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METHOD OF MAKING MEMORY CORE

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1 Claim. (Cl. 252—62.5)

Our invention relates to an annular magnet core suitable for use as a so-called "storage element" and to a method of manufacturing such a magnet core.

Storage elements are generally employed in electronic computers, their utility for this purpose being determined by their so-called "pulse characteristics" or "dynamic characteristics." It is important in this respect that there is a distinct difference between the maximum value, $uV1$, of the undisturbed 1-signal and the maximum value, dVz, of the disturbed 0-signal (for a good storage element, the value $uV1$ and the value $rV1$, i.e. the maximum value of the disturbed 1-signal, differ only slightly from each other. For a description of the values $uV1$, $rV1$, and dVz, reference is made to U.S. Patent 2,988,508).

A further important pulse characteristic, in this respect is the switching time, T_s. The shorter this switching time, the "more rapid" is the storage element. In general, there is a tendency to attain minimum values of the switching time.

It is a principal object of our invention to provide a core which is suitable as a storage element in which the condition

$$\frac{uV1}{dVz}>3$$

is met with a disturbance ratio of 0.61.

Another object of our invention is to provide a magnet core suitable as a storage element having a switching time, T_s, of less than 0.25 μsec.

These and further objects of the invention will appear as the specification progresses.

The magnet cores, according to the invention, are obtained by sintering a pre-sintered product of a mixture of oxides of copper, iron and manganese, which oxides may be replaced wholly or partly and individually by an equivalent quantity of one or more other compounds of the metal concerned, which can be converted into the oxides concerned during sintering, in which mixture the relative quantities of copper (calculated on CuO), iron calculated on Fe_2O_3) and manganese (calculated on MnO) are:

4 to 6 mol percent of CuO,
38 to 44 mol percent of Fe_2O_2, and
50 to 58 mol percent of MnO.

While the cores, according to the invention, have a rather high coercive force, i.e. up to 6 oersted, due to their small size, i.e. an outer diameter of 0.6 mm. maximum and an inner diameter which is at least half of the outer diameter, this has not been found objectionable.

The best results are obtained by processing the aforesaid pre-sintered product with a solution of polyvinyl alcohol in water to obtain a paste which is inspissated to a mass having a weight 1.1 to 1.2 times the quantity of pre-sintered product. Thereafter, the particles of the largest size, i.e. more than 1/10 of the outer diameter of the product to be pressed, are sieved out, the smaller particles being dried and compressed to obtain a product of the desired shape with a density of 2.3 to 3.0 gm./cm.^{3}. This compressed product is heated within a period of 1 minute in air or in an air-oxygen mixture on a substratum of a high-melting-point metal or a high-melting-point metal alloy at a temperature lying between 1040° C. and 1120° C., which temperature is maintained for 1.5 to 10 minutes. Thereafter, the sintered product is cooled within about 30 minutes to a temperature lying at least 70° C. below the sintering temperature, the product being finally quenched by the contact with air at room temperature.

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The invention will be described with reference to the following illustrative example. The invention is not limited to this particular example, but is defined in the claims annexed to this specification. In this example, not only the switching time of the magnet cores, but also the "peaking time" is indicated. The "peaking time," T_p, of a magnet core denotes the period of time lying between the instant when the control-current attains an intensity of 10% of its maximum value and the instant when the output voltage of the 1-signal produced by the control-current pulse concerned is at a maximum. This "peaking time" depends, of course, upon the rising time (T_r) of the control-current pulse. In expreiments leading to the present invention, this rising time always amounted to 0.05 μsec.

A finely divided mixture of 5 mol percent of copper oxide, CuO, 40 mol percent of iron oxide, Fe_2O_3 and 55 mol percent of manganese carbonate, $MnCO_3$ was presintered for two hours at a temperature of 750° C., and then cooled. This presintered product was reduced to a powder 50 gms. of which was mixed in a mortar with 25 cm.^{3} of a 6% solution of polyvinyl alcohol in water until a paste was obtained. At 80° C. this paste was inspissated to a weight of 55 to 59 gms. Then the mass was sieved through different sieves having gradually smaller widths of mesh, i.e. in order of succession: 600, 300, 100, 75, 60, 50 and 42μ. The fractions of 60 to 50μ, 60 to 42μ or 50 to 42μ were dried for 16 hours and again sieved. The fractions were compressed to annular bodies with a density of 2.3 to 3.0 gms./cm.^{3} using stampers of tungsten carbide. The compressed bodies were heated in air on a substratum of platinum or a platinum-rhodium alloy in an electric furnace at a temperature of 1100° C. within 45 seconds, which temperature was maintained for 2 minutes. Subsequently, the sintered cores were cooled in and with the furnace within a period of about 20 minutes to a temperature of 890° C. Finally, the sintered products were removed from the furnace and quenched by contact with air at room temperature.

The outer diameter of the sintered bodies obtained was 0.540 mm. The inner diameter was 0.355 mm. The pulse characteristics, measured with a control-current of 750 ma., a pulse duration of 0.450 μsec, and a rising time of 0.050 μsec, were as follows:

$uV1$=45 mv.
$rV1$=39 mv.
dVz=6.5 mv.
T_s=0.185 μsec.
T_p=0.105 μsec.

If, instead of a sintering temperature of 1100° C., a sintering temperature of 1065° C. was used, annular cores were obtained, the outer diameter of which was 0.550 mm., the inner diameter being 0.360 mm. The pulse characteristics, measured under the same conditions, were:

$uV1$=27 mv.
$rV1$=21 mv.
dVz=9.5 mv.
T_s=0.182 μsec.
T_p=0.100 μsec.

While we have described our invention with reference to particular examples and applications, other modifications will be apparent to those skilled in this art without departing from the spirit and scope thereof as defined in the appended claim.

What we claim is:

A method of manufacturing an annular magnet core having an outer diameter not exceeding 0.6 mm., an inner diameter of at least half the outer diameter, a maximum switching time of 0.25 μsec, and a value of the quotient

$$\frac{uV1}{dVz}>3$$

with a disturbance ratio of 0.61 comprising the steps forming a finely-divided mixture of about 4 to 6 mol percent of CuO, 38 to 44 mol percent of Fe_2O_3, and 50 to 58 mol percent of MnO, heating said mixture at a temperature of about 750° C. to presinter the same, finely-dividing the presintered mixture, forming said presintered mixture into a paste, inspissating the paste to a mass having a weight of 1.1 to 1.2 times the weight of the presintered mixture, removing particles from said inspissated paste having a size exceeding 1/10 the outer diameter of the core, drying and compressing the particles in said paste

into an annular core having a density of 2.3 to 3.0 gms./cm.^{3}, heating the compressed core in an atmosphere containing at least as much oxygen as air and on a substrate of a high-melting-point metal at a temperature of about 1040° C. to 1120° C. for about 1.5 to 10 minutes, cooling the so-heated core to a temperature which is at least 70° C. below the said temperature at which the core is heated in about 30 minutes, and quenching the thus-cooled core by contact with air at room temperature.

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