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(54) Title: METHOD OF MANUFACTURE OF AMORPHOUS TRANSDUCER ELEMENTS

(57) Abstract

The present invention relates to a method for manufacturing amorphous transducer elements with a high magnetomechanical coupling and with various non-planar cross-sectional shapes. According to the invention the amorphous strip or ribbon is arranged in a shaping fixture and is annealed in a two-step process with an intermediate cooling step, the annealing process during the first step being carried out with the strip or ribbon firmly fixed in the fixture but with no influence from any magnetic field, and the annealing process during the second step being carried out at a higher temperature with the strip or ribbon no longer being fixed in the fixture and under the influence of a transverse magnetic field.

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Method of manufacture of amorphous transducer elements

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The present invention relates to a method for manufacturing amorphous transducer elements with a high magnetomechanical coupling and with various non-planar cross-sectional shapes.

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A well known fact is that amorphous magnetic strips, such as ribbons, wires, etc., can be made into transducer elements with a high magnetomechanical coupling by heat-treating or annealing the strip or the ribbon in a transverse magnetic field. For instance, see IEEE Transactions on Magnetics, Vol. MAG-17, NO. 6, November 1981: "Magneto-

15 mechanical Coupling and Permeability in Transversely Annealed Metglas 2605 Alloys". The accepted procedure is to place the un-annealed strip in a vacuum or argon-filled furnace and anneal the strip at a temperature of 380°C to

20 430°C. In this temperature range an atomic motion occurs, but the material maintains its non-crystalline structure. During the annealing process a magnetic field is applied, which is sufficiently strong to develop magnetic domains, and the axes of which are perpendicular to the strip.

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A difficulty arises when it is desired to give the magnetic strip a particular cross-sectional shape and at the same time achieve a high magnetomechanical coupling. The ideal design is a thin ribbon with an arched cross-sectional shape.

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If the ribbon for this purpose is placed in a two-part fixture forming the strip to the desired shape, the fixture inevitably generates undesired forces in portions of the strip, generally along the edges. The stresses caused by the fixture unfortunately prevents the develop-

35 ment of domain configurations with a high coupling factor

during the annealing process. The result is a substantially reduced coupling factor.

Until now, the difficulties described above have limited amorphous magnetoelastical strips or ribbons to planar
5 thin strips or ribbons, which due to their flexibility and lack of stiffness have caused difficulties when the strips are being used in certain applications.

According to the present invention a method is provided that renders it possible to manufacture amorphous
10 magnetic strips or ribbons with any desired non-planar cross-sectional shape, while achieving a high magneto-mechanical coupling.

In the method according to the invention the strip annealing process is divided into two steps, fixture
15 tension being released between the two steps.

An application of the method according to the invention, which has proved successful, comprises the following steps:

a) The strip or ribbon is arranged in a two-part fixture adapted to give the strip the desired cross-sectional
20 shape, the fixture then being closed and the strip, firmly fixed inside the fixture, being exposed to an annealing process at a temperature of around 360°C, without influence from any magnetic field during the annealing process.

25 b) After the annealing process has been completed according to step a), the fixture and the strip are cooled.

c) After the cooling the upper part of the fixture is removed, and the strip, now resting on the lower part of the fixture, is exposed to a second annealing process in
30 the temperature range between 380°C and 430°C, a transverse magnetic field sufficiently strong to develop a domain structure with a high coupling factor being applied in a manner known per se during the annealing process.

The resulting product is a transducer element with a
35 high magnetic coupling and with the desired shape.

CLAIMS

1. Method for manufacturing amorphous transducer elements with a high magnetomechanical coupling and with various cross-sectional shapes, characterized in that the amorphous strip or ribbon is arranged in a shaping fixture and is annealed in a two-step process with an intermediate cooling step, the annealing process of the first step being carried out with the strip or ribbon firmly fixed in the fixture but with no influence from any magnetic field, and the annealing process of the second step being carried out at a higher temperature with the strip or ribbon no longer being fixed in the fixture and under the influence of a transverse magnetic field.

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2. Method according to claim 1, characterized in

a) that the strip or ribbon is put into a two-part fixture adapted to give the strip or ribbon a desired cross-sectional shape, the fixture then being closed and the strip, firmly fixed inside the fixture, being exposed to an annealing process at a temperature of approximately 360°C,

b) that the fixture and the strip are cooled down after the annealing process of a) having been completed, and

c) that after the cooling, the upper part of the fixture is removed, and the strip or ribbon, now resting upon the lower part of the fixture, is exposed to a second annealing process in a temperature range between 380°C and 430°C, a transverse magnetic field sufficiently strong to develop a domain structure with a high coupling factor being applied in a manner known per se during the annealing process.

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00984

| A. CLASSIFICATION OF SUBJECT MATTER | | |
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| IPC6: C22C 45/00, C22F 1/00, H01F 1/153, H01L 41/12 According to International Patent Classification (IPC) or to both national classification and IPC | | |
| B. FIELDS SEARCHED | | |
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| C. DOCUMENTS CONSIDERED TO BE RELEVANT | | |
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| Y | DE 3705893 C2 (KABUSHIKI KAISHA TOSHIBA), 19 May 1993 (19.05.93), page 4, line 3 - line 33; page 4, line 54 - line 58; page 5, line 30 - line 34 -- | 1-2 |
| Y | DE 1533487 A1 (DEUTSCHE POST), 9 April 1970 (09.04.70), page 3, line 13 - page 4, line 7 -- | 1,2 |
| A | DE 2709626 A1 (VACUUMSCHMELZE GMBH), 7 Sept 1978 (07.09.78), page 3, line 1 - line 9; page 8, line 7 - line 19; page 9, line 26 - page 10, line 29, claims 1-5 -- | 1-2 |
| <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex. | | |
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| C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|---|---|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| A | DE 1154277 B (HENSCHEL-WERKE AKTIENGESELLSCHAFT), 12 Sept 1963 (12.09.63) -- | 1-2 |
| A | EP 0318875 A1 (GKSS-FORSCHUNGSZENTRUM), 7 June 1989 (07.06.89), column 1, line 38 - column 2, line 18 -- | 1-2 |
| A | Patent Abstracts of Japan, Vol 11, No 3, C-395, abstract of JP, A, 61-183453 (TOSHIBA CORP), 16 August 1986 (16.08.86) -- | 1-2 |
| A | Patent Abstracts of Japan, Vol 12, No 283, C-518, abstract of JP, A, 63-60264 (TOHOKU METAL IND LTD), 16 March 1988 (16.03.88) ----- | 1-2 |

INTERNATIONAL SEARCH REPORT

Information on patent family members

30/10/95

International application No.

PCT/SE 95/00984

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|--|--|
| DE-C2- 3705893 | 19/05/93 | JP-A- 62276810 US-A- 4859256 | 01/12/87 22/08/89 |
| DE-A1- 1533487 | 09/04/70 | NONE | |
| DE-A1- 2709626 | 07/09/78 | AT-B- 362154 CA-A- 1099406 FR-A,B- 2382082 GB-A- 1548124 JP-A- 53108026 NL-A- 7801282 SE-B,C- 439399 SE-A- 7801353 US-A- 4314594 | 27/04/81 14/04/81 22/09/78 04/07/79 20/09/78 29/08/78 10/06/85 27/08/78 09/02/82 |
| DE-B- 1154277 | 12/09/63 | NONE | |
| EP-A1- 0318875 | 07/06/89 | DE-A,C- 3741290 US-A- 5043027 | 15/06/89 27/08/91 |