Nov. 19, 1940. H. G. WEHE 2,222,425

MAGNETIC STRUCTURE

Filed Aug. 20, 1938 2 Sheets-Sheet 1

FIG. 1

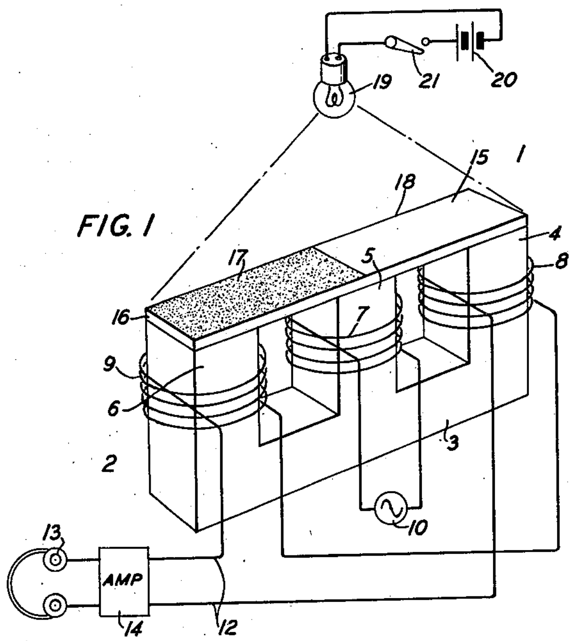


FIG. 3

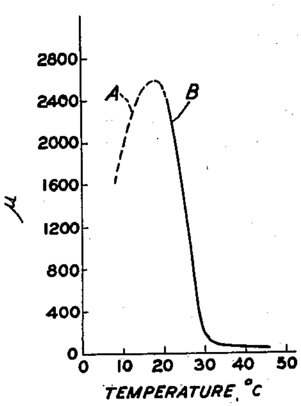


FIG. 2

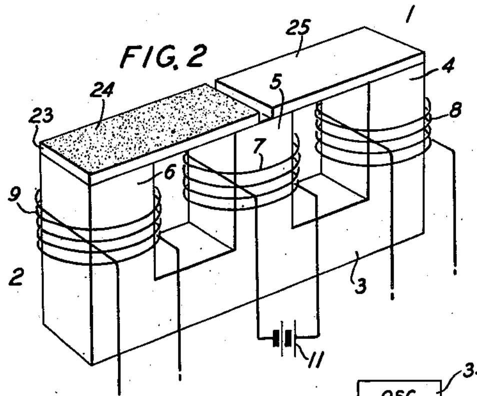


FIG. 4

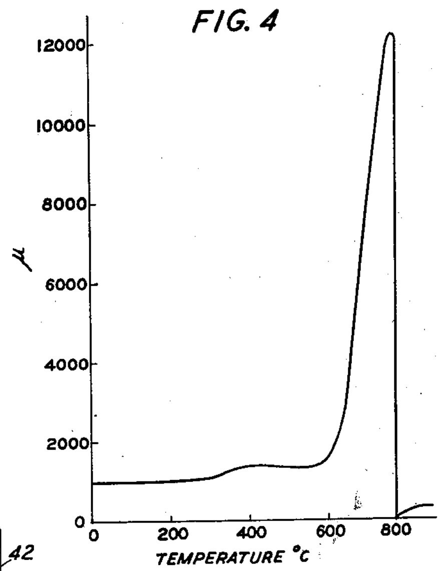
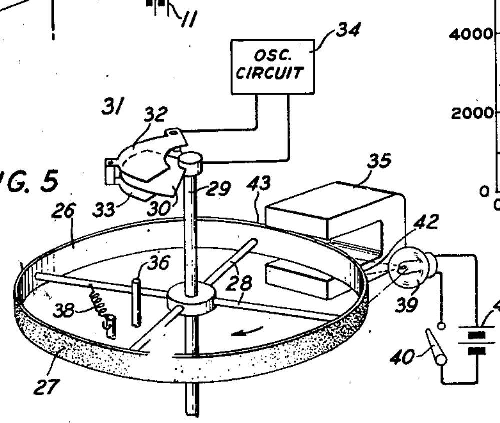


FIG. 5



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Filed Aug. 20, 1938 2 Sheets-Sheet 2

FIG. 6

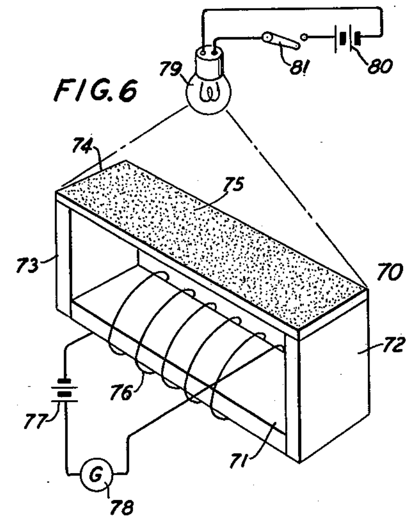
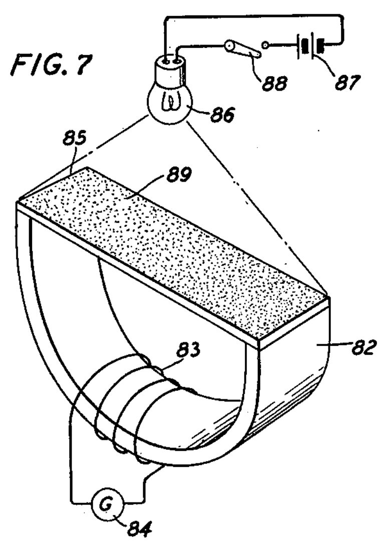


FIG. 7



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MAGNETIC STRUCTURE

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Application August 20, 1938, Serial No. 225,913

13 Claims. (Cl. 250—42)

This invention relates to magnetic structures for converting radiant energy by magnetic means into other forms of energy and particularly to relays which are controlled by radiant energy.

One object of the invention is to provide a magnetic structure that shall be controlled in an improved manner by received radiant energy.

Another object of the invention is to provide a magnetic structure that shall have the permeability of a magnetic circuit controlled in accordance with received radiant energy.

Another object of the invention is to provide a magnetic structure having a magnetic circuit completed with a material having a Curie region much lower than the Curie region of iron that shall be controlled in an improved manner by radiant energy.

A further object of the invention is to provide a relay having two magnetic circuits including pyromagnetic material differently affected in the two magnetic circuits by radiant energy impressed thereon to indicate received signals in the form of radiant energy.

When magnetic materials are subjected to heat, a change takes place in the permeabilities of the materials. A temperature permeability curve for a magnetic material shows that the material suddenly loses its magnetic properties when heated to a predetermined temperature. The temperature permeability curve for a magnetic material has very steep portions in the region where the material ceases to be magnetic. The term Curie region is intended to cover that portion of a temperature permeability curve where a small change in temperature causes a large change in permeability. The Curie regions for different materials are in many cases widely separated. The Curie region for iron is high and a very high temperature is necessary to cause iron to lose its magnetic property. Certain alloys have been found to have relatively low Curie regions when compared with the Curie region of iron. Material composed of 30 per cent nickel and 70 per cent iron has been found to have a relatively low Curie region.

According to the invention it has been found that the permeability of certain magnetic materials, for example the above-mentioned material composed of 30 per cent nickel and 70 per cent iron, may be readily changed by radiant energy if the surface of the magnetic material is darkened. The surface of the magnetic material may be darkened by applying a coating of lampblack or graphite combined with a binder material.

In one form of the invention a core composed of suitable laminations of iron is constructed with a base portion and three projecting legs. An energizing coil connected to a suitable source of alternating current is mounted on the central leg. Two output windings respectively mounted on the two outside legs are oppositely connected to an output circuit. The output circuit is connected to a suitable receiver, such as ear phones, and may, if so desired, be provided with an amplifier. A strip of pyromagnetic material is mounted on the free ends of the three core legs. The pyromagnetic material should have a very low Curie region as compared with the Curie region of iron. This material may be composed of 30 per cent nickel and 70 per cent iron, if so desired. A portion of the surface of the pyromagnetic strip is darkened in any suitable manner, as by applying a coating of lampblack or graphite combined with a suitable binder material. The portion of the pyromagnetic strip having the darkened surface formed thereon is included in one magnetic circuit of the magnetic structure whereas the other part of the strip free from the coating of darkened material is included in the other magnetic circuit of the magnetic structure.

In a magnetic structure constructed as above set forth, no currents will flow through the output circuit under normal conditions because the two output windings have equal and opposite currents generated therein. Thus no signals will be heard in the ear phones. However, if a radiant energy signal is applied to the pyromagnetic strip, the permeability of the different sections of the strip will vary differently so that one of the output windings will have a stronger current generated in it than is generated in the other output winding. The radiant energy applied to the strip may be produced by an incondescanet or other suitable lamp. Radiant heat may also be impressed on the pyromagnetic strip. When radiant energy is applied to the strip, the darkened surface absorbs a quantity of the energy which is turned into heat for changing the permeability of that portion of the pyromagnetic strip associated therewith. The portion of the pyromagnetic strip having no darkened surface thereon will not absorb nearly so much of the radiant energy.

In the above manner radiant energy signals may be employed for producing signals in the ear phones attached to the output circuit of the magnetic structure. Preferably the energizing winding on the central leg of the core is energized by alternating current but if so desired, this winding may be energized by direct current.

In the accompanying drawings:

Fig. 1 is a diagrammatic view of a relay magnetic structure constructed in accordance with the invention;

Fig. 2 is a diagrammatic view of a modification of the relay structure shown in Fig. 1;

Fig. 3 is a permeability temperature curve of a pyromagnetic material composed of 30 per cent nickel and 70 per cent iron;

Fig. 4 is a permeability temperature curve of iron;

Fig. 5 is a modification of the magnetic structure shown in Fig. 1 wherein an oscillation circuit is controlled in accordance with radiant energy signals;

Figs. 6 and 7 are diagrammatic views of modified relay magnetic structures which employ a single winding.

Referring to Fig. 1 of the drawings, a magnetic structure 1 comprises a core 2 having a base portion 3, and three projecting legs 4, 5, and 6. An energizing winding 7 is mounted on the central leg 5 and two output windings 8 and 9 are respectively mounted on the outside legs 4 and 6. The energizing winding 7 is connected to a suitable source of alternating current 10. However, if so desired the winding 7 may be energized by a suitable battery 11 as shown in Fig. 2 of the drawings. The output windings 8 and 9 are oppositely connected to an output circuit 12. Thus, when the windings 8 and 9 are subjected to like magnetic forces, the output from the circuit 12 will be zero. The output winding 12 is connected to a suitable indicator, for example, a set of ear phones 13. If so desired a suitable amplifier 14 may be provided in the circuit 12.

A pyromagnetic strip 15 is positioned across the core legs 4, 5 and 6 so as to complete two magnetic circuits through the core 3. The strip 15 is composed of a material having a low Curie region as compared with the Curie region of iron. For example, the strip 15 may be composed of 30 per cent nickel and 70 per cent iron. The permeability temperature curve for a material composed of 30 per cent nickel and 70 per cent iron is shown in Fig. 3 of the drawings. It will be noted that when this material is subjected to a temperature of the order of 20° C. the permeability of the material rises to a maximum and drops rapidly. The curve shown in Fig. 3 of the drawings has portions A and B which are very steeply inclined and called the Curie region. The magnetic structure 1 may, if so desired, be operated on either steeply inclined portions A and B of the curve shown in Fig. 3. If the magnetic structure is operated on the portion A of the curve shown in Fig. 3, an increase in heat will cause an increase in the permeability. If the magnetic structure is operated on the portion B of the curve shown in Fig. 3 an increase in heat will cause a decrease in the permeability of the magnetic circuit. Preferably the magnetic structure is operated on the portion B of the curve shown in Fig. 3 of the drawings.

The strip 15 has a darkened coating 17 formed on a portion 16 thereof. The darkened coating 17 may be composed of lampblank or graphite with a suitable binder material. The portion 16 of the strip 15 having the darkened surface 17 thereon completes a magnetic circuit which includes the legs 5 and 6 of the core 3. A portion 18 of the strip 15, which has no darkened surface formed thereon, completes a magnetic circuit including the legs 4 and 5 of the core 3.

An incandescent lamp 19 connected to a source 20 by means of a switch 21 is provided for impressing radiant energy signals in the form of light on the strip 15. If the switch 21 is closed, and the lamp 19 lighted, radiant energy in the form of light will be directed across both portions 16 and 18 of the strip 15. The darkened surface 17 formed on the portion 16 of the strip will absorb a greater portion of the energy and will heat the portion 16 of the strip to lower the permeability of the portion 16. In this apparatus it is assumed the strip 15 is operated on the portion B of the curve shown in Fig. 3. Thus the permeability of the magnetic circuit including the core legs 5 and 6 will be much less than the permeability of the magnetic circuit including the core legs 4 and 5. Accordingly, more energy will be induced in the output winding 8 than will be induced in the output winding 9. Consequently, a signal will be produced in the ear phones 13.

A tone will be heard in the ear phones 13 if the energizing winding 7 is connected to an alternating current source. If the energizing winding 7 is connected to a direct current source, then only one pulse of current will be induced in the output winding 8 for giving one signal in the ear phones 13. It is, of course, apparent that radiated heat from any suitable source may also be employed to operate the magnetic structure.

Referring to Fig. 2 of the drawings, a modification of the magnetic structure shown in Fig. 1 is illustrated which may also serve as a temperature indicator. Like parts of the apparatus shown in Fig. 2 to those shown in Fig. 1 will be indicated by similar reference characters. The output circuit and the means shown for producing radiant energy, in Fig. 1, have been omitted from the apparatus shown in Fig. 2.

A strip of pyromagnetic material 23 having a low Curie region as compared with iron is connected across the two legs 5 and 6 of the core 3. The strip 23 may be formed of a material comprising 30 per cent nickel and 70 per cent iron. A darkened surface 24 is formed on the strip 23 to increase the heating effect when the strip is subjected to radiant energy waves. The darkened surface 24 formed on the strip 23 may be composed of lampblack or graphite with a suitable binder material.

A second strip 25 is connected across the two legs 4 and 5 of the core 3. The strip 25 may be formed of iron or any other material having a relatively high Curie region. In the operation of the structure shown in Fig. 2, the strip 25 must only have a Curie region different from the Curie region of the strip 23. The strips 23 and 25 are formed of such size that under normal temperature conditions the magnetic circuits of the output windings 8 and 9 produce equal and opposite potentials in the output circuit. However, if heat is applied to the strips 23 and 25 or if radiant energy is applied to the strips 23 and 25, the permeability of the magnetic strip, including the strip 23, will be reduced as compared to the permeability of the magnetic circuit including the strip 25. Accordingly, a signal will be produced in the output circuit for operating the ear phones.

The permeability temperature curve of iron shown in Fig. 4 of the drawing indicates the degree of heat required to effect any substantial decrease in the permeability of iron. Fig. 3 shows the permeability temperature curve for a strip composed of 30 per cent nickel and 70 per cent iron as above set forth. The energizing winding 7 in the magnetic structure shown in Fig. 2 may be energized either from an alternating current source as shown in Fig. 1 or by a direct current source as shown in Fig. 2.

Referring to Fig. 5 of the drawings, a pyromagnetic relay is shown which may be operated by means of radiant energy signals. The relay comprises a ring 26 of magnetic material having a relatively low Curie region as compared to the Curie region of iron. Preferably the ring 26 is composed of 30 per cent nickel and 70 per cent iron. A darkened coating 27 is formed on the outside surface of the ring 26. This coating may be composed of lampblack or graphite combined with a suitable binder material. The ring 26 is supported by suitable spokes 28 on a rotatable shaft 29. The shaft 29 also carries an adjustable plate 30 of a condenser 31. The adjustable condenser plate 30 cooperates with stationary plates 32 and 33. The condenser 31 is connected to a suitable oscillatory circuit 34 so that signals may be indicated by the change in tuning of the circuit 34. A permanent magnet 35 in the shape of a horseshoe is provided for subjecting the ring 26 to magnetic lines of force. A stationary pin 36 is provided for engaging one of the spokes 28 to limit the movement of the ring 27 in a counter-clockwise direction. A suitable spring 37 is provided to return the ring 26 to initial position.

A light 39 which may be connected by a switch 40 to a suitable source 41 is provided for controlling the rotative movement of the ring 26. The lamp 39 is positioned to impress radiant energy at a point 42 on the ring 26 adjacent to one side of the permanent magnet 35. When radiant energy is applied at the point 42 of the ring 26, the magnetic pull of the permanent magnet of that portion of the ring 26 will be weakened because of the reduction in the permeability of that portion of the ring. Consequently, the ring 26 will be given a rotative movement in a clockwise direction. The rotative movement of the ring 26 changes the setting of the condenser 31 to adjust the oscillatory circuit 34. If a light signal were applied to a point 43 on the ring 26, and the ring was free to move, it would be given a movement in a counter-clockwise direction. It is also apparent that if the ring 26 were free to rotate that continuous application of light to the point 42 or the point 43 would cause rotation of the ring in a clockwise direction or in a counter-clockwise direction. The darkened surface 27 on the ring 26 absorbs the radiant energy converting it to heat so that it will be effective in changing the magnetic properties of the ring 26.

Referring to Fig. 6 of the drawings a magnetic structure is illustrated having a core 70 comprising a base section 71 and two legs 72 and 73 projecting therefrom. A strip 74 of pyromagnetic material is connected across the legs 73 and 72. The strip 74 is preferably composed of 30 per cent nickel and 70 per cent iron. A blackened coating 75 is formed on the surface of the strip 74. This blackened coating may be composed of lampblack or graphite with a suitable binder material. A winding 76 which is mounted on the base portion 71 of the core is connected through a battery 77 to a suitable galvanometer 78. A lamp 79 is connected to battery 80 by a switch 81 and serves to impress radiant energy signals on the surface 75 of the strip 74.

Upon operation of the switch 81 radiant energy in the form of light is impressed on the strip 74. The light waves absorbed by the surface 75 are changed into heat to lower the permeability of the strip 74. This lowers the current flow through the winding 76 to give an indication by the galvanometer 78 of the received signal.

In Fig. 7 of the drawings a modification of the structure shown in Fig. 6 is illustrated comprising a permanent horseshoe magnet 82 having a winding 83 thereon. The winding 83 is connected to a suitable galvanometer 84. A strip 85 of pyromagnetic material is connected across the ends of the horseshoe magnet 82. The strip 85 is composed of a material having a low Curie region. The strip may be composed of 30 per cent nickel and 70 per cent iron. A lamp 86 connected to a battery 87 by a switch 88 is provided for impressing radiant energy signals on the strip 85. A blackened coating 89 is formed on the strip 85 to absorb the received radiant energy waves and change them into the form of heat. The blackened coating may be composed of lampblack or graphite combined with a suitable binding material. The structure shown in Fig. 7 operates in the same manner as the structure disclosed in Fig. 6.

Modifications in the apparatus and in the arrangement and location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In combination, pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof, a darkened surface formed on said pyromagnetic material so that a large change in permeability takes place when the material is subjected to radiant energy, means for subjecting said pyromagnetic material to a magnetic field, means for subjecting said pyromagnetic material to radiant energy, and means controlled by the change in the permeability of said pyromagnetic material for indicating when the material is subjected to radiant energy.

2. In combination, pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof, means for subjecting said pyromagnetic material to a magnetic field, means for subjecting said pyromagnetic material to radiant energy in a manner to change the permeability thereof, indicating means and means controlled upon change in the permeability of said pyromagnetic material to operative said indicating means.

3. In combination, pyromagnetic material operating at a temperature in the Curie heat sensitive region, means for producing a magnetic field to include said pyromagnetic material, a surface of dark material formed on said pyromagnetic material for absorbing radiant energy waves to heat the pyromagnetic material, means for subjecting said pyromagnetic material to radiant energy, and means controlled by the change in the permeability of said pyromagnetic material for indicating when the material is subjected to radiant energy.

4. In combination, pyromagnetic material composed of 30 per cent nickel and 70 per cent iron and having a Curie point close to room temperatures, a darkened surface formed on said pyromagnetic material for raising the temperature of the material under the darkened surface when

subjected to radiant energy, means for impressing a magnetic field on said pyromagnetic material, means for subjecting said pyromagnetic material to radiant energy and means controlled by the change in the permeability of said pyromagnetic material for indicating when the material is subjected to radiant energy.

5. In combination, pyromagnetic material composed of 30 per cent nickel and 70 per cent iron and having a Curie region close to normal room temperatures, means for subjecting said pyromagnetic material to a magnetic field, means at times for subjecting said pyromagnetic material to radiant energy in a manner to change the permeability thereof, indicating means and means operated upon change in the permeability of said pyromagnetic material by radiant energy for controlling said indicating means.

6. In combination, a core having three pole-pieces projecting from a straight section, a winding mounted on each of said pole-pieces, a source of current connected to the winding mounted on the central pole-piece, an output circuit connected in series to the windings mounted on the two outside pole-pieces, said windings on the two outside pole-pieces being connected to have opposite effects on the output circuit, pyromagnetic material operating in the Curie heat sensitive region thereof and connected across the free ends of said pole-pieces to complete two magnetic circuits having the same permeabilities under normal conditions and means for insuring different permeabilities by the pyromagnetic material in the two magnetic circuits when the pyromagnetic material is subjected to radiant energy so that the two outside windings supply no current to the output circuit when the magnetic circuits have the same permeabilities and supply current to the output circuit when the permeabilities of the two magnetic circuits are different.

7. In combination, a core having three projecting pole-pieces, means comprising pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof for completing two magnetic circuits through said core, means for varying differently the permeability of the pyromagnetic material in the two magnetic circuits when subjected to radiant energy, a winding connected to a source of current for energizing said two magnetic circuits, two equal output windings respectively controlled by said two magnetic circuits and means comprising an output circuit oppositely connected to said output windings for indicating when the permeabilities of said magnetic circuits vary differently.

8. In combination, a core, an energizing winding and two output windings mounted on said core, a source of current connected to said energizing winding, means comprising pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof for completing two magnetic circuits through said core, means for varying the permeability of the pyromagnetic material in the two circuits differently when subjected to radiant energy, said magnetic circuits respectively linking the two output windings, and means comprising an output circuit oppositely connected to said output windings for indicating when the permeability of said magnetic circuits are varied differently by subjecting said pyromagnetic material to radiant energy.

9. In combination, a core of magnetic material having three pole-pieces projecting from a straight section, a winding mounted on each of said pole-pieces, a source of current connected to the winding mounted on the central pole-piece, an output circuit connected in series with the windings mounted on the two outside pole-pieces, said windings on the two outside pole-pieces being connected to oppose each other in the output circuit, and two strips of magnetic material respectively connecting the free ends of the outside pole-pieces to the free end of the central pole-piece, the two strips being operated at a temperature in the Curie heat sensitive region thereof, and means for insuring changing of the permeabilities of the two strips differently when subjected to radiant energy so that current flows in the output circuit.

10. In combination, a relay comprising a three-legged core having a strip of pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof and connected across one end of the core legs, a winding mounted on each of said legs, two of said windings being connected in series to an output circuit so as to have opposite effects on the output circuit, a source of current being connected to the third winding, and a darkened surface formed on said strip of pyromagnetic material between two of said legs for varying the heating of the strip when subjected to radiant energy to induce currents of different amounts in the two windings connected to the output circuit.

11. In combination, a core member, an energizing winding and two output windings mounted on said core, means comprising pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof for completing two magnetic circuits through said core, a darkened surface formed on a portion of said pyromagnetic material to vary the permeabilities of the two magnetic circuits when the pyromagnetic material is subjected to radiant energy, a source of current connected to said energizing winding for energizing said magnetic circuits, said two output windings being respectively linked with said two magnetic circuits, and means comprising an output circuit oppositely connected to said output windings for indicating when the permeability of said magnetic circuits are varied differently by subjecting said pyromagnetic material to radiant energy.

12. In combination, pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof, means for producing a magnetic field to include said pyromagnetic material an energy absorbing surface formed on said pyromagnetic material for absorbing radiant energy waves to heat the pyromagnetic material, means for subjecting said pyromagnetic material to radiant energy and means controlled by the change in the permeability of said pyromagnetic material for indicating when the material is subjected to radiant energy.

13. In combination, pyromagnetic material operating at a temperature in the Curie heat sensitive region thereof, means for subjecting said pyromagnetic material to a magnetic field, a source or radiant energy applied to said pyromagnetic material, means for controlling the application of said radiant energy to said pyromagnetic material so that different parts of said material receive different amounts of the radiant energy and indicating means controlled according to the change in permeability of said pyromagnetic material.

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