

Aug. 2, 1955

W. E. BRADLEY

2,714,710

TRANSFORMER

Filed July 23, 1949

FIG. 3.

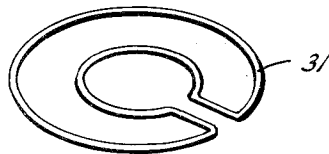
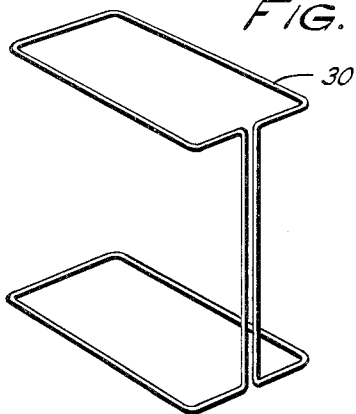


FIG. 4.

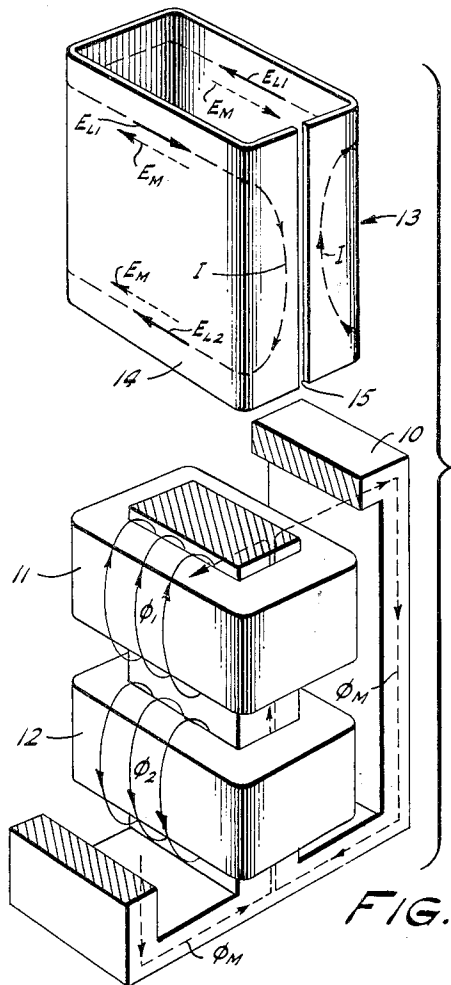


FIG. 1.

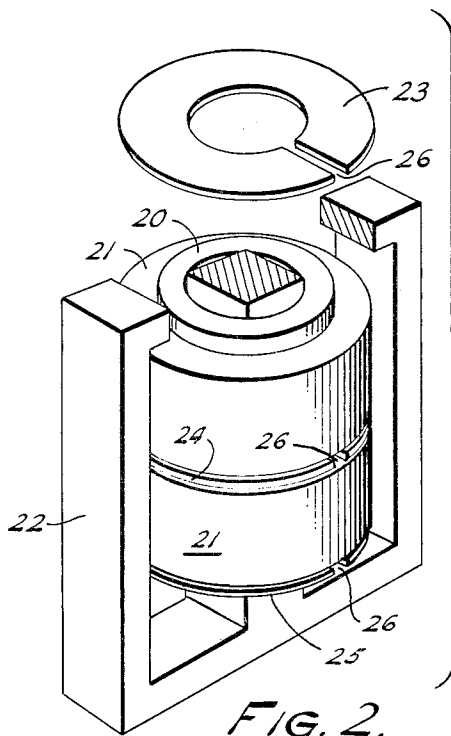


FIG. 2.

INVENTOR.

WILLIAM E. BRADLEY

BY

Brown, Denk & Synnestvedt

AGENTS

1

2,714,710

TRANSFORMER

William Earle Bradley, Newtown, Pa., assignor to Philco Corporation, Philadelphia, Pa., a corporation of Pennsylvania

Application July 23, 1949, Serial No. 106,417

1 Claim. (Cl. 336—84)

The present invention relates to electrical transformers, and is concerned especially with means for improving their response to input signals of pulse-like waveform.

Pulses of electrical energy having a substantially rectangular configuration now find considerable use in signalling systems, particularly in television and allied fields, as a means for transmitting intelligence or for initiating or terminating desired actions within the system. Furthermore, these circuit arrangements frequently employ transformers in order to provide regeneration (such as in blocking oscillators), as interstage coupling devices, or as impedance-matching devices (in video amplifiers). The quality of the performance attained in systems of this character usually depends upon the fidelity with which the circuit components reproduce the waveform of the signals impressed upon them. This is exemplified in television apparatus, wherein pulses are used to control the deflection of the cathode ray beam according to some desired scanning pattern. Any variation in the waveform of the energy applied to the deflecting means may deleteriously affect the quality of the reproduced image.

Because of certain inherent characteristics of transformers, a voltage wave impressed upon the primary normally is not faithfully reproduced across the secondary. The usual form of departure from correct performance in pulse transformers lies in a "ringing," or transient oscillation, set up in the transformer windings by the impact of the leading edge of the applied pulse. The most pronounced distortions have been found to be due, primarily, to oscillations produced by resonance between the leakage inductance and the distributed capacity of the coils. Thus, the leakage flux resulting from the inherently imperfect coupling between transformer windings contributes to a distortion of the output wave. Such transient oscillations are objectionable in all pulse transformers, but in television they are especially harmful, inasmuch as the beginning of each line-scanning operation may be distorted to such a degree that it cannot escape notice by an observer of the reproduced image.

In accordance with one feature of the present invention, the performance of transformers, especially as utilized in the transmission of pulse waveforms, is substantially improved by the provision of means for minimizing the transient oscillations which normally result from the presence of leakage flux between the coils.

This is accomplished, in one embodiment, by disposing one or more conductive members on the transformer which serve to link the leakage flux of the transformer without encircling the useful flux. These members are loaded with resistance in such a way as to damp out the transient oscillations in the transformer windings. The utility of the invention is enhanced by the fact that the undesirable oscillations may be greatly attenuated, and their duration considerably shortened, without diminishing the useful output, or efficiency, of the transformer. To identify the special elements of this invention, they will be referred to hereinafter as "transient suppressor members," or "suppressor members."

2

It is one object of this invention, therefore, to provide means for suppressing transient oscillations in transformers ordinarily resulting from the presence of leakage flux between the coils.

It is an additional object of the invention to cause the leakage flux impedance of transformers to be strongly dissipative.

Another object of the invention is to provide means for improving the response characteristic of transformers to input pulse energy.

A further object of the invention is to provide an improved pulse transformer structure.

Other objects and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawing, in which:

Figs. 1 and 2 are exploded isometric views of two otherwise conventional transformer constructions embodying different forms of the present invention; and

Figs. 3 and 4 illustrate modifications of the invention applicable to Figs. 1 and 2, respectively.

Referring now to the drawing, Fig. 1 shows in partly diagrammatic fashion a shell-type transformer having an iron core 10. Two windings 11 and 12 are placed end-to-end on the center leg of this core structure. Each of the windings 11 and 12 may consist of a single coil, as shown by way of example, or in accordance with common transformer practice one or both of the windings may be divided into sections and the sections interposed on the core leg. However, the simpler two-coil construction shown will suffice for purposes of explanation. For clarity a portion of core 10 has been cut away, and the connecting leads to the coils have been omitted.

With "end-to-end" transformer winding arrangements, such as illustrated in Fig. 1, the transient suppressor member, identified generally by the reference numeral 13, may comprise a sheet 14 of resistive material, bent to form a nearly complete cylinder, and fitting closely around the transformer windings 11 and 12. For a clearer showing of the invention, suppressor member 13 is illustrated in a position just above the main transformer assembly. It will be understood, however, that the member 13 is to be positioned coaxially and substantially coextensively with the windings 11 and 12. The opening 15 between the ends of the sheet 14 permits the member 13 to act in effect as an "open-circuited turn" with respect to the mutual coil flux, and, accordingly, the presence of the transient suppressor member has no appreciable effect upon the normal operation of the transformer. However, with respect to the leakage flux, the suppressor member forms a closed conductive path in which eddy currents are induced by the leakage flux. The flow of these currents through the resistive component of the member "loads" the transformer circuit in such a manner as quickly to dissipate the energy in the oscillations resulting from the leakage flux. This damping action may also be obtained with the special winding 13 placed in other locations, such, for example, as between the center leg of the core 10 and the main windings 11 and 12. If desired, two such suppressor members may be used, one mounted within and one placed around the windings of the transformer.

An explanation will now be given of the action of suppressor member 13 as a closed semi-conductive path with respect to the leakage flux, and as an effective open-circuited path for the mutual flux, whereby oscillations in the transformer windings due to leakage flux are damped out without affecting the useful output of the transformer. It will be understood in this connection that the magnetic flux established by the currents flowing in the windings is composed of a mutual component, from which the useful output of the transformer is derived, and a leakage component. The mutual flux follows a path which completely links both of the transformer windings, as indi-

cated by the dotted lines ϕ_M in Fig. 1. For all practical purposes, the leakage flux may be considered as the flux encircling each winding individually, and the solid lines ϕ_1 and ϕ_2 represent the portions of this leakage flux that surround windings 11 and 12, respectively. The arrowheads on the flux lines ϕ_M , ϕ_1 and ϕ_2 show the respective directions of the mutual and leakage fluxes at a given instant. It will be noted that throughout the length of the center leg of the core 10 the mutual flux flows in one direction only at any instant, but, because of the opposed phase relation of the currents in the transformer windings, the leakage flux ϕ_1 and ϕ_2 flows in opposite directions in the air space surrounding the windings. With suppressor member 13 in position, it will be seen that the mutual flux links the entire member in the same direction, while the leakage flux links the upper and lower portions of the member in opposite directions. Consequently, the voltages induced in the suppressor member by the mutual flux are in the same circumferential direction in all portions thereof, whereas the voltages induced by the leakage flux in the upper and lower portions of winding 13 are in opposite circumferential directions. For the assumed directions of the two flux components the dotted arrows E_M and the solid arrows E_{L1} and E_{L2} indicate the directions of the voltages induced by the mutual and leakage fluxes, respectively. Currents tend to flow around the winding 13 in the direction of the induced voltages, but because of the gap 15 no current is established in this winding by voltage E_M . Consequently, the presence of the suppressor member 13 does not affect the mutual flux. However, the opposed leakage flux voltages E_{L1} and E_{L2} act to cause an eddy current to flow around the member along paths indicated by the dashed line I, and the energy representing the leakage flux is thus dissipated in this flow of eddy current in the resistive component of the suppressor structure.

An embodiment of the invention suitable for use with transformers having concentric coil windings is illustrated in Fig. 2. This arrangement comprises a two-section winding, each section consisting of an inner coil 20 and an outer coil 21, mounted on the center leg of an iron core 22. The two inner coils 20 and the two outer coils 21 form the primary and secondary windings, respectively, of the transformer, although only one of the inner coils 20 is visible in the drawing. Again, for clarity, a portion of the core 22 has been cut away and the coil leads have been omitted.

For transformers having such concentric windings, the transient suppressor member may be a sheet of resistive material made in the form of a radially split annular disc of suitable size to cover the ends of the coils, and mounted adjacent thereto. Preferably, one of these suppressor members is placed at each end of each winding section, but, with closely-spaced sectional windings, one suppressor member between adjacent sections with normally suffice. In the drawing, the transient suppressor members, arranged as described above, are identified by the reference numerals 23, 24 and 25, member 23 being drawn exteriorly of the transformer to show more clearly its construction. Each suppressor member is provided as shown with the radial slit 26. The annular disc type of transient suppressor member of Fig. 2 functions in the same manner as the cylindrical suppressor winding 13 of Fig. 1 to damp out the transient oscillations without loading the useful output of the transformer.

In practice, pulse transformers may have concentric coil arrangements other than that illustrated in Fig. 2; for example, a different number of winding sections or interposed primary and secondary windings may be employed. In such cases, a suitable number of appropriately

dimensioned annular discs similar to those illustrated in Fig. 2 may be used.

Preferably the transient suppressor members are made in sheet form as illustrated in Figs. 1 and 2. However, other forms may be employed provided they are arranged, in accordance with the principles of the invention, to link the leakage flux without encircling the mutual flux of the transformer. For example, wire loaded with resistance may be shaped to form the outline or boundary of the split cylinder embodiment of Fig. 1, or of each split annular disc in Fig. 2. Members 30 and 31 in Figs. 3 and 4, respectively, illustrate such modifications.

While various embodiments of the invention have been described with reference to Figs. 2 to 4, it is believed unnecessary to include here an explanation of their operation, as it will be apparent to those skilled in the art that the suppressor members in these embodiments function in essentially the same manner as that given for the suppressor member 13 in Fig. 1.

In carrying out the invention, the transient suppressor members may be made from any suitable conductive non magnetic material of appropriate thickness and which includes a sufficiently high resistive component effectively to damp out the transient oscillations. By way of example, the suppressor member material may be an alloy, such as Advance or Monel metal, having a specific resistance of, say, from 250 to 300 ohms per circular milfoot. Advance (constantan) and Monel metal are copper-nickel alloys, the former having a composition of the order of 60% Cu and 40% Ni, and the latter having a composition which may consist of 60-70% Ni, 25-35% Cu, 1-7% Fe, 0-2% Mn, 0-1.5% Si, and 0-0.3% C. Other suitable metals having sufficiently high resistivity may also be used.

While the disclosed invention may be employed to particular advantage in iron-core pulse transformers, it is to be understood that it is not limited thereto. Obviously, the method set forth herein for suppressing transient oscillations due to leakage flux in the windings of transformers may be applied to transformers having cores of other materials and with other coil arrangements.

Having thus described my invention, I claim:

In an electrical transformer provided with a core along which are positioned at least one primary winding and at least one secondary winding in side-by-side relation, and in which energization of the said primary winding establishes a mutual magnetic flux as well as individual leakage fluxes respectively surrounding each of said windings, the improvement which comprises a transient suppressor member which is composed of an electrically conductive sheet of non-magnetic material having a resistivity many times that of copper and which member is disposed in the form of a single longitudinally slit hollow cylinder substantially wholly encompassing both of said windings, the axis of said cylinder being generally coaxial with the axis of said windings.

References Cited in the file of this patent

UNITED STATES PATENTS

60	767,503	Scott	Aug. 16, 1904
	1,235,373	Peek, Jr.	July 31, 1917
	1,548,022	Casper et al.	Aug. 4, 1925
	1,709,054	Bennett	Apr. 16, 1929
	1,839,038	Kronmiller	Dec. 29, 1931
65	1,872,293	Hodnette et al.	Aug. 16, 1932
	2,170,048	Dunning et al.	Aug. 22, 1939
	2,202,506	Robin	May 28, 1940
	2,296,452	Rust	Sept. 22, 1942

FOREIGN PATENTS

70	468,973	Germany	Nov. 27, 1928
----	---------	---------	---------------