

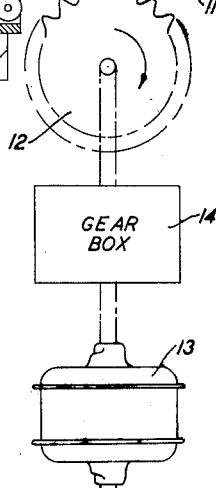
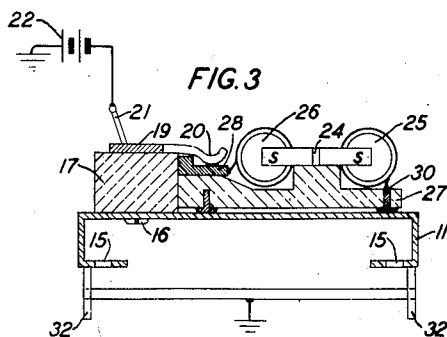
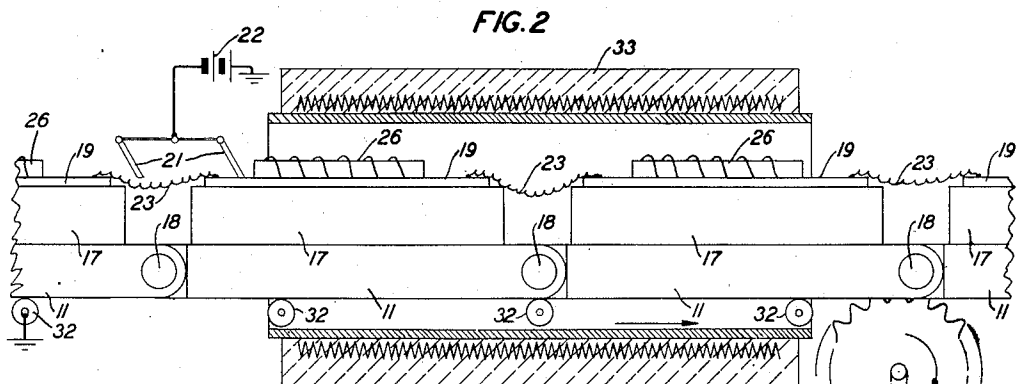
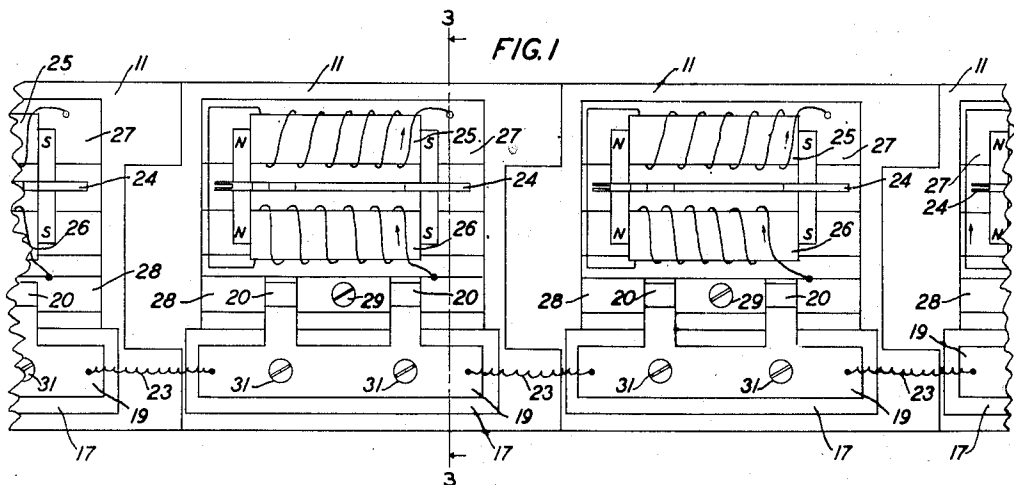
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2,482,364

DEVICE FOR HEAT-TREATING MAGNETIC MATERIALS

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DEVICE FOR HEAT-TREATING MAGNETIC MATERIALS

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This invention relates to a device for heat treating in magnetic fields magnetic materials ordinarily having permeability of a high degree at low magnetizing forces.

It has been previously proposed to heat treat magnetic materials in a magnetic field to improve, modify, or change their properties in a direction parallel to that of the applied field to be employed in use. It has also been proposed to make a practical use of material, so treated, in relays. Hitherto no method of treating magnetic piece parts in quantity with a magnetic field definitely controlled in direction and strength at different temperatures and ranges of temperatures of treatment and cooling has been known. Consequently, among the objects of the invention are to provide improved means for heat treating and cooling magnetic parts while under the influence of magnetic fields, to provide partially automatic means for so doing, and to decrease the cost per unit of so doing, to provide for quantity production and uniformity of product.

A feature of the invention is an arrangement whereby a plurality of piece parts may be treated during progressive movement thereof through a furnace under the combined influence of magnetic fields and heat.

A feature of the invention is a means for causing a magnetic field and an associated magnetic part to progress through a furnace in fixed relation.

A further feature of the invention comprises individual mountings and assemblies of such mountings for accomplishing the associated progress of a field and a magnetic part through a furnace.

A feature of the invention is a moving instrumentality for continuously passing magnetic materials in separate magnetic fields through varying temperatures.

According to the present invention an electric furnace of the conveyer link belt or chain type is provided wherein a large number of pieces or bodies of magnetic material, such as relay armatures, yokes, pole-pieces and the like, may be removably arranged in magnetic fields located at intervals along the length of the belt and the belt passed through one or more heating furnaces in order that such pieces may be heat treated in magnetic fields. The magnetic fields applied during heat treatment are in a direction to apply magnetic flux longitudinally to the magnetic pieces during heating and cooling.

By this means various types of magnetic materials in the form of piece parts, finished or unfin-

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ished, short bars, short rods and other parts may be given treatments suitable to impart to them desired properties. Dependent upon the kind of magnetic material and its intended use magnetic fields of various strengths, either alternating or direct, may be applied in combination with various temperatures or ranges of temperatures and, if desired, the field may be applied as the material passes through a certain limited zone or range of temperatures. Thus, the permeability, hysteresis losses, magnetic uniformity, magnetic symmetry, coercive force, residual inductions, or other properties or combinations of properties may be changed, modified or increased dependent upon the type of material, its composition, temperatures and field strengths applied, all in accordance with the intended use of the material.

Its specific application is for the treatment of shaped and finished armatures for polar relays composed of 18 to 36 per cent iron and the balance nickel.

A further feature of the invention comprises apparatus for heating a large number of parts simultaneously in a continuous process but with a separate device for applying to each its field which may thus be kept longitudinally symmetrical and of suitable strength.

A further feature of the invention resides in the fact that the apparatus for practicing the invention may be employed in connection with a furnace which is kept heated to a substantially uniform temperature during relatively long periods of time; consequently, the necessity for heating and cooling or heating and partially cooling the furnace with each batch of parts to be treated is avoided.

A better understanding of the invention will be had by reference to the accompanying drawing in which:

Fig. 1 is a plan view of a conveyer chain having sections or links hinged together and toothed to be longitudinally driven by a motor driven cog wheel or several such wheels located at intervals along the path of the conveyer chain or belt, each of said sections having fixedly mounted thereon an electrical insulating block of refractory material, such as fire clay, for supporting a winding structure capable of producing a magnetic field for magnetizing one or more magnetic pieces during heat treatment, together with contact shoes for applying current to energize the windings;

Fig. 2 is a side elevation of the belt conveyer shown in Fig. 1; and

Fig. 3 is a cross section through Fig. 1 taken on the line 3—3.

Hinged moving sections, or links, 11 of the belt conveyer are driven by means of cog wheels 12 located at intervals along the path of the belt and driven by motor 13 through transmission gears in box 14. One cog wheel driven by its individual motor is shown in Fig. 3 although it is understood that by means of proper shafting and gears a plurality of cog wheels may be driven by a single motor. The cross section view (Fig. 3) shows in the underside of the conveyer belt holes 15 for engaging the teeth of the cog wheels, there being holes on opposite sides of the conveyer belt as shown.

The underside of each of the moving sections 11 is provided with an opening so that a screw or rivet 16 or the like, may be inserted to fasten a ceramic material such as clay or other similar electrically insulating substance premolded into blocks 17. The belt sections 11, the hinge pin 18 and other parts of the conveyer belt are composed of metal or other sufficiently strong material of high melting point and are electrically connected to ground at some convenient point through the base of the machine (not shown).

Upon each insulating block 17 is fastened a metallic, or electrically conducting plate 19 having spring prongs 20. Brushes 21 which may be located outside of the furnace, conduct current from a source 22 to plate 19 as shown, or to any one of the other plates that happen to be in moving engagement with brushes 21. All plates 19 or groups of several successive plates 19 are connected in series circuit by flexible connectors, or wires 23 which permit the belt sections 11 some freedom of motion about the hinged pins 18.

A magnetic piece or part, such as armature 24, to be heat treated is placed between electromagnetic coils 25 and 26 which are mounted upon another block 27 of ceramic material such as clay, tile or other electrically insulating substance. The piece parts may be placed in the blocks manually while cold; various shapes and sizes of pole-pieces N, N and S, S may be provided for different shapes or sizes of parts to be treated. Coils 25 and 26 are supported on open cylinders, or receptacles, composed of refractory material such as tile or porcelain. Each of blocks 27 is placed upon the conveyer belt and pressed tightly against a block such as those designated 17, where it is firmly held in place by means of prongs 20 which bear upon a metal, or conductor plate 28 as shown in Fig. 3. Each metal plate 28 is securely fastened to a block 27 by means of screws 29. The flexible connectors 23 are welded to plates 19 so that current from source 22 may flow through all or a connected group of the plates 19 as they progress with the conveyer chain through the furnace. An electrical conductor is welded to each of the plates 28 and connected to the winding of coil 26 which is connected in series to the winding of coil 25. The coils 25 and 26 are symmetrical and equal and the current flows from source 22, plate 19, prongs 20, plate 28, coils 26 and 25, screw 30, section 11, to ground G upon the frame or the metallic base of the machine. Because of the high temperature to be encountered in the furnace plates 19, prongs 20, plates 28, the heads of screws 30 and 31 and the top surface of sections 11 near the heads of screws 31, are covered at the contact points with a special material such as gold, platinum, etc. that will not oxidize, say at temperatures of about 650° centigrade or other temperatures employed.

As shown in Fig. 1, the poles N, N and S, S of each of the electromagnets comprising coils 25 and 26 are arranged to produce in the magnetic pieces, such as relay armatures, pole pieces, pieces for permanent magnets etc., being treated, symmetrical flux which in the specific case of relay armatures will be in the same direction as each of the pieces will have in its final position in a magnetic structure. On pulling a block 27 off its belt section 11, which may be done manually or otherwise after passage from the furnace coils 25 and 26 are deenergized and the armature may be removed. The top surface of each block 27 has a raised portion which is or may be flat or otherwise shaped over the lower surface, or edge, of the piece to be heat treated so that such piece is supported all along its length and cannot sag during heat treatment. If necessary, although not shown, side pieces of non-magnetic and heat resisting material could be added to prevent warping of the piece while in the furnace.

In the above-mentioned arrangement the heat treatment of magnetic pieces employs the moving chain system wherein the belts carry the pieces in their respective magnetic fields through a furnace having varying temperatures along its length. A cylindrical or other open ended furnace may be used with the conveying chain passing through and the one winding may be used to supply the magnetic field as well as to increase the temperature. Thus, for example, the conveying chain may pass through a furnace such as disclosed in Elmen Patent 1,536,884, June 1, 1926 in which the central tube 23, 24 is of a shape and cross section to accommodate the moving chain belt; or a series of heating and cooling tubes such as disclosed in Elmen 1,722,079, July 23, 1929 may be similarly shaped and sized to accommodate the chain belt; or a succession of furnace zones of different temperatures may be employed as in Elmen Patent 1,763,884, June 17, 1930. Moreover, the brushes 21 may be applied to the inlet or outlet end of the furnace or several brushes may be employed which with suitably selected numbers of blocks 17 conductively connected together may make a variety of treatments possible. Moreover, each block may be separate from the others and receive current only upon emerging from the furnace and during a part or all of the cooling process. Many other capabilities of the apparatus will be apparent.

A block 27 which has only one coil of an electromagnet may be provided. This coil may be used in the heat treatment of a yoke, or U-shaped member, which terminates in pole-pieces at the ends of the legs of the yoke. This yoke may be located in the position approximately the same as that which the other electromagnetic coil would have occupied if it had been present and the pole-pieces may be adjacent to the north and south poles of the electromagnet.

It will also be possible with the arrangement shown in Fig. 1 to heat treat magnetic pieces simply by removing the cores from the coils of the electromagnets and using the pieces to be treated as cores. It would also be possible in the latter case, as well as in the first case, to use a single winding surrounding the magnetic piece instead of the two windings 25 and 26. For frail pieces a special shape may be given to the lower surface of the hole in the vitreous support of this winding in order to support a piece of a small cross section without strain due to sagging.

It would also be possible in certain instances to use permanent magnets of a composition which

retains its magnetism at the temperatures of treatment in place of the electromagnet, when the temperature required for the heat treatment of certain alloys such as iron-nickel in a magnetic field would be sufficiently low. However, electromagnets are preferred because their strength can be more easily controlled and they can be de-energized so that the magnetic piece such as an armature can be removed from the carrier plates 17 without adhering strongly to the magnet, whereas permanent magnets would not let go so easily and the armature might be deformed or strained in some cases in pulling them off. Moreover, the application of the magnetic force can be more readily timed and regulated.

It is also within the scope of the invention to substitute a single furnace having shelves for supporting a plurality of armatures in magnetic fields during a heat treatment. Electromagnets used to supply magnetizing fields may also be provided with excess current to supply part or all of the heat in the furnace although, in general, other heating means are preferred. If desired non-oxidizing or inert gases such as, nitrogen, hydrogen or carbon dioxide may be supplied to the furnace which in addition to a beneficial effect upon the magnetic properties of the product will serve to reduce oxidation of the conductive surfaces of elements 19, 21, 27 and 11.

Rollers 32 may be provided inside or outside the furnace or both to guide the carrier links 11. The furnace tube is illustrated diagrammatically by the broken or dotted line 33. The links 11 may be connected in an endless chain passing through the furnace but if desired a long chain of links may be passed backward and forward therethrough.

Furthermore, it is contemplated that for heat treating certain magnetic materials conductive leads insulated with asbestos, perforated beads of vitreous material or other means may be extended into the furnace and connected to the brushes 21 which would then be located within the furnace. Furthermore, as stated above any desired number of the units 11 may be connected together by conductive leads 23 and these leads may be either of negligible resistance or considerable resistance. In the latter case a graduation of the field may be accomplished, i. e., the unit immediately under the brushes 21 will have the strongest field and other units progressively further away may, at that instant, have weaker fields. The fields may thus be graduated proportionally to the temperature over a certain range, inversely proportional or otherwise; or the field may be applied only as the magnetic material is passing through a certain range of cooling temperatures. Pluralities of brushes may be provided spaced one per unit or at greater or lesser distances.

The furnace or furnaces may be any forms of heating chambers, which are heated electrically by internal heating elements, by heating elements embedded in the walls, by externally applied gas or other flames, by heated gases blown through the furnace or furnaces or by combinations of these methods. The furnaces may be quite short i. e., 20 cm. or very long i. e., several meters. In the case of one or a plurality of furnaces they may be provided at their exit ends or between furnaces with cooling zones in the form of water jackets, jets of cold air or other gas or jets for supplying cooling fluids such as water or fluids of conductive or non-conductive nature and having or not having special specific heats or

quenching properties. The magnetic fields may be applied to the treated material during the application of such cooling regulating means or not as the requirements of particular magnetic bodies treated for particular purposes or to have particular magnetic properties may demand, all these things being incidental to the main purposes and objects of the invention in providing improved methods and means of heat treating or cooling magnetic bodies during the application of magnetic fields.

In the appended claims reference to heating magnetic materials without specification of temperature is to be construed as referring to temperatures considerably above 100° centigrade such as are adapted to change, modify or improve magnetic materials or materials for magnetic uses.

In a copending application Serial No. 109,352, filed August 9, 1949, the method of heat treating magnetic materials as hereinbefore described is claimed.

What is claimed is:

1. A device for simultaneously subjecting pieces of magnetic material to heat and a magnetic field comprising heating means, means for supporting said pieces of magnetic material in refractory means, a chamber heated by said heating means, means for carrying said supporting means and said pieces throughout said heated chamber, and means supplying a magnetic field moving throughout said chamber with said refractory means in fixed relation to said pieces.

2. A device for increasing the permeability of a plurality of pieces of magnetic material in a continuous process comprising a moving conveyor belt, heat applying means through which said belt is continuously moved, magnetizing means removably supported from said belt, means for positioning magnetic material in relation to said magnetizing means in such a manner that the direction of magnetic flux in said magnetic material while passing throughout said heat applying means is maintained uniform in direction.

3. In an apparatus for modifying the permeability of a body of magnetic material, means for moving a conveyor through a heating furnace of different temperature zones, one or more coils arranged in groups for respectively producing magnetic fields on said conveyor, means for forming with magnetic pole members, in combination with said coils, flux paths within said magnetic fields, means for removably mounting bodies of said magnetic material in said flux paths, individual removable supports of ceramic material for said groups of coils on said conveyor a source of electromotive force for energizing the magnetic field of each group of said coils, and other means supported from said conveyor for establishing a conductive contact between said coils and said source and for permitting the ready removal of each of said individual supports with its group of coils from said conveyor when said magnetic bodies in each group of coils emerge from said heating furnace.

4. In an apparatus for heating treating magnetic material, comprising, in combination, a heat resistant block provided with heat resistant insulated electric windings and removably attached to a carrier, a positioning receptacle associated with said block for positioning magnetic parts in a magnetic field formed with said windings, terminals for said windings, a source of current for energizing said windings to produce magnetic fields thereby, means for moving said carrier

through a heating furnace of relatively high temperatures, and means effective during said movement to maintain said conductive terminals closed to establish a path from said source through said windings.

5. In an apparatus for heat treating magnetic parts, comprising in combination a heating furnace, a winding, a hollow vitreous support for said winding, a mounting adjacent to said winding adapted to receive a magnetic part, a movable carrier, attaching means for attaching said support and said mounting to said carrier, and current supply means for supplying current to said carrier while attached thereto, wherein the current supply means includes a source of current for energizing said winding in combination with means for moving said support and said mounting throughout said furnace while the winding is so energized.

6. In an apparatus according to claim 5 wherein said carrier comprises a plurality of links of a chain respectively provided for mounting units, each of which comprises said vitreous support, said mounting adjacent thereto and said attaching means.

7. In an apparatus for heat treating magnetic material comprising, in combination, a heating furnace, a chain of links adapted to be driven progressively through said furnace, each link having a removably mounted winding heat resistantly insulated, each link being provided with support means for supporting a piece of magnetic material in fixed relation to said winding, and means for causing said chain of links to progress throughout said furnace and other means for supplying energizing current to said winding during said progress.

8. Apparatus for heat treating materials which comprises means for subjecting the materials to a magnetic field and means for moving the field and materials throughout a heated chamber and to a point outside said chamber without changing their relation to one another.

9. In an apparatus for treating magnetic material, means for applying to said material a magnetic field in combination with means for mounting said materials and means for moving both said first and second named means together throughout a heated chamber and to a point outside said chamber.

10. Apparatus for heat treating materials which comprises means for subjecting the materials to a magnetic field maintained in a definite direction with respect to the materials, means for moving the materials throughout a heated region while controlling throughout the entire heated region the intensity and direction of the field applied to the materials, means for controlling to a point outside the heated region the application of the field to maintain a fixed relation between said field and said materials while still moving the materials to a cooler region, and means for thereafter removing the field at a temperature at which its removal does not detrimentally affect the magnetic properties of the materials for the production of which a combined magnetic and heat treatment is employed.

11. A device for heating magnetic material comprising a conveyor belt having a plurality of links, supporting units of ceramic material fixedly mounted on said links respectively, a source of current, electrically conducting means provided on each of said units and connected in series to said source, electric windings on each of said units connected through said conducting means to said

source, said windings being designed to produce a magnetic field, means adapted to hold magnetic material within said field and in fixed relation thereto, a furnace, and driving means for moving said belt throughout said furnace and to a point outside said furnace.

12. A device for heating magnetic material comprising (a) a conveyor belt having a plurality of links, (b) a chamber, means for driving said belt in a closed path throughout said chamber, and a source of current, (c) units, each comprising a base member, a winding member, contacts for establishing an electrical connection to said winding member, and a mounting of a ceramic material for receiving a body of magnetic material to be treated within the field of said winding members when energized, (d) means in said chamber for heating the mounted body of magnetic material sufficiently to improve the magnetic properties of said body, (e) mounting means for attaching said units to said links to be carried into said heated chamber, and (f) means to continuously supply current over said contacts during the passage of said units throughout said heated chamber.

13. A device for further increasing the permeability of bodies of magnetic material ordinarily having a high permeability at low magnetizing forces, comprising a heating furnace of different temperature zones, a moving heat-resisting conveyor arranged to pass through said furnace, and a plurality of heat resisting windings removably mounted on said conveyor, each of said windings comprising a heat-resistant coil, pole members arranged to form with said coils flux paths within said windings, mountings for mounting said bodies removably in the path formed by said members, electric exciting means for maintaining each of said windings energized during the time that said windings are mounted on said conveyor, and traversing said furnace, and heat resistant means maintaining each of said windings removably conductively connected to said exciting means, arranged when the windings are removed from said conveyor to deenergize said windings.

14. A unit for heat treating magnetic materials comprising a block of ceramic material provided with an electric winding heat resistantly insulated, a positioning mounting associated with said block for positioning magnetic parts in the field produced by a current in said winding, terminals for said winding, and means for attaching said block to a carrier having conductive terminals in conductive relation with the terminals on said block.

15. A unit for heat treating magnetic parts consisting of a hollow vitreous support for a winding, means for mounting a magnetic part inside said hollow vitreous support, attaching means for attaching said support and said mounting means to a carrier, and conductive means for supplying current from said carrier to said winding while said support is attached to said carrier.

16. An arrangement in accordance with claim 15, and a source of current for energizing said winding, in combination with means for moving said support throughout a heating furnace and to a point outside said furnace while the winding is so energized.

17. A device for further increasing the permeability of bodies of magnetic material ordinarily having a high permeability at low magnetizing forces, comprising a heated chamber for simultaneously subjecting pieces of magnetic material to

heat treatment and a magnetic field, heating means for furnishing the heat treatment in said chamber, ceramic means for supporting said pieces of magnetic material, other removably mounted ceramic means for supporting the first-mentioned ceramic means and said magnetic field, means for carrying said first-mentioned ceramic means, said other removably mounted ceramic means, said magnetic field and said pieces into and throughout said heated chamber, and means for effectively supplying a magnetic field moving throughout said heated chamber in fixed relation to said pieces.

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