Dec. 21, 1948. R. LEE 2,456,962

INDUCTION HEATING APPARATUS WITH WORK CONVEYER

Filed April 19, 1947

Fig. 1.

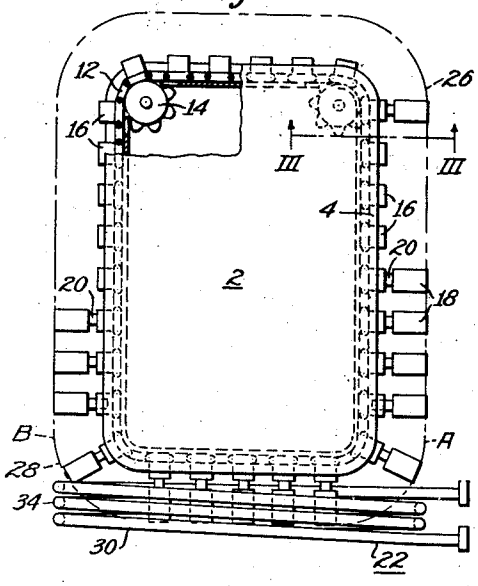


Fig. 3.

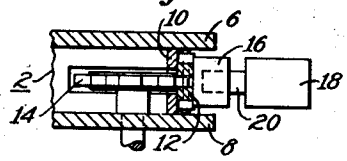


Fig. 4.

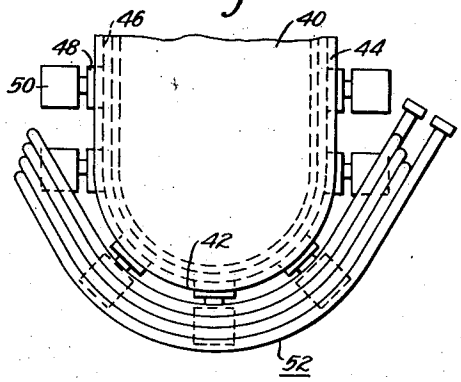


Fig. 2.

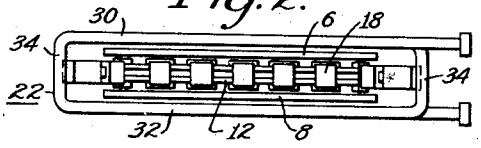
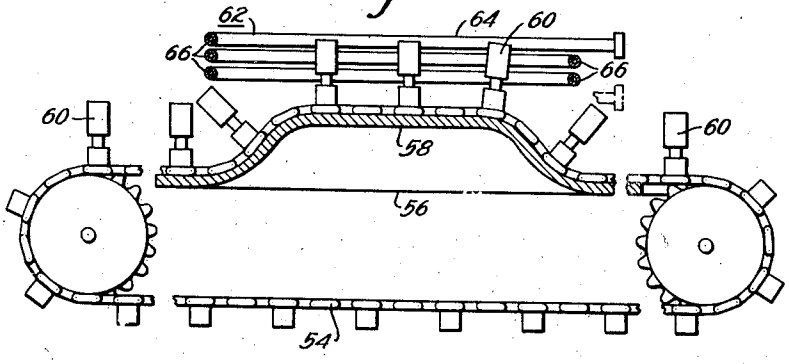


Fig. 5.



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INDUCTION HEATING APPARATUS WITH WORK CONVEYER

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1 Claim. (Cl. 219—47)

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This invention relates to induction heating equipment of a type in which material or work to be inductively heated is carried, by a conveyor, into and out of an induction heating inductor coil.

An object of the invention is to provide an induction heating system of a type described in which a conventional inductor coil, of simple form and construction, can be used to heat an article on a moving conveyor, the coil occupying but a small fraction of the length of the work-carrying portion of the conveyor.

A particular feature of my invention is to provide an induction heating system of a type described in which work carried on a conveyor can be passed into and out of an inductor coil without requiring specially bent or turned ends.

Objects, features and innovations of my invention, in addition to the foregoing, will be discernible from the following description of several embodiments thereof, now preferred. The description is to be taken in conjunction with the accompanying schematic drawing, in which:

Figure 1 is a plan view of an embodiment of my invention;

Fig. 2 is an end view thereof;

Fig. 3 is an enlarged sectional view on the line III—III of Fig. 1;

Fig. 4 is a partial plan view of a modified form of my invention; and

Fig. 5 is an elevational view of still another embodiment of the invention.

Referring to Figs. 1–3, a rectangular support or table 2 is provided, having rounded corners and an edge in the form of a channel 4. The channel comprises spaced legs 6 and 8 joined by a base portion 10. The leg 6 is above the lower leg 8, and both extend outwardly with respect to the center of the table. The channel 4 carries an endless conveyor 12 which slides along the lower leg 8 and the base portion 10, and is driven by any suitable motor-driven gearing 14. The conveyor is provided with a plurality of spaced work-receiving fixtures 16, each of which is designed to carry a piece of work 18 which is to be inductively heated. The preferred embodiment is shown in connection with work-pieces which are to be heated substantially throughout, although our invention is equally as well applicable to the heating of work-pieces which are to be heated in some other manner. The mounting of the pieces on the conveyor determines the character of the heating. Each work-piece is provided with a stem 20 adapted

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to be secured to the associated fixture 16 in a manner permitting the work-piece to extend outwardly beyond the legs of the channel 4.

For inductively heating each work-piece, a simple multiturn rectangular induction heating inductor coil 22 is provided. The inductor coil 22 is of such size and shape, and is so mounted with respect to the conveyor, that a part of the path through which the work is carried by the conveyor is encompassed by the inductor coil. This is indicated in Fig. 1 where the outer broken line represents the outer limit of a path 26 in which the work-pieces 18 are moved by the conveyor 4. It will be observed that this path 26 includes a curved portion 28, between points A and B, a part of which is within the inductor coil 22. If the direction of movement of the conveyor is assumed to be clockwise with reference to Fig. 1, then the work enters the coil at the right-hand side near the point A, and leaves at the left-hand side near the point B.

The inductor coil 22 can be said to constitute a rectangular loop having elongated straight side-conductors 30 on one side of the loop and elongated straight side-conductors 32 on the other side, the opposite side-conductors being connected by substantially straight end-turn conductors 34 which have a length substantially equal to the spacing between the side-conductors on laterally opposite sides of the path in which the work moves. Hence, a hairpin-like arrangement is provided by the side-conductors and each end of the inductor coil. In the embodiment of Fig. 1, a single turn of the inductor coil 22 can be considered, for lack of better nomenclature, to lie substantially in a plane.

The coil-loop can be said to have an open face, toward the conveyor, which is bounded by the outermost conductors at the open side of the inductor coil, which is closest to the table 2. The conveyor 12 and inductor coil 22 are so arranged that the work-pieces move in a line midway between the side-conductors 30 and 32 of the inductor coil. At spaced points, the work-pieces 18 enter and leave the inside of the coil through this open face. These points, at which the work-pieces successively pass into and leave the inductor coil, lie in the open face of the inductor coil, and are closer together than the opposite end-turns of the inductor coil.

By spacing the inductor coil radially or outwardly from the legs 6 and 8 of the table 2, only the portions of the work-pieces 18 that are to be heated pass inside of the coil-loop. However, the inductor coil can be made somewhat wider and

placed closer to the table 2, thereby directly overlying the legs 6 and 8 of the channel 4. In such case, it may be desirable to make the legs 6 and 8 of the table of some non-metallic material. An inductor coil of such width is shown in Fig. 2, but a narrower coil can be used.

When the inductor coil is energized by high-frequency current, in any suitable manner, it will produce magnetic flux lines that extend axially, or centrally, inside the coil, in a direction generally corresponding to a perpendicular to the face of the loop and to the conductors of the inductor coil. The curved portion 28 of the work-path 26, which lies inside the inductor coil 32, has radii of curvature which can be said to lie in a plane or planes substantially parallel to such magnetic flux lines.

A further embodiment of my invention is shown schematically in Fig. 4. A table 40 is provided with a rounded outer side 42 provided with an outer channel 44. A chain conveyor 46 moves inside the channel 44, and is provided with a plurality of work-receiving stations 48 which receive work-pieces 50. As the work-pieces move along the curved portion of their path of movement at the table-side 42, they pass into and out of an inductor coil 52 which is shaped to conform generally to the curvature of the table-side 42. However, the curvature of the inductor coil is less than that of the portion of the path in which the work-pieces move through the inductor coil. Such construction permits the work-pieces to enter and leave the open coil-face at the side of the coil facing the conveyor. Curving the inductor coil increases the portion of the path of travel of the work-pieces in which they are subjected to induction heating.

In the embodiment shown in Fig. 5, a part of an endless conveyor 54 rides on the top of a stationary table 56 having a curved arcuate raised table-portion 58. As shown in the drawing, the table portion 58 has a substantially straight top and curved sloping portions at each end thereof on which the conveyor rides. The curved end-portions give the raised table-section 58 an arcuate shape. As each work-piece 60, on the flexible conveyor, approaches the curved raised table-portion 58, it rides upwardly with the conveyor and passes into a rectangular inductor coil 62. It leaves the inductor coil at the other end of the raised table-portion 58. The inductor coil 62 being rectangular, each of its turns lies substantially in a plane and has elongated substantially straight side-conductors 64 which are joined by end-turn conductors 66. The side-conductors extend beyond both ends of the top of the raised section 58 of the table. The work-pieces move along and between the side-conductors 64 for heat-treatment, entering the inductor coil as they rise on a sloped end-portion of the raised section 58, and leaving the coil as they go down the other end-portion.

In each embodiment, the work-pieces obviously can be applied to the conveyor at a point before they enter the inductor coil and removed at a point after they leave it.

In general, a pair of side-conductors and the connecting end-turn conductors lie substantially at a plane or in a surface having a shape corresponding to a surface which was originally flat, but had been curved continuously, that is, without introducing angular bends at or near the end-turns of the inductor coil, or in the portions of the side-conductors adjacent to the end-turns.

While I have described my invention in a manner which is believed will make its teachings clear to those skilled in the art, it is evident that the description of the association of the parts is attended with some difficulty. Hence, it is to be understood that the claim is to be interpreted in the light of the drawing and the disclosure and is intended to particularly point out the invention in the manner which is thought to be clear, distinct, and definite.

I claim as my invention:

An induction heating system of a type described comprising, in combination, a table having a raised section with a substantially straight top and sloping portions at each end thereof, a flexible conveyor movable along said table and arranged to ride up a first of said sloped end-portions, along said substantially straight top, and then down the other of said sloped end-portions, and a multi-turn inductor coil arranged near said raised section, each turn of said inductor coil having spaced elongated substantially straight side-conductors, each side-conductor being longer than said substantially straight top-portion and extending beyond said top-portion at both ends thereof, said conveyor having means for receiving material to be inductively heat-treated, and carrying such material along therewith as it rides on said raised section of said table, with the material moving lengthwise of and between said side-conductors for inductive heat treatment, the material entering said inductor coil as it rides up a first of said sloped end-portions and leaving said inductor coil as it rides down the other of said sloped end-portions.

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