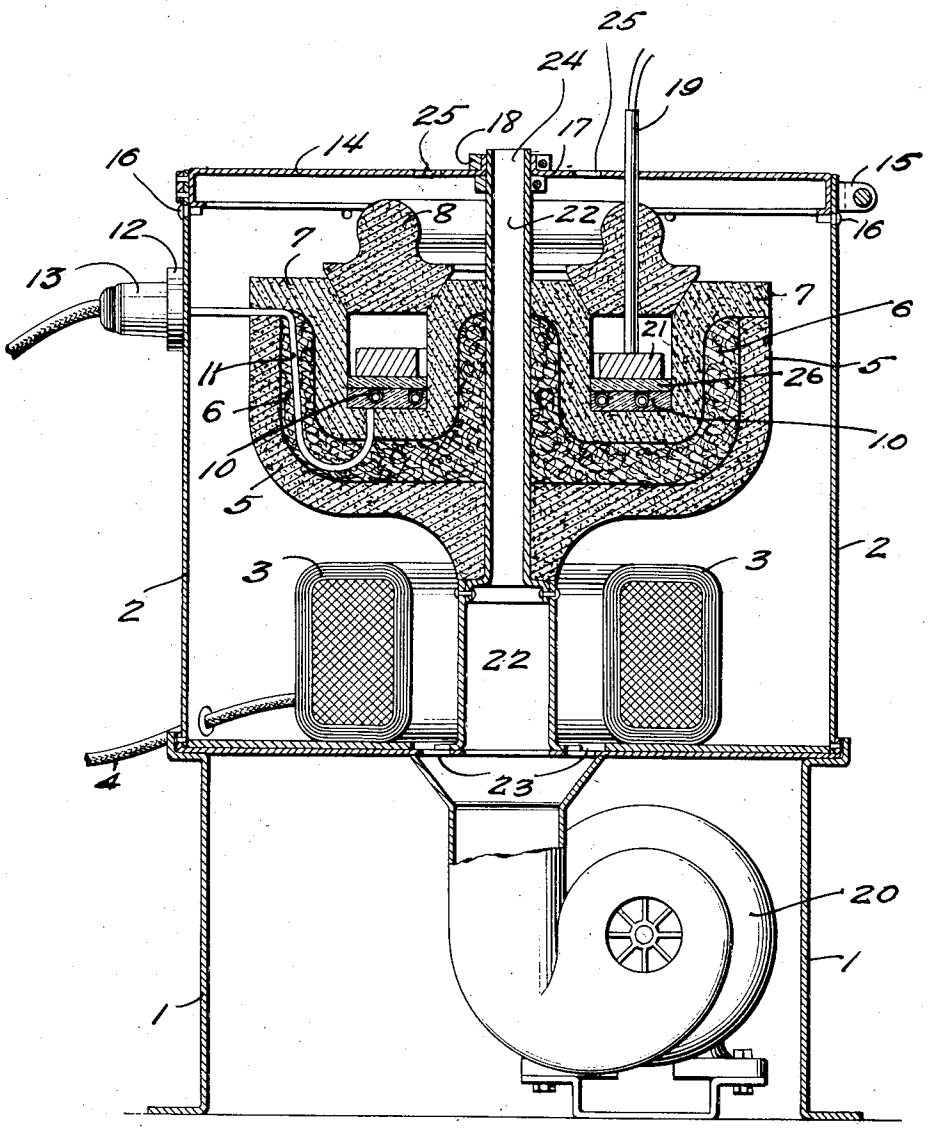
June 5, 1923. 1,457,438

G. A. KELSALL

PERMEAMETER FURNACE

Filed March 23, 1921



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UNITED STATES PATENT OFFICE.

GEORGE A. KELSALL, OF BELLEVILLE, NEW JERSEY, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

PERMEAMETER FURNACE.

Application filed March 23, 1921. Serial No. 454,814.

To all whom it may concern:

Be it known that I, GEORGE A. KELSALL, a citizen of the United States, residing at Belleville, in the county of Essex, State of New Jersey, have invented certain new and useful Improvements in Permeameter Furnaces, of which the following is a full, clear, concise, and exact description.

This invention relates to devices which are employed to determine the characteristics of magnetic materials, such devices often being referred to as permeameters.

The main object of the present invention is to provide a permeameter which may be used in investigating the magnetic properties of magnetic materials at elevated temperatures.

Other objects will be apparent from a consideration of the devices as described herein.

In the drawing, 1 represents a stand which is used in supporting a one-turn transformer secondary 2 made of thin copper sheet. Within the secondary 2 is located a primary coil 3, which consists of an appropriate number of turns of wire wound on a finely divided magnetic coil. By means of the leads 4, current is supplied to the primary windings.

Positioned directly above the primary coil and mounted on suitable supports is a shell 5 of heat-resisting insulating material which is capable of withstanding elevated temperatures without change of form or deterioration. Inside the shell is placed a packing of insulating material 6, such as, for example, kieselguhr, and a second insulating shell 7, which is so formed that a circular heating chamber is provided. A cover 8, preferably made of the same insulating material used for the two shells mentioned above, is also provided. Within the circular heating chamber an electrical heating unit 10 is placed, electrical power being conveyed thereto by means of a cable 11, which terminates in a terminal bushing 12, said bushing being adapted to be engaged with a plug 13.

The secondary 2 also comprises a cover 14, which must necessarily be placed in position before the secondary circuit is completed. This cover is held in position by means of a clamping band 15, stop pins 16, cover stop 17, and a cover clamp 18, to insure good electrical contact. The cover of the secondary and the furnace cover 8 are provided with an aperture through which a thermo-couple 19, or other temperature-measuring device, may be inserted into the circular heating chamber. A blower fan 20, associated with operating means is located below the primary coil 3, outside the secondary. The purpose of this blower fan is to keep the primary coil and the copper shell from becoming too warm, thereby maintaining the electrical and magnetic constants of the instrument unchanged. Further, the blower fan is used to rapidly cool the specimen 21 which is to be tested whenever such cooling is desirable. The air from the fan is blown up through the ducts 23 and 22, and leaves the apparatus at 24 and 25.

In operating the permeameter, the specimen 21, which has been formed preferably to a toroidal shape, is placed in the circular heating chamber directly above the heating unit 10 and the separator 26 of asbestos or similar material. The heating unit is wound so as to be non-inductive to other electrical circuits of the permeameter. The furnace cover and secondary cover are then placed in position as shown. By means of the leads 4, the primary winding is included in one arm of an impedance bridge, said bridge comprising a pair of ratio arms of non-inductive resistance, a variable inductance, a variable resistance, a telephone receiver, and a source of high frequency alternating current. To anyone familiar with the theory of the transformer, it is evident that the permeability of the magnetic material to be measured may be expressed as a function of the dimensions of the core tested and of the inductance of the permeameter as determined by the bridge measurement. Such an expression is

$$\mu = K\left(\frac{LL_p}{L_p - L} - L_s\right)$$

in which μ equals permeability, L_p equals primary inductance, L_s equals secondary leakage inductance referred to the primary, and L equals permeameter inductance with

the material in the circular heating chamber. The expression

$$\frac{LL_p}{L_p - L}$$

equals the total secondary inductance referred to the primary when measured with no specimen in position. K is a constant whose value depends on the number of turns in the primary.

In some cases it is desirable to retain the specimen in a particular magnetic state, which has been produced by the heat treatment, and which may be accomplished by cooling the specimen suddenly to room temperature. To do this, the cover 8 may be quickly raised by means of lugs (not shown) which project through the cover 14 and the air from the blower fan 20 allowed to come into contact with the specimen. It is apparent that other means may be devised by which the cover 8 may be removed without requiring any more than mere mechanical skill.

Although the device described herein has been termed a permeameter furnace, it may be employed as a core loss tester when the loss in the magnetic material at elevated temperatures is desired. The method of measuring these core losses is described in Patent 1,296,813, granted to me March 11, 1919.

Although a specific construction of a permeameter furnace has been described herein, such construction may be changed or altered in order that the requirements of any particular investigation may be met without departing from the spirit of the invention.

What is claimed is:

1. A permeameter furnace comprising a primary and a secondary winding, means for testing a specimen of magnetic material, and heating means adapted to heat the specimen to be tested.

2. A permeameter furnace comprising a primary winding, a containing case of conducting material for said winding forming a secondary therefor, means for testing a specimen of magnetic material, and heating means adapted to heat this specimen.

3. A permeameter furnace comprising primary and secondary windings, means for testing a specimen of magnetic material, and a heating chamber suitably heat insulated from said windings, said heating chamber containing heating means which is adapted to heat the specimen to be tested.

4. A permeameter furnace comprising heating means, primary and secondary windings, said primary and heating means being located within the secondary, and cooling means associated with said furnace.

5. A permeameter furnace comprising means for testing a specimen of magnetic material, and a secondary winding mounted upon a suitable support, said secondary being in the form of a metallic shell and containing a primary winding and heating means.

6. A permeameter furnace comprising heating means enclosed within an insulating medium, a primary winding, and means for testing a specimen of magnetic material, said heating means and said primary winding being enclosed within a secondary.

7. A permeameter furnace comprising primary and secondary windings, heating means associated with suitable insulating mediums, and means for cooling said primary and secondary windings.

8. A permeameter furnace comprising a metallic shell mounted upon a suitable support, a primary coil, and heating means associated with insulating mediums within said metallic shell, and means for directing a current of air within said shell.

9. A permeameter furnace comprising a single turn secondary having a removable cover, said secondary enclosing a primary coil, and heating means associated with insulating mediums.

10. A permeameter furnace comprising an electric furnace located within a secondary winding.

11. A permeameter furnace comprising an electric furnace and a primary coil, said furnace and said coil being located within a secondary winding.

12. A permeameter furnace comprising an electric furnace located within a secondary winding, said furnace and said secondary being provided with covers having therein an aperture through which a temperature-measuring device may be inserted.

13. A permeameter furnace comprising an electric furnace having a circular heating chamber and a toroidal magnetic coil, said furnace and said coil being located within a metallic shell and means for testing a specimen of magnetic material.

14. A permeameter furnace comprising an electric furnace having a heating chamber, said chamber provided with a cover of heat insulating material, and means to pass a current of air into said chamber when said cover is removed.

15. The method of determining the magnetic state of a magnetic material at elevated temperatures, which consists in heating said material in an electric furnace located together with a primary winding within a secondary, and ascertaining the permeability of said material from the effect of its presence upon the current induced in said secondary by the current passing through said primary winding.

In witness whereof, I hereunto subscribe my name this 15th day of March, A. D. 1921.

GEORGE A. KELSALL.