the said protected area about said valve casing.

2. A fast-acting deluge-type fire extinguisher system comprising in combination, a deluge type fire extinguisher valve casing having outlet ports for the delivery of extinguishing agent to protect an area about said valve casing from flash ignition of a valve element in said chamber seated in a normally-closed position, a central valve stem

connected at one end with said valve and extending axially therefrom at its opposite end, a circular base for said casing a central boss on said base having an opening through which said valve stem extends exteriorly of the casing, a slidable sleeve on said valve stem positioned within said opening and having a locking opening therein, a releasable firing pin extending through said boss into said locking opening to hold said valve in the closed position, a gas-pressure-actuated firing-pin release mechanism connected with said firing pin and extending from said base member at a right angle to the axis of said valve stem, a gas-actuated piston in said mechanism connected with said valve stem and held in a retracted position with the firing pin in engagement with said locking opening, an explosion-proof housing mounted in spaced relation to said valve casing, tubular high-pressure conduit means connecting the interior of said explosion-proof housing and the interior of said release mechanism to apply an explosive high-pressure force in rear of said piston to drive it in a direction to release said firing pin, an electrically activated detonator element in said explosion-proof housing for creating said explosive high pressure force therein for communication through conduit means to said piston, a fast-acting light-sensitive switch associated with the protected area about said valve casing for receiving light from the flash ignition of said materials in said area, and a direct-current supply circuit connected through said switch with said highly-sensitive operation of said switch and detonator to provide instant activation of said detonator in response to said light, thereby to provide instantaneous release of said valve and more effective application of extinguishing agent to the protected area about said valve casing.

3. A deluge-type fire extinguisher system comprising in combination, a deluge-type extinguisher valve head mounted to deliver a deluge of extinguisher agent in a hazard area to be protected and including a releasable valve element having a threaded valve stem. A cylindrical sleeve element on said valve stem adapted for the dropping therewith to release said valve element, a movable firing pin engaging and holding said sleeve element, a high-pressure gas-actuated firing-pin release mechanism connected to move said firing pin from engagement with said sleeve, an explosion-proof housing including an electric detonator cartridge as a sourceof high-pressure gas for said release mechanism and coupled therewith for instant operation on firing, a firing circuit including extended circuit leads providing direct current for actuating said detonating cartridge, a fast-acting light-sensitive switch of silicon-controlled rectifier type located adjacent to said hazard area and in circuit with said detonator cartridge for applying actuating current thereto in response to operation of the switch, means in circuit with said switch and detonator for controlling the application of current to said detonator, and explosion-proof cable means providing a protective covering for said firing circuit leak.

4. A deluge-type fire extinguisher system for applying an extinguisher agent to a hazardous fire source, comprising in combination, a deluge-type extinguisher-agent release valve mounted to deliver a deluge of extinguishing agent in a hazard area about said fire source and including a normally-closed releasable valve element, means providing a threaded valve stem and a surrounding holding sleeve adapted to drop and release said valve element, a release mechanism for said valve element including a gas-pressure-actuated firing-pin element engaging said sleeve to hold said valve member closed, an explosion-proof housing including an electric current-activated detonator cartridge as a source of high-pressure gas connected with said release mechanism for instant operation of said firing pin, a firing circuit providing direct current for actuating said detonating cartridge, a fast-acting light-sensitive switch located adjacent to said hazard area and connected in said firing circuit with said detonator cartridge for applying said actuating current thereto in response to operation of the switch, and series resistance means in said circuit for controlling the application of said current to said detonator.

5. An ultra-fast powder-actuated deluge-type fire extinguisher system for a fast-acting type of light-sensitive switch positioned in said area for receiving light from the ignition flash of said materials in the event of undesired combustion, a deluge-type extinguisher valve positioned over said area and including a normally-closed releasable central valve element which drops by gravity and liquid pressure upon release, said valve having a casing including a base element, with a central opening therethrough, a threaded valve stem extending from said valve element through said opening externally of said base element, a releasable sleeve surrounding said valve stem in said opening and including a locking hole therein, a gas-actuated firing-pin release mechanism mounted on said base element and mechanism including a movable piston element and a connected coaxial firing pin engaging said locking hole means in said mechanism providing a gas-inlet chamber in rear of said piston element an explosion-proof housing positioned at a distance from said valve casing and having an interior detonating chamber, a high-pressure conduit line connecting said detonating chamber with said inlet chamber in rear of said piston, and electrically-activated detonator element in said detonating chamber adapted to explode upon activation to create high-explosive gas pressure for actuation of said piston through said conduit line, means providing electrical terminals for said detonator through said housing, a direct-current supply source having supply leads connected with said detonator through said terminals and a circuit including said light-sensitive switch, and means in said circuit for limiting the flow of current to said detonator upon closure of said switch.

6. An ultra-fast deluge-type fire extinguisher system for applying an extinguishing liquid over an area including fast-burning powder and like high-incendiary materials, comprising in combination, a fast-acting light-sensitive switch of the silicon-controlled-rectifier type located in the area of said materials for receiving a light flash therefrom in the event of undesired combustion thereof, a deluge-type extinguishing-liquid delivery valve positioned over said area and including a normally-closed releasable central valve element which drops upon release and having a casing with a threaded valve stem extending therethrough from said valve element, a cylindrical sleeve surrounding said valve stem and including a radial locking opening in the side thereof, a gas-pressure-actuated release mechanism for said valve element having a firing pin extending at a right angle to the axis of said valve stem into releasable engagement with said locking opening and a movable piston element coaxial and connected with said firing pin to move it out of the engagement with said opening and release said sleeve and valve element, means in said mechanism providing a gas-inlet chamber in rear of said piston element, an explosion-proof housing positioned at a distance from said valve casing and having an interior high-pressure chamber, a high-pressure conduit line connecting said high-pressure chamber with said gas inlet chamber in rear of said piston, an electrically-activated detonator element in said chamber, a firing circuit having extended circuit leads and including said light-sensitive switch and a direct-current supply source connected with said detonator through said firing circuit and said light-sensitive switch therein.

7. An ultra-fast deluge-type fire extinguisher system as defined in claim 6, wherein the direct-current supply source comprises a rectifier unit having alternating-current input leads and a rectifier device therein, and wherein the firing circuit leads are included in explosion-proof cable means and provided with a junction box having terminals therefor and a current-limiting resistor box having terminals therefor and a current-limiting resistor

connected between two of said terminals for inclusion serially in said circuit.

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