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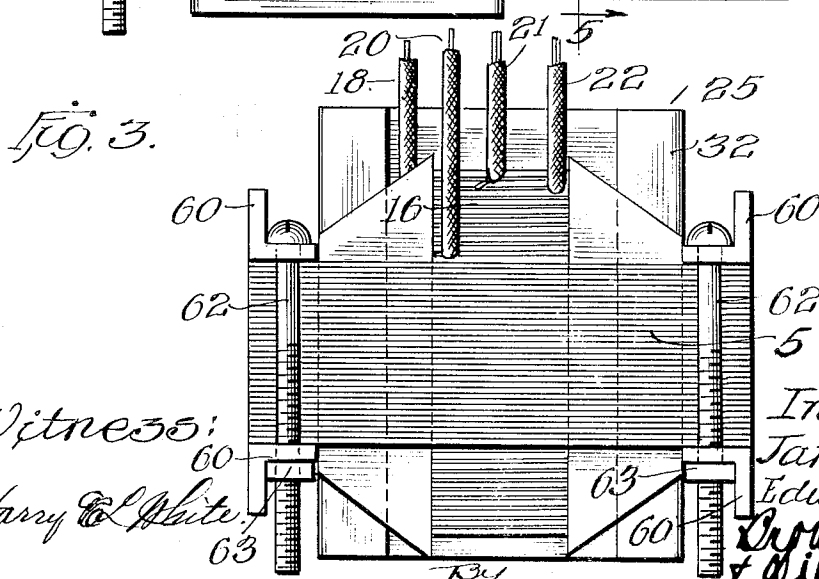
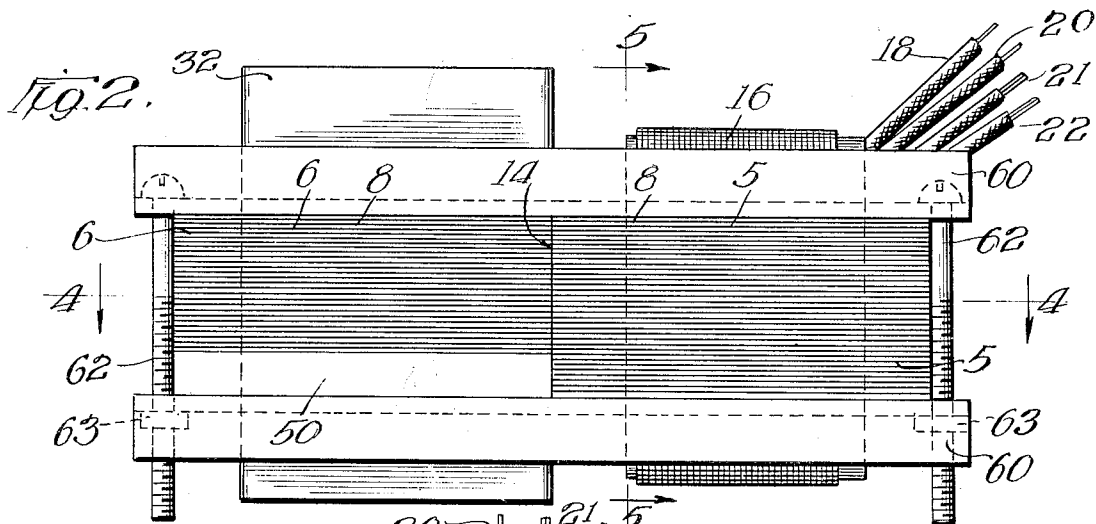
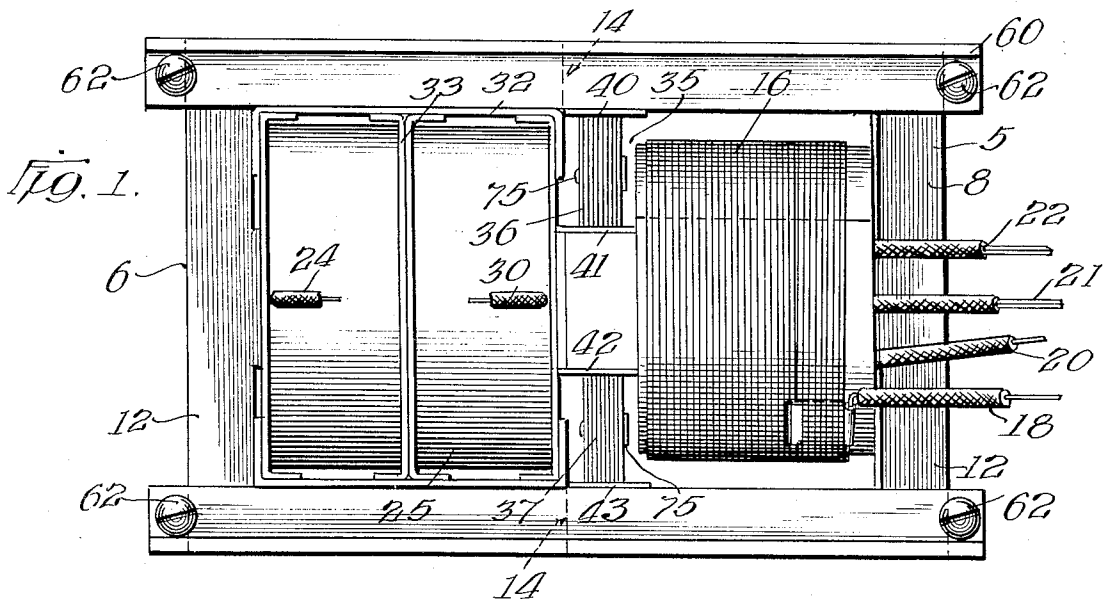
J. C. DALEY ET AL

1,786,422

TRANSFORMER

Filed Nov. 11, 1927

2 Sheets-Sheet 1



Witness:

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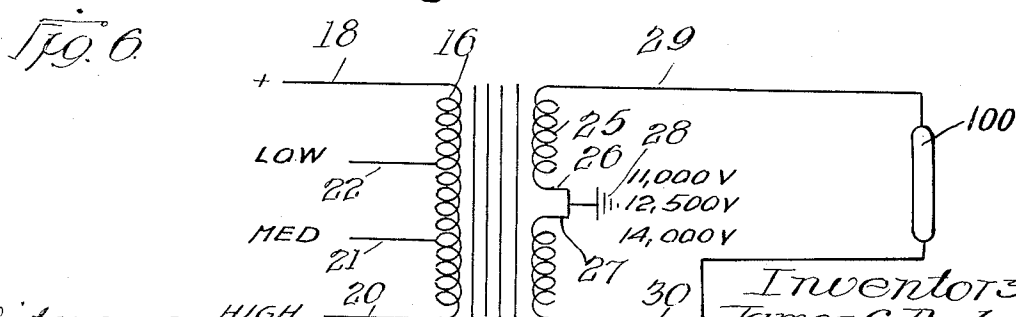
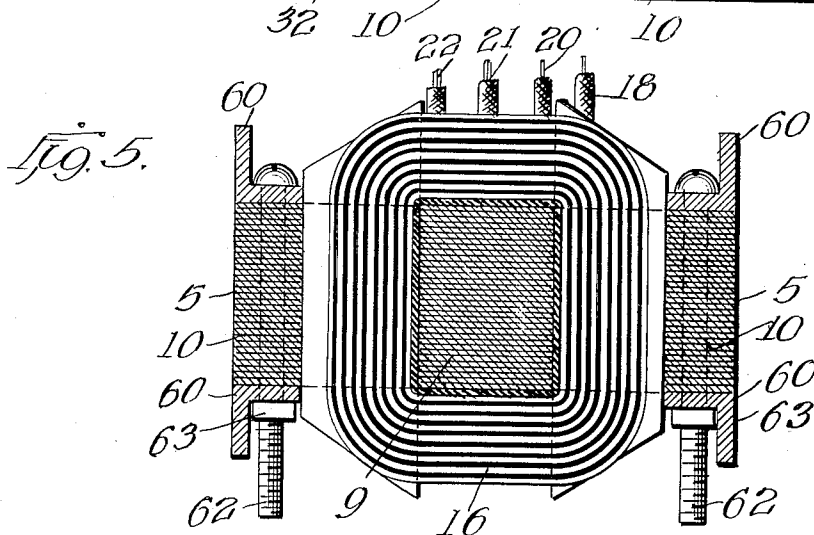
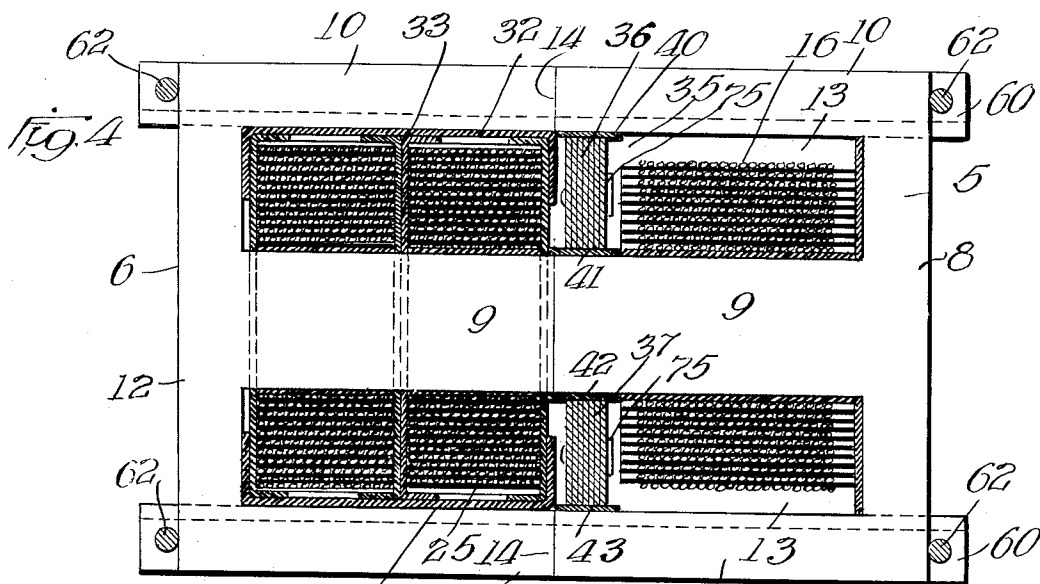
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TRANSFORMER

Filed Nov. 11, 1927

2 Sheets-Sheet 2



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UNITED STATES PATENT OFFICE

JAMES C. DALEY AND EDWIN G. GODDARD, OF CHICAGO, ILLINOIS, ASSIGNORS TO JEFFERSON ELECTRIC MANUFACTURING COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS

TRANSFORMER

Application filed November 11, 1927. Serial No. 232,523.

This invention relates to improvements in transformers and pertains more particularly to transformers for neon or other gaseous lighting tubes.

5 These tubes require a relatively high initial or break-down voltage and a lower subsequent or normal operating voltage and it is the object of the present invention to provide a self compensating transformer for
10 providing a relatively high or increased initial or starting voltage and thereafter a reduced or relatively low voltage for the decreased load following the greater initial starting or breakdown load.

15 While the invention has particular utility in connection with gaseous tubes and the like, it is to be understood that the invention is not limited to a particular use or purpose but may be employed for ignition purposes or
20 wherever suitable or desired, as for example, wherever a relatively high initial voltage is desired followed by a reduced or relatively low voltage for a decrease in load.

25 According to the present invention, we provide the transformer with a shunt path which shunt path has a reluctance higher than the reluctance of the secondary core, so that upon initial energization of the primary winding substantially the entire magnetic
30 flux spreads through the secondary core and a relatively high initial voltage is induced in the secondary winding. Upon energization of the secondary winding the opposition set up thereby, increases the reluctance of the
35 secondary core beyond the reluctance of the shunt path, whereupon the reluctance of the shunt path is overcome and at least a part of the primary flux leaks through the shunt and threads back and through the primary field.
40 The flux threading through or intensity of the secondary field is thereby reduced with an accompanying reduction in the electromotive force and voltage in the secondary winding. The device may be designed to proportion,
45 as desired, the leakage back through the shunt with respect to the flux which threads through the secondary core, by means of which the voltage which follows the relatively high initial voltage may be reduced as
50 desired and effectively controlled.

We further find that by reducing the cross section of the secondary core below the cross section of the primary core, a natural stricture is produced between the main and secondary fields which stricture when disposed
55 on the secondary side beyond the shunt, with the shunt on the primary side of the core with reference to the reduction in section produces a natural shunting tendency. We find that the smaller cross section of the secondary
60 core enables a reduction in the section of the shunt path, which reduction in the section of the shunt reduces the space between the primary and secondary windings and enables
65 reducing the dimensions of the entire device and increasing the size of the primary and secondary windings. This increases the compactness and efficiency of the device and the smaller section of the secondary core appears
70 to saturate the secondary core to provide a high induced initial voltage, the opposition set up upon energization of the secondary winding apparently increasing the reluctance of the secondary field and decreasing the
75 amount of flux thereafter required to saturate the same.

The present invention also preferably employs a butt joint or gap between the legs of the primary and secondary cores, which butt joint or gap is preferably disposed adjacent the end of the secondary winding and
80 on the secondary side of the shunt and provides an additional retardation to the flux between the primary and secondary cores.

The invention further provides a self-contained, enclosed shunt and a device in which the effect thereon of external magnetic materials adjacent the device, such as metallic housings supporting brackets, or the like, is
85 reduced and in which undesirable variations in the action or operation of the device, such as might be caused by different external magnetic materials are avoided.

Still further objects of the present invention are the provision of a generally improved and simplified construction that may
90 be economically produced and which construction may be standardized for devices of different sizes and for devices of different types.

We reserve, of course, the right to correct or supplement the theory of action and advantages should it at any time become desirable.

5 The invention is illustrated in the accompanying drawings, in which

Figure 1 is a top plan view of a transformer embodying the invention;

10 Figure 2 is a side elevational view of the transformer shown in Figure 1;

Figure 3 is an end view;

Figure 4 is a sectional view taken on the line 4—4 of Figure 2;

15 Figure 5 is a transverse section taken on the line 5—5 of Figure 1; and

Figure 6 is a wiring diagram of the transformer selected for illustration.

Referring to the drawings the transformer shown is of the shell or confined type having 20 a main core 5 and a secondary core 6.

The main and secondary cores 5 and 6 each comprises a plurality of similar stacked laminations 8, said laminations 8 being suitably shaped to form a central extension 25 around which the transformer coils or windings are wound and outer legs which form a laminated iron ring or envelope surrounding or enclosing the coils. While the laminations 8 may be of any desired or preferred 30 form or configuration they are preferably and are shown as of E-shaped form, each having a central or intermediate leg 9 and outer legs 10 extending from a connecting base 12 with coil or winding receiving spaces 35 13 formed between the central and outer legs of each lamination, these spaces 13 opening from one end of each core stack and being closed at the other end by the base portion 12 of the E-shaped laminations.

40 The transformer is assembled with the end of the primary core 5 from which the spaces 13 open, in opposition to the corresponding end of the secondary core 6 and with the central and outer legs 9 and 10 in register and preferably in abutting contact. A closed 45 magnetic ring or envelope divided longitudinally by the central legs 9 is thus formed with butt joints 14 between the ends of the legs of the two laminated core stacks. Where 50 we use the expression butt joint or gap between the primary and secondary cores in this specification or in the appended claims, either term is used in a broad sense and we intend that they be interchangeable.

55 Any desired or preferred arrangement of transformer coils or windings may be employed. For the purpose of illustration we have shown a single primary coil or winding 60 16 wound around or encircling the central leg 9 of the primary core 5 through the spaces 13 and between the central leg 9 and outer legs 10 of the primary core. The primary winding 16 is shown as provided with a terminal lead 18 for connection with one side 65 of the source of current and with high, me-

dium and low leads or taps 20, 21 and 22 respectively, for connection with the other side of the source of current depending upon the voltage required by the gaseous tube or other device connected across the terminals 70 of the secondary winding. The particular manner of connecting the source of current across the primary winding and the number of leads or connections therefore may, of course, be varied widely within the scope of 75 the present invention.

While it is to be understood that there may be a plurality of secondary windings and that any suitable or preferred arrangement thereof may be employed, we have, for purposes of illustration shown a single secondary winding 25 wound about or encircling the central leg 9 of the secondary core 6 with the turns of the secondary winding passing through the spaces 13 and between the central leg 9 and 85 outer legs 10 of the secondary core. The secondary coil 25 is shown as being sectionalized centrally at 26 with the sections connected as illustrated diagrammatically at 27 in Figure 6 and grounded through the central connection 27 as shown at 28. The secondary winding 25 is provided with terminal leads 29 and 30 for connection across the gaseous tube or other device which is to be supplied from the secondary winding of the transformer. A 95 gaseous tube 100 is shown more or less diagrammatically in Figure 6 as connected across the leads 29 and 30.

It is to be understood, of course, that the turns of the primary and secondary windings 100 are insulated from each other and from the magnetic core as desired and in any suitable or preferred manner as well understood in the art. The secondary coil or winding 25 shown is inclosed in a generally rectangular 105 open ended box-like insulating structure of "micanite" or other suitable material. This structure designated at 32 forms an intervening insulating barrier between the secondary winding and the outer legs 10 and base 12 110 of the secondary core, as well as between this winding and the shunt to be hereinafter referred to. This intervening insulating barrier is provided with an insulating partition 33 which may be of similar insulating material and is disposed between the sections of 115 the secondary coils 25.

The shunt designated in its entirety at 35 comprises a pair of transversely laminated stacks 36 and 37 disposed between the legs of 120 the primary core 5 adjacent the butt joint 14 and on the primary side. The butt joint 14 is adjacent the primary end of the secondary winding and the shunt path is disposed between the legs of the primary core adjacent 125 the butt joint 14 and on the primary core side as well as between the primary and secondary windings. For the purpose of illustration the shunt stack 36 has an insulating barrier 40 between it and the adjacent outer leg 10 of 130

the primary core with a similar insulating barrier 41 between the opposite end of the shunt stack 36 and the central or intermediate leg 9 of the primary core and the shunt stack 37 has similar insulating barriers 42 and 43 between the central or intermediate leg of the primary core and one end of the shunt stack 37 and between the opposite end of the shunt stack and the adjacent outer leg 10 of the primary core. These insulating barriers 40, 41, 42 and 43 which may be of red fibre or other suitable insulating material provide gaps or insulating barriers in each of the shunt stacks 36 and 37, it being understood that although the particular arrangement shown and described in detail provides two gaps in each shunt stack, one gap or any desired number of gaps may be provided in each shunt stack as suitable or preferred.

In operation the exciting current is applied across the desired terminals of the primary winding 16. This exciting current is of relatively high electromotive force and upon initial energization of the primary winding substantially the entire magnetic flux threads through the primary and secondary cores and the relative great initial intensity in the secondary field provides a high induced initial voltage in the secondary winding. This relatively high initial voltage in the secondary winding is particularly desirable in the initial breaking down of or ionization of the gases in a neon or other gaseous tube.

The shunt path 35 has a reluctance higher than the reluctance of the secondary core so that upon initial energization of the primary winding substantially the entire magnetic flux threads through the secondary core to provide the high initial voltage in the secondary winding as referred to and then upon energization of the secondary coil or winding, the opposition set up increases the reluctance of the secondary core and thereafter the amount of flux required to saturate the secondary core. Upon energization of the secondary winding the increase in reluctance of the secondary core with the decrease in the amount of flux required to saturate the same causes the magnetic flux threading through the primary core to break down or overcome the reluctance of the shunt path and at least a part of the primary flux leaks through the shunt path 35 and threads back through the primary core. As already pointed out the flux threading through and intensity of the secondary field is thereby reduced with an accompanying reduction in the voltage in the secondary winding below the relatively high initial voltage. This is particularly desirable in connection with gaseous tubes and the like where a relatively high initial voltage is required and thereafter the voltage required to operate or maintain the tube lighted is less.

As already pointed out the device may be designed to proportion as desired the leakage

back through the shunt path with respect to the flux which threads through the secondary core, by means of which the voltage which follows the relatively high initial voltage may be reduced as desired and effectively controlled.

The cross section of the secondary core 6 is preferably less than that of the primary core. This smaller section in the secondary core may be conveniently provided in the embodiment illustrated by stacking fewer laminations in the secondary core than in the primary core and blocking the reduced height of the secondary core 6 up to the height of the primary core by means of suitable blocks or strips 50 of wood or other suitable insulating material. The reduction in section of the secondary core not only results in saturating the secondary core to provide a high induced initial voltage and decreases the flux required to saturate the secondary core but apparently decreases the amount of flux which is shunted through the shunt path 35 upon energization of the secondary winding. This enables a reduction in the section of the shunt 35 which reduces the space between the primary and secondary windings and increases the space allowed for these windings in a device of given size. The size of the windings may thereby be increased. The resulting device is exceedingly compact and the cost is reduced.

In the particular device illustrated the core laminations are standardized, that is the same laminations are employed in both the primary and secondary cores and these laminations may be standardized with the core laminations of transformers of other types. As already pointed out the transformer of the present invention is not limited to any particular use or purpose but may be employed as and where suitable or desired and may be made up in any desired size.

In the particular embodiment shown the laminations of both the primary and secondary cores are clamped on each side between a pair of clamp bars or brackets 60. These bars or brackets 60 may be of angle iron formation, as shown, and their opposite ends project beyond the closed end of the primary core at one end and beyond the closed end of the secondary core at the opposite end. These projecting ends of the bars or brackets 60 are provided with registering apertures through which extend clamping bolts 62, each provided with a head engageable with one bar or bracket 60 and having threaded engagement beyond the other bar or bracket with a suitable nut 63 for clamping and securing the assembled core laminations together. The blocks or strips 50 block the secondary core up to the same height as the primary core and the bars or brackets 60 form a common clamping frame for both cores of the transformer

and for binding the two cores together into a unitary device.

The shunt stacks 36 and 37 may have pressed fit between the legs of the primary core 5 or they may be otherwise mounted therebetween. The pressed fit of the shunt stacks 36 and 37 enables conveniently adjusting the position of these stacks between the legs of the primary core which provides a convenient adjustment for adjusting and rating the device.

The transformer may be arranged in any suitable casing or housing which has been omitted for the sake of clarity and it may be mounted upon metal brackets or adjacent external magnetic materials without being affected thereby and without any undesirable variation in the action or operation of the device.

The laminations of the shunt sticks 36 and 37 may be suitably bound or secured together as by means of rivets 75, studs passing through the stacks and headed over or by any other suitable or preferred means.

It is to be understood that the laminations of the primary and secondary cores, although shown alike, may be different from each other with respect to form or type as well as of different sizes relative to each other.

It is also to be understood that the central leg of the secondary core may be of a width less than the width of the central leg of the primary core and where there is a shunt it may be adjustably held in other manners than by means of the pressed fit shown.

It is to be still further understood that the larger cross section primary may be employed with the smaller cross section secondary with the shunt. In this case the greater density in the secondary will provide a self compensation by a flux leakage to atmosphere instead of thru the shunt between the legs of the primary.

With the arrangement illustrated the entire shunt is in the primary and the gap or butt joint between the legs of the primary and secondary cores lies in a common transverse plane.

We claim:—

1. In a transformer having a primary coil for connection with the exciting current, a secondary, primary and secondary cores, and means in said transformer for inducing a relatively high initial voltage in the secondary and for thereafter decreasing the voltage in the secondary, said means including a shunt path in the primary core and a butt joint between the primary and secondary cores adjacent said shunt and on the secondary side thereof.

2. In a transformer having a primary coil for connection with the current supply, a secondary, a primary core, a secondary core having a cross section less than that of the primary core, a butt joint between the pri-

mary and secondary cores, and a shunt between the legs of the primary core adjacent said joint and on the primary core side.

3. In a transformer having primary and secondary coils, the combination of a primary core, a secondary core, a butt joint between the primary and secondary cores, and a shunt adjacent said joint and on the primary side thereof for shunting the primary flux back through the primary core following energization of the secondary coil.

4. In a transformer having primary and secondary coils, the combination of a primary core, a secondary core having a cross section less than the cross section of the primary core, a butt joint between the primary and secondary cores, and a shunt adjacent said joint and on the primary side thereof for shunting the primary flux back through the primary core following energization of the secondary coil.

5. In a transformer having primary and secondary coils, the combination of a primary core, a secondary core having a cross section less than the cross section of the primary core, a butt joint between the primary and secondary cores, a shunt adjacent said joint and on the primary side thereof for shunting the primary flux back through the primary core following energization of the secondary coil, and a gap in said shunt increasing the open circuit reluctance of the shunt beyond the open circuit reluctance of the secondary core.

6. A transformer comprising primary and secondary coils having separate laminated cores therefor, said cores having central and enclosing legs in register and in butt contact and a shunt between the enclosing and central legs of the primary core adjacent said butt contact and on the primary side, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core.

7. A transformer comprising a laminated primary core, a laminated secondary core of a cross section less than that of the primary core, said cores having central and enclosing legs in register and in butt contact and a shunt between the enclosing and central legs of the primary core adjacent said butt contact and on the primary side, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core.

8. A transformer comprising primary and secondary coils, a laminated primary core, a laminated secondary core of a cross section less than that of the primary core, said cores having central and enclosing legs in register and in butt contact and a shunt between the enclosing and central legs of the primary core adjacent said butt contact and on the primary side, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core.

9. A transformer comprising primary and

secondary coils, a laminated primary core, a laminated secondary core of a cross section less than that of the primary core, said cores having central and enclosing legs in register and in butt contact and a shunt between the enclosing and central legs of the primary core adjacent said butt contact and on the primary side, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core, said shunt comprising laminated shunt stacks interposed between the outer and central legs of the primary core and each insulated at its opposite ends from said legs.

10. A transformer comprising primary and secondary coils, a laminated primary core, a laminated secondary core of a cross section less than that of the primary core, said cores having central and enclosing legs in register and in butt contact and a shunt between the enclosing and central legs of the primary core adjacent said butt contact and on the primary side, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core, said shunt comprising laminated shunt stacks interposed between the outer and central legs of the primary core and each insulated at its opposite ends from said legs, said stacks having pressed fit between said main core legs and being adjustable therebetween.

11. In a transformer having primary and secondary coils, the combination of a generally E-shaped primary core, a generally E-shaped secondary core of a cross section less than the cross section of the primary core and a butt joint between the legs of the cores and lying in a common transverse plane.

12. In a transformer having primary and secondary coils, the combination of a generally E-shaped primary core, a generally E-shaped secondary core and a butt joint between the legs of the cores and lying in a common transverse plane.

13. A transformer comprising primary and secondary coils, a laminated primary core, a laminated secondary core of a cross section less than that of the primary core, said cores having registering legs in butt contact, and a shunt between the legs of the primary core, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core and comprising a laminated shunt stack interposed between the legs of the primary core.

14. A transformer comprising primary and secondary coils, a laminated primary core, a laminated secondary core of a cross section less than that of the primary core, said cores having registering legs in butt contact, and a shunt between the legs of the primary core, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core and

comprising a laminated shunt stack adjustably supported between the legs of the primary core.

15. A transformer comprising primary and secondary coils, a laminated primary core, a laminated secondary core of a cross section less than that of the primary core, said cores having registering legs in butt contact, and a shunt between the legs of the primary core, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core and comprising a laminated shunt stack adjustably supported between the legs of the primary core and having an insulated gap therein.

16. In a transformer having primary and secondary coils, the combination of a shell type magnetic core having a magnetic envelope completely surrounding and enclosing said coils and having a primary core part and a secondary core part, a shunt for the primary core part and having a reluctance greater than the reluctance of the secondary core part, and a butt joint in the coil surrounding envelope of said magnetic core.

17. In a transformer having primary and secondary coils, the combination of a shell type magnetic core having a magnetic envelope completely surrounding and enclosing said coils and having a primary core part and a secondary core part, a shunt for the primary core part and having a reluctance greater than the reluctance of the secondary core part, and a gap in said shunt increasing the open circuit reluctance of the shunt beyond the open circuit reluctance of the secondary core part.

18. A transformer, comprising a pair of laminated magnetic core stacks, each having inner confined and outer enclosing legs in register and in butt contact, primary and secondary coils surrounding the inner confined legs of said core stacks, and an internal and confined shunt between the inner confined and outer enclosing legs of one core stack.

19. A transformer, comprising a pair of laminated magnetic core stacks, each having inner confined and outer enclosing legs in register and in butt contact, said core stacks forming primary and secondary core parts, primary and secondary coils surrounding the inner confined legs of said core stacks, and an internal and confined shunt between the inner confined and outer enclosing legs of one core, said shunt having an open circuit reluctance greater than the open circuit reluctance of the secondary core part.

20. In a transformer having primary and secondary coils, the combination of a pair of cores each having a pair of outer coil enclosing legs and an inner intermediate leg,

a base connecting the outer and inner legs at the outer end of each core and completing the coil enclosure, said outer and inner legs of each core being open at the inner ends of the cores, and a butt joint between the inner open ends of the inner and outer legs of said cores, and lying in a common transverse plane.

21. In a transformer having primary and secondary coils, the combination of a pair of generally E-shaped cores, inverted with reference to each other and each having a pair of outer and an intermediate leg closed at the outer ends and open and in register at the inner ends of the cores with a butt joint between the inner ends of said outer and inner legs, and lying in a common transverse plane.

22. In a transformer having primary and secondary coils, the combination of a core comprising a pair of laminated core stacks each having a base portion and inner confined and outer enclosing legs extending from the base portions, said stacks being assembled in inverted relation with respect to each other with the base portions of the respective stacks at opposite ends of the core to form with the outer legs of the stacks a surrounding magnetic envelope and with the ends of the inner and outer legs in register and in butt contact.

23. In a transformer, the combination of a pair of laminated core stacks each having a base portion with inner confined and outer enclosing leg means extending from said base portions, said stacks being assembled in inverted relation with respect to each other with the base portions of the respective stacks at opposite ends of the core to form with the outer legs of the stacks a surrounding magnetic envelope and with the ends of the inner and outer leg means in register and in butt contact, a pair of secondary coil parts surrounding the inner leg means and enclosed by the outer leg means, a ground connection between said secondary coil parts and a primary coil also surrounding the central leg means and enclosed by the outer leg means.

24. In a transformer, a core comprising a pair of laminated core stacks each having a base portion with inner confined and outer enclosing legs extending therefrom, said stacks being assembled in inverted relation with respect to each other with the base portions of the respective stacks at opposite ends of the core to form with the outer legs of the stacks a surrounding magnetic envelope and with the ends of the inner and outer legs in register and in butt contact, and means for clamping the laminations of the stacks together and for holding the two stacks in assembled relation with respect to each other.

25. In a transformer, a core comprising a pair of laminated core stacks each having a base portion with inner confined and outer

enclosing legs extending therefrom, said stacks being assembled in inverted relation with respect to each other with the base portions of the respective stacks at opposite ends of the core to form with the outer legs of the stacks a surrounding magnetic envelope and with the ends of the inner and outer legs in register and in butt contact, means for clamping the laminations of the stacks together and for holding the two stacks in assembled relation with respect to each other, said means comprising clamping means extending along the top of the core, clamping means extending along the bottom of the core, and means for clamping said means together with the core stacks assembled therebetween.

26. In a transformer, the combination of a core having outer enclosing and inner leg means, a pair of stationary secondary coil parts surrounding the central leg means and enclosed by the outer leg means, a ground connection between the secondary coil parts, a primary coil also surrounding the central leg means and enclosed by the outer leg means, and stationary shunt means disposed between said central and outer leg means for reducing the voltage in the secondary coil means by saturation of the magnetic core.

In witness whereof, we hereunto subscribe our names this 8th day of November, 1927.

JAMES C. DALEY.

EDWIN G. GODDARD.