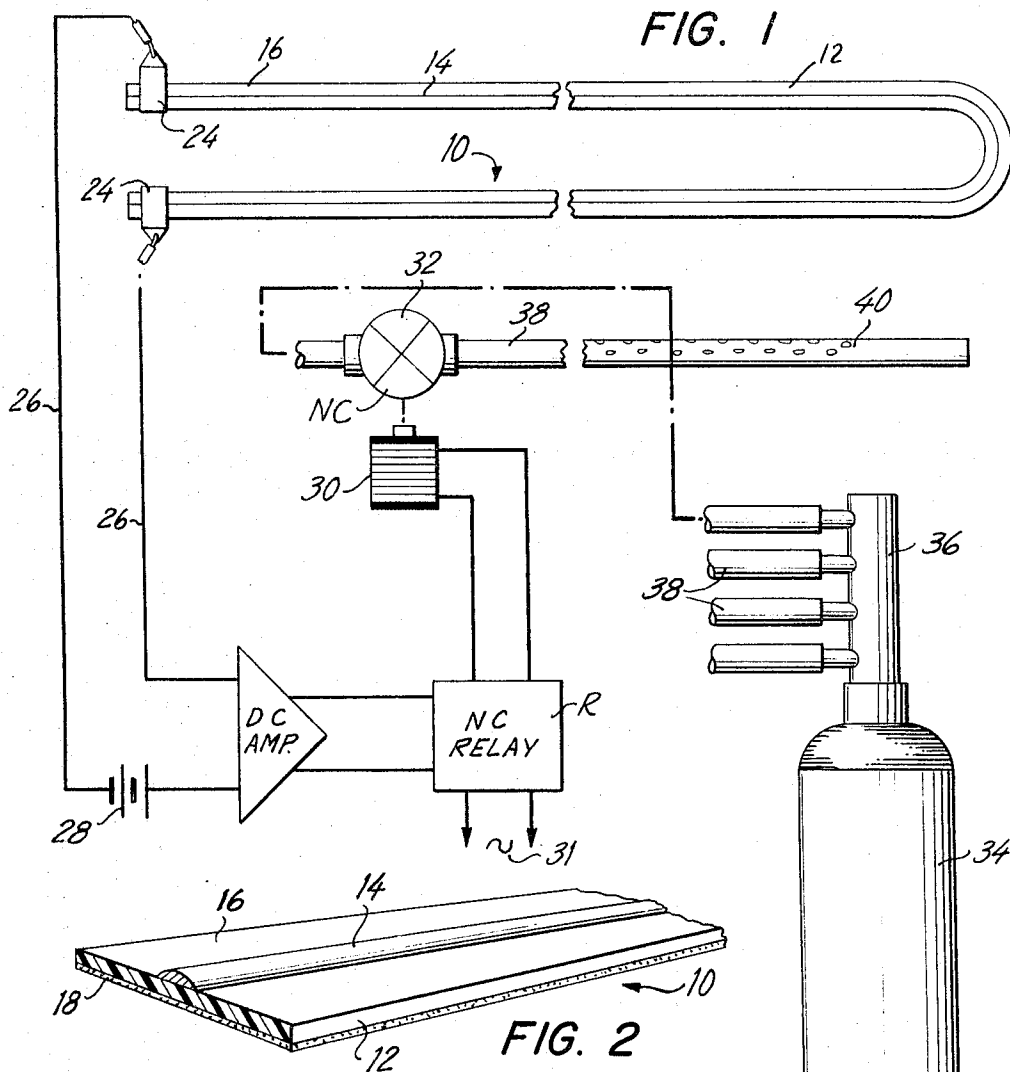
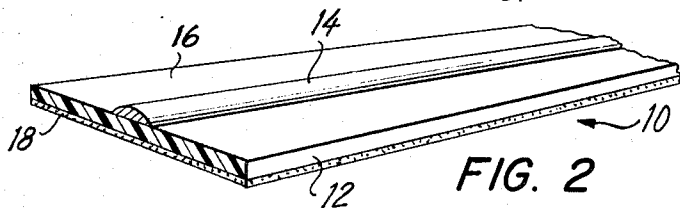
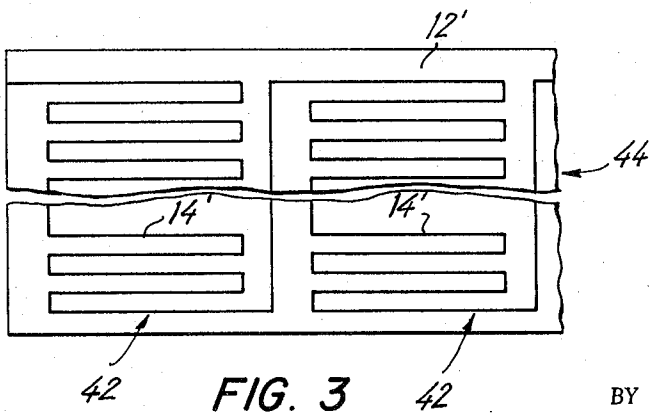


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FUSIBLE FIRE SENSING TAPE FORMED OF METAL PARTICLES
DISPERSED IN A FLEXIBLE PLASTIC BINDER
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FUSIBLE FIRE SENSING TAPE FORMED OF METAL PARTICLES DISPERSED IN A FLEXIBLE PLASTIC BINDER

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This invention relates to fire sensing tape for use in a fire detection and extinguishing system and to a system incorporating such a tape.

It is an object of this invention to provide a fire sensing tape in conjunction with a fire detection and extinguishing system which reacts to flame or elevated temperatures at great speed, so as to enable the extinguishing system to discharge a fire extinguishing agent and bring the fire under immediate control before the fire has gained an appreciable headway.

It is known in the art to provide a fire extinguishing system which is actuated upon the fusion of a low-temperature melting element or trigger. An overhead fire sprinkler system is a typical example of such a system.

Said fusible element commonly holds closed a valve on the discharge port of a sprinkler nozzle, which prevents the egress of a fire-extinguishing medium under pressure. When a fire occurs, the fusible element eventually is heated to its fusion temperature and melts, clearing the port and permitting the sprinkler to discharge.

The above-described sprinkler system has a defect characteristic of any fire sensing system which depends for actuation upon the fusion of a low-temperature melting metal. This defect is that the system does not have the sensitivity and fast reaction time required in many critical applications. Even a short exposure to intensive flame will destroy a large quantity of information-storage cards or delicate electrical components. Further, as the fire increases in intensity toward its maximum burning rate, it becomes exceedingly more difficult to quench at the first burst of the fire extinguishing medium, and a prolonged period of discharge soon becomes necessary to put out the fire.

One reason for the insensitivity of the mentioned type of system is the fact that the fusible element typically has a substantial heat storage mass and is engaged as well by a holder of considerable heat storage mass. These masses act as heat sinks which slow the temperature rise to the trigger temperature. Before the trigger element reaches its melting point, the mass immediately adjacent the heat-sensitive element must be heated to substantially the same temperature.

Another factor also prevents any system employing a fusible element from working at a fast reaction rate. This is a physical characteristic of such materials that has been mentioned above in passing, to wit: that the fusion temperature must be maintained for a certain period of time until a sufficient quantity of heat has been imparted to the material to cause it to change from the solid to the liquid phase. The absorption of this quantity of heat necessarily requires a delay in the complete fusion of the fire alarm trigger, with a resultant delay in the actuation of the system.

It is the primary object of my invention to provide a fire sensing tape for use in a fire alarm system which reacts to flame and high temperature at a rapid speed and without the delay inherent infusible-element systems.

It is a further object of my invention to provide a fire sensing tape of the character described which upon its degradation or destruction by flame or high temperature causes a fire extinguisher to discharge so as to bring the conflagration under immediate control.

It is yet another object of my invention to provide a fire sensing tape of the character described which is an

elongated flexible element and which can be readily fixed in a continuous length to walls, ceilings or any surface areas of varied structures whereby the tape can be brought in close adjacency to any potential source of fire.

It is a further object of this invention to provide a fire sensing tape of the character described in conjunction with a fire detection and extinguishing system wherein the extinguishing medium is discharged through perforated ducts whereby the extinguishing medium is directed to specified sites in a structure remote from the source of the medium.

It is another object of my invention to provide a fire sensing tape of the character described wherein the tape has the characteristic of accelerating its own destruction upon the application of flame or heat.

It is a further object of my invention to provide a fire sensing tape of the character described wherein the continuous length of the tape can react to different temperatures at different positions along its length so that when a structure maintains different areas at different temperature levels, the tape will actuate its fire extinguisher system at an approximately constant increment above normal temperature.

These and various other objects and advantages of my invention will become apparent to the reader in the following description.

My invention accordingly consists in the features of construction, combinations of elements, arrangements of parts and series of steps which will be exemplified in the fire sensing tape and system hereinafter described and of which the scope of application will be indicated in the appended claims.

In the accompanying drawings in which is shown various possible embodiments of my invention,

FIG. 1 is a schematic view of my fire sensing tape incorporated into a fire detection and extinguishing system;

FIG. 2 is an enlarged fragmentary perspective view of the fire sensing tape; and

FIG. 3 is a top plan view of my fire sensing tape in the form of a mat.

Referring now to the drawings, and especially FIG. 2, the reference numeral 10 denotes a fire sensing tape constructed in accordance with the teaching of my invention. The fire sensing tape comprises an elongated electrically non-conductive flexible carrier 12 of synthetic plastic sheet material and an elongated flexible electrically conductive stripe 14 fixed to an exposed face 16 of the carrier. In a preferred form of my invention, a pressure-sensitive adhesive layer 18 is fixed to the opposed (back) face of the carrier 12 and is utilized to stick lengths of tape 10 to any solid area of a structure to be protected against the outbreak of fire.

The stripe 14 is, as has been mentioned, electrically conductive and flexible and is narrower than the carrier 12. In the illustrated embodiment of my invention, the stripe 14 overlays only a small fraction of the exposed (front) face 16 of the carrier, and is disposed intermediate, and preferably centered between, the side edges of the carrier.

It may be advantageous to note at this point that the term "exposed" face refers to that face of the tape which, when the tape 10 is attached to, say, the walls or ceiling of a room, is most directly subject to the effect of flame or heat. In other words, it is the face which is not directly adhered to the protected structure.

The stripe 14 is continuous along the length of the carrier and, as will be subsequently detailed, forms the major portion of an electrical loop which is part of the fire detection and extinguishing circuit. The stripe is composed of finely divided particles of a low resistivity, high melting point metal or metal alloy held in a binder,

the metal preferably being silver. The term "low" resistivity" refers to the resistance of conductors typically used in electrical circuits which are in the vicinity of 2 microhm-cm. The conductor should transmit electrical energy with a minimum of I²R loss, so as not to affect the temperature sensitivity of the tape itself.

The term "high melting point" refers to the melting point of a metal which fuses at a temperature far above the temperature at which a normally sensitive fire extinguisher system should be set off to be effective in protection. For this purpose, a high melting point would be considered in the range starting about at 700° F. The melting point of the metal in the stripe is thus far higher than the melting temperature of fusible elements such as Woods metal or lead alloys used in fusible trigger fire extinguishing systems.

The binder for the metallic particles must be flexible so that the stripe 14 is flexible on the carrier 12, and serves to hold the metal particles in contiguous adjacency to render the stripe conductive as well as a means to adhere the stripe to the carrier. The binder comprises any electrically non-conductive material which either decomposes or fluidifies at a temperature within the range in which the fire extinguisher should be discharged for adequate fire protection. This range should be substantially from 175° to 550° F. for different applications. Preferably, the binder is a synthetic thermoplastic, typical suitable materials being: cellulose acetate, cellulose acetate butyrate, acrylics, polyamides, polyethylene, polyurethanes, polyvinyl chloride, and polyesters. There also may be used natural rubber or synthetic rubber. Said synthetic rubbers include Buna S, a copolymer of butadiene and styrene; Buna SS, a product with a higher styrene content than Buna S; Buna N, a mixed polymer of butadiene and acrylonitrile; polybutene, prepared by the polymerization of isobutane; or Butyl rubber, a copolymer of isobutene and butadiene. A limitation in the selection of the binder is that it must not react with the metal particles to impair the metal's electrical qualities.

The carrier 12 is a continuous elongated length of thin flexible plastic, and is commercially produced by cutting the carrier from plastic sheet stock. The plastic must be electrically non-conductive to insulate the stripe 14 from the surface to which the tape 10 is affixed. The plastic is also dimensionally stable and inert to the materials comprising the stripe 14. The plastic is heat-destructable at a low temperature, i.e., a temperature within the range in which the fire extinguisher must be actuated to give effective fire protection. The term "heat-destructable" includes destruction by burning, destruction by fluidification, destruction by substantial loss of physical strength or destruction due to physical distortion, i.e., "balling up" or "curdling."

Suitable plastics for the carrier include cellulose acetate, polyvinyl chloride, acrylics, polyvinyl acetate, cellulose acetate butyrate, polystyrene, polyamides, polyvinylidene chloride, polyesters, polyethylene, polypropylene, and polycarbonate resins. The stiffer of these plastics are suitably modified by the addition of conventional flexibilizing plasticizers, as is well-known to the art.

The adhesive layer 18 is preferably formed from a pressure sensitive adhesive composition such as plasticized polyisobutylene. The adhesive layer is protected by a backing (not shown) having a high release characteristic before it is applied to the surface of a structure. Alternatively, the tape 10 can be attached to some surfaces by mechanical fastening means, e.g., stapling or tacking, taking due care that the stripe 14 is not severed by the fastener.

The stripe material fluidified by a solvent, e.g., naphtha or butyl acetate is applied to the carrier 12 by any conventional means as for example by brush painting, spraying, a ruling pen or a striping disc.

In a tested and highly satisfactory embodiment of my invention, Mylar tape such as is used as a carrier for magnetic tape, was utilized as the carrier 12. Mylar is manufactured by the E. I. du Pont de Nemours & Co., Inc., Wilmington, Delaware, and is a polyester film which is the condensation product of ethylene glycol and terephthalic acid. This material has been found useful because it is dimensionally-stable and remains flexible to below freezing temperatures. Its melting point is about 500° F. The Mylar tape used in a tested form of my invention has a width of about 0.25" and a thickness of about 0.0015". In said embodiment a conductive stripe was formed by applying a line of silver paint. Said paint constituted about 43% finely divided silver particles, 32.5% of a thermoplastic binder which was methyl methacrylate and 24.5% of an organic liquid solvent which was butyl acetate. Thus the silver constituent of the dried stripe was about 60% by weight of the solids. The line was applied by a ruling pen to the Mylar tape carrier and the solvent allowed to evaporate so as to leave the stripe. The stripe had a cross-section 0.0625" wide and 0.005" thick. A thickness of about one-half to 5 mils constitutes a suitable range. In said embodiment, the stripe was found to have a resistance of 20 ohms/linear foot.

Turning then to the incorporation of the fire sensing tape 10 into a fire detection and extinguishing system, the tape is affixed as by means of its pressure-sensitive adhesive layer as a continuous length, for example on the walls and ceiling of a structure, optionally through several continuous rooms, internally or externally of machinery as the housings of electrical apparatus, or through various compartments of automobiles, ships, computers or aircraft. The tape may be installed in any position or orientation, i.e., horizontally, vertically, etc., and with the tape lying in any desired plane.

As shown in FIG. 1, the stripe 14 forms the major portion of an unbroken loop and its ends are connected by terminal clips 24 to conducting wires 26. One of said wires 26 leads to a source of power, e.g., a 6 volt battery 28 and then to one terminal of a D.C. amplifier, and the other wire leads to the other terminal of said amplifier. The amplifier output feeds and controls a normally closed relay R. The relay in its normally closed position energizes a solenoid 30 from an A.C. source of power 31. The solenoid when energized opens a normally closed discharge valve 32 which controls the discharge of a fire extinguishing medium from a container 34 in which said medium is stored under pressure. Thus, breaking the stripe discharges the medium.

The fire extinguishing medium is discharged through a manifold 36, from which lead several discharge ducts 38. The ducts 38 run to different areas of a structure to be protected, and are perforated as at 40 where desired to permit some portion of the extinguishing medium to pass through the perforations to a local area and to direct the remainder of the medium further down the duct.

The actuation of the system takes place at a high speed, far faster than previously known systems.

The sensing tape can readily be utilized with other systems, as for example where only an alarm is sounded on the breaking of the tape.

A theory may be advanced which, it is believed, accounts for the high fire sensing speed of the described system. First, it will be appreciated that the mass of the stripe and carrier at any one location is extremely small especially as compared to the mass of the conventional fusible trigger and the trigger holder of existing systems. Consequently, there need be no protracted heat build up over a period of time, but rather a practically instantaneous reaction to heat or flame.

Second, the carrier 12 itself is heat-destructable, and itself may burn to hasten its own elimination. The re-

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removal of the carrier causes the stripe to be without a structural support and thus to fail more quickly.

Third, it must be remembered that the stripe itself does not fuse (due to the high temperature melting point of the silver particles) but rather the application of heat to the binder causes the binder to melt, writhe, ball-up, curdle, or distort so as to separate the particles and cause a break in the stripe. There is no waiting period for the absorption of a heat of fusion of the fusible material at a fixed temperature, before the system will be set off.

Further, it should be appreciated that as the stripe begins to part, the effective local cross-section of the conductor stripe diminishes. The consequent increase in resistivity causes the generation of I^2R heat, which accelerates the parting of the stripe.

The following are examples of the effectiveness of my fire sensing tape. The tests were conducted in a room 8' x 8' x 7½' high. One wall of the room contained a door located near one corner thereof, and an adjacent wall of the room near an opposite corner contained a window.

The fire extinguishing agent used was Freon FE 1301 manufactured by E. I. du Pont de Nemours, Wilmington, Delaware. This agent is a liquified compressed bromotrifluoromethane (CB_3F_3).

The extinguishing agent was discharged from four discharge ports, each located in a different corner adjacent the ceiling and directed at the center of the room.

TEST 1

Fire.—An Underwriters' Laboratories Type 1B naphtha fire in a canister 0.72 ft.², set in the center of the room and two alcohol fires, each 0.72 ft.², set in opposite corners of the room.

Tape Location.—Window to ceiling, across ceiling to center of room, back across ceiling to window.

Time to detect fire.—12 seconds.

Time after detection to extinguish fire.—30 seconds.

TEST 2

Fire.—Two 0.72 ft.² alcohol fires, one on floor, one elevated 2', both 1' from wall opposite door.

Tape location.—Along wall opposite door, 4' above floor, and then out window.

Time to detect fire.—34 seconds.

Time after detection to extinguish fire.—11 seconds.

Remarks.—Tape not parted, conductive stripe "balled up" and separated. Same fire required 12 minutes to activate 165° F. water sprinkler heads in previous tests.

TEST 3

Fire.—Type 1B naphtha fire, 0.72 ft.², in corner, with metal junk piled in the same corner.

Tape location.—Along wall opposite door, above fire and 4' from floor.

Time to detect fire.—5 seconds.

Time after detection to extinguish fire.—13 seconds.

Remarks.—This is considered a very rapid extinguishment for this type of fire, and was primarily due to fast detection time.

TEST 4

Fire.—Naphtha soaked paper towels plus a small quantity of naphtha in a metal cap were located on the floor in the center of the room.

Tape location.—On a frame 30" above towels.

Time to detect fire.—Less than 1 second.

Time after detection to extinguish fire.—17 seconds.

Remarks.—Detection was practically instantaneous, and the fire was extinguished so quickly that less than 10% of the paper towels was burned or charred. Due to quick sensing, the fire did not achieve maximum burning rate.

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FIG. 3 illustrates another embodiment of my invention wherein the tape is in the form of a mat capable of covering a broad area. Therein, the stripe 14' is applied over a carrier 12' which is much wider than the carrier previously shown. The stripe 14' is laid down in numerous closely spaced series interconnected parallel rows on the carrier 12' to form a number of contiguous series connected blocks 42 which constitute the elongated, yet wide, mat 44. The mat 44 can be cut to fit any desired area by severing it between any two blocks 42. The remaining ends of the stripe 14' are then connected to the electrical system as heretofore described.

The mat embodiment of my invention is utilized in fire-prone locations where the nature of the risk demands every precaution be taken by blanketing the area to be protected with fire sensing tape. Examples of such areas are engine compartments of aircraft and vessels, areas for storing explosives and fuels, and boiler rooms.

The temperature at which the fire sensing tape is set off can be varied by a judicious selection of the carrier material, the binder material, and the effective cross-section (length and/or width) of the conductive stripe. The entire length of tape may be of the same temperature sensitivity, or tapes of various sensitivities can be joined together in series so that in different locations of the protected structure, the tape will be set off at different critical temperatures. The D.C. amplifier is employed to enable a very long length of tape to be utilized.

It thus will be seen that I have provided fire sensing tapes and a system which achieve the several objects of my invention and which are well adapted to meet the conditions of practical use.

As various possible embodiments might be made of the above invention, and as various changes might be made in the embodiments set forth, it is to be understood that all matter herein described, or shown in the accompanying drawings, is to be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, I claim as new and useful and desire to secure by Letters Patent:

1. A temperature sensing tape, for use in a heat detection system, comprising in combination:

(A) an elongated, dimensionally stable, electrically non-conductive, synthetic plastic sheet carrier of slight thickness;

(I) said carrier being composed to be destructible by heat in the temperature range of from about 175° F. to about 550° F.;

(B) superimposed on said carrier a slender, thin, flexible stripe of electrically conductive-low resistivity metallic material,

(I) said metallic material being composed of finely divided particles of a low resistance high-temperature-fusing metal dispersed in a solid flexible plastic binder;

(II) said binder being composed to be destructible by heat in the range of from about 175° F. to about 550° F.;

(III) said stripe being narrower than said carrier, and being adherent to an exposed face of said carrier, and extending continuously along the length of said carrier,

(C) whereby the indicated degree of heat applied externally to said tape acts upon said carrier so that it no longer properly supports said stripe, and acts on said stripe causing it to part so as to interrupt an electrical circuit.

2. A fire sensing tape as set forth in claim 1 wherein the metal is silver.

3. A fire sensing tape as set forth in claim 1 wherein the binder is thermoplastic.

4. A fire sensing tape as set forth in claim 1 wherein the carrier is a polyester film.

5. A fire sensing tape as set forth in claim 4 wherein the carrier is a polymeric resin constituting the condensation product of ethylene glycol and terephthalic acid.

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6. A fire sensing tape as set forth in claim 1 wherein the thickness of the stripe is from about one-half to five mils.

7. A fire sensing tape as set forth in claim 1 wherein the stripe is arranged in a pattern providing portions extending transversely across the width of the tape.

8. A fire sensing tape as set forth in claim 1 wherein a pressure-sensitive adhesive layer is disposed in the back of the carrier.

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