

Feb. 16, 1937.

R. E. FRICKEY ET AL

2,070,889

RAIL TREATMENT METHOD

Filed March 13, 1933

4 Sheets-Sheet 1

FIG. 1

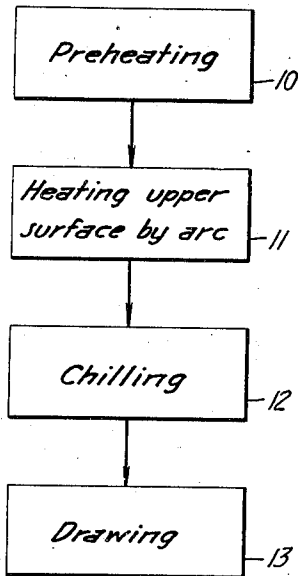
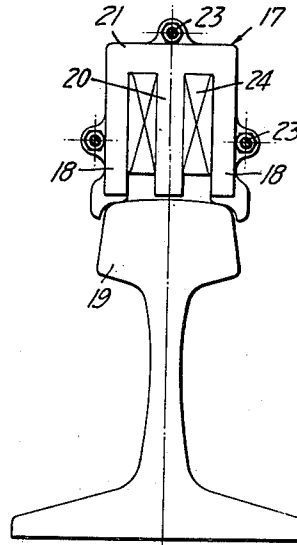
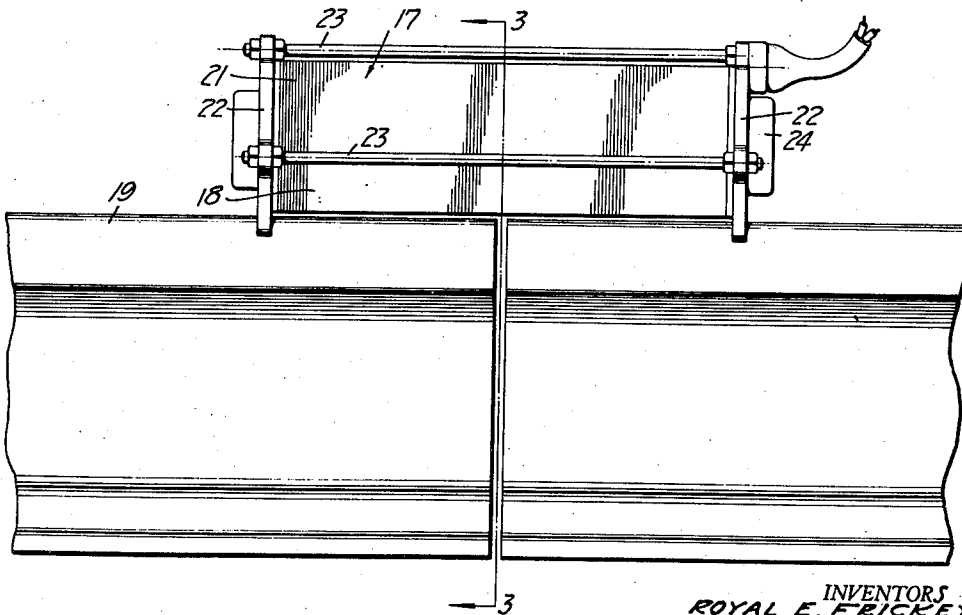


FIG. 3

FIG. 2



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4 Sheets-Sheet 2

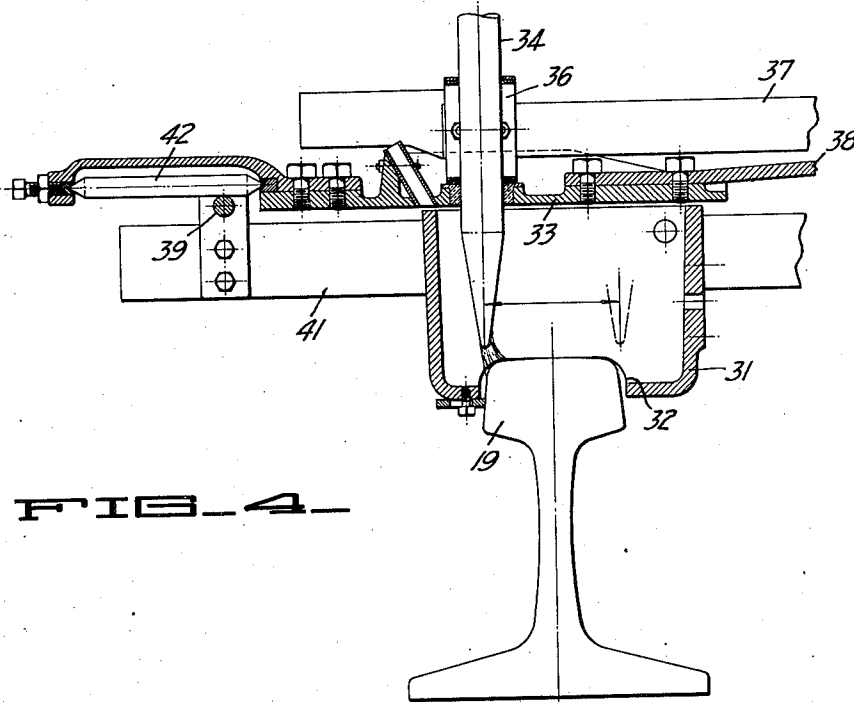


FIG. 4-

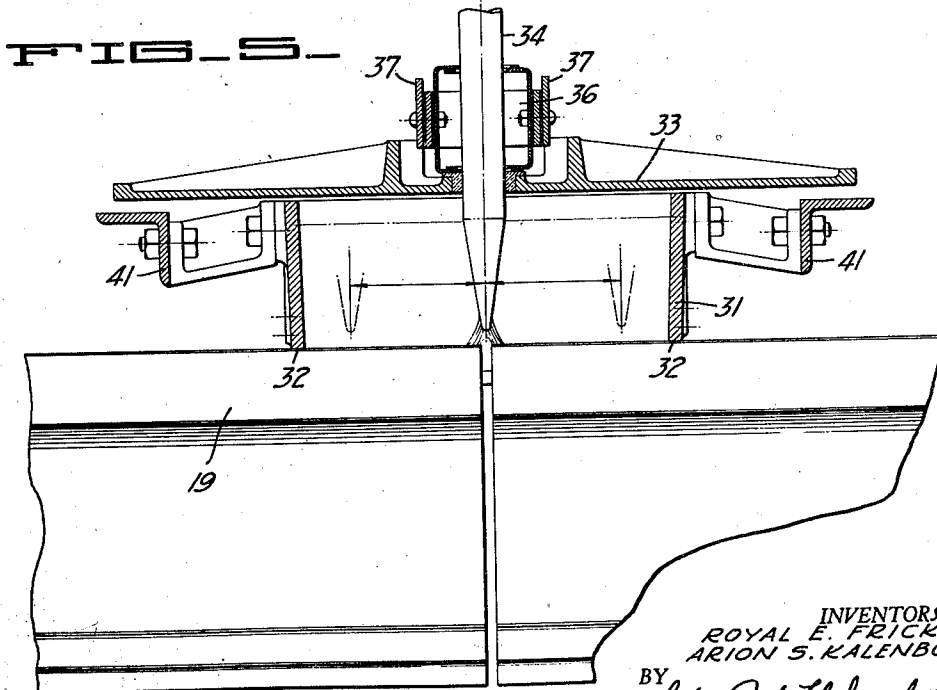


FIG. 5-

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4 Sheets-Sheet 3

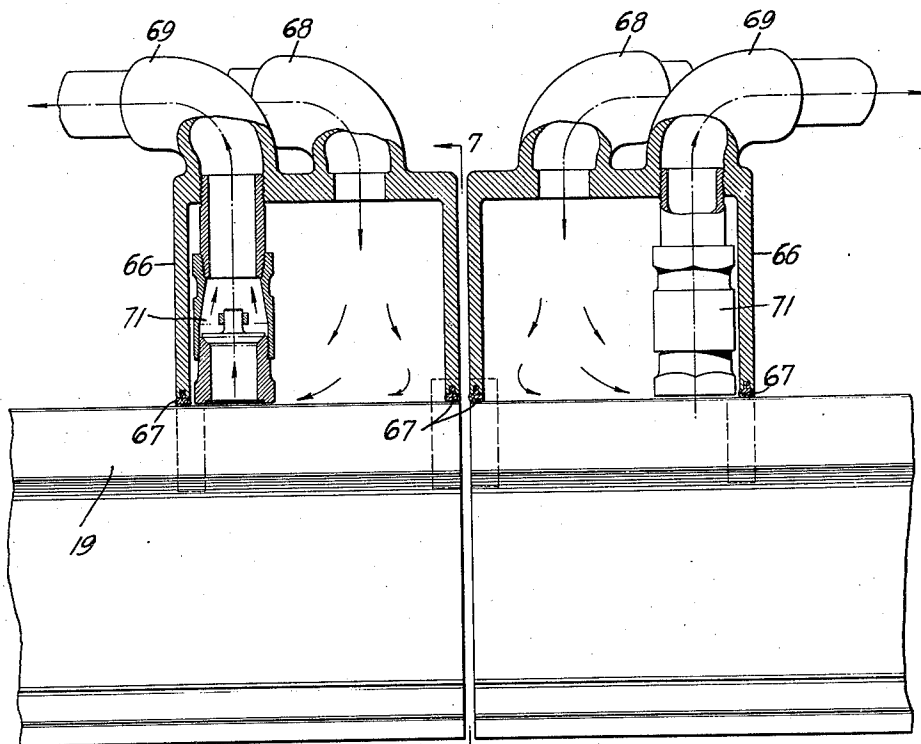


FIG. 6-

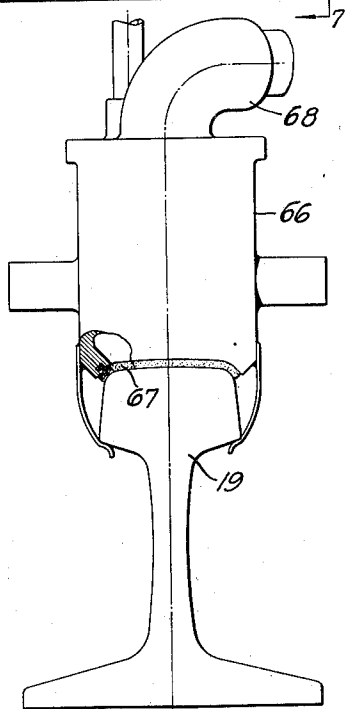


FIG. 7-

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4 Sheets-Sheet 4

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UNITED STATES PATENT OFFICE

2,070,889

RAIL TREATMENT METHOD

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Application March 13, 1933, Serial No. 660,544

6 Claims. (Cl. 148—21)

This invention relates generally to methods for the treatment of railroad rails, to effect hardening of the same. It has particular application to the treatment of rail joints, to harden the upper surfaces of the adjacent rail ends.

In the past it has been proposed to harden rail ends by generally heating the same to a relatively high temperature of say 1500° F., by an oxy-acetylene torch, followed by rapid chilling with water. After chilling a reheating was necessary to secure a proper temper. Such methods have not met with universal approval, due among other reasons to lack of uniformity of the degree of hardness produced, and to frequent breakage of the heat treated portion caused both by severe stresses imposed by sudden quenching with water, and by locked up stresses of large magnitude which result.

It is an object of the present invention to provide a method for the hardening of railroad rails which will make possible uniformly good results in successive hardening operations, and which will be well adapted for prevailing field conditions.

A further object of the invention is to provide a method of the above character which will produce a predetermined hardness pattern.

A further object of the invention is to provide a method of the above character which will permit the use of oil as a liquid chilling medium, but which will conserve the oil utilized for each treatment.

Another object of the invention is to provide a rail hardening method which will not cause deleterious effects upon the rail being treated.

Further objects of the invention will appear from the following description in which the preferred embodiment of the invention has been set forth in detail in conjunction with the accompanying drawings. The appended claims are to be accorded a range of equivalents consistent with the state of the prior art.

Referring to the drawings:

Figure 1 is a diagram illustrating the preferred successive steps in carrying out our method.

Figure 2 is a side elevational view, showing apparatus for effecting a preheating of the rail section or joint to be treated.

Figure 3 is a cross-sectional view taken along the line 3—3 of Figure 3.

Figure 4 is a view, in transverse cross-section, illustrating a portion of the apparatus utilized to effect a heating of an area of the upper surface of the rail, by the use of an electric arc.

Figure 5 is a side elevational view of the ap-

paratus shown in Figure 4, in transverse cross-section.

Figure 6 is a side elevational view, in transverse cross-section, showing apparatus utilized to effect quenching of that area of the joint or rail which is heated by an electric arc.

Figure 7 is an end view of the apparatus shown in Figure 6, certain portions being broken away for clarity.

Figure 8 is a plan view, showing parts of the arc heating apparatus.

Figure 9 is a diagrammatic view showing a portion of the path traced by the heating arc.

Figure 10 is a curve drawn to three dimensions, showing a desirable heat distribution pattern.

The present specification is a continuation in part of subject-matter disclosed in our application Serial No. 612,066, entitled Rail treatment apparatus, and application Serial No. 641,714, entitled Heating apparatus. In said application Serial No. 612,066 we have disclosed and claimed an apparatus for the chilling of heated rails with oil, which can be utilized in conjunction with the present method. Application Ser. No. 641,714, discloses and claims an apparatus utilizing an electric arc, for the heating of rails preparatory to a chilling or quenching operation. This machine can likewise be utilized in carrying out the present method, as will be presently explained.

When our method is carried out in its preferred form, it consists of four general steps which are carried out in sequence. Thus as diagrammatically illustrated in Fig. 1, the step 10 is to preheat a section of the rail, which contains the area or areas to be hardened. The next step following the pre-heating, is to heat the limited area or areas of the upper surface of the rail to be hardened, as indicated at 11. As will be presently explained, this heating can be accomplished by traversing an electric arc over the area to be hardened. Following the heating at 11, the limited area which is heated to an elevated temperature is chilled as indicated at 12, and following this chilling, there is a drawing operation 13 to temper the hardened layer of metal.

With respect to the so-called step of preheating, this can be accomplished in a number of ways, other than by the use of the apparatus which we shall presently describe. Assuming that the upper surfaces of adjacent rail ends at a rail joint are to be hardened, the preheating should extend for a substantial distance on either side of the center of the joint, beyond the localized area to be hardened.

The preheating facilitates subsequent heating of the localized area of the upper surface of the rail by an electric arc, and makes possible certain additional advantages, as will be presently explained. Although there is no specific critical temperature to which the rail section must be preheated, in practice with rails now commonly employed in the United States, the preheating is continued to secure a temperature level which will give the desired results as hereinafter outlined. By way of example these results can be secured with a temperature level of 600° F.

The preheater illustrated in Figs. 2 and 3, which can be utilized with good results, is constructed as follows: A laminated magnetic core 17 is provided, which can be formed to afford side depending magnetic legs 18, a central magnetic leg 20, and an upper leg 21 adjoining the legs 18 and 20. The laminations of the core are held together by suitable means, such as the end plates 22, connected by tie rods 23. A winding 24 surrounds the central leg 20 and is adapted to be connected to a suitable source of alternating current, such as a supply circuit having a frequency of 180 cycles. The lower edges of plates 22 are shown extended to engage the upper surface of the rail, thereby maintaining an air gap between the lower ends of the magnetic legs 18 and 20 and the upper surface of the rail. Both Figs. 2 and 3 show the preheater positioned upon a rail at a rail joint, for heating the same. When the winding 24 is connected to a source of alternating current for exciting the same, the ball 19 of the rail forms a flux path between the legs 18 and 20, and the varying magnetic flux which is thus caused to pass thru the rail causes heating of the rail ball both by induced eddy currents and hysteresis loss. In order to enable an operator to gauge the amount of heat input into the rail, it is desirable to include a watt-hour meter in the exciting circuit. Knowing the amount of watt-hour consumption required for a definite desired amount of preheating under certain conditions, the operator can terminate the preheating operation in accordance with the reading of the watt-hour meter; with the knowledge that a predetermined temperature level has been attained. It is also possible for the operator to continue the preheating until the temperature has risen to the desired value, as determined by a pyrometer, thermometer, or other suitable heat indicating or recording instrument.

Apparatus, utilizing an electric arc, for heating a limited area of the upper surface of the rail, has been described in detail in the aforesaid application Ser. No. 641,714, and a part of such apparatus has been illustrated in Figs. 4 and 5. The parts illustrated in these figures include a box-like structure 31, the bottom of which is provided with a longitudinal slot 32 to receive the uppermost portion of the rail ball 19. Extending over structure 31, there is a closure plate 33, thru which an arc electrode 34 projects. A suitable gripper or holder 36 is provided for electrode 34, and this holder is adapted to be connected to one side of an arc circuit, the other side of which is grounded to the rail. Arms 37 and 38 are connected to mechanism for traversing the electrode 34 over the upper surface of the rail encompassed by the structure 31. It may be explained that this actuating mechanism traverses the arc simultaneously in two directions, one being lateral of the rail, and the other longitudinally of the rail. In other words the movements of the electrode, when an arc is maintained be-

tween the lower end of the electrode and the upper surface of the rail, causes the arc to repeatedly traverse the upper surface of the rail in accordance with a predetermined pattern, so that this upper surface and the layer of metal adjacent the same is heated to a relatively high temperature. Reciprocating movement of plate 33, in conjunction with electrode 34, is permitted by having this plate supported in part upon a longitudinal roller 39. The ends of this roller are pivotally carried by spaced support members 41, which are also connected to the box structure, and to the frame of the remainder of the machine. Transverse rollers 42 serve to engage roller 39, and are pivotally carried by the outer end of plate 33.

Suitable means for reciprocating the electrodes 34 with respect to the rail has been illustrated particularly in Fig. 8. Thus a carriage 44 is provided, having its ends slidably supported by bars 46. These bars extend parallel to each other and longitudinally with respect to the rail, and have their ends secured to the main frame 43. Supported by carriage 44, are the cams 47 and 48, which are fixed to shafts extending from a gear box 49. The train of gears housed within box 49 are driven from a suitable source of power, such as an electric motor 51. The groove of cam 47 is engaged by a roller 52, which in turn is journaled and connected to the end of a reciprocable rod 53. The end of rod 53 nearest the rail being operated upon, has a pivotal connection 54, to arms 37. Cam 48 has its groove engaged by a roller 56, which in turn is journaled to a stationary bracket 57. Rotation of cam 48 at a predetermined speed reciprocates carriage 44 longitudinally of the rail and thus reciprocates the electrode 34 in the same manner. Rotation of cam 47 reciprocates rod 53 and electrode 34 laterally of the rail. In practice cam 47 is operated at a considerably higher speed than cam 48, but the ratio between the speeds of these two cams is an odd ratio, rather than even. Therefore in its travel across the rail, electrode 34 follows a zig-zag course, but in successive passes over the rail in a longitudinal direction, the paths traced by the arc overlap. Thus during a normal period of operation substantially every portion of the surface of the rail over the area being heated, is contacted by the arc. In Fig. 9 the line 1 indicates the zig-zag course for the arc, as has been explained.

In operating the apparatus of Figs. 4, 5 and 8, the current input to the arc is maintained substantially constant. Therefore the input of heat to the rail will depend largely upon the manner in which cams 47 and 48 are formed. Since uniformity of resulting hardness is desired over a substantial area of the rail ends at a joint, cams 47 and 48 should be so designed that the resulting heating of the rail surfaces, followed by chilling and drawing in accordance with our method, produces a desired hardness pattern. By uniformity of resulting hardness we have reference not only to uniform surface hardness in directions lateral and longitudinal of the rail, over the area being treated, but also substantial uniformity with respect to the depth of the hardened layer of metal. We have found that heat imparted to the side edges of the rail tends to dissipate into the atmosphere and cool more rapidly than intermediate surface portions. Likewise we have found that the longitudinal end portions of the area being heated by the arc, require considerably more heating than other portions to secure the desired

heat and ultimate hardness patterns, due to rapid conduction of heat to the cooler portions of the rail. We therefore so proportion cams 47 and 48, that a greater amount of heat is transferred from the arc to the side edge portions of the rail, as compared to the intermediate portions, and also a considerably greater amount of heat to the end portions of the area being traced by the arc, as compared to both the intermediate area and intermediate side portions. This can be explained more clearly by reference to the heat input curves of Fig. 10, which are plotted with respect to three dimensions. Curves 2, because of their upwardly curved ends, show that a considerably greater amount of heat is being imparted to the side edge portions of the rail. Curve 3 on the other hand shows, because of its upwardly curved ends, a considerably greater amount of heat input in the end portions of the area being traced by the arc. Curves 2a show that even at the end portions of the area being traced by the arc, a somewhat greater amount of heat input occurs near the side edges of the rail, as compared to intermediate portions. Curves 3a show that even along the side edge portions of the rail, the ends receive considerable more heat. Thus in general, considering a section lateral of the rail, the side edges of the area traced by the arc probably receive from 15 to 25% more heat input, than intermediate portions. Considering a longitudinal section intermediate of the rail, the end portions of the area being traced by the arc likewise receive from 15 to 25% more heat input than intermediate portions. A considerable part of the area traced by the arc, lying within both the ends and side edges of this area, receives heat comparatively uniformly. The proper design to use for cams 47 and 48, to secure the results desired, will vary somewhat for varying conditions of operation and the hardness pattern desired.

In Figs. 6 and 7, we have shown a part of the apparatus or machine disclosed and claimed in our aforesaid application 612,066, and which is preferably utilized in chilling the metal heated by the electric arc. The parts illustrated include a pair of open-bottomed boxes or receptacles 66, the lower edges of which are provided with sealing rings or gaskets 67 to engage the upper surface of the rail ball. Oil as a chilling medium is introduced into boxes 66, by way of pipe fittings 68. Oil can be removed from the boxes after being introduced into the same, through pipe fittings 69. These fittings may communicate with the interior of the boxes 66, thru check valves 71. As explained in said copending application 612,066, in the complete machine of preferred form, oil is introduced into the boxes 66 thru fitting 68 under a substantially constant head and at a predetermined temperature from a storage reservoir. Shortly thereafter, when pools of oil have been formed within the boxes 66, oil is withdrawn thru the boxes thru fittings 69 at a predetermined rate, and eventually returned to the storage reservoir for reuse. After a predetermined amount of oil has been introduced into the boxes thru fittings 68, further flow of oil is discontinued, but the withdrawal of oil thru fittings 69 is continued until substantially all of the oil has been removed. When these operations are properly controlled, either manually by an operator, or automatically, a predetermined amount of chilling of the rail by oil can be accomplished. In other words the time period of chilling, and likewise the amount of heat removed by the oil from the rail, can be

predetermined and controlled, assuming given temperature conditions for the rail at the beginning of a chilling operation.

Our method can now be reviewed in entirety. The joint to be hardened is first faced off, as by means of a grinding wheel. Such facing removes any decarbonized surface film, and reduces the upper surfaces of the rail ends to the same level. The operator then positions the preheater over the joint, in the manner illustrated in Figs. 2 and 3. Preliminary heating is continued until the rail section has attained a predetermined temperature level. It should be noted that the preheater covers a section of the rail which is substantially longer than the combined length of the areas on the adjacent rail ends to be hardened.

Assuming that the joint or section being treated has been preheated to a given temperature level, the operator then commences the next operation with the apparatus indicated in Figs. 4 and 5. As the electric arc established between electrode 34 and the upper surface of the rail traverses the area or surface encompassed by box structure 31, it is evident that the layer of metal forming the upper portion of the rail ball, and underlying the area being traversed, is heated to a relatively high temperature. In practice good results have been secured by continuing the heating by the arc until this upper layer of metal has attained a temperature of about 1500° F.

Following heating by the electric arc, as explained above, this apparatus is removed from the joint, and the apparatus illustrated in Figs. 6 and 7 is placed over the heated area. The operator then causes introduction of oil thru pipe fittings 68 to establish a pool of oil upon the heated areas encompassed by boxes 66. The operations followed during chilling of the rail have been specified and need not be repeated.

At the end of the chilling operation, that is after oil has been removed from boxes 66, considerable heat remains in the adjacent portions of the rail. It has been found that this heat is sufficient to effect tempering of the hardened layer or layers of metal. Thus to effect tempering, the chilling apparatus is removed from the joint being treated, and heat flow permitted to occur back into the chilled and hardened layers of metal. During this tempering or drawing operation, the joint can be covered with an asbestos blanket, or other suitable heat insulating means, to prevent too rapid dissipation of heat to the surrounding atmosphere.

While rails can be hardened without the first step of preheating, as described herein, preheating is desirable for several reasons, some of which are as follows:—Preheating tends to avoid shock from the high temperature arc, it tends to minimize stresses or strains between the high and low temperature zones, and it facilitates establishment and maintenance of the arc. Furthermore if preheating were not employed, a relatively high rate of heat flow would occur between the layer of metal heated by the electric arc, and the colder portions of the rail. In other words the relatively cold portions of the rail adjacent the heated layer of metal would tend to participate in the chilling and hardening operation. By preheating we minimize to a substantial degree, any participation in the chilling operation by the surrounding portions of the rail metal, particularly when the rail is initially at a relatively low temperature. Furthermore, the temperature of

the layer of metal being heated by the arc can be more readily brought to a predetermined value, irrespective of climatic conditions, following preheating to a predetermined temperature level substantially above atmospheric.

It may be further explained that there is an interrelationship between preheating and drawing. In general the higher the temperature level to which preheating is carried, the greater will be the available drawing after the chilling operation. However the heat for drawing is supplied only in part by preheating, since a certain amount of heat input from the arc is also available for drawing after the chilling operation, particularly since the chilling is accomplished by contacting only a limited area of the upper surface of the rail with the chilling medium. Under certain conditions, as for example during warm weather, the method can be carried out without preheating, but the amount of drawing secured (which will then be by virtue of remaining heat from the arc) will not be as great as is desired for best results. Likewise during cold weather it is possible to carry out the process by an amount of preheating merely sufficient to warm the rail.

It is evident from the above that our method makes possible successive hardening operations under prevailing field conditions, with uniformly good results and to a predetermined hardness pattern, provided the different factors affecting the degree of final hardness are properly controlled in accordance with prevailing conditions and experience. In practice it has been found that with all factors remaining the same, varying degrees of hardness may result due to varying composition of the rails. We therefore prefer to so carry out successive heating and chilling operations as to produce undue hardening of certain rails (e. g. rails having high carbon content) with a hardening of other rails (e. g. rails of lower carbon content) within the hardness range desired. The subsequent tempering or drawing operation then brings the hardness of all treated joints within the desired range, because its softening effect is most pronounced upon metal which has been hardened to a high degree.

With further reference to control, and particularly with respect to controlling the heating by the electric arc, it has been previously stated that the electrical input to the arc is preferably maintained substantially constant. We have found that it is somewhat difficult to accurately measure the temperature of the metal to be chilled, under field conditions. With our method, the arc heating apparatus is preferably kept in operation until a predetermined amount of watt-hour consumption has taken place, and therefore the total heat units imparted to the joint will be the same for successive operations upon the same rail. Likewise since the area traversed by the arc is constant for successive treatments, the mass of metal heated likewise remains constant. With these factors being constant, the same change in temperature of the layer of metal being heated must occur in successive operations, and therefore the proper temperature level will always be attained. Obviously this method avoids the nec-

essity of measuring the temperature of the metal being heated by the arc, before the chilling operation.

We claim:

1. In a method of treating rails to effect hardening of the same, heating a localized area of the upper horizontal surface of the rail ball, causing a stream of chilling liquid to be directed upon said heated area, and confining said area so that the liquid from said stream forms a pool upon the same.

2. In a method for the treatment of rails to effect hardening of the same, the steps of heating the upper surface of the rail to be hardened over a localized area of the same, causing a stream of chilling liquid to flow upon said area for a predetermined period of time, confining said chilling liquid whereby a pool of said liquid is formed upon said area from said stream, and removing liquid from said pool at a predetermined rate which will exhaust the pool after a predetermined interval following termination of flow to said area.

3. In a method of treating rails to effect hardening of the same, preheating a portion of the rail, effecting a further heating of a localized area of the upper horizontal surface of the rail ball within said preheated portion, causing a stream of chilling liquid to be directed upon said heated area, confining said area so that the liquid from said stream forms a pool upon the same, removing the pool of liquid after a predetermined period of time, and thereafter permitting tempering of the chilled area by flow of residual heat back into said area.

4. In a method of treating rails to effect hardening of the same, heating a localized area of the upper horizontal surface of the rail ball, causing a stream of chilling liquid to be directed upon said heated area, confining said area so that the liquid from said stream forms a pool upon the same, removing the pool of liquid after a predetermined period of time, and thereafter permitting tempering of the chilled area by flow of residual heat back into said area.

5. In a method of treating railroad rails to effect hardening of the same, the steps of heating a limited area of the upper surface of the rail by rapidly traversing an electric arc over the same, said area extending substantially the full width of the rail ball and for a substantial distance longitudinally of the rail, a proportionally greater amount of heat being supplied to the side and end edges of said area than to the intermediate portions of the same, and then chilling the heated area.

6. In a method of treating rails to effect hardening of rail ends, heating an upper layer of metal in the rail ball, over an area extending for a substantial distance back from the end of the rail, applying a stream of chilling liquid to the heated area, and confining the liquid from the stream to afford a liquid blanket of substantial depth upon said area.

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