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# MAGNETIC SIGNAL STORING ELEMENTS COMPRISING A VACUUM-EVAPORATED MAGNETIZABLE COATING APPLIED TO A NON-MAGNETIC SUPPORTING MEMBER PROVIDED WITH AN ELASTOMERIC ADHESIVE LAYER

Charles Maho, Kontich, Belgium, assignor to Gevaert Photo-Producten N.V., Mortsel-Antwerp, Belgium, a Belgian company

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2 Claims. (Cl. 117—71)

## ABSTRACT OF THE DISCLOSURE

Magnetic signal storing elements such as rigid or flexible supports of tape, disc or drum form, provided with vacuum-evaporated magnetizable coatings of specified iron-cobalt-chromium, iron-nickel-aluminum, or iron-nickel-molybdenum alloys applied to a subbing layer of a synthetic elastomer of butadiene-acrylonitrile or aliphatic polyesteramide modified with a diisocyanate, for improved smoothness, tenacity and adhesion.

This invention relates to magnetic signal carriers of the kind comprising a supporting member provided with a coating of a magnetizable material which is applied to said supporting member by vacuum deposition.

It is an object of the present invention to provide on a supporting member a magnetizable layer which combines desired magnetic properties for use for instance in computers as magnetic storage element with desired technological properties such as tenacity, smoothness and a good adhesive power of the magnetizable coating to the supporting member.

It has been found that the above mentioned magnetic and technological requirements can be fulfilled with a magnetic memory or signal carrier comprising a film deposited upon its supporting member, such as a tape or drum surface, by a vacuum deposition process. Accordingly the present invention relates to such a memory or signal storing means and to a method of making the same.

More especially it has been found that a vacuum deposited metal coating consisting of 64.5% of iron, 35% of cobalt and 0.5% of chromium, a vacuum deposited metal coating consisting of 55% of iron, 28% of nickel, 5% of cobalt and 12% of aluminum and vacuum deposited metal coatings consisting of from 15 to 25% of iron, from 70 to 80% of nickel and from 2 to 5% of molybdenum are well suited for use as magnetizable storage element in electrical computers.

The deposition of said magnetizable metal coatings on a flexible or rigid supporting member may occur by vaporization in vacuum of the previously prepared metal alloys having the above composition. Such a method is among others described in the U.K. patent specification 874,541 filed Feb. 27, 1957 by Associated Electrical Industries Ltd., England.

Since, however, the different metals have a different rate of vaporization the metals are not deposited onto the supporting member in the desired ratio therefore preference is given to simultaneous and continuous vacuum deposition of the pure metals from different crucibles, the metallisation velocity being adapted for each metal. The metals are melted in the crucibles e.g. by electric high frequency heating. The rate of vaporization of the metals is controlled e.g. by determining the power supplied for heating.

According to a preferred embodiment of the invention ingots of the pure metals are used in the metallizing step,



said ingots being gradually melted and vaporized in different crucibles. The crucibles are preferably heated by a very intense direct current (for instance 780 A.) which is conducted through the crucibles at a low voltage (for instance 38 v.). The superposition of a high frequency voltage (e.g. 1000 c.p.s.) onto the direct current voltage is very advantageous for obtaining a rapid vaporization, resulting in a uniform stream of metal vapor containing no coarse metal particles. The metallizing of flexible foils or tape according to this method may occur at a rate of 100 m./min., the thickness of the magnetizable coating then being of the order of magnitude of 200 A.

The deposition of said magnetizable coatings may occur by means of known apparatus for vacuum metallizing. Said magnetizable coatings are preferably vacuum deposited in a vacuum less than $10^{-6}$ mm. Hg. Before metallizing, the supporting member is freed as usual from all adsorbed impurities by conducting said supporting member successively through a direct current field of 7000 v. and an alternating-current field of 15,000 v. and 1000 c.p.s.

To avoid oxidation of the vaporizing metal the air in the vacuum bell-jar is replaced before evacuation of the bell-jar by a non-oxidizing gas such as nitrogen gas, hydrogen gas or a noble gas whereupon the bell-jar is evacuated to about $10^{-6}$ mm. Hg.

The crucibles wherein the metals to be deposited are melted are usually made of graphite, aluminum oxide, tungsten or tungsten carbide.

Advantageously the supporting member of the magnetizable coating consists of a nonferro-magnetic material for instance glass, mica, a copper containing material such as bronze or a plastic material such as polyethylene terephthalate or polytetrafluoroethylene.

The supporting member may have all kinds of forms. Foils or narrow ribbons and solid plates or cylinders may for instance be used as supporting member.

By using a support which withstands heat of about 1200° C., the vacuum deposited ferro-magnetic layer can be annealed, in a strongly magnetic field to obtain a preferred axis of magnetization without risking to destroy the support.

If the ferro-magnetic layer is applied by vacuum deposition to a supporting member which does not withstand high temperatures, the ferro-magnetic layer may still undergo changes in its structure by local and very short high-frequency heating.

The thickness of the magnetizable coatings varies preferably from $10^2$ to $10^5$ A. It has been stated that a coating composed of 64.5% of iron, 35% of cobalt and 0.5% of chromium has a coercivity of 27.6 oersteds for a thickness of 200 A. and 200 oersteds for a thickness of 40,000 A. This difference in coercivity according to the thickness of the magnetizable layer points to a difference in metallographic structure between very thin (100–300 A.) and thicker (10,000–50,000 A.) layers.

A vacuum deposited layer of only some hundreds of A. (100–300 A.) having one of the above mentioned compositions and a very low coercivity ($\simeq$2 oersteds) is suited for use as high speed magnetic switching element in digital computers. For a suitable method for preparing such element and the application thereof we refer to "Electronics" June 26, 1959, pages 44–45, which pages should be read in conjunction herewith.

The supporting member, especially if it is of plastic material is preferably coated beforehand with an adhesive layer for the ferro-magnetic layer to be vacuum deposited. Synthetic elastomers appear to be very well suited for being applied as adhesive layer. Among these elastomers we may mention for instance copolymers of butadiene and acrylonitrile more especially of 55 parts of butadiene to 45 parts of acrylonitrile marketed under the name Hycar

OR 15 (trade name of Hydrocarbon Chemical and Rubber Company division of B. F. Goodrich Company, Cleveland, Ohio, U.S.A.), further polyesters and polyester amides modified with organic diisocyanates, such as those described in British patent specifications No. 580,524 filed Oct. 14, 1941 by Imperial Chemical Industries and No. 585,205 filed Dec. 22, 1944 by Imperial Chemical Industries and in U.S. Patents No. 2,422,271 filed Dec. 17, 1943 by G. E. Vaala and C. E. Frank and No. 2,424,883 filed Nov. 20, 1942 by B. J. Hobgood, T. A. Harper and R. I. Reynolds.

Synthetic elastomers which may advantageously be applied are elastomers having in their molecule structure urethane, urea and amide groups such as the elastomers known under the name Vulcaprene (trade name of Imperial Chemical Industries, Ltd., London, England) more especially Vulcaprene AC 230 (trade name of Imperial Chemical Industries, Ltd., London, England, for a polyester amide modified with hexamethylene diisocyanate, the polyester amide being made starting from ethylene glycol, adipic acid and ethanol amine). This modified polyester amide is applied from a mixture of acetone and ethyl lactate (50:50) preferably to a polyethylene terephthalate support. The thickness of the dry adhesive layer is not critical, for instance layers of from 50 to 200 A. suffice.

*Example*

A poly(ethylene terephthalate) support of 25$\mu$ thickness and coated with an adhesive layer of Vulcaprene AC 230 (trade name) having a thickness of 6$\mu$ is vacuum metallized (the vacuum being $10^{-6}$ mm. Hg.) with a magnetizable coating of the following composition: 55% of iron, 28% of nickel, 5% of cobalt and 12% of aluminum. Each of said metals are vaporized simultaneously in separate crucibles. The thickness of the vacuum deposited coating is 3$\mu$. The coercivity of said coating is 26 oersteds and the remanence 200 gauss.

What I claim is:

**1.** A magnetic signal storing element comprising a non-magnetic supporting member and a vacuum-evaporated magnetizable coating applied to a subbing layer thereon, wherein said coating has a composition selected from the group consisting of



(A) 64.5% of iron, 35% of cobalt and 0.5% of chromium

(B) 55% of iron, 28% of nickel, 5% of cobalt and 12% of aluminum, and

(C) from 15 to 25% of iron, from 70 to 80% of nickel and from 2 to 5% of molybdenum,

and wherein said subbing layer consists essentially of a synthetic elastomer selected from the group consisting of a copolymer of butadiene and acrylonitrile and an aliphatic polyesteramide modified with a diisocyanate.

**2.** A magnetic signal storing element according to claim **1**, wherein the non-magnetic support is polyethylene terephthalate and the elastomer is a copolymer of 55 parts of butadiene and 45 parts of acrylonitrile.


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WILLIAM D. MARTIN, *Primary Examiner.*

W. D. HERRICK, *Assistant Examiner.*