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HIGH-VOLTAGE TRANSFORMER

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This invention relates to electrical transformers of the type having "potted cores"; in particular, it relates to a novel structure particularly adapted for use as a horizontal-deflection transformer for television receivers.

The sawtooth current required for horizontal deflection of the cathode ray in a television picture tube is usually obtained from a power amplifier driven by a suitable multivibrator or blocking oscillator. Coupling between the anode circuit of the power amplifier tube and the deflection yoke mounted on the picture tube is accomplished by means of a specially designed transformer having a primary winding connected in the amplifier-tube anode circuit and a secondary winding connected to the deflection yoke.

In addition to the primary and secondary coils just described, it is customary also to use an additional winding, sometimes called the tertiary winding, which contains a great many turns and is, as a rule, connected in series with the primary coil to provide, by auto-transformer action, a very high peak voltage.

The peak voltage developed during the generation of a sawtooth current occurs during the "flyback," that is, the rapid change of current which causes the cathode ray to return quickly to its origin following a horizontal trace. That rapid change of current is accompanied by a very large peak voltage in the coupling transformer. The peak voltage across the primary coil may, in a typical case, be of the order of 5,000 volts, while the total peak voltage across the series combination of the primary and tertiary coils may exceed 20,000 volts.

The high voltage thus obtained is, in the usual television receiver, rectified by a suitable diode tube and, after being filtered, is applied to the accelerating anode of a picture tube.

The design of suitable coupling transformers for the application just described has been attended by many difficulties. The type of transformer in general use heretofore has employed a conventional open core made of laminated iron and having the various coils wound on the respective legs of the open core. This construction has been satisfactory from the insulation standpoint, since the various windings have been separated from one another by adequate distances. It has left much to be desired in performance, however, because the open-core construction, particularly with windings on the different core legs, has led to extensive flux leakage and thus to transformer action that is far from ideal. The relatively poor inter-coil coupling in the usual horizontal-deflection transformer leads to poor current wave-form characterized particularly by "rounding off" of the wave in its later portion. In terms of picture appearance, this means that the picture tends to be "squeezed together" on the right-hand side. Anyone familiar with the performance of conventional television receivers has observed that effect.

Television set designers have attempted, with some degree of success, to improve the wave-form by means of auxiliary peaking coils, which are rather difficult to adjust

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properly and which, of course, add to the cost of the receiver.

In the present invention, I have provided a greatly improved horizontal-deflection transformer using a "potted core"—that is, a core which is radially symmetrical with respect to its principal axis and in which, as normally used, the windings are wholly enclosed by the core. This type of transformer construction has been used heretofore in other applications; the complete enclosure of the windings by the core explains the term "potted core" which is in general use in the art.

Use of potted cores in horizontal-deflection transformers has in the past been considered impractical, primarily because of insulation difficulties. The peak voltages involved are so high that it has been considered impractical to use the potted core construction, due to the excessive cost of insulating adequately the windings from one another and from the core.

In the present invention, by combining the use of a special core material with a novel physical construction, I have provided a horizontal-deflection transformer which is inexpensive to construct and far superior in performance to conventional structures. In the transformer of my present invention, I have eliminated almost completely flux leakage between the primary and secondary coils and have provided a transformer in which the advantages of potted core construction are obtained without any of the insulation difficulties which heretofore have attended the use of potted cores in horizontal-deflection applications.

Thus it may be said that the principal object of my invention is to provide a transformer, suitable for use in horizontal-deflection circuits, characterized by virtually perfect coupling between the primary and secondary coils and highly efficient high-voltage generation in the tertiary coil without the necessity for elaborate and expensive insulation precautions.

Another object of my invention is to provide a transformer suitable for horizontal-deflection circuits in which excellent wave-form linearity can be obtained without the necessity for external peaking coils.

Still another object of my invention is to provide a transformer suitable for horizontal-deflection circuits in which the amplitude of the sawtooth current fed to the deflection yoke can readily be adjusted by a simple mechanical means rather than by auxiliary coils such as have been conventional heretofore.

A still further object of my invention is to provide a transformer made of a non-conducting magnetic material such as ferrite wherein the core itself is employed as part of the insulation between windings.

Other objects and advantages of my invention will appear from the detailed description thereof which follows.

In the drawing which forms a part of the present specification, I have shown, in Fig. 1, a perspective view of a typical transformer made in accordance with the present invention; in Fig. 2, I have shown a sectional view of the transformer of Fig. 1, the section being taken in a plane which includes the axis of the transformer; and in Fig. 3, I have shown an exploded perspective view of the transformer of Fig. 1, showing the manner in which the various parts are interrelated.

As may be seen from the drawing, my transformer is constructed around a pair of axially symmetrical core pieces denoted respectively 11 and 12. These core pieces may be molded from a suitable magnetic material, preferably a non-conducting magnetic material such as ferrite. Ferrite, when properly processed, possesses very high permeability combined with remarkable insulation properties.

The core pieces 11 and 12 may also be made of pow-

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dered iron suspended in a thermosetting resinous binder. Such core materials, when molded and hardened, possess high electrical resistance and are suitable for the present application, although ferrite is preferable both from the standpoint of permeability and insulation.

The particular core pieces 11 and 12 illustrated in the drawing are molded to mate tightly around their outer rims, but the central portions 11a and 12a are slightly shortened so as to leave a small air gap 13.

The inclusion of air gap 13 is an optional matter of design. In many cases, particularly those in which relatively large core pieces are used, the air gap will be found desirable. In smaller, less expensive designs, where the maximum possible flux density is needed, the air gap may be made very small or dispensed with entirely.

The core pieces 11 and 12 may be held together by any suitable means, such as a bolt 14 and nut 15, bolt 14 passing through a suitable central axial aperture 16 in the core pieces 11 and 12. Normally it will be desirable to use a bolt 14 of non-magnetic metal, particularly if air gap 13 is being used.

I have found that an excellent control over the amplitude of the output current, which in turn controls the length of the horizontal sweeps, may be obtained by adjusting within narrow limits the spacing between core pieces 11 and 12. That is, instead of having the core pieces held in direct abutment, as shown in Fig. 2, they may be mounted with any suitable mechanical arrangement which will permit them to be very slightly separated, thus providing an air gap around the outer rim as well as between the central core pieces. Any suitable mechanical arrangement, of which many will occur to anyone skilled in the art, will thus provide a simple mechanical "horizontal-size control" for the television receiver with which my transformer is being used. Thus, for such a purpose, bolt 14 and nut 15 might be replaced by an arrangement in which suitable threaded studs are molded into the core pieces 11 and 12 and joined by a bolt having reverse threading at its respective ends. With such an arrangement, rotation of the bolt in one direction would pull the core pieces together, while rotation in the other direction would spread them apart, turnbuckle fashion. Many other simple mechanical arrangements for accomplishing the same result will occur at once to persons skilled in the art.

In the wholly enclosed zone 17 between the rim and central portions of core pieces 11 and 12, I have provided the primary winding 18 and secondary winding 19 of my transformer. These coils may be wound one over the other, with suitable insulating tubes 21 serving as coil forms and spacers. The wire leads 22 from those coils may be protected by suitable "spaghetti" jackets and may be brought out through suitable apertures molded or drilled into one of the core pieces, as shown in Fig. 1.

Wholly enclosed as they are by the core pieces 11 and 12, the windings 18 and 19 have almost perfect magnetic coupling. The leakage flux is so small as to be virtually absent.

The tertiary winding 23 is wound on the outside surface of one of the core pieces 11 or 12. Since its function is entirely to develop the high voltage for use on the accelerating anode of the picture tube, the tertiary coil need not have perfect coupling with the primary coil, so that the small amount of flux leakage which results from winding it on the outside of the core is not objectionable. At the same time that construction entirely removes from the vicinity of the other coils the high peak voltage which appears across the tertiary coil 23, and, furthermore, provides as insulation between the tertiary coil and the other windings the thick non-conducting rim portion of the core itself.

It is customary in horizontal-deflection transformers to provide a current source for heating the high-voltage rectifier tube by adding a one-turn additional secondary winding which, in the conventional transformer, is

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wrapped around one of the legs of the open core. Such a filament winding can easily be provided in my transformer by passing one turn of suitably insulated wire over the core piece which does not carry the tertiary coil. Thus, in a transformer arranged in accordance with Fig. 2, the filament loop might be placed over core piece 11.

Appropriate external connections to the various windings of the transformer may be made by suitably connecting leads 22 and 24 to an external terminal strip, which may be mounted on the chassis of the television receiver.

No special mounting precautions are necessary with respect to my transformer; in fact, it may be, if desired, bolted directly to the chassis by means of bolt 14. This represents an additional great advantage of my transformer over the conventional open core deflection transformers now in use.

While I have in the present specification described in considerable detail one embodiment of my invention, it is to be understood that that is illustrative merely. It is my desire that the scope of my invention be determined primarily with reference to the appended claims.

I claim:

1. A combination cathode ray deflection and high-voltage power supply transformer, comprising magnetic core means made of a magnetic nonconductive material and having a central bar-like supporting element and an outer shell substantially completely surrounding said bar-like element and connected with the opposite ends thereof, said bar-like element and said outer shell defining therebetween a substantially closed annular space, a primary coil and a secondary coil disposed around said bar-like element within said space, means bringing electrical connections to said coils from outside said core, and a third high voltage secondary coil generally coaxial with said primary coil and disposed around the outside of said outer shell, said third coil having substantially more turns than said primary coil to provide a voltage step-up therebetween, said outer shell being substantially continuous between said third coil and said first and second coils and thereby constituting a substantially continuous high-voltage insulating barrier therebetween.

2. A combination cathode ray deflection and high-voltage power supply transformer, comprising magnetic core means made of magnetic nonconductive material and including a pair of cup-shaped opposed members having outer rims disposed in abutting relation, said core means also including coil supporting means extending axially in said cup-shaped members, said cup-shaped members and said axial means defining a substantially closed annular space therebetween, a primary coil and a secondary coil disposed around said axial means within said annular space, means for bringing in electrical connections to said coils from outside said core means, and an additional secondary coil generally coaxial with said primary coil and disposed around the outside of said core means, said additional secondary coil having many more turns than said primary coil to afford a voltage step-up therebetween, said cup-shaped members being substantially continuous and thereby defining a substantially continuous high-voltage insulating barrier between said additional coil and said primary and secondary coils.

3. A combination cathode ray deflection and high-voltage power supply transformer, comprising magnetic core means made of nonconductive magnetic material and including a pair of opposed cup-shaped members having rim portions in closely adjacent relation, said core means also including axial coil supporting means extending axially in said cup-shaped members and thereby defining an annular substantially closed space between said members and said axial means, a primary coil and a secondary coil disposed around said axial means within said annular space, means for making electrical connections to said coils, and an additional

secondary coil disposed around said rim portion of one of said cup-shaped members in generally coaxial relation with said primary coil and having a substantially greater number of turns than said primary coil to afford a voltage step-up therebetween, said rim portions of said cup-shaped members defining a substantially continuous high-voltage insulating barrier between said additional coil and said primary and secondary coils.

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