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ELECTRICAL HEATING APPARATUS

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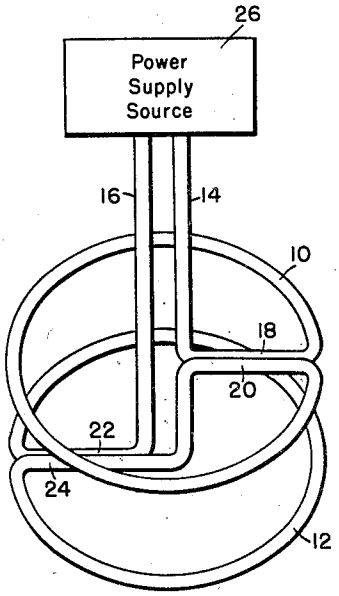


Fig. 1.

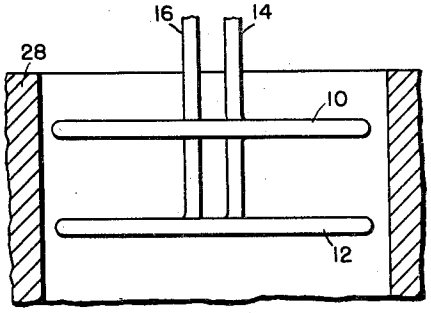


Fig. 2.

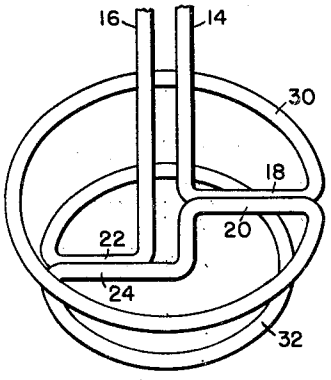


Fig. 3.

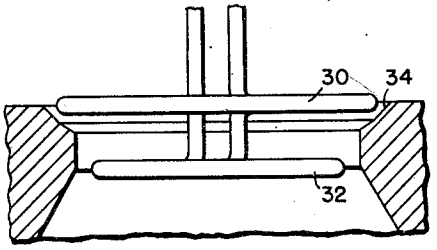


Fig. 4.

WITNESSES

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ELECTRICAL HEATING APPARATUS

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7 Claims. (Cl. 219—10.79)

The present invention relates to electrical heat treating apparatus and, in particular, to an inductor member for use in the heat treatment of metallic work-pieces.

There is a serious problem in the use of conventional prior art inductor coil members, such as coils, in that at a position corresponding to the gap or space between the ends of each turn of the coil there is an uneven heating effect in the workpiece such that it is difficult to obtain uniform heat treatment throughout the full 360° area of revolution of the workpiece. Practical experience shows that this uneven heating effect is due to an uneven flux distribution at the coil transition point corresponding to the gap or spacing where the energy supply leads are connected to the coil turn or turns. Further, the energy supply leads themselves may have undesirable non-uniform heating effects. One known way to overcome this non-uniform heat distribution pattern of the prior art inductor members is to rotate the workpiece relative to a stationary coil, or rotate the coil relative to a stationary workpiece, or some relative motion combination of both of these.

It is one object of the present invention to provide an inductor member which gives a more uniform heat distribution pattern throughout the surface of the workpiece to be heat treated.

It is another object to provide a more uniform heating pattern in the surface of the workpiece to be heat treated without requiring rotation of the workpiece or rotation of the coil.

It is a different object to provide an inductor coil having a plurality of turns, which coil is operative to provide a more uniform heat treatment of the surface of a workpiece.

It is an additional object to provide an inductor coil for the heat treatment of particularly internal surfaces of a workpiece, which inductor coil minimizes non-uniform heat treatment resulting from the energy supply leads or from the inductor coil turn transition point at which the energy supply leads are connected to the ends of each individual turn of the inductor coil.

It is a further object of the present invention to provide an inductor member particularly adapted for the heat treatment of the internal tubular work surface of cylinder bores in automotive engine blocks.

Other objects of this invention will become apparent upon reading the following description taken in connection with the drawings, in which:

Figure 1 is a perspective view of an inductor coil in accordance with the present invention;

Fig. 2 is a side view of the inductor coil shown in Fig. 1;

Fig. 3 is a perspective view of a modified coil; and

Fig. 4 is a side view of the inductor coil shown in Fig. 3.

In general, the inductor coil in accordance with the present invention is a multi-turn coil having at least two turns, with the turn transition point for the first turn corresponding to the junction between the energy supply leads for that first turn and the ends of the first turn being remotely positioned relative to the turn transition point for a different turn. In this way, the non-uniform heating flux pattern caused by the turn transition point of the first turn is made more uniform by means of the second turn which is continuous in the region of the turn transition point of the first turn. Similarly, the same holds for the turn transition point of the second turn, since the first turn is continuous in its region. Further, the energy supply leads are closely spaced and paralleled such that the magnetic field of each energy supply lead is balanced or substantially cancelled out by the magnetic field of the parallel and adjacent energy supply lead.

Referring to the drawings in detail, in Fig. 1 there is shown a perspective view of a two-turn inductor coil in accordance with the present invention, including a first turn **10** and a second turn **12**. A pair of energy supply leads **14** and **16** are provided for supplying suitable frequency energy to the first turn **10** and the second turn **12**, from a suitable power supply source **26**. The energy supply leads **14** and **16** are preferably located substantially along the coincident axes of the turns **10** and **12**, to minimize any undesired heating effect by them. The turns **10** and **12** are preferably located respectively in planes which are perpendicular to the energy supply leads **14** and **16**. Second and third energy supply leads **18** and **20** are positioned substantially parallel relative to each other and are provided in the plane of the turn **10** and are connected to the ends of the turn **10** to supply energy to that turn. Fifth and sixth energy supply leads **22** and **24** are similarly provided in the plane of the turn **12** and are connected to the respective ends of the turn **12** to supply heating energy to that turn. As shown in Fig. 1, the first energy supply lead **14** is connected to the third energy supply lead **18**, and the second energy supply lead **16** is connected to the fifth energy supply lead **22**, with the fourth energy supply lead **20** being connected to the sixth energy supply lead **24**, such that the turns **10** and **12** are effectively connected thereby in series and are adapted for connection to a suitable source of energy **26** through the first and second energy supply leads **14** and **16**.

In Fig. 2, the first energy supply lead **14** and the second energy supply lead **16** are shown positioned substantially along the axis of the first turn **10** and the axis of the second turn **12**. The inductor coil assembly is shown positioned within a cylinder bore or similar tubular recess in an engine block **28** or like member. In accordance with the present invention, the inductor assembly is suitable for scansion or progressive heat treatment of a work surface or for stationary positioning relative to the work surface. In this respect, the power supply source **26** can be moved in conjunction with the inductor coil assembly to scan a work surface, or the energy supply leads **14** and **16** can be made sufficiently flexible to allow the inductor assembly alone to be moved relative to the work surface.

In Fig. 3, there is shown a perspective view of a modified inductor coil assembly including a first turn **30** and a second turn **32**, with the first turn having a radius larger than the radius of the second turn. The energy supply leads for the inductor coil assembly shown in Fig. 3 substantially correspond to the energy supply leads for the inductor coil assembly shown in Fig. 1.

In Fig. 4, there is shown the inductor coil assembly of Fig. 3 with the first turn **30** having a larger radius than the second turn **32**, such that a tapered or similar work surface **34** can be heat treated. In Fig. 4, the work surface may be a valve seat or the like in an automotive engine block.

The inductor coil assembly in accordance with the teachings of the present invention is related to the teachings in copending application of J. M. Edwards, Serial No. 350,131, filed April 21, 1953.

Although specific embodiments of the present invention are shown and described, it is to be understood that still further modifications thereof may be made without departing from the spirit and scope of the invention. For example, the inductor member could be readily modified for the heat treatment of external surfaces of a workpiece as well as for the heat treatment of internal work surfaces.

I claim as my invention:

1. In heat treating apparatus operable with a suitable source of energy, the combination of an inductor member having an axis and having at least first and second turns, said first turn lying in a first plane and said second turn lying in a second plane, with the first plane and the second plane being substantially perpendicular to said axis, first and second spaced energy supply leads lying substantially in said first plane and being connected to said source of energy and to said first turn, third and fourth energy supply leads lying substantially in the second plane and being connected to said source of energy and to said second turn.

2. In induction heating apparatus operable from a suitable source of energy, the combination of an inductor member having an axis and having a plurality of turns, with a first of said turns lying in a first plane and a second of said turns lying in a second plane, said planes being parallel and substantially perpendicular to said axis, first and second spaced energy supply leads lying substantially in said first plane and being connected to said first turn, third and fourth spaced energy supply leads lying substantially in the second plane and being connected to said second turn, with said energy supply leads being connected to said source of energy such that the first turn is connected in series with the second turn.

3. The appartus of claim 1 with the first and second energy supply leads being substantially parallel relative to each other and with the third and fourth energy supply leads being substantially parallel relative to each other.

4. The apparatus of claim 1, each of said turns having end portions and with the end portions of said first turn being positioned substantially radially opposite said axis relative to the end portions of the second turn.

5. The apparatus of claim 1, including fifth and sixth

energy supply leads which are substantially parallel to said axis and are adapted for connection between said source of energy and the other energy supply leads.

6. The apparatus of claim 5, with the fifth energy supply lead being connected to the first energy supply lead, the second energy supply lead being connected to the third energy supply lead, and with the fourth energy supply lead being connected to the sixth energy supply lead.

7. Induction heating apparatus for heat treating a circular valve seat surface, said apparatus including an induction heating member having an axis and having a first turn and a second turn, with each of said turns having a pair of ends, said turns being respectively positioned in parallel first and second planes, said heating member having a plurality of leads extending along said axis, with a first of said leads extending along said axis in a first direction until it reaches said first plane where it turns radially and extends along said first plane in a second direction and is connected to one end of the first turn, with a second of said leads extending along said first plane from the other end of the first turn in a third direction substantially parallel and opposite to said second direction until it reaches said axis where it turns to extend substantially along said axis and in said first direction until it reaches said second plane where it turns radially and extends along said second plane in said third direction and is connected to one end of the second turn, and with a third of said leads extending along said second plane from the other end of the second turn and in said second direction until it reaches said axis where it turns to extend along said axis in a fourth direction substantially parallel and opposite relative to said first direction.

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