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Tipton et al.

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[54] RATE OF RISE THERMAL DETECTOR

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[52] **U.S. Cl.**.....**340/229,** 73/368

[51] **Int. Cl.**.....**G08b 17/04,** G08b 17/06

[58] **Field of Search** .....73/368, 179; 337/306, 307, 337/308, 320; 340/229; 200/83 B, 83 C; 75/222

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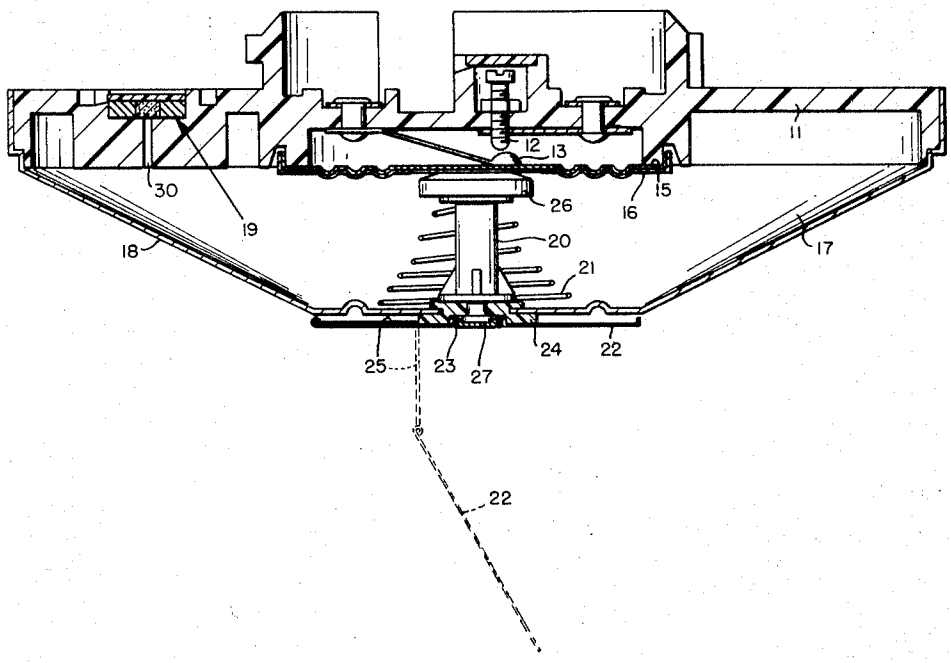
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Assistant Examiner—Denis E. Corr
Attorney—Harold S. Wynn and John P. DeLuca

[57] **ABSTRACT**

A rate of rise thermal detector has been provided having a chamber for enclosing an atmosphere, control means within the chamber responsive to increases in the atmospheric pressure within the chamber occasioned by a relatively rapid rise in ambient temperature for producing a warning signal and governing means communicating within and without the chamber for regulating the rate equalization of the atmospheric pressure within the chamber. The improved governing means comprises a restrictor mounted in a wall of the chamber for permitting a selected calibrated rate of atmospheric equalization. The restrictor includes a body of precalibrated porous metal in a mounting ring fitted into a counterbore in a wall of the chamber over an opening in the chamber.

2 Claims, 6 Drawing Figures



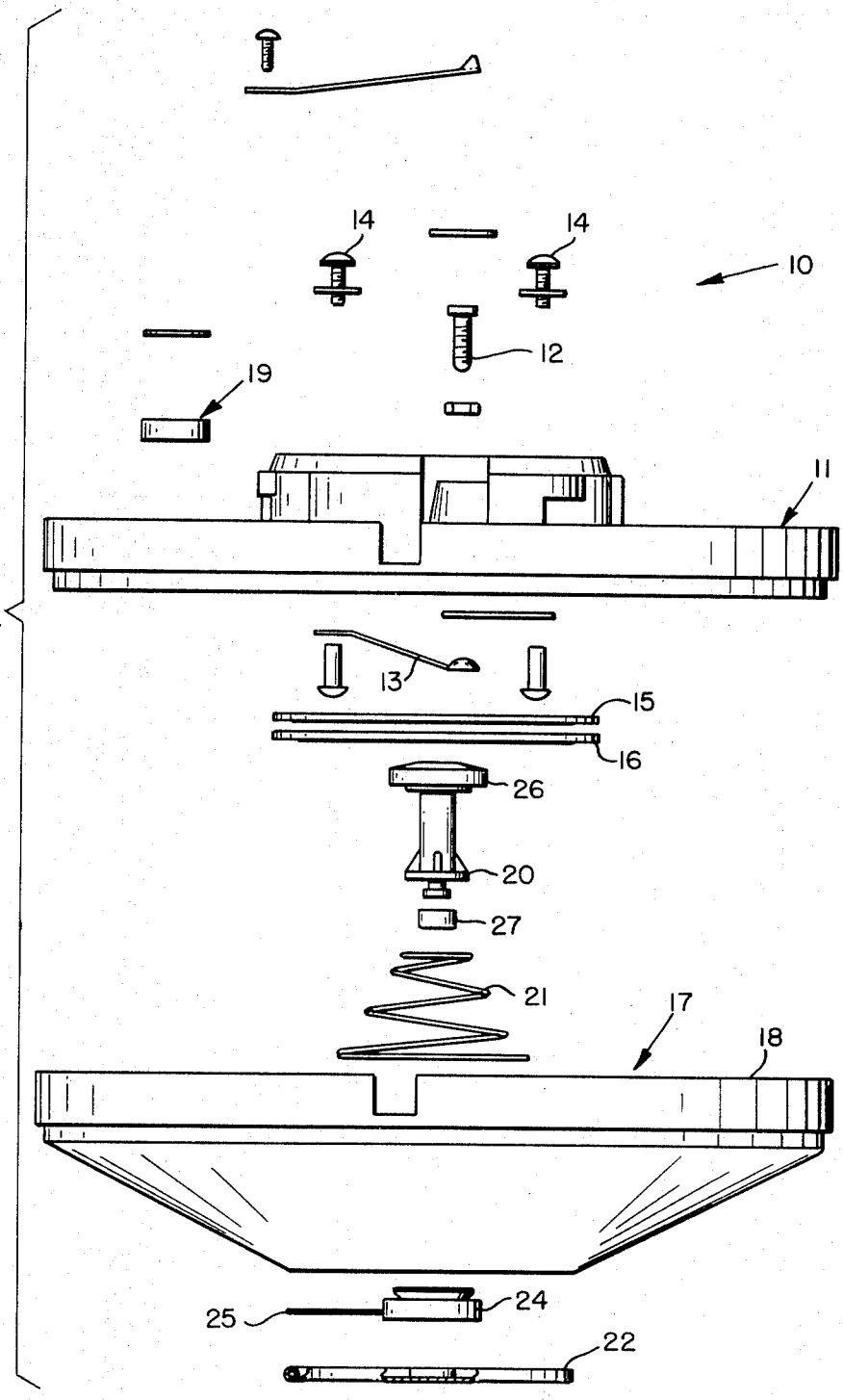


FIG. 1

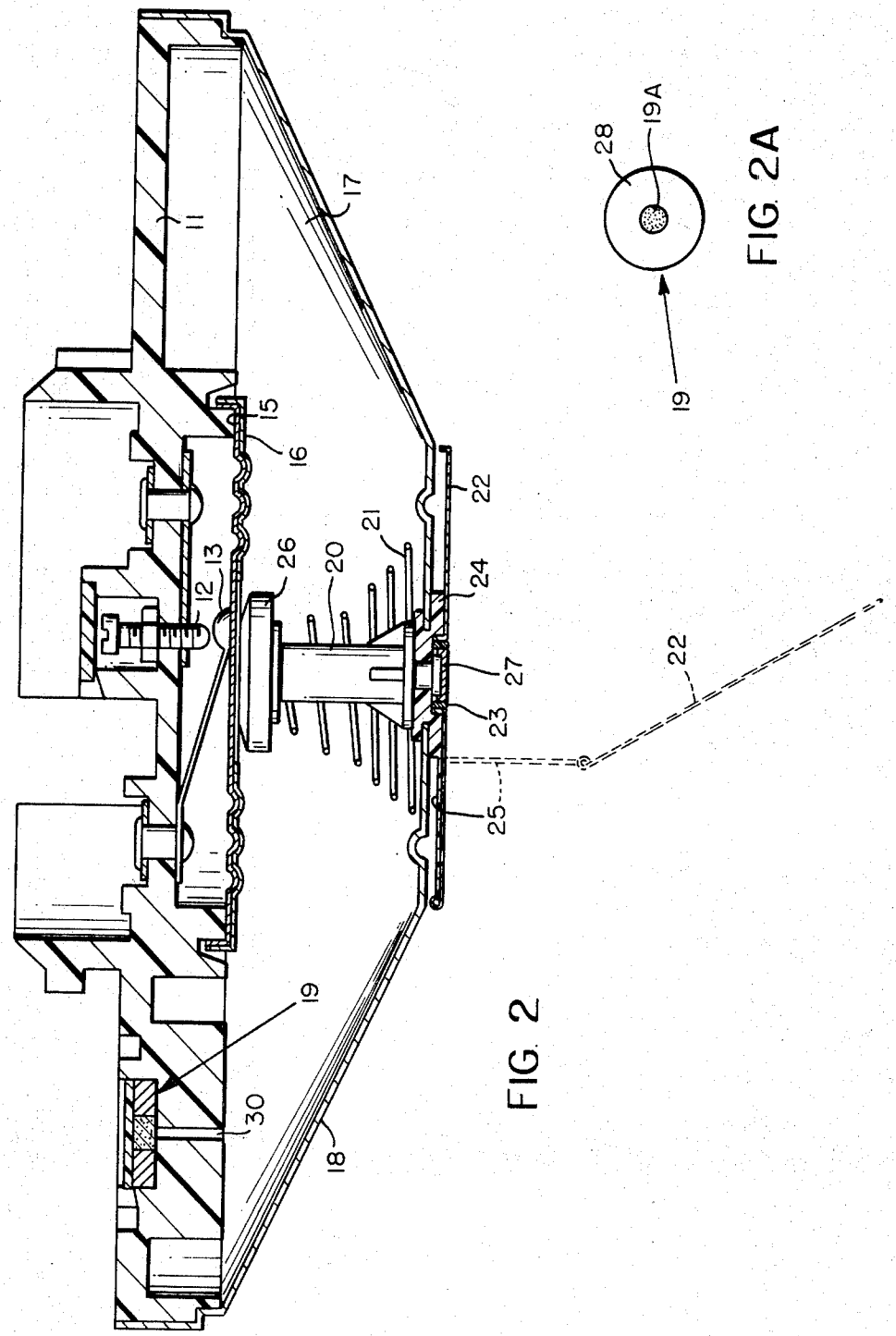


FIG. 2

FIG. 2A

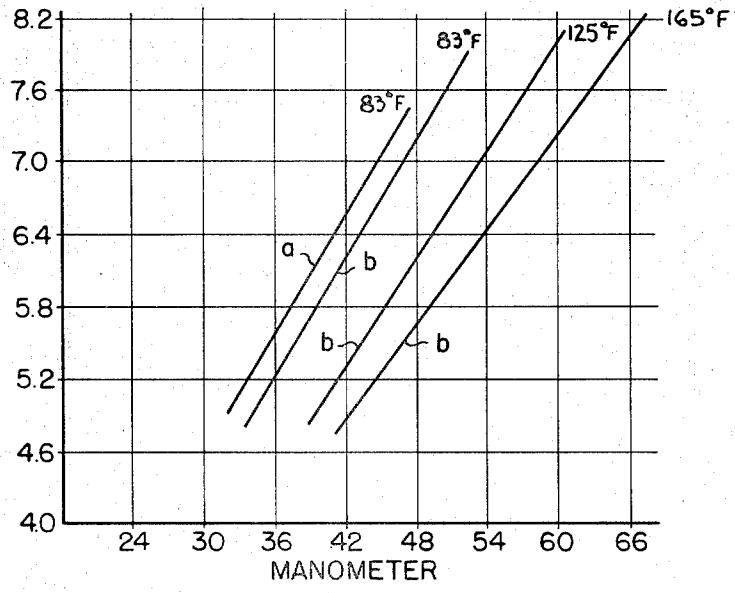


FIG. 3A

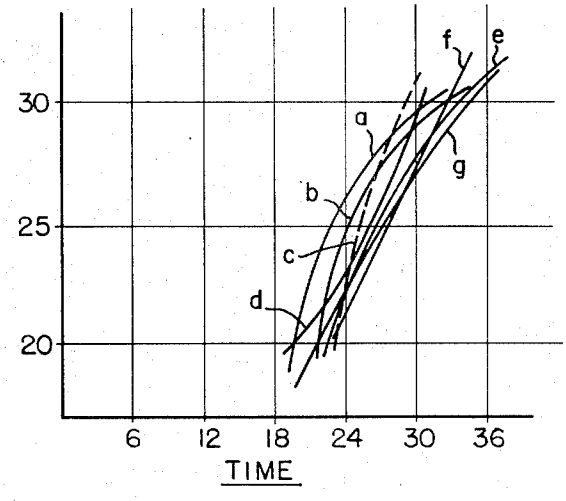


FIG. 3B

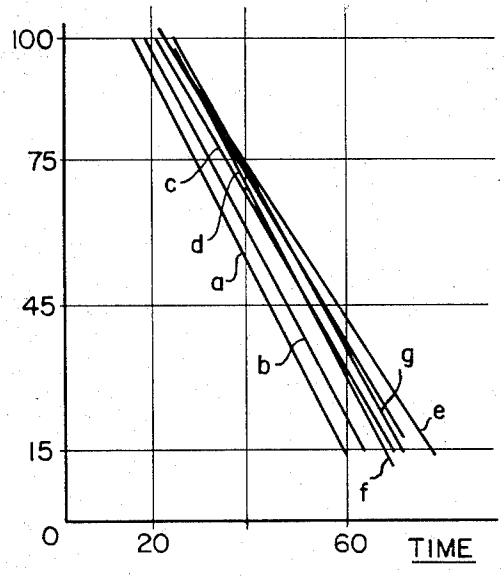


FIG. 3C

RATE OF RISE THERMAL DETECTOR

BACKGROUND OF INVENTION

This invention relates to pressure sensitive devices and in particular to devices having an air chamber one wall of which is a distensible diaphragm movable by increased pressure of expanded air within the chamber. The relaxed diaphragm is placed adjacent to a movable member of open switch contacts which are closed at a particular distortion level of diaphragm to activate an alarm signal. The chamber has a vent to allow the escape of expanding air, but the air flow through the vent is restricted so the air does not escape fast enough if the rate of rise of pressure exceeds a certain figure. The increase in pressure is occasioned generally by heat transferred to the device from a fire or other source of heat.

Generally, fire detectors of this sort or heat detectors must be capable of compensating for changes in atmospheric pressure occasioned by normal occurrences such as increased atmospheric pressure due to the weather; namely, ambient temperature and atmospheric density. The device must be vented and the vent calibrated to provide a certain leak rate at a specific pressure differential. Present practice is to provide an orifice or aperture between the chamber and a small cavity which is opened to the ambient atmosphere. The cavity is filled with a plastic foam material, in a manner that will allow it to be mechanically compressed into a smaller volume over the orifice thereby reducing the effective porosity of the material in restricting the air flow through the orifice filter. Some disadvantages of this technique are that the thermostatic device must be completely assembled or complex sealing arrangements must be provided before the vent can be calibrated. The calibration procedure is generally slow and expensive in terms of assembly time because the atmosphere within the chamber must stabilize before an accurate reading may be taken on the test. It may also be possible for calibration to change due to tampering with the device or over a long period of time due to "-cold flow" and setting characters of the plastic foam. It is possible also in some environments that the plastic material will, due to chemical attack and age, change its characteristics.

It is therefore an object of the present invention to provide an arrangement which substantially obviates one or more of the limitations and disadvantages of the described prior arrangement.

It is another object of the invention to provide an accurately pre-calibrated vent.

It is another object of the present invention to provide a vent which is practically impervious to all environments.

SUMMARY OF INVENTION

There has been provided a rate of rise thermal detector comprising a chamber for closing an atmosphere, and control apparatus associated with the chamber responsive to increases in the atmospheric pressure within the chamber occasioned by a relatively rapid rise in ambient temperature for producing a warning signal. An orifice covered by filter material is provided in a wall of the chamber for regulating the rate of equalization of the atmospheric pressure within the chamber. The filtering is accomplished by a vent valve

including a restrictor mounted in a wall of the chamber for permitting a selected calibrated slow rate of pressure change in accordance with ambient conditions including a body of compacted sintered metallic particles having a calibrated permeability to the atmosphere dependent upon the degree of compactness of the particles within a mounting ring which is in turn press fitted into a counterbore in a wall of the chamber, whereby calibration of the restrictor before assembly of the detector obviates need for calibration of the detector after assembly and the ring protects the porous metal during assembly.

For a better understanding of the present invention, together with other and further objects thereof, reference is had to the following description taken in connection with the accompanying drawings, while its scope will be pointed out in the appended claims.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded side view of the thermal detector of the present invention;

FIG. 2 is a side section elevation of the detector according to one embodiment of the present invention;

FIG. 2A is a detail front elevation of the filter used in the present invention;

FIGS. 3A, 3B and 3C illustrate the linearity of the filter of FIG. 2 according to certain operative parameters.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The thermal detector **10** shown in FIG. 1 includes a base member **11** with suitable means not shown for mounting the detector in an area to be supervised. Generally, detectors of the type shown in FIG. 1 have a two-fold purpose. Firstly, they are designed to react to a specific temperature level, that is, when the ambient of the area to be supervised reaches or exceeds a certain temperature, the device is automatically actuated by a temperature sensitive means and an alarm signal is produced. The second and more important for the purposes of this disclosure, is a rate of rise feature which provides if the temperature of the ambient increases at a rate faster than some specific predetermined rate, then the detector senses such a condition and similarly produces an alarm condition.

The construction of the detector **10** is now described with reference to FIG. 1 wherein contacts **12** and **13** are connected to respective wire terminals **14** through the base **11** and are positioned to be normally open. The contact **13** is a movable contact that is disposed opposite fixed contact point **12**, and is subject to actuation by pressure on a diaphragm **15** of flexible material. The diaphragm **15** is seated along a ring formed in the underside of the base plate **11** so as to be disposed adjacent to the contacts **12** and **13**. A suitable rigid shield **16** is preferably used over the diaphragm **15** to restrict the movement of the diaphragm away from contact **13** while permitting free movement toward the contact. By this means, diaphragm **15** is free to actuate the movable contact **13** either in response to a rise of air pressure within the thermal detector, or in response to the sensing of a fixed temperature at which the thermal detector is designed to be actuated.

The diaphragm **15** constitutes a portion of the wall of a substantially air tight chamber **17**, the outer housing **18** of which is metal to facilitate heating of the enclosed air in response to any temperature rise of the atmosphere in the room. This will in turn lead to heating of the air within the enclosure, with a consequent rise in the internal air pressure. The internal pressure is vented at a controlled rate by means of a vent valve comprising a filter **19** press fitted into a counterbore over a small opening **30** through base **11**. Whenever the rate of increase of internal pressure exceeds the rate of venting by a pre-determined amount, diaphragm **15** will move sufficiently to close the contact circuit. Any pressure differential resulting from slower changes in the ambient temperature, or from normal atmospheric pressure changes, will be equalized by leakage through filter **19**, detail structure and advantages of which will be hereinafter considered.

An actuating pin or plunger **20** is axially disposed opposite the contact finger **13** and has its lower end extending through the housing **18** and secured against the bias of a spring **21** to a metal heat collector disc **22** by low temperature solder **23**. The pin **20** is journalled by a suitable sealing grommet **24** which has a resilient tab **25** extending therefrom and connected to the outer periphery of heat collector disc **22**.

Operation of the thermal detector in response to a rise in temperature to a designed trigger level is accomplished by the melting of the low temperature solder **23** which releases the actuating pin **20** from collector disc **22**, allowing the pin to be biased by the spring **21** against the diaphragm **15**, and causing contacts **12** and **13** to close an electrical circuit for indication at a remote point that the thermal detector has been actuated. Upon the melting of the solder **23**, the heat collector disc **22** also drops away from its normal position and is suspended by the tab **25** as is shown by dotted lines in FIG. **2**. This clearly manifests to an observer in the room that the sensing means has been actuated and that a remote indication of the actuation should have been provided. It also serves to identify which one of a series of detectors has been triggered.

The pin **20** may be of plastic material with an enlarged operating head **26**. A metal cap **27** is secured to the lower end of the pin **20**, and the cap **27** is secured to the heat collector **22** by the low temperature solder **23** which fills an annular joint between cap **27** and a central opening in heat collector disc **22**. The heat collector disc **22** is biased by the spring **21** against the grommet **24** under normal conditions. Thus release of the plunger **20** to actuate the contact **13** is dependent upon the melting of the solder **23** to release actuating pin **20** from the heat collector disc **22**.

A detail examination of the filter or vent element **19** shows that it is constructed of an annular member **28** and a filter element **19A** disposed in the opening of the member **28**. The element **19A** is constructed of compressed particles of metallic substance with precision controlled porosity, so that leak rates are independent functions of the area and thickness of the filter element **19A** and of the pressure differential. The materials of which such a filter can be constructed include all grades of stainless steel, monel, nickel, inconel and many other types of alloys. The advantages of this technique in addition to precision pre-calibration of the leak rate are all of those that accrue to these metals over plastic foams in chemically and otherwise adverse atmospheres.

Additional advantages of this system can be observed by the examination of FIGS. **3A**, **3B** and **3C**. The graphs illustrate the stability of the filter element **19A** over a wide range of conditions at which this device must be operative. In particular, FIG. **3A** indicates in arbitrary units the linearity of flow rate of air through two sintered metal filters at 83°F. The graph is a plot of flow rate vs. pressure and it can be seen that filters a and b have substantially equal and linear flow rates over a specific range of pressures. Additionally, the flow rate of one of these devices b was checked at an ambient of 125°F and 165°F. The flow rates, while different from those at 83°F, are noted to be in a fail-safe direction, within practical limits, and still linear over a wide range of temperature variations. As the temperature increases, the flow rate decreases considerably, thereby providing likelihood of alarm as the ambient increases.

FIG. **3B** illustrates the range of contact gap settings required for a narrow range of filters. The gap setting is arbitrary units of diaphragm displacement in terms of air pressure (oil manometer). For each curve *a* through *f* a specific flow rate is illustrated ranging from approximately 1.85 to 2.2 cc per minute. The ordinate shows contact setting, and pressure, while the abscissa shows actuation time of the contacts. It can be seen from this set of curves that the variation is not substantial and within practical limits of operation of safety.

FIG. **3C** shows the resulting operating time on the abscissa of seven different detectors *a* through *f* at two heating rates; that is, 15°F per minute and 100°F per minute. The graph illustrates substantially equal time of actuation ranging from a 20 second differential at 15°F per minute to less than an 8 second differential at 100°F per minute. From this it can be seen, that as the rate of temperature rise increases, the time between the actuation of different units decreases which would be in a fail-safe or safety direction.

The practical observation from these curves and the previous discussion is that the system would tend to be less susceptible to environmental variations over long periods of time because a stable substance such as steel is utilized for the vent. In addition, pre-calibrated vent filters eliminate adjustment upon assembly providing an easily manufactured device which may be tested before assembly by randomly sampling the filter elements to be inserted in the detector.

While there has been shown what is at present considered to be the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is therefore aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A rate of rise thermal detector having an atmospheric chamber including a diaphragm for operating contacts to generate an alarm signal in response to an abnormal increase of atmospheric pressure within the chamber and having a vent valve for permitting relatively slow changes in the atmosphere within the

chamber to correspond with ambient atmospheric changes wherein the improvement comprises:

a. a base of plastic material supporting the contacts and the diaphragm forming one wall of the chamber including an integral vent valve having;
   1. a relatively small opening extending through the base for venting the chamber to atmosphere,
   2. a counterbore recessed into the base co-axial with the small opening,
   3. a restrictor comprising a mounting ring fitted into the counterbore having a core fitted into the ring, said core being of porous metal having precalibrated permeability relative to passage of atmosphere through the valve,
   4. the core being of a diameter greater than the diameter of the small opening, but substantially less than the diameter of the mounting ring,
b. whereby calibration of the restrictor before assembly of the detector obviates need for calibration of the detector after assembly and the ring protects the porous metal during assembly.

2. The thermal detector according to claim 1 wherein the permeability of the body decreases as the ambient temperature increases.

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