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HIGH-FREQUENCY TRANSFORMER FOR THE TRANSMISSION OF ELECTRIC IMPULSES

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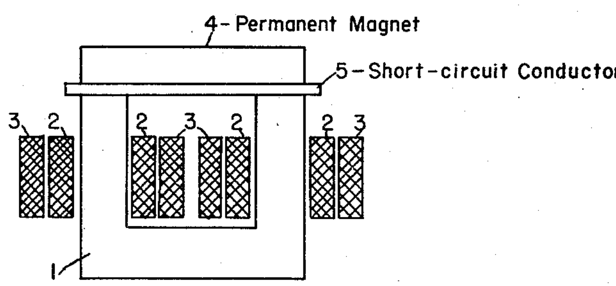

FIG. 1

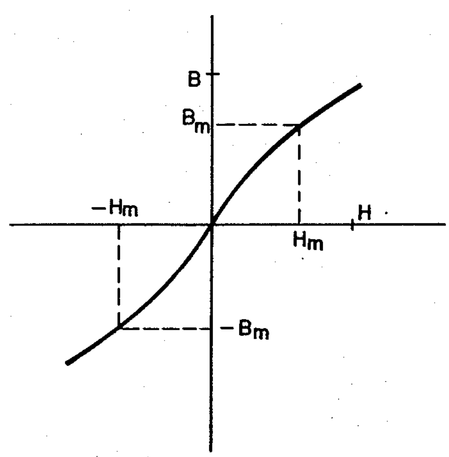

FIG. 2

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HIGH-FREQUENCY TRANSFORMER FOR THE TRANSMISSION OF ELECTRIC IMPULSES

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2 Claims. (Cl. 317—210)

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This invention relates to a high-frequency transformer for the transmission of electric impulses, for example radar impulses, in an undistorted manner which comprises a magnetic circuit consisting of high-frequency ferro-magnetic material, preferably ferrite.

For transmitting radar impulses with the use of a high-frequency transformer, by means of which substantially rectangular primary pulses of, say, 5 kilovolts and having a duration of, say, 1 μ sec. and a pulse recurrence frequency of more than 50 c./sec., can be converted into similar secondary pulses of, say 30 kilovolts, use has hitherto been made of a transformer which comprises a ferro-magnetic circuit, for example of rolled sheet iron, which is adapted to be magnetised to a comparatively high magnetic induction before exceeding the limit which is set to the magnetic induction by the bend of the magnetisation curve of the magnetic material. The disadvantage of the use of rolled sheet iron is that the losses are comparatively high, so that the material becomes more and more unsuitable for an impulse-recurrence frequency of more than several kc./s. In this respect it has been found that ferrite, which is highly permeable and substantially non-conductive, yields better results, notably the ferrite as described in prior Patent application Serial No. 78,432, filed February 25, 1949, which ferrite is likewise magnetisable to a very high induction. The ferrite described in this application consists of a manganese ferrous-ferrite having the formula $MO \cdot Fe_2O_3$, where M represents bivalent iron and manganese, in which iron and manganese atoms are in the ratio between 4.0:1 and 1.5:1, and the ferrite has a Curie point exceeding 250° C.

The present invention has for its object to provide a method by which the maximum permissible magnetic induction can apparently be further increased, which permits a larger primary impulse to be transmitted in an undistorted manner. In other words the transformer is suitable for a higher power. According to the invention, a constant magnetic field is produced in the magnetic circuit by means of a permanent magnet, due to which field, in the absence of an impulse, the ferro-magnetic material of the circuit tends to become saturated, the magnetic field produced by the pulses opposing the said constant magnetic field, a closed conductor consisting of electrically conductive material being provided between the permanent magnet and the magnetic circuit.

In order that the invention may be more clearly understood and readily carried into effect it will now be described more fully with reference to the accompanying diagrammatic drawing, given by way of example, in which Fig. 1 represents one embodiment thereof, Fig. 2 being a graph (magnetisation curve) showing the magnetic induction B as a function of the magnetic field strength H of the material in the magnetic circuit.

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Fig. 1 represents a high-frequency transformer for the transmission of electric impulses in an undistorted manner. It comprises a ferro-magnetic circuit **1** carrying a primary winding **2** and a secondary winding **3**. For the sake of clearness these windings, which actually are arranged as close together as possible, are spatially separated in the drawing. A primary voltage impulse of, say, 10 kilovolts is supplied to the primary winding **2** and an amplified but undistorted voltage impulse of, say, 200 to 500 kilovolts is required to be taken from the secondary winding **3**. To this end, it is necessary that the magnetic circuit **1** should not involve excessive distortion of the voltage impulse fed to the winding **2**, and that the size of the magnetic circuit and the windings should be as small as possible, in order to reduce the leakage inductances and the parasitic capacities of the two windings as much as possible. As appears from the magnetisation curve shown in Fig. 2, the magnetic inductance B of the ferro-magnetic material of circuit **1** can be permitted to vary only between a value zero and a given maximum inductance B_m, where the magnetisation curve tends to depart materially from linearity. Thus, a limit is set to the size of the primary impulses, which limit is determined by the maximum primary field strength H_m associated with this maximum inductance.

When, however, a constant magnetic field is made operative in the magnetic circuit, the magnetisation produced by the primary impulses is not restricted to the range from 0 to the maximum value B_m, but it may vary from a value $-B_m$ to $+B_m$, provided that the constant magnetic field operative in the magnetic circuit is such that, in the absence of a voltage impulse, the magnetic circuit tends to become saturated to a value $-B_m$.

The constant magnetic field might, for instance, be produced by means of a separate winding on the magnetic circuit, which winding is traversed by direct current. If this direct current winding is provided in the immediate vicinity of the primary and secondary windings **2** and **3**, it is necessary, in order to avoid a high-frequency short-circuit by this winding, to insert a high-frequency choke in the electric circuit of the said auxiliary winding, whereby the circuit-arrangement is made expensive. Alternatively, the auxiliary winding may be provided on the magnetic circuit so as to be spaced from the primary and secondary windings **2** and **3**. In this event, the short-circuit then constituted by this winding in regard to high-frequency currents only brings about that the magnetic field produced by the pulses is locally suppressed in the ferro-magnetic material. However, an additional auxiliary winding involves the drawback that the magnetic circuit has an undue size. Moreover, this auxiliary winding absorbs energy.

The embodiment shown in Fig. 1 comprises a permanent magnet **4** which produces a magnetic induction $-B_m$ in the absence of impulses in the ferro-magnetic material of circuit **1**. In order to prevent the high-frequency magnetic field produced by the impulses from suffering excessive losses in the material of the permanent magnet **4**, a closed conductor, for example a plate **5** of electrically conducting material, is provided between the permanent magnet **4** and the remainder of the magnetic circuit **1**. Due to this, Foucault currents are induced in the said conductor, and the high-frequency field in the magnetic circuit **1** is locally suppressed, but otherwise losses are not caused.

What I claim is:

1. A pulse transformer comprising a closed magnetic circuit comprising a ferro-magnetic ferrite core portion and a permanent magnet portion producing in said core portion a constant magnetic field having an intensity at which the core portion tends to become saturated, primary and secondary windings wound on said core portion, and a short-circuit electrical conductor disposed between the entire core portion of the magnetic circuit and the entire permanent magnet portion, whereby when pulses of current are flowing through said windings in a direction producing a field in said core portion in opposition to the field produced therein by the permanent magnet substantially distortionless transformation of the pulses is obtained.

2. A pulse transformer comprising a ferromagnetic ferrite core constituted by a generally U-shaped member, a permanent magnet constituted by a bar-shaped link fixedly connected across the ends of the U, primary and secondary windings wound on said U-shaped member, said permanent magnet inducing in said core a constant magnetic field having an intensity at which the core tends to become saturated, and an electrically conductive sheet disposed between the entire bar-shaped link and the ends of the U, whereby when pulses of current are flowing through said windings in a direction producing a field in said core in opposition to the field produced therein by the permanent magnet substantially distortionless transformation of the pulses is obtained.

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