CONTINUOUS WIRE FIRE DETECTION SYSTEM - PART II

HOW DOES IT WORK?

The continuous sensing element is a heat sensing device. The Inconel tube sheath contains a ceramic-like thermistor material in which are embedded the electrical conductors. The thermistor changes its electrical resistance between the conductors with temperature. At normal ambient temperatures, resistance is high, dropping rapidly as the sensor is heated. A control unit using a simple transistorized bridge and trigger circuit switches on the alarm when the resistance of the sensor drops to the pre-set level. When the fire or overheat condition has been eliminated, the sensor resistance rises again, the control unit resets automatically and is immediately available for further detecting duty.

EXPERIENCE

Developed over 15 years ago, the Continuous Wire Fire Detector has seen service on each new generation of aircraft since. It has undergone continual updating to meet the more severe requirements of advancing aircraft specifications, and to incorporate service-indicated improvements.

INSTALLATION

The sensing element may be mounted on or in electronic boxes or in wire bundles. The location and length of sensing element depends on the physical characteristics of the installation.

The temperature-resistance characteristics of the sensing element are selected to provide an alarm at a temperature usually 100° to 200° F above the maximum ambient temperature of the areas to be covered. Different standard sensing element types are available so that any desired alarm temperature can be provided. The temperatures of normal "hot spot" areas should be known or estimated so that proper allowance can be made in the element selection to provide

INSTALLATION (continued)

proper sensitivity without nuisance alarms from the normal hot spots.

MOISTURE

In the presence of soluble salts, moisture forms a conductive solution (electrolyte) which, when allowed to enter a sensing element connector, can form a low resistance bridge across the connection. This is no problem to this system. The sensing element circuit operates at a low D-C voltage (approximately 0.5 volts) which is well below that required to overcome the polarization potential of the electrolyte so that it does not conduct sufficiently to trip the alarm - in other words, it appears as a resistance considerably higher than the trip resistance.

Since the thermistor is not water-soluble, it is not dissolved and made conductive by moisture which might gain entrance to the element through a break or chafed opening in the Inconel sheath.

TEST SET

Only standard test equipment is required for the maintenance testing and trouble shooting of the Continuous Wire Fire Detector. The integrity of the entire fire detector system may be tested by merely switching one end of the element loop from the control unit to ground.

AVERAGING

The sensing element consists, essentially, of an infinite number of unit thermistors electrically in parallel along its length. The resistance of the sensing element, thus, is a function of the length heated, as well as the temperature-heating of less than the full length of element will require that portion to be heated to a higher temperature to achieve the same total resistance. As a result the system responds, not to a fixed alarm temperature, but to the sum of the resistance (in parallel) which reflects a non-arithmetic "average". The sensing element may thus be routed close to

AVERAGING (continued)

non-hazardous hot spots that may have a normal temperature well above the overall alarm temperature, without danger of causing a false alarm. This feature permits the alarm point to be set close to the maximum general ambient temperature, giving greater sensitivity to a general overheat or fire, without being subject to false alarms from localized non-hazardous hot spots.

LOOP CONNECTION

Normally the sensing elements are connected in a loop with each end of the loop connected to the control unit, thus should a break occur, the control unit continues to monitor the sensing element from each end to each side of the break and thus continues to function normally as a fire detector. Of course, should a second break occur, the section of sensing element isolated by the two breaks becomes inactive.

INSTALLATION HARDWARE

A wide variety of wire connectors, quick-release clamps, grommets, elbow connectors, feed-through plates and stand-off brackets is provided for the convenient installation of the sensing element and its connection into the spacecraft wiring.

FEATURES OF THE SYSTEM

- Continuous sensing element - for full, positive coverage
- Thermal type - sensitive to excessive heat
- "Averaging" - no nuisance alarms from normal, non-hazardous hot spots
- Fast response
- Automatic resetting - after fire or overheat condition has been corrected
- Simple continuity test completely checks integrity of system
- Sensing element continues to function even if broken
- Operates from either AC or DC, over normal and emergency ranges

FEATURES OF THE SYSTEM (continued)

- Unaffected by high voltage "spikes"
- Withstands severe environment - vibrations, shock, temperature extremes
- Impervious to oil, hydraulic fluis, cleaning solvents, water
- High reliability - dependable fire detection and freedom from false warning
- 2-stage alarm - overheat and fire - from single sensing element loop
- "Armored" sensing elements
- Easy to maintain
- Lightweight
- Low cost

OPTIONAL FEATURES

The thermistor-type sensor permits two variations to the basic fire detector system.

COMBINATION FIRE AND OVERHEAT - The control circuit may give a two-stage alarm from the same sensing element loop, one at a low temperature slightly above maximum normal ambient, for overheat; the second at a higher temperature indication a more severe hazard, fire.

RATE OF TEMPERATURE RISE - For extremely fast response, when desired, the control unit can be arranged to trigger the alarm signal when the rate of temperature rise exceeds a pre-determined value, as well as triggering when the fixed alarm temperature is reached. The rate sensitivity is adjusted so that it will not trip on normal ambient changes.

THE ARMORED ELEMENT

The sensing element is positioned within a pre-bent protective sheath of perforated stainless steel tubing by closely spaced teflon-asbestos bushings where it is supported from vibration and protected from abrasion, pinching or excessive bending.

REDUNDANT SYSTEMS

For those applications where extreme reliability is desired, redundant systems may be employed. Sensing elements are run parallel to each other approximately one-half inch apart. Dual control units may be provided with the redundant control circuits within one envelope. With such systems the inherent reliability of the Continuous Wire Fire Detector assures that double failures will not occur between periodic inspections.

VOLTAGE TRANSIENTS

The control circuit is protected by a zener diode regulator so that volatge transients as high as 1000 volts are harmlessly shunted without a flicker of the fire signal or damage to the transistor circuits. Power failure will cause no malfunction and upon power restoration, the system will resume standby.

THE SHORT DISCRIMINATOR

Operating on the difference in rate of resistance change, the short discriminator circuit discriminates between a lowered resistance caused by fire and a lowered resistance due to a short circuit, and prevents short circuits from causing false fire warnings. A shor circuit may activate a separate trouble warning indicator, if desired.

THE DUAL ARMORED ELEMENT

Two sensing elements, within a single protective armor sheath, combine the protection afforded by armored elements with the advantages of a redundant system but with the weight saved by only a single armor tube.

CONTINUOUS WIRE OVERHEAT DETECTOR

SEVERAL TYPES AVAILABLE

- SALT TYPE
- GAS/PNEUMATIC TYPE
- THERMISTOR MATERIAL

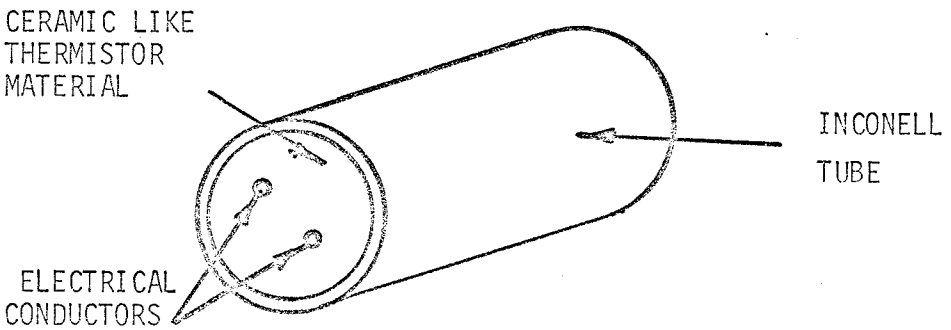
THERMISTOR TYPE SELECTED FOR DISCUSSION

- RUGGEDNESS
- PROVEN LONG-TERM PERFORMANCE AND RELIABILITY FROM 15 YEARS USE BY COMMERCIAL AIRLINES WITH A CONTINUAL UPDATE AND IMPROVEMENT PROGRAM

PRINCIPLE OF OPERATION

A. THERMISTOR MATERIAL IS THE KEY ELEMENT

B. THE SENSING UNIT IS A TUBE LIKE ASSEMBLY



C. THERMISTOR MATERIAL - ITS ELECTRICAL RESISTANCE VARIES

D. SHARPLY IN A KNOWN MANNER WITH TEMPERATURE

D. RESISTANCE IS HIGH AT NORMAL AMBIENT TEMPERATURE, AND IT DROPS RAPIDLY BETWEEN CONDUCTORS AS TEMPERATURE INCREASES (EFFECTIVELY SHORT CIRCUITS THE LOOP)

E. SIMPLE TRANSISTORIZED BRIDGE AND TRIGGER CIRCUIT IN CONTROL BOX PROVIDES RESPONSE AT A PRESENT LEVEL OF RESISTANCE

PRINCIPLE OF OPERATION (CONTINUED)

F. THE SENSOR IS RESET AUTOMATICALLY WHEN THE HEAT SOURCE IS REMOVED. (INDICATES TROUBLE CORRECTED)

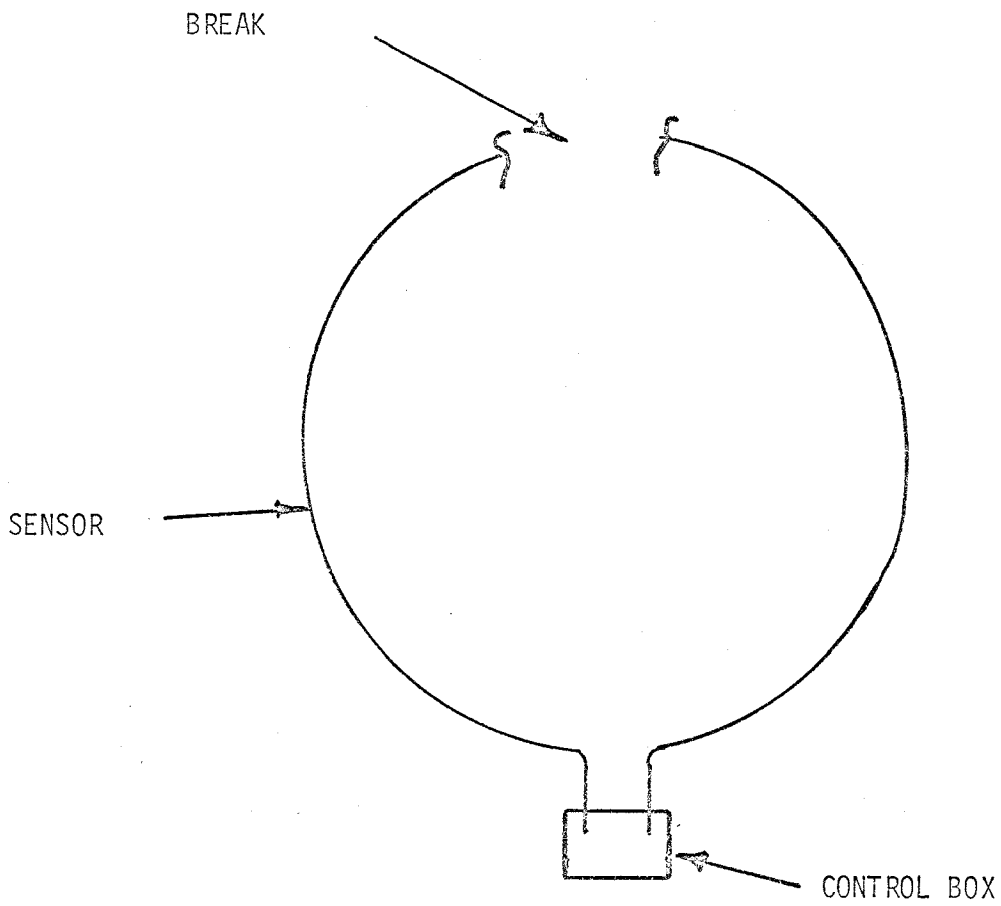
G. THE ELEMENT CONSISTS OF AN INFINITE NUMBER OF UNIT THERMISTORS ALONG ITS LENGTH

H. THE EFFECTIVE RESISTANCE SEEN BY THE TRIGGER UNIT IS A RESULT OF THE LENGTH OF THE SENSOR HEATED AS WELL AS THE TEMPERATURE

I. THE ALARM CIRCUIT RESPONDS TO THE SUM OF THE RESISTANCES (IN PARALLEL) WHICH REFLECT A NON ARITHMETIC AVERAGE

NORMAL APPLICATIONS

- CAN BE INSTALLED IN WIRE BUNDLES
- CAN BE INSTALLED IN OR ON BLACK BOXES
- CAN BE INSTALLED IN WIRING OR PLUMBING DUCTS OR BEHIND PANELS
- CAN PROVIDE LOCATION INFORMATION BY MEANS OF RESISTANCE READING TO POINT OF EFFECTIVE SHORT CIRCUIT, WHERE FIRE OR OVERHEAT POINT EXISTS
- NORMALLY INSTALLED AS A LOOP, BOTH ENDS OF WHICH ARE CONNECTED TO A CONTROL BOX
- ARMORED AND REDUNDANT UNITS ARE AVAILABLE FOR USE IN AREAS OF HIGH TRAFFIC AND OTHER AREAS WHERE PROBABILITY OF MECHANICAL DAMAGE IS HIGH



BREAK IN CONTINUOUS LOOP ALLOWS OPERATION OF BOTH HALVES AS A DETECTOR

ADVANTAGES

A. IF BREAK OCCURS IN CONTINUOUS LOOP, BOTH ENDS STILL FUNCTION AS A DETECTOR (BUT LOCATION CAPABILITY IS LOST).

B. DOUBLE ALARM FEATURE

   A. RATE OF TEMPERATURE RISE (LOW RANGE) GENERAL AREA OVERHEAT

   B. TOTAL HEAT MEASUREMENT (HIGH RANGE) FIRE

C. PROVEN SYSTEM - USED IN COMMERCIAL AIRCRAFT.

D. CAN BE USED IN ALMOST ANY LOCATION.

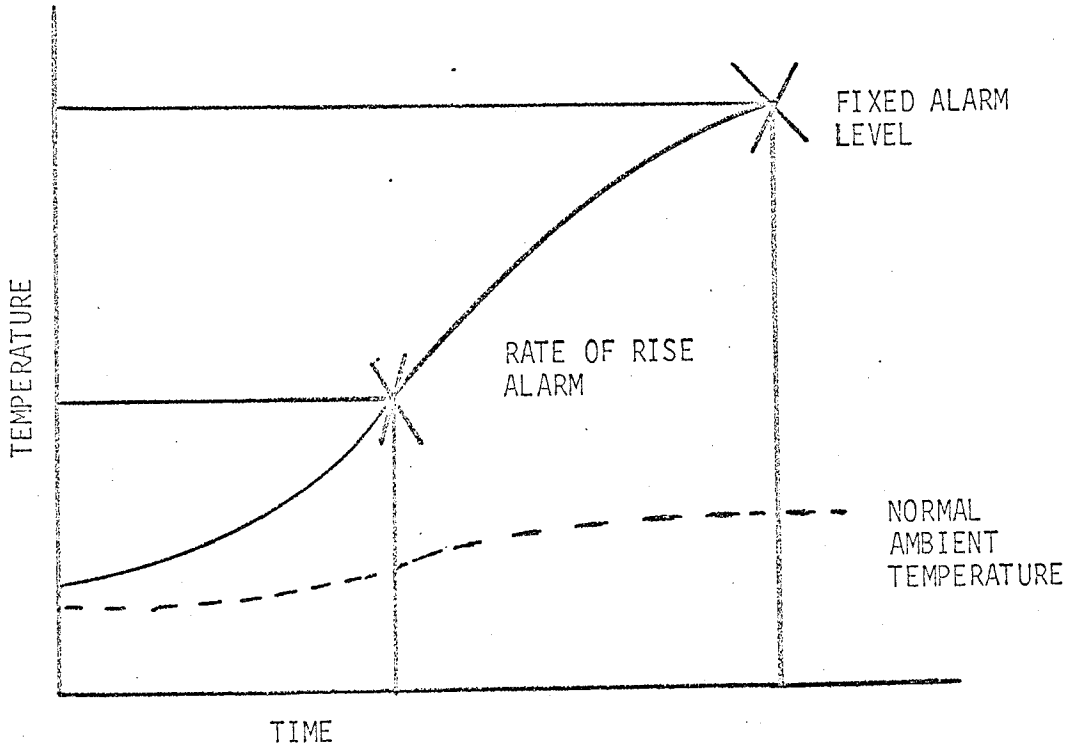
E. SIMPLE CHECK OUT WITH STANDARD TEST EQUIPMENT.

F. READILY AVAILABLE, RELATIVELY LOW COST, LIGHT WEIGHT AND LOW POWER DEMAND (2 WATTS OR LESS/PER LOOP).

DOUBLE ALARM FEATURE

A. RATE OF TEMPERATURE RISE INDICATION

B. FIRE/HIGH TEMPERATURE ALARM (FIXED)



ADVANTAGES (CONTINUED)

G. LOW VOLTAGE, APPROXIMATELY .5V - ELECTRICAL HAZARD.

H. FALSE ALARM PROBLEM VIRTUALLY ELIMINATED.

I. OVERHEAT/FIRE LOCATION INFORMATION AVAILABLE FROM BASIC SYSTEM.

J. THE SYSTEM WILL OPERATE IN THE PRESENCE OF MOISTURE.

DISADVANTAGES

A. MINIMAL CONVECTION IN AREAS WHERE AIR CIRCULATION IS LOW WILL SLOW DOWN SYSTEMS RESPONSE.

B. 200° F IS THE PRESENT LOW LIMIT FOR SYSTEMS RESPONSE. 150° F WOULD BE BETTER.

C. NORMAL AMBIENT OPERATING TEMPERATURE SURVEY IS REQUIRED IN ORDER THAT ALARM MARGINS CAN BE REALISTICALLY SET TO ELIMINATE FALSE ALARMS AND TO MATCH SENSING ELEMENT TEMPERATURE RANGE WITH THE AREA TO BE MONITORED. THE CHOICE OF SNESING ELEMENT MUST BE MADE FROM AMONG 14 DIFFERENT MATERIALS IF MAX. SYSTEMS PERFORMANCE IS TO BE REALIZED.

COST - WEIGHT - POWER REQUIREMENTS

A. HARDWARE COST - EST. $1000 TO $1500 DOLLARS FOR A 50' LOOP WITH A CONTROL BOX.

B. WEIGHT - (1) CONTROL BOXES 1-2 # EACH

(2) SENSING ELEMENT APPROXIMATELY .1 # PER FOOT

C. POWER REQUIREMENTS APPR. 2W/.5V PER LOOP.