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TEMPERATURE CHANGE RESPONSIVE DEVICES

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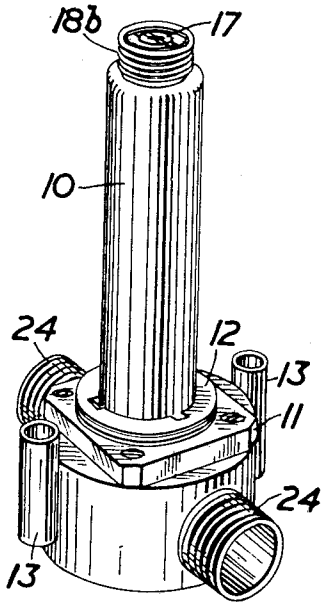


FIG. 1.

FIG. 2.

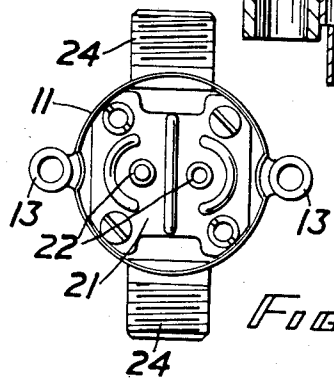


FIG. 3.

FIG. 4.

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TEMPERATURE CHANGE RESPONSIVE DEVICES

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10 Claims. (Cl. 200—137)

This invention relates to temperature detectors.

Although the invention is applicable to temperature detectors in general it is particularly applicable to temperature detectors for use in aircraft. Such detectors are commonly used in aircraft engine bays in order to indicate the existence of an excessive temperature due, for example, to a fire in the bay.

One form of temperature detector which is commonly used in aircraft operates on a differential thermal expansion principle and comprises a barrel of a metal having a high coefficient of thermal expansion in which is housed a spring bow assembly of a metal having a low coefficient of thermal expansion. The spring bow assembly comprises two bow springs whose ends are united and whose centres are bowed outwardly from one another, an electrical contact being mounted centrally on each bow spring. One end of the spring bow assembly is attached to the base of the detector to which one end of the barrel is also attached. The other end of the spring bow assembly is provided with a screw thread which engages a screw-threaded member secured to the free end of the barrel.

Under normal conditions the spring bow assembly is compressed by the barrel so that the centre portions of the bow springs are bowed outwardly from one another and thus the two electrical contacts are separated. The degree of compression can be varied by adjusting the threaded engagement between the spring bow assembly and the free end of the barrel.

When the detector is subjected to an elevated temperature the expansion of the barrel is greater than that of the spring bow assembly and the spring bows are no longer compressed to the same extent but are free to move towards one another due to their inherent resilience, thereby closing the electrical contacts. Thus, by adjustment of the degree of compression applied to the spring bow assembly by the barrel at room temperature it is possible to alter the elevated temperature at which closure of the electrical contacts occurs. The electrical contacts are normally arranged to operate an indicator, such as an electric lamp, in the pilot's cockpit to give an indication that the elevated temperature condition exists.

Such temperature detectors have proved very successful in use but with the development of more powerful engines, and in particular with the development of jet propulsion units, the possible permissible rates of rise of temperature in power plants has increased considerably. Under such conditions the existing temperature detectors are not always satisfactory. If the detector is submitted to a very rapid increase in temperature, for example due to the fact that it is mounted close to the combustion chambers of a jet propulsion unit, the barrel will be heated considerably before the heat has penetrated to the spring bow assembly so that there will be rapid expansion of the barrel and little or no expansion of the spring bow assembly. As a result the electrical contacts may be closed even though the actual temperature is less than that at which the switch is set to operate and the pilot will be under the impression that an excessive temperature condition is present. In a short time, however, the heat will penetrate to the spring bow assembly which will in turn expand, albeit to a more limited extent due to its lower coefficient of thermal expansion, and, assuming that the temperature is lower than that at which the switch is set to operate, this expansion will result in the contacts reverting to the open condition. As a result the fire warning given to the pilot will be cancelled. Such false fire warnings upon aircraft are extremely undesirable as, on the one hand, they may cause the pilot to mistrust the detector and thereby fail to take appropriate action when a fire or other elevated temperature condition actually exists, or, on the other hand, they may cause him to take the action appropriate to the existence of a fire or like condition when, in fact, no such condition exists.

The difficulty experienced with very rapid rises of temperature would not, of course, arise if it were possible to use a material for the spring bow assembly which had a substantially zero coefficient of thermal expansion over the necessary temperature range, and which, at the same time had the necessary resilient properties over the temperature range to give firm and positive opening and closing of the contacts However, at the present time it appears that no such material is commercially available.

The applicants have found a novel solution of the problem and according to the present invention there is provided a thermal detector comprising a first member having a relatively high coefficient of thermal expansion over a predetermined temperature range and a second member having a small or negligible coefficient of thermal expansion over said range, said members being so arranged that when the detector is subjected to an elevated temperature expansion of said first member causes a variation in the mechanical force applied to the other member, and wherein said second member comprises a main element having a very small or negligible coefficient of thermal expansion together with a resilient element urging said main element into a predetermined position, the engagement of said resilient element with said main element being such that thermal expansion of said resilient element has a negligible effect on the position of said main element.

The invention also provides a thermal detector comprising a first member having a substantial coefficient of thermal expansion over a predetermined temperature range, a second member having a small or negligible coefficient of thermal expansion over said range, said second member being fixed relative to said first member at two spaced points in such a manner that said second member is under stress below a predetermined temperature and said stress is reduced due to thermal expansion of said first member, and resilient means adapted to urge said second member into a predetermined position, said resilient means being so coupled to said second member that the position of said latter member is unaffected by thermal expansion of said resilient means.

The invention further provides a thermal detector comprising an elongated member having a substantial coefficient of thermal expansion over a predetermined temperature range, a second elongated member fixed relative to said first member at two spaced points thereon, said second member comprising a continuous element extending at least between said two points and bowed at low temperatures in said range, said element being made of a material of low or negligible coefficient of thermal expansion over said temperature range, and one or more resilient elements which do not extend continuously between said two points, the arrangement being such that with increasing temperatures said resilient element or elements tend to straighten said continuous element as differential expansion occurs between the two elongated members.

One construction of temperature detector according to

the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a perspective view of the detector;

Figure 2 is a sectional side elevation of the detector on an enlarged scale;

Figure 3 is an underside view of the detector, and

Figure 4 is a fragmentary view of a part of the spring bow assembly seen in the direction of the arrow IV in Figure 2.

The temperature detector shown in the drawings is designed on a similar principle to the existing temperature detector described above, but the spring bow assembly is entirely novel and the actual construction also differs in details.

The temperature detector comprises an alloy steel barrel **10** having a high coefficient of thermal expansion secured to a steel case **11** by means of a nut **12**, the steel case **11** being provided with two lugs **13** adapted to accommodate bolts (not shown) for the mounting of the detector. Mounted within the barrel **10** is a spring bow assembly comprising two composite bow springs **14** which will be described in detail below. At one end the two bow springs **14** are secured in a fixed carrier **15** which is slidably mounted in a spigot **11***a* formed in the case **11**, whilst at the other end the two bow springs **14** are secured in an adjustable carrier **16**. The adjustable carrier **16** has a threaded stud **16***a* which engages with the internal screw thread of a cylindrical adjusting member **17** which is also provided with an external thread. The barrel **10** is closed at its free end by an end plug **18** which has a centrally threaded hole engaging the external thread on the adjusting member **17**. The lower portion of the end plug **18** has two fingers **18***a* which engage diametrically opposed slots **16***b* formed in the adjustable carrier **16** which is thus free to move in a direction parallel to the axis of the barrel, the fingers **18***a* serving to prevent rotation of the adjustable carrier **16**. It will be understood that the pitch of the respective threads of the adjusting member **17** are chosen to be slightly different so that by rotation of the adjusting member **17**, it is possible to obtain a fine variation in the degree of compression of the spring bow assembly by the barrel **10** and thus a fine adjustment of the temperature at which closure of contacts **19** will occur. The adjustable member **17** is locked in position to which it is set by means of a locking screw **20**.

After locking of the adjusting member **17** the end of the detector may be closed by an end cap (not shown) which engages an external screw thread **18***b* formed on the end plug **18**, the end cap subsequently being locked in position by spinning. A washer (not shown) may be provided between the top surface of the end plug **18** and the end cap to prevent ingress of dirt. The case **11** carries a terminal block **21** of insulating material having connecting studs **22** mounted therein and connected to the electrical contacts **19** by fire resisting connecting wires **23**. Cables entries **24** are provided on opposite sides of the case **11** for the passage of cables to the connecting studs **22**. The base of the case may be closed by a cap (not shown).

Referring now in greater detail to the bow springs **14**, each of these is a composite member comprising a continuous metal strip **14***a* of very low coefficient of thermal expansion which extends throughout the length of the bow spring assembly. In practice it is necessary for the bow springs to be considerably bowed at normal low temperatures, when closure of the contacts is not required until high temperatures of the order of 400°–500° C. As stated above, no material is known to be available commercially which meets both the requirement of very low coefficient of expansion and at the same time has the required resilience over a wide temperature range. To impart the necessary resilience to the assembly two cantilever leaf springs **14***b* are mounted on the outside,

or convex surface, of each continuous strip **14***a* adjacent each end portion thereof. Moreover a further leaf spring **14***c* is provided adjacent the central portion of the continuous strip **14***a* and on the inside, or concave surface, thereof, this central leaf spring **14***c* extending sufficiently far towards each end so as to overlap the free ends of the cantilever springs **14***b*. The ends of the central spring are provided with side lugs **14***d* which are turned up to straddle the strip **14***a* and the adjacent leaf spring **14***c* to locate the central springs relative to the continuous strip **14***a*. Location of the central springs **14***c* is also provided by the associated contact **19** and its mica insulation. In an alternative construction (not shown) instead of the lugs **14***d* dimples are raised in the continuous strip **14***a* which engage notches in the ends of the springs **14***b* and **14***c* to afford the necessary location.

It will be appreciated that as the spring members **14***b* and **14***c* are not continuous their thermal expansion will not affect the operation of the detector, and the extent to which variations in operating temperature occur as a result of rapid rises of temperature will depend upon the coefficient of expansion of the continuous strips. As the material for these latter may now be chosen without regard to resilient properties it is possible to use a metal having a much lower mean coefficient of thermal expansion than was possible when the bows were required to have resilient properties, so that the likelihood of false operation is very substantially reduced.

It may be stated, by way of example only, that a suitable material for the continuous strips is that sold by Messrs. Henry Wiggins and Co. under the name "Nilo K," which is understood to be a nickel-cobalt-iron alloy which has a very low mean coefficient of thermal expansion over a range of temperatures from room temperature to 450° C. Over the more limited range of temperatures from room temperature to 300° C., the material sold by the same company under the name "Nilo 36" has a lower mean coefficient of thermal expansion than "Nilo K." For the spring elements suitable materials are nickel-chromium-base alloys, sold by that company under the names "Nimonic 80" and "Nimonic 90" which have resilient properties up to temperatures of the order of 450° C.

A further advantage of the use of spring bow assemblies according to the invention is that due to their composite form they may be made of relatively light construction, for example thin and narrow, the spring portions ensuring adequate pressure for satisfactory contact closure. This has the further result that less compressive force is required to maintain the contacts open so that the barrel may also be of lighter construction, whereby the reduced thermal capacity results in an increased rapidity of response of the detector to temperature changes.

Whilst the embodiment shown utilises two opposed composite spring bows, it will be understood that the invention is not limited to such temperature detectors but may, for example, be applied to detectors utilising a single composite spring bow co-operating with a fixed contact. Moreover, as an alternative to electrical operation, movement of the spring bows may be arranged to effect a mechanical operation for performing a desired function.

Whilst particular reference has been made to the use of such temperature detectors for fire warning devices on aircraft, it will be appreciated that the detectors may be used for domestic or industrial purposes, for example, to operate as thermostats.

What we claim is:

1. A thermal detector comprising in combination a supporting base for said detector, a tubular metallic member, said tubular member being fixed at one end to said base and being composed of a material having a substantial coefficient of thermal expansion over a predetermined temperature range, an elongated metallic strip, said strip being secured at one end to said base and being secured at the other end to that end of the tubular member which is remote from said base, the distance between the two

points at which the strip is secured being less below a predetermined elevated temperature within said range than the length of said strip whereby said strip is bowed below said predetermined temperature, and said strip being composed of a material having a coefficient of thermal expansion over said temperature range which is negligible by comparison with the coefficient of thermal expansion of said tubular member, means for adjusting the relative position of the adjacent ends of said tubular member and said strip to vary the extent of bowing of said strip, two leaf springs each secured adjacent one end of said strip in contact with the convex surface of said strip, and a third leaf spring secured adjacent the middle of said strip in contact with the concave surface of said strip whereby said strip is urged towards a straightened condition by the three leaf springs.

2. A thermal detector comprising in combination a supporting base for said detector, a tubular metallic member, said tubular member being fixed at one end to said base and being composed of a material having a substantial coefficient of thermal expansion over a predetermined temperature range, two elongated metallic strips secured together at one end to said base and secured together at the other end to that end of the tubular member which is remote from said base, the distance between the securing points on the base and the end of the tubular member respectively being less at temperatures below a predetermined elevated temperature within said range than the length of said strips and the central portions of said strips being bowed apart from one another in opposite directions, said strips being composed of a material having a coefficient of thermal expansion over said temperature range which is negligible by comparison with the coefficient of thermal expansion of said tubular member, means for adjusting the relative position of the adjacent ends of said tubular member and said strips to vary the separation between the central portion of said strips, two electric contacts each mounted on the central portion of one of said strips, four leaf springs each secured adjacent one end of one of said strips respectively in contact with the convex surface of the strip, and two further leaf springs each secured adjacent the central portion of one of said strips in contact with the concave surface of the strip, the leaf springs serving to urge said contacts towards one another as differential expansion between said tubular member and said strips permits unbowing of the latter.

3. A thermal detector according to claim 2 in which said temperature range is from room temperature to 300° C.

4. A thermal detector according to claim 2 in which said temperature range is from room temperature to 450° C.

5. A thermal detector comprising in combination a supporting base for said detector, a tubular metallic member, said tubular member being fixed at one end to said base and being composed of a material having a substantial coefficient of thermal expansion over a predetermined temperature range, an adjustable member fixed in that end of said tubular member which is remote from said base and movable towards and away from said base, two elongated metallic strips each secured at one end to said base and at the other end to said adjustable member, said adjustable member being movable to a position at which said strips are bowed apart at their central portions when said detector is at temperatures below a predetermined elevated temperature within said range, said strips being composed of a material having a coefficient of thermal expansion over said temperature range which is negligible by comparison with the coefficient of thermal expansion of said tubular member, two electric contacts each mounted on the central portion of one of said strips, two electric terminals insulatingly mounted in said base, electrical connections between each of said contacts and one of said terminals respectively, four leaf springs each secured adjacent one end of one of said strips respectively in contact with the convex surface of the strip, and two further leaf springs each secured adjacent the central portion of one of said strips in contact with the concave surface of the strip, the leaf springs serving to urge said contacts towards one another as differential expansion between said tubular member and said strips permits unbowing of the latter.

6. A thermal detector comprising in combination a base for said detector, a tubular metallic member, said tubular member being fixed at one end to said base and being composed of a material having a substantial coefficient of thermal expansion over a predetermined temperature range, an elongated metallic strip extending through the interior of said tubular member, one end of said strip being fixed relative to said tubular member, abutment means secured to said tubular member, said abutment means being adapted to engage the other end of said metallic strip over a portion of said predetermined temperature range, said strip being composed of a material having a coefficient of thermal expansion over said temperature range which is negligible by comparison with the coefficient of thermal expansion of said tubular member, means for adjusting the fixing of said one end of said strip relative to said tubular member, two leaf springs each secured adjacent one end of said strip in sliding contact with one surface of said strip, and a third leaf spring positioned adjacent the middle of said strip in contact with the other surface of said strip whereby said strip is urged towards a predetermined shape by the three leaf springs.

7. A thermal detector comprising in combination a first metallic member, said first member having a substantial coefficient of thermal expansion over a predetermined temperature range, a second metallic member, said second member having a coefficient of thermal expansion over said range which is negligible by comparison with the coefficient of thermal expansion of said tubular member, an abutment member fixed relative to said first member, abutment engaging means secured to one end of said second member and adapted to engage said abutment member to limit in one direction only movements of said second member relative to said first member which are caused by temperature changes, the other end of said second member being fixed relative to said first member, said second member being curved between its two ends, and resilient means freely engaging said second member along a portion of the latter which lies intermediate its ends, said free engagement of said resilient means and said second member permitting relative movement between said resilient means and said second member caused by thermal expansion of said resilient means.

8. A thermal detector according to claim 7, in which said resilient means comprises a leaf spring positioned adjacent the middle of said second member in sliding contact with one surface of said second member, said resilient means being adapted to oppose variations in the curvature of said second member caused by differential thermal expansion between said first and second members.

9. A thermal detector according to claim 8, in which said resilient means further comprises two leaf springs each secured adjacent one end of said strip in sliding contact with one surface of said strip.

10. A thermal detector comprising in combination an elongated metallic member, said elongated member having a substantial coefficient of thermal expansion over a predetermined temperature range, a second elongated metallic member having one end fixed relative to said first member, a stop member fixed to said first member and adapted to engage the other end of said second member over a predetermined portion of said temperature range, said second member comprising a continuous bowed element which is composed of a material having a very low coefficient of thermal expansion over said temperature range, relative expansion of said first member with respect to said bowed element due to changes in

temperature over said predetermined portion of the temperature range resulting in the application of a varying force to said second member which produces corresponding variations in the curvature of said bowed element, said second member also comprising at least one resilient element engaging said continuous element at a position intermediate its ends, said resilient element being adapted to oppose changes in the curvature of said bowed element resulting from variations in said force, said resilient element being free to move relative to said continuous element to allow for differential thermal expansion between said resilient element and said continuous element.

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