Nov. 13, 1928. 1,691,125

W. J. POLYDOROFF

TRANSFORMER

Filed April 11, 1925 3 Sheets-Sheet 1

Fig. 1.

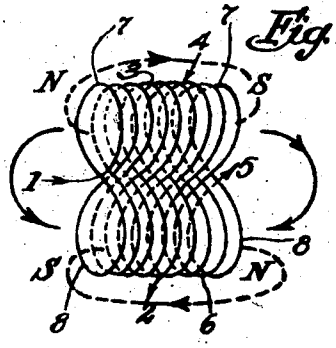


Fig. 2.

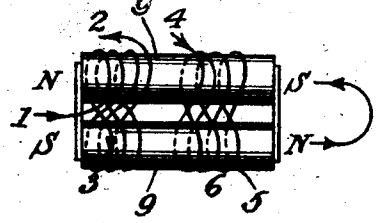


Fig. 3.

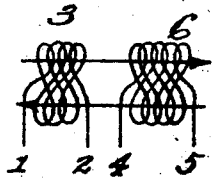


Fig. 4.

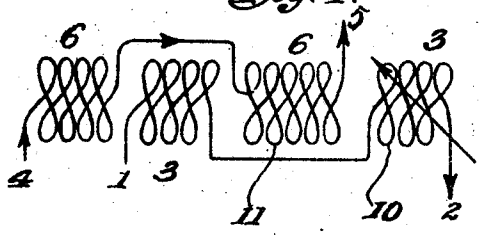
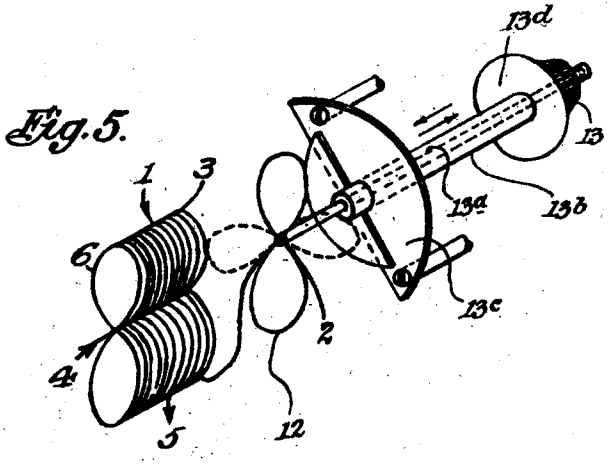


Fig. 5.



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TRANSFORMER

Filed April 11, 1925 3 Sheets-Sheet 2

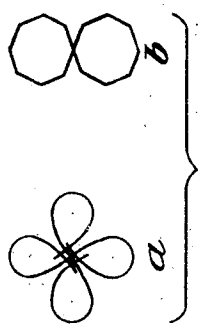


Fig. 6.

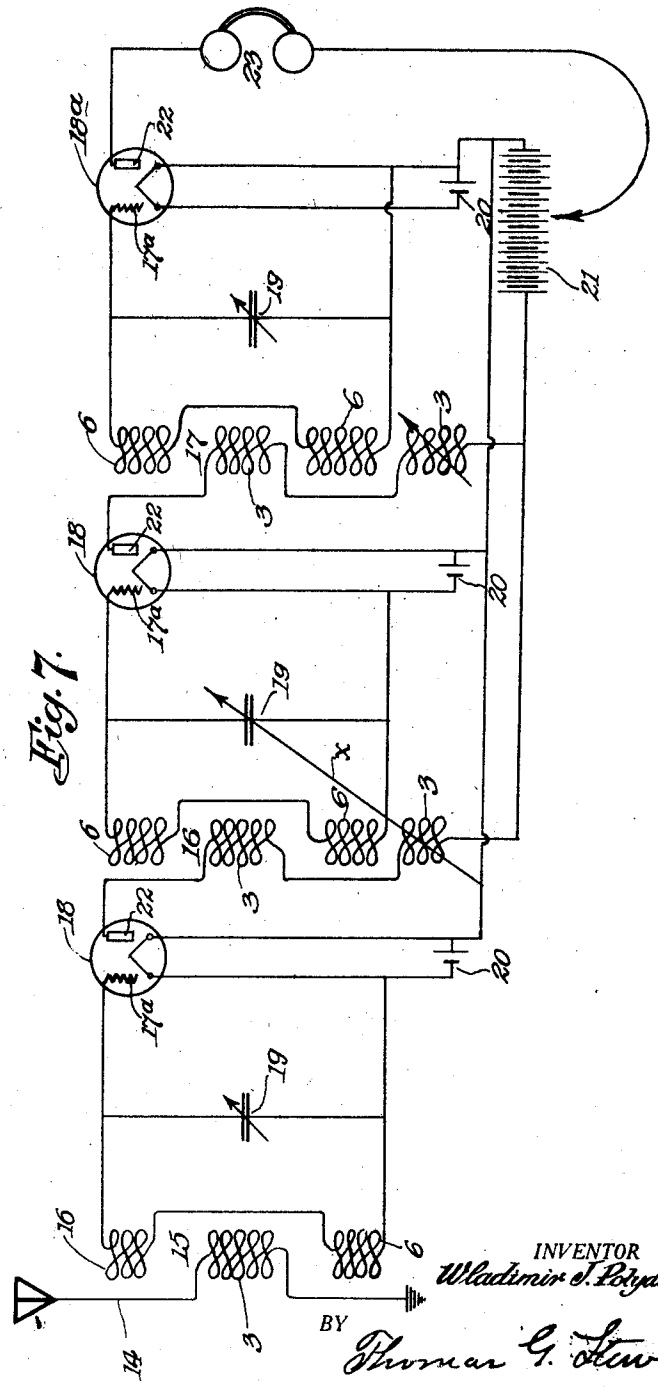


Fig. 7.

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TRANSFORMER

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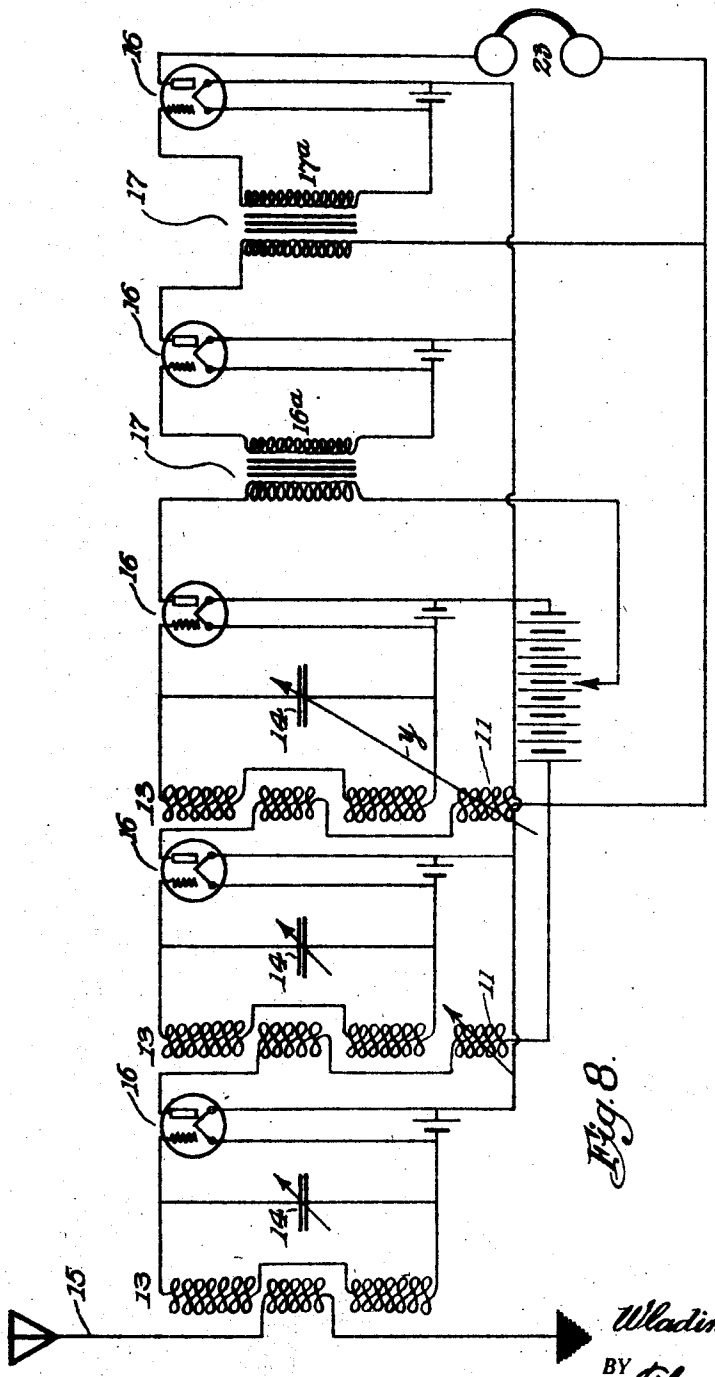


Fig. 8.

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Patented Nov. 13, 1928. 1,691,125

UNITED STATES PATENT OFFICE.

WLADIMIR J. POLYDOROFF, OF CHICAGO, ILLINOIS, ASSIGNOR TO JOHNSON-WILLIAMSON LABORATORIES, INC., OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

TRANSFORMER.

Application filed April 11, 1925. Serial No. 22,291.

The invention relates to transformers in general, and is especially adapted to high or radio frequency work.

It is common knowledge that one of the difficulties experienced in present-day high-frequency apparatus, such as oscillators and radio-receiving and transmitting sets, is radiant electro-magnetic energy effects. The present invention has for its object a device for rendering magnetic energy ineffective on apparatus associated with various sources of such energy.

In the ordinary type of high-frequency transformers magnetic energy is radiated when an electrical current is passed through the windings. Furthermore, this radiant energy is not instantaneous throughout the entire winding, but progresses through each successive turn until the current and the consequent magnetic field have reached their maximum values throughout the coil. This is due, of course, to the fact that the current has to overcome the impedance of the coil. In order to counterbalance this energy thus radiated by a coil, I have devised a means for establishing equal and opposite fields associated with each successive turn, so that the radiant energy manifests itself as external fields of equal magnitudes and of opposite polarities which tend to counterbalance each other, to thereby minimize interference with adjacent circuits. Likewise, energy radiated from some external source will not materially affect the transformer because it is so wound that currents of opposite direction are established and neutralize each other. The invention will be better understood if reference is had to the accompanying drawing forming part of this specification, and in which—

Figure 1 shows the winding of the transformer;

Figure 2 shows the transformer provided with an iron or a non-magnetic core;

Figure 3 is a schematic view of the windings of the transformer;

Figure 4 shows a modification having alternating primary and secondary windings;

Figure 5 shows the transformer provided with an adjustable element, and associated with a variable condenser;

Figure 6 shows modifications of the transformer windings;

Figure 7 shows ordinary radio-frequency circuits, and a telephone circuit which is of audio frequency;

Figure 8 shows an apparatus having both radio-frequency and audio-frequency circuits, and terminating in a telephonic circuit.

In all of the figures of the drawing, 1 and 2 are terminals of the primary winding 3, and 4 and 5 are terminals of the secondary winding 6.

The primary and the secondary windings are similar, both of said windings, as shown, having continuous and reversed half-turns simulating the figure 8. When a current of electricity is passed through the windings, two magnetic fields are set up with unlike poles at each end. This forms a complete magnetic circuit of flux within the transformer. Progressively from turn to turn a field is set up in one half turn, followed by a separate field in the other half turn, until the field is established throughout the entire transformer. The aforesaid half turns produce what may be regarded as solenoidal elements with their windings in series, although other than serial windings may be employed provided the polarities are such that a complete magnetic circuit, such as described, is established.

As shown in Figure 1, the windings are self-sustaining, but said windings may be disposed on iron or on non-magnetic cores 9, as shown in Figure 2.

Figure 3 shows the primary and the secondary windings separated.

Figure 4 shows extensions 10 and 11 of the primary 3 and the secondary 6, respectively.

Figure 5 shows a rotary extension 12 of the primary having an actuating element 13 on its shaft 13^a, which shaft extends through the hollow shaft 13^b of a condenser 13^c having a knob 13^d. Said knob and said actuating element 13 may be operated simultaneously or separately in order to secure the desired adjustments of the primary coil, the secondary coil and the condenser. Reversal of the rotary extension 12 operates to reduce transformation from maximum to minimum.

The coils may be of various forms as shown in Figure 6, but, in all cases, the wires should be laid in parallel if maximum transformation is desired. *a* represents a winding having four partial turns, while *b* represents a winding of polygonal form.

Figure 7 shows the new transformer applied to a radio apparatus. 14 is the antenna, and 3 the primary winding of the first transformer 15, 6 being the secondary winding. Additional transformers 16, 17, in series with the grids 17^a, may be employed, and these additional transformers may be of the type shown in Figure 4.

Figure 8 shows a network similar to that revealed in Figure 7, there being, however, stages of audio frequency 16^a and 17^a. In Figure 7 the arrow x indicates that the transformer and the condenser of the second radio stage are simultaneously adjustable, and the arrow y in Figure 8 shows that the corresponding elements in the detector grid circuit are simultaneously adjustable.

The set includes a plurality of radio-frequency amplifying tubes 18, and variable condensers 19 shunted across the filament-grid circuits, as shown in Figure 7. The third tube 18^a is a detector tube. Batteries 20 supply current to each of the filaments of said amplifying tubes, and the detector tube, and the battery 21 supplies current to the telephonic circuits which include the plates 22, the primaries of the second and third condensers, and the telephone 23. This description applies to the corresponding elements of Figure 8.

A transformer of the type herein set forth may be wound in such a way that both primary and secondary coils will be very close together, and such a transformer is very useful as an interstage coupling between three-electrode tubes operating as radio or high-frequency amplifiers in a radio receiving apparatus.

Every half turn of the transformer forms substantially a circle with a magnetic field of the same strength as the adjacent half turn, so that both of these half turns build up a magnetic field passing through the coils, thus closing itself with a minimum number of lines of force outside and a maximum number of lines of force inside said coils.

The primary and secondary windings of the transformer, being in close magnetic relation, insure a good transformation of energy from the primary to the secondary circuit, without radiation of material energy to the adjacent coil or to the wires of the receiving circuit. It appears to be the fact that the external lines of force developed by the half turn of the transformer are of opposite polarities, and that, for this reason, they substantially neutralize each other and cannot, therefore, induce currents in extraneous or adjacent circuits. The close coupling between the primary and the secondary admits of a small number of turns in the primary winding, so that the natural period of said primary winding is considerably lower than that of the secondary winding.

The transformer has a low distributed capacity and a low natural period as compared with a single-layer solenoid.

Having thus described my invention, what I claim is:

1. An electrical device including a radio frequency transformer having a plurality of separate windings, said windings being in close magnetic relation, a magnetic field of a primary winding being substantially enclosed in other windings, and said windings being wound in such a way that every half turn forms a complete circle and is continued in the same plane and same form, but in a direction opposite to another half winding.

2. A radio frequency coupling transformer having a plurality of separate windings, said windings being closely wound in such manner that to each half turn of said winding another half turn of same shape and area is continually added, wound in reverse direction; the said windings being placed in sections so that a primary winding is substantially in the center, whereby a magnetic field is enclosed within the transformer.

3. A radio frequency transformer having a plurality of inductively related windings wound in such a way that every half turn completes a circle, producing a definite magnetic polarity when current flows, and to said half turn another half turn in the form of a similar circle is added in reversed direction, whereby equal and opposite field polarities are produced in primary turns and induced upon an adjacent secondary turn wound in the same way as said primary turn.

4. A radio-frequency transformer having primary and secondary windings so wound that the halves of complete turns are of the same shape and area, both halves are in the same plane, magnetic lines of force produced by current flow in the turns are equal and opposite, and the resultant field of the turns tends to close itself within said turns and within an adjacent secondary turn.

5. A radio-frequency transformer having two or more continuous windings, alternatively wound in sections of primary and secondary windings, every turn of said winding being placed in halves wound symmetrically and in different directions, thereby producing a magnetic field which tends to close itself within said windings.

6. A transformer having a primary and a secondary winding, the turns of said windings being arranged in groups, and each of said windings having a plurality of reversed half turns through which currents may flow in opposite directions to thereby establish a continuous flux circuit within said half turns.

7. A radio-frequency transformer having primary and secondary windings laid in such a way that a primary winding is substantially in the middle portion of the transformer,

and so wound that to every half turn of the winding a symmetrical and oppositely wound half turn is added so that outside electric disturbances are equally and oppositely induced upon two halves of every turn, whereby said electric disturbances are neutralized inside of the transformer.

8. A radio-frequency transformer having primary and secondary sectional windings laid in such a way that primary sectional windings are wound with relation to the secondary sectional winding, every section being wound to produce two equal and opposite magnetic fields, the said fields being substantially a continuation of one another.

9. A radio-frequency transformer having two solenoidal windings, these solenoidal windings being laid alternatively on two cylindrical forms so that to every half turn of the windings a symmetrical and opposite half turn is added, the primary winding being in the middle portion of said forms, and the secondary winding being at the ends of said forms, whereby the primary magnetic field is substantially enclosed in the secondary winding.

10. A radio-frequency transformer having sectional primary and secondary windings wound in the shape of a double solenoid with every turn of the winding spread over two cylindrical forms, so that half turns complete circles around the cylindrical forms, but in opposite directions so that an infinite number of points of each half turn of the transformer will produce magnetic fields equal and opposite at the same points on the other half turn, the magnetic field of primary winding being substantially enclosed in secondary turns.

11. A transformer having in combination windings in reversed half turns arranged alternately in adjacent groups, the conductors crossing at single points and operatively connecting alternate half turns.

12. A transformer having a primary and secondary winding each laid in reversed half-turns which together simulate the figure 8.

13. A transformer including continuous windings wound so that half turns are arranged side by side successively reversed and conductively connected one with another.

14. An electrical device including a transformer with plurality of windings wound so that half turns are arranged side by side and are successively and conductively connected one with another, and that a strong closed internal field and two equal and opposite and external fields are produced when a current progresses through said windings.

15. A radio-frequency transformer having an input, and a winding leading from said input and constituting a reversed half-turn, said winding leading from said half-turn and forming another reversed half-turn disposed in substantially the same plane as said first-named turn, the winding being continued in the same manner throughout the transformer.

In testimony whereof I affix my signature.

WLADIMIR J. POLYDOROFF.