June 7, 1932. T. H. LONG 1,861,869

ADJUSTABLE INDUCTION HEATING DEVICE

Filed Sept. 20, 1930

Fig. 1.

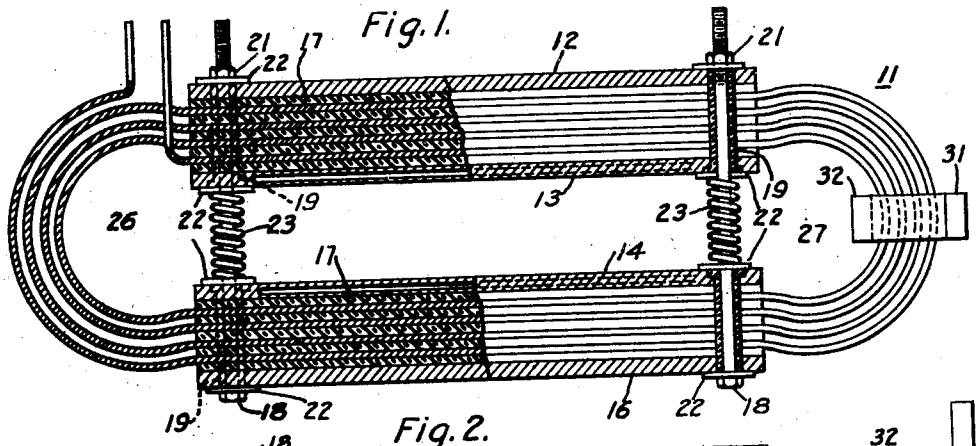


Fig. 2.

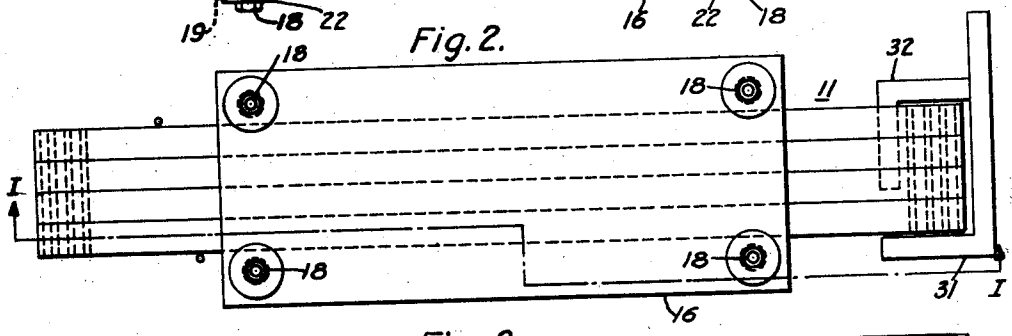


Fig. 3

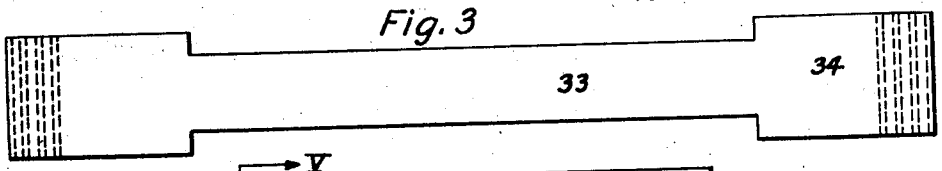


Fig. 4.

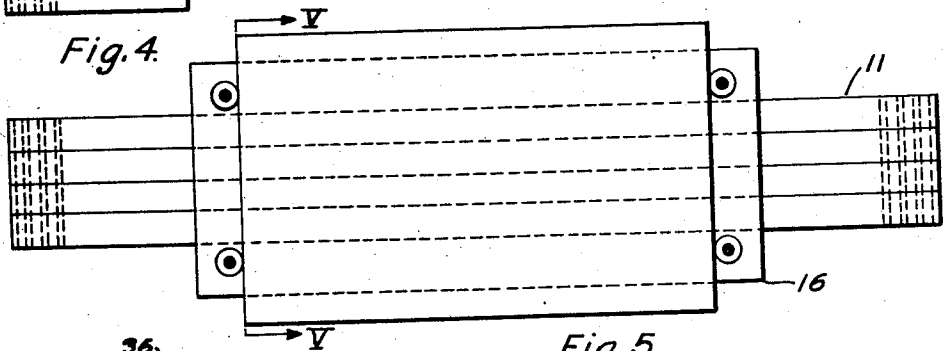
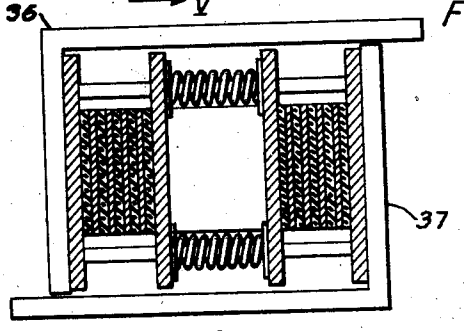


Fig. 5.



INVENTOR

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Patented June 7, 1932 1,861,869

UNITED STATES PATENT OFFICE

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ADJUSTABLE INDUCTION HEATING DEVICE

Application filed September 20, 1930. Serial No. 483,243.

My invention relates to electric heating devices and particularly to electric inductive heating devices.

An object of my invention is to provide an adjustable energizing coil for an inductive heating device.

In practicing my invention, I provide an adjustable coil structure including a plurality of turns of a current-traversed conductor embodying alternate yielding and stiffened portions, together with means for varying the area included within the energizing coil. Means may also be provided for decreasing the electric resistance of the conductors and the stray leakage flux, as well as means for reducing the magnetic reluctance of the coil structure.

In the single sheet of drawing,

Figure 1 is a horizontal sectional view through an inductive heating device embodying my invention;

Fig. 2 is a side elevational view thereof;

Fig. 3 is a similar view of a modified form of the coil only;

Fig. 4 is a view, in side elevation, of a still further modification of the device of my invention, and

Fig. 5 is a view, in lateral section therethrough taken on the line V—V of Fig. 4.

In the inductive heating of metal objects, it has been found desirable to be able to vary the area included within an inductive energizing coil, in order that material of different dimensions may be heat treated in the same energizing coil without the necessity of providing an entire different furnace and coil structure therefor.

Referring more particularly to Figs. 1 and 2 of the drawing, I have there shown an energizing coil 11 as including four turns, the material of which the conductor is made being a flexible metal strip of any suitable or desired width and thickness, as may be required by the work to be heat treated and the current traversing the same. Two spaced portions of the coil, which is in the form of a spiral winding, are clamped between metal plates 12 and 13 and 14 and 16, respectively, strips 17 of electric-insulating material being located at each side of the conductors and between the conductors and the clamping plates. This provides two substantially rigid portions out of the peripheral length of each layer, separated or spaced apart by intermediate yielding portions which are here shown as substantially of arcuate shape. The metal members 12, 13, 14 and 16 are made somewhat wider than the width of the conductor or conductors constituting the coil 11, in order that clamping and adjusting means, such as a plurality of bolts 18, may be located outside the coil structure proper. The metal of which these plates are made is preferably a non-magnetic steel having a high ohmic resistance, in order that the heating and the eddy current losses, may be reduced as much as is practicable. The plates 13 and 14 may be made hollow, as shown in Fig. 1 of the drawing, to receive cooling fluid.

The relatively long bolts 18 extend through insulating bushings 19, which serve to electrically insulate the metal bolts from the conductors constituting the coil 11, as well as from the stiffening and clamping plates. Nuts 21 may be located on that end of each bolt opposite to the head thereof, and washers 22 of electric-insulating material may be provided under the head and the nut on each bolt. Springs 23 are located between the washers 22 to operatively engage the plates 13 and 14 and serve to yieldingly space the two stiffened portions of the coil structure away from each other. It is, therefore, only necessary to effect a turning movement of the nuts 21, on the respective bolts 18, in order to vary the area included within the coil structure or the distance between the plates 13 and 14.

I have elected not to show any specific supporting structure of the energizing coil, as

this constitutes no part of my present invention.

If it be assumed that the axis of the coil extends in a vertical direction, it is obvious that small metal objects may be introduced into the area within the coil at the left-hand end thereof at the point designated by numeral 26, after which they may be moved toward the right to rest upon suitable supports (not shown in the drawing) and dropped downwardly out of the coil structure at the point indicated by the numeral 27. It is obvious, of course, also that, if it is desired to move relatively long metal objects through the coil, this may also be done, the entire movement of these objects or articles being in a substantial axial direction.

If it should be found that the axial width of a single conductor is too great, a plurality of relatively narrow strips could be employed, and such construction is shown in the side view of Fig. 2 of the drawing, in which four narrow strips are employed and are suitably connected in parallel-circuit relation to each other to carry the current traversing the coil structure 11.

If it is desired to vary the reluctance of the electro-magnetic circuit so as to vary the power input into the material being heat treated, independently of the applied voltage, a laminated magnetic structure may be employed at the arcuate portion of the coil and this is shown in the right-hand ends of Figs. 1 and 2. I have there illustrated a set of iron or steel laminations, including one set having predetermined dimensions and of L-shape designated by the numeral 31, and a second cooperating set of laminations also of L-shape designated by numeral 32. No supporting or clamping structure is shown, as any such structure may be used in cooperation with these laminations. The set 32 may be moved relatively to set 31, to vary the portion of one leg located within the coil and any suitable moving means may be utilized.

If it is desired to reduce the electrical resistance of the conductor of the energizing coil, this may be done in the manner illustrated in Fig. 3 of the drawings, in which the stiffened or straight portions of the coil have a conductor portion 33 which is of somewhat less width than the end portions 34 thereof. This will have the effect of reducing the end losses and the end leakage fluxes.

Referring to Figs. 4 and 5, I have there illustrated another modification including, more particularly, the location of the adjustable laminations to improve the power factor. The laminations in this case, do not cover the end portions of the conductor but cover the stiffened straight portions thereof. Sets of laminations, each of L-shape and designated by the numerals 36 and 37, are located in operative relation to the coil at the straight stiffened portions thereof, the laminations being, therefore, of greater dimensions than the laminations in the sets 31 and 32 of Figs. 1 and 2.

The device embodying my invention thus provides a relatively simple inductive heater having a plurality of turns, each turn including a plurality of substantially straight portions and a plurality of intermediate arcuate portions, together with means for varying the separation between the straight portions.

Since various modifications may be made in the device embodying my invention without departing from the spirit and scope thereof, I desire, that only such limitations shall be placed thereon as are imposed by the prior art or are set forth in the appended claims.

I claim as my invention:

1. In an electric induction heater, a coil having a plurality of turns, each of said turns including two substantially straight portions and two arcuate portions, and means operatively associated with said straight portions to vary the separation thereof.

2. In an electric induction heater, a coil having a plurality of turns, each of said turns including a substantially fixed portion and another portion movable relatively to the fixed portion, and means operatively associated with the movable portion to adjust its position relatively to the fixed portion.

3. In an electric induction heater, a coil having a flexible portion in each of its turns, and means operatively associated with the flexible portions for varying the area included within said coil.

4. In an electric induction heater, a coil having a plurality of turns of a flexible electric-conducting member, a stiffening member closely operatively associated with a portion of a periphery of said turns and means operatively associated with said stiffening member for varying its position and that of a portion of the periphery of the turns of the coil relatively to the rest of the periphery of the turns.

5. In an electric induction heater, a coil having a flexible portion in each of its turns, means operatively associated with the flexible portions to vary the area included within the coil and ferro-magnetic means adjustably associated with the coil to vary the flux density within the coil independently of the area therewithin.

6. In an electric induction heater, a coil having a normally flexible conductor and means directly associated with a portion of said coil to maintain said portion in a substantially unyielding condition to provide an enclosed area within the coil of predetermined size and shape.

7. In an electric induction heater, a coil having a pair of flexible portions in each of its turns, and adjustable means operatively associated with the intervening portions of

the turns for varying the area included within said coil.

8. In an electric induction heater, a coil having a pair of flexible portions in each of its turns, and adjustable means operatively associated with the intervening portions of the turns for simultaneously moving said intervening portions toward and away from each other.

In testimony whereof, I have hereunto subscribed my name this 12th day of September, 1930.

THOMAS H. LONG.