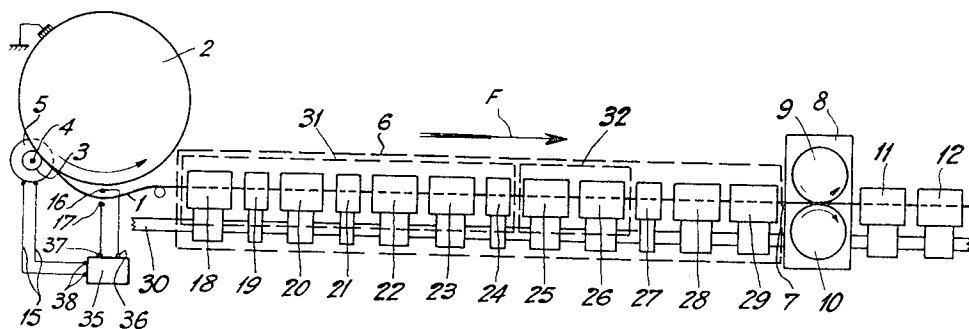
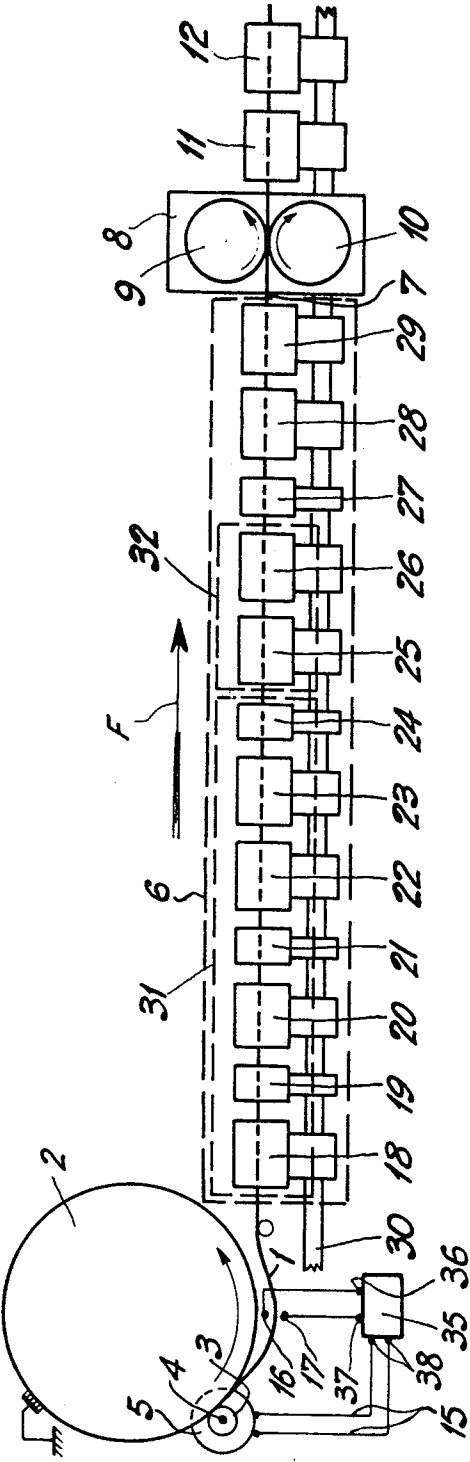


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11 Claims, 1 Drawing Figure





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APPARATUS FOR OBTAINING WIRES FOR MAGNETIC MEMORIES

BACKGROUND OF THE INVENTION

This invention relates to processes and apparatus providing for continuous fabrication of wires having a conductive core covered with a thin magnetic film and for verifying the physical properties of the wires obtained.

To effect such process, the conductive core is unwound from a drum and, under the action of driving means, traverses first a fabrication apparatus consisting of treatment means for preparing the core for receiving a magnetic deposit and of means for effecting such deposit and treating the deposit, and then traverses apparatus for measuring the physical properties of the completed wire. The treatment and deposition means consist generally of electrolysis tanks.

In some known arrangements, the core is pushed through the core preparation means, the deposition and deposit treatment means, and the device for measuring the properties of the fabricated wire. These arrangements, however present the following disadvantages:

It is impossible, without danger of buckling, to utilize for such fabrication wires having a diameter of only a few 10s of microns;

It is impossible to employ a long wire fabrication apparatus, thereby requiring numerous phases of treatment;

It is difficult, on the finished wire, to test the magnetostriction (necessitating a mechanical torsion and a tension of the wire), because mechanical stresses can not be effected at the end of such fabrication apparatus without disturbing the conditions of deposit of the magnetic material and of the conductive layer.

Moreover, the need to have a short fabrication apparatus, and therefore, short electrolysis tanks, requires improving the particular methods of deposit in order to increase the speed of deposition (higher electrolyte temperatures and stronger agitation). The control of the thickness and of the composition in the case of an alloy becomes difficult. On the other hand, this method permits the orientation of the magnetization of the magnetic deposit in the circumferential direction by passing current through wire. Nevertheless, this method of orientation is limited due to the heating of the wire and to the tolerable drop of potential along the wire. Thus, for a diameter of 125 microns, the orienting field is limited to about 10 oersteds, which is scarcely sufficient. This limitation becomes all the more important as the diameter of the wire decreases.

In other known arrangements, the wire is pulled through the fabrication apparatus and the measuring device by imposing a mechanical tension of some 10s to about 100 grams. This method does not have all the disadvantages of the preceding, but it presents others. For example, it is imperative that the deposition of the magnetic film and possibly the conductive film (at the time of treatment of the core) be free of internal stresses in order to prevent a degradation in time of its properties due to the release of these stresses. If the wire during deposition is subjected to an external stress of tension, the release of this stress when it is freed generates such stress in the deposit. These depositions can be effected under internal stresses of the same sense and of the same magnitude, so that the wire emerging from the output of the fabrication apparatus has been compensated for, but this is difficult to provide. Moreover, if a stabilization annealing of the magnetic deposit is effected when the wire is under mechanical tension, it produces a release of the tension due to the elevated temperature (of the order of 300° C.), modifying the mechanical characteristics of the wire. Therefore, it is apparent that such a process is difficult to implement if a final product free from stresses is desired. These limitations are all the more important as the diameter of the wire is reduced. Finally, this process presents the same disadvantages as the preceding process relative to the disturbances produced by the magnetostriction test.

The present invention remedies these disadvantages.

SUMMARY OF THE INVENTION

In accordance with the invention, the process for continuous fabrication of a wire having a conductive core covered with a thin magnetic film, wherein the conductive core is prepared for receiving a magnetic layer, the layer is deposited and then treated for conferring on it the desired properties, after which the physical properties of the completed wire are measured, is characterized in that the core is pulled with substantially zero tension during the preparation of the wire, the deposition and the treatment of the magnetic layer, and then pushed during the measure of its physical properties.

For this purpose, in accordance with the invention, an arrangement for the continuous fabrication of such a wire starts with a core which is wound on a drum. The core traverses, under the action of driving means, apparatus comprising in succession, preparation means for such core, means for deposition of the layer, means for treatment of the magnetic layer on the core, and a device for measuring the magnetic properties of the fabricated wire. This arrangement is characterized in that the driving means comprises, first, a motor driving the drum to unwind the core to provide a zero-tension sag in the core between drum and fabrication apparatus, a device for sensing the dimensional extent of said sag, and means controlled by the sag sensing device for providing regulation of the speed of the motor to a value greater or lesser in accordance with the tendency of the size of the sag to decrease or to increase, and, second, a driving device disposed between the fabrication apparatus and the measuring device.

Thus, the core is pulled under very low mechanical tension through the means of deposition and of treatment, such that the two steps can be carried out under the best conditions. Furthermore, the wire is pushed through the measuring device so that its properties can be measured without stresses, which is important because it will be employed without stresses. In addition, when the measuring device effects a magnetostriction test of the magnetic deposit, which necessitates a mechanical torsion or a tension of the wire, the conditions of deposition (which are sensitive to external stresses), are not disturbed because the driving device is formed, for example, of two rollers turning in opposite sense between which passes the wire, thereby isolating the means of deposition and of treatment from the measuring device.

BRIEF DESCRIPTION OF THE DRAWING

The invention will be described with reference to the accompanying drawing, wherein:

The sole figure illustrates schematically the process and the arrangement of the invention providing for obtaining continuously a wire, especially adapted for magnetic memories, having a conductive core covered with a thin magnetic sheath.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A conductive metallic core 1, for example a wire of an alloy of copper and of beryllium having a diameter of some 10s of microns, is unwound from a drum 2 by the action of a roller 3 keyed on a shaft 4 of an electric motor 5.

This conductive core 1 is then introduced into a fabrication apparatus 6 which provides for obtaining at its output a wire 7 having a core covered with a thin magnetic sheath. Wire 7 is pulled in the direction of the arrow F through apparatus 6 by a device 8, which comprises the non-slipping driving rollers 9 and 10 between which passes wire 7. Next, wire 7 is pushed through a device 11 for measuring the wire's physical properties and then a cutting device 12. The latter can be controlled by device 11 for cutting wire in which a defect is detected.

Conductive core 1 is disposed in a manner to have a sag of predetermined size between drum 2 and device 6. This sag is maintained as constant as possible by means of a servomechanism which enables regulation of the speed of motor 5 to a greater or lesser value according to the tendency of the sag to decrease or to increase. This sag provides a supply of the core of substantially zero tension for the subsequent fabrication.

This servomechanism consists of a sag sensing device comprising two contact members 16 and 17 disposed on opposite sides of conductive core 1 and connected to two inputs 36 and 37 of an electrical device 35. The output terminals 38 of device 35 are connected to the supply terminals of motor 5 by connecting leads 15. The servomechanism is arranged so as to deliver on output terminals 38 a supply voltage V or a supply voltage U, according to whether input 36 or input 37 is placed at the potential of conductive core 1.

These supply voltages U and V are such that conductive core 1 is unwound from drum 2 with a speed which is less or greater than its velocity of transit through device 8, according to whether the motor is supplied by the voltage U or the voltage V.

When the sag tends to decrease, conductive core 1 makes contact with contact member 16, input 36 of electrical device 35 is placed at the potential of conductive core 1, and device 35 furnishes to motor 5 the supply voltage V. The conductive core is then unwound from drum 2 at a greater speed than its velocity of transit through device 8 and the sag tends to increase.

Conversely, when the sag tends to increase, conductive core 1 makes contact with contact member 17, input 37 of electrical device 35 is placed at the potential of conductive core 1, and device 35 furnishes to motor 5 the supply voltage U. The conductive core is then unwound from drum 2 at a lesser speed than its velocity of transit through device 8 and the sag tends to decrease.

Accordingly, an unwinding device is provided for unwinding the core from its roll and feeding it to the input of fabrication apparatus 6 with substantially zero tension on the wire at the input point of the fabrication apparatus. Therefore, the wire can be drawn through the fabrication apparatus with the exertion of only minimum tension in the pulling device, i.e., the tension required only to overcome the residual friction imposed on the wire as it passes through the fluid-lubricated opening in each wall of the electrolysis and rinsing tanks. Hence, a wire processed according to the instant invention is coated with a magnetic film under substantially zero imposed stresses. This is very important for a high quality of finished wire.

Fabrication apparatus 6 comprises a plurality of tanks 18-28 and an oven 29 traversed by the wire. These tanks and the oven, as well as driving device 8, measuring device 11, and cutting device 12 are mounted slidably, but in a manner to be able to be removable or fixed on a rail 30 parallel to the wire.

The wire passes through each of devices 18-29, 8, 11, and 12. The surface of core 1 is first subjected to preparation in treatment means 31, comprising the electrolysis tanks 18, 20, 22, and 23. In these electrolysis tanks core 1 serves as the cathode or the anode and is surrounded by a helicoidal or annular anode or cathode, according to the particular circumstances. The electrolyte in tanks 18, 20, 22, and 23 is preferably circulated. Rinsing tanks 19, 21, and 24 for the circulation of water are similarly provided in treatment means 31. Depending on the velocity of displacement of core 1, the length of electrolysis tanks 18, 20, 22, and 23 are chosen in order that each portion of the core remains about 1 minute in such tanks.

Core 1 is introduced into electrolysis tank 18, which contains a degreasing bath formed of a mixture of sodium bicarbonate and of sodium carbonate at 60° C. The current density is about 20 amperes per square decimeter.

After having traversed rinsing tank 19, core 1 enters into electrolysis tank 20, which contains a deoxidation bath formed, for example, of a hydrochloric acid bath of one-tenth normality at ambient temperature. Core 1 is again rinsed by passage through tank 21 and then is subjected to a polishing. To effect this, it traverses an electrolysis tank 22 containing an 85 percent orthophosphoric acid bath. This bath is at the temperature of 17° C. and the current density is selected to be approximately 300 milliamperes per square centimeter.

After polishing, the core is activated at the time of its passage through electrolysis tank 23, and then it is rinsed in

tank 24. The activation bath of tank 23 is formed, preferably, of 30 percent sulfuric acid maintained at 50° C. The action of the sulfuric acid may be augmented by passing core 1 later into a bath (not shown) containing 30 percent nitric acid held at 17° C.

The core emerging from treatment means 31 is at that time prepared for receiving a conductive deposit of copper, which is provided by means 32 containing, for example, two electrolysis tanks 25 and 26. In these two tanks, as well as in that bearing reference numeral 28, which will be described hereinafter, the electrolyte is circulated so as to cause only a very weak agitation.

Tanks 25 and 26 contain a copper-plating bath of 250 grams per liter of cuprous sulfate mixed with sulfuric acid. This bath is employed at a temperature below 40° C. with a current density of some tens of milliamperes per square centimeter. It is thus possible to cover core 1 with a copper layer of some thousands of angstroms of thickness.

In some circumstances, deposition means 32 includes a gilding device (not shown) permitting the deposit of copper to be covered with a layer of gold of some thousands of angstroms.

In the instance where it is desired to obtain a wire for a memory in which the information must not be destroyed by reading, the wire emerging from deposition means 32 passes through an electrolytic tank 27 containing an acid solution.

After its passage through tank 27, the wire traverses an electrolysis tank 28 containing a bath capable of depositing on such wire a layer of magnetic material. This bath may be that which is described in French Pat. No. 1,438,564 and which provides for the deposition on a copper wire of an alloy of iron and nickel comprising about 18 percent of iron. This iron-nickel electrolyte permits obtaining suitable speeds of deposition without agitation and controlling almost perfectly the thickness of the deposit. Moreover, it has the advantage of giving to the deposit zero magnetostriction (at 18 percent of iron) and very low internal stresses. Nevertheless, this electrolyte does not tolerate large variations of potential along the wire without creating variations in the composition of the magnetic deposit along tank 28 and a composition gradient in the thickness. This disadvantage may be avoided by adapting the procedure described in French Pat. No. 1,533,398.

One such alloy of iron and nickel which is known comprises "voids," that is to say crystalline gaps, which through their subsequent displacement in time modify the magnetic properties of the sheath. In order to eliminate this known property of these voids, the wire covered by its magnetic layer is introduced into an oven 29 which subjects the wire to annealing at a temperature of the order of 300° C., in certain circumstances in the presence of a magnetic field.

From the output of annealing oven 29, wire 7, consisting of core 1 covered with a magnetic layer passes between driving rollers 9 and 10 of device 8, which pushes the wire into device 11 for measuring its properties, then into cutting device 12. The latter may be controlled by device 11 for cutting the wire when a defect is detected.

Since the core-supplying servomechanism supplies all of the force and energy required to maintain the core at a constant mid-sag level, to the device 8 pulling the core through the fabrication apparatus, the core virtually commences at the mid-bottom of the sag, and the only pull required of device 8 ahead of the fabrication apparatus is that required to lift the small length of core between the mid-bottom of the sag and the input of the fabrication apparatus. Thus the sag becomes a zero-tension reservoir of core for the processing apparatus. Device 8 has only to overcome the residual friction imposed on the wire as it passes through the fluid-lubricated openings in the wall of the tanks.

Thus, the wire is pulled through fabrication apparatus 6 and pushed through measuring device 11. This mode of fabrication in accordance with the invention is, as has been explained above, particularly important. Moreover, in accordance with the invention, the position of driving device 8 is between device 11 and oven 29 which stabilizes by annealing.

Core 1 traverses the various tanks, which are sealed by means of plugs of synthetic material covering the openings provided in the opposed walls of these tanks. These plugs comprise two parts fitted opposite each other along surfaces at least partially plane, one of the two opposed plane parts being provided with a channel in which is engaged the wire.

In some embodiments the mechanical tension exercised on the wire by each of these plugs is only of the order of 30-60 milligrams. Therefore, the total tension required to pull the wire through the entire fabrication apparatus is between 0.7 and 1.4 grams.

The details of the particular process which has been described above may be modified without departing from the heart of the present invention. It is thus possible to modify the fabrication apparatus and the measuring device without departing from the invention.

We claim:

1. An arrangement provided with fabrication apparatus for the continuous fabrication of a wire having a conductive core covered with a thin magnetic film starting with a core which is wound on a drum and which traverses, under the action of driving means, said fabrication apparatus, wherein said fabrication apparatus comprises, successively, means for preparation of the core, means for electrolytically depositing the magnetic film on said core, and means for the treatment of a magnetic film on said core, said arrangement being provided further with a device for measuring the magnetic properties of the completed wire, wherein the improvement comprises: said driving means comprising a first means having a motor driving said drum in a sense to unwind said core, a device for sensing the sag of said core in the portion thereof between said drum and said fabrication apparatus, and means controlled by said sensing device for regulating the speed of said motor to a value greater or less in accordance with the tendency of the sag to decrease or to increase, and a second means having a driving device disposed between said fabrication apparatus and said measuring device.

2. The arrangement of claim 1, wherein said driving device comprises rollers between which passes the wire emerging from the fabrication apparatus.

3. The arrangement of claim 1, wherein there is further provided, following the device for measuring the magnetic properties of the completed wire, a device for cutting the completed wire controlled by said measuring device.

4. Apparatus for continuously fabricating a wire having a core with a layer thereon, said core being initially provided as a roll, comprising: a deposition device for continuously electrolytically depositing said layer on said core as said core passes therethrough, first driving means for unwinding said core from said roll and inserting it into one end of said deposition device, wherein said first driving means maintains a sag in said core between said roll and said deposition device, said sag being maintained between predetermined maximum limits, and second driving means for pulling the coated core emerging from said deposition device with a very low tension.

5. The apparatus of claim 4, further including a testing device for testing the condition of said layer on the core of said completed wire, wherein the second driving means pushes the completed core through a testing device.

6. The apparatus of claim 4 wherein said first driving means unwinds said core from said roll with a speed for maintaining substantially zero tension in said core at a point between said roll and said deposition device.

7. Apparatus for continuously fabricating a wire having a conductive core covered with a thin magnetic layer, comprising, in combination: deposition means for receiving said core and for electrolytically depositing said layer on said core as said core moves therethrough, supply means disposed at one end of said deposition means for supplying said core to said deposition means with substantially zero tension in said core, and driving means disposed at the other end of said deposition means for pulling the coated core emerging from said deposition means.

8. The apparatus of claim 7 wherein the tension exerted by said driving means to pull said coated core is substantially that required for overcoming the residual friction imposed on said core in passing through said deposition means.

9. The apparatus of claim 7 further including a testing device for testing the condition of the layer on said core, and wherein said driving means pushes the coated core pulled from said deposition means through said testing device.

10. The apparatus of claim 7 wherein said supply means comprises a servomechanism for maintaining substantially zero tension in the core supplied to said deposition means.

11. The apparatus of claim 10 wherein said servomechanism maintains a sag in said core between predetermined dimensional bounds.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,669,866 Dated June 13, 1972

Inventor(s) Rene Fernand Victor Girard et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 9, before "limits" insert -- and
minimum --.

Signed and sealed this 19th day of December 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents