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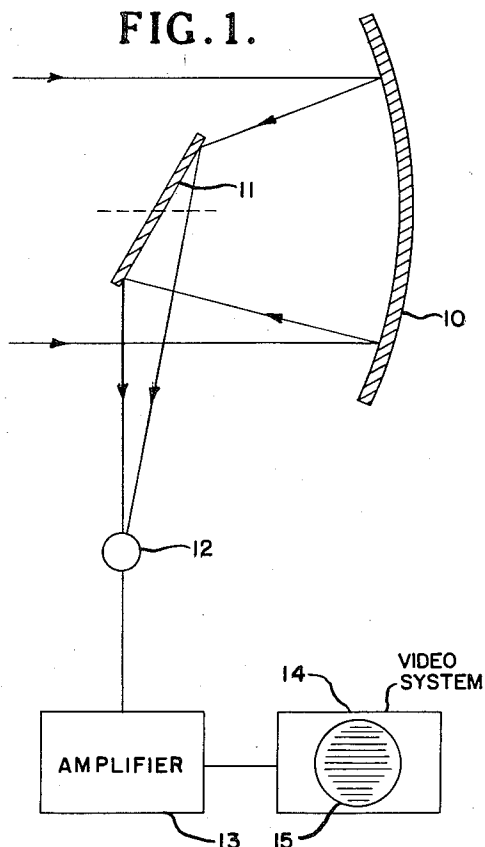
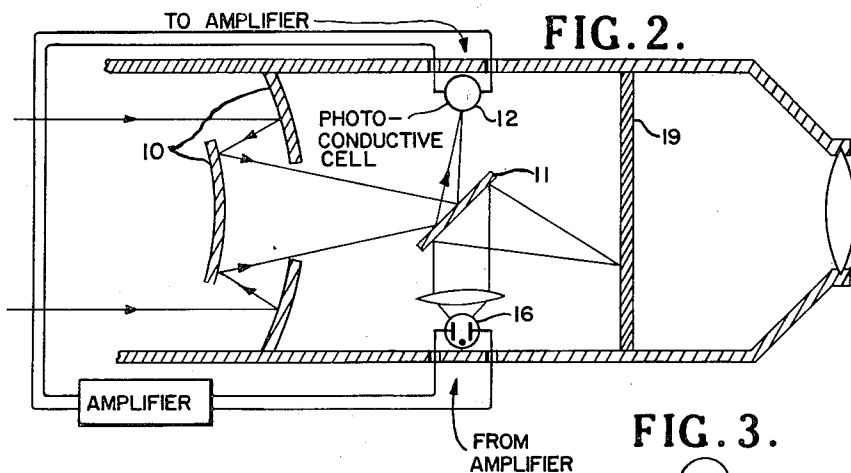
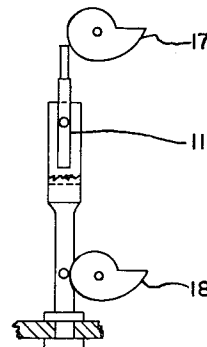
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INFRA-RED IMAGE SYSTEM

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**FIG. 3.****FIG. 4.**

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INFRA-RED IMAGE SYSTEM

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(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

This invention relates to infra-red image systems and more particularly to a system for detecting infra-red radiations from a warm object.

In the past infra-red image systems have been of two general types. The first type, in which the radiations are produced by photoelectric emission from an illuminated object, is limited in wave length to the wave band between approximately one and 1.2 microns. It is apparent that this type system requires external lighting means to illuminate the object and, hence, is not feasible for military or other purposes in which it is desirable that the observer position remain hidden. The second type system presently known utilizes a large area photoconducting surface of lead sulphide in which the image arises from the modulation of a surface-sweeping electron beam by the surface charge on the lead sulphide semiconductor. This type detector is limited in sensitivity to wave lengths shorter than approximately 2.5 microns and, hence, is inadequate for detection of low temperature objects which do not emit sufficient radiation in this region.

The present invention utilizes a small area, short time constant, photoconductive cell which renders the system responsive to thermal radiations from the object to be detected. This type detector is responsive to the wave band region between 1 and 6 microns and thus the system is able to detect objects having a temperature in the body temperature range and higher. Thus the present system is sensitive to radiations from low temperature objects and requires no external illuminating source to produce infra-red radiations.

Accordingly, an object of the present invention is to provide an image system responsive to thermal radiations from a low temperature body.

Another object of the present invention is to provide a detecting system for infra-red radiating objects in which the position of the detector is not divulged by the use of an illuminating source.

A further object is to provide an infra-red image system employing a small area, short time constant, photoconductive cell.

Other objects and many of the attendant advantages of this invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in conjunction with the accompanying drawing wherein:

FIG. 1 shows a preferred embodiment of the infra-red image system of the present invention;

FIG. 2 illustrates a second embodiment in which the electronic visible image system of the first embodiment is replaced by a directly responsive reproduction system;

FIG. 3 shows an elevation view of a special type cam system which may be used to produce vibration of the mirrors to sweep the image and provide rapid flyback time of the sweep; and

FIG. 4 shows a front view of the system shown in FIG. 3.

Referring now to the drawing, wherein like reference

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characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 a reflector 10 which collects infra-red thermal radiations from the object to be detected and directs it towards a mirror 11, which may be a plane mirror which vibrates in two planes, two separate mirrors which vibrate in the two planes, or a rotating polygonal faced mirror. The mirror 11 is illustrated as a plane mirror which vibrates about both a vertical and horizontal vibrational axis so as to enable the infra-red image from the reflector 10 to sweep across the sensitive area of a small area, short time constant, photoconductive cell 12 of lead telluride or lead selenide. Lead telluride photoconductive cells respond to radiation from relatively low temperature objects so that an image system using a sensitive detector of this type does not require a search light for illuminating the objects to be detected.

The lead telluride cell is placed in the focal plane of the image reflected from the mirror 11 so that the vibrating mirror causes the image to sweep back and forth across the cell in a horizontal plane while simultaneously the image is moved more slowly in the vertical plane. Thus the infra-red image is broken into a series of strips of varying intensity which cross the small sensitive area of the lead telluride cell and cause the cell to produce electrical signals at the portions of the sweep which contain the infra-red radiations. The electrical signal from the cell may then be amplified by an amplifier 13 and used to recreate the image in visible form.

One means of forming the visible image is shown in FIG. 1 in which a television video system 14 having its horizontal sweep frequency synchronized with the mirror horizontal vibrational frequency, having its vertical sweep frequency synchronized with the vertical vibrational frequency of the mirror, and having the electron beam intensity modulated by the signal output from the lead telluride cell. A visible image is thus produced on the oscilloscope screen 15 of the video system 14 which corresponds to the thermal radiations from the object detected.

A second system for producing a visible image from the electrical signal output of the lead telluride cell is shown in FIG. 2 in which the electronic image system of FIG. 1 is replaced by a directly responsive system. The output from the lead telluride cell after amplification may be used to operate a neon bulb 16, which will go on or off at points in the image corresponding to high and low signal intensity. The light from this neon bulb may then be directed back to the vibrating mirrors 11 and may be focused on a screen 19, of such material as ground glass or the like or may be viewed directly so as to form a virtual image reproduction of the original infra-red image such as is formed in a microscope. A system of the second type obviates the necessity for complicated electronic synchronizing systems which would be found in the television type reproduction systems shown in FIG. 1.

It is desirable that a sweep picture be produced every $\frac{1}{10}$ second inasmuch as this rate is approximately the flicker limit for the human eye. Thus if a 100 line sweep picture is desired each line would require $\frac{1}{10}$ times $\frac{1}{100}$ seconds or 1,000 microseconds. A detector having a response time of 20 microseconds would therefore distinguish 50 variations in infra-red intensity in each such line, whereby a total of 5,000 intensity elements would be available for the production of a visible image every $\frac{1}{10}$ second. The horizontal vibration frequency of the mirror must then be 10 cycles per second and the vertical vibration frequency must be 500 cycles per second, both of which are mechanically attainable vibrational rates. The horizontal vibration of the mirror may be returned

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on its back sweep by a special cam system of the type shown in FIG. 3 to avoid a double trace picture and produce a quick fly-back time. It is to be understood that the above figures are merely illustrative and that the image system will function satisfactorily at rates different from those specified.

It can be seen in FIG. 3 that a cam 17 causes the mirror to vibrate about its horizontal axis while a similar cam 18 simultaneously causes vibration of the mirror about its vertical axis at a slower rate than the horizontal vibration. The shafts for the two cams 17 and 18 may be driven by the same source with an appropriate gear ratio interconnecting the shafts or may be driven in any suitable manner.

The present system enables an observer to detect objects solely as a result of their thermal radiation and no external illuminating source is required. The useful radiation from these objects is within the wave length band of from 1 to 6 microns and thus the system permits the detection of objects having a body temperature or higher. Such a system would be useful in detecting even in complete darkness the presence of human bodies, tanks, planes, trucks and other military equipment which operate at temperatures above their surrounding atmosphere due to the hot exhaust pipes, warm motors, or other exposed warm areas.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings, it is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a system for viewing a thermal image of an object comprising a first image forming means, means for scanning the image formed by said first image forming means including means for sweeping said image across a photoconductive cell, amplifying means connected to the output of said photoconductive cell, a glow tube driven by said amplifier for converting electrical energy into light, said light having intensity variations which correspond to the intensity variations of said thermal image,

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reflecting means mounted to sweep simultaneously with said means for sweeping said image, a viewing screen, means for focusing said light from the glow tube on to said reflecting means to be swept across said screen to form a visual image, and viewing means for said screen.

2. A system as claimed in claim 1 in which the scanning means comprises a mirror and means for oscillating said mirror in two planes at right angles to each other.

3. A system as claimed in claim 2 in which said reflecting means is a second mirror mounted back-to-back with the mirror of said scanning means.

4. In a system for viewing the thermal image of an object emitting thermal radiations, a first image forming means, a vibratory means for scanning the image formed by said image forming means including a mirror pivotally mounted for vibratory movement in two directions at right angles to each other, said movements bearing such a relation between their periods of vibration as to produce a scan of said image, a photo-sensitive cell positioned to be swept by the reflection of said image from said vibratory means, means responsive to the output of said photo-sensitive means for producing a visible light having variations in intensity corresponding to the variations in the intensity of the image as it is swept across said photo-sensitive cell, a second mirror mounted back to back with said first mirror, a viewing screen, said second mirror being adapted for sweeping the light from said means for producing visible light across said screen.

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