

Oct. 6, 1959

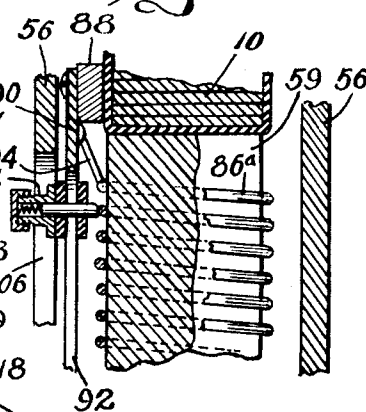
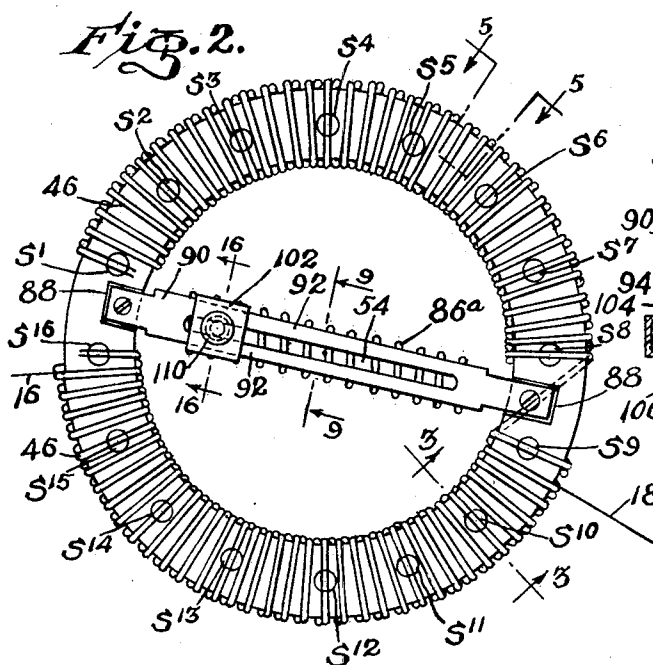
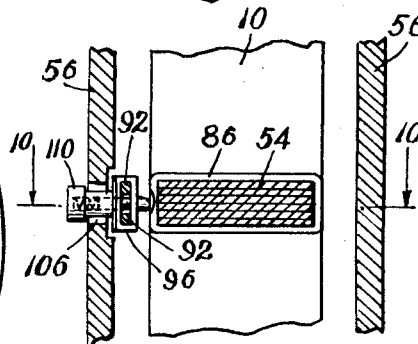
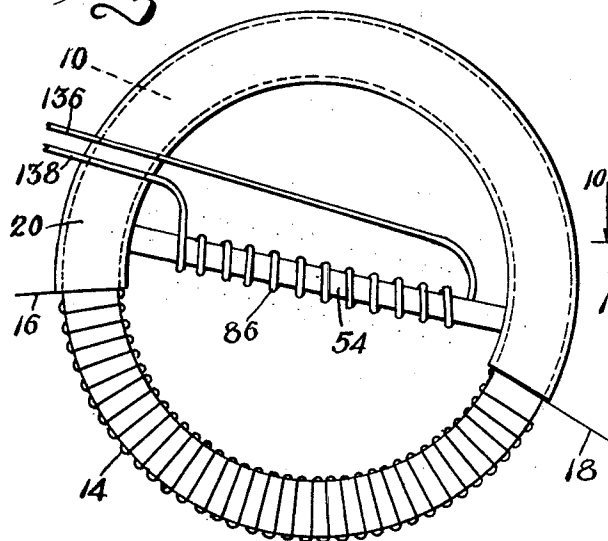
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2,907,945

TRANSFORMER WITH MAGNETIC SHUNT CONTROL

Filed Dec. 13, 1954

4 Sheets-Sheet 1



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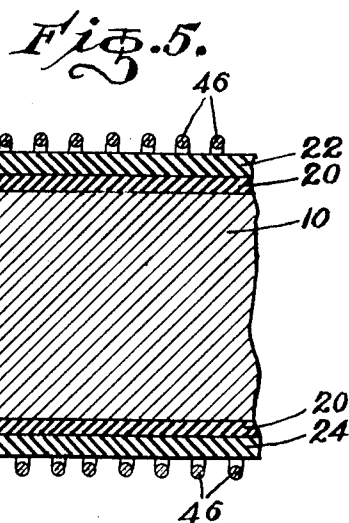
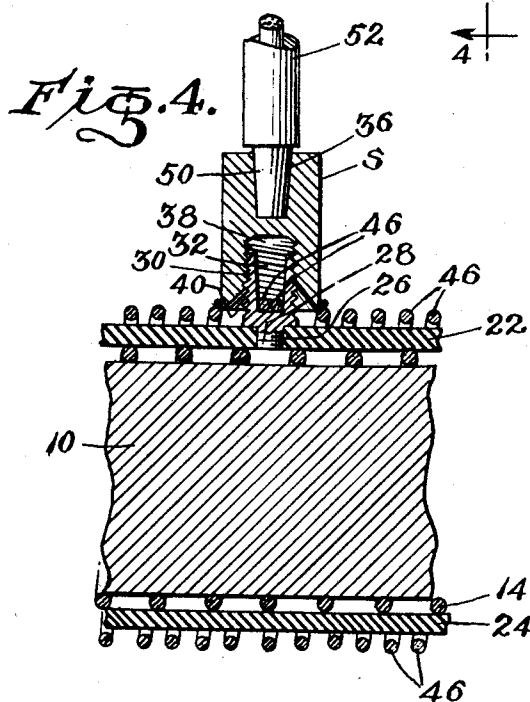
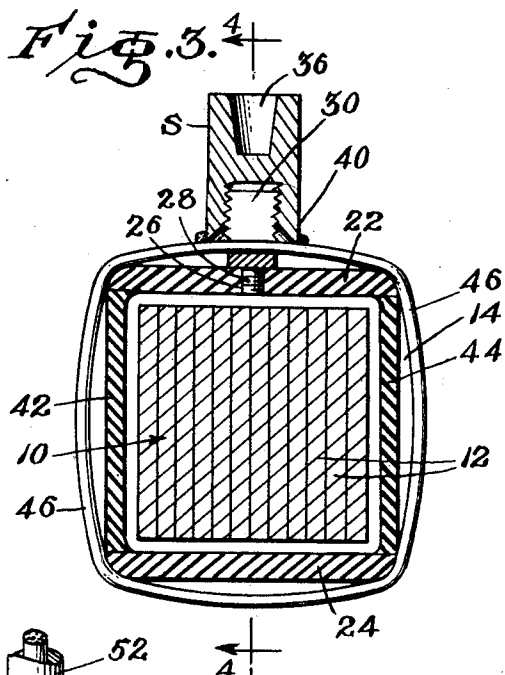
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4 Sheets-Sheet 2



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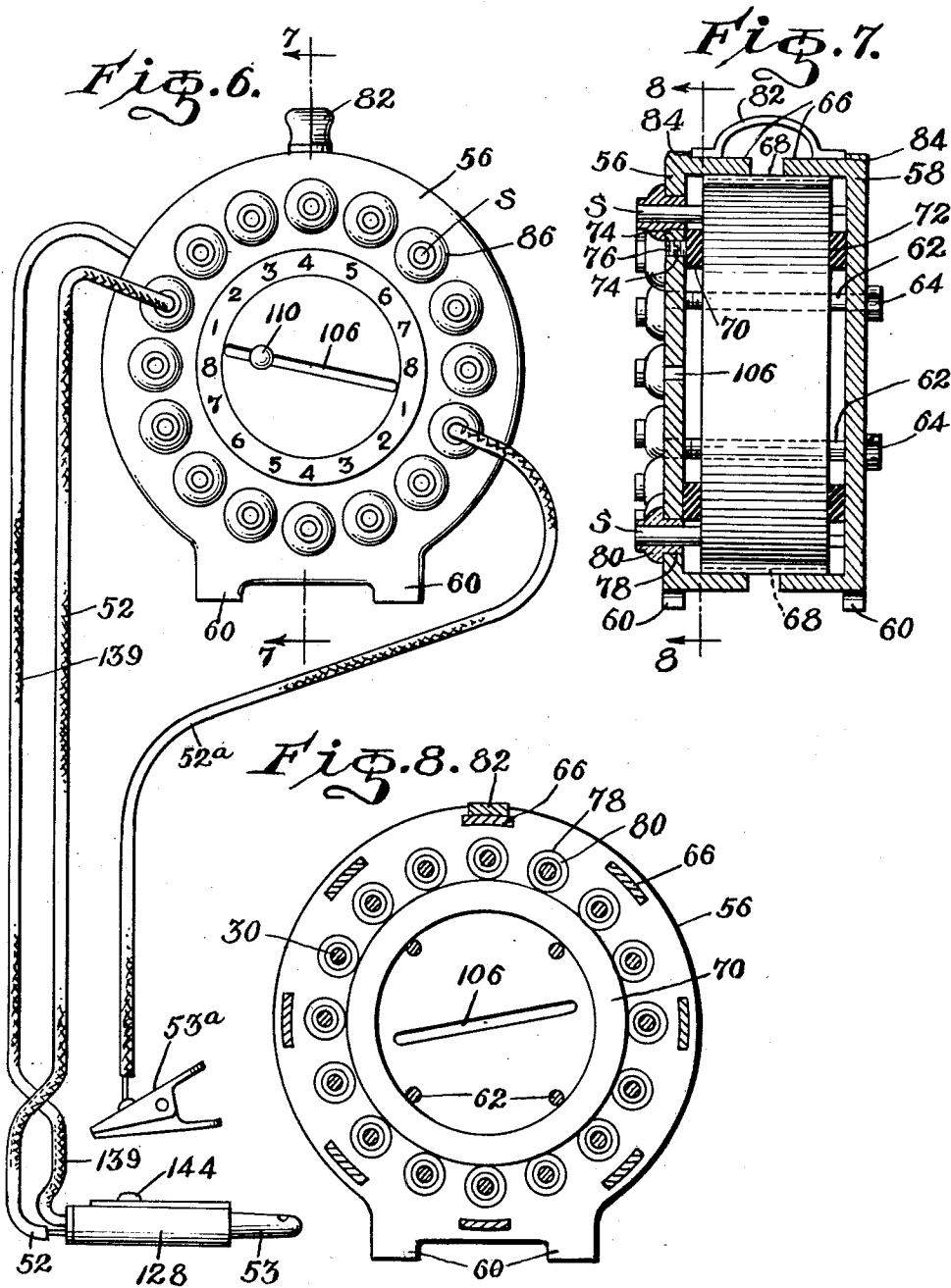
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4 Sheets-Sheet 3



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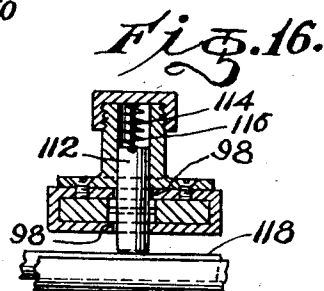
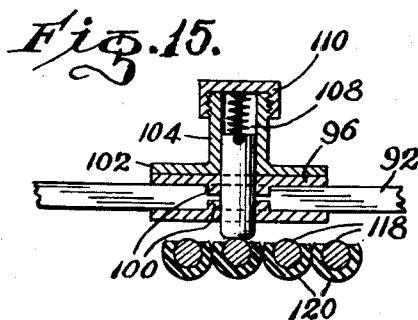
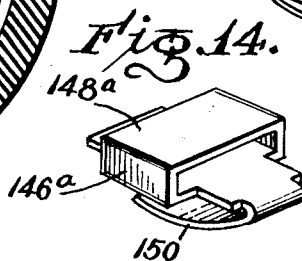
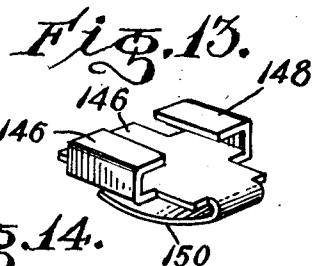
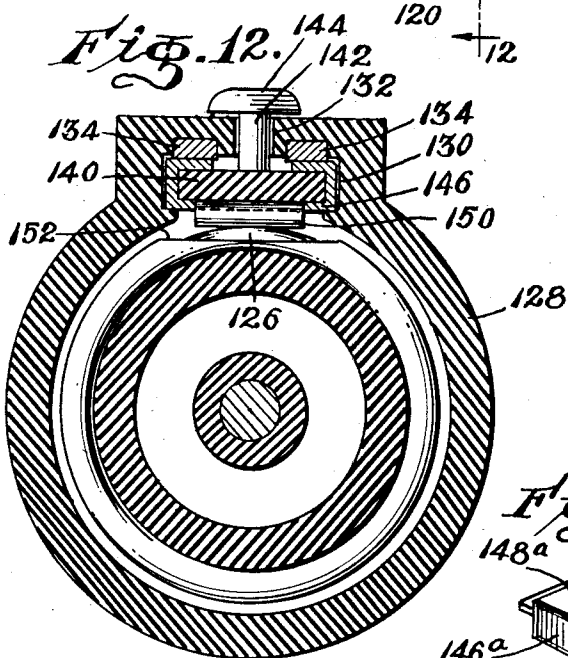
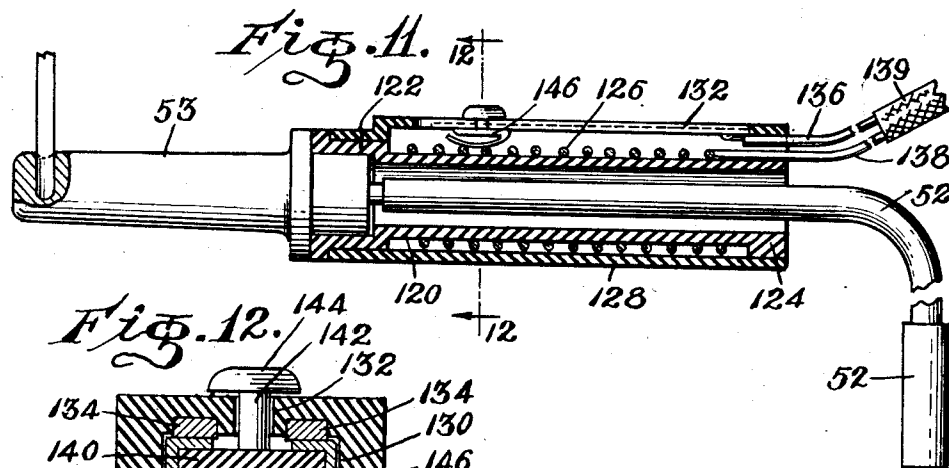
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TRANSFORMER WITH MAGNETIC SHUNT CONTROL

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4 Sheets-Sheet 4



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2,907,945

TRANSFORMER WITH MAGNETIC SHUNT CONTROL

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5 Claims. (Cl. 323—60)

This invention relates to electrical transformers and more particularly to step down transformers for electric welding though it is noted that in some of the claims the invention is not limited to step down or welding transformers.

Objects of the invention are to provide an improved transformer of this kind which gives a large current but has little weight and size and gives maximum current for its weight and size, and has only one layer of secondary windings giving relatively large radiating surface to prevent overheating.

Other objects of the invention are to provide an improved transformer of this kind which has no moving parts and substantially no inside connections.

Other objects of the invention are to provide a toroidal core transformer having a limited length primary and a secondary around the whole core whereby the current may be varied by inserting plugs into different sockets connected to the secondary at different parts of the core and optionally to provide a magnetic shunt bridge shunting the primary to increase the variation of the current resulting from different positions of the plugs.

Other objects are to provide a shunt flux control coil around the bridge and different arrangements of means for varying the control effect of the control coil to provide finer adjustments of the output current.

Additional objects of the invention are to effect simplicity in such transformers and to provide an extremely simple transformer of this kind which is economical, durable, and reliable in operation, and economical to manufacture and transport.

Still other objects of the invention will appear as the description proceeds; and while herein details of the invention are described in the specification and some of the claims, the invention as described in the broader claims is not limited to these; and many and various changes may be made without departing from the scope of the invention as claimed in the broader claims.

The inventive features for the accomplishment of these and other objects are shown herein in connection with an electric welding transformer which briefly stated, includes a primary winding wound around nearly half of a toroidal core. A series of socket members of even number are disposed equal angles apart around the core; and one or more secondary windings are wound around substantially the entire length of the core and electrically connected to the sockets, their ends being connected to adjacent sockets near one end of the primary. The transformer is mounted between upright members through one of which said sockets are exposed.

A pair of plugs adapted to fit in sockets of any of the socket members and having cables attached thereto for connection to a ground clamp and electrode holder for electric welding, may be plugged in sockets 180° apart to give a constant voltage between plugs, said plugs giving current that is a function of the number of included secondary coils that are adjacent to the primary.

If desired a magnetic shunt bridge may be provided

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magnetically connected at both ends to the core in position to shunt the primary winding to increase the difference between maximum and minimum current output of the transformer. Also we may provide a flux control coil of a number of convolutions of insulated conducting wire wound around the bridge; and we may provide regulating means for connecting one or more or all of the convolutions of the control coil in a series circuit, or regulating means for varying the resistance of said circuit, thereby to regulate by small variations the flux leakage in the bridge, thereby to regulate by small variations the current output of the transformer.

In one form of the invention a rheostat coil of insulated wire is carried by the handle of the electrode holder; and metal bars secured longitudinally of the handle have one pair of their adjacent ends electrically connected to one end of the flux control coil, the other end of the control coil being electrically connected to the one end of the rheostat coil. A metal conducting sleeve in slidable contact with said bars and carrying a contact presses on adjacent portions of the rheostat coil, whereby the resistance of the circuit may be varied.

In another form the rheostat coil is omitted and the metal bars are secured longitudinally of and spaced from the flux control coil and have one pair of adjacent ends electrically connected to one end of the flux control coil. A metal conducting sleeve in slidable contact with said bars carries a contact pressing on adjacent portions of the coil, whereby a circuit is formed and the number of effective flux control convolutions may be varied thereby to adjust the amount of flux that may pass through the bridge.

In the accompanying drawing showing, by way of example, several of many possible embodiments of the invention,

Fig. 1 is a side elevation showing the primary windings and a filler section on the core, and also a flux control winding on the bridge;

Fig. 2 is a diagrammatic side elevation showing the secondary winding on the core and showing a different form of flux control winding;

Fig. 3 is a transverse sectional view taken on the line 3—3 of Fig. 2;

Fig. 4 is a fragmental sectional view taken on the line 4—4 of Fig. 3;

Fig. 5 is a fragmental sectional view on the line 5—5 of Fig. 3;

Fig. 6 is a side elevation showing the housing with transformer therein;

Fig. 7 is a sectional view partly in side elevation the section being taken on the line 7—7 of Fig. 6;

Fig. 8 is a sectional view partly in side elevation the section being taken on the line 8—8 of Fig. 7;

Fig. 9 is an enlarged sectional view taken on the line 9—9 of Fig. 2;

Fig. 10 is a sectional view taken substantially on the line 10—10 of Fig. 9;

Fig. 11 is a longitudinal axial sectional view, partly in side elevation, of the electrode holder and handle;

Fig. 12 is an enlarged sectional view taken on the line 12—12 of Fig. 11;

Fig. 13 is a perspective view of the slidable metal contact sleeve;

Fig. 14 is a perspective of a modified form of contact sleeve;

Fig. 15 is an enlarged fragmental sectional view of the slidable contact as shown in Fig. 10; and

Fig. 16 is an enlarged fragmental sectional view taken on the line 16—16 of Fig. 2.

The toroidal transformer core 10 comprises a thin strip 12 (Fig. 3) of soft iron wound completely around a geometric cylindrical surface, continuing convolutions

of said strip being wound and superposed upon the previously wound portion of the strip, to form laminations 12, the adjacent edges of the strip registering.

The layers or laminations are sufficient in number to build up the core 10 to the required thickness, as shown, whereby the magnetic flux may pass circumferentially around the core longitudinally of the strip without having to pass through the contacting faces of the strip and the intervening slight air gap between layers. Said laminations or layers 12 are secured together in superposed position as shown by adhesive or spot welding. This allows the core to be cut through to provide an air gap if quick collapse of the flux is desired. The construction also avoids the uneven hardness and consequent uneven reluctance of stamped out laminations.

The core 10 is of square cross-section and may be wrapped with tape (not shown). The core is provided with a primary winding 14 of insulated wire preferably extending about 150° along the core and having terminal ends 16 and 18 (Fig. 1) for connection to a suitable source of current. A spacing or filling sector member 20 of Bakelite or other suitable insulator about the thickness of the depth of the primary winding is disposed on each flat face of the core to fill the unwound portions of the core to the same thickness as the primary winding as shown by a comparison of Figs. 4 and 5.

Annular flat rings 22, 24 (Fig. 3) of Bakelite or the like are disposed on the flat parts of the primary windings and said sector members 20; and the ring 22 is provided with an even number of equally spaced holes 26 in each of which is disposed the tip 28 of an externally threaded tapping stud 30 having a wedge-shaped diametric slot 32. On each stud is disposed a socket member or cable connector S having an outer-end tapered socket 36 and an inner end threaded bore 38 received on said stud and having a sharp edge 40 at the inner end of the connector.

The curved sides of the core with the primary windings thereon are covered with strips 42, 44 of fish paper or other insulation, between the edges of the rings 22, 24; and the thus covered core is wound substantially throughout with one, two or more insulated primary wires 46 in parallel, forming secondary windings 46 in parallel beginning at and secured to the socket member S1, and passing side-by-side successively through the slots 32 under the socket members S2 to S15 and secured to the socket member S16. The socket members S are screwed down to cause the sharp edge 40 to force the wires 46 into the slots 32 where the sharp edge is brazed to the wires to make good electric connection, a part of the insulation being scraped away.

The socket members are tapped by the insertion of tapered plugs 50 in the tapered sockets, to which plugs are attached cables 52, 52a here shown connected to an electrode holder 53 and a ground clamp 53a.

The ratio of the primary 14 to half the turns in the secondary is such as to give a satisfactory working secondary voltage, which may be about 30 volts. The transformer may be wound to be connected by the terminal ends 16, 18 to a commercial supply of 110 or 220 volts or other suitable voltage.

The socket members S are tapped by the plugs 180° apart. The current output is varied by selectively tapping half of the secondary turns according to their closeness to the primary. Thus if the socket members S16 and S8 are tapped, the included turns of the secondary are nearest the primary and the inductive coupling is closest and the current is maximum. If socket members S1 and S9 are tapped, the included turns are most remote from the primary and the current is at a minimum. Intermediate values of current are obtained by tapping, for instance, socket members S3 and S11 or S5 and S13.

A magnetic shunt bridge 54 diametrically across the core increases the maximum current and decreases the minimum current by allowing the flux to flow through a

shorter magnetic path. However the shunt 54 may be omitted if desired.

The transformer may be mounted in any suitable manner but is here shown secured between two circular frame members 56, 58, each provided with feet 60 and secured together by bolts 62 through the space enclosed by the transformer and having heads 64 engaging one frame member 58 and having threaded connection with the other member 56.

Each frame member is provided with inturned peripheral lugs 66 disposed over the periphery of the transformer and separated from the transformer by a strip 68 of Bakelite or other insulator, the members also being separated from the transformer by rings 70, 72 of Bakelite or the like. Set-screws 74 in the frame member press the adjacent ring 70 against the transformer, and the transformer against the other ring 72, thereby to hold the transformer firmly in place. Lock screws 76 lock the set-screws in place.

The frame member 56 is provided with a series of large openings 78 receiving flanged insulating bushings 80 receiving the S socket members.

A handle 82 is secured to the top of the frame members. A perforated sheet metal protection may surround the lugs 46 between the flanges 84 of the frame members, but this is omitted for clearance.

The intramarginal part of the strip 68 may be perforated or partly omitted, if desired, to facilitate cooling.

The duplicated numbers of the duplicated series of large easily read numbers 1 to 8 on the outer face of the frame member 68 indicate socket members 180° apart, the larger numbers indicating larger currents.

Our transformer has a large radiating surface and carries a large secondary current in proportion to weight and size of the transformer without overheating.

The secondary wires being connected in parallel give twice as much radiating surface as would a single wire of the same current-carrying capacity. The secondary wires are disposed in only one layer, and slightly spaced apart, thus facilitating radiation. Also the wires being large and somewhat stiff, will during winding, assume a somewhat outwardly bowed position between core corner edges thus spacing the wires from their support and giving further radiating surface at the face adjacent to the core, as shown in Fig. 3.

The transformer having no moving parts and no inside connections and contacts to get out of order is economical in up-keep and manufacture, and simple in operation.

The current output variation between any two adjacent diametric positions of the plugs 50 in the sockets S is considerable especially when the shunt bridge 54 is provided. In order to provide intermediate variations in current output between that provided by the socket positions alone, flux control coils 86 (Fig. 1) and 86a (Fig. 2) are provided, together with means for varying the control effect of these coils.

In the form of the invention of Figs. 2, 9, 10, 15 and 16, blocks 88 (Fig. 10) of insulating material secured on the toroidal core 10 near the ends of the bridge 54 carry a slotted member 90 providing a spaced pair of bars 92 of conducting metal disposed longitudinal to and spaced from the bridge. Said member has its ends secured to said blocks 88, and has one end electrically connected by a conductor 94 (Fig. 10) to the adjacent end of the coil 86a (Fig. 10), the other end of the coil being unconnected.

A sheet metal conducting sleeve 96 Figs. 15 and 16 surrounding and slidable on said bars in contact therewith has its front and back walls cut to form registering cutouts 98 at the space between the bars, and to form tabs 100 inturned between the bars in said space to form a passage opening in the cutout between the tabs and between the bars. A block 102 of metal mounted on the front face of said sleeve is provided with a stem 104 projecting through a slot 106 (Fig. 6) in the frame

member 56 and is provided with a bore 108 alined with said passage opening and with outer end threads removably receiving an internally threaded cap 110. A carbon brush 112 slidable in said bore and opening is connected to the cap by a flexible conductor 114 soldered at its ends to the cap and brush. A spring 116 in said bore compressed between the brush and cap presses the brush against adjacent portions 118 of the coil 86a, the insulation 120 of said portions being removed as at 118 to provide electric contact of the wire with said brush, whereby an electrically conductive circuit is provided through the portion of the member 90 and bars 92 and coil 86a between the sleeve 96 and the connected end of the member at the conductor 94, whereby during operation of the transformer an electric circuit may be completed to modify the flux leakage in the shunt, and whereby the sleeve 96 may be slid along the bars to put more or any number of convolutions of the coil 86a in said circuit, thereby to regulate by small variations the flux leakage in the bridge, thereby to regulate by small variations the current output of the transformer.

In the form of the invention of Figs. 1, 11, 12 and 13, the metal electrode holder 53 (Fig. 11) carries a coaxial tubular extension 120 of insulating material 122, 124 around the ends and through which the associated conductor 52 passes to the holder. A rheostat coil 126 of insulated resistance wire wound around said extension approximately from end to end of the extension is enclosed by a tubular housing 128 of insulating material mounted on said collars and closely spaced from the rheostat coil and provided substantially from end to end with an inner inwardly opening longitudinal guide way 130 (Fig. 12) having a longitudinal narrow slot 132 through its outer wall. One or two bars 134 of conducting metal secured longitudinally in the trackway at the respective sides of the slot and spaced from said coil and slot have one pair of adjacent ends electrically connected by a conductor 136 (Figs. 1 and 12) to one end of the flux control coil 86, the other end of the control coil 86 being electrically connected by a conductor 138 to one end of the rheostat coil 126, the conductors 136, 138 being covered by a single insulation 139 (Fig. 6).

A block of insulating material 140 (Fig. 12) slidable in said guide way 130 and provided with a stem 142 projecting through said slot 132 in the housing is provided with an exterior knob 144 whereby the block may be moved along the guide way. A sheet metal conducting plate 146 (Fig. 13) secured to the inner face of said block 140 has lateral extensions 148 curved over the edge of the block into contact with said bars and an end extension 150 curved to provide a cam face pressing on said adjacent portions of the coil 126 and holding the block pressed in the guide way, the insulation 152 of said portions of the coil being removed to provide electric contact of the wire with said cam face of the extension 150, whereby an electrically conductive circuit is provided through the control coil 54 and the portion of the bar and rheostat coil between the cam faced extension and the ends of the bars 134, and rheostat coil 126 connected to the conductors 136, 134, whereby during operation of the transformer an electric circuit may be completed through the coils to modify the flux leakage in the shunt and whereby said block may be slid along the guide way to cut in one or more or any number of convolutions of the rheostat coil in said circuit, thereby to regulate by small variations the resistance and current of the circuit and the flux leakage in the bridge 54, thereby to regulate the current output of the transformer.

If desired, the form of sliding contact with the cam-faced extension 150 may be used in connection with the arrangement of Fig. 2 instead of the carbon brush, in which case the plate 146 (Fig. 13) would be formed into a sleeve 146a (Fig. 14) closed at the outer face 148a slidably disposed on the member 90 (Fig. 2); and

the stem 104 as in Figs. 15 and 16 would be mounted on the face 148a, but need not be provided with the inner bore and removable cap.

On the other hand, the contact arrangement of Figs. 9, 10, 15 and 16 could be used in the electrode handle of Fig. 11, in which case the member 90 of Fig. 2 would be mounted on blocks such as the blocks 88 (Fig. 10) which would be mounted at the ends of the extension 120 (Fig. 11) with the member 90 adjacent to the slot 130 and the stem 104 passing through the slot 132.

We claim as our invention:

1. A transformer comprising a toroidal core; a primary winding disposed on a portion of the core over nearly one-half of the circumference of said core; a secondary wound around the core over substantially the entire circumference and overlaying said primary winding; a magnetic shunt bridge having both ends adjacent to the core near the ends of the primary winding; a shunt flux control coil of conducting wire around the bridge approximately from end to end thereof; a rheostat coil; a metal bar secured longitudinally of and spaced from the rheostat coil and having one end electrically connected to one end of the rheostat coil, a metal conducting sleeve in slidable contact with said bars and carrying a contact pressing on adjacent portions of the rheostat coil; and conductors connecting the ends of the control coil respectively with an end of the bar and an end of the rheostat coil.

2. A transformer comprising a toroidal core; a primary winding disposed on a portion of the core; contact members spaced around the core; a secondary around the core and having taps electrically connected to the contact members; a magnetic shunt bridge having both ends contacting the core near the ends of the primary windings; a shunt flux control coil of conducting wire wound around the bridge approximately from end to end; a pair of conductors adapted to be connected to any of said contact members; an elongated handle formed of insulating material; a rheostat coil of insulated wire wound around the handle; metal bars secured longitudinally of the handle and having one pair of adjacent ends electrically connected to one end of the flux control coil, the other end of the control coil being electrically connected to one end of the rheostat coil; and a metal conducting sleeve in slidable contact with said bars and carrying a contact part pressing on adjacent portions of the rheostat coil, the insulation of the rheostat coil being removed at the points of contact of said contact part to provide a path of travel for the latter.

3. A transformer according to claim 1, having a toroidal core comprised of a continuous thin strip of soft iron wound so as to have predetermined outer and inner diameters, said strip being continuous from said outer diameter to said inner diameter with adjacent edges registering and all permanently secured in superposed relation, said primary and secondary windings being wound directly on said continuously wound soft iron strip without the interposition of other elements.

4. A transformer according to claim 1, having a toroidal core comprised of a thin strip of soft annealed iron wound in continuing convolutions each of which is superposed upon its previously wound neighbor with adjacent edges of the strip registering, said primary and secondary windings being wound directly on said continuously wound soft iron strip without the interposition of other elements, said layers being sufficient in number to provide the required thickness for said core whereby magnetic flux may pass circumferentially around the core and longitudinally of the strip without having to pass through the contacting faces of said strip and the intervening air gap, said layers being permanently fixed together in superposed relation to one another.

5. A transformer according to claim 1 in which a layer of insulating material is placed around that portion of

said core not occupied by said primary winding, said layer being of a thickness approximating that of said primary winding, said magnetic bridge contacting said core near the ends of said layer of insulating material.

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