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MAGNETIC MATERIAL
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1,982,810

FIG. 1

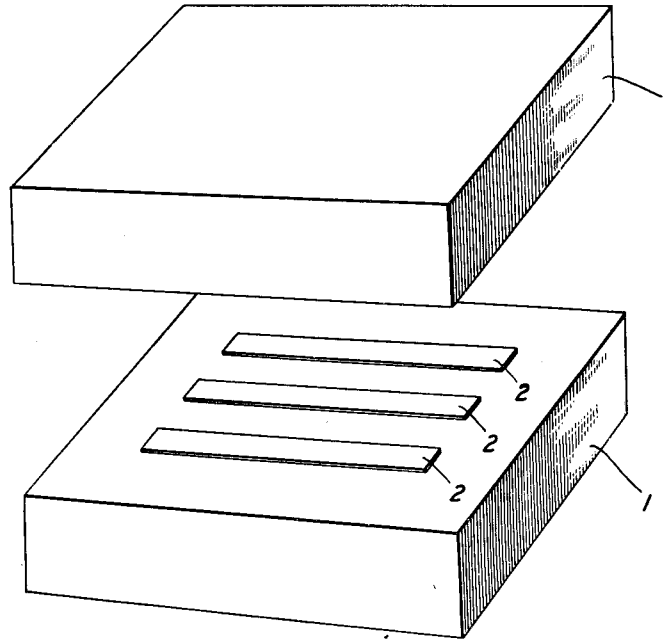
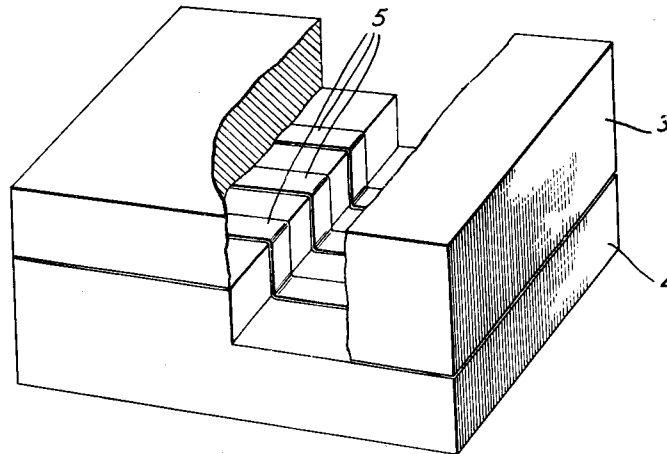


FIG. 2



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MAGNETIC MATERIAL

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6 Claims. (Cl. 175—21)

This invention relates to magnetic materials and more particularly to a method of heat treating them. The object of the invention is to produce thin flat strips or sheets of magnetic material in such a manner that the resulting product will be of high permeability.

For certain uses such as for laminations for the pole-pieces of magnetic telegraphones magnetic materials are required in the form of very thin flat strips. One very satisfactory material for this particular use is a permalloy of high initial permeability, the general nature of which is well known in the art and is fully described in Patent 1,586,884 to Elmen, June 1, 1926. The methods and apparatus used in heat treating permalloy to obtain a desired permeability characteristic are also well known and clearly described in such patents as 1,866,925 and 1,880,806 and British Patent 342,676 to P. P. Cioffi.

It is found however when permalloy is made up in very thin laminations of the order of one mil in thickness or less and heat treated in the usual manner that the thin strips in cooling become more or less warped. When such strips are assembled, as in a telegraphone pole-piece for instance, compressive forces must be applied to force them into the desired closely spaced relation. This stressing of the material destroys the high permeability characteristic obtained by the heat treating process and makes them entirely unsuited for uses where high permeability is required. The warping of the material as a result of the heat treatment may be readily prevented by placing the material between blocks of a refractory substance while it is being heat treated and for strips six mils or more in thickness this procedure gives a very satisfactory product. For very thin strips of the order of two mils or less in thickness, warping is prevented but the finished strips are found to be of very much lower permeability than the thicker strips.

While the reason for this lower permeability is not fully understood, it is believed to be due at least in part to stresses set up in the strips during the heat treatment due to the difference in the coefficients of expansion of the magnetic material and the refractory material of the blocks. Another possible explanation is that thinner strips due to their small bulk are more affected by slight impurities absorbed during the heat treatment.

The preferred method of making these very thin laminations, comprises treating a molyb-

denum permalloy wires about one-eighth inch in diameter in hydrogen to improve its permeability as explained in the patents to Cioffi referred to above, rolling the wire to the desired thinness and then restoring the permeability, which has been impaired by the rolling by annealing the flat strip between blocks of the same material as the strip, in this case molybdenum permalloy. When treated in this way very thin annealed laminations are not only flat but they have substantially as high permeability as can be obtained in much thicker strips.

The hydrogenization process requires a temperature of the order of 1400° C. whereas the annealing may be done at 800° C. to 1000° C. or less so that by heat treating before rolling, no trouble is ordinarily experienced in annealing the strips. If the strips are hydrogenized between the blocks after rolling they sometimes tend to stick to the blocks and in this case it may be necessary to spray the block faces with a thin film of suitable refractory material such as quartz dust or magnesium dioxide. In general, it is preferable, however, to avoid the use of the refractory matter, as by hydrogenizing before rolling, so that a very even surface is presented to the strips and no foreign matter can be absorbed. In the British patent referred to above, it is stated that with the hydrogen treatment iron with an initial permeability as high as 10,400 has been obtained. It will be noted, however, that this iron was in the form of wire of 40 mils diameter. Prior to this invention, this value could not be approached for even the thickest strips under discussion here. Even with 6 mil strips treated between blocks of refractory material, a maximum initial permeability of only 8000 could be obtained and one and two mil strips ranged from 200 to 1000.

In the drawing, Fig. 1 shows the annealing assembly for making flat laminations according to the invention and Fig. 2 shows one form of assembly for producing annealed strips which conform to the contoured faces of the annealing blocks.

In Fig. 1 the opposed faces of the molybdenum permalloy blocks 1, 1 are optically flat. The thin strips 2 of molybdenum permalloy to be treated are placed between the blocks as shown and the assembly is placed bodily in the heat treating oven. As already stated the preferred treatment is to hydrogenize the metal before rolling in accordance with Cioffi's teachings, roll it to the desired thinness and then use the blocks 1 only for ensuring that the strips will

be perfectly flat after being annealed. When using these strips for the other purposes or when treating thin strips of other materials, it may in some cases be desirable to roll the material to its finished dimensions before hydrogenizing or applying other high temperature heat treatments. In these cases any tendency of the strips to stick to the block faces can be prevented by spraying the block faces with a very thin layer of quartz dust or other refractory material.

Very thin strips, that is, strips ranging from two mils down to one-half mil in thickness annealed according to this invention have been found to have and retain an initial permeability of 6000 as compared with 1000 or less for similar strips annealed between blocks of refractory material. Great care must be used in handling the finished strips for even slight stresses will materially reduce their permeability. With this treatment it is possible to make thin strips which immediately after annealing have an initial permeability as high as 10,000 or even 12,000 but even the slight amount of careful handling necessary in assembling the completed strips into a pole-piece is sufficient to reduce them to a permeability of about 6,000.

If finished strips of other shapes are desired the flat strips should be annealed between blocks 3, 4 with faces corresponding to the desired shape of the finished strip as shown in Fig. 2 so that the stresses incident to deforming the strips to the contours of the faces of the blocks are entirely removed by the annealing treatment.

While the invention has been described for purposes of illustration by specifying blocks of exactly the same material as the strips being treated it should be understood that slight dif-

ferences between the composition of the strips and the blocks are not always objectionable. Care should be taken, however, not to use blocks which have a coefficient of expansion materially different from that of the strips or which contain any objectionable material which may be absorbed by the strips during the treatment.

What is claimed is:

1. The step in the method of making thin, flat laminations of magnetic material of high permeability which comprises annealing the laminations between flat faced blocks composed of a material having substantially the same coefficient of expansion as the laminations.

2. The step in the method of making thin flat laminations of hydrogenized molybdenum permalloy which comprises annealing the laminations at a temperature of from 800 to 1000° C. between flat faced blocks of molybdenum permalloy.

3. The method of increasing the permeability of thin laminations of magnetic material which comprises assembling the laminations between blocks of the same material having faces corresponding to the desired contours of the finished laminations, heating the assembly to an annealing temperature and permitting it to cool slowly.

4. A flat lamination of magnetic material less than two mils thick and having an initial permeability substantially in excess of 1000.

5. A flat lamination of magnetic material less than one mil thick and having an initial permeability substantially in excess of 1000.

6. A flat lamination of molybdenum permalloy less than two mils in thickness and having an initial permeability of about 6000.

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