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ROTARY HIGH-FREQUENCY WELDING TRANSFORMER

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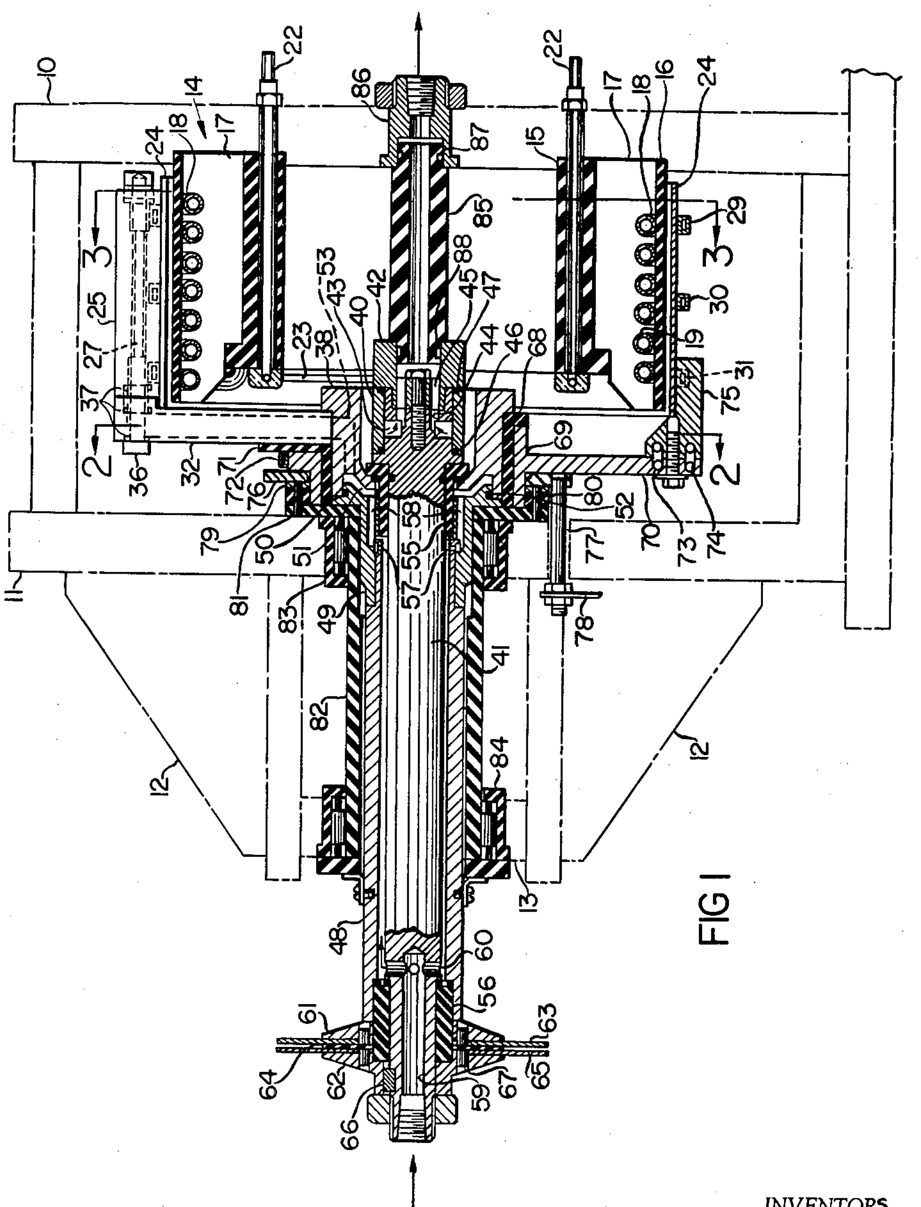

FIG I

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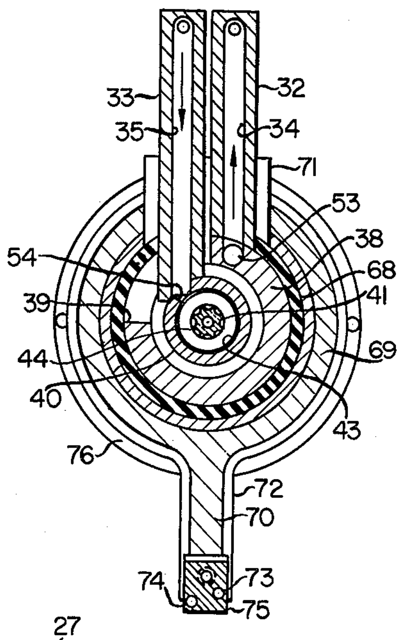

FIG 2

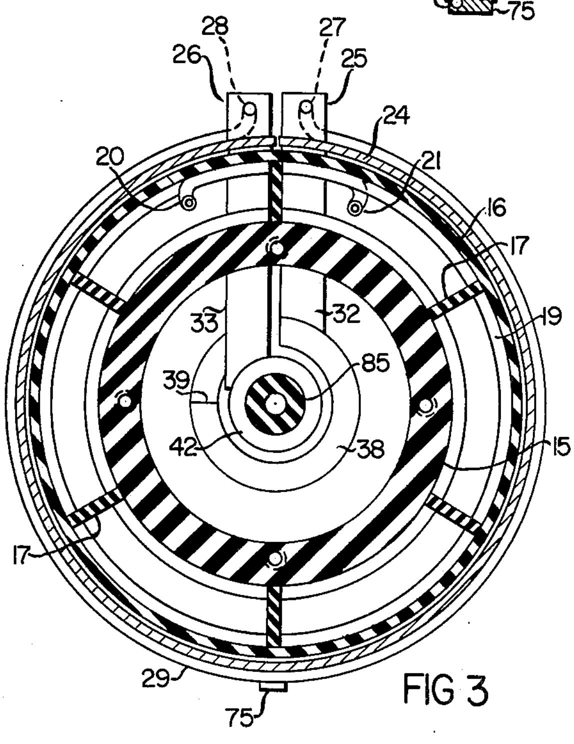

FIG 3

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ROTARY HIGH-FREQUENCY WELDING TRANSFORMER

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4 Claims. (Cl. 219—63)

The present improvements relate to a rotating transformer for high-frequency welding of the general type shown in U.S. Patent No. 2,964,610.

The transformer disclosed in said patent comprises a unitary assembly of rotary electrodes, conductors for the supply of welding current thereto, and a single turn secondary transformer winding, all mounted for rotation with such secondary in coupled relation to a stationary primary winding of the transformer. Such transformer is designed to operate at frequencies on the order of from about 9600 to about 450,000 cycles per second, with the stationary primary coil being made of tubing and cooled by circulation of water through the same. The structure is coreless, and the fixed mounting of the primary of course simplifies the connection of the primary to the high frequency energy source. The embodiment illustrated and described in the patent further locates the single turn secondary within the primary winding, and provision is made for air cooling of the assembly.

The present invention provides a particular construction for such a transformer, with a rotating secondary-electrode assembly, in which the secondary is outside the primary winding or encircles the same, thereby to screen the field generated by the primary coil or winding. Such screening has the effect of containing the field, reducing the radiation of the same and accordingly adverse influence on instruments and the like in the vicinity of the welder, such as the instruments in a welder control stand or panel.

It is also an important object to provide such a rotating welding transformer having a system for water cooling of the conductor assembly and the secondary of the transformer.

A further object of the invention is to provide a water cooled transformer of this type in which conductor and secondary winding coolant passages are serially connected for circulation of the water through both such component assemblies with a minimum of external connections.

Other objects and advantages of the present invention will become apparent as the following description proceeds.

To the accomplishment of the foregoing and related ends, the invention, then, comprises the features hereinafter fully described and particularly pointed out in the claims, the following description and the annexed drawings setting forth in detail certain illustrative embodiments of the invention, these being indicative, however, of but a few of the various ways in which the principle of the invention may be employed.

In said annexed drawings:

FIG. 1 is a longitudinal section of a high-frequency rotating welding transformer in accordance with the present invention;

FIG. 2 is a transverse sectional view taken on the plane of the line 2—2 in FIG. 1; and

FIG. 3 is a further transverse section as viewed from the plane of the line 3—3 in FIG. 1.

Referring now to the drawings in detail, the dashed outline in FIG. 1 represents a stand or frame comprising a vertical rear plate 10, a parallel front plate 11, and arms 12 extending forwardly from the latter and carrying an outer support ring or collar 13. Although the details

of such frame are unimportant, as shown by the nature of the illustration, the structure outlined provides a convenient base which will assist in description and understanding of the welding transformer of the invention.

The new transformer comprises a stationary primary assembly designated generally by reference numeral 14 which is secured to the rear plate 10 of the stand, partially seated in a recess provided therefor in the forward surface of such plate. Such primary assembly includes inner and outer cylinders 15 and 16 made of suitable high-temperature electric insulation material, with a plurality of radial spacers 17, similarly insulative, bridging the annular space between the two such co-axial cylinders. The outer edges of these spacers are provided with longitudinally spaced notches 18 so relatively formed as to follow a helix about the inner surface of the outer cylinder 16. A primary coil or winding 19, preferably made of copper tubing, is disposed against the interior of such outer cylinder, with its turns engaged in the notches 18 of the several spacers 17 and accordingly held in spaced or separated relation. The primary is adapted for connection of its ends 20 and 21 to a suitable oscillator, not shown, for energization at high-frequency, not only within the range earlier set forth but at frequencies up to one megacycle or even higher.

Such primary coil is of course also adapted for cooling by circulating water through the same, and the mounting thereof in the stand is preferably accomplished by means of water cooled bolts 22 extending through the length of the inner cylinder 15 and through the rear plate 10. Such bolts are thus hollow and interconnected at their inner ends, for example, in pairs, by conduit members such as shown at 23 for closed circulation of water through the same.

A single turn secondary 24, in the form of a split metallic sleeve, encircles the primary winding assembly in slightly spaced relation to form a high-frequency, air-core transformer therewith. The transformer is mounted on a substantially horizontal axis, with the secondary split at the top. A first manifold 25 is secured externally to the secondary along one side of the gap or split therein, and a second manifold 26 is correspondingly provided at the other side of the gap or interruption. These manifolds, which are conductive and have interior longitudinal passages 27 and 28, are thus at the respective ends of the secondary and serve as terminals for the same.

Three coolant tubes 29, 30 and 31 of rectangular cross-section extend about the outer surface of the secondary 24 from one manifold to the other in longitudinally spaced relation with the ends of the tubes in fluid communication with the interior passages of the manifolds, as best shown in FIG. 3. A support arm 32 is secured to and depends from the front end of the manifold 25, while another support arm 33 is similarly attached to the forward end of the other manifold 26, the two such arms extending downwardly in spaced parallel relation, as shown in FIG. 2, and being of unequal length. Support arm 32 has a passage 34 therethrough which communicates with the interior passage 27 of the connected manifold 25, and the arm 33 has a corresponding through passage 35 in communication with the passage 28 of the manifold 26 to which it is attached. The two such arms can be attached to the manifolds by any appropriate means, such as tie bolts 36, with the resulting joints sealed against the escape of fluid, the illustrated embodiment employing O-rings 37 for the purpose.

The short support arm 32 is secured at its lower end to an outer conductor piece 38 in the form of a sleeve having a cut-out 39 of slightly more than 90° in its side wall. As will be apparent from FIGS. 2 and 3, such cut-out is provided and located to permit the longer support arm 33 to extend through the outer conductor piece 38 for connection at its lower end to a co-axial inner conductor sleeve 40.

Such inner conductor sleeve 40 is fitted on a reduced end portion of a shaft 41 and held thereagainst by a clamp ring 42 fastened to the shaft end by a center screw. For a purpose to be described, the end portion of the shaft thus enclosed by the sleeve 40 is provided with an annular groove 43 and a series of small passages 44 extending rearwardly from the bottom of the same, while the clamp ring 42 has passages 45 respectively in register with such shaft end passages 44. The joint between the forward end of the sleeve and the shaft is sealed by an O-ring 46, while a like ring 47 is interposed between the rear end of the sleeve and the abutting end of the clamp ring.

The center shaft 41 extends forwardly an appreciable distance and constitutes the main inner conductor from one electrical end of the secondary through the manifold 25, support arm 32 and sleeve 40. Surrounding the shaft in spaced relation is the main outer conductor 48 having a welded inner end extension 49 which abuts the previously mentioned outer conductor piece 38 connected to the support arm 33. The adjacent ends of extension 49 and piece 38 are shaped so that there is limited conductive contact of the two at the periphery 50 and an inner generally annular chamber 51 at the interior of the joint. An O-ring 52 seals the contact of the two such members, and the outer conductor piece 38 is provided with a passage 53 which extends from the noted chamber 51 to the passage 34 provided in the connected support arm 32. As shown in FIG. 2, the inner conductor sleeve 40 is provided with a port 54 for communication between the passage 35 of the long support arm 33 and the shaft groove 43 enclosed by such sleeve.

The outer conductor 48 is spaced from the shaft 41 at the inner end by a hat-shaped sleeve 55 of electrical insulation and, at its outer end, by a further spacer sleeve 56 of the same material. Just forwardly of such rear conductor separator 55, the outer conductor is provided with a series of radial holes 57 and respectively communicating axial passages 58 which extend to the inner chamber 51, and the forward end of the shaft 41 has a reduced extension in which there is a bore 59 leading to radial passages 60 just inside of the outer conductor separator 56.

An inner electrode plate 61 is abutted against the outer end of the outer conductor 48, about the insulative separator 56, and an outer electrode plate 62 is fitted on the projecting extension of the shaft or inner conductor 41. An inner electrode disc or ring 63 is disposed against the forward face of the plate 61, an insulating disc 64 overlies the same, and an outer electrode 65 is held against the opposite side of such insulator by the outer electrode plate 62. The latter is locked to the shaft rotatively by a key 66, and a number of pins 67 are pressed through registered holes in the outer and inner electrode plates and through the insulator 64, the latter being of approximately the same area.

Returning to the inner end of the coaxial conductor assembly (41, 48), an insulating sleeve 68 surrounds the outer conductor piece 38, with the former cut away to accommodate the vertical support and conductor arms 32, 33 at the top. A secondary grounding member 69 encircles the sleeve 68 and has an integral arm 70 projecting at the bottom. This ground member is similarly cut out at the top about the arms 32, 33 and an insulator plate 71 is interposed between such arms and the adjoining surface of the ground member. A coolant tube 72 extends around the periphery of such ground member with its ends connected to separate passages 73 and 74 in a manifold 75 which is inserted in the forward conduit 31 extending around the outside of the secondary 24. It will be understood that this manifold connection places the conduit 72 around the ground member in series with the secondary cooling conduit 31 and serves to connect the member electrically to the secondary opposite the slit in the latter.

A stationary metal ground disc 76 overlies the ground member 69 at the front of the same, with such disc having a forwardly projecting stud 77 which passes through the front plate 11 of the welder stand. A ground connecting strap 78 is attached between nuts on the end of such stud. A wear plate 79 is disposed against the outer or front face of the stationary ground disc 76, a rubber disc 80 is placed against the wear disc 79, and a further insulative disc 81 overlies disc 80. It will be noted that the insulator disc 81 is against the inner face of the front mounting plate 11 of the stand.

Extending forwardly about the outer conductor 48 is an insulative sleeve 82 forming an inner bearing race. The outer race of an inner roller bearing 83 is mounted in the opening provided in the front plate 11 of the welder stand for passage of the conductor assembly, while an outer roller bearing 84 about the sleeve is held in the forward support ring or collar 13 of the stand. It is preferred that these bearings, including the rollers thereof, be non-metallic, to avoid heating of the same by reason of their location within the field of the transformer.

The transformer structure is completed by an insulative sleeve 85 extending from the inner conductor clamp 42 on the inner end of the shaft 41 to a water fitting 86. Such sleeve is sealed at its end by O-rings 87 and 88, and the fitting has a tapped passage with a nut threaded externally thereon as shown.

It will be understood that the work to be welded, such as a tube blank, is advanced in engagement with the electrodes 63 and 65, whereby the latter, the coaxial conductor assembly (41, 48) and the transformer secondary 24 rotate together in the support provided by the bearings 83 and 84. The conductive arms 32 and 33 both connect the coaxial conductors to the ends of the single-turn secondary and support the latter about the stationary primary assembly. The primary coil is cooled by circulating water therethrough, and the various passages which have also been noted provide water cooling of the rotating secondary assembly.

In this last connection, we will assume that water is supplied through a suitable rotatable union to the forward or electrode end of the shaft 41 as shown by the arrow. This water flows through the shaft bore 59 and the connecting radial passages 60 to the space between the inner and outer conductors 41 and 48. It thus flows rearwardly along the conductors to the outer conductor ports 57 and passages 58 to the inner water chamber 51. From this chamber, the water flows through the passage 53 in the outer conductor piece 38 to the arm 32 and from the latter to the secondary manifold 25. The water then proceeds to the commonly connected conduits 29—31 about the exterior of the secondary, with a portion of the water being diverted through the cooling conduit 72 of the secondary ground member 69, and the several such passages discharge into the other secondary manifold 26. The recombined flow then proceeds through the long arm 33 and the port 54 in the inner conductor sleeve 40 to the groove 43 in the reduced end portion of the shaft. From such groove, the water flows rearwardly through the passages 44 and 45 respectively in the end of the shaft and the clamp ring 42 and through the sleeve 85 to the rear outlet 86.

The water accordingly traverses the entire rotating secondary assembly for extremely efficient cooling of all parts of the same, and it will be understood that the described flow could as well be in the reverse direction. That is, the water inlet can be provided at either end of the shaft and its extension to the rear, with the discharged water either being collected for recirculation or simply exhausted.

It will be observed that there is an insulation body between the primary and secondary, with the latter at a slight spacing from such body. This spacing is provided as an allowance for any eccentricity in either the primary or secondary, the two relatively rotating, and, for practical purposes, the design employs solid dielectric between the two.

Other modes of applying the principle of the invention may be employed, change being made as regards the details described, provided the features stated in any of the following claims or the equivalent of such be employed.

We, therefore, particularly point out and distinctly claim as our invention:

1. A rotary high-frequency welding transformer comprising a stationary water-cooled primary winding adapted for connection to a source of high-frequency energy, a single turn secondary surrounding said primary winding in spaced relation, a conductor assembly including a pair of conductors and having first and second separate coolant passages respectively terminating in an inlet and an outlet at the ends of the assembly, rotary electrodes respectively connected to corresponding end portions of said conductors, connector means having coolant passages therein connecting the other ends of the conductors to the electrical ends of the single turn secondary, said connector means supporting said secondary on said conductor assembly, with one such connector coolant passage in communication with the first coolant passage of the conductor assembly and another connector coolant passage communicating with the second conductor coolant passage, conduit means extending around the secondary from the one connector coolant passage to the other, whereby cooling fluid supplied under pressure to a coolant passage at one end of the conductr assembly flows from the same through such assembly, the connector means, and the conduit means to the passage at the other end of the assembly, and means for supporting the electrodes, conductor assembly and secondary for rotation as a unit.

2. A rotary high-frequency welding transformer comprising a rotatable conductor assembly having a water inlet and an outlet respectively at the ends of the same, a pair of rotary electrodes supported at one end of said conductor assembly, a transformer secondary turn supported at the other end of the assembly, the latter serving to connect the ends of the secondary turn respectively to the rotary electrodes, conduit means extending about the secondary turn between the ends thereof, means for defining a passage for water extending from the inlet of the conductor assembly to one end of said conduit means, means for defining a water passage from the other end of the conduit means to the outlet of the conductor assembly, whereby water supplied under pressure to the inlet flows to the outlet through the conductor assembly and about the secondary for cooling thereof, and a stationary primary winding in spaced relation within the secondary turn and being adapted for connection to a source of high-frequency energy.

3. A rotary high-frequency welding transformer comprising a stationary tubular primary winding adapted for connection to a high-frequency energy source, a single secondary turn about said primary winding in spaced relation, solid dielectric disposed in and substantially filling the space between the primary winding and secondary turn, a co-axial conductor assembly, connector means for connecting the ends of the secondary turn rigidly to said conductor assembly with the secondary turn being supported in such surrounding relation to the primary winding on the conductor assembly by said connector means, rotary electrodes supported on the conductor assembly, the latter serving conductively to interconnect the secondary ends and electrodes, and means for mounting the conductor assembly for rotation on the axis thereof.

4. A rotary high-frequency welding transformer comprising a co-axial conductor assembly, bearing means engaging and supporting said conductor assembly freely for rotation on its axis, a pair of rotary electrodes fixed on said conductor assembly adjacent one end thereof, conductive radially outwardly extending support means fixed on the conductor assembly adjacent the other end of the same, a secondary in the form of a split sleeve mounted by and projecting to the rear from said support means with its interior and outer end unobstructed, the electrical ends of said secondary at the split therein being conductively connected through the support means and conductor assembly respectively to said electrodes, a water-cooled primary coil adapted for connection to a high-frequency energy source, stationary mounting means for supporting said primary coil within said secondary in close-spaced relation, the secondary being free to rotate with the electrodes and conductor assembly, and means for circulating liquid coolant about the thus rotating secondary.

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