

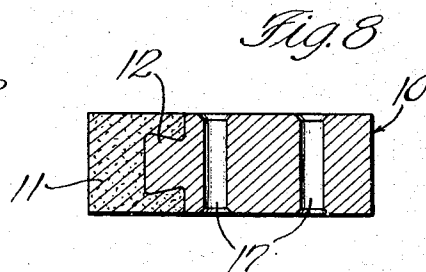
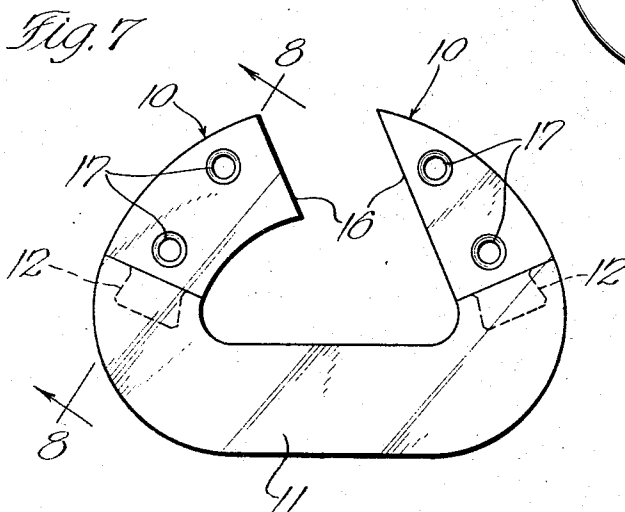
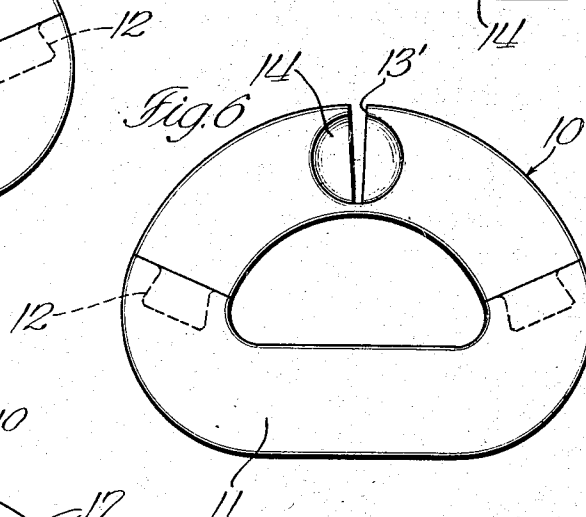
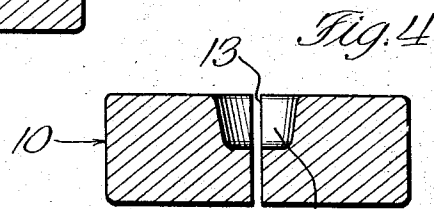
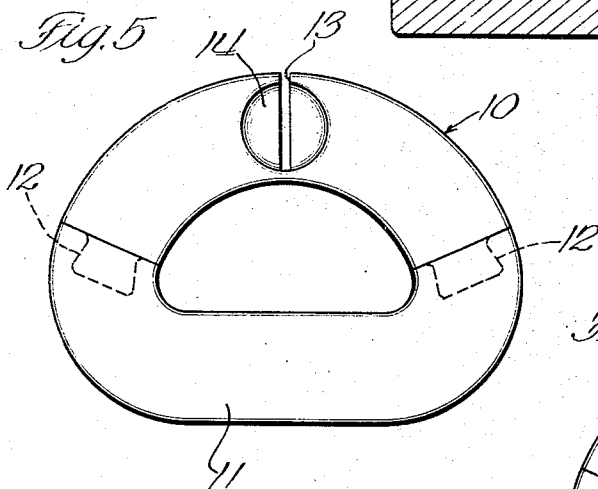
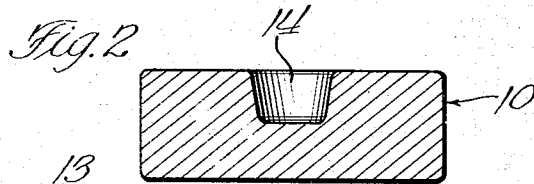
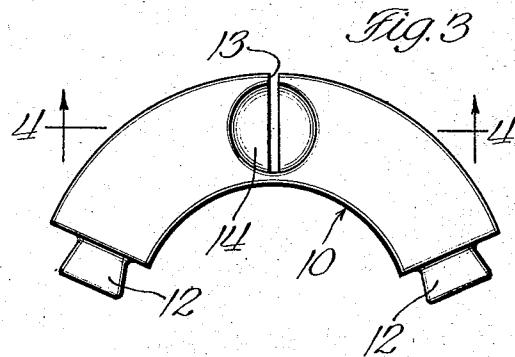
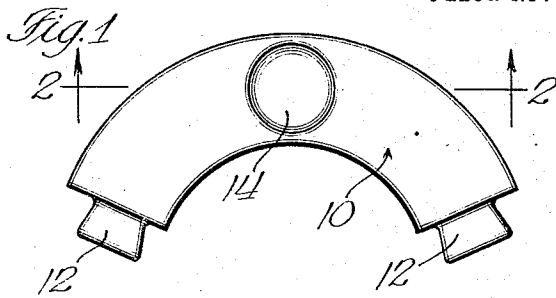
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A. J. McMASTER

2,320,632

METHOD OF PRODUCING MAGNET STRUCTURES

Filed Nov. 27, 1939



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UNITED STATES PATENT OFFICE

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METHOD OF PRODUCING MAGNET STRUCTURES

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2 Claims. (Cl. 29—155.5)

My invention relates to permanent magnets for use in electric meters and the like. It relates more in particular to methods of producing such magnets and the structures resulting from the practice of the method.

There has been an increase in the demand for the production of relatively low-cost electric meters having, however, the extreme sensitivity and accuracy obtainable by use of the D'Arsonval principle. The characteristics of high sensitivity and accuracy, such as demanded in current practice, are obtainable in a relatively inexpensive instrument only by the use of very high coercive force materials, for example, such as shown in the Mishima patent, No. 2,027,998, dated January 14, 1936, and by an extremely accurate control of the position of the finished surfaces, particularly as to the trueness of the pole piece surfaces facing the moving coil and the mounting of the supports for the moving coil.

Very high coercive force permanent magnet materials are not machinable except by grinding, and it is impossible to finish such permanent magnet materials at the pole pieces with sufficient accuracy for the purpose at hand. Moreover, when the high coercive force material is finished to produce pole pieces of the same material, the field across the pole pieces is usually non-uniform and there is a loss of accuracy as a result. This loss of accuracy may in part be overcome by the use of subsequently attached pole pieces formed of low coercive force material, such as soft iron, but this practice is substantially impossible on a commercial scale, particularly in a relatively inexpensive, highly sensitive device.

In my prior application Serial No. 225,332, filed August 17, 1938, I disclosed the use of a method wherein pole pieces of soft iron or similar material are inserted in a mold in which the high coercive force permanent magnet material is cast and wherein the resulting structure, after cooling, is machined at the insert to produce the final magnet structure. While this method is a very desirable step forward in the art of producing electric meters, I have found that, in the cooling of the casting comprising the high coercive force material, excessive strains were set up in both the inert portion and in the cast portion. The introduction of such strains produced two undesirable results. One of the results of setting up such strains is that the high coercive force material, being very brittle, will crack as it cools to room temperature, thus setting up an added expense in the operation equiv-

alent to the proportion of breakages. In some structures, I find that as high as one-third of the castings will fracture on cooling. Another disadvantage concerns the accuracy of the instrument. Even though the final structure would be annealed, strains in the insert, which later would comprise the pole pieces, would be relieved and, even though the machining operation was carried out with extreme accuracy, subsequent measurements would show inaccuracies of a type such as seriously to impair the functioning of the final instrument. These inaccuracies could be explained only on the assumption that the structure was not relieved of strains, even after prolonged annealing. The result introduced still a further problem in that, when a completed magnet structure was found to be inaccurate in its measurements, it was impossible to determine whether or not the blame was to be placed upon the machining operation or was to be accounted as resulting from relief of strains in the casting. Proper control and checking of manufacturing processes, therefore, suffered.

An object of the invention is to overcome the difficulties recited hereinabove.

A further object is the provision of an improved method of producing permanent magnets for electric meters and the like.

Still a further object is the provision of an improved magnet structure which may be machined to its final shape with the assurance that that shape will be retained and any inaccuracies found in the measurements can be traced to faulty machining.

A still further object is to decrease the cost of producing permanent magnet structures for electric meters and the like while still maintaining extreme accuracy.

In carrying out my invention, I first produce a magnet pole piece member which will comprise both pole pieces of the final magnet structure, this pole piece member being formed preferably of material like soft iron which has a low coercive force and is, therefore, unsuited in itself for use as a permanent magnet. The ends of the pole piece member are formed so as readily to be mechanically bound to a permanent magnet structure cast with the pole piece member as an insert, and intermediate such ends I form a slot leaving just enough material connecting the portions lying on opposite sides of the slot to hold the member together during all of the subsequent operations incident to inserting it in a mold and casting the permanent magnet body

around it. The casting of a high coercive force material in such a way as to form a closed ring-like structure of which the pole piece member forms a part is then carried out with the result that, when the structure cools, the slot formed in the pole piece member will function to relieve strains, thereby cutting down substantially entirely breakages such as described and permitting the final accurate finishing of the pole pieces and other parts of the magnet structure. A further advantage results from the fact that the pole pieces may be machined as a unit, thus permitting greater accuracy in a machining operation than is usually obtainable when the pole pieces are separately machined.

Other specific objects, advantages and features of the invention will be apparent as the detailed description proceeds.

Looking at the drawing, Fig. 1 is a plan view showing the pole piece member partly completed preparatory to its being inserted in a mold for casting;

Fig. 2 is a sectional view taken on the line 2-2 of Fig. 1;

Fig. 3 is a view similar to Fig. 1, but showing the pole piece member completed;

Fig. 4 is a sectional view taken on the line 4-4 of Fig. 3;

Fig. 5 shows the completed magnet structure as cast prior to its cooling, this being generally the appearance which the structure has when in the mold;

Fig. 6 shows the same structure when removed from the mold and cooled;

Fig. 7 shows one form of completed magnet structure after all of the finishing machine work has been done upon it; and

Fig. 8 is a sectional view taken on the line 8-8 of Fig. 7.

Referring now to the drawing, the numeral 10 identifies generally the magnet pole piece member, and the numeral 11 the portion of the magnet structure comprising high coercive force material. It will be noted that the pole piece member 10 has its ends 12 shaped to be readily bound within the structure of the high coercive force material cast around it, and intermediate such ends, a slot 13 is provided, this slot extending substantially entirely through the body of the pole piece member. A recess 14 also appears, cut entirely through by the slot 13, the function of this recess being described subsequently.

The pole piece member may be formed in various ways. A structure such as shown in Figs. 1 and 2 may be formed, as by casting or forging, utilizing material of low retentivity and low coercive force, such as soft iron. The slot 13 is simply formed by a sawing operation. This permits the production of a relatively very narrow slot, it being understood, however, that the slot may be formed with a forging operation. The advantage of the narrow slot is that it lends itself to the production of a single form of magnet structure from which permanent magnets of various forms may be machined. The magnet shown in Fig. 7 could be produced if the slot 13 were much wider than shown, but, in cases where a different final structure is required, a wide slot would not be suitable. The recess 14 is to facilitate finishing of the final magnet structure to a final form such as shown, for example, in Fig. 11 of my prior application. Thus, by utilizing the particular shape of the pole piece member shown in Fig. 3, I may, in a manner to be de-

scribed, produce a single form of blank from which various types of final magnet structures may be produced.

The pole piece member produced in accordance with Fig. 3 is then inserted into a mold where the high coercive force material 11 is cast. This produces a ring-like structure, as shown in Fig. 5. When this structure is removed from the mold and allowed to cool, strains are relieved through the expansion of the slot to the form of a V 13' as shown in Fig. 6. High coercive force material of the type utilized in permanent magnet structures shrinks quite greatly on cooling and, without the provision of the slot, none of the resulting strain would be relieved and excessive breakages would occur. Such strains as may remain in the structure shown in Fig. 6 are readily relieved by annealing. The manufacturer is therefore assured that, when a structure such as shown in Fig. 6 is then finished to final form, there will be no further relief of strains such as would lead to inaccuracy in the final magnet, and should inaccuracies occur, found later, for example on inspection, the cause of inaccuracy is immediately traced to the machining operation and it can be readily corrected.

A structure such as shown in Fig. 6 can, as stated, be finished in several ways, and, in Fig. 7, I illustrate one form which the finished magnet may take after final machining operations have been completed. Oppositely spaced pole piece surfaces 16 will be found to be extremely accurate, and tapped holes 17, utilized subsequently for mounting the meter movement, will also be true.

The pole piece member may be of any suitable para-magnetic material, such as a material with low retentivity and high magnetic permeability, such as iron. It moreover should be a material which is readily machinable to a highly accurate degree. In place of the product of the Mishima patent, known to the trade under the name "Ainico," other similar high coercive force materials may be used to form the portion 11 which functions to retain its magnetism and thereby impart the characteristics of a permanent magnet to the structure as a whole.

I have found that a structure such as shown in Fig. 6 may be produced in the foundry and delivered to the instrument maker substantially free of all mechanical strains. This structure may comprise an intermediate manufactured article from which the instrument maker, by suitable tooling and assembly operations, may produce a relatively inexpensive but highly accurate meter.

What I claim as new and desire to protect by Letters Patent of the United States is:

1. The method of producing a magnet structure for electric meter and the like, which comprises forming a magnet pole piece member of low coercive force material having ends of such a shape as to become readily mechanically bound to a permanent magnet body when cast around them, and with a transverse slot intermediate such ends, said slot extending almost across the pole piece member from that edge thereof which will comprise the periphery of the final magnet structure, casting a permanent magnet body of high coercive force material with said magnet pole piece member inserted so that its ends are banded to the magnet body, the said slot allowing the pole piece member to be distorted about the slot when the permanent magnet body cools after casting whereby to relieve strains in the

entire structure, and machining the resulting structure to final form wherein the pole piece member forms pole pieces of the final structure.

2. The method of producing a magnet structure for electric meters and the like, which comprises forming a magnet pole piece member having its ends shaped to become readily mechanically bound to a permanent magnet body when cast around them, cutting a slot intermediate the ends from that surface of the pole piece member which will comprise the periphery of the

final cast body, said slot being cut substantially entirely across the said pole piece member, leaving only enough metal to support the member as a single unit during handling, placing said pole piece member in a mold, casting a permanent magnet body of high coercive force material with the ends of the pole piece member mechanically bound therein, and machining said pole piece member to final shape.

ARCHIE J. McMASTER.