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TEMPERATURE RESPONSIVE CADMIUM-SILVER-GOLD ALLOYS

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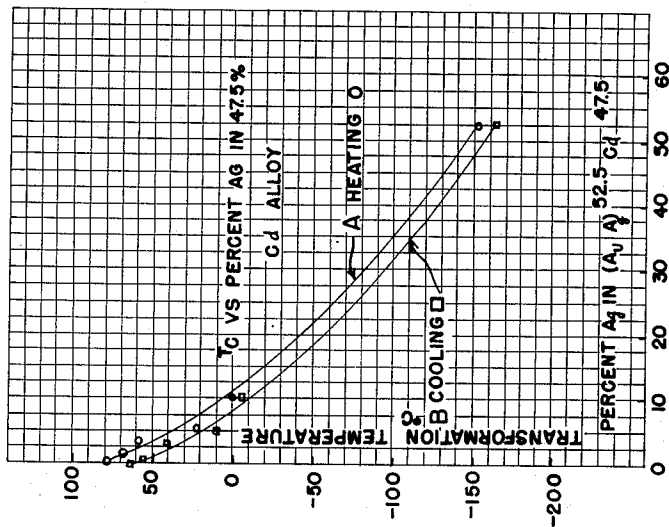


FIG. 3.

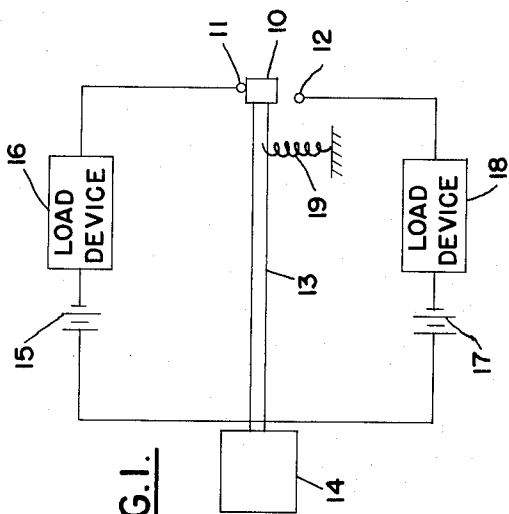


FIG. 1.

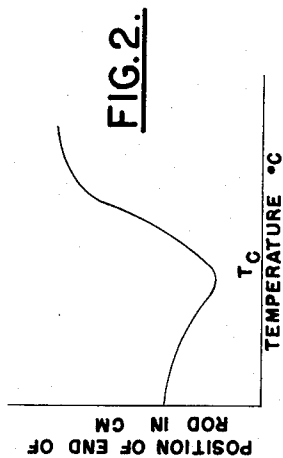


FIG. 2.

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TEMPERATURE RESPONSIVE CADMIUM-SILVER-GOLD ALLOYS

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3 Claims. (Cl. 75—134)

This invention relates to metal alloys and more especially to a metal alloy which undergoes a phase change at a temperature which is dependent on its composition and its previous treatment.

It is known that certain gold-cadmium alloys undergo a phase change when exposed to a critical temperature which is hereinafter designated as T_c . Thus rods of these alloys are flexible at temperatures below T_c and rigid at temperatures above T_c . If such a rod is subjected to a transverse force in its flexible condition, it will suddenly straighten when heated to T_c . As a result of this characteristic such rods are capable of producing mechanical effects when their temperature is raised or lowered through their critical temperatures.

T_c has a value which is close to 70° C. in the case of an alloy consisting of 52.5% atomic percent gold and 47.5% atomic percent cadmium. It is the purpose of the present invention to extend the range of temperatures at which a phase change in the alloy may be realized. This is advantageous in that a member consisting of the alloy may be made to produce a mechanical effect at any selected temperature within a wide range of temperatures. It is accomplished by replacing variable atomic percentages of gold by silver.

The invention will be better understood from the following description when considered in connection with the accompanying drawings and its scope is indicated by the appended claims.

Referring to the drawings:

FIG. 1 illustrates one of the many possible uses of the alloy,

FIG. 2 indicates the positions assumed by the free end of a $\text{Au}^{52}\text{Cd}^{48}$ rod in response to various temperatures, and

FIG. 3 indicates the relation between T_c and the atomic percentage of gold replaced by silver in alloy $(\text{AuAg})^{52.5}\text{—Cd}^{47.5}$, curve A showing this relation as the temperature is raised through T_c and curve B showing this relation as the temperature is lowered through T_c .

The switch of FIG. 1 includes a movable contact 10 and fixed contacts 11 and 12. The contact 10 is fixed to the free end of a rod 13 consisting of an alloy of the type discussed above. The opposite end of the rod 13 is fixed to a support 14. Connected between the contacts 10 and 11 are the rod 13, a power source shown as a battery 15 and a load device 16. Similarly connected between the contacts 10 and 12 are a battery 17 and a load device 18. The rod 13 has a transverse force applied to it by a spring 19.

Under these conditions, the contacts 10 and 11 are engaged when the temperature is raised through T_c and the contacts 10 and 12 are engaged when the temperature is lowered through T_c .

If the rod 13 has a length of 8.7 cm., a diameter of 1 mm., a composition of $\text{Au}^{52}\text{—Cd}^{48}$ and is subjected to a pull of 12 gm., the position of the contact 10 at various temperatures is indicated by the curve of FIG. 2. It can be seen from this curve that there is a sudden change in the position of the end of the rod 13 and the movable contact 10 at the temperature T_c .

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The beta range for Au-Cd alloys has an appreciable width and the transformation of the cubic phase into a lower symmetry phase takes place at a temperature which depends upon the percentages of gold and cadmium. Thus the 47.5% Cd alloy shows a T_c at about 60° C. on cooling and about 75° C. on heating. The 49.0% Cd alloy shows a T_c at about 30° C. on cooling and about 35° C. on heating. The maximum range in T_c for pure Au-Cd alloy is therefore about 75° C. since alloys can be made over a 3 or 4% range.

We have found that this maximum range of 75° C. in T_c may be greatly extended by substituting third elements for various percentages of the gold or cadmium. The advantages of such substitutions are that much greater changes in T_c can be produced and that the phase transformation maintains the same character. Thus alloys of 47.5% Cd, with the remainder either all gold or all silver, undergo similar transformations.

FIG. 3 shows T_c for alloys from $\text{Au}^{52.5}\text{—Cd}^{47.5}$ to $\text{Ag}^{52.5}\text{—Cd}^{47.5}$ these percentages being atomic in all cases as previously indicated. In this figure, curves A and B show the variation in T_c as the percentage of silver is changed, curve A indicating the change in T_c when the temperature is raised through T_c and curve B indicating the change in T_c when the temperature is lowered through T_c . It can be seen from these curves that T_c for raising the temperature through the critical value is somewhat higher than the T_c for lowering the temperature through the critical value.

The particular alloy to be chosen depends on the temperature at which the mechanical effect is to be produced. As can be seen from FIG. 3, T_c values from about +70° C. to about -160° C. are available. While the silver-gold-cadmium alloy has been shown as applied to an electrical switching device, this is only one of the many applications possible. Other uses of it to produce mechanical effects dependent on temperature will be readily understood by those skilled in the art.

As shown in FIG. 1, the alloy rod itself is part of the electrical circuit but this need not be the case. It may be used to produce mechanical effects which may include the operation of electrical switches.

We claim:

1. An alloy having critical temperatures at which it changes phase, said critical temperatures being about 60° C. and 40° C. when said alloy is heated and cooled respectively through said critical temperatures, said alloy consisting essentially of 47.5 atomic percent cadmium, about 2.5 atomic percent silver and about 50.0 atomic percent gold.

2. An alloy having critical temperatures at which it changes phase, said critical temperatures being about 0° C. and -6° C. when said alloy is heated and cooled respectively through said critical temperatures, said alloy consisting essentially of 47.5 atomic percent cadmium, about 10 atomic percent silver and about 42.5 atomic percent gold.

3. An alloy having critical temperatures at which it changes phase, said critical temperatures being about -145° C. and -155° C. when said alloy is heated and cooled respectively through said critical temperatures, said alloy consisting essentially of 47.5 atomic percent cadmium, about 50 atomic percent silver and about 2.5 atomic percent gold.

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