Feb. 16, 1932. H. NEUHAUSS 1,845,322

METHOD OF INDUCTIVE HEATING

Filed Oct. 24, 1928

Fig. 1.

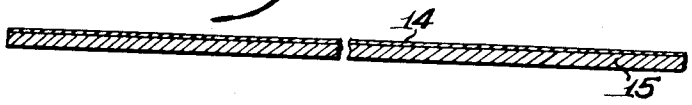


Fig. 1a

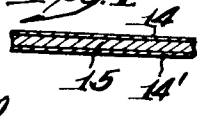


Fig. 2.

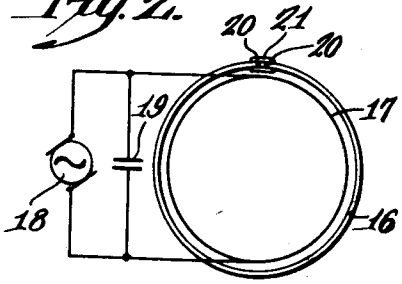


Fig. 3.

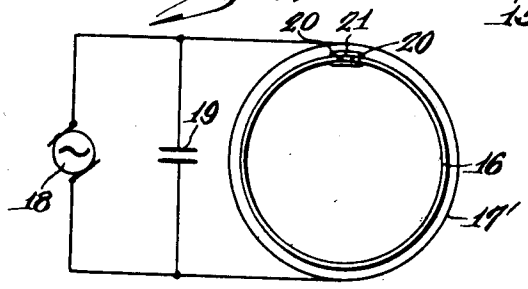


Fig. 4.

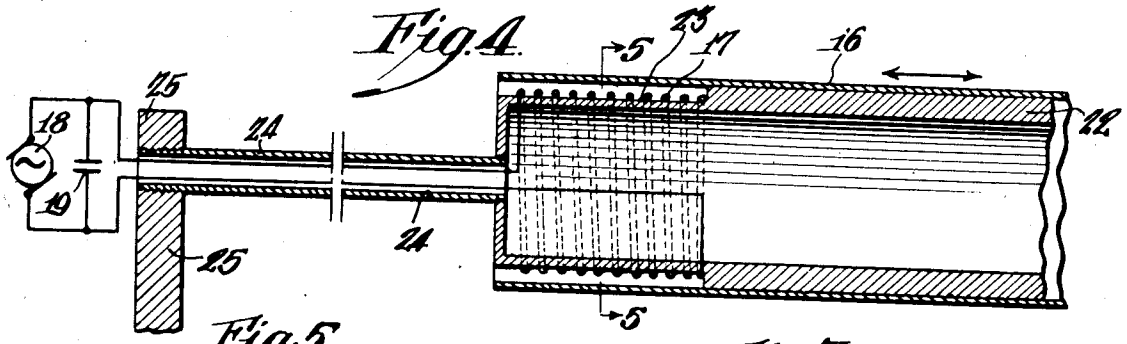


Fig. 5.

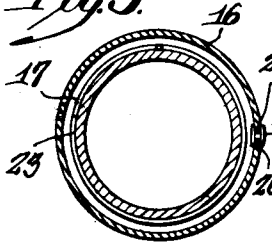


Fig. 6.

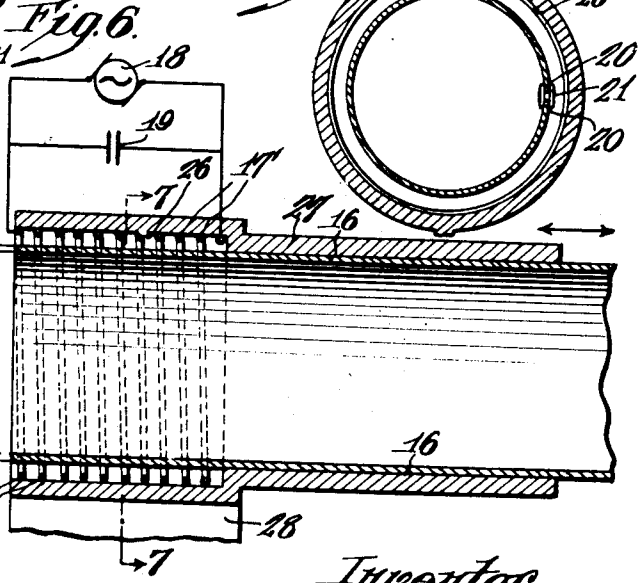


Fig. 7.

Fig. 8.

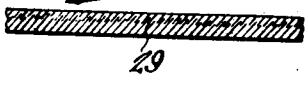
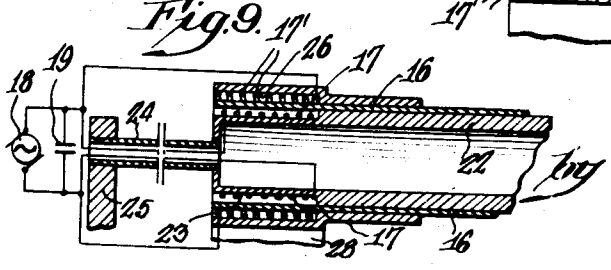


Fig. 9.



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UNITED STATES PATENT OFFICE

HEINRICH NEUHAUSS, OF DUSSELDORF, GERMANY, ASSIGNOR TO THE AJAX METAL COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA

METHOD OF INDUCTIVE HEATING

Application filed October 24, 1928. Serial No. 314,648.

My invention relates to the fusing of adherent coatings upon metal into union with the metal upon which they are coated.

My purpose is to induce alternating current flow through a plate or sheet for the purpose of fusing a coating into union with it.

A further purpose is to provide for greater heating of the metal upon either side of the plate or sheet at will by inducing the current within that side largely or exclusively or apply the induction from both sides of the plate concurrently or from the two sides successively as desired.

A further purpose is to bend a plate or sheet into cylindrical form so that it may be conveniently used as a transformer secondary.

A further purpose is to provide a form or support for a cylinder of bent initially-flat plate whereby the spacing of the metal from an inductor primary may be determined and may be made uniform.

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

My invention relates both to the methods or processes involved and to apparatus by which they may be carried out.

I have preferred to illustrate my invention by views which are largely diagrammatic and which have been selected from the standpoint that they particularly well illustrate the principles involved.

Figures 1 and 1*a* are sections intended to illustrate any sheet of metal carrying an adherent coating, covering or plating of other metal upon one surface or carrying such coatings or coverings upon both sides or faces.

Figures 2 and 3 are diagrammatic views showing the same sheet of metal forming outer and inner secondaries respectively for electric inductor primaries.

Figures 4, 6 and 9 are longitudinal sections showing guides or supports for bent sheets to subject them to the best advantage to the induction from inductor coils.

Figures 5 and 7 are sections of Figures 4 and 6 upon lines 5—5 and 7—7 respectively.

Figure 8 is an enlarged section corresponding generally to Figure 1 taken after fusion has been effected.

In the drawings similar numerals indicate like parts.

My invention is intended to apply to the fusion of an adherent coating 14 or coatings 14, 14′ upon the surface of a sheet or strip of metal 15, here viewed as a base, into union with the sheet. It applies to these coatings however they have been deposited upon or applied to the surface of the base metal. For example, the coatings may have been electroplated or applied by a metal gun, or in any other manner by which adhesion of the coating to the base metal may be secured.

Prior to my invention coatings of this character have been fused into contact with the base metal in the form of hollow inductor secondaries to which they had previously adhered but to the best of my knowledge this invention has never been applied to initially flat sheets. The fusion of these coatings to sheets of initial plate metal, or of metal not in closed cylindrical form I believe to be new to me.

In Figures 2 and 3 I show the composite body 16, initially in sheet form, as bent into form of a cylinder 16′ surrounding a high-frequency inductor primary 17 in Figure 2 and surrounded by such an inductor 17′ in Figure 3. In each case I have shown a conventional source of high-frequency supply 18 and conventional condenser power factor correction 19.

As the sheets may be of considerable size, and it is not desirable to distribute the inductor primary over a very long length of coil, I provide for feeding of the composite sheet or of the coil, one with respect to the other, in order that the inductor coil may progressively heat the sheet and fuse the coating into engagement with the metal base. This operation normally will be carried out in the diagrammatic forms shown in Figures 2 and 3.

The edges 20 of the sheets are electrically connected and are at the same time mechanically joined by any means which I show in its simplest form as a clamp 21 extending lengthwise of the cylinder formed.

These figures do not show any control of

the radial spacing of the secondary with respect to the primary, nor do they indicate whether it be the intention to feed the secondary with respect to the primary. Evidently my invention may be applied with or without making the spacing uniform or with or without feeding in an axial direction, omitting the additional features where their advantages are not sought.

It is quite desirable that the radial spacing be uniform, that positive means be provided for maintaining uniformity of the spacing, as by guides, and that feeding movement between the primary and the secondary be provided and guided.

In Figure 4 I have shown such means in a guide 22 about which the secondary may be fed so as to provide for proper spacing of the secondary from the primary 17. The primary is conveniently mounted upon a reduced portion 23 of the diameter of the guide and support 22. This guide is shown as hollow and is mounted upon any desirable thrust bar 24 from a support 25.

In Figure 6 the primary 17′ is mounted within a recess 26 in an external guide 27 whose support is shown at 28.

Both forms of support and guide are shown in Figure 9, where two primaries are illustrated.

In operation the sheet of composite material is bent into curved shape and is mechanically held in this form at the same time that its side or end edges, as the case may be, are electrically joined so as to permit induction of current circumferentially through it. Where it is coated upon one side only, unless it be extremely thin, it is desirable that this side should be toward the inductor, for example, the inner side if used with the inductor of Figure 2, and the outer side if used with the inductor of Figure 3. This is for the reason that the current is much more intense along a thin layer including that face of a secondary closest to the primary than throughout any other corresponding depth of the body of the secondary, causing higher temperature in the region where the fusion is desired than in the rest of the plate. Where both sides are coated or plated—as would usually be the case—the entire sheet may be heated to the required temperature by either an inside or outside inductor, where the sheet is thin, or the inner face of the sheet may be heated to fusing temperature by the use of an inside inductor and the outside of the sheet may be heated to the same temperature by the use of an outside inductor where the thickness of the sheet makes this desirable.

As shown in Figure 9 inductors may be used both inside and outside the sheet during the same travel.

Where the heating takes place wholly from one side the support or guide can be of metal since the tendency of the current to traverse the "skin" closest to the inductor will insure that the heating effect will be concentrated in that face. Of course the heat must be applied rapidly enough to avoid undue conduction heat losses. The guide or support may very acceptably be made of a refractory.

Where the length of the bent sheet is too long for the use of a stationary coil, the bent sheet with its electrical conducting connecting strip, or strips, to insure completion of the circuit, may be moved progressively over or within the inductor coil, or over one inductor coil and within the other, by successive increments of movement at a speed just rapid enough for proper fusion to take place between the coating the metal base and without excessive melting of the metal base until the entire area of the plate which was intended to be treated has been so treated. The tendency of the induced current to increase the coupling by traversing that portion of the secondary nearest to the inductor primary and the difference normally existing in the conductivities of the metal base and the coating both contribute to a relatively excessive flow of current through the coating or covering. The fact that the coating or covering usually melts at a much lower temperature also helps to give as good results at a lower temperature than would otherwise be effective.

As a result of the fusion the sharp line of demarcation between a plating or coating or other covering and the base metal gives way to a blending of the two metals across the initial division line, giving a resultant metal structure closely akin to that illustrated diagrammatically at 29 in Figure 8 in which one coating only is shown. A similar condition would exist as to the other coating if both sides be coated.

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. The method of fusing an adherent covering or coating into union with a base sheet of metal normally having free ends which consists in folding a normally extended coated metal sheet into cylindrical form, in forming electrical connections between the ends, in inducing high-frequency current in the exterior circumferential surface of the cylinder so formed to produce a temperature about the circumference sufficient to fuse the coating

into contact with the base metal and in straightening the sheet back to sheet form.

2. The method of fusing an adherent covering or coating into union with a normally extended metal sheet which consists in coating the sheet, in bending the sheet, establishing electrical connection between the edges as bent and inducing high-frequency current flow in the circumferential surface of the sheet as bent to produce a temperature about the circumference sufficient to fuse a coating into contact with the base metal and in straightening the sheet.

3. The method of fusing an adherent covering or coating upon a normally extended coated metal sheet into fused engagement with the backing metal, which consists in bending the sheet, establishing electrical connection between the edges as bent and inducing high-frequency current flow in the sheet as bent to fuse the coating to the adjacent metal of the sheet about the circumference of the sheet, while maintaining substantially uniform spacing between the sheet and the inducing primary and in straightening the sheet back to sheet form.

4. The method of fusing an adherent covering or coating upon a normally extended metal sheet into fused union with the backing metal, which consists in bending the sheet, establishing electrical connection between the edges as bent, inducing high-frequency current flow in the sheet as bent to fuse the coating to the adjacent metal of the sheet about the circumference of the sheet, progressively moving the bent sheet transversely to the planes in which the sheet is bent to cause travel of the induction progressively throughout the length of the bent sheet and in straightening the sheet back to sheet form.

5. The method of fusing an adherent covering or coating upon a normally extended coated metal sheet into fused union with the backing metal, which consists in bending the sheet, establishing electrical connection between the edges as bent, inducing high-frequency current flow in the sheet as bent, progressively moving the bent sheet to cause travel of the induction progressively throughout the length of the sheet, in maintaining uniform distance between the bent sheet and the inductor primary and in straightening the sheet back to sheet form.

6. The method of fusing an adherent covering or coating upon a normally extended coated metal sheet into fused union with the backing metal, which consists in bending the sheet, establishing electrical connection between the edges as bent, in passing high-frequency primary current outside of it and also inside of it to cause it to act as secondary to both primary inductions and in straightening to the sheet back to sheet form.

7. The method of fusing an adherent covering or coating upon a normally extended coated metal sheet into fused union with the backing metal, which consists in bending the sheet, establishing electrical connection between the edges as bent, in passing high frequency primary current outside of it and also inside of it to cause it to act as secondary to both inductions, in progressively passing the bent sheet through the fields of both inductions and in straightening the sheet back to sheet form.

8. The method of fusing an adherent covering or coating upon a normally extended coated or covered metal sheet into fused union with the backing metal, which consists in bending the sheet with the covered or coated side out, in establishing electrical connection between the edges as bent, in passing high frequency primary current outside of the sheet to cause it to act as a secondary to the primary and in straightening the sheet back to sheet form.

9. The method of fusing an adherent covering or coating upon a normally extended coated or covered metal sheet into fused union with the backing metal, which consists in bending the sheet with the covered or coated side inside, in establishing electrical connection between the edges as bent, in passing high frequency primary current inside of the sheet to cause it to act as a secondary to the primary and in straightening the sheet back to sheet form.

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