May 30, 1933. E. F. NORTHRUP 1,912,214

INDUCTION ELECTRIC FURNACE

Filed Sept. 3, 1929

Fig. 1.

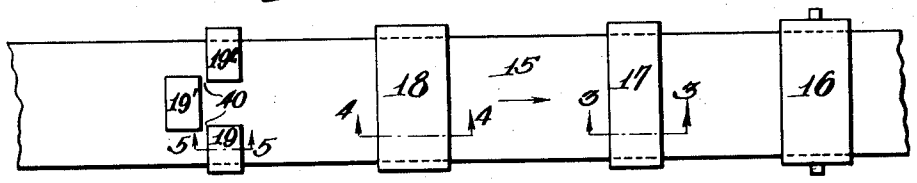


Fig. 2.

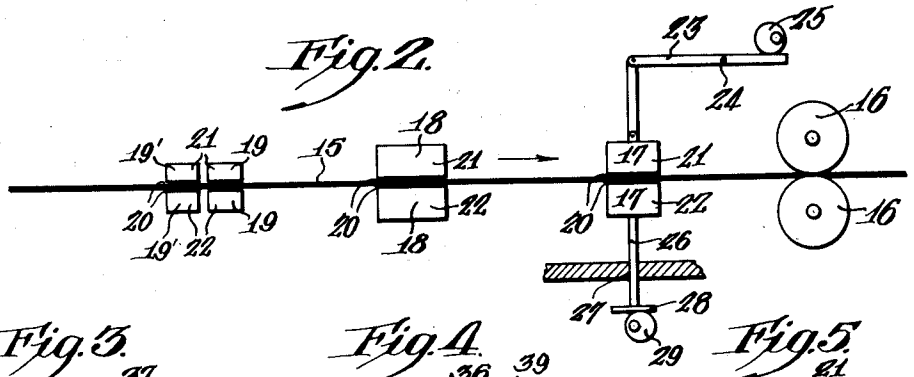


Fig. 3.

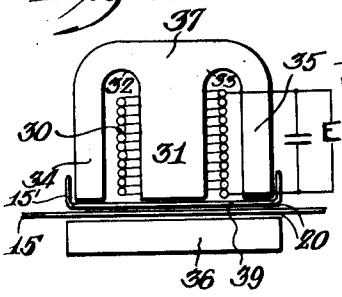


Fig. 4.

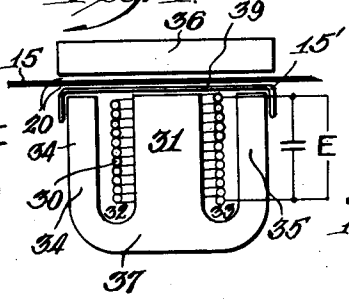


Fig. 5.

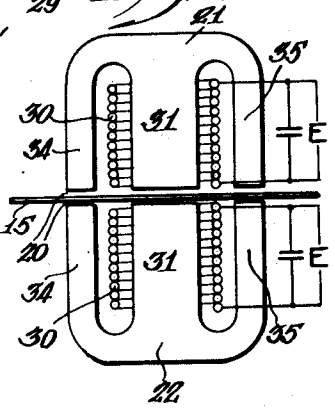


Fig. 7.

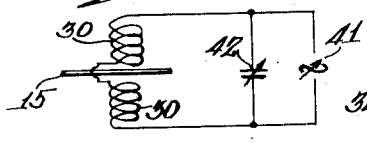
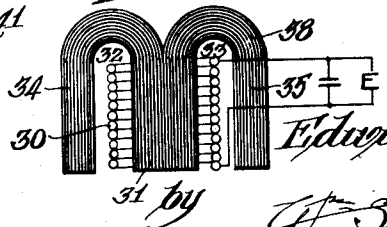


Fig. 6.



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Patented May 30, 1933 1,912,214

UNITED STATES PATENT OFFICE

EDWIN FITCH NORTHRUP, OF PRINCETON, NEW JERSEY, ASSIGNOR TO AJAX ELECTRO-THERMIC CORPORATION, OF AJAX PARK, NEW JERSEY, A CORPORATION OF NEW JERSEY

INDUCTION ELECTRIC FURNACE

Application filed September 3, 1929. Serial No. 389,888.

My invention relates to a device for electro-magnetically heating a moving sheet of conducting material, for example a plate which is to be heated between successive passes of a plate mill.

A purpose of my invention is to electro-magnetically heat a wide travelling plate of conducting material at a rate that is substantially uniform across the width of the plate.

A further purpose is to electro-magnetically heat a travelling plate with a minimum expenditure of electrical energy.

A further purpose is to provide a high frequency electro-magnetic mechanism for heating a moving plate in which the stray magnetic fields around the mechanism shall be extremely low.

A further purpose is to place laminated transformer iron inside and outside of inductor windings upon opposite sides of a travelling plate in order to eliminate stray fields around the inductors.

Further purposes will appear in the specification and in the claims.

I have preferred to illustrate my invention in one main form only showing however, detail modifications and selecting a main form and modifications that are efficient and reliable in operation and which well illustrate the principles involved.

Figures 1 and 2 are diagrammatic views respectively in plan and side elevation illustrating the application of my invention for obtaining uniformity in the distribution of heating across a wide travelling plate.

Figures 3, 4 and 5 are vertical sections of slightly different forms of my heating device, any one of which may be considered as being a section taken upon the line 3—3, 4—4 or 5—5 of Figure 1.

Figure 6 is a modification of detail structure shown in Figures 3, 4 and 5.

Figure 7 is a diagrammatic view illustrating electrical connections.

Like numerals refer to like parts in all figures.

Describing in illustration and not in limitation and referring to the drawing:—

In rolling mill practice in rolling plates the plate must ordinarily be reheated before the rolling operation has been completed. Electromagnetic heating has been proposed for this purpose and my invention is intended to apply this.

My invention provides a correction for this undesirable condition by electromagnetically heating the plate while it is travelling intermediate successive passes to one of the rolls and among its other features secures a more even distribution of heat generation across the travelling plate and provides a desirable form of magnetic circuit and means for readily adjusting the intensity of heating.

In Figures 1 and 2 a plate 15 travelling in the direction of the arrow to a roll 16 is heated by one or more electro-magnetic heating devices 17, 18, 19, 19^1, and 19^2.

It will be understood that the rolling plates are of somewhat indefinite width and of progressively greater width after they pass through the successive passes. At each device the plate moves across an air gap portion 20 of a rapidly alternating magnetic field, between and in soft iron pole members 21 and 22 respectively above and below the travelling plate.

Heating is effected by eddy currents induced in the travelling plate 15 by the rapidly alternating field. The plate 15 is conducting but usually non-magnetic as its temperature is usually above that at which, if iron or steel, it will be magnetic.

I extend the heating devices across the full width of the plate so as to effect uniformity of heating across the plate. Thus the heating devices 17 and 18 are desirably extended somewhat more than all the way across the plate while the devices 19, 19^1 and 19^2 comprise smaller units staggered so as together to reach across the whole width of the plate.

I may vary the intensity of heating by adjusting the reluctance of the magnetic circuit, as by vertically adjusting one or both of the pole members.

This is indicated diagrammatically in Figure 2 where the upper member 21 is suspended upon a rocker member 23 which is

pivoted at 24 and vertically positioned by a cam 25, the angular position of the cam being subject to setting by the operator in any suitable way not shown.

In the same figure the lower core member 22 is vertically adjustable, being supported upon a stem member 26, guided at 27 and presenting a plate 28 against an adjustment cam 29, the cam being adapted to be set by the operator in any suitable way not shown, to determine the height of the core member with respect to the plate.

It will be understood that the intensity of heating will be greater the more closely the magnetic members upon the opposite sides of the plate are brought to the plate, the magnetic reluctance of the circuit being dependent upon the extent of the non-magnetic gap between the two core members.

The structure shown in Figures 3, 4 and 5 may each be considered as a vertical section to any one of the devices 17 to 19 inclusive. In Figure 3 the inductor coil 30 surrounds the middle leg 31 of a laminated core which has the general contour of a capital E, extending laterally from the middle leg 31 at 32 and 33 to outer legs 34 and 35 which extend down toward the travelling plate 15.

My heating device includes means for passing the plate 15 through a rapidly alternating magnetic field in the non-magnetic portion 20 between the core members spaced upon opposite sides of the plate, normally above and below the plate and extending all the way across the plate. The magnetic field is generated by the inductor coil or coils 30, mounted upon the middle leg or legs of one or both of the core members.

If one only of the core members carry an inductor coil the other member is an armature functioning to complete a magnetic circuit that includes the soft iron core members, the intermediate non-magnetic space 20 between the core members and the plate 15 as it moves through this space.

The armature member 36 may be below the plate as best seen in Figure 3 or above the plate as shown in Figure 4, the core member 37 carrying the inductor 30 being then respectively above as in Figure 3 or below as in Figure 4.

In Figure 5 the middle legs of both core members carry inductor coils, the inductor coils being connected in series or not, according to circumstance.

The core members should be formed to give an easy path to the magnetic field and to avoid eddy currents in the core, and may desirably comprise a succession of thin soft iron sheets as indicated in Figures 3 to 5, the sheets being relatively electrically insulated in any suitable way as by intermediate layers of mica or coats of insulating paint. Optionally the magnetic core may comprise wire 38 as indicated in Figure 6.

The inductors 30 are suitably insulated electrically at 38 from the core.

Since the cores and inductors both develop considerable internal heat and also receive heat by radiation from the travelling plate 15, some provision is desirable for shielding both the cores and the inductor members from direct radiation from the plate 15′ and for cooling the combination.

The shielding may be effected by asbestos sheets 39.

Cooling may be effected by spacing the laminated core plates slightly at intervals and forcing air through the spaces, such as 40 in Figure 1.

The inductor coils 30 may be connected in series or not, according to circumstance, being shown connected in series in Figure 7.

Desirably the applied alternating voltage should be adjustable and at 41 I indicate the voltage as being supplied by a variable speed alternator, the frequency and voltage therefore varying according to the adjustment of the speed of the alternator.

I also preferably provide an adjustable capacity 42 across the coil in order to correct the power factor. It will be understood that the proper capacity for this purpose will depend among other factors upon the speed of the alternator and also upon the characteristics within the magnetic circuit.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art to obtain all or part of the benefits of my invention without copying the structure shown, and I, therefore, claim all such in so far as they fall within the reasonable spirit and scope of my invention.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a heater for travelling sheets of metal, an inductor coil close to the plane of travel of a sheet and having its axis perpendicular to the plane of the sheet and a surrounding return magnetic circuit for said coil laminated in planes perpendicular to the sheet, concentrating the magnetic flux at the sheet inside and also at the outside of the coil.

2. In a heater for travelling sheets of metal, an inductor coil close to the plane of travel of a sheet and having its axis perpendicular to the sheet and return magnetic circuits for the coil on both sides of the sheet, laminated in planes perpendicular to the sheet, and on opposite sides of the coil considered in the direction of travel of the sheet.

3. In a heater for travelling sheets of metal, an inductor coil close to the position of

the travelling sheet and having its axis perpendicular to the plane of travel of a sheet, a laminated core for said inductor coil close to the sheet and to the coil both inside and outside of the coil and a laminated armature for the coil forming a return circuit on the opposite side of the sheet, the laminations of the core and armature being in planes perpendicular to the sheet.

4. In a heater for travelling sheets of metal, an inductor coil close to the position of the travelling sheet and having its axis perpendicular to the plane of travel of a sheet, a laminated core for said inductor coil close to the sheet and to the coil both inside and outside of the coil and a second coil and a laminated return magnetic circuit therefor upon the opposite side of the sheet, the core and return magnet circuit both being laminated in planes perpendicular to the sheet.

5. In a heater for travelling sheets of metal, an inductor coil close to the position of the travelling sheet and having its axis perpendicular to the sheet, a laminated return magnetic circuit for the coil inside and outside the coil and approaching the sheet, a return magnetic circuit upon the opposite side of the sheet and an adjustment for the spacing of one of the magnetic return circuits from the sheet while maintaining the position of the other.

6. In a heater for travelling sheets of metal, an inductor coil close to the position of the travelling sheet and having its axis perpendicular to the sheet, a laminated return magnetic circuit for the coil inside and outside the coil and approaching the sheet, an armature upon the opposite side of the sheet and an adjustment for the spacing of the armature from the sheet.

7. In a heater for travelling sheets of metal, a pair of inductor coils on opposite sides of the position of the sheet substantially in line and having their axes perpendicular to the sheet and means for adjusting the spacing of the coils from the sheet to vary their heating effect.

8. In a heater for travelling sheets of metal, a pair of inductor coils on opposite sides of the position of the sheet substantially in line and having their axes perpendicular to the sheet, laminated return magnetic circuits for the coils and means for altering the spacing of the coils and return circuits from the sheet.

9. In a heating mechanism for heating sheets of metal as they are fed lengthwise, an inductor coil close to the position of the sheet and having its axis perpendicular to the sheet and a laminated return magnetic circuit for said coil having spacings for cooling fluid between the laminations.

10. In a heating mechanism for heating sheets of metal as they are fed lengthwise, an inductor coil close to the position of the sheet and having its axis perpendicular to the sheet, a laminated return magnetic circuit for said coil having spacings and means for cooling the laminations.

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