Jan. 17, 1939. R. REESE ET AL 2,144,546

PERMANENT MAGNET CONSTRUCTION

Filed March 9, 1938

Fig. 4.

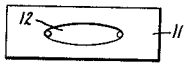


Fig. 3.

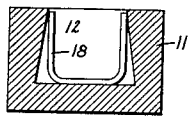


Fig. 2.

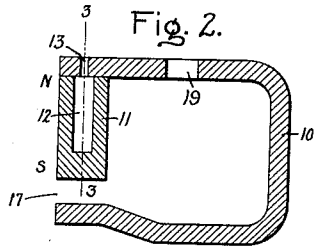


Fig. 1.

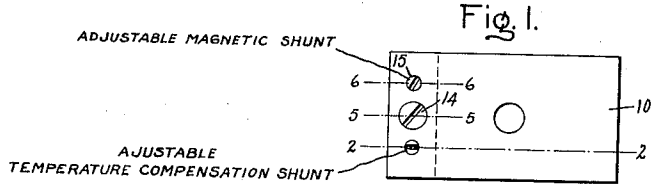


Fig. 5.

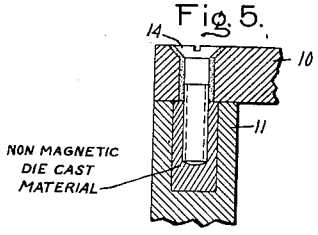
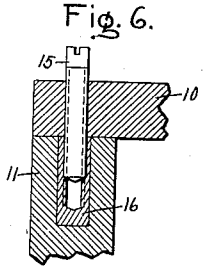


Fig. 6.



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UNITED STATES PATENT OFFICE

2,144,546

PERMANENT MAGNET CONSTRUCTION

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Application March 9, 1938, Serial No. 194,870
In Germany May 5, 1937

4 Claims. (Cl. 175—21)

Our invention relates to improvements in permanent magnets, particularly those used for damping magnets in meters and the like, and it has for its object an improved construction which minimizes grinding operations, facilitates adjustment of magnetic strength and provides for temperature compensation where that is desirable.

The features of our invention which are believed to be novel and patentable will be pointed out in the claims appended hereto. For a better understanding of our invention reference is made in the following description to the accompanying drawing. Fig. 1 represents a plan view of a permanent magnet structure embodying our invention; Fig. 2 may represent a sectional view taken on line 2—2, Fig. 1, prior to the final uniting of the iron yoke part 10 and bar permanent magnet part 11; Fig. 3 represents a section of bar magnet part 11 taken on line 3—3, Fig. 2; Fig. 4 is a plan view of the bar magnet part 11; and Figs. 5 and 6 are fragmentary sections taken on line 5—5 and 6—6 respectively of Fig. 1 and representing holding and compensating features to be described.

The main parts of the magnet here illustrated comprise a horse shoe shaped magnetic yoke part 10 and a permanent magnet bar part 11. The yoke part 10 is made of a relatively inexpensive suitable magnetic iron or soft steel that can be readily formed into the shape desired, and machined. Part 11 is a cast bar magnet of high coercive force material which is permanently magnetized along one axis as indicated by the poles designated N and S, Fig. 2. It is provided with a central axial cavity or opening 12 which is preferably oblong in shape as indicated in Fig. 4. This opening may extend through the magnet but we generally prefer to close the lower end as indicated, in Figs. 2 and 3. This cavity is formed during the casting operation and its interior surface is generally rough and is preferably larger in one dimension at the bottom end to secure a dove-tail effect as best illustrated in Fig. 3. It is only necessary to grind the end polar surfaces of this bar magnet casting. After the parts 10 and 11 have been formed to the proper shape and dimensions, these parts are united by filling the cavity 12 by suitable material by a high pressure die-casting operation. The die-cast material is preferably non-magnetic and can be readily machined. The yoke 10 is provided with one or more openings 13 opposite cavity 12 through which the die-casting material is forced. One or more holding bolts or lag screws 14 are provided and fitted through an opening or openings in the yoke part 10 and enter well into the die-cast material as shown in Fig. 5. Such holding screw is preferably inserted in place prior to the die-casting operation. However, the screw hole in the yoke may also be used to insert the die-casting material and the screw hole is then subsequently bored out and tapped and the screw inserted. The bar magnet 11 is thus secured to the inner surface of one limb of the yoke 10 and extends towards the other limb to form the air gap at 17.

The screw 15, Figs. 1 and 6, may comprise a screw for adjusting the strength of the magnet. For example, if the die-cast material 16 be of non-magnetic material as is preferable and the screw 15 of magnetic material, the depth to which the screw 15 is adjusted along the magnetic axis will vary the strength of the flux crossing the air gap at 17, Fig. 2. If the screw 15 be fully inserted, it will shunt more or less of the flux between the opposite poles of the permanent magnet and decrease the flux which passes about the yoke portion 10 and crosses the air gap. Then, by raising the screw 15, it will have less and less shunting effect and the flux across air gap 17 will be increased. Such adjustable screw may be of a magnetic material having constant permeability with temperature change in which case it will merely serve to adjust the magnetic strength independently of temperature changes. If temperature compensation is desired another screw vertically adjustable in opening 13 may be made of a magnetic material having a positive or negative temperature coefficient of permeability. For example, a screw made of an iron-copper-nickel alloy will have a negative temperature coefficient of permeability. When fully inserted in its opening, such screw will shunt flux between the ends of the permanent magnet. This shunting effect will decrease with rise in temperature and hence, compensate the entire magnet structure for the tendency of such a magnet to decrease in strength with temperature rise. Then, by raising the screw, this compensation may be decreased until just the desired temperature compensation is obtained. At the same time the proper strength of magnetic field at a given temperature may be obtained by adjustment of screw 15.

The temperature compensation desired may be predetermined by experiment and a non-adjustable temperature compensating member of the required characteristic may be inserted in the cavity of the permanent magnet prior to the

die-casting operation. Such a compensating strip is indicated at 18 in Fig. 3. Likewise, such compensation may be obtained by making the holding screw 14 of the proper alloy and dimensions.

Such fixed or adjustable means for varying the effective strength of the permanent magnet are a component part of the structure and are well protected against damage or displacement by being within the structure itself and in most of the forms described, assist in securing the yoke and permanent magnet parts together. These compensating provisions add little to the cost of an otherwise relatively inexpensive magnet construction. They are suitable for use with bar permanent magnets generally, independent of the use of a yoke part such as part 10. The yoke 10 may be provided with one or more bolt holes 19 for securing the same to the meter or other device on which it is used.

In accordance with the provision of the patent statutes, we have described the principle of operation of our invention together with the apparatus which we now consider to represent the best embodiment thereof but we desire to have it understood that the apparatus shown is only illustrative and that the invention may be carried out by other means.

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

1. A permanent magnet comprising a bar-shaped casting of permanent magnetic material polarized along one axis and having an inner cavity, said cavity containing a machinable non-magnetic material and a magnetic shunt for said magnet in the form of a screw threaded in the material contained in said cavity and adjustable therein along said axis.

2. A permanent magnet comprising a bar-shaped permanent magnet comprising a casting of high coercive force magnetic material polarized along one axis, said casting containing a cavity extending along its polarized axis containing non-magnetic die-cast material, and a shunt for said magnet supported in said die-cast material said shunt being made of a magnetic material the permeability of which varies with temperature changes.

3. A permanent magnet comprising a casting of high coercive force magnetic material, polarized along one axis, a cavity extending from one end nearly through said casting along said axis, a non-magnetic die-cast material filling said cavity, and a shunt for said magnet in the form of a screw threaded into said die-cast material along said axis, said shunt being made of a magnetic material the permeability of which varies with changes in temperature.

4. A permanent magnet comprising a bar-shaped casting of high coercive force magnetic material polarized along one axis, a cavity extending throughout the greater length of the magnetic axis of said magnet, said cavity being filled with a machinable non-magnetic material containing a pair of parallel, threaded screw holes extending in the direction of said axis, an adjustable screw made of a constant permeability magnetic material threaded in one hole and an adjustable screw made of a magnetic material having a temperature coefficient of permeability which varies with temperature threaded in the other screw hole.

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