April 11, 1944. P. G. COBB 2,346,555

METHOD OF PRODUCING MAGNETIC STRUCTURES

Filed Oct. 9, 1937

Fig. 1.

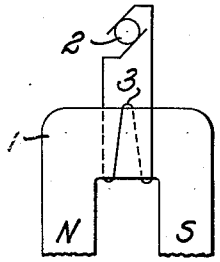


Fig. 2.

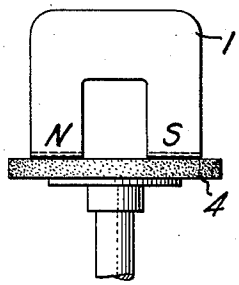


Fig. 3.

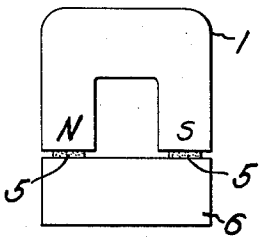


Fig. 4.

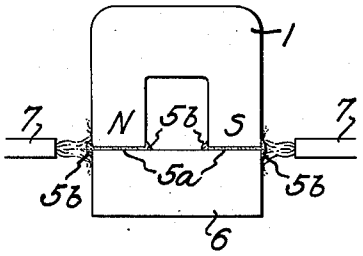


Fig. 5.

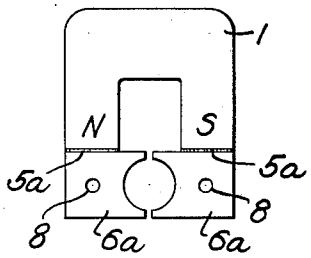


Fig. 6.

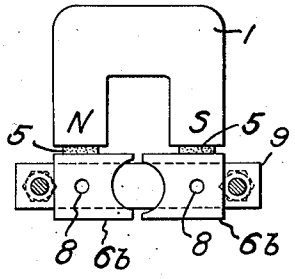
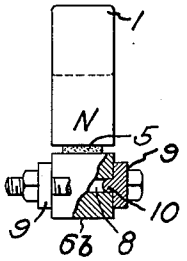


Fig. 7.



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METHOD OF PRODUCING MAGNETIC STRUCTURES

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6 Claims. (Cl. 29—155.5)

This invention relates to methods of producing magnetic structures and particularly to methods of producing magnetic structures for use in the manufacture of direct current measuring instruments, relays and the like.

The high coercive properties of the recently developed magnetic alloys could be used to advantage in electrical measuring instruments but the physical properties of the new alloys have raised difficult manufacturing problems. Minor variations in the hardness of the alloys cause variations in flux distribution when the pole pieces are formed directly on the cast magnet and it is very desirable to use soft iron pole pieces to obtain a uniform flux distribution. The practice has been to bolt soft iron pole pieces of relatively high permeability to tungsten and chrome steel magnets but more recently developed magnet alloys, for example an alloy comprising about 12% aluminum, 18% nickel and 70% iron, are not subject to annealing to a point which permits of drilling and tapping. It has been proposed to cast screw holes in the alloy castings, but such cast screw holes have been rough and of such large size as to result in a detrimental loss of active material.

An object of the present invention is to provide novel and efficient methods of producing magnetic structures of the type in which soft iron pole pieces are secured to a magnet of a high coercive alloy or steel. An object is to provide a process for the manufacture of magnetic structures by magnetizing a hard steel or alloy blank, placing on the magnetized blank a solder that melts at a temperature lower than that which will change the magnetized blank back to its original non-magnetized state, holding soft iron pieces to the magnetized blank and against the solder by magnetic attraction, and securing the pole pieces to the blank heating the assembled blank and pole pieces to a temperature above the melting point of the solder and below the demagnetization temperature of the magnetized blank. An object is to provide a process for the manufacture of a magnetic structure for assembly in a direct current measuring instrument, the process including the steps of magnetizing a blank of high coercive force, placing a pole piece blank or a pair of shaped pole pieces on the ends of the blank with a thin sheet of solder or brazing alloy between the magnet blank and the pole piece blank, and heating the assembly to a temperature above the melting point of the solder or brazing alloy but below the point which affects the magnetism of the alloy blank.

These and other objects and advantages of the invention will be apparent from the following specification when taken with the accompanying drawing in which:

Figs. 1 to 5 are somewhat schematic views illustrating successive steps in the formation of a magnetic structure in accordance with this invention; and

Figs. 6 and 7 are a plan and side elevation, respectively, which illustrate a modification of the process.

In the drawing, the reference numeral 1 identifies a blank of approximately horeshoe shape cast from an alloy or steel of high coercive force. The blank is heavily magnetized by appropriate means which is indicated diagrammatically in Fig. 1 as a direct current source 2 supplying current to a coil 3 about the casting. The ends of the magnet casting are ground to smooth plane surfaces on a grinding wheel 4, Fig. 2, but the relative order of the magnetizing and the grinding operation is not material. The end surfaces are coated with a flux, such as a thin solution of borax in water, thin strips 5 of a brazing alloy are placed on the ends of the flux-coated magnet blank, and a bar 6 of soft iron is placed upon the alloy strips; this assembly being held in place solely by magnetic attraction, Fig. 3. The soft iron bar has a smooth plane surface which is coated with the flux before the assembly.

The brazing alloy may be of the type known in the trade as low melting point silver solder. Such silver solders are commercially available in several varieties that have melting points ranging upward from about 1200° F. to the melting point of pure copper. Brazing alloys having a melting point of approximately 1175° F. are suitable when the magnet alloy is of the aluminum-nickel-iron type which retains its magnetism at temperatures of the order of 1300° F.

The assembly is then heated to a temperature above the melting point of the brazing alloy. This operation is preferably carried out in a heating furnace which permits regulation of the temperature but, for clarity of illustration, burners 7 are shown in Fig. 4 as the source of heat. An inert atmosphere such as hydrogen may be used in the furnace but this is not essential as good joints are obtained when the assemblies are heated in air.

The soft iron bar 6 is drawn to the magnet blank 1 when the brazing alloy melts, and the alloy is reduced to a thin layer 5a as the excess metal 5b is squeezed out at the edges of the joints. The final thickness of the brazing alloy layer 5a is greatly exaggerated in Fig. 5, as it is not possible to show, in a small scale view, the minute layer of silver solder that forms the joint between the magnet alloy and the soft iron bar.

The manufacture of the permanent magnet structure of an instrument is completed by cutting through the bar 6 to form the spaced pole pieces 6a between which the core and moving coil, not shown, of the measuring instrument are to be mounted. Holes 8 may be drilled and tapped

in the pole pieces 6a for the mounting of bridges that carry the bearings for the moving coil. The splashes 5b of excess silver alloy may be ground off or may be left in place when the design is such that there is some latitude in the outside dimensions of the magnetic structure.

A pair of pole pieces 6b of soft iron may be attached to the magnet blank 1 by the described brazing process. This method is desirable when the pole pieces are formed of drawn stock to reduce machining operations or when the polar faces are of special forms that are difficult to shape by cutting through the bar 6. As shown in Figs. 6 and 7, the separate pole pieces may be clamped between straps 9 of iron which preferably have pins 10 entering holes 8 in the pole pieces to retain the pole pieces in predetermined relationship.

The invention is particularly useful in the manufacture of measuring instruments from magnetic structures of the newer alloys that cannot readily be machined, but the process may be used with other magnetic materials by an appropriate selection of brazing alloys that melt at temperatures below those which affect the magnetism of the magnetized magnet blank.

I claim:

1. In the manufacture of a permanent magnet structure of the type including a magnetized blank and soft iron polar extensions soldered to the blank, the process which comprises magnetizing a magnet blank to form a permanent magnet, placing upon each end of the magnetized blank flux and solder having a melting point lower than the demagnetization temperature of the magnetized blank, placing soft iron polar extension means upon the flux and solder, whereby magnetic attraction draws the polar extension means towards said magnetized blank and into close engagement with the solder, and heating the entire assembly of magnetized blank and polar extension means to a temperature between the melting point of the solder and the demagnetization temperature of the magnetized blank, whereby magnetic attraction moves the polar extension means to the magnetized blank upon the melting of the solder to expel excess solder from the joints.

2. The method for uniting a magnetic pole member to a pole portion of a permanent magnet member having magnetic properties which change appreciably at high temperatures, which comprises magnetizing said permanent magnet member, interposing between said members a binder which melts at a temperature below that at which said permanent magnet member undergoes a substantial change in its magnetic properties but above that encountered in machining said members, placing said members in a position such that said magnetized permanent magnet member magnetically attracts said pole member to compress therebetween said binder, and heating said members to a temperature sufficient to melt said binder without substantially changing the magnetic properties of said permanent magnet member, whereby the magnetic force developed between said members urges said members together as said binder melts.

3. In the manufacture of a permanent magnet structure of the type including a magnetized blank and soft iron polar extensions soldered to the blank, the process which comprises magnetizing a magnet blank to form a permanent magnet, assembling separate soft iron polar extensions and interleaved solder upon each end of the magnetized blank, the solder having a melting point lower than the demagnetization temperature of the magnetized blank, mechanically spacing the outer ends of the pair of polar extensions from each other, and heating the entire assembly of magnetized blank and polar extensions to a temperature between the melting point of the solder and the demagnetization temperature of the magnetized blank, whereby the polar extensions and the magnetized blank are moved towards each other by magnetic attraction to expel excess solder when the solder melts.

4. In the soldering of a soft iron polar extension to each end of a blank of magnetizable material by placing solder and a flux between the blank and each polar extension, the solder having a melting point lower than the demagnetization temperature of the magnetizable material, and melting the solder; the process which comprises magnetizing the blank to form a permanent magnet prior to the assembly of the polar extensions and solder upon the ends of the blank, whereby the polar-extensions are drawn towards the magnetized blank and against the solder by magnetic attraction, and heating the assembly to a temperature between the melting point of the solder and the demagnetization temperature of the magnetized blank, whereby the pressure for obtaining a good soldered connection upon the melting of the solder is supplied by magnetic attraction.

5. In the manufacture of a permanent magnet structure of the type including a magnetized blank and soft iron polar extensions soldered to the blank, the process which comprises magnetizing a magnet blank to form a permanent magnet, placing flux and a thin strip of solder upon each end of the magnetized blank, the solder having a melting point lower than the demagnetizing temperature of the magnetized blank, placing a soft iron bar upon the flux and solder, heating the entire assembly of magnetized blank and soft iron bar to a temperature between the melting point of the solder and the demagnetization temperature of the magnetized blank, whereby the soft iron bar is moved by magnetic attraction towards the magnetized blank to expel excess solder when the solder melts, and dividing the iron bar after it is soldered to the magnetized blank to form spaced pole pieces.

6. In the manufacture of a permanent magnet structure of the type including a magnetized blank and soft iron polar extensions soldered to the blank, the process which comprises magnetizing a magnet blank to form a permanent magnet, assembling separate soft iron polar extensions and interleaved strips of solder upon each end of the magnetized blank, the solder having a melting point lower than the demagnetization temperature of the magnetized blank, mechanically spacing the outer ends of the pair of polar extensions from each other, and heating the entire assembly of magnetized blank and polar extensions to a temperature between the melting point of the solder and the demagnetization temperature of the magnetized blank, whereby the polar extensions and the magnetized blank are moved towards each other by magnetic attraction to expel excess solder when the solder melts.

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