

Dec. 18, 1923.

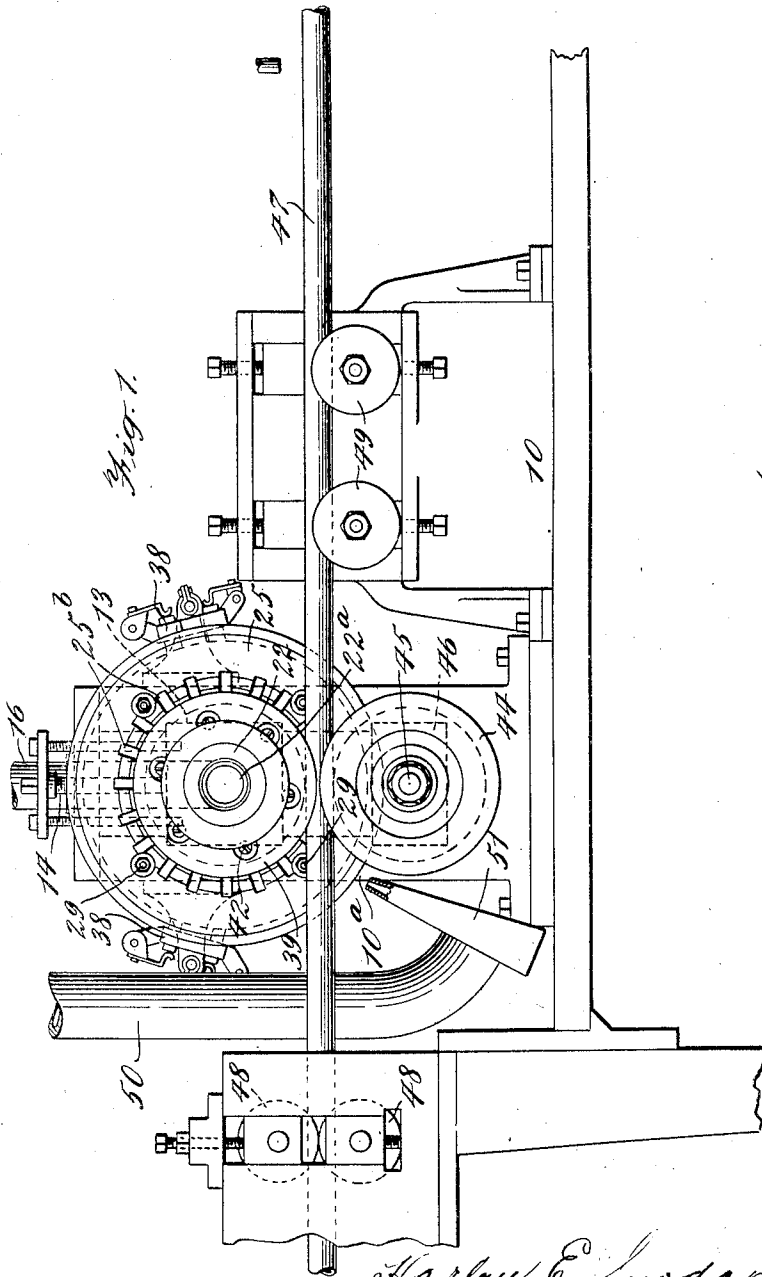
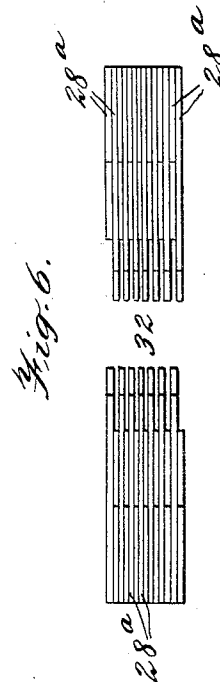
1,478,262

H. E. SNODGRASS ET AL

TRANSFORMER AND APPLICATION OF THE SAME TO HEATING

Filed Feb. 18, 1921

4 Sheets-Sheet 1



Harlan E. Snodgrass
Thomas W. Hunter INVENTORS

BY

Lippard & Bull ATTORNEYS

Dec. 18, 1923.

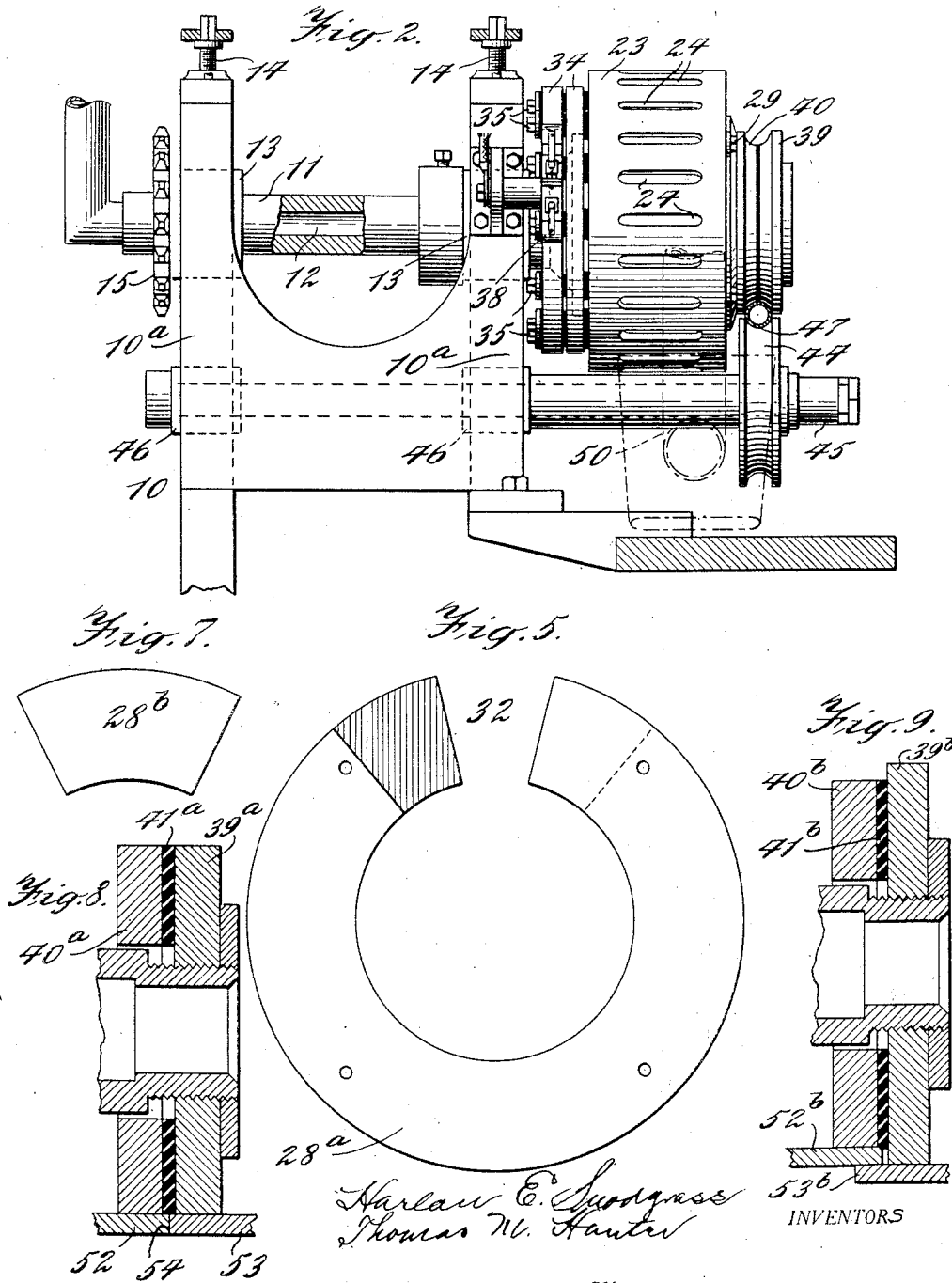
1,478,262

H. E. SNODGRASS ET AL

TRANSFORMER AND APPLICATION OF THE SAME TO HEATING

Filed Feb. 18, 1921

4 Sheets-Sheet 2



Harlan E. Snodgrass
Thomas W. Hunter

INVENTORS

BY

Leopold T. Bull
Attorney

ATTORNEYS

Dec. 18, 1923.

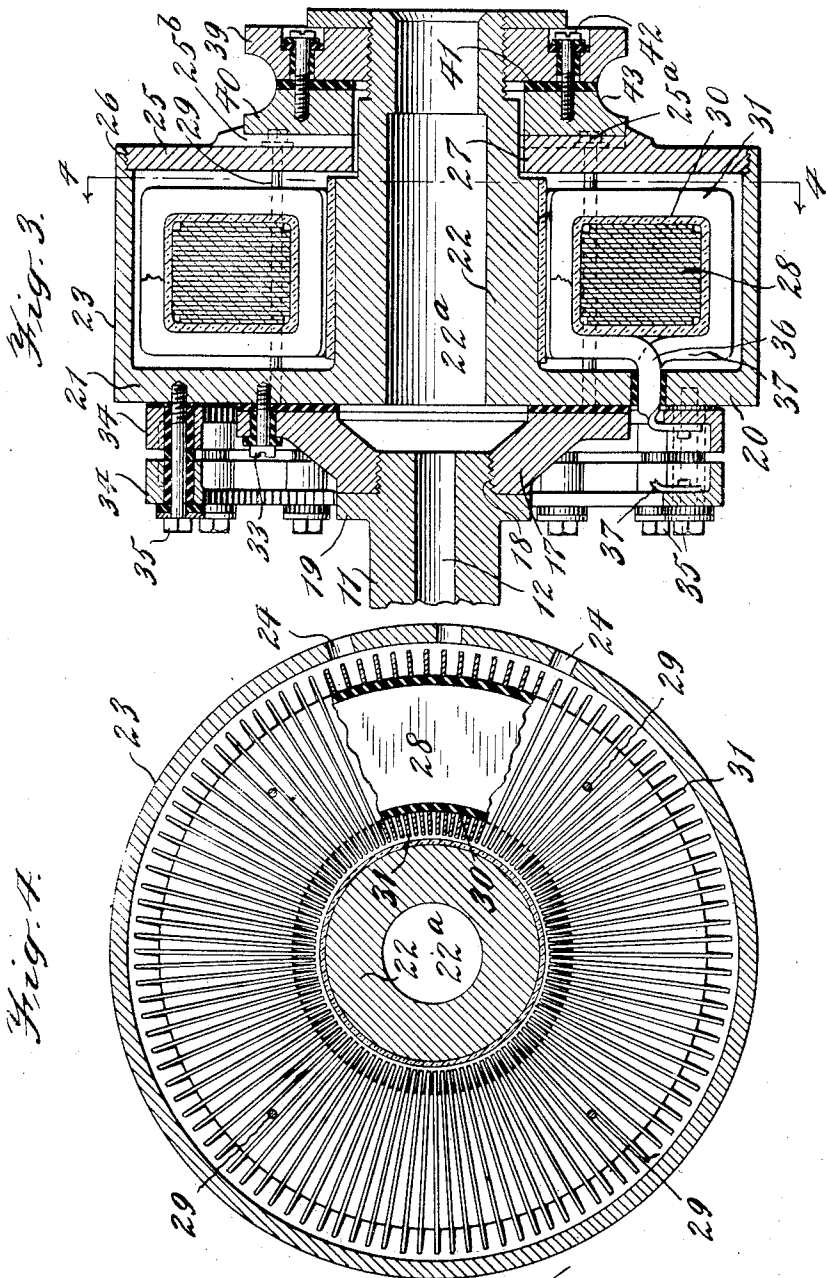
1,478,262

H. E. SNODGRASS ET AL

TRANSFORMER AND APPLICATION OF THE SAME TO HEATING

Filed Feb. 18, 1921

4 Sheets-Sheet 3



Harlan E. Snodgrass
Thomas W. Hunter

INVENTORS

BY

Gifford & Puel

ATTORNEYS

Dec. 18, 1923.

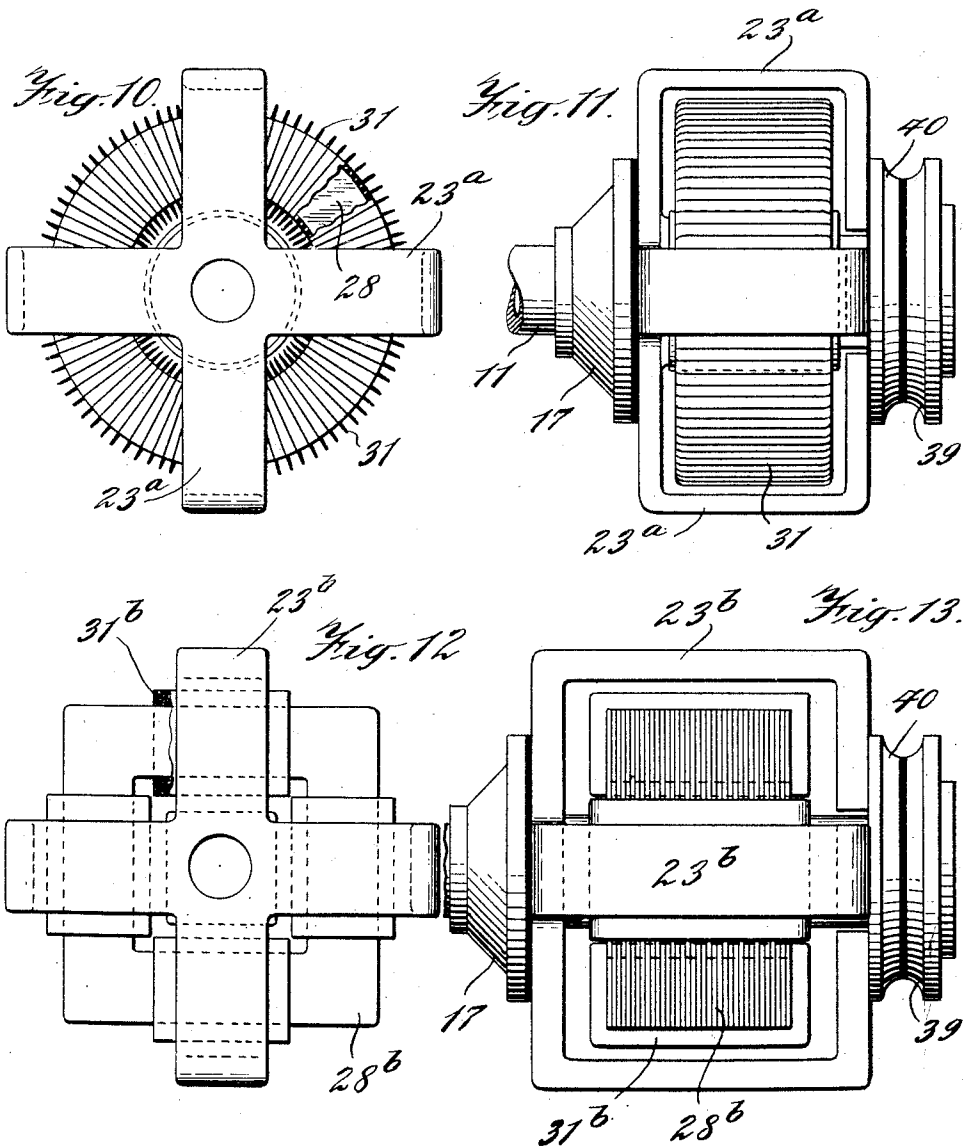
1,478,262

H. E. SNODGRASS ET AL

TRANSFORMER AND APPLICATION OF THE SAME TO HEATING

Filed Feb. 18, 1921

4 Sheets-Sheet 4



Harlan E. Snodgrass
Thomas W. Hunter INVENTORS

BY

Gifford T. Bull ATTORNEYS

UNITED STATES PATENT OFFICE.

HARLAN E. SNODGRASS, OF SUMMIT, AND THOMAS M. HUNTER, OF NEWARK, NEW JERSEY, ASSIGNORS, BY MESNE ASSIGNMENTS, TO NEWARK TUBE COMPANY, OF NEWARK, NEW JERSEY, A CORPORATION OF NEW JERSEY.

TRANSFORMER AND APPLICATION OF THE SAME TO HEATING.

Application filed February 18, 1921. Serial No. 446,050.

To all whom it may concern:

Be it known that we, HARLAN E. SNODGRASS and THOMAS M. HUNTER, citizens of the United States, residing at Summit, in the county of Union and State of New Jersey, and Newark, in the county of Essex and State of New Jersey, respectively, have invented certain new and useful Improvements in Transformers and Application of the Same to Heating, of which the following is a specification.

Our invention more particularly relates to a novel form of transformer and its application to welding and similar heating operations. Our present application is a continuation in part of our application Serial Number 399,449 which was filed in the Patent Office on or about July 28, 1920.

Our invention will best be understood by reference to the accompanying drawings, in which Figure 1 is a side elevation of a welding apparatus in which we have illustrated one embodiment of our invention; Fig. 2 is an end view, partially in section, of the device shown in Fig. 1; Fig. 3 is a longitudinal section through the transformer and associated parts; Fig. 4 is a cross section taken along the line 4—4 of Fig. 3; Fig. 5 is a side view of the laminated core for the transformer with the filling pieces for the opening omitted; Fig. 6 is a plan view of the core shown in Fig. 5; Fig. 7 is a detail view illustrating one of the filling pieces for the opening of the core of the transformer; Fig. 8 is a detail view illustrating our invention applied to butt welding, Fig. 9 is a similar view illustrating our invention applied to lap welding, Fig. 10 is an end view, with the supporting member omitted, and Fig. 11 is a side view of a modified form of transformer embodying our invention, and Fig. 12 is an end view similar to Fig. 10, and Fig. 13 is a side view of a further modification.

Referring, now, to the drawings, 10 is the frame of a welding machine provided with standards 10^a, 10^b. An operating shaft 11, which when the device is to be air-cooled, is preferably provided with a central passage 12, has its bearing at 13 in the standards 10^a, 10^b. The shaft is preferably vertically adjustable by screws 14 in a known manner, and is driven from any suitable source of power through suitable connec-

tions, here shown as a sprocket-wheel 15. The air-supply pipe 16, in the form of our invention here illustrated, supplies air to the passage 12 in the hollow shaft 11. The end of the shaft 11 is preferably provided with a supporting member 17, which is provided with a central opening screw-threaded at 18 to engage the screw-threaded end of the shaft 11, the supporting member abutting against a flange 19 formed on the shaft 11. The transformer, which is here shown as rotatable and which is preferably secured to the member 17, comprises a secondary 20, which may conveniently be formed of cast metal, and which in the form of our invention illustrated in Figs. 1 to 7, comprises a shell having a face plate 21 electrically connected to and preferably integral with one end of an axis 22 extending axially through the transformer, the central passage 22^a communicating with the central passage 12 of the shaft 11. The secondary shell also comprises a cylindrical part 23, preferably integral with the face plate 21, and preferably formed with openings 24 for ventilating purposes. The opposite side of the secondary shell is closed by a plate 25 which may be screw-threaded on its periphery, as at 26, to engage a similar screw-threaded part on the inner side of the shell 23. The plate 25 is provided with a central opening 27, which is of a slightly greater diameter than the axis 22, so that the plate 25 is spaced from the axis 22 sufficiently to insulate the same therefrom. A core 28 for the transformer, preferably annular in form, is located within and, in the form shown in Figs. 1 to 7, entirely enclosed by the shell of the secondary of the transformer, which constitutes a chambered body, the shell of the secondary of the transformer being electrically continuous in the direction of the generated current throughout the region of the core—i. e., without the inner side of the core. The secondary completely enclosing the core and primary, as described, may be considered as made up of an indefinite number of conductors symmetrically arranged with reference to the axis thereof, thus providing for a magnetic, mechanical and electrical balance under load conditions, and this balance is not affected by the rotation of the transformer. It will be apparent, for example, from an inspection of Fig. 3,

which may represent a section through the transformer taken along the axis at any angle, that for each assumed conducting loop of the secondary around the core and primary, there will be a loop of equal length on the opposite side of the axis of the transformer and symmetrically arranged with reference to said axis. The core may be held in position within the secondary by bolts 29 extending through the core and through the plates 21 and 25, respectively. The core 28 is covered by suitable insulation 30 and is surrounded by a primary winding 31, preferably in the form of a flat ribbon, and wound edgewise around the core. When the winding is made in ribbon-form and is formed before the winding operation, it is necessary to provide an opening in the core which is closed after the winding is placed in position. Referring particularly to Figs. 5, 6 and 7, it will be seen that the core is provided at one side with an opening 32 formed by making the laminations 28^a from which the core is formed somewhat less than a complete ring, the annualr laminated rings being completed by filler pieces 28^b, such as shown in Fig. 7. Adjacent laminated sheets or rings are preferably angularly displaced, as best shown in Fig. 6, so that one end of a given filler piece will lie between two alternate segments which project beyond the adjacent end of the intermediate segment. The secondary of the transformer is secured to the supporting member 17 by bolts or screws 33, suitable insulation being interposed between the side 21 of the secondary and the supporting member 17, and suitable insulating material also being interposed between the bolts 33 and the member 17, as clearly shown in Fig. 3.

Current is supplied to the primary of the transformer by collector rings 34, 34 secured to the face plate 21 by bolts 35, suitable insulation being interposed between the bolts and the plate. Terminals 36 and 37 connect the primary terminals to the respective collector rings. Alternating current is carried to the collector rings from any suitable source of supply by brushes 38 (see Fig. 1). Contact members or electrodes 39 and 40 are electrically connected to the axis 22 and to the face plate 25, respectively, the plate 25 preferably being provided with a plurality of bosses 25^a against which the contact member 40 is seated, thereby providing ventilating spaces 25^b between the member 40 and the plate 25. When our invention is applied to tube welding, as here illustrated, the contact rolls 39 and 40 are preferably formed as a unitary roll, separated by insulation 41 and secured together by bolts 42. The two contact rolls 39 and 40 are also formed on their inner edges with peripheral recesses, which together form a groove 43 adapted to engage a tube which

is to be welded. When the device is used for welding, a second roll 44, also provided with a peripheral groove, is disposed below the unitary roll and is mounted on a shaft 45 having its bearings at 46 in the brackets 10^a. The tube, which is illustrated at 47, passes through suitable guides 48 between the welding rolls 39, 40 and the lower roll 44, and over suitable supporting rolls 49, it being understood that the seam of the tube to be welded registers with the insulation 41 between the contact members 39 and 40. The work may be cooled by air supplied by a pipe 50 passing through a nozzle 51.

In the operation of the welding machine illustrated, the relatively high voltage, low current of the primary is changed to a low voltage, high current in the secondary, which terminates in the contact members 39 and 40, and when a tube is passed through the machine, the current passes from the metal on one side of the seam to the metal on the other side of the seam, thereby welding the tube. The current is, of course carried to the work at one point on the periphery of the electrodes, which point advances around the periphery of the electrode as the device rotates. Since, however, the electrode 40 makes contact with the end plate 25 near the axis 22, and the electrode 39 makes annular contact with the axis 22, and since these two contacts are in close proximity to each other and within the core 28, it will be apparent that the secondary is made up of an infinite number of conducting loops which form complete turns around the magnetic core and primary winding and which are magnetically closely associated therewith. It is, therefore, apparent that substantially uniform current density will be induced in each integral portion of the shell and axis, constituting the secondary and flow to the electrodes 39, 40 as equipotential points, said electrodes forming the poles of the secondary. In consequence of the uniform current distribution in each integral portion of the shell and axis, and the close magnetic association of the secondary with the primary winding and core throughout the entire magnetic path, the leakage reactance of the two windings when considered together and the leakage inductance of each winding separately are reduced to a minimum. The total reactance and impedance of the transformer will, therefore, be low and the power factor high, and in practice we have obtained a power factor as high as ninety-five per cent, and even higher, under unusually heavy current loads at extremely low voltages. The device is, therefore, highly efficient and has been found satisfactory in practice.

Furthermore, the potential is substantially uniform on each of the electrodes 39 and 40, and the current density is substantially uniform in each integral portion of the

shell and axis, and this uniformity is not dependent upon the diameter of the electrodes, but upon the relation of their points of contact with the end plate 25 and axis 22, respectively.

During the operation of the machine, air is preferably passed from the pipe 16 through the shaft 11 and the passage 22^a of the axis 22, in order to cool the transformer and the contact members. Additional means are also preferably provided for cooling the machine, comprising an air-supply pipe, from which the air is directed against the machine by a nozzle 51.

In Fig. 8 we have illustrated our invention applied to the butt welding of plates, in which case the two contact members 39^a and 40^a are preferably formed with flat peripheries, which engage the plates 52 and 53 which abut against each other, as at 54, about as indicated.

In Fig. 9 we have shown our invention applied to lap welding, in which case one of the contact members 40^b is made of a less diameter than the contact member 39^b and engages one plate 52^b, while the other member 39^b engages a second plate 53^b, which forms a lap joint with the plate 52^b.

In Figs. 10 and 11 we have shown a modified form of our invention in which the secondary of the transformer comprises a plurality of U-shaped conductors 23^a symmetrically arranged with reference to the axis of the transformer and which form with the axis conducting loops surrounding the core and primary. It will be apparent that the advantages of the magnetic mechanical and electrical balance, under load conditions, will be present in this form of our invention.

In Figs. 12 and 13 we have illustrated a still further modification of our invention in which the core is rectangular in form, and the primary 31^b is arranged in separate sections. The secondary here comprises separate conducting loops 23^b as in the case of Figs. 10 and 11. While in Figs. 10 to 13 we have illustrated four separate conducting loops surrounding the core and primary, it will of course be understood that any desired number of conducting loops may be used, so long as the symmetrical arrangement thereof is preserved.

It will be apparent that the device made in accordance with our invention is compact, that it eliminates all sliding or moving contacts in the secondary circuit, and that the contact members which project to one side of the transformer are readily accessible. It will further be apparent that both windings form a short path for their currents; that a uniform current density is induced in each integral portion of the secondary shell and axis; that the primary and secondary currents are closely associated with each other

and with the core throughout the entire magnetic path, thereby reducing the resistance, reactance, stray field or eddy-current losses in the transformer as a whole, over other known forms of construction. The efficiency of the transformer will, therefore, be high, and in practice we have obtained an efficiency of ninety-seven per cent and even higher under commercial conditions.

While we have illustrated the preferred embodiment of our invention, it will be understood that the transformer described may be used for operations other than welding, and that the machine embodying the transformer may be used for heating operations other than electrical welding.

What we claim and desire to secure by Letters Patent of the United States is:

1. A heavy current transformer for heating and the like, comprising a closed core, a primary surrounding said core, and a secondary comprising conductors surrounding the core and symmetrically arranged with reference to the axis of said transformer, and constructed and arranged to produce a substantially uniform distribution of current in said secondary.

2. A heavy current rotatable transformer for heating and the like, comprising a closed core, a primary surrounding said core, and a secondary surrounding said core and primary and comprising conductors symmetrically arranged around the core with reference to the axis of said transformer, and constructed and arranged to produce a substantially uniform distribution of current in said secondary.

3. A transformer for heating and the like comprising a core, a primary surrounding said core, and a heavy current secondary completely enclosing said core and primary and electrically continuous around said core, and constructed and arranged to produce a substantially uniform distribution of current in said secondary.

4. A transformer for heating and the like comprising a core, a primary surrounding said core, and a heavy current secondary enclosing said core and primary and electrically continuous throughout the region of said core, and constructed and arranged to produce a substantially uniform distribution of current in said secondary.

5. A transformer for heating and the like comprising a continuous core, a primary surrounding said core, and a heavy current secondary enclosing said core and primary and electrically continuous throughout the region of said core, and constructed and arranged to produce a substantially uniform distribution of current in said secondary.

6. A transformer for heating and the like comprising an annular core, a primary surrounding said core, and a heavy current secondary enclosing said core and primary

and electrically continuous throughout the region of said core, and constructed and arranged to produce a substantially uniform distribution of current in said secondary.

7. A transformer for heating and the like comprising an annular core, a primary surrounding said core, and a heavy current secondary comprising an axis extending through said core and a shell electrically continuous with said axis at one end thereof and completely enclosing said core and primary.

8. A transformer for heating and the like comprising an annular core, a primary surrounding said core, a heavy current secondary comprising an axis extending through said core and a shell electrically continuous with said axis at one end thereof and completely enclosing said core and primary, and electrodes for said secondary located at one side of said transformer and electrically connected to said axis and to one side of said shell respectively.

9. A transformer for heating and the like comprising an annular core, a primary surrounding said core, a heavy current secondary comprising a hollow axis extending through said core and a shell electrically continuous with said axis at one end thereof and completely enclosing said core and primary, and means for passing a cooling fluid through said axis.

10. In a heating device, a rotatable transformer comprising a core, a primary surrounding said core, a secondary having a plurality of conducting loops symmetrically arranged about the axis of said transformer and electrically continuous outside of the periphery of the core, and electrodes connected to the ends of said loops.

11. In a heating device, a rotatable transformer comprising a core, a primary surrounding said core, and a chambered secondary enclosing said core and primary and electrically continuous throughout the region of said core.

12. In a heating device, a rotatable transformer comprising a core, a primary surrounding said core, a secondary comprising an axis extending through said core and having a plurality of looped conductors electrically connected at one end to said axis and symmetrically arranged about the same, and electrodes at the side of said transformer connected to said axis and to the free ends of said loops respectively.

13. In a heating device, a rotatable transformer comprising a core, a primary surrounding said core, a secondary comprising an axis extending through said core and a shell electrically continuous with said axis at one side and extending close to said axis at its other side, said shell enclosing said core and said primary, and electrodes at

one side of said transformer rotating therewith and electrically connected to said axis and to one side of said shell respectively.

14. In a heating device, a shaft, a transformer comprising a chambered secondary secured to the end of said shaft, a core mounted within said secondary, and a primary surrounding said core, said secondary terminating in electrodes at one side of said transformer and rotating therewith.

15. In a heating device, a rotatable transformer comprising an annular core, a primary surrounding said core, a secondary comprising an axis extending through said core and a shell electrically connected at one side to said axis and at the other side extending adjacent thereto but insulated therefrom, and electrodes mounted on said axis and electrically connected to said axis and to one side of said shell respectively.

16. In a heating device, a rotatable transformer comprising an annular core, a primary surrounding said core, a secondary comprising an axis extending through said core and a shell electrically connected at one side to said axis and at the other side extending adjacent thereto but insulated therefrom, and a unitary contact roll mounted on said axis and comprising two insulated contact members electrically connected to said axis and to the free side of said shell respectively.

17. In a heating device, a transformer comprising a core, a primary surrounding said core and a secondary comprising an axis extending through said core and a shell electrically connected to said axis at one end thereof, and electrodes located at one side of said transformer and forming annular electrical connections with said axis and said shell respectively.

18. In a heating device, a rotatable transformer comprising a core, a primary surrounding said core and a secondary comprising an axis extending through said core and a shell electrically connected to said axis at one end thereof, and contact rolls located at one side of said transformer and rotating therewith and forming annular electrical connections with said axis and said shell respectively.

19. A heating device comprising a transformer having a chambered metallic body forming its secondary and an axis through said body electrically connected to one end of said body and passing near to the opposite end but insulated therefrom, and electrodes each of which is of substantially equal potential throughout connected to the free end of chambered body and axis respectively.

20. In a heating device, a transformer comprising a continuous core and a primary winding surrounding said core, a metallic

envelope enclosing said core and said primary and constituting the secondary of the transformer, an axis extending through said envelope and electrically connected to one side of said envelope and insulated from the other side thereof, and electrodes each of which is of substantially equal potential throughout forming continuous contact with the free side of said envelope and with the free end of said axis, respectively.

21. A transformer comprising a core, a primary and a secondary consisting of a chambered body with a part protruding axially through the center of said body, said secondary completely enclosing the primary and the core, and electrodes each of which is of substantially equal potential throughout forming continuous contact with the free ends of the chambered body and the axially protruding part, respectively.

22. In a tube welding apparatus, in combination, a rotatable transformer, a two-part welding wheel side by side therewith, the secondary of said transformer being connected to the respective parts of said welding wheel.

23. In a tube welding apparatus, in combination, a rotatable transformer, a two-part welding wheel in axial alignment with said transformer and independent thereof,

the secondary of said transformer being connected to the respective parts of said welding wheel.

24. In a tube welding apparatus, in combination, a rotatable transformer, a two-part welding wheel of lesser diameter than and in axial alignment with said transformer, the secondary of said transformer being connected to the respective parts of said welding wheel.

25. A transformer comprising an annular core, a primary, and a secondary formed of looped conductors surrounding the primary and core and symmetrically arranged about the axis of the transformer, the axis of the transformer lying substantially in the plane of each loop.

26. In a welding apparatus, a rotatable transformer comprising an annular core, a primary, a secondary formed of looped conductors surrounding the primary and core and symmetrically arranged about the axis of the transformer, the axis of the transformer lying substantially in the plane of each loop, and welding electrodes to which the respective ends of the loops are connected

HARLAN E. SNODGRASS.
THOMAS M. HUNTER.