

March 2, 1954

F. C. OWEN

2,671,196

WELDING TRANSFORMER

Filed June 24, 1948

3 Sheets-Sheet 1

Fig. 1.

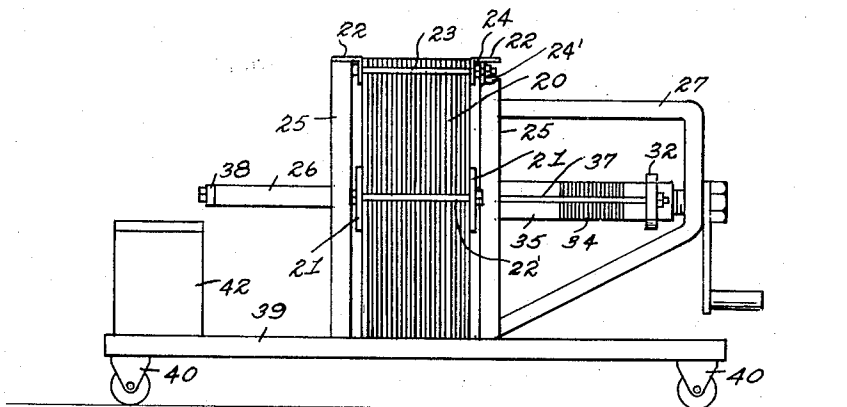


Fig. 2.

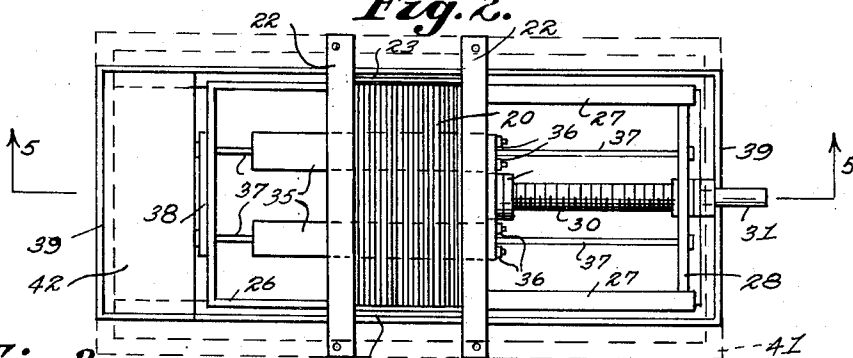


Fig. 3.

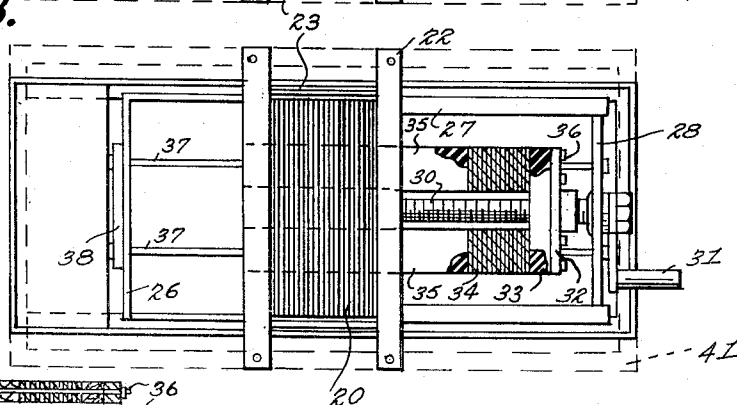
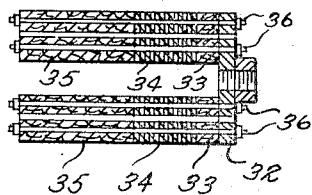


Fig. 9.



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Fig. 10.

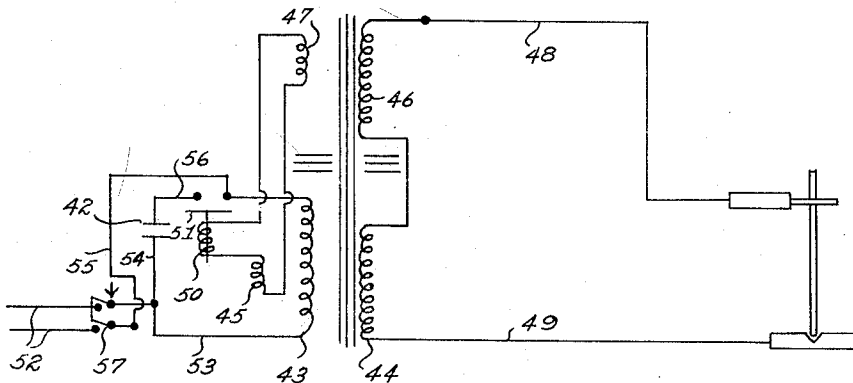


Fig. 12.

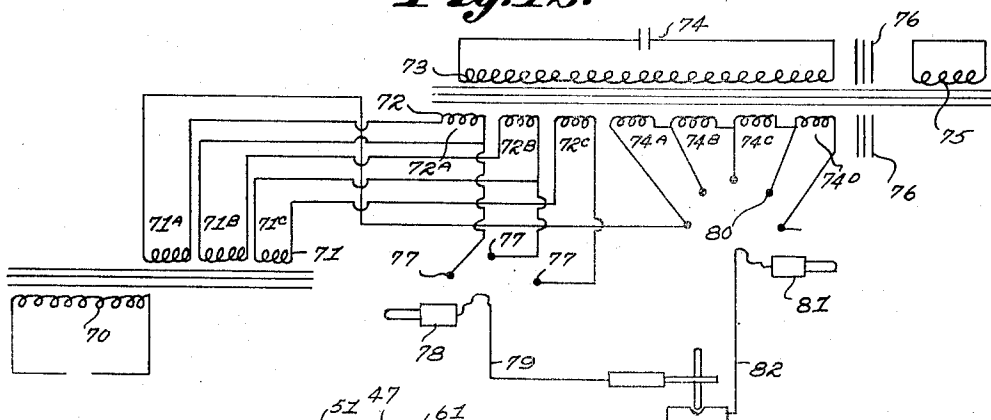
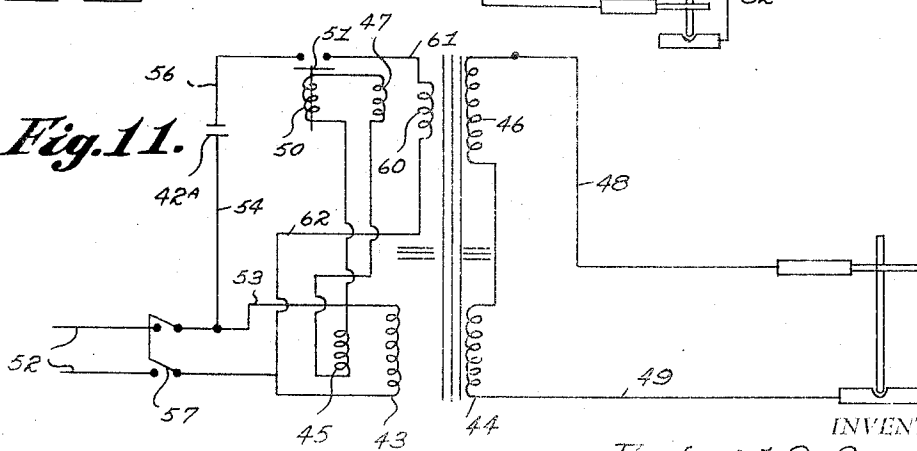


Fig. 11.



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WELDING TRANSFORMER

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8 Claims. (Cl. 323-45)

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The object of the invention is to provide a welding transformer in which a capacity is incorporated, not only to correct a relatively poor power factor, but to generate oscillating currents by which the welding arc is materially improved; to provide a transformer of the oscillating and power factor correction type wherein the capacity is instantly rendered inactive automatically when the secondary or work current is opened, thereby avoiding not only the monetary loss that would otherwise result from capacity charging currents during periods of idleness, but also reducing to a minimum the open circuit voltage, so that the hazard of serious shocks to the operator will be eliminated; to provide a mechanism of the kind indicated in which the unit weight per unit output is in the range of one pound per ampere for the maximum output in amperes; to provide a transformer for the purpose specified wherein the primary absorption in amperes will not be excessive even when the secondary is subjected to a short-circuit; to provide a welding transformer having a plurality of magnetic circuits whose coupling is variable in infinitesimal increments and decrements; and generally to provide an alternating current arc welder which, for the character of work which it may perform, is comparatively cheap to manufacture and which is of such sturdy form that failure under most exacting conditions is highly improbable.

With this object in view, the invention consists in a construction and combination of parts in which preferred embodiments are illustrated in the accompanying drawings, in which:

Figure 1 is a side elevational view of the single unit form of the invention with the cover or case removed;

Figure 2 is a top plan view of the structure of Figure 1 with the magnetic inserts in flux shunting position;

Figure 3 is a view similar to Figure 2 but with the magnetic inserts withdrawn;

Figure 4 is a sectional view on the plane indicated by the line 4-4 of Figure 5;

Figure 5 is a sectional view on the plane indicated by the line 5-5 of Figure 2;

Figure 6 is a perspective view of the magnetic inserts or shunts and their supporting and operating means;

Figure 7 is an elevational view of the series transformer used in the dual form of the invention, this having the leakage flux shield;

Figure 8 is an elevational view of the power transformer with the leakage flux shield attached;

Figure 9 is a central horizontal sectional view

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of the magnetic inserts and their connected cross-head;

Figure 10 is a diagrammatic view of one form of the single unit style of the invention;

Figure 11 is a similar view of another form of the single unit style of the invention; and

Figure 12 is a similar view of the dual unit form of the invention.

The invention is susceptible of embodiment in separate machines to be used conjointly, or in one machine of either single unit or double unit form. Since a single machine is the most compact and since the dual unit and single unit are substantially identical structurally, the latter has been selected for illustration of the structural details.

In this form the core 20 which is of the shell-type, carries the windings W-1 and W-2 on the center leg thereof, these windings being axially spaced and maintained in such spaced relation by the spacer plates 21 which span the core transversely (at right angles to the center leg) on opposite faces thereof, the spacer plates being tied together by bolts 22' which are preferably of non-magnetic material, the spacer plates being non-conducting material, as, for example, fiber.

Being mounted on the same leg, the windings W-1 and W-2 have a common magnetic circuit and are therefore more or less closely coupled. Since the effective operation of the invention depends on changing this coupled relation, means have been provided for doing so without physical change in the relative positions of the windings. These means consist of magnetic inserts which are movable into and out of position between the windings and are so dimensioned that they span the distances between the center leg and the sides of the core. When in position between the center leg and sides of the core, they serve to divert the fluxes from the two windings back through those sections of the core on which the windings are located. In other words, they divide the magnetic circuit in two, so that each winding has substantially its own magnetic circuit when the inserts are in position. This of course does not mean that there is actually no flux from one winding entering the magnetic circuit of the other, but to all practical purposes that is the case in full shunting positions of the inserts. Of course the extent to which they are inserted determines the degree to which the two magnetic circuits are separated or isolated.

The core 20 is of laminar construction, as is conventional, and the laminar are held together by clamp bars 22 arranged in pairs at the top and bottom of the core, the units of each pair

being on opposite faces of the core, and the two pairs being held in clamped position by the tie-bolts 23, which, however, extend far enough beyond the nuts 24 to receive the strut bars 25 which are vertically arranged, but which the nuts 24 space from the faces of the core, the strut bars crossing the spacer plates 21. The second nuts of course secure the strut bars in position and these latter act as a supporting means for the elements by which the inserts are supported and actuated. The strut bars on the rear are spanned by yoke 26, welded or otherwise secured to the strut bars. The strut bars on the front carry each a yoke 27, the two yokes 27 lying in vertical planes while the yoke 26 lies in a horizontal plane. To the cross pieces of the yokes 27, there is secured a plate 28, preferably of insulating material, centrally in which is a bearing 29 in which the journal portion of a screw 30 is rotatively mounted, this journal portion extending far enough out from the plate to receive a crank 31 by which the screw may be rotated. The screw is threadingly engaged with a cross head 32, both it and the cross head being of non-magnetic material. The cross head acts to unite the two inserts, each of which comprises a laminated section 34, a filler section 35, and a spacer section 33, the laminated section being of the same material as the core 20, the filler section being certainly nonmagnetic and preferably non-conducting as, for example, fiber, and the spacer section being preferably of the same material as the filler section. The three sections of the insert are assembled by tie-bolts 36 of non-magnetic material passing through them and through cross head 32.

The inserts are mounted to move on slides 37 which are terminally connected with the plate 28 and with the cross bar of the yoke 26, being insulated from the latter by a block 38 of insulating material. It is essential to effect this insulation since otherwise eddy currents might be generated in the slides, in view of the fact that they are within the inductive range of the windings. The slides are non-magnetic but nevertheless are of conductive material.

Obviously rotating the crank 38 will effect axial movement of the inserts. The screw, while mounted for angular movement is precluded from axial movement, and, must, therefore impart axial movement to the inserts since they are connected to the cross head with which they are threadingly engaged.

The core is supported on an open frame 39 made transportable by means of the casters 40 positioned one at each corner. A frame 41 co-terminus with the frame 39 is supported by the core at its upper end, the clamp bars in each instance providing the connections between the frame and the core and being welded or otherwise secured to the frame.

The bank of condensers 42 employed for power factor correction and the generation of oscillating currents is carried on the frame 39 below the yoke 26.

The spacer plates 21 have clearance openings therein for the passage of the inserts and the spacer sections 33 of the latter are of the same thickness as these spacer plates, so that when the cross head abuts the plates, the magnetic sections of the inserts are in full bridging relation to the center and side legs of the core.

The filler sections 35 are essential to prevent chattering or vibration when the inserts are withdrawn. These filler sections fill the spaces

previously occupied by the magnetic sections and yet leave the magnetic circuits unaffected. They fit the spaces snugly enough to prevent vibration of the magnetic sections when withdrawn as would otherwise be the case.

In some forms of the invention, the winding W-1 will consist of a primary and a closely coupled secondary together with a small winding designed to effect the operation of the circuit closer; and the winding W-2 will consist of a reactance and a companion winding to the circuit closer actuating means.

In another form of the invention, the winding W-2 will include in addition to the reactance, the circuit closer actuating winding and an additional winding whose purpose is to introduce oscillations into the circuit.

In the dual form of the invention, there will be two transformer cores, one surmounting the other, with one core carrying below the spacer plates 21 the primary and above them the secondary. The upper transformer will include a series transformer whose function is to introduce a capacity into the welding circuit.

These various forms are graphically illustrated in the drawings.

One form of the invention is illustrated graphically in Figure 10. In this form the lower winding is composed of a primary 43 and a closely coupled secondary 44 wound directly over it. There is also incorporated in this winding a coil 45. The upper coil is composed of a reactance 46 and a coil 47, complementary to the coil 45. The secondary 44 and reactance 46 are in series with each other and with the welding leads 48 and 49. The coils 45 and 47 are serially connected but differentially, that is, differentially physically but electrically cumulatively. Thus the coil 47 is sometimes energized by the flux due to the winding 46 and at other times from the flux due to the coil 43. Also serially included in the circuit with the coils 45 and 47 is the magnetic actuator 50 of the circuit closer 51 which, when it bridges the spaced contacts connects the capacity 42 or bank of condensers across the line 52, one side of which is connected to one terminal of the primary 43 by the conductor 53 and to one side of the condenser by the conductor 54, and the other side of which is connected to the opposite terminal of the primary by the conductor 55, the opposite terminal of the capacity 42 being connected to the remote terminal of the circuit closer by conductor 56.

When the power switch 57 is closed, the primary is immediately placed across the circuit, current, at a certain instant, flowing over the conductor 53 through the winding 43, the conductor 55 back to the opposite side of the line. When the primary is energized, it energizes the secondary 44 and also the coil 45. But of course no current flows in the secondary if the latter circuit is open, as when the welding electrode is withdrawn from the work. But when there is contact between the electrode and the work, or when a metal welding arc is in existence, current will flow through the secondary 44, and the reactance 46, but the phase of this generated current is displaced substantially 180 degrees from the phase of the primary current, which means that the energizing means for the coil 47 is opposite to that of the energizing means for the coil 45. Thus if they are differentially connected, as shown, they will be cumulative in effect on the circuit closer actuating coil 50. Thus when the electrode is brought into contact with the work

the circuit closer 51 is immediately actuated and the capacity 42 is placed across the line, current flowing from one side of the line over the conductor 54, through the bank of condensers 42, over the conductor 56, through the circuit closer 51 and back to the other side of the line over the conductor 55.

When the electrode is separated from the work, as when the welding operation is discontinued, the secondary circuit will be broken and then the coils 45 and 47 will be energized only from the flux of the winding 43, it being still across the line and passing its flux around the core which will have a generating effect both on the coils 47 and 45, but in each, the reverse of the other, with the result that the two cancel each other in effect and the circuit closer coil 50 is deprived of current, thus allowing the circuit closer to drop to open position and cutting the capacity out of the circuit. It will be seen that the inclusion or exclusion of the capacity from circuit depends on whether the secondary 44 is on closed or open circuit.

The reactance 46 while in a sense a supplemental secondary, is to all effects and purposes an inductance which provides a voltage component substantially in excess of the voltage drop across the welding arc. And the extent to which this functions depends on the adjustment of the magnetic inserts or shunts 33 which, by reason of the screw by which they are actuated, can be positioned with mathematical nicety, thus providing for regulation of the welding current in infinitesimal increments and decrements.

And the effective manner in which the capacity is cut out of circuit during periods of inactivity provides for obtaining an open circuit voltage in the range of 47 volts.

Designed for excitation from a 220 volt line, the secondary output in amperes is in the range of 10 to 260, depending on the adjustment of the inserts. With the secondary on dead short-circuit, the primary intake is but 29 amperes.

As illustrated in Figure 11, the construction is modified over that shown in Figure 10, only to the extent of varying the capacity circuit, so that corresponding parts in the two figures are identified by similar characters. In this form of the invention, the capacity 42a is in series with a winding 60 which is laid over the inductance or supplementary secondary 46. This winding 60 and the capacity are cut out of circuit during idle periods, or when the circuit is open, and are placed in circuit when the secondary is closed as during the welding operation, coils 47 and 45 functioning as in the construction shown in Figure 10, to actuate the circuit closer 51, so that when the switch 57 is closed, current while flowing through primary 43, also flows through winding 60 and capacity 42a, over the conductor 61, the circuit closer 51 and the conductor 62.

The resonant circuit composed of the capacity 42a and inductance 60 provide a more effective oscillating current than in the companion form of the invention, the secondary having an open circuit voltage of 42 volts when the output is 260 amperes, and 37½ volts when the output is but 25 amperes.

In the form of the invention illustrated in Figure 12, a dual form is employed, there being two transformers, the one a power transformer and the other a series transformer, by which the resonant circuit is energized and controlled. The power transformer is like that of the previous forms described except that on the lower section

of the core, the primary 70 is disposed on the upper section, the secondary 71, which, however, is divided into several sections 71a, 71b, and 71c.

These sections of the secondary 71 are connected in series with the sections 72a, 72b, and 72c of a reactance which at the same time is the primary of a series transformer, across the secondary 73 of which the capacity 74 is connected. The primary of the series transformer includes sections 74a, 74b, 74c, and 74d, which are selectively placeable in circuit. With the series transformer, the primary and secondary circuits are placed on the lower end of the center leg of the core and on the upper end and axially spaced from the primary and secondary is a reactance 75 consisting of a number of turns of comparatively small wire or alternatively a few turns of wire of comparatively large cross section. This reactance has its terminals connected together. In other words it is short-circuited and its reactive effect on the series transformer is controlled by the adjustment of the inserts 76 which are identical in form to the inserts 33.

The sections of the primary 72 are connected intercurrently in series with the sections 71 of the power transformer secondary and taps between sections 72 are led to jacks 77 to selectively receive a plug 78 of the welding lead 79. Similarly the sections 74 are connected by intermediate taps to jacks 80 in any of which the plug 81 of the ground terminal 82 may be inserted.

The adjustment of the plug 78 is for variation in voltage ranges and the adjustment of plug 81 is for variation in current ranges.

If, for example, the plug 78 be placed in left-hand jack 77 and the plug 81 in the left hand jack 80, the sections 71a and 72a will be rendered operative, the current having its inception in the winding 71a, flowing through the section 72a to the left-hand plug 77 over the lead 79, through the electrode and the work, the lead 78, the left-hand jack 80 and back to the section 71a. Similarly, if the plug 78 be placed in an intermediate jack, the sections 71b and 72b will be rendered operative, the generating current flowing through all four sections, through the welding electrode and back to the secondary 71 through one or more of the sections 74, depending on the adjustment of the plug 81.

The positioning of the plug 79 in the right-hand jack 77 connects in circuit all three of the sections of the secondary 71 and all three of the sections of the reactance 72, this providing for the greatest voltage that the appliance will generate. If through accident or carelessness the plug 81 be inserted in one of the jacks 77 and plug 78 in one of the jacks 80, the operation of the apparatus will be unaffected, since it will operate as effectively that way as the other, the adjustment of plug 81 being for amperage variations and the adjustment of plug 78 for voltage variation.

The adjustments of the inserts 76 is of course the fine adjustment of the appliance and the plug adjustment 81 is for coarse adjustment. But this latter adjustment as well as the former effects a change in the oscillating or resonant circuit, varying both the frequency and the voltage thereof. The fact that the resonant circuit is energized by a series transformer, however, places the capacity effectively in series with the welding arc and provides for its immediately being cut out of circuit when the welding operation is discontinued, thereby providing as in the other form for a low open circuit voltage.

As above stated, the dual form of the invention calls for surmounting the power transformer with the series or oscillating transformer and except for this variation, the structure is otherwise like that disclosed in Figure 1.

Some designs of transformers call for flux leakage and in cases of that character involving the present invention, the core is shielded with a ring 90 of laminar construction similar to that of the core but of much less cross sectional area than the core. The ring is spaced from the core by insulating spacers 91 and is secured to the core by clamp plates 92 positioned at such points as may be necessary to hold the ring in place, the flux leakage passing around this ring, and therefore not affecting any metal case or housing which encloses the whole mechanism over the frames 39 and 41.

The invention having been described, what is claimed as new and useful is:

1. An alternating current arc welder comprising a shell-type core, primary and secondary windings on the center leg of said core with at least part of the latter axially spaced from the former, and magnetic inserts dimensioned to span the distances between center and side legs of the core and movable into and out of positions between the spaced windings on the said center leg, and a resonant circuit reactive on said windings and having its resonant frequency dependent on the setting of said inserts.

2. An alternating current arc welder comprising a shell-type core, primary and secondary windings on the center leg of said core with at least part of the latter axially spaced from the former, and magnetic inserts dimensioned to span the distances between center and side legs of the core and movable into and out of positions between the spaced windings on the said center leg, and a resonant circuit reactive on said windings and having its resonant frequency dependent on the setting of said inserts, said inserts being adjustable in infinitesimal increments and decrements.

3. An alternating current arc welder comprising a shell-type core, a plurality of windings on the center leg of said core with one axially spaced from the others and constituting an impedance, one of said windings being energized from an alternating current source, a resonant circuit rendered active by another of said windings, and magnetic inserts dimensioned to span the distances between the center and side legs of the core, and movable into and out of positions between the impedance and the other windings.

4. An alternating current arc welder comprising a shell-type core, a plurality of windings on the center leg of said core with one axially spaced from the others and constituting an impedance, one of said windings being energized from an alternating current source, a resonant circuit rendered active by another of said windings, magnetic inserts dimensioned to span the distances between the center and side legs of the core, and movable into and out of positions between the impedance and the other windings, and means to adjust the inserts in infinitesimal increments and decrements.

5. An alternating current arc welder comprising a shell-type core, a plurality of windings on the center leg of said core with one axially spaced from the others and constituting an impedance, one of said windings being energized from an alternating current source, a resonant circuit rendered active by another of said windings, mag-

netic inserts dimensioned to span the distance between the center and side legs of the core, and movable into and out of positions between the impedance and the other windings, and means to adjust the inserts in infinitesimal increments and decrements, and comprising a non-magnetic crosshead to which the inserts are connected and a crank-actuated non-magnetic screw having a rotary mounting on the core and a threaded mounting in the cross head.

6. An alternating current arc welder comprising a shell-type core, a plurality of windings on the center leg of said core with one axially spaced from the others and constituting an inductance, one of said windings being energizing from an alternating current source, a resonant circuit rendered active by another of said windings, inserts cross-sectionally dimensioned to span the spaces between the center leg and the side legs and including each a filler section and a laminated section of which the latter is magnetic and the former non-magnetic, parallel guides carrying the inserts and disposed in a plane at right angles to the center leg and between the inductance and the other windings, and manual means for advancing and retracting the inserts to position them where either the laminated sections or the filler sections span the spaces between the center leg and the side legs or where such spaces are spanned in part by the laminated sections and in part by the filler sections.

7. An alternating current arc welder comprising a core, primary and secondary windings closely coupled and positioned at one point on the core, an additional winding in series with the secondary winding and positioned at a remote point on the core, a resonant circuit and a switch controlling its inclusion in circuit with one of the aforesaid windings, magnetic operating means for said switch, and means for energizing the magnetic means, said energizing being actuated jointly by the primary winding and the additional winding to effect closing of the switch and by the primary winding alone to effect opening of the switch.

8. An alternating current arc welder comprising a core, primary and secondary windings closely coupled and positioned at one point on the core, an additional winding in series with the secondary winding and positioned at a remote point on the core, a resonant circuit and a switch controlling its inclusion in circuit with one of the aforesaid windings, magnetic operating for said switch, and means for energizing the magnetic means and comprising a pair of windings of which one is closely coupled to the primary winding and the other similarly coupled to the additional winding, the said pair of windings being differentially connected in series with each other and in series with the magnetic operating means.

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