July 31, 1951 W. H. CARTER, JR 2,562,770

THERMAL RECEIVER AND METHOD FOR PRODUCING SAME

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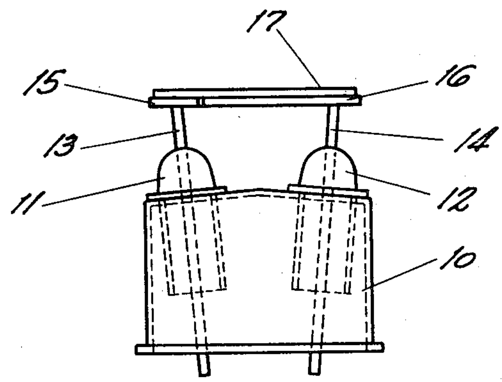

FIG. 1.

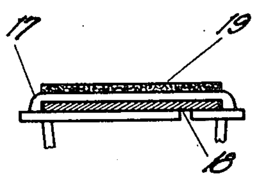

FIG. 3.

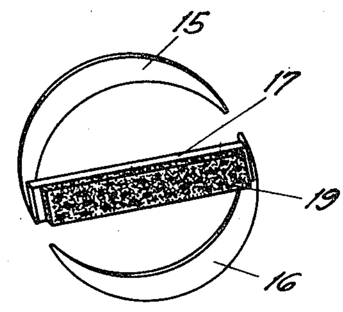

FIG. 2.

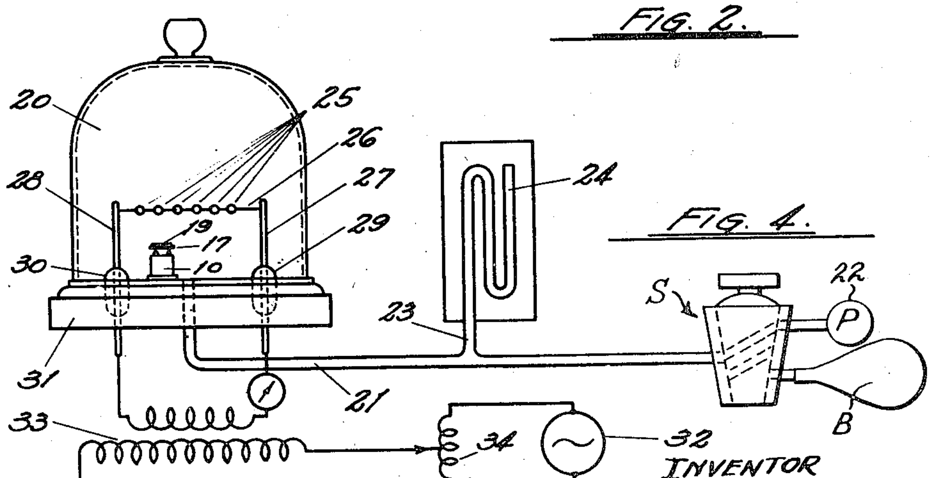

FIG. 4.

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THERMAL RECEIVER AND METHOD FOR PRODUCING SAME

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8 Claims. (Cl. 201—63)

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This invention relates to improvements in devices for detecting or measuring infrared radiant energy. It relates particularly to improvements in methods of blackening the heat-receivers of bolometers and thermocouples to render them more sensitive to infrared radiations and to improvements in such heat-receivers.

It has been common to provide the heat-receiving surfaces or strips of bolometers and thermocouples with blackened surfaces to increase their ability to absorb radiant energy. Zinc oxide, aluminum oxide, and other black materials have been used for this purpose. Some of these materials have been deposited on the heat-receiving elements by evaporation and condensation under moderately low air or other gas pressure.

None of the materials used heretofore is really black, that is, they are not highly absorbent of radiant energy having a wave length in the vicinity of ten microns, and, therefore, thermocouples or bolometers treated with these materials have not been as sensitive as might be desired.

An object of the present invention is to provide heat-receiving elements for thermocouples and bolometers having increased sensitivity.

Another object of the invention is to provide methods of blackening the heat-receiving elements of thermocouples and bolometers to increase the sensitivity of such thermocouples and bolometers.

A further object is to provide controllable methods of blackening the heat-receiving elements of thermocouples and bolometers whereby the deposited blackening agent may be rendered conductive or non-conductive, as desired.

Other objects of the invention and the advantages of the invention will become apparent from the following disclosures of typical methods and articles embodying the present invention.

I have discovered that gold, when properly deposited on the strip that forms the heat-receiver of a bolometer or on the hot junction portion of a thermocouple, forms an absorbent for infrared radiations that is superior to any of the blackening materials heretofore used.

I have discovered, moreover, that by controlling the conditions under which the black gold is deposited, it is possible to control the electrical conductivity of the deposit, thereby permitting its use on either electrically conductive or nonconductive heat-receivers for thermocouples and bolometers.

In accordance with the present invention, metallic gold is evaporated in the presence of an

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inert or inactive gas at low pressure and at least a portion of the gold vapor is condensed on the heat-receiving element of the thermocouple or bolometer. The condensed gold forms a velvety black deposit having extremely low reflecting power, and it may be rendered either electrically conductive or non-conductive, depending largely upon the pressure of the gas during deposition.

More particularly, the gold may be evaporated by heating it in a vacuum chamber which has been substantially completely evacuated and then adjusted to a suitable reduced pressure by admitting an inactive or inert gas, such as nitrogen, helium, argon or neon into the chamber.

As indicated above, the pressure of the gas in the vacuum chamber controls the electrical conductivity of the deposit. Thus, if the gas pressure in the chamber is maintained between about 2 mm. and 12 mm. of mercury, the deposit is substantially electrically nonconductive. Such nonconductive deposits are entirely suitable for use on heat-receivers formed of electrically conductive metal such as gold, bismuth, platinum or the like.

If the pressure in the vacuum chamber is reduced to not more than about 0.5 mm. of mercury, the deposit of black gold is rendered electrically conductive. Such conductive deposits may be formed on an electrically nonconductive strip such as, for example, a tape formed of cellulosic material such as cellulose nitrate.

For a better understanding of the present invention, reference may be had to the accompanying drawings in which:

Figure 1 is a view in side elevation of a typical form of bolometer having a heat-receiving element which may be blackened in accordance with the present invention;

Figure 2 is a perspective view of the electrodes and the heat-receiving strip of the bolometer;

Figure 3 is a view in side elevation of the electrodes of the bolometers with the thickness of the heat-receiving strip, the film of blackened material, and a nonconductive strip exaggerated in thickness in order to better illustrate the invention; and

Figure 4 is a diagrammatic view of a typical form of apparatus for practicing the method of the present invention.

The invention will be described with reference to its use in the blackening of a conventional bolometer. It will be understood that the invention is applicable to other forms of bolometers, to thermocouples, or other devices for detecting radiant energy in the infrared range.

The bolometer illustrated in Figures 1 to 3 may include a base member 10 which supports a pair of insulating beads 11 and 12, which carry the conductors 13 and 14, respectively. The conductors 13 and 14 are provided with a pair of spaced apart, crescent-shaped electrodes 15 and 16, respectively, which are arranged in end to end relation, as shown in Figure 2.

The electrodes 15 and 16 are connected by means of metal strip 17, formed of gold, platinum, bismuth, or the like, which forms the heat-receiving strip of the bolometer. As shown in Figure 3, the heat-receiving strip 17 may be provided with a backing strip 18 formed of cellulose nitrate, for example, and is provided on its upper surface with a coating or film 19 of black gold, which is formed in the manner described hereinafter.

In order to deposit the film 19 of black gold on the surface of the strip 17, the bolometer may be placed in a vacuum chamber (Figure 4), such as the bell jar 20, which has a connection 21 leading to a vacuum pump 22 and a branch connection 23 connected to a pressure gauge 24. The gold to be deposited on the heat-receiving strip 17 is fused in a series of droplets 25 on a tungsten wire or filament 26, which is connected at its opposite ends to the posts 27 and 28 formed of brass or other conductive material.

Posts 27 and 28 are mounted in insulators 29 and 30 sealed in the base 31 of the bell jar, and are connected with a source of electrical energy. The source of electrical energy may be a battery or, as illustrated, an alternating current generator 32, which is connected through a transformer 33 to the posts 27 and 28. A rheostat 34 or a variable ratio transformer is connected between the generator and the transformer 33 in order to regulate the current supply to the filament 26.

In operation, the bell jar 20 is evacuated by means of the pump to a pressure of about 0.05 mm. of mercury or less. A dry, inert or inactive gas, such as nitrogen, helium, argon or neon is then admitted into the bell jar until a desired pressure is obtained. The gas may be supplied from a conventional rubber bladder B, for example, and its admittance may be controlled by means of a conventional two-way stop-cock S as shown. A suitable pressure for producing electrically non-conductive deposits of black gold is about 2 mm. of mercury, although pressures as high as 12 mm. of mercury are satisfactory.

A carefully controlled amount of current is then passed through the tungsten filament or wire 26 until large quantities of black or orange-black vapor or fog begin to come from the gold drops on the filament. Some of this fog will settle and condense on the heat-receiving strip 17 of the bolometer, while the remainder will condense on the walls of the bell jar 20. The parts of the bolometer which are not to receive a deposit may be masked. Preferably, only the strip 17 acquires a deposit of the condensed gold.

As the evaporation and condensation of the gold continues, the strip 17 becomes covered with a velvety black layer. The thickness of the layer can be determined by observation of the degree of opacity of the deposit formed on the walls of the bell jar.

When a sufficiently thick film or deposit of the black gold has been produced, the current through the filament 26 is cut off, and air is slowly admitted to the bell jar.

The deposit 19 of black gold so formed on the strip 17 has a blackness such as to increase the sensitivity of the bolometer to a greater degree than any other material heretofore used. It also has the advantage of reducing the amount of electrical noise generated in the bolometer when that unit carries the direct current that is necessary for its operation.

If the pressure of the gas used during the evaporation of the gold is reduced considerably, for example, to about 0.5 mm. of mercury, or less, a film 19 is formed which is black to the infrared rays and is also a fairly good electrical conductor. The electrical conductivity of the black film is such that the gold or platinum strip 17 may be omitted, if desired. Thus, for example, the black gold may be deposited directly on a strip of cellulosic material such as cellulose nitrate, acetate or the like and the coated strip may be used as the heat-receiving element.

It has been observed also that for some purposes even better results may be obtained if a small quantity of tellurium is placed in a hole or cavity drilled in the top of one of the supporting posts 27 or 28. Apparently, the tellurium is heated, some slight evaporation occurs during evaporation of the gold, and the tellurium vapor is deposited with the gold on the heat-receiving strip. However, the use of tellurium is not essential, and the black gold can be deposited without it.

As indicated above, the heat-receiving strip used for supporting the heat-absorbing film of black gold may be formed of nonconductive materials, such as cellulosic tapes or strips or conductive materials such as gold, platinum, bismuth and similar conductors as may be desired. The black gold deposits may be used on thermocouples and other devices where high sensitivity to infrared radiations is desired. Therefore, the form of the invention disclosed herein should be considered as illustrative and not as limiting the scope of the following claims.

I claim:

1. A method of blackening heat-receivers for heat-sensitive detectors which comprises evaporating gold under a partial vacuum not exceeding approximately 12 mm. of mercury and in the presence of an inactive gas and condensing a portion of the vapor on a heat-receiver.

2. A method of blackening heat-receivers which comprises evaporating gold and tellurium under a pressure not exceeding approximately 12 mm. of mercury and in the presence of an inactive gas and condensing a portion of the vapor on a heat-receiver.

3. A method of blackening metallic heat-reivers for thermocouples and bolometers which comprises evaporating gold in the presence of an inactive gas and under a gas pressure of approximatcly 2 mm. of mercury, and condensing a portion of the vapor on a metallic heat-receiver.

4. A method of producing blackened conductive heat-receivers for thermocouples and bolometers which comprises evaporating gold in the presence of an inert gas at a pressure not exceeding approximately 0.5 mm. of mercury, and condensing a portion of the gold vapor as a black conductive film.

5. A heat-receiver for heat-sensitive detectors comprising a supporting element of small thermal capacity having a film of black gold thereon produced by evaporating gold under a partial vaccuum not exceeding 12 mm. of mercury and in the presence of an inactive gas, and condensing a portion of the vapor on said supporting element.

6. A heat-receiver for heat-sensitive detectors comprising a supporting element of small thermal capacity having a film of black gold and tellurium

thereon produced by evaporating gold and tellurium under a partial vacuum not exceeding approximately 12 mm. of mercury and in the presence of an inactive gas, and condensing a portion of the vapor on said supporting element.

7. A heat-receiver for heat-sensitive detectors comprising a strip of electrically conductive metal of small thermal capacity having a substantially electrically nonconductive layer of black gold thereon produced by evaporating gold in the presence of an inactive gas and under a pressure of approximately 2 mm. of mercury, and condensing a portion of the vapor on said strip of conductive metal.

8. A heat-receiver for heat-sensitive detectors comprising a strip of electrically nonconductive material of small thermal capacity having an electrically conductive layer of black gold thereon produced by evaporating gold in the presence of an inert gas at a pressure not exceeding about 0.5 mm. of mercury, and condensing a portion of the gold vapor on said strip of nonconductive

material as a black electrically conductive film.

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