Sept. 14, 1937. J. A. RIETMANN 2,092,779

TRANSFORMER

Filed Dec. 11, 1934

Fig. 1

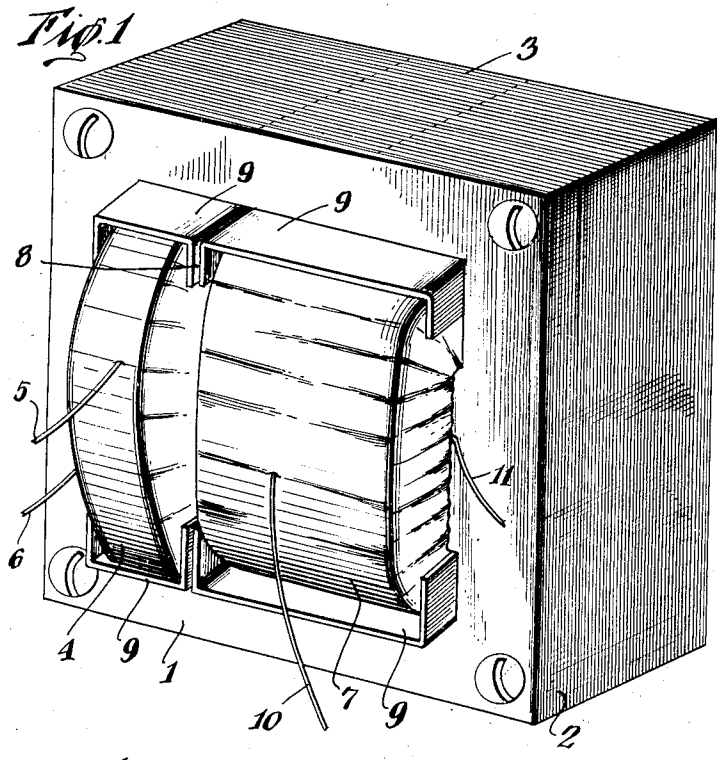


Fig. 3

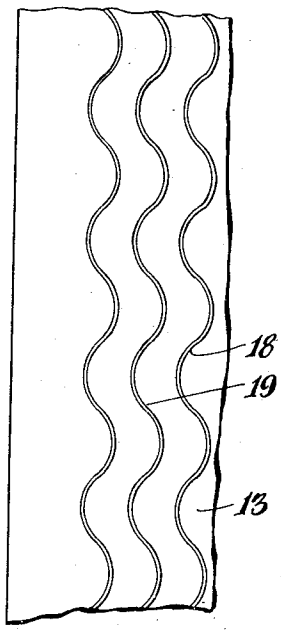


Fig. 2

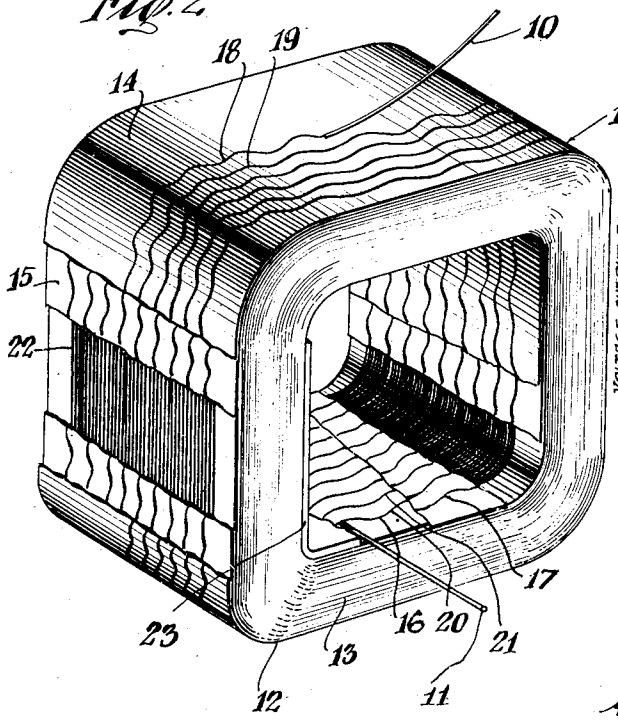
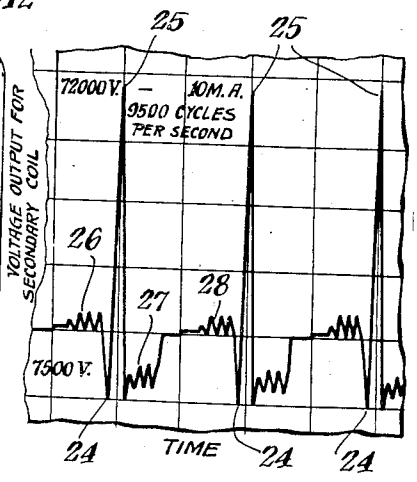


Fig. 4



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2,092,779

TRANSFORMER

John A. Rietmann, Great Neck, N. Y.

Application December 11, 1934, Serial No. 756,917

9 Claims. (Cl. 175—356)

My invention relates to alternating current transformers and similar electrical devices, and more particularly to the construction of the secondary coil of such devices.

A prominent feature of my invention is the novel type of winding employed in the secondary coil whereby extremely high voltage outputs and relatively high currents may be obtained from low voltage inputs in the primary coil. The voltage ouput is characterized by regularly occurring high peaks that are sufficiently close together from the standpoint of time to enable any type of desired work circuit to utilize these peak voltages, whereby a substantially greater operation efficiency is obtained.

I am aware of the well known fact that in the prior art devices of this character, an interrupted alternating current in a primary winding of comparatively few turns is stepped up or increased into a current of greatly amplified voltage by means of a secondary winding of many turns. Theoretically, by proper proportioning the turns in the secondary and primary coils of such devices, one may obtain almost any desired voltage output. However, from a practical standpoint there are definite limitations on the extent to which this principle may be applied. In the absence of special and expensive precautionary means to avoid such, there is a great amount of heat generated in these high voltage transformers, which more or less determines the practically obtainable maximum voltage outputs. It is quite common for this type of device to generate, during operation, sufficient heat to actually melt some of the materials that are used. Also, when a transformer is constructed to give these high voltages, the current ouput is extremely small. The input is characterized by low voltage and comparatively high current, and the output by high voltage and comparatively low current.

Another very common and serious practical limitation in the construction of transformers of the high voltage type is that the secondary coil, which is characterized by many turns of fine wire, is easily burned out by sudden surges of high electrical potentials. To overcome these limitations there have been various suggestions made in the prior art. One example of these is the provision of a large amount of insulating material around the terminals of the secondary coil, where the difference of potential is greatest. Another prior art attempt in this direction comprises separating the adjacent innermost and outermost layers of the several windings to increase the dielectric strength in those regions. None of these attempts, however, has proven commercially satisfactory, as evidenced by their absence from the trade.

In accordance with my invention, I have minimized the disadvantages and limitations characteristic of the prior art, such as those mentioned above, and have developed a transformer that is unique in design and operates with a high degree of efficiency.

The novel features of my invention are set forth with particularity in the appended claims. The invention itself, however, both as to its organization and method of operation will be clearly understood from the following more detailed description taken in connection with the accompanying drawing in which:

Figure 1 is a perspective view of my transformer, with its outside cover removed to show the arrangement of the core and the primary and secondary coils;

Figure 2 is a perspective view of the secondary coil showing my novel method of winding the inner and outer layers of wire forming this coil;

Figure 3 is an enlarged fragmentary plan view illustrating the type of winding shown in Figure 2;

Figure 4 is a copy of an oscillograph curve showing the actual operation of my transformer.

Referring now to Figure 1, my transformer comprises a silicon steel or other metal core 1. This core is composed of a number of substantially E shaped laminations 2. These laminations overlap, as shown at 3, and their middle sections form a core or center piece around which the primary and secondary coils are located. The primary coil 4 is of the conventional type and has input leads 5 and 6. This primary coil 4, as well as the metal core 1, are not claimed, per se, as parts of my invention and are of importance only with respect to their relationship with the secondary coil in forming the complete transformer.

The secondary coil 7 is placed adjacent to and substantially parallel with the primary coil 4. Around the top and bottom portions of the secondary coil 7 and also the primary coil 4 are positioned shaped pieces of insulating material 9. The purpose of these pieces is to maintain the two coils in proper alignment with each other. It is to be noted also that the secondary coil 7 and primary coil 4 do not actually touch each other but are separated by an air space 8. The main purpose of this air space is to provide for cooler operation of the transformer. Output leads 10 and 11 are provided for connecting the secondary coil to any desired alternating current type of device operating with high voltages.

Referring now to Figure 2, the secondary coil 12 as shown, comprises a large number of sheets of suitable insulating material 13 such as glassine paper, and a layer of wire wound around each of these sheets of paper. For sake of simplicity only a few of these layers are shown in Figure 2, but it is to be understood that in actual practice there are a very large number of these layers

of paper and upon each of the layers is wound the current conducting wires of the coil.

One of the special features of my invention, mentioned above, and illustrated in Figure 2, consists in winding several of the innermost and outermost layers of wire in such a manner that adjacent turns of the wire are separated by comparatively wide spaces and each of the turns is laid down in a wave-like form. In this specific embodiment the two outside layers 14 and 15 and also the two inside layers 16 and 17 are wound in this manner, as shown, for example, by the form and relationship of the individual turns 18 and 19 in the outermost layer and 20 and 21 in the innermost layer. As a result of numerous experiments I have found that either 1, 2 or 3 of the outermost and innermost layers of winding may be constructed in this manner with satisfactory results, but that to produce the optimum results only the two outermost and the two innermost layers should be wound in the manner shown in Figure 2. The layers of wire in between the two specially wound outer and inner layers are wound in the conventional closely spaced parallel manner, as shown at 22.

While any suitable means or method may be employed for manufacturing the special type of secondary coil shown in Figure 2, I have found it most convenient to effect the winding operation in the following manner: A strip of glassine paper or other suitable insulating material is first wound around a core of insulating material 23, only a portion of which is shown in the drawing, and upon this strip of paper is wound, in the special manner indicated, the first layer 16 of the desired number of turns. Next, a second separate strip of insulating material is placed around this first layer of wires 16 and the second layer of wires 17 is then wound around this second insulating strip. After the first two layers 16 and 17 have been wound in the spiral or wave shape manner illustrated, the winding is continued according to a conventional manner. That is, winding a layer of closely spaced parallel turns, placing over such layer a strip of insulating material, winding another layer of wire on this strip, and repeating this process until the desired number of layers have been made. When the last or outermost layer of the conventional type winding is made, as shown at 22 in Figure 2, the proper adjustment is made upon the winding apparatus to again space the turns and wind them in a wavy manner, as shown by the two outermost layers 14 and 15.

It is to be noted that the lead wire 11 is attached to one end of the coil wire, at the starting point of the winding on the innermost layer 16 and that the lead wire 10 is attached at the other end of this same continuous piece of wire which terminates at approximately the center of the outermost strip 14. I have found that it is very important to have the lead wire 10 connected at this point, that is, at the center, rather than to continue the winding to the outer edge of the strip 14 and connect the lead wire there as is commonly done. My main reason for connecting the outside lead wire in this manner is that such an arrangement provides less opportunity for burnouts and other well known failures characteristic of secondary coils.

The special form of winding that I have used for the inner and outer layers of the coil, shown in Figure 2, is more clearly illustrated in magnified form in Figure 3. The strip of glassine paper or other insulating material 13, shown in this figure, forms the base upon which the current conducting wire is wound. It is evident from this illustration that the adjacent turns, such as 18 and 19, have corresponding wave-like formations.

Although I do not wish to be limited to any specific dimensions in the construction of my coil, I have found it advantageous to have the adjacent turns, such as 18 and 19, separated by a space of approximately one-quarter of an inch in width. It is to be understood, of course, that the intermediate turns, such as those shown at 22 in Figure 2, are not spaced to any material extent but are wound very close together.

The efficient operation of my transformer and the highly beneficial results that can be obtained from it are represented by the curve shown in Figure 4. Referring to this figure, it is to be noted that the voltage output of the coil varies between the points 24 and 25. In between these extremes are shown the varying voltage outputs 26, 27, and 28, which repeat themselves in a more or less constant manner during operation. The voltage output from the secondary coil of my transformer, as shown by this curve, varies between 7,500 volts and approximately 72,000 volts with an input in the primary coil of approximately 8 volts. The current in the primary coil at 8 volts is approximately 2.5 amperes, and the current drawn by the secondary coil at the peaks of 72,000 volts is approximately 10 milliamperes. Of course, the current and voltage outputs vary in a more or less constant manner between the minimum and maximum outputs.

The curve shown in Figure 4 is a copy of an actual oscillograph curve produced by my transformer when operating at a frequency of 9,500 cycles per second. As stated, this curve was made with an input of 8 volts and approximately 2.5 amperes in the primary coil. I have also tested my transformer with other input voltages and measured the output voltage and current. Examples of these, and also the data for the above described operation, are as follows:

Primary coil input			Secondary coil peak output		
Voltage	Current	Volt-amperes	Voltage	Current	Volt-amperes
Volts	*Amperes*		*Volts*	*Milliamperes*	
2	2.5	5	48,000	14	672
6	2.5	15	60,000	12	720
8	2.5	20	72,000	10	720

One of the most important features of the operation of my transformer, as shown by the curve in Figure 4, is that the peaks of extremely high voltage occur with sufficient frequency to operate a device, connected to the secondary coil of this transformer, with these peak voltages. It is important to note that with an input of 15 or 20 volt-amperes a peak output of 720 volt-amperes is obtained. Although this comparatively enormous amount of output is present for only a small

fraction of a second the peaks are sufficiently close together to make them useful for operation. I have found that to produce the high voltage peak form of operation, supra, the secondary coil should be wound in the manner shown in Figure 2 and the ratio of wire turns in the secondary coil to those in the primary coil should be within the range of (215 to 1) to (390 to 1). I have also found, as the result of numerous tests that the ratio of 340 to 1 gives the optimum results.

My transformer is particularly useful for operating gaseous tubes and lamps, such as the well known neon tubes and the like commonly used for advertising purposes. By means of the high operation efficiency of my transformer, as shown by the curve in Figure 4 and by the above tabulated input and output values, I have been able to substantially reduce the cost of operation of these gaseous tubes. Most of the present gaseous types of luminous tubes used for advertising purposes are connected to the line supply through the intermediary of a step-up transformer, which furnishes approximately 15,000 volts output with an input of 110 volts. The maximum length of half inch tubing that one of these transformers will satisfactorily operate is approximately 30 feet. By means of my transformer, and especially due to its regularly occurring peak type of operation described above, I have made it possible to operate luminous tubes and other gaseous devices with less power consumption and, therefore, at substantially less expense. I find also that the extremely high voltages produced by my transformer increase the brilliancy or intensity of the light emitted by the gaseous devices with which it is associated. Also, due to the high efficiency of the transformer it will satisfactorily operate approximately 70 feet of the half inch tubing used for neon signs and the like.

As shown by the above, my transformer is especially suitable for operating gaseous tubes and lamps; however, it may be adapted to any type of high voltage alternating current type of device. Furthermore, if the peaks of 60,000 to 70,000 volts are too high to be suitable for any particular operation, these peaks may be reduced to the desired value by proper adjustment of the input voltage and current or by reducing the ratio of wire turns in the secondary coil to those in the primary coil.

It is to be understood that my invention is not limited to the above description and illustrations but that various changes may be made in the construction and operation of my device, all of which come within the purview of the following claims.

What I claim is:

1. An alternating current transformer comprising a magnetic core, a primary coil, and a secondary coil, said secondary coil having certain of its innermost and outermost portions wound in such sinuous form that the power output from said transformer is characterized by relatively high voltage peaks occurring at constant frequent intervals.

2. A coil for use in alternating current devices comprising a plurality of layers of wire wound in continuous form, and a plurality of layers of insulating material separating adjacent layers of said wire, the two inner layers and the two outer layers of said wire having each of the wire turns wound in wave like form.

3. A coil for use in alternating current devices comprising a plurality of layers of wire wound in continuous form and a plurality of layers of insulating material separating adjacent layers of said wire, the two inner layers and the two outer layers of said wire having the wire turns wound in wave like form and each of the turns of said two inner and outer layers being spaced substantially farther apart than the turns forming the intermediate layers.

4. A secondary coil for use in an alternating current transformer comprising a central core, a plurality of discontinuous strips of insulating material wound around said core, and a layer of current conducting wire wound around each of said strips, the two innermost and the two outermost layers of wire being wound in wave like form.

5. A secondary coil for use in alternating current transformers comprising a central core, a plurality of discontinuous strips of insulating material wound around said core, and a current conducting layer of wire wound around each of said strips, the two innermost and the two outermost layers of wire being wound in wave like form, the adjacent turns of wire forming said innermost and outermost layers having the same wave form and being spaced a relatively large and constant distance apart.

6. A secondary coil for use in alternating current transformers comprising several inner layers of wire insulated from each other and wound in sinuous form, a plurality of insulated layers of wire superimposed upon said several innermost layers and wound in straight parallel form, and several outermost layers of wire insulated from each other and wound in the same sinuous manner as said several innermost layers.

7. A secondary coil for use in alternating current transformers comprising several inner layers of wire insulated from each other and wound in sinuous form, a plurality of insulated layers of wire superimposed upon said several innermost layers and wound in straight parallel form, and several outermost layers of wire insulated from each other and wound in the same sinuous manner as said several innermost layers, each of said layers being formed from a single continuous piece of wire, one terminal of which is located at one edge of said innermost layer and the other terminal of which is located at approximately the center of one side of said outermost layer.

8. An alternating current transformer comprising a primary coil and a secondary coil, means for producing from said secondary coil an output characterized by extremely high voltage peaks occurring at sufficiently frequent intervals to enable operation thereby of a gaseous discharge device such as a neon tube without any apparent flicker, said means comprising a sinuous form of winding for the innermost and outermost portions of said secondary coil.

9. An alternating current transformer comprising a primary coil and a secondary coil, the output of the secondary coil being characterized by extremely high voltage peaks occurring at constant frequent intervals, said secondary coil having a portion of its innermost and outermost wire turns wound in sinuous form and the ratio of wire turns in the secondary coil to the wire turns in the primary coil being within the range of 215 to 1 to 390 to 1.

JOHN A. RIETMANN.