Dec. 31, 1940. K. SCHLESINGER 2,227,029

ELIMINATION OF THE MAGNETIC DISPERSION OF TRANSFORMERS

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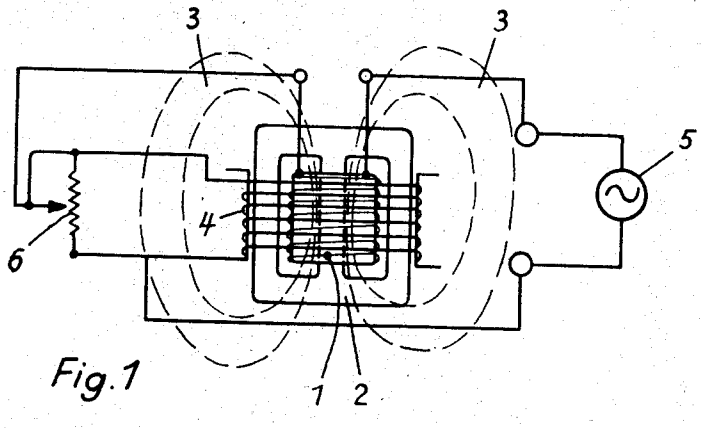



Fig. 1

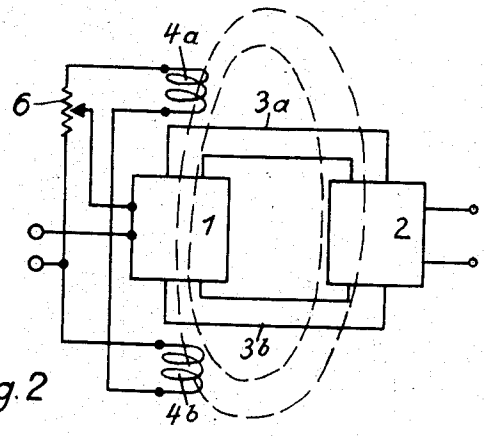



Fig. 2

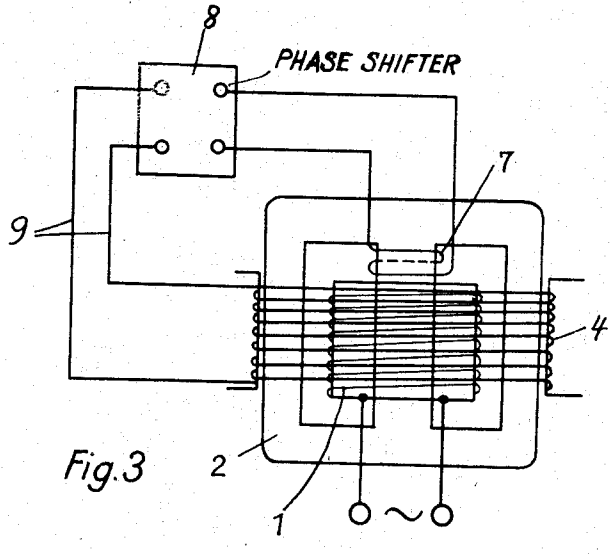



Fig. 3

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## ELIMINATION OF THE MAGNETIC DISPERSION OF TRANSFORMERS

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6 Claims. (Cl. 171—97)

In television receivers and in oscilloscopes wherein cathode ray tubes are used considerable interference is present as a result of the presence of stray magnetic fields particularly in the vicinity of power transformers. It has been found that when using normal types of transformers, even with generous dimensioning of the cross-section of the iron and when avoiding any magnetic resistances, air gaps and the like, the dispersion of the magnetic field is still of such extent that a compact assembly of the transformer with the tube is usually impossible without interfering deflection of the cathode ray. An interfering deflection of this kind at power line frequency must, however, be very extensively suppressed in view of the high precision of modern television receivers and oscilloscopes. Up to now a remedy has been sought by providing the tube or the transformer with a jacket or shield composed of sheet iron of the greatest possible permeability, and these shields must not be allowed to be in magnetically conductive connection with the core of the transformer. It was also recognised quite early that there are certain relative positions with respect to transformer and cathode ray tube in which the leakage effect is particularly small or in which the effect is just compensated. A position of this kind is to be found for example when the axis of the coil of the transformer and the axis of symmetry of the tube are parallel to each other.

These known measures, however, are not sufficient to fully overcome the undesirable interference. It is not always possible to select the neutral zone as the point of location of the transformer, and an effective absorption of the leakage flux can be carried out in practice when using sheet iron only when considerable masses of such shielding are used (compare ironclad galvanometers and the like).

In the present invention, there are used, as already known, a separate coil or coils for compensating for the detrimental leakage field of the transformer windings. In accordance with the invention, these compensating means comprise a separate winding and a potentiometer resistance connected in parallel therewith. The parallel combination is then connected to the power line in series with the primary winding of the transformer. The potentiometer is so adjusted that a magnetic field is produced which has the same magnitude and position as the undesirable leakage field of the transformer, but which is substantially 180 electrical degrees out of phase with respect thereto.

The invention will best be understood by referring to the accompanying drawing, wherein:

Figure 1 shows one form of the present invention as applied to a shell type transformer,

Figure 2 shows another form of the present invention as applied to a core type transformer, and

Figure 3 shows a modified form of the present invention as applied to a shell type transformer.

Referring now to Figure 1, the power transformer consists of a winding 1, or a plurality of windings, of which, however, there is shown only the primary winding. The winding is located on a core 2, which, being of the shell type, inherently produces a certain amount of shielding and reduces the distortion produced in adjacently positioned cathode ray apparatus. Even when the best iron is used in a transformer of this kind, there still remains a certain stray magnetic field as represented by the lines of force 3. The idea according to the invention consists in arranging an auxiliary field coil 4 in such fashion and exciting the same with a current of such phase and intensity that the alternating magnetic field produced by the same, at least at some distance from the transformer, is equal in amount but opposite to the interfering leakage field 3. The leakage interference must then be compensated for regardless of the position of the transformer with respect to the affected cathode ray tube.

Advantageously the additional winding for compensating purposes is arranged coaxially and symmetrically round the transformer winding. In the case, therefore, of an ironclad or shell type transformer the auxiliary field coil must be wound coaxially with respect to the transformer winding but over the complete iron body or magnetic structure of the transformer.

The correct adjustment of the compensating current according to extent and phase depends, generally speaking, on the condition of loading of the transformer. In the majority of cases in practice, however, the small transformers of measuring and receiving apparatus of the character referred to so closely approach the no-load condition that the stray flux is substantially in phase with the primary current. In this case good results may be obtained with a connection such as described above and shown in Fig. 1, the primary current flowing from the power supply 5 through the transformer primary winding 1 and through a potentiometer 6. The auxiliary field coil 4 is excited to an extent depending upon the position of this potentiometer, which

is in parallel with the field coil and the total resistance of which must be small in comparison with the input resistance of the transformer. The turns of 4 may be so selected in number that there is an over-compensation of the dispersion. Upon varying the tap on the potentiometer a point can then readily be found at which the dispersion just disappears.

It is quite readily possible with normal technical knowledge of design in the case of transformers with higher load, in which the flux phase and the primary current phase do not agree, to use phase shifters which would cause the current in the compensating field coil to be in phase opposition to the stray flux. It is also possible to arrange the compensating field coil in relation to the transformer in a different manner to that shown in Fig. 1.

In Fig. 2, for example, the arrangement according to the invention is shown as applied to a core type transformer. The primary coil of this transformer is located at 1, the secondary coil at 2. The leakage flux leaves the iron at the ends 3*a* and 3*b* of the primary winding. Favourable results are then obtained, for example, when the neutralising coil 4 is provided in the form of two part-windings 4*a* and 4*b*, which are situated immediately in front of the ends 3*a* and 3*b*. The two compensators 4*a* and 4*b* are connected magnetically in series and their field is opposed to the leakage field. The adjustment of the correct value for the no-load condition can again take place by means of a parallel potentiometer 6. The optimum position of the field coil 4 may naturally vary somewhat depending upon the location of the cathode ray tube.

In the case of an ironclad or shell type transformer such as shown in Fig. 1 the most exact simulation of the stray field generator is obtained, for example, when the length of the auxiliary field coil coincides with the length of the primary coil of the transformer and the coils are situated exactly one over the other.

Preferably the combined resistance of the potentiometer and the auxiliary field coil should be so chosen that the voltage drop thereacross shall not exceed 10% of the power line voltage, thus leaving at least 90% of the line voltage for excitation of the primary winding. Furthermore, the resistance of the coil should at least be equal to or greater than the resistance of the potentiometer. It is, therefore, readily possible to compute the approximate desirable resistance of the potentiometer and the field coil when the power consumption of the transformer and the voltage of the power line are known. For such computation the following equation may be used where $r$ is the resistance of the potentiometer and the auxiliary field coil, $p$, is the percentage voltage drop across the potentiometer and field coil, $e_n$ is the power supply voltage, and $w$ is the power input of the transformer in watts.

$$r \leqq p\frac{e_n^2}{w}$$

I claim:

1. In combination a transformer core, primary and secondary windings surrounding at least a portion of said core, an electrical source for creating a flux in said core by means of said primary, means for compensating the leakage field of the transformer, said means comprising an additional winding and a potentiometer resistance both in parallel connection, said additional winding being arranged external to said transformer core and coaxial with respect to said primary winding thereof, the tap of said potentiometer resistance being connected via said primary to one terminal of said electrical source, the other terminal of which is connected to said parallel connection, and being so adjusted that a field is produced by said means which has the same magnitude and disposition as, but is of opposite phase to, the leakage field of the transformer.

2. In combination a transformer core, primary and secondary windings surrounding at least a portion of said core, an electrical source for creating a flux in said core by means of said primary, means for compensating the leakage field of the transformer, said means comprising an additional winding and a potentiometer resistance both in parallel connection, said additional winding being arranged external to, but wound round said transformer core and coaxial with respect to said primary winding thereof, the tap of said potentiometer resistance being connected via said primary to one terminal of said electrical source, the other terminal of which is connected to said parallel connection, and so adjusted that a field is produced which has the same magnitude and disposition as, but is of opposite phase to, the leakage field of the transformer.

3. In combination a transformer core, primary and secondary windings surrounding at least a portion of said core, an electrical source for creating a flux in said core by means of said primary, means for compensating the leakage field of the transformer, said means comprising an additional winding and a potentiometer resistance both in parallel connection, said additional winding being arranged external to, but wound round said transformer core with said windings and being approximately equal in its length to said primary and coaxial with respect to said primary winding thereof, the tap of said potentiometer resistance being connected via said primary to one terminal of said electrical source, the other terminal of which is connected to said parallel connection, and being so adjusted that a field is produced which has the same magnitude and disposition as, but is of opposite phase to, the leakage field of the transformer.

4. In combination a transformer core, primary and secondary windings surrounding at least a portion of said core, an electrical source for creating a flux in said core by means of said primary, means for compensating the leakage field of the transformer, said means comprising an additional winding and a potentiometer resistance both in parallel connection, said additional winding being arranged external to, but wound round said transformer core and coaxial with respect to said primary winding thereof, the tap of said potentiometer resistance being connected via said primary to one terminal of said electrical source, the other terminal of which is connected to said parallel connection, and being so adjusted that a field is produced which has the same magnitude and disposition as, but is of opposite phase to, the leakage field of the transformer, said potentiometer having a resistance which is so small that the potential at its terminals is merely a few per cent less than the potential of said source, whilst the impedance of the additional winding still remains small as compared with the ohmic resistance of said potentiometer.

5. In combination a transformer core, primary and secondary windings surrounding at least a portion of said core, an electrical source for

creating a flux in said core by means of said primary, means for compensating the leakage field of the transformer, said means comprising an additional winding and a potentiometer resistance both in parallel connection, said additional winding being arranged external to said transformer core and coaxial with respect to said primary winding thereof, the tap of said potentiometer resistance being connected via said primary to one terminal of said electrical source, the other terminal of which is connected to said parallel connection, and being so adjusted that a field is produced which has the same magnitude and disposition as, but is of opposite phase to, the leakage field of the transformer, said additional winding consisting of two winding-parts each one arranged adjacent to the front sides of the ends of said primary and secondary windings.

6. In combination a transformer core, primary and secondary windings surrounding at least a portion of said core, an electrical source for creating a flux in said core by means of said primary, means for compensating the leakage field of the transformer, said means comprising an additional winding and a potentiometer resistance both in parallel connection, said additional winding being arranged external to said transformer core and coaxial with respect to said primary winding thereof, the tap of said potentiometer resistance being connected via said primary to one terminal of said electrical source, the other terminal of which is connected to said parallel connection, and being so adjusted that a field is produced which has the same magnitude and disposition as, but is of opposite phase to, the leakage field of the transformer, the resistance value $r$ of said additional winding together with said potentiometer resistance being determined by the equation

$$r \leq p\frac{e_n^2}{w}$$

$p$ being the permissible percentage of the electrical source $e_n$ and $w$ the power input of the transformer in watts.

KURT SCHLESINGER.