May 2, 1933. T. McL. DAVIS 1,907,400

TRANSFORMER SYSTEM

Filed July 23, 1927

FIG. 1

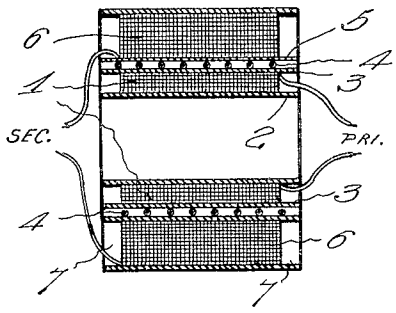


FIG. 2

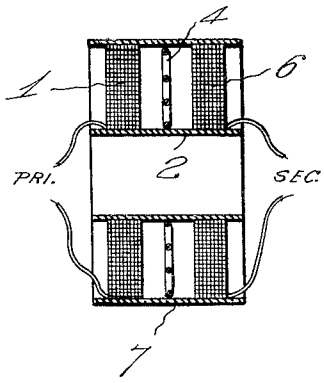


FIG. 3

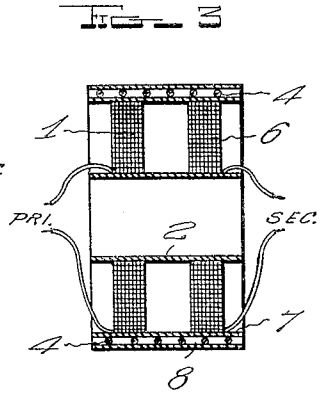


FIG. 4

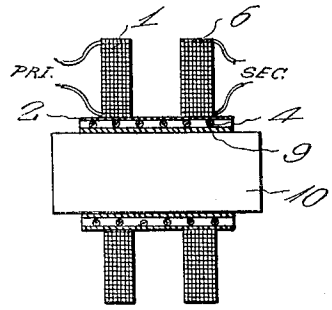


FIG. 5

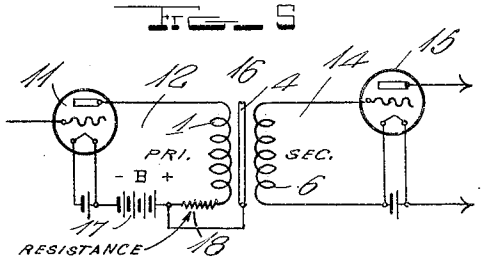
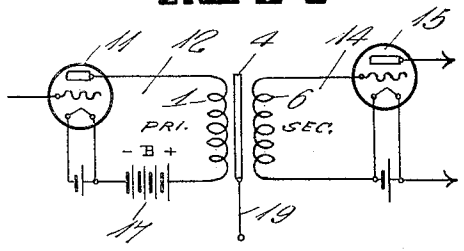
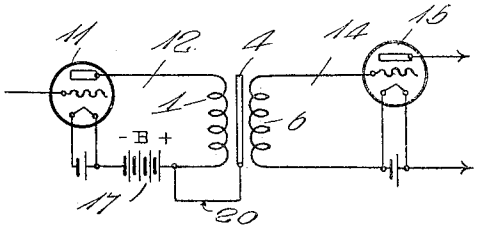


FIG. 6



TO SOME HIGHER VOLTAGE THAN "+B", SUCH AS A POWER TAP ON THE "B" BATTERY-ELIMINATOR.



SHIELD CONNECTED DIRECT TO "+B" GIVING IT A HIGHER POTENTIAL THAN COIL, DUE TO ITS LOWER RESISTANCE.

FIG. 7

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Patented May 2, 1933 1,907,400

UNITED STATES PATENT OFFICE

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TRANSFORMER SYSTEM

Application filed July 23, 1927. Serial No. 208,042.

My invention relates broadly to amplification circuits and more particularly to a system for protecting the fine wire windings of the amplifying transformers which are connected in such amplification circuits.

One of the objects of my invention is to provide a construction of amplifying transformer and a circuit arrangement for such transformer whereby the fine wire windings of the transformer may be protected against destruction.

Another object of my invention is to provide a circuit arrangement for an amplifying transformer in which the permanency of the condition of the transformer is increased by the protection of the fine wire windings in the transformer from the action of electrolysis.

Still another object of my invention is to provide a transformer system for amplifiers used in connection with electron tubes wherein the primary and secondary windings have an electrode interposed therebetween, which electrode is charged to a higher positive potential than either the primary or secondary windings, with the result that the said primary and secondary windings will both be at cathode potential with respect to the said electrode, and deterioration due to electrolysis will occur in the said electrode and not in the said primary or secondary windings.

My invention will be more clearly understood from the specification hereinafter following by reference to the accompanying drawing, wherein:

Figure 1 illustrates an amplifying transformer having its parts arranged in accordance with the principles of my invention with an electrolysis shield disposed between the primary and secondary windings; Fig. 2 shows a modified construction of transformer illustrating the relative arrangement of the electrolysis shield with respect to the primary and secondary windings; Fig. 3 illustrates a modified arrangement of the electrolysis shield with respect to the primary and secondary windings; Fig. 4 illustrates a further modified form of transformer system showing an arrangement of electrolysis shield which may be employed; and Figs. 5, 6 and 7 show some of the circuit arrangements in which the amplifying transformer may be employed, with several of the ways in which relatively high potential may be placed upon the electrolysis shield in accordance with my invention.

In electron tube amplification systems it is customary to utilize relatively high potentials for exciting the plate circuits of the electron tubes. The amplifying transformer and other inductances in the amplification circuits may have a comparatively large difference in potential in adjacent or closely spaced parts, and there is a tendency for open circuits to occur in the high potential windings.

Investigations with amplifier coupling transformers have proven that the cause for open circuits is generally due to electrolytic action between the high direct current potential of the primary and that of the secondary or other low potential parts. If it were possible to find a non-leaking insulation medium, under all conditions, this would in itself prevent the action. It has been found, however, that with the use of waxes and other substances common to the art, there will be an electrolytic leakage in a humid atmosphere due to the hygroscopic properties of the insulating medium.

In the process of this electrolytic action the anode or higher potential winding decomposes at a rate depending upon the leakage current. I have found that this difficulty may be avoided by using a special type of coil in which a third winding or electrode is supplied. This electrode is placed in the leakage path and is maintained at a higher direct current potential than that of either the primary or secondary windings. By this arrangement the transformer windings are both at cathode potential with respect to the third electrode and the deterioration would occur in the third electrode only.

The third electrode is placed in the path of the greatest possible leakage. The location and form of the third electrode is dependent upon the type of coil employed as well as its surrounding dielectric and protection from moisture.

Referring to the drawing, reference character 1 designates the primary winding which is disposed upon the insulating tube 2 and is covered by the insulating tube 3. The electrolysis shield is represented at 4 as wound over the insulating tube 3. An insulating tube member 5 is disposed over the electrolysis shield 4, and upon this insulating tube 5 is wound the secondary coil 6, the entire assembly being enclosed by the insulating tubular member 7. The electrolysis shield 4 which constitutes the third electrode is in the form of an open ended winding of insulated conductive material which may be similar to that of the windings but larger in cross-section. By using similar metals the possibility of galvanic action is eliminated.

As the duration of effectiveness depends upon the life of the electrode, it is made of wire of relatively large size as compared to that of the windings 1 and 6. Inasmuch as the electrolysis shield 4 may actually be destroyed by the electrolytic action the arrangement of the coils may be such as to permit a renewal of this element as it becomes necessary.

In Fig. 2 the primary winding 1 is of the pancake type and is positioned adjacent a similar secondary winding 6. The electrolysis shield is wound in the form of a flat spiral represented at 4 between the windings 1 and 6. The insulating member 7 encloses the windings 1 and 6 as heretofore explained in connection with Fig. 1.

In Fig. 3 I have shown the electrolysis shield 4 disposed in a different relation with respect to the primary and secondary windings 1 and 6. In this instance the electrolysis shield 4 is wound upon the outside of the insulating cover member 7, and thereafter the electrolysis shield 4 is covered by means of a protective housing 8.

In Fig. 4 I have shown the primary winding 1 and secondary winding 6 disposed on tubular member 2, and then concentrically beneath the tubular member 2 the electrolysis shield 4 is disposed, the shield 4 being mounted upon the tubular member 9 which may be mounted directly over the core represented at 10.

In Fig. 5 I have shown the circuit arrangement of an amplification system employing my invention where electron tube 11 has its output circuit 12 coupled with the input circuit 14 of a succeeding stage of amplification including electron tube 15. The amplifying transformer system is designated at 16. The electrolysis shield 4 is shown as disposed between the primary winding 1 and secondary winding 6. In order to impress a higher direct current potential upon the electrolysis shield 4 than exists in either winding 1 or winding 6, I provide a connection from the positive side of the B battery 17 to the electrolysis shield 4. The primary winding 1 is connected to the positive side of the B battery 17 through the resistance 18. In this way the electrolysis shield 4 serves as an electrode charge to a positive potential higher than that of either the primary winding 1 or the secondary winding 6 so that leakage currents will cause deterioration only in the electrolysis shield 4.

In Fig. 6, I have shown the electrolysis shield 4 provided with a terminal 19 which may extend to a selective terminal at a voltage of higher positive potential than the positive side of B battery 17, such as for example, a power tap on a B battery eliminator.

In Fig. 7 I have shown the electrolysis shield 4 connected direct to the positive side of B battery 17 through conductor 20 for imparting to the electrolysis shield 4 a potential higher than potentials existent in coils 1 and 6 by reason of the lower resistance of the electrolysis shield 4 due to the large wire size thereof as compared to the fine wire windings in coils 1 and 2.

The transformer system may be impregnated in wax or resin or a combination thereof for avoiding the penetration of moisture. I find that moisture penetrates the outer surfaces of the coils first, and once the leakage starts, it generally continues to follow the same path due to the increasing conductance of that path by virtue of electrolytic action. In cases where it would not be objectionable from the insulation standpoint, the core itself or even the container and core could be made to serve as the third electrode.

Stray currents which would otherwise tend to electrolytically attack the fine wire windings of the amplifying transformer system are so controlled by the electrolysis shield 4 that the transformer remains substantially permanent. Where the electrolysis shield 4 becomes worn by the continued electrolytic action, it is a simple matter to replace the shield, thus saving the transformer windings. Such replacement is very infrequent by reason of the relatively large size of the third electrode and the fact that it may be subjected to deterioration over a substantial period of time without being rapidly consumed.

While I have described my invention in certain of its preferred embodiments, I desire that it is to be understood that modifications may be made and that no limitations upon my invention are intended other than are imposed by the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is as follows:

1. A transformer system comprising primary and secondary windings inductively related to each other and a member in the form of a winding the individual turns of which being larger in cross-section than the cross-section of the individual turns of said primary and secondary windings and charged

to a positive potential higher than the potentials existing in said primary and secondary windings for confining the leakage path between said windings to a predetermined limit.

2. In a transformer system for electron tube amplifiers, a transformer having primary and secondary windings for coupling the output circuit of one electron tube with the input circuit of a succeeding electron tube, a member disposed adjacent said windings, said member having an open ended conductor of larger cross section than the cross section of the individual turns of said primary and secondary windings and being charged to a positive potential substantially greater than the potentials existing in said windings for providing a definite leakage path from each of said windings to said member and preventing the action of leakage currents from one winding upon the other winding.

3. An inductance device comprising a plurality of elements of electrically conducting material, one of which is a winding in close proximity to another of said elements, a source of direct current potential applied directly to said other of said elements and through a resistance to said winding and means for preventing electrolytic corrosion of said winding including said resistance for lowering the potential of said winding with respect to said other element, said means also including a more massive structure of said other element than of said winding whereby it is rendered durably resistive to corrosion.

4. An inductance device comprising a plurality of windings; a source of direct current potential connected directly to one of said windings and through a resistance to a second of said windings, the first said winding being characterized by a relatively greater cross sectional area of its conductor than that of the second said winding and by having only one connection with said source of potential; and means including said resistance for preventing an electrolytic flow of current from the second to the first of said windings.

5. An inductance device comprising primary and secondary wire windings, a conductive shield member composed of an open ended coil of wire of larger gauge than that of the wire in said primary winding, said shield being rendered durably resistive to electrolytic corrosion by its relatively massive structure, and said shield being disposed in the path of possible leakage currents between said windings, and means including suitably differentiated potentials applied to said windings and to said shield member respectively for determining the direction of flow of said leakage currents from said shield to said windings.

6. An amplifying transformer for electron tube circuits having primary and secondary windings arranged for coupling the output circuit of one electron tube with the input circuit of a succeeding electron tube, a shield member disposed adjacent said windings, a source of energy supplying one potential to said primary winding and a more positive potential to said shield member and means to confine the leakage current between said windings to a predetermined limit, said means including the open ended conductive portion of said member whereby its potential throughout is maintained above that of said primary winding, and a relatively massive formation of said member whereby it is rendered durably resistive to electrolytic corrosion.

THOMAS McL. DAVIS.