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MECHANICAL BOLOMETER

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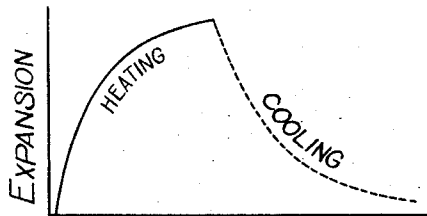
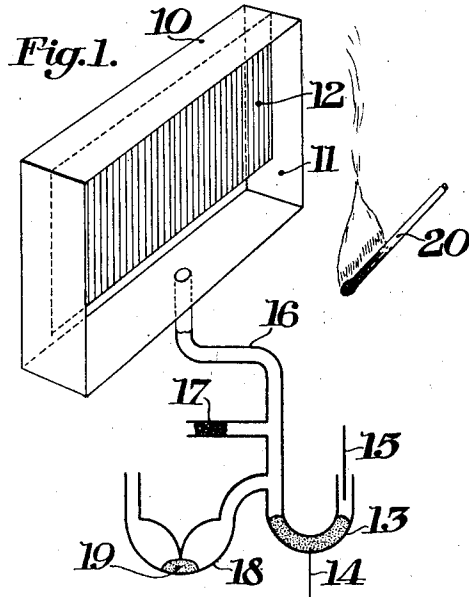
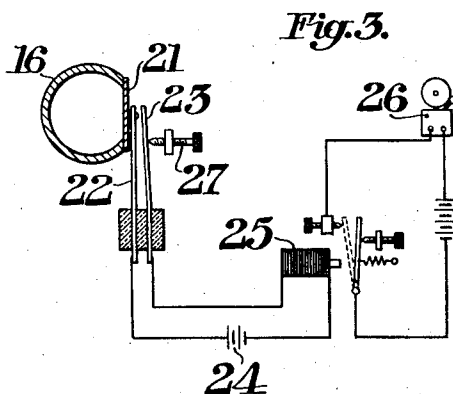
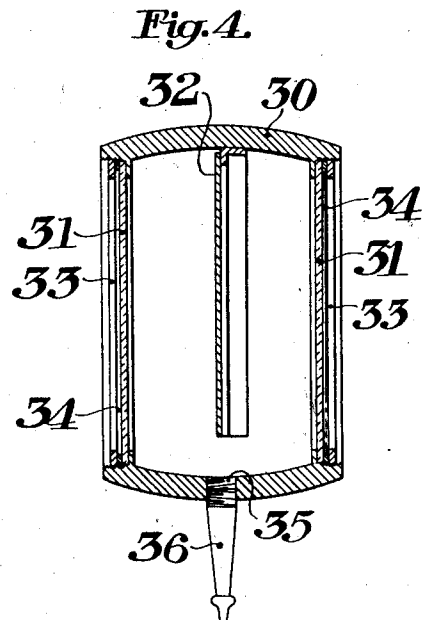
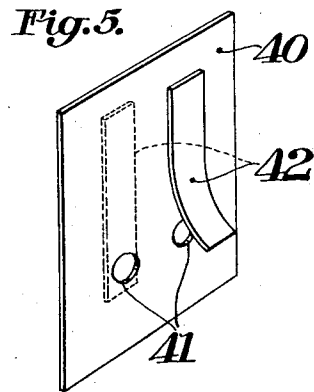


Fig. 2.



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MECHANICAL BOLOMETER

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2 Claims. (Cl. 297—3)

My present invention relates to radiation sensitive devices for translating radiant energy into mechanical energy and more particularly to devices, the operation of which utilize the expansion of a gas occurring when the temperature of the gas is increased. Such devices are designated as mechanical bolometers since their action depends upon a pressure change in a gas when its temperature is varied.

It has long been known that a colored gas expands on illumination owing to the heat generated by the absorption of light within the molecules of the gas. Obviously such a gas may be confined and the pressure developed by expansion employed to do work. A black gas would be ideal for an instrument embodying this principle, but unfortunately such a gas is unknown at present and the colored gases such as iodine vapor, bromine vapor, nitrogen dioxide, etc., are all intensely corrosive and it is extremely difficult to construct a mechanical apparatus with containers capable of holding these corrosive gases permanently.

It occurred to me that a thin heat absorbing diaphragm placed in a closed vessel would absorb heat rays almost completely and might warm the gas in contact with its surface very rapidly to give an expansion impulse capable of operating some external device. Experiments proved this to be true.

One object of my invention is to provide a gas filled vessel in which a small change in pressure corresponding to a given change in temperature of the gas will operate to close an electrical contact.

Another object of my invention is to produce a radiation sensitive device, the operating characteristics of which do not change with a gradual growth of radiation of any kind nor with a gradual change in the temperature of the gas enclosed in the device.

A further object of my invention is to provide a device which is extremely sensitive to such changes in the amount of radiation falling upon it such as might be caused by the outbreak of a fire in the immediate vicinity of the device.

Further objects of my invention will become apparent upon the reading of the following description taken in connection with the accompanying drawing in which:

Fig. 1 is a schematic showing, partially perspective, of the principal features of my invention;

Fig. 2 is a graphical illustration of the rate of expansion of a gas;

Fig. 3 is a detail of one form of a pressure operated contact and a circuit controlled thereby;

Fig. 4 is a side elevation in section of a preferred form of a gas envelop; and,

Fig. 5 is a perspective view of a two-way flap valve which may replace the bubbler of Fig. 1.

The general principles of my invention will be readily understood by reference to Fig. 1 in which the reference numeral 10 designates a flat container having at least one transparent side 11. Mounted within the container 10 is a heat absorbing diaphragm 12 which may consist of thin metal foil, suitably blackened; a cellulose ester containing a heat absorbing pigment (finely divided silver, silver sulphide, lead sulphide, etc.); or a thin sheet of gelatine containing a black photographic deposit. The vessel 10 may contain any gas, although for obvious reasons ordinary air is most convenient and will give quite satisfactory results.

A mercurial U-tube 13 having contacts 14 and 15 is in communication with the vessel 10 through a connecting tube 16 so that an increase in pressure of the gas in the vessel 10 will affect the level of the mercury and close the contacts 14 and 15. In order that the level of the mercury will not be affected by changes in barometric pressure, I attach a breather 17 to the vessel 10 or somewhere between the vessel 10 and the mercury which allows minute quantities of the gas to pass in either direction in response to changes of conditions without the passage being sufficient to prevent the mercury being affected by a rapid expansion of the gas. The breather 17 may conveniently comprise a small wad of cotton or other material which will allow only a gradual passage of gas therethrough. The same compensation could be obtained by placing the open limb of the U-tube 13 in communication with a closed chamber subjected at all times to the same conditions which affect the vessel 10. The breather 17 may be supplemented by a small bubbler 18 containing a drop 19 of non-volatile liquid; the function of the bubbler 18 will be described below.

With the apparatus of Fig. 1 in stable condition, i. e., the pressure of the gas in the vessel 10 is equal to the pressure on the open limb of the U-tube 13, the contacts 14 and 15 are open. If the diaphragm 12 is suddenly exposed to radiation from any source 20, it absorbs heat and raises the temperature of the gas enclosed in the container 10. The consequent expansion of the gas occurs with maximum rapidity the moment the radiation is received and gradually dies down until the amount of expansion is in equilibrium

with the reception of radiation. This expansion may be represented by a curve of the general form of the solid path shown in Fig. 2. If the source 20 of radiation is now withdrawn, the contraction curve during cooling is of the same general form but of reversed shape being the steepest at the beginning of the cooling as shown by the broken line in Fig. 2. The time taken for the complete cycle of heating and cooling is appreciable, being from five to ten seconds for apparatus of robust commercial utility. However, the first response either to heating or cooling is practically instantaneous; a powerful indication being available a fraction of a second after the application or withdrawal of heat rays.

The operation of the apparatus shown in Fig. 1 is as follows: At the moment radiation is received by the diaphragm 12 the gas in the vessel 10 experiences its most rapid expansion and the increased pressure forces the drop 19 to the left and moves the mercury into contact with the wire 15. The movement of the mercury is limited, because any further expansion of the gas is released by the gas passing through the bubbler 18.

This continues until no further expansion takes place after which, in the absence of the breather 17 and in the temporary absence of external temperature and pressure fluctuation, the mercury maintains contact with the wire 15. The moment the radiant energy is withdrawn from the diaphragm 12, the mercury recedes from the contact 15 and the liquid drop 19 is forced to the right. Air is now drawn in through the bubbler 18 until equilibrium is established.

It will be seen from the above that the bubbler 18 enables utilization to be made of the steepest portion of the expansion and contraction curves and in addition permits automatic accommodation after each operation to external pressure changes. Since the device operates on the initial expansion, it will perform when exposed to radiation of an intensity sufficient only to force one bubble of gas through the bubbler 18 and it will respond equally well to a source of radiation which expels a considerable quantity of gas.

In actual practice, the mercury in the U-tube 13 may be replaced by a conducting salt solution of less weight or the entire U-tube may be replaced by a flexible diaphragm as will be described in connection with Fig. 3. In Fig. 3 a flexible diaphragm 21 which may be of thin rubber is secured, by cementing or otherwise, over an opening in the tube 16 so as to be exposed to the pressure present in the container 10. An increase in pressure in the system causes the diaphragm to bulge outwardly. Two finger contacts 22 and 23 are positioned to be pressed together by such bulging of the diaphragm 21. The closing of the contacts 22 and 23 may be utilized to control any suitable circuit in a manner well known in the art. By way of example, the contacts 22 and 23 may close in a circuit through a battery 24 and a relay winding 25 to control the closing of an alarm circuit to sound a bell 26. The sensitiveness of the device may be adjusted by means of a set screw 27 which is adapted to vary the gap between the contacts 22 and 23 when in open circuit position.

A preferred form of the gas filled envelop is shown in Fig. 4 as comprising a container 30 provided with two transparent sides 31 and a centrally positioned heat absorbing diaphragm 32. The transparent sides 31 may be of glass and are secured in place in any suitable manner as by threaded rings 33 adapted to screw into threaded

openings in the vessel 30. The whole is rendered air tight by packing material 34 or in any other well known manner. The diaphragm 32 by not extending entirely across the vessel 30 leaves a communication path for the gas to pass freely from one side of the diaphragm 32 to the other. An outlet port 35, threaded to receive a tube 36 to which the tube 16 of the apparatus shown in Fig. 1 may be attached, is provided in the wall of the vessel 30 and preferably is located adjacent to the communication passageway left open by the diaphragm 32. The casing 30 is preferably made of some material which is a poor conductor of heat such as bakelite or similar moldable compounds.

The bubbler 18 above described may be replaced by a two-way flap valve, see Fig. 5, comprising a plate 40 provided with two small openings 41 and two oppositely mounted flap members 42 which may be moistened with a non-volatile liquid to render their action most effective. The flaps 42 are so constructed that the pressure necessary to operate them is sufficient to bring about closing of the contacts 14 and 15 or 22 and 23.

To understand clearly the operation of the apparatus of my invention it is necessary to appreciate the very essential difference between a mere breather and the bubbling device. The bubbling device imposes a pressure resistance in either direction and it is only when this pressure has been overcome that the gas is free to pass either way. When the passage of the gas has reduced the pressure to the particular value corresponding to the above unit pressure, no further passage occurs and the apparatus remains stimulated in one direction until the stimulus is withdrawn. The breather on the other hand permits the apparatus to come to a standstill at neutrality after a relatively long period, as from 5 to 10 seconds.

The apparatus embodied in my invention is suitable for various uses and particularly may be used as a fire alarm for film vaults and other places where it is imperative that the first appearance of heat radiation be detected. It is to be noted that the apparatus is entirely independent of the gradual growth of radiation of any kind and therefore not affected by daylight or the gradual heating or cooling of rooms. However, it is immediately responsive to sudden fires and I have constructed experimental models which operate upon the striking of a match at a distance of six feet.

Other uses for my apparatus will readily occur to those skilled in this art, among which the following suggest themselves: Operating garage doors by headlights, operating street lights, railroad signals and other monitoring devices where a comparatively powerful beam containing heat rays can approach the device relatively closely.

Although I have described only specific devices embodying my invention, it is to be understood that I do not limit myself thereto, as the principles described are susceptible of many modifications without departing from the spirit of my invention as set forth in the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:—

1. In combination with a pressure responsive device, a casing containing a confined gas, means for varying the temperature of the confined gas in accordance with the intensity of radiation incident thereon, means for compensating for gradual variations in the volume of the gas to main-

tain its pressure constant, and means for applying a predetermined pressure to said device upon a sudden variation in the volume of said gas.

2. A radiation sensitive device comprising a
5 partly transparent casing, a gas confined within the casing, means within said casing and in contact with the gas for translating radiation incident thereon into heat, pressure responsive means connected to the said casing, a restricted open-

ing connecting said casing to the surrounding atmosphere whereby gradual variations in the volume of the gas do not result in pressure differences between the gas in said casing and the surrounding atmosphere, and means for limiting
5 to a predetermined value the pressure difference applied to the pressure responsive means upon sudden variations in the volume of said gas.

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