May 23, 1933. P. H. DOWLING 1,910,381

ELECTRICAL TRANSLATING APPARATUS

Filed Dec. 26, 1929 2 Sheets-Sheet 1

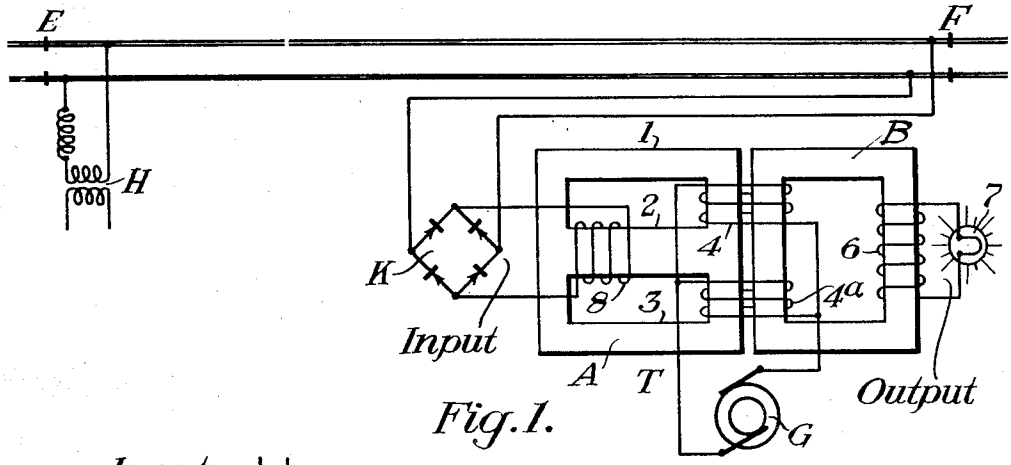


Fig. 1.

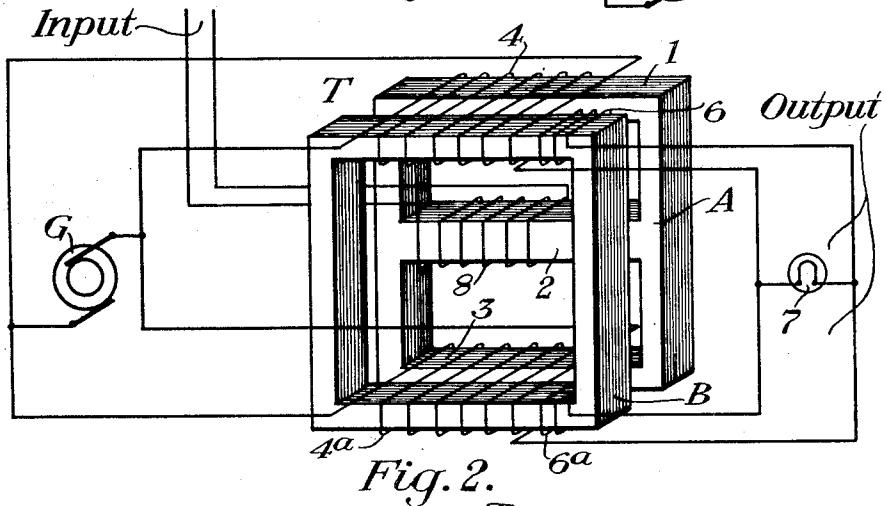


Fig. 2.

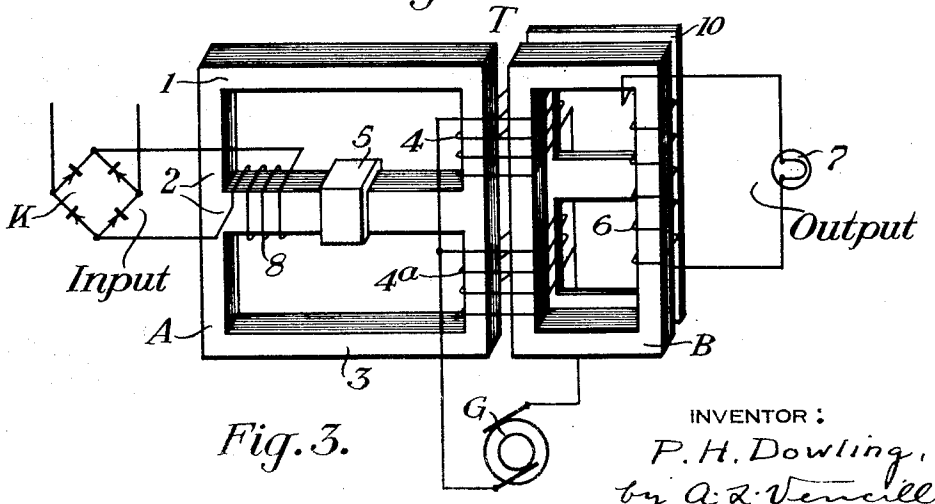


Fig. 3.

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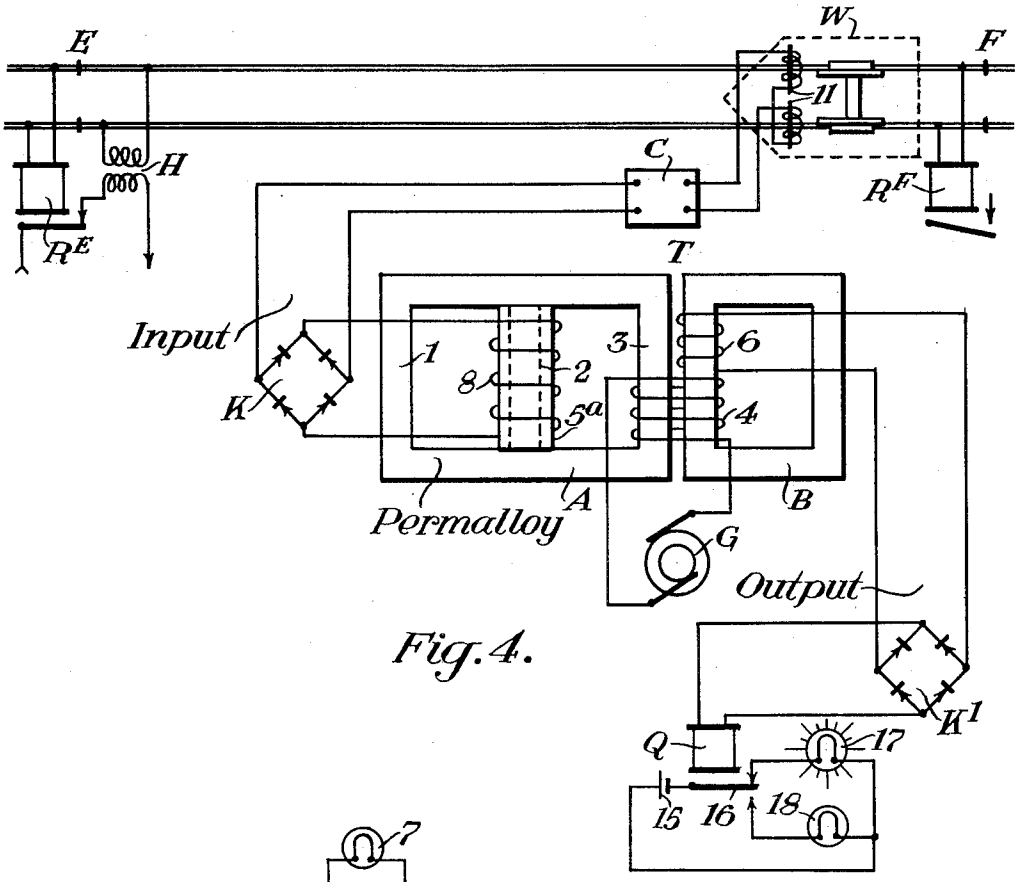


Fig. 4.

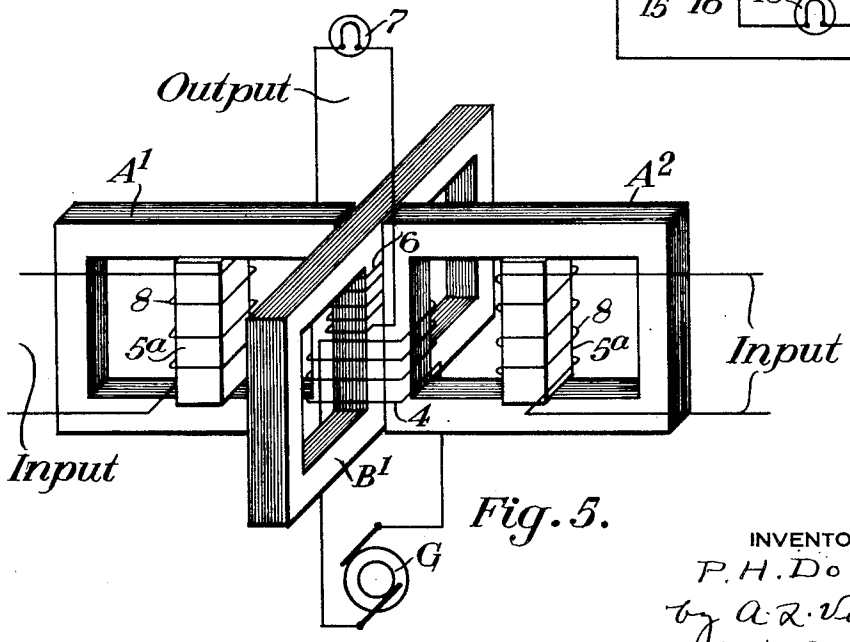


Fig. 5.

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Patented May 23, 1933 1,910,381

UNITED STATES PATENT OFFICE

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ELECTRICAL TRANSLATING APPARATUS

Application filed December 26, 1929. Serial No. 416,355.

My invention relates to electrical translating apparatus, and particularly to apparatus of the type comprising an input circuit which is at times supplied with current and an output circuit in which the flow of current is controlled in accordance with the current supplied to the input circuit.

I will describe several forms of electrical translating apparatus embodying my invention, and will then point out the novel features thereof in claims.

In the accompanying drawings, Fig. 1 is a diagrammatic view illustrating one form of translating apparatus embodying my invention as applied to the control of a trackway signal. Figs. 2 and 3 are views showing modified forms of the apparatus illustrated in Fig. 1 and also embodying my invention. Fig. 4 is a view showing still another form of translating apparatus embodying my invention as applied to the control of governing means on a train in accordance with traffic conditions in the trackway. Fig. 5 is a view showing still another form of translating apparatus embodying my invention.

Similar reference characters refer to similar parts in each of the several views.

Referring first to Fig. 1, the reference character T designates a transformer, which as here shown, comprises two cores A and B of magnetizable material. Core A is of the well known shell type, and comprises three legs 1, 2 and 3 connected in parallel to form two magnetic paths with the leg 2 forming a bridging member common to both paths. Alternating flux is supplied to the transformer T by a primary which as here shown comprises two windings 4 and 4^a connected in parallel and linking the core A on opposite sides of the bridging member 2 in such manner that the fluxes created by current in windings 4 and 4^a produce substantially no flux in member 2. Alternating current is supplied to the windings 4 and 4^a from any suitable source of alternating current, here shown as a generator G. Core B also links windings 4 and 4^a in such manner that the fluxes created in core B by currents in windings 4 and 4^a are additive. The core B also carries a secondary or output winding 6 which may supply energy to any suitable output circuit. As here shown the winding 6 is connected with a lamp 7.

For the purpose of controlling the electromotive force induced in winding 6, an input winding 8 is located on the bridging member or middle leg 2 of core A and current is at times supplied to this winding to vary the permeability of core A. It is preferable, though not essential, to supply the winding 8 with unidirectional current, and if the source of controlling current delivers alternating current, a rectifier K may be included in circuit with winding 8.

The parts are so adjusted that when a predetermined value of the current supplied to winding 8, (usually when this current is zero), a very small current is drawn by the device 7 supplied from the output circuit. This small current is insufficient to operate device 7 but is effective to force the major portion of the total alternating flux created by windings 4 and 4^a into the core 1, where this flux circulates in legs 1 and 3, without flowing through the bridging member or middle leg 2. When current is supplied to winding 8, however, there is created, in the middle leg 2, magnetic flux which decreases the permeability of core A to flux due to current flowing through windings 4 and 4^a. The result is that an increased proportion of the flux from windings 4 and 4^a is forced to flow through core B, and the electromotive force induced in winding 6 is correspondingly increased to a value which is sufficient to operate the device 7. With the parts constructed as illustrated in the drawings, a comparatively small change in current supplied to winding 8 will produce a comparatively large change in the current supplied to device 7 by winding 6.

Although the apparatus may be utilized to control the supply of current to any form of output load, I have shown it controlling a signal lamp in a railway signaling system. Thus E—F is a section of railway track which is normally supplied with current from a track transformer H connected across the rail adjacent one end of the sec-

tion. The input winding 8 of transformer T is connected, through the rectifier K, across the rails adjacent the other end of the section. The lamp 7 controlled by the output winding 6 may then indicate "proceed" traffic conditions in section E—F. It will be plain that when section E—F is unoccupied, current is supplied to the winding 8, and lamp 7 is lighted. If section E—F is occupied by a train, however, current is shunted away from winding 8 and lamp 7 is then extinguished.

It should be pointed out that a lamp 7 of the usual tungsten filament type is peculiarly adapted for co-operation with apparatus embodying my invention. In this connection, it should be stated first that the total flux delivered by windings 4 and 4^a is substantially constant. When no current is being supplied to winding 8, under which conditions, lamp 7 is extinguished, the resistance of this lamp is relatively small, so that winding 6 is substantially short-circuited. The effect of the short-circuited winding 6 is to force most of the flux from windings 4 and 4^a through core A, as explained hereinbefore. When current is supplied to winding 8, to light lamp 7, however, the increase in resistance of lamp 7 tends to increase the ratio between the flux in core B and the total flux delivered by windings 4 and 4^a. It follows therefore that the temperature coefficient of resistance of tungsten lamp filaments of the usual type when supplied with energy from the output winding 6 of apparatus embodying my invention assists in maintaining at a high value a ratio between the power expended in the lamp when winding 8 is energized and that expended in the lamp when this winding is de-energized.

Referring now to Fig. 2, in the form here shown, the parts are essentially the same as in Fig. 1, but their physical arrangement is somewhat different. Cores A and B are here arranged side by side in parallel planes, the windings 4 and 4^a embracing legs 1 and 3 of core A, and also the adjacent legs of core B. Furthermore, the secondary of the transformer T is made in two windings 6 and 6^a which are located at spaced points on the core B. The two windings 6 and 6^a are connected in parallel across the load 7 in such manner that the electromotive forces induced in these coils oppose each other but are additive in their tendency to send current through the load 7. The input winding 8 is located on the bridging member or middle leg 2 of core A, and the operation of the apparatus is similar in all respects to the operation of the apparatus shown in Fig. 1.

In the modification shown in Fig. 3, transformer T is similar to that shown in Fig. 1, except that a short-circuited winding or conducting ferrule 5 surrounds the bridging member 2 of core A for the purpose of preventing the flow of alternating flux through the input winding 8. The transformer also comprises a third magnetizable core 10 of smaller cross-sectional area than either cores A or B. The core 10 is a shell type core similar to core A and links the primary windings 4 and 4^a in the same manner as core A.

With this arrangement, if winding 8 is supplied with current from a source of direct current, it is impossible to light lamp 7 excepting when current is supplied to winding 8. When the input winding 8 contains a rectifying device such as K, if any failure occurs in a core or a coil of the transformer T which tends to send alternating flux through winding 8, the induced electromotive force would be rectified, and would create in the core A, a unidirectional flux which would operate to change the permeability of this core in exactly the same way as controlling current supplied to the input winding. In order to prevent this, I have provided the ferrule 5 on leg 2 of core A, and it will be seen that should any failure occur which would normally tend to cause alternating flux to thread the winding 8, this ferrule 5 will choke out such flux to prevent improper operation of lamp 7. The core 10 assists in this protection, and is particularly valuable under the most severe failure, that is, when one of the windings 4 or 4^a becomes completely short-circuited and also disconnected from the primary coil. Should this occur, all of the flux paths except one-half of core 10 would carry short-circuited coils and the core 10, under these conditions, would assist in by-passing flux away from core B, and would therefore prevent energization of lamp 7, unless current were supplied to winding 8.

Referring now to Fig. 4, the transformer T, as here shown, comprises two cores A and B, similar to those shown in Fig. 1. Core A is so disposed, however, that an end leg 3 of the core is adjacent the core B, and a single primary winding 4, supplied with alternating current from generator G, embraces this end leg and a portion of the core B. Core B carries the output winding 6 as in the previous views. Alternating flux from winding 4 has two paths through core A, one through the middle leg 2, and the other through the outer leg 1. I prefer to provide a conducting sleeve 5^a on the middle leg 2 which carries the input winding 8, to prevent the passage of alternating current through this winding 8 as explained in connection with Fig. 3. If desired, the leg 2 may be made of some solid material of high permeability and low resistivity to assist in holding to a low value the amount of alternating flux which threads this leg, without materially affecting the reluctance of this leg to the unidirectional flux created

by control current in winding 8. The operation of the transformer shown in Fig. 4 is similar in all respects to the apparatus previously described in connection with Fig. 1. The form shown in Fig. 4, however, is particularly safe from the standpoint of short-circuited coil, because even though the input winding is in direct inductive relation with the alternating current winding 4, there is always an open flux path through the leg 1 in parallel with that through the input winding 8. The worst condition of alternating flux through winding 8, is, therefore, the normal operating condition. If the apparatus is adjusted to prevent undesirable operation, due to the amount of alternating flux which normally threads leg 2, it is obvious that no coil failure can increase this amount of flux to cause improper operation of the device connected with the output circuit.

The apparatus shown in Fig. 4 may control the supply of current to any suitable load, but as here shown, is part of a system of automatic train control. In systems of this type, alternating train controlling current is ordinarily supplied to the rails adjacent the exit end of each section when traffic conditions in advance are safe. As shown in the drawing, section E—F is supplied with alternating current from transformer H when the track relay R^E next in advance is energized. A train indicated diagrammatically at W is provided with a receiver 11 located in inductive relation with the track rails and arranged to have induced therein, an electromotive force in accordance with train controlling current flowing in the track rails. The receiver 11 is connected through a filter C and rectifier K with the input winding 8 of transformer T. The output winding 6 of transformer T is connected through another rectifier K^1 with a relay Q. When section E—F is supplied with train controlling current, a corresponding current is supplied to winding 8 of transformer T and sufficient current is then supplied to relay Q from winding 6 to energize the relay. The relay Q may control governing means of any suitable type, but as here shown, when relay Q is energized, current is supplied from battery 15, over front contact 16 of the relay to a lamp 17. If the supply of train controlling current is for any reason interrupted, winding 8 becomes de-energized and relay Q is then released to deenergize lamp 17 and light lamp 18.

In systems of the type described the amount of energy available in the receiver 11 is comparatively small and in order to obtain a large change in the permeability of core A of transformer T in response to small changes in current in a winding 8, it may be desirable, under some conditions, to construct the core A of permalloy or of some other material having the characteristic of exhibiting large variations in its permeability in response to comparatively small changes in the density of the flux through the material.

It may also be desirable to introduce another stage or stages of amplification between the receiver 11 and the the relay Q. Thus the output winding 6 of transformer T, instead of feeding relay Q directly, might supply energy to the primary of a second transformer similar to that here shown, and the output winding of which would in turn supply the relay Q.

In the form of apparatus shown in Fig. 5, the transformer T comprises three magnetizable cores of the shell type and each having three legs connected in parallel. The primary winding 4 embraces a middle leg of the core B^1 and an end leg of each of the cores A^1 and A^2. The secondary or output winding 6 is located on the middle leg of core B^1 and is connected with the load 7. One input winding 8 is located on the middle leg of each of the two cores A^1 and A^2 and these middle legs are also provided with conducting sleeves 5^a to prevent the passage of alternating flux from winding 4 through the input winding 8. When no current is supplied to the windings 8, sufficient flux is by-passed through cores A^1 and A^2 away from the winding 6 so that load 7 is de-energized. If current is supplied only to winding 8, as winding 8 on core A^1, the permeability of the corresponding core is decreased and the reluctance of that core is increased, but flux from the winding 4 can still thread the other core A^2 without passing through the output winding 6. If both of the windings 8 are energized, however, the permeabilities of both cores A^1 and A^2 are decreased and flux from the winding 4 is then obliged to pass through core B^1 and winding 6. The load 7 may be adjusted to become energized when and only when the windings 8 are both supplied with current.

One advantage possessed by the apparatus shown in Fig. 5 is that it permits the control of a load in such manner that the load is energized only when two wholly independent circuits are energized. It should be noted in this connection that this result can not be obtained by the use of two independent input windings on a single core A, such as is shown in Fig. 4.

Although I have herein shown and described only a few forms of electric translating apparatus embodying my invention, it is understood that various changes and modifications may be made therein within the scope of the appended claims without departing from the spirit and scope of my invention.

Having thus described my invention, what I claim is:

1. In combination, a first magnetizable core comprising two magnetic paths having a bridging member in common, a first winding linking one of said paths, means for supplying periodically varying current to said first winding, a second winding on said bridging member, a second magnetizable core linking said first winding, a third winding on said second core, and means for at times supplying current to said second winding to vary the electromotive force induced in said third winding.

2. A transformer comprising a first magnetizable core having two magnetic paths including a bridging member in common, a first winding linking one of said paths and supplied with periodically varying current, a second winding for supplying energy to an output circuit, a third magnetic path linking said first and second windings, and a third winding located on said bridging member and operating when supplied with current to vary the coupling between said first and second windings.

3. A transformer comprising a first magnetizable core having two magnetic paths including a bridging member in common, a first winding linking one of said paths and supplied with periodically varying current, a second winding for supplying energy to an output circuit, a third magnetic path linking said first and second windings, and a third winding located on said bridging member and arranged when supplied with current to vary the permeability of said first core to flux resulting from current in said first winding.

4. A transformer comprising a first magnetizable core having two magnetic paths including a bridging member in common, a source of periodically varying current, a first winding connected with said source and linking one said path in such manner that flux created thereby threads a portion of said core but not said bridging member, a second magnetizable core linking said first winding, a second winding on said second core, a current consuming device connected with said second winding, and a third winding on said bridging member arranged when supplied with current to reduce the amount of flux from said first winding which is forced to traverse said first core by the current in said second winding.

5. In combination, a first magnetizable core comprising two magnetic paths having a bridging member in common, a first winding linking one of said paths, means for supplying periodically varying current to said first winding, a second magnetizable core linking said first winding, a second winding on said second core, a device connected across said second winding and having the property of varying its resistance in response to variations in the electromotive force applied thereto, a third winding on said bridging member, and means for at times supplying current to said third winding to vary the permeability of said first core to flux from said first winding.

6. In combination, a first magnetizable core comprising two magnetic paths having a bridging member in common, a first winding linking one of said paths, means for supplying periodically varying current to said first winding, a second magnetizable core linking said first winding, a second winding on said second core, a device connected across said second winding and having the property of increasing its resistance in response to increases in the electromotive force applied thereto, a third winding on said bridging member, and means for at times supplying current to said third winding to increase the proportion of flux from said first winding which threads said second core.

7. In combination, a first magnetizable core comprising two magnetic paths having a bridging member in common, a first winding linking one of said paths, means for supplying periodically varying current to said first winding, a second winding on said bridging member, a second magnetizable core linking said first winding, a third winding on said second core, and means for at times supplying unidirectional current to said second winding to decrease the permeability of said first core.

8. In combination, a first magnetizable core comprising two magnetic paths having a bridging member in common, two primary windings linking said two paths respectively, means for supplying alternating current to said two primary windings in parallel in such manner that the resultant flux in said bridging member is substantially zero, a second core linking both said primary windings in such manner that the fluxes created thereby are additive in said second core, a third winding on said second core for supplying energy to an output circuit, and a fourth winding on said bridging member and adapted when supplied with current to modify the electromotive force induced in said third winding.

9. In combination, a magnetizable core comprising two magnetic paths having a bridging member in common, a primary winding supplied with periodically varying current and linking one said path, means for preventing the flow of varying flux through said bridging member, a second winding inductively related with said primary winding, a third winding on said bridging member, and means for at times supplying current to said third winding to vary the electromotive force induced in said second winding.

10. In combination, a magnetizable core

comprising three legs connected in parallel, a first winding supplied with periodically varying current for supplying flux to one of said legs, means for preventing flux from said first winding from flowing through another one of said legs, a second winding on said other leg, a third winding inductively related with said first winding, and means for at times supplying current to said second winding.

11. In combination, a magnetizable core comprising two magnetic paths having a bridging member in common, a first winding linking one said path and supplied with alternating current, a second winding inductively related with said first winding for supplying energy to an output circuit, a third winding on said bridging member, and means for at times supplying unidirectional current to said third winding.

12. In combination, a magnetizable core comprising two magnetic paths having a bridging member in common, a first winding linking one said path and supplied with alternating current, a second winding inductively related with said first winding for supplying energy to an output circuit, a short-circuited winding on said bridging member, a fourth winding on said bridging member, and means for at times supplying unidirectional current to said fourth winding.

13. In combination, a first magnetizable core comprising two magentic paths having a bridging member in common, two primary windings linking said two paths respectively, means for supplying alternating current to said two primary windings in parallel in such manner that the resultant flux in said bridging member is substantially zero, a second core linking both said primary windings in such manner that the fluxes created thereby are additive in said second core, a third winding on said second core for supplying energy to an output circuit, a fourth winding on said bridging member, means for supplying current to said fourth winding to control the electromotive force induced in said third winding, and a third magnetizable core having two magnetic paths linking said two primary windings respectively.

14. A transformer comprising a primary winding and a secondary winding in inductive relation with said primary, a core of permalloy for shunting a portion of the flux from said primary winding away from said secondary winding, and a winding associated with said core and arranged when supplied with current to vary the permeability of said core.

15. In combination, a magnetizable core comprising three legs connected in parallel, a first winding supplied with periodically varying current for supplying flux to one of said legs, a sleeve of conducting material on another one of said legs, a second winding on said other leg, a third winding inductively related with said first winding, and means for at times supplying current to said second winding.

16. In combination, a magnetizable core comprising three legs connected in parallel, a first winding located on one said leg and supplied with periodically varying current, means for preventing flux from said first winding from flowing through another one of said legs, a second winding on said other leg, a second magnetizable core linking said first winding, a third winding on said second core, and an electro-responsive device connected with said third winding and arranged to be energized when and only when current is supplied to said second winding.

17. In combination, two magnetizable cores each having three legs connected in parallel, a first winding embracing the middle leg of one core and an end leg of the other core and supplied with alternating current, a second winding located on the middle leg of said one core for supplying energy to an output circuit, a third winding on the middle leg of said other core, and means for at times supplying current to said third winding to vary the permeability of said other core.

18. In combination, three magnetizable cores each having three legs connected in parallel, a first winding supplied with alternating current and embracing the middle leg of a first one of said cores and an end leg of each of the other two cores, two input windings one located on the middle leg of each of said other two cores, an output winding located on the middle leg of said one core, and a current consuming device connected with said output winding and arranged to be energized when and only when current is supplied to both said input windings.

19. In combination, a primary winding and a secondary winding inductively related therewith, and two additional windings separately supplied with current and operating to separately produce additive variations in the coupling between said primary and secondary windings.

20. In combination with two windings located in inductive relation, two cores each linking at least one of said windings, and means for separately varying the reluctances of said two cores to produce additive variations in the coupling between said two windings.

21. In combination with two windings located in inductive relation, a source of periodicaly varying current connected with one said winding, a load receiving energy from the other winding, two magnetizable cores each linking at least one of said windings,

and means for separately varying the reluctances of said cores to produce additive variations in the current supplied to said load.

22. In combination, primary and secondary windings in inductive relation, means for supplying such primary winding with periodically varying current, two magnetizable cores each linking at least one of said windings, a third winding for controlling the reluctance of one core in accordance with the current supplied thereto, a fourth winding for controlling the reluctance of the remaining core in accordance with the current supplied thereto, and a load connected with said secondary winding and arranged to be energized when and only when both said third and fourth windings are supplied with currents of predetermined values.

23. In combination with a primary winding supplied with periodically varying current, a first core linking said primary winding, a secondary winding on said first core, two other cores each linking said primary winding but not said secondary winding, means for independently varying the reluctances of said two other cores, and a load receiving energy from said secondary winding.

24. In combination with a primary winding supplied with periodically varying current, a first core linking said primary winding, a secondary winding on said first core, two other cores each linking said primary winding but not said secondary winding, two input windings one located on each of said other cores and each operating to vary the reluctance of the associated core in response to the current supplied thereto, and a load receiving energy from said secondary winding.

25. In combination, a winding supplied with periodic current, two magnetizable cores each linking said winding, and means for independently varying the reluctances of said two cores to cause independent additive variations in the effective impedance of said winding.

In testimony whereof I affix my signature.

PHILIP H. DOWLING.