May 9, 1944. G. H. BROWN 2,348,325

ELECTRICAL TRANSFORMER

Filed April 26, 1941

FIG. 1.

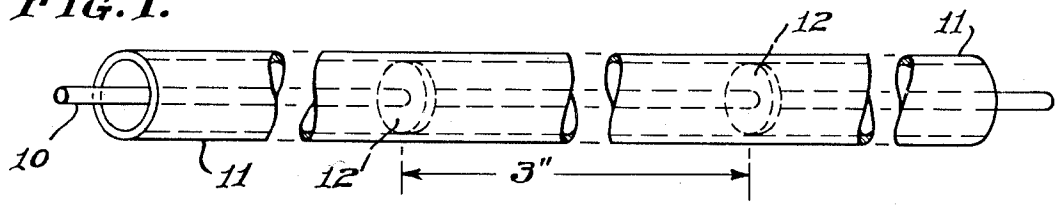


FIG. 2.

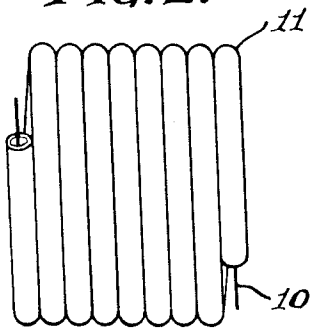


FIG. 3.

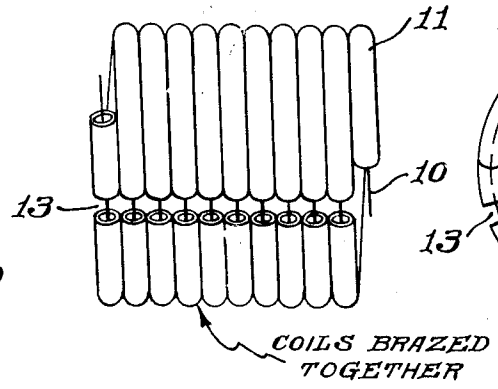


FIG. 4.

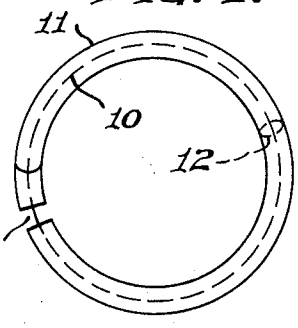


FIG. 5.

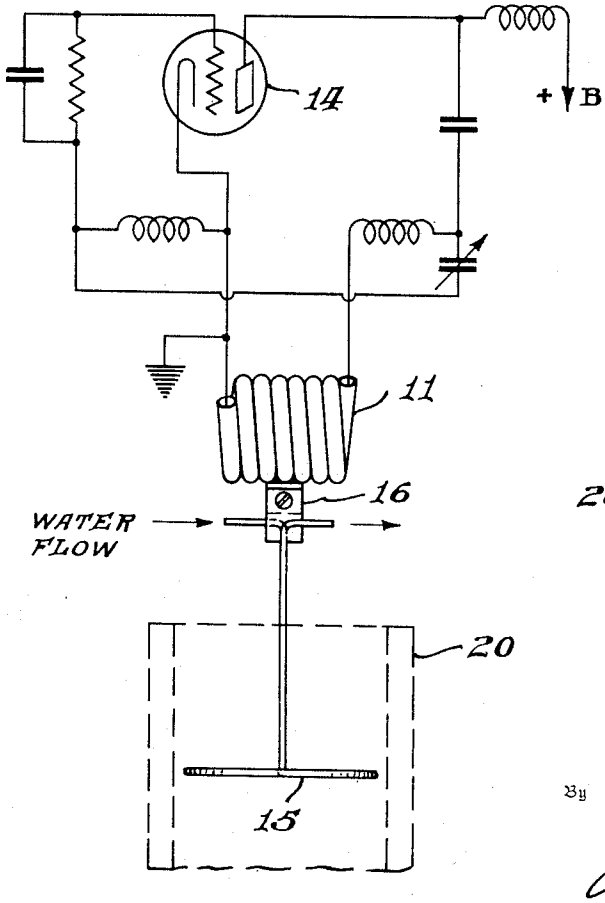
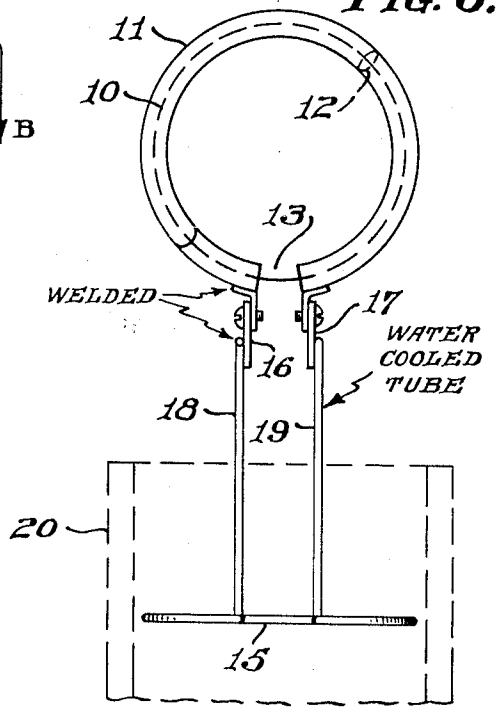


FIG. 6.



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2,348,325

ELECTRICAL TRANSFORMER

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Application April 26, 1941, Serial No. 390,628

4 Claims. (Cl. 175—359)

This invention relates to electrical transformers such as are useful in the heat treatment of various materials, and has for its principal object the provision of an improved construction and method of operation whereby the transformer primary voltage required to produce a desired heating effect is greatly reduced over that required in the case of transformers heretofore available for this purpose.

For the heating of metals and the like, it has been proposed to provide a high frequency oscillation generator which is coupled to the work through a transformer including a secondary circuit in the form of a relatively wide copper sheet. This type of transformer is not altogether satisfactory on account of its high leakage reactance which requires a relatively high primary voltage to produce the desired heating effect.

In accordance with the present invention, this difficulty is minimized or altogether avoided by the provision of a transformer constructed of a concentric transmission line wound into the form of a helix with the adjacent turns of its outer conductor in electrical contact and cut away to provide terminals so that the inner conductor functions as a multi-turn series-connected primary and the turns of the outer conductor function as parallel-connected secondaries. This construction has the important advantage in that it provides a relatively low leakage reactance and a relatively high coefficient of coupling.

Thus it has been found that, in the case of a transmission line including an inner conductor one-quarter inch in diameter and a three-quarter inch outer conductor spaced from the inner conductor by insulation beads, the primary voltage required to produce a given heating result may be reduced to one-third that ordinarily required. It is apparent, however, that these dimensions are not critical but that the improved result is dependent on the type of construction rather than on the particular dimensions of the various parts. In its broader aspects, the invention provides an improved means for coupling a high frequency oscillation generator to a low impedance load such as that involved in hardening the surface of an internal combustion engine cylinder.

The invention will be better understood from the following description considered in connection with the accompanying drawing and its scope is indicated by the appended claims.

Referring to the drawing,

Figure 1 illustrates a section of concentric transmission line, such as that used in the construction of the transformer,

Figure 2 shows the concentric transmission line of Fig. 1 rolled into the form of a helical solenoid,

Figure 3 illustrates the various turns of the outer conductor as brazed together and cut away longitudinally of the solenoid axis to provide secondary output terminals,

Figure 4 is an end view of the solenoid,

Figure 5 is a circuit diagram of the apparatus showing its application to the surface hardening of an internal combustion engine cylinder, and

Figure 6 illustrates certain details of the circuit of Fig. 5.

The transmission line of Fig. 1 includes an inner conductor 10 and an outer conductor 11 which is spaced from the inner conductor by means of insulation buttons 12 suitably spaced along the line.

As indicated by Figs. 2, 3 and 4, the transmission line 10—11 is wound into the form of a solenoid. The adjacent turns of the outer conductor are electrically interconnected and these turns are cut at 13 leaving the inner conductor 10 intact. There is thus provided a high frequency transformer, the primary circuit of which is constituted of the series connected turns of the inner conductor and the secondary circuit of which is constituted of the parallel-connected turns of the outer conductor.

High frequency current is supplied to the primary circuit 10 from any suitable oscillation generator such as that illustrated by the electron discharge device 14 (Fig. 5) and its associated circuit elements, the various functions of which are readily understood without detailed explanation.

High frequency current is delivered from the parallel-connected secondary turns to a water cooled applicator 15 through lugs 16 and 17 attached to the opposed ends of the secondary turns and leads 18 and 19 connected between the applicator 15 and the opposed ends of the secondary turns. With these connections, the current induced in the parallel-connected secondary turns is delivered to the applicator 15.

The applicator 15 is maintained in proximity to the treated surface only long enough to attain the temperature required for proper hardening of the surface. To this end, the applicator may be moved with respect to the surface or the surface may be moved with respect to the applicator. In either case, cooling or quenching may be accomplished by dissipating the heat in a cooling fluid or in the relatively cool body of the material treated. In the case of internal combustion engine cylinders, it has been found that suitable

quenching is readily effected by dissipating the heat in the engine body, as disclosed, for example, in my copending application Serial No. 421,746, filed December 5, 1941. In any case, the heating effect is kept near the surface of the material due to "skin effect" and the scanning of the surface by the applicator may be relatively rapid. Obviously, many suitable means are available for producing the desired relative movement between the applicator and the treated surface and it is within the purview of the invention to apply such means either to the applicator 15 or to the work which is indicated as a cylinder 20.

I claim as my invention:

1. An electrical transformer comprising a pair of concentric conductors wound into the form of a helix whereby the outer one of said conductors constitutes one winding of the transformer and the inner one of said conductors constitutes a second winding of the transformer, said outer winding comprising a plurality of adjacent, incomplete, outer turns each having an entire cross-sectional portion thereof removed.

2. An electrical transformer comprising a pair of concentric conductors wound into the form of a helix whereby the outer one of said conductors constitutes one winding of the transformer and the inner one of said conductors constitutes a second winding of the transformer, said outer winding comprising a plurality of adjacent, incomplete, outer turns each having an entire cross-sectional portion thereof removed, said outer turns being connected together electrically in parallel relation to constitute a single-turn winding, and said inner conductor being continuous and constituting a plurality of series connected turns inductively associated with said single turn winding.

3. An electrical coupling element including an inner conductor wound helically to provide a multi-turn primary circuit and an outer conductor helically wound concentric with said inner conductor and constituting a secondary circuit, said outer conductor being composed of a plurality of adjacent, incomplete turns of hollow conductive material, said inner conductor being composed of the same number of turns as said outer conductor and each inner turn being surrounded by a separate outer turn, said hollow turns being connected together in parallel relation electrically and the ends of said hollow turns providing opposed secondary terminal groups.

4. An electrical coupling element including an inner conductor wound helically to provide a multi-turn primary circuit, an outer conductor helically wound concentric with said inner conductor and constituting a secondary circuit, said outer conductor being composed of a plurality of adjacent, incomplete turns of hollow conductive material, said inner conductor being composed of the same number of turns as said outer conductor and each inner turn being surrounded by a separate outer turn, said hollow turns being connected together in parallel relation electrically and the ends of said hollow turns providing opposed secondary terminal groups, and means electrically interconnecting the terminals of at least certain ones of each of said groups to provide a pair of secondary output terminals.

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