Jan. 10, 1939. E. E. WICKERSHAM 2,143,811

ELECTROMAGNETIC CORE CONSTRUCTION AND METHOD OF MAKING SAME

Filed March 29, 1933 2 Sheets-Sheet 1

Fig. 1.

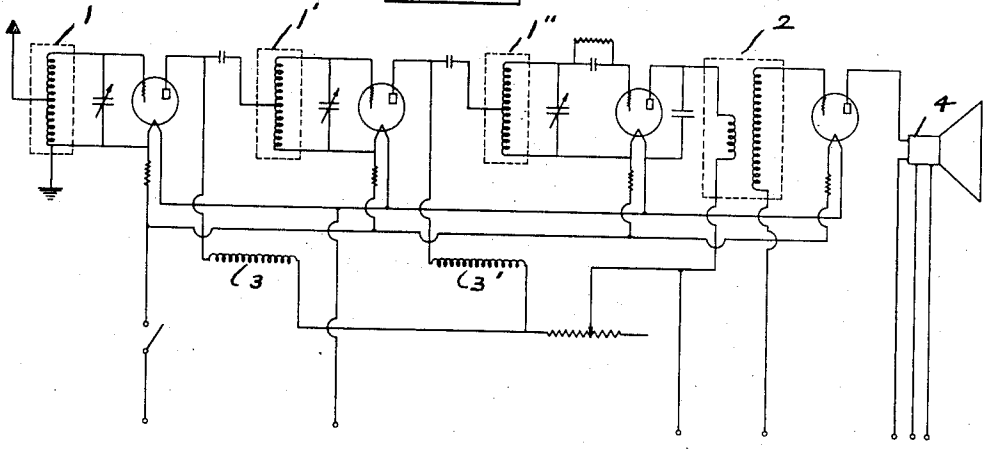


Fig. 2.

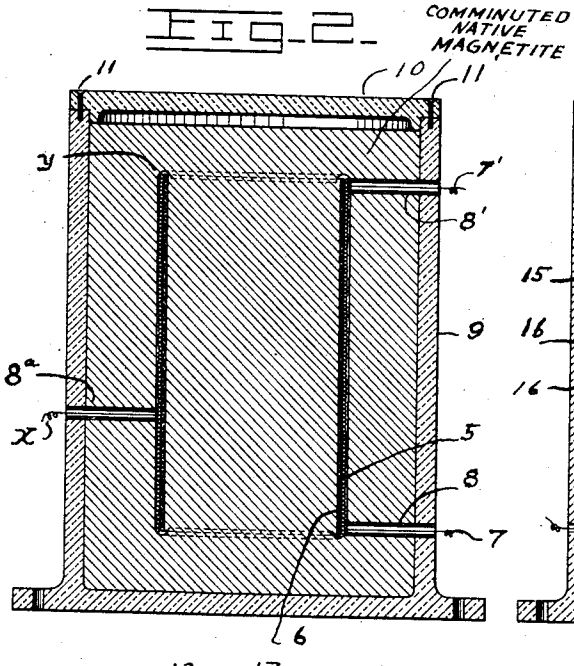


Fig. 3.

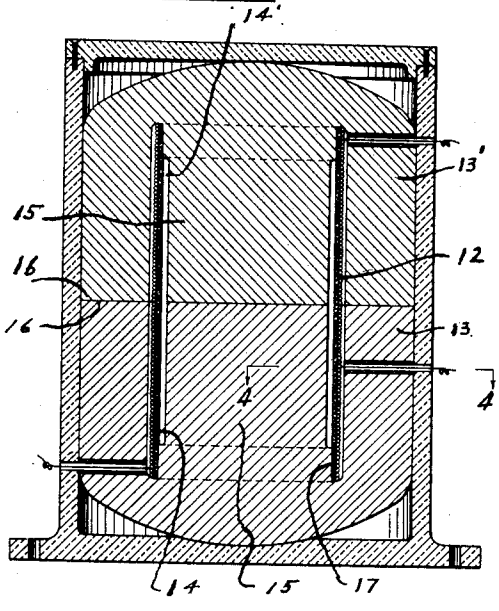
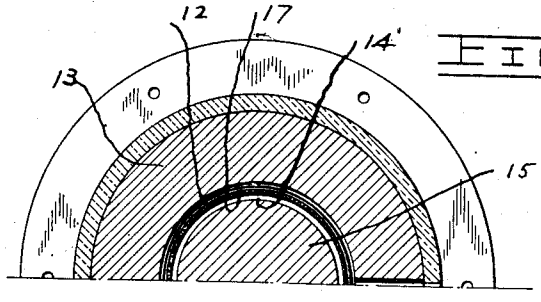


Fig. 4.



INVENTOR.

Elmer E. Wickersham

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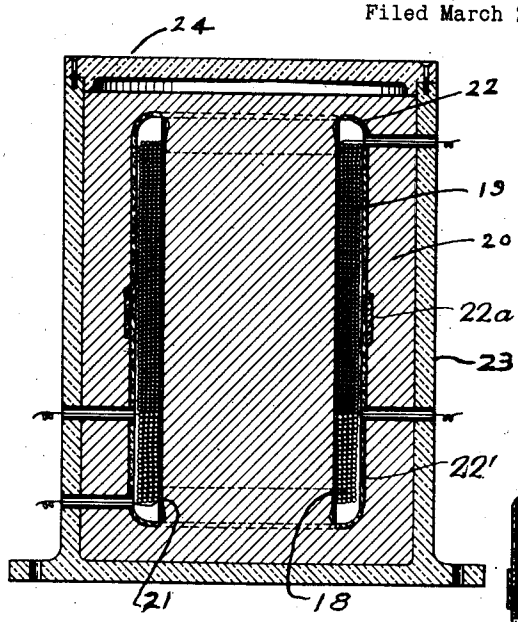


Fig. 5.

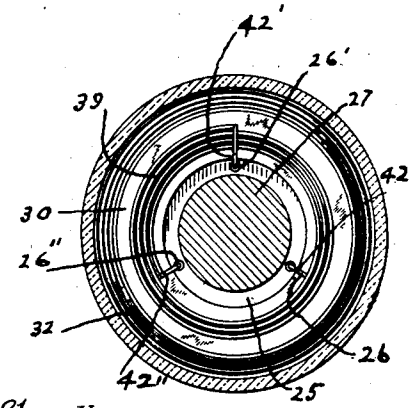


Fig. 7.

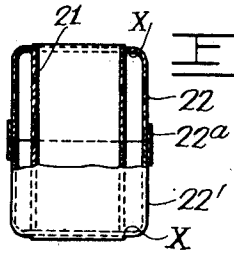


Fig. 9.

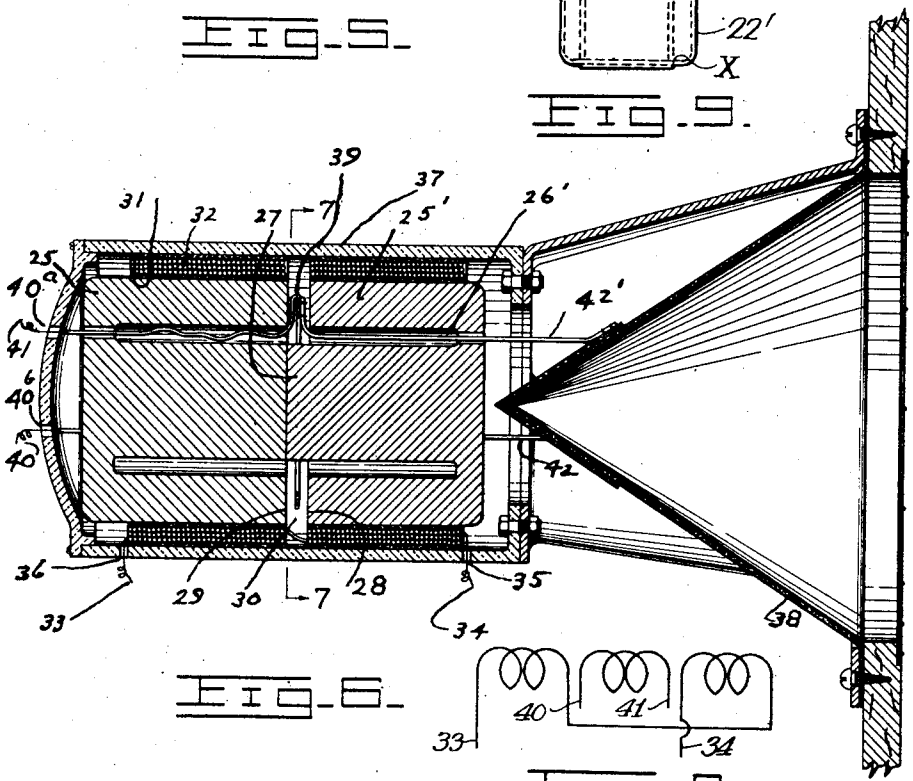


Fig. 6.

Fig. 8.

INVENTOR.

Elmer E. Wickersham.

Patented Jan. 10, 1939

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UNITED STATES PATENT OFFICE

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ELECTROMAGNETIC CORE CONSTRUCTION AND METHOD OF MAKING SAME

Elmer E. Wickersham, San Leandro, Calif.

Application March 29, 1933, Serial No. 663,298

4 Claims. (Cl. 175—21)

My invention relates to the method of construction of, and particularly to the material used in the cores of transformers, coils, artificial magnets, and other similar devices such as are used in the construction of both radio and audio frequency current devices.

My first object of this invention is to construct the cores of the various magnetic components of radio receiving and broadcasting sets of a finely divided magnetic material having a relatively high electrical resistance, and of good magnetic quality, so as to shorten the natural air gap length of the magnetic circuit in these various magnetic components of such sets.

Another object is to provide a simple and effective method of constructing cores for inductance coils, transformers, and the like.

Another object is to produce a practically closed magnetic circuit for coils and transformers of a noncorrosive, finely divided magnetic material which may be poured dry into a coil housing to form a magnetic unit of small compact form which may be easily and cheaply constructed.

Another object is to produce a magnetic core for coils and transformers of a magnetic material which is naturally in a finely divided state, by mixing such material with shellac or other similar quick-drying ingredient, shaping the core material in a mould and subsequently baking the core so formed, at such a temperature that the core material will become dry, rigid, and self-supporting.

Another object is to produce a core for a magnetic unit of a finely divided magnetic material which will act as a shield for the unit.

Another object is to produce a magnetic circuit of a finely divided, non-corrosive material having high magnetic properties and whose contact resistance between the various magnetic particles is high enough to prevent or reduce to a minimum any eddy currents which may be induced therein.

Another object is to produce a radio frequency transformer having a closed magnetic circuit embracing and enclosing the coil component of the transformer and arranged so that a quantity of said core material may be removed from or added to said core, whereby two or more of such transformers may be matched to such a degree of exactness that each and every coil so treated will have the same inductance.

My chief object among others is to produce certain components of an electrical instrument adapted to receive short wave, broadcast, or long wave frequencies, the magnetic components of which, comprise one or more coils in each unit having a combined core and shield therefor, composed of a finely divided magnetic material such as magnetite, which is commonly called black sand, such as is found in large deposits along the Pacific coast and elsewhere.

Still another object is to produce a radio wave receiver and reproducer, having the magnetic components thereof composed of magnetite, or of that material which is commonly known as "black sand," that will reproduce these radio waves truly over the entire audible musical scale.

I attain these objects by constructing the cores of the various magnetic components, as illustrated in the accompanying drawings, in which:

Fig. 1 shows a fragmentary circuit of a type to which my invention may be applied.

Fig. 2 is a vertical sectional elevation of a transformer having a single winding, a combined magnetic core and shield therefor, of the loose dry type, and a housing for the core and the coil member.

Fig. 3 is a vertical sectional elevation of a transformer having a combined core and shield therefor, of the moulded type, enclosed in a housing.

Fig. 4 is a plan sectional view on line 4—4 of Fig. 3.

Fig. 5 is a vertical sectional elevation of a transformer including a two circuit coil which is embraced by a combined magnetic core and shield therefor, all enclosed in a housing.

Fig. 6. is a vertical sectional elevation of the reproducer or loud speaker component, having the magnetic core element thereof formed in accordance with the spirit of my invention.

Fig. 7 is a transverse sectional view taken on line 7—7 of Fig. 6, showing the passage ways and chambers in the core member and the general arrangements of the coils relative to the core.

Figure 8 is a schematic wiring diagram of the device of Fig. 6.

Figure 9 is a detail view partly in section and partly in elevation of a coil form and container.

In addition to these objects as set forth above, other objects will be apparent in the following specification:

I will state here and now that I am aware that metallic cores for coils and transformers have been used, including the so-called iron clad type of magnetic core; also, that iron cores have been and are used today in transformers employed as intermediate amplifiers in radio sets employing the super-heterodyne principle; and that iron cores of the laminated type have been and are used in audio transformers, choke coils, and, in the magnetic components of loud speakers, or reproducers; but, I am not aware that iron having the same characteristics and physical form as that of magnetite, which is generally termed in the gold mining districts, black sand, or that magnetite or black sand has ever been used as a material to form the cores of electro-magnetic coils,

transformers, loud speakers, and especially those used in the art of manufacturing radio receiving and/or broadcasting equipment.

In practicing the improved method of constructing cores in accordance with my invention, I mix comminuted native magnetite retaining its native magnetic qualities substantially as they occurred in the virgin magnetite with a binding material, and form the mixture into a core of permanent form suitable for association with inductance windings.

Referring to Fig. 1, 1—1'—1'' represent the radio frequency transformers of my preferred form as being positioned in an electrical circuit, they being particularly illustrated in Fig. 2 and Fig. 3. In Fig. 1, 2 is the audio transformer, while 3—3' represent the choke coils in this circuit and 4 represents the magnetic component of the loud speaker or reproducer of the character illustrated in Fig. 6.

In order that others skilled in this art may make and use my invention, in spirit, I will describe the construction of the various magnetic components as set forth in the drawings.

Referring to Fig. 2, the coil member 5 is preferably formed by winding the desired number of turns of wire upon a non-conductive form, or tube, 6 and bringing the free ends of said wire 7—7' out through restricted tubes 8—8', to which other wires of an electrical circuit may be attached. At some desired point intermediate the ends of coil 5, a tap wire X is brought out from coil 5 through tube 8^a, which may be connected to a source of electrical energy, not shown. The coil is preferably supported inside of housing 9 by tubes 8—8' and 8^a. It will be seen that the housing for the coil is provided with a cover 10 which is normally held in position on housing 9 by screws 11—11'.

In carrying out the spirit of my invention, I will assume that the coil 5 has been formed and properly insulated as at Y, by a covering of cloth, paper, or wax, and suspended in housing 9 and that the cover 10 has been removed therefrom. The next step, I prefer to pour a quantity of magnetite or black sand, into housing 9, sufficient to completely submerge the coil 5 and to practically fill said housing to the top thereof, to form a combined core and shield, and thus also form a closed magnetic circuit. The cover 10 may now be replaced on housing 9 and secured by screws 11—11' or by other means. The magnetic coil or transformer unit is now completed and ready for use.

Fig. 3 shows a coil or transformer 12 having its combined core and shield formed in two parts, upper and lower, as shown at 13—13' that are composed of magnetite or black sand, which has previously been wetted or moistened with a quick-drying binding material such as shellac and subsequently baked to dryness in a metal mould, not shown, so that the moisture in the binder may be evaporated and the cores become dry, hard, and self-supporting.

Each section of said cores 13—13' has an annular channel 14—14' formed in the inner face thereof, and has a central post 15 extending from the depth of said annular channel to a point in the plane of faces 16 of cores 13—13' which are adapted to support the coil 12 and its form 17 as it clearly shown in Fig. 3.

Fig. 4 shows the coil in said annular channel and also the manner in which the combined core and shield of magnetite or black sand, completely engulf and encloses the coil 12 and its form 17; it being a view taken on line 4—4 of Fig. 3.

Fig. 5 shows and illustrates a transformer of the so-called audio type, the current carrying components of which are preferably formed in the two parts termed primary and secondary coils, as at 18 and 19, respectively. The combined core and shield 20 forming practically a closed magnetic circuit may be formed according to the method described in the forming of the corresponding component illustrated in Fig. 2, the coils 18—19 are preferably wound on a form of insulating material 21 and then covered and sealed by a tubular insulating form such as shown at 22 and 22' to effectively prevent the various metallic particles which form the core and shield from making physical contact with the windings of the coils 18—19. The insulation 22 may be of any suitable material such as paper.

The insulating members 22 and 22', shown in Figures 5 and 9, may be formed in any suitable manner, as, for instance, by die casting, molding, or otherwise shaping plastic, semi-plastic, or other suitable material, and when necessary subsequently drying the material to give the forms the desired rigidity.

The forms 22 and 22' as shown may comprise a pair of similar parts, each of which is cup-shaped and is formed with an aperture x in the bottom thereof. The apertures x are of such size as to permit an end of the form 21 to be received in the aperture with a sealing or snug fit. The side walls of the members 22 and 22' are of sufficient length to permit the ends thereof to be placed in abutting relation. Preferably, the members 22 and 22' are held in position by means of a band 22a. Suitable apertures are provided in the walls or bottoms of the parts 22 and 22' for accommodating wires leading from the coils exterior of the casing.

Referring again to Fig. 5, it will be readily understood that the coil and core housing 23 is adapted to receive and enclose both the coil and core components of the transformer and that a cover 24 is readily detachable so that the said components may be readily installed and mounted therein.

One of the effects of the presence of magnetite in the field of a coil through which current is flowing, is: that for the same number of turns in a coil, its inductance is increased, and consequently a coil having a closed magnetic circuit of magnetite will require a lesser number of turns of wire and proportionately reduce the ohmic resistance, which, for coils and transformers such as are used in radio apparatus, is advantageous.

One advantage gained by the use of these cores for transformers when constructed of magnetite, as described, is the ease with which two or more coils may be inductively matched. The magnetite, as used, is finely divided, and so pure that oxidation does not occur, and that due to the thousands of particles of the magnetite or black sand, included in a sufficient quantity of this material to make or construct a core, as described, it is apparent now that by the addition of a few grains of magnetite to the core of a coil or transformer the inductance thereof will be increased, and conversely when a few grains are deleted from the core mass the inductance of said coil will be decreased.

Thus, in order that two or more coils of the character described be made to have the same inductance, it is only necessary to either add to,

or take away a sufficient quantity of magnetite or black sand from the core of one or more of said coils, to equalize their inductances. I have found by experiments and use in actual service that, when coils having cores constructed of magnetite or black sand are utilized in short wave radio circuits, the results are highly satisfactory and are superior to the results obtained when using air core inductances. I also have found that a radio broadcast receiver equipped with magnetite for its inductances and audio transformers is very stable in operation and is possessed of a high degree of selectivity, being thereby capable of efficient operation in congested districts. In addition to the aforementioned advantages, the tonal quality of reproduction is greatly improved. This appears to be due in part to the fact that eddy currents, if formed, are immediately localized and dissipated by the high contact resistance between the minute particles of the magnetite cores. Another of the principal benefits resulting from the use of magnetite in the flux path of an electromagnetic device lies in its permanency of electrical and magnetic characteristics and resulting constancy of performance. I prefer to employ a magnetite material containing about 70% magnetic oxide of iron having a high permeability and a relatively high specific resistance. Magnetite material of the character previously referred to usually contains about this percentage of magnetic oxide of iron associated with certain other ore oxides, such as limonite, ilmonite, and also hematite and titanium. In some instances, titanium occurs as an element, but in most cases titanium occurs in combination as ilmonite. A particular characteristic of magnetite as it occurs in nature and which renders it especially suitable for use as core material is its resistance to decomposition. A further favorable characteristic is that the iron constituent of magnetite is not hard enough to permit any substantial degree of permanent polarization, which feature alone is invaluable and advantageous as compared to ordinary iron when used as a core material.

Fig. 6 is a vertical longitudinal section of a loud speaker or reproducer having the magnetic core component 25—25' thereof constructed in two parts and in accordance with the spirit of my invention. In constructing this device as illustrated, I prefer to form the cores 25—25' of magnetite or black sand, and to preferably moisten or mix said magnetite with a quick-drying liquid, such as shellac and then press the mixture into suitable metal molds and subsequently subject the so-formed cores to a sufficient temperature to evaporate the moisture from the binder, or shellac, and thus cause the magnetite core to become dry, rigid, and self-supporting.

It will be noted that the core members 25—25' are preferably formed with three spaced holes 26—26'—26'' running longitudinally of said cores, as shown in Fig. 7, and arranged so that the holes in one core member will be in register with the holes in the other core member when they are in abutting relation as illustrated in Fig. 6. It will be noted that one of the core members 25' has a protrusion 27 thereon which acts as a spacer, to space apart the faces 28 and 29 to form an encircling groove 30 between cores 25—25'. The purpose of said holes 26—26'—26'' and the channel or groove 30 will be presently explained. Assuming that the core members 25—25' have been formed and the ends thereof arranged in abutting relation as shown, I next prefer to cover each of the core sections 25—25' with an insulating material 31 and upon which I wind a relatively large number of turns of fine wire 32 and bring the free ends 33—34 of said winding out through holes 35 and 36 in housing 37, into which the cores 25—25' have been placed, and arrange them for connection to a source of electrical energy, not shown. The coil 32 just described is called the field coil of an instrument of this character.

In order that the cone 38 of the loud speaker be adapted to be driven, I place a coil 39 freely in groove 30 and bring the free ends 40—41 thereof through holes 26—26' in core 25 and holes 40^a—40^b in housing 37 and arrange them in a manner that they may be readily connected to a source of electrical energy, not shown. Coil 39 is suspended in groove 30 by three suspension rods 42—42'—42'' which pass freely through holes 26—26'—26'', of core 25' and connect to cone 38. The coil 39 is the armature coil and is free to move and drive the cone 38 by means of rods 42—42'—42'' when excited by an electric current, and the field thereof is reacted upon by the electro-magnetic field produced by coil 32, when it is excited by an electric current. Inasmuch as the particular wiring scheme I have shown in Fig. 1 to illustrate the application of these various components which I have heretofore described forms no part of this invention and also that the principles governing the workings of the coils, transformers, and loud speakers, or reproducers are well understood by those skilled in this art, therefore, I deem it unnecessary to make further explanations in this regard.

I have constructed and used coils and cores as described herein and am not familiar with all the phenomena which take place therein, but I do know the results obtained by their use are indeed gratifying and I realize that these cores and shields may be made in many other physical forms employing the use of magnetite, or what is known as black sand, without departing from the spirit of this invention; and, accordingly, I wish the meaning and intent of the following claims to be limited only by the state of the art to which they pertain.

I, therefore, claim as my invention:

1. An electro-magnetic core comprising a body of native black sand including a large proportion of magnetite, and means for maintaining said magnetite in predetermined form.

2. An electro-magnetic core comprising a body of comminuted native magnetite retaining its native magnetic properties substantially as they occurred in the virgin magnetite and means for maintaining said magnetite in predetermined form.

3. The method of constructing a core for inductance coils, transformers, and the like, which method consists in mixing comminuted native magnetite with a binder, moulding the resulting mixture into a core, and subsequently treating the core to give it self-supporting characteristics.

4. A method of constructing cores for inductance devices and transformers which consists in mixing finely divided native magnetite with a binding material, and forming the mixture into a core of permanent form suitable for association with inductance windings.

ELMER E. WICKERSHAM.