July 2, 1940. H. S. GEORGE 2,206,839

METHOD OF TREATING STEEL RAIL AND THE RESULTING RAIL AND JOINT

Original Filed Feb. 14, 1934

Fig 1

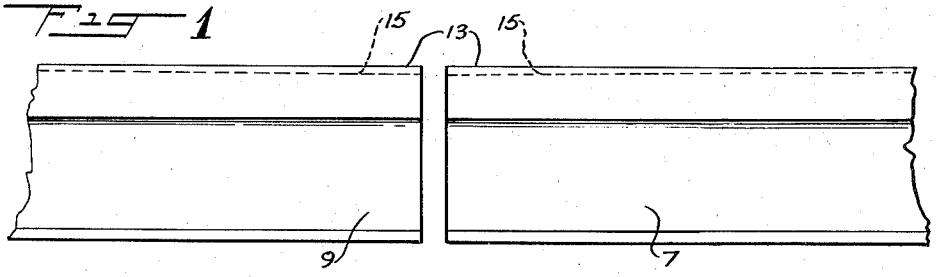


Fig 3

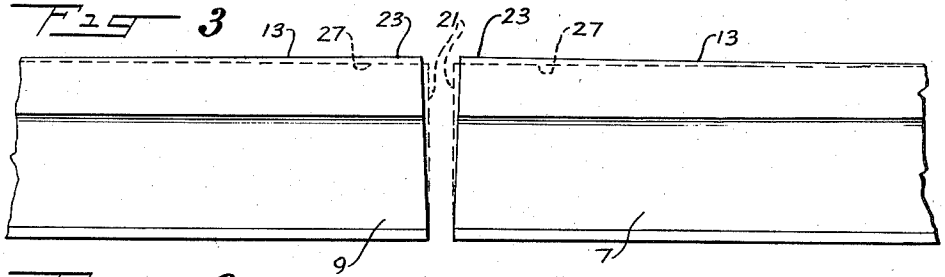


Fig 2

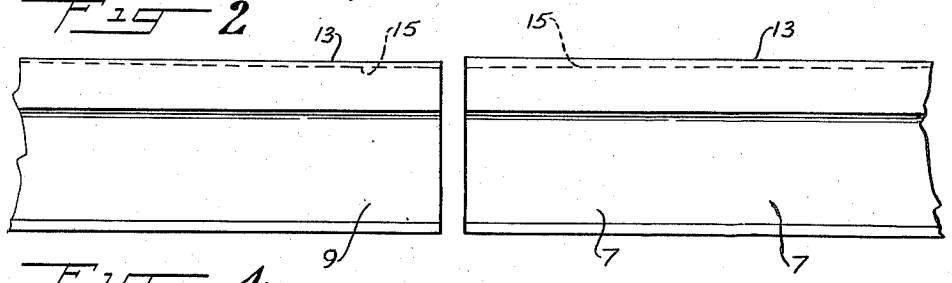


Fig 4

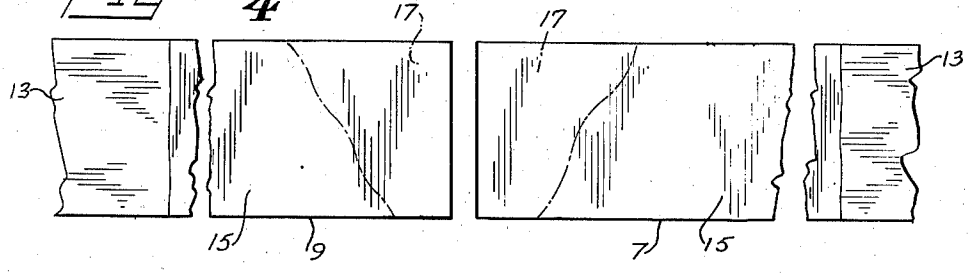
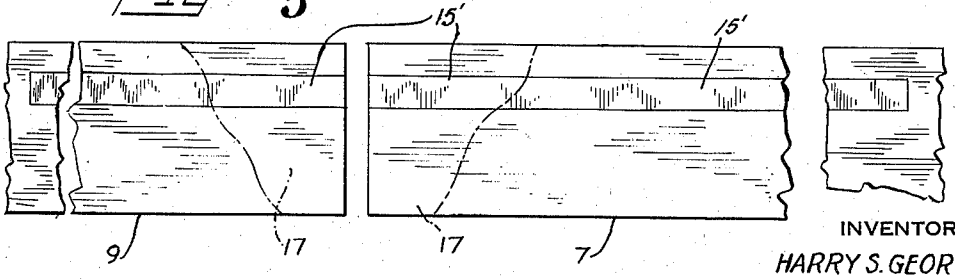


Fig 5



INVENTOR
HARRY S. GEORGE
BY
E. L. Greenewald
ATTORNEY

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METHOD OF TREATING STEEL RAIL AND THE RESULTING RAIL AND JOINT

Harry S. George, Massapequa, N. Y., assignor, by mesne assignments, to Union Carbide and Carbon Corporation, a corporation of New York

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28 Claims. (Cl. 148—12)

The present invention relates to the production of an improved rail and to a rail joint that is highly resistant in service to the deforming forces or batter normally occurring at the rail joints in railroad tracks.

When trains pass over a rail, the load applied thereto through the wheels in time gradually causes a cold flow of the metal, which finally becomes noticeable due to a perceptible lowering of the rail tread surface at the rail ends. Metal breaks from the rail at the tread ends as a result of this cold flow of the metal.

Rails as produced at the steel mills have their surfaces decarburized by the treatment undergone in their formation. This is known to produce a condition in the rail tread which exaggerates the effect of the rail end batter encountered in normal service, and shortens the active life of the rail before a joint reforming treatment becomes necessary. To partly overcome this condition, rails have been given an overall heat treatment at the mills, thus giving the rail tread, except the decarburized and unhardenable surface layer, a higher degree of hardness than it ordinarily possesses. Other prior methods involve a local heating of the rail ends or tread surface thereof to a high temperature followed by a more or less rapid quenching of the heated rail portions for hardening purposes. In all of these methods in use prior to the present invention, the rail end or joint in its final form has a decarburized tread surface of metal of different composition and physical characteristics from the metal in the body of the rail.

It is true that prior processes for protecting rail joints from excessive wear due to traffic batter, involving heat treatment of the rail tread surfaces somewhat improved the wear-resistance of the rail tread surfaces even where the latter include a decarburized surface film. Nevertheless, such heat treatment applied to the decarburized metal lacks the power to harden such decarburized metal sufficiently to prevent the initial slight depression of .01 to .02 inch, due to batter which occurs within the first week or two of service. It is now known that this initial batter—coupled with the natural inequality in rail level due to mill tolerances on rail height—while seemingly very slight and inconsequential, exerts an exaggerated effect on rail end flow, which is observable from $\frac{3}{16}$ to ¼ inch deep where traffic is heavy. The effect of this initial depression is to multiply the effect of passing traffic to a point such that heat treatment alone may not always be adequate to prevent excessive batter (eventual rail chipping) where the usual rails having decarburized surfaces are used.

Therefore, among the more important objects of the present invention are: to provide a novel rail and/or rail joint free or at least largely free from decarburized tread surfaces before the rail or the joint is used in service; to provide a heat treated rail joint or rail end having a tread surface of substantially the same composition and carbon content as the body of the rail; to provide a novel manner for raising the elastic limit of the tread portion of a rail joint or rail end at or near the rail ends for limiting or preventing cold flow of the metal under service conditions; and to provide a rail end of uniform composition, insuring that measurements of the surface hardness shall be a true indication of the hardness of the hardened zone, thus facilitating the accurate periodic determination of the efficacy of the hardening treatment.

Referring now to the accompanying drawing illustrating the present invention:

Fig. 1 is a side elevation of a pair of rails at a joint (the connecting parts being omitted) showing by dotted lines the final location of the tread surfaces of the rails for treatment according to the present invention;

Fig. 2 is a view similar to that shown in Fig. 1, with the tread surfaces of the adjacent rails at different levels before being treated in accordance with the present invention;

Fig. 3 is a view similar to Fig. 1 illustrating a modification of the invention for treating rail ends before the rails are positioned in a track;

Fig. 4 is a plan view of adjacent rails at a joint to illustrate more clearly the manner in which the tread surface areas are ground and heat treated according to the present invention; and

Fig. 5 is similar to Fig. 4 with a narrow ground portion extending longitudinally of the rails at their ends.

In the respective figures, the rail joint includes the adjacent ends of the rails 7, 9, the fish plates and connecting members being omitted for convenience in showing the changes in the rail tread effected by the practice of the present invention.

In the form shown in Figs. 1, 2, 4 and 5, the upper tread surfaces 13 of the rails are gently bevelled or sloped downwardly as at 15 toward the rail joint from a distance, preferably of from 1 to 2 feet or more from the joint. In this manner tread surface areas at the extreme ends of the rails are slightly inclined to the tread surface areas spaced from the ends of the rails and

adjacent to the extreme end areas. This is effected by grinding so applied that the end margins of the tread surfaces of the rails forming the joint are at the same level after the grinding. The grinding, therefore, may be about equally applied to the tread surfaces of the rails near the joint, or, if required, most of it can be applied to the "receiving" rail based upon the direction of traffic. The subsequent heat treatment may be applied to a portion of the rails near the joint across their entire width, as shown at 17, in Figs. 4 and 5.

The area thus heat-treated preferably is generally trapezoidal or triangular in shape, as shown in Figs. 4 and 5. By thus terminating the heat-treated portion of the tread surface diagonally, the traffic will not pass so abruptly from a heat-treated tread surface area to an unheat-treated area or vice versa.

In the practice of the invention in accordance with a form thereof which is especially adapted for the treatment of rails already laid—and particularly to rail joints prior to being worn due to the batter of traffic—the portions of the rails adjacent the joints, and which rails have tread surfaces decarburized at the mill to a depth of about .02 to .04 inch, are surface ground to a depth sufficient to remove a substantial portion at least of the decarburized material, and preferably to a depth of .02 to .04 inch or more at the rail ends, by means of any suitable rail-grinding machine such, for example, as the portable rail grinder disclosed in Patent No. 1,937,665 of S. R. Oldham et al.

Although it is generally desirable to remove substantially all of the decarburized tread surface at the rail joint, it has been found in practice that frequently the removal of portions only of the decarburized tread surface is very beneficial, and definitely adds to the life and serviceability of the rail. In certain instances, the removal of around .015 inch of the decarburized material at the rail tread surface has produced this marked improvement. These advantages are particularly noticeable after the major portion of the decarburized material has been removed from the tread surfaces. A rail grinding machine in the hands of a skilled operator readily accomplishes this remarkably uniform light-grinding with precision.

The ground surface of the rail is sloped gently away from the rail joint, tapering off in depth to zero at points one or two feet or more from the joint at each side thereof, as indicated diagrammatically at 15 in Figs. 1 and 2. This slope is so slight that the traffic in passing over the tapered portion of the rail tread does not produce perceptible batter.

The area of the rail treads subjected to grinding may not extend the full width of the rail. A narrow strip of ground area on the part of the rail tread where initial riding occurs is sufficient. For instance, on canted rail, on tangent track, the ground strip 15' may be around one-half inch wide and located between the middle and the outer side margin of the tread, as shown in Fig. 5. Thus, an exposed and hardened longitudinally extending area is provided on the rail tread, which area is spaced from both longitudinal edges of the head but is closer to one of said edges than the other. Tread portions consisting of thin layers of decarburized metal overlying undecarburized metal will thus remain on opposite sides of the exposed undecarburized portion 15'. In addition, a thin layer of decarburized metal will cover the tread surface of each rail between the portions 15' and longitudinally of each rail tread.

Prior to the grinding operation there may be a depression at the rail ends of the order of from zero up to .02 inch or more, due to actual batter under traffic loads, plus the difference in the original heights of the rails allowed by mill tolerance. This depression extends but a very short distance from the joint, and of course is much more noticeable than if gently tapered by grinding. This short initial depression at the rail joint, or the difference in elevation of the adjacent rail ends at the joint, multiplies the effect of traffic batter by transforming the rolling load into successive impacts. By the provision in a rail of a long-tapered, hardened tread surface free from decarburized metal, such impacts are eliminated.

The rail joints of the present invention are heat-treated in a suitable manner, either before or after the grinding operation, but preferably afterwards. Although the grinding can be done at any time, it is generally preferred, where new rails are being laid, to delay the grinding of the rail joints and ends for a day or two (but not much longer) after the rails have been laid, so as to allow the joints to work slightly. The angle bars may then be retightened, and the joints ground, after which the rail joints are heat-treated.

One very satisfactory way of heat-treating the ground rail joint is that set out in my Patent No. 2,075,982, issued April 6, 1937, according to which a source of high temperature heat is directed for a short predetermined time upon the tread surface areas of the rails adjacent the joint. The size of the flame and the length of time that it is applied locally on tread surface areas are so selected that the underlying mass of rail metal remains relatively cool, thereby rapidly transferring heat away from the tread surface areas being heat-treated and exerting a quenching effect. As a result, the tread surface areas are uniformly hardened naturally to a shallow depth by the combined cooling effect of conduction to the underlying and adjacent cold metal of the rail, and by convection and radiation of heat from the surfaces of the rail.

The tread surface areas to be treated—preferably triangular or trapezoidal in shape—are quickly and uniformly raised to a suitable temperature above the critical range of the steel, for example, about 1600° F., after which the heat-treated areas cool and harden naturally in the manner indicated. The pressure of gas and the length of time of applying a flame for heat-treating the tread area to the desired depth, say ¼ inch, may readily be determined by trial, for a given size of rail and size of heat-treated area. The heat treatment is preferably such that the resultant rail tread has a hardness of about 350 Brinell. Such hardened rail will develop a scleroscope hardness of about 55–60, after being in service for a short time.

Fig. 3 illustrates a modification of the invention particularly adapted for the treatment of the rail ends prior to installation of the rails in a track. The rail as it comes from the mill, having its tread surface decarburized to a depth of .02 inch or more, is heated adjacent its ends to a suitable temperature—such as a red heat—and the head or ball 21 of the rail adjacent the end is upset in a vertical direction upwardly, as shown at 23, by forces applied at the ends of the rail ball, as by hammering or pressure thereon. This results in slightly raising the level of the rail tread at these points.

The force applied is regulated to raise this level by an amount equal to the depth of the decarburized surface skin or layer on the rail tread surface. Thereafter, upon laying the rails, the rail tread surfaces **23** adjacent the joint are lightly ground in the manner described, to remove the decarburized layer and preferably provide a substantially level tread at the joint, so as to practically eliminate initial rail batter. This is then followed by a heat treatment of a portion of the rail tread, such as that already described.

The upsetting or reshaping of the rail ends may be effected subsequent to the installation of the rails in a track as, for example, by means adapted to elongate the rail web at the joint the required amount. Among such means may be mentioned fish plates of the type described in Patent No. 2,004,081 of L. C. Ryan; and also that type of fish plate having a curved upper rail-bearing surface, the mid-portion thereof at the rail joint being its highest point; and which fish plate is adapted, upon being tightened against the rail, to press upwardly upon the margins of the rail ball at the joint for the purpose indicated. This treatment may be applied to either a cold or a hot rail.

In any event, where the rail ends are upset by any means, the grinding operation preferably is so conducted that the rail tread surfaces at the joint do not slope but are in exact alignment at the same level, as shown at **27** in Fig. 3. This procedure produces a hardened tread surface of undecarburized metal and an initially-level joint structure.

The upsetting of the rail ends by hammering or the like eliminates the necessity for cross grinding, so that, if desired, the only grinding done is that required for the removal of the surface skin or decarburized metal on the tread surface of the rails adjacent the joint.

By the practice of the present invention, it is possible to produce at the mill a new rail having a level or substantially level tread, or to recondition and reform in the field a rail already in service; and to provide a level rail joint made up of such rails. The new rail is provided with an undecarburized wearing surface or surfaces of suitable width extending throughout all or a selected portion or portions of its length. The undecarburized wearing surface may include all or only a portion of the entire rail tread surface. These undecarburized surfaces may or may not be heat-treated in whole or in part in suitable manner, such as that described, to increase the surface hardness of the rail at such points.

I claim:

1. A method of reducing rail batter adjacent the end of a steel rail initially having a tread surface consisting of a relatively thin layer of decarburized metal overlying undecarburized metal, such method comprising removing at least a portion of said layer of decarburized metal from the tread surface adjacent the end of said rail to expose the underlying undecarburized metal; and thereafter heat treating at least a part of such exposed undecarburized surface portion to harden the same.

2. A method of treating the ends of adjacent rails having layers of decarburized metal, which method comprises heating an end of each rail, upsetting each of the said rail ends in a vertical direction while hot by force applied upon the ends of the heads of said rails, thereby raising the level of the respective rail tread surfaces adjacent their ends an amount approximately equal to the depth of the layer of decarburized metal, laying the rails in place to form the rail joint, lightly grinding the rail tread surfaces adjacent the rail joint to remove the decarburized layer and bring the tread surfaces of the rails at the joint to the same level, and heat-treating the rail tread surfaces adjacent the joint so as to harden the same and render them highly resistant to wear.

3. A method of treating at a rail joint the ends of adjacent rails which have surface layers of decarburized metal, which method comprises heating an end of each rail, upsetting said rail ends in a vertical direction while hot by impact applied upon the ends of the heads of said rails, thereby raising the level of the respective rail treads adjacent their ends an amount approximately equal to the depth of the layer of decarburized metal, laying the rails in place to form the rail joint, lightly grinding the rail tread surfaces adjacent the rail joint to remove the decarburized layer and bring the tread surfaces of the rails at the joint to the same level, and heat-treating the rail tread surfaces adjacent the joint so as to harden the same and render them highly resistant to wear.

4. A method of treating at a rail joint the ends of adjacent rails which have surface layers of decarburized metal, which method comprises heating an end of each rail, upsetting said rail ends in a vertical direction while hot by pressure applied upon the ends of the head of said rails, thereby raising the level of the respective rail treads adjacent their ends an amount at least approximately equal to the depth of the layer of decarburized metal, laying the rails in place to form the rail joint, lightly grinding the rail tread surfaces adjacent the rail joint to remove the decarburized layer and bring the tread surfaces of the rails at the joint to the same level, and heat-treating the rail tread surfaces adjacent the joint to harden the same and render them highly resistant to wear.

5. A method of treating at a rail joint the ends of adjacent rails which have surface layers of decarburized metal, while the rails are in place in a track, which comprises vertically elongating said rail ends thereby raising the level of the respective rail tread surfaces adjacent the rail ends, lightly grinding the rail tread surfaces adjacent the rail joint to remove a substantial portion at least of the decarburized layer and bring the tread rail surfaces at the joint to substantially the same level, and heat-treating the rail tread surfaces adjacent the joint to harden the same and render them highly resistant to wear.

6. A method of treating at a rail joint the ends of adjacent rails which have surface layers of decarburized metal, which method comprises heating an end of each rail, upsetting said rail ends in a vertical direction by force applied upon the ends of the heads of said rails, thereby raising the level of the respective rail tread surfaces adjacent their ends an amount at least equal to the depth of the layer of decarburized metal, lightly grinding the rail tread surfaces adjacent the rail ends sufficiently to remove at least the major portion of the decarburized layer at such point, and heat-treating the rail tread surfaces adjacent the joint to harden the same and render them highly resistant to wear.

7. A method of treating the end of a rail having a surface layer of decarburized metal, which comprises heating an end of the rail, upsetting

the rail end in a vertical direction while hot by force applied to the end of said rail, thereby increasing the height of the rail tread an amount approximately equal to the depth of the layer of decarburized metal, and lightly grinding the rail tread at the end for a distance at least one foot back therefrom to remove the decarburized layer at that area with but slight change in the level of the tread surface at such point.

8. A method of treating the end of a rail having a surface layer of decarburized metal, which comprises heating an end of the rail, upsetting the rail end in a vertical direction by force applied to the end of said rail, thereby increasing the height of the rail tread an amount in the neighborhood of .02 up to .06 inch, and lightly grinding the rail tread at the end for a distance back therefrom to at least a depth of the order of from .02 up to .06 inch, to remove the decarburized layer at that area.

9. A method of treating the end of a rail having a surface layer of decarburized metal, which comprises heating an end of the rail, upsetting the rail end in a vertical direction while hot by force applied to the end of said rail, thereby increasing the height of the rail tread an amount approximately equal to the depth of the layer of decarburized metal, lightly grinding the tread at the rail end for a distance of at least one foot back therefrom to remove at least the major portion of the decarburized layer with but slight change in the level of the tread surface at such point, quickly applying a regulated amount of heat locally to the rail tread adjacent the end of the rail, and then effecting natural cooling of the thus heat-treated portion of the rail tread surface to harden the same.

10. A method of treating the end of a rail having a surface layer of decarburized metal, which comprises heating an end of the rail, upsetting the rail end in a vertical direction while hot by force applied to the end of said rail, thereby increasing the height of the rail tread an amount approximately equal to the depth of the layer of decarburized metal, lightly grinding the tread at the rail end for a distance of at least one foot back therefrom to remove the decarburized layer with but slight change in the level of the tread surface at such point, rapidly heating the tread surface of the rail at the rail end above the critical temperature range of the metal by local application of a regulated quantity of heat, and allowing such heated portion to cool entirely by the conduction of heat to surrounding portions of the rail body and by convection and radiation to the surrounding atmosphere so as to harden said heated tread surface.

11. A method of treating at a rail joint the ends of adjacent rails having surface layers of decarburized metal, which method comprises heating an end of each rail, upsetting said rail ends in a vertical direction while hot by force applied upon the ends thereof, thereby raising the level of the respective rail treads adjacent their ends an amount approximately equal to the depth of the layer of decarburized metal, laying the rails in place to form the rail joint, lightly grinding the rail tread surfaces adjacent the rail joint to remove the decarburized layer at such point and bring the tread surfaces of the rails at the joint substantially to the same level, rapidly heating a portion at least of the ground tread surface adjacent the rail ends above the critical temperature range of the metal by local application of a regulated quantity of heat for a preselected time, and allowing said heated tread surfaces to cool by the natural conduction of heat therefrom to surrounding portions of the rails and by convection and radiation to the surrounding air, in the absence of a quenching liquid.

12. A method of improving a rail having at an extreme end thereof a tread surface area of decarburized metal, which comprises upsetting such rail end in a vertical direction by force applied to the end of said rail, thereby increasing the height of said rail tread surface an amount approximately equal to the depth of the layer of decarburized metal, and lightly grinding said rail tread surface at the extreme end of said rail to remove therefrom the layer of decarburized metal.

13. A method according to claim 6, including the step of hardening said tread surface area at the extreme end of said rail after the layer of decarburized metal has been removed therefrom.

14. A method of providing an improved rail joint comprising a pair of rails each having at an extreme end thereof a tread surface area of decarburized metal, which comprises upsetting such rail ends in a vertical direction by force applied to the ends of said rails, thereby raising the height of the respective rail tread surfaces adjacent their ends an amount approximately equal to the depths of the layers of decarburized metal, laying the rails in place to form a rail joint, and lightly grinding said rail tread surface areas adjacent the joint to remove the layers of decarburized metal and bring the extreme ends of the tread surfaces of the rails substantially to the same height at the joint.

15. A method according to claim 8, including the step of hardening said tread surface areas at the extreme ends of said rails after the layers of decarburized metal have been removed therefrom.

16. A method of treating a steel rail prior to its installation in track in order to prevent battering of the ends thereof during service in track, such rail prior to its service in track normally having a thin decarburized metal layer upon the tread surface thereof; such method comprising removing said decarburized layer from at least a portion of the tread surface adjacent each of the ends of the rail; and thereafter applying high temperature heat to at least a part of each of the surfaces so exposed to heat treat the same.

17. A method of treating a steel rail prior to its installation in track in order to prevent battering of the ends thereof during service in track, such rail prior to its service in track normally having a thin decarburized metal layer upon the tread surface thereof; such method comprising removing said decarburized layer from only a portion of the width of said tread surface and longitudinally of the rail adjacent each of its ends only, so as to expose underlying portions of undecarburized metal only adjacent such ends; thereafter applying high temperature heat to such exposed portions of undecarburized metal to heat the same to a temperature above the critical range; and effecting cooling of such exposed and heated portions at a rate sufficient to harden the same.

18. A steel rail having a tread surface extending throughout the length of the head of the rail and comprising a thin layer of decarburized metal overlying undecarburized metal along a major portion of the tread surface, the remainder of said tread surface adjacent the ends of the rail comprising, at least in part, exposed and hardened undecarburized portions from which the thin layer of decarburized metal has been removed.

19. A steel rail having adjacent each end there-

of a tread surface portion comprising hardened undecarburized metal; said rail also having between such hardened portions a tread surface portion extending longitudinally of said rail and comprising a thin layer of decarburized metal overlying undecarburized metal.

20. A steel rail having a tread surface comprising a thin layer of decarburized metal overlying undecarburized metal over a major portion of the length of the rail, and at each end a hardened portion from which decarburized metal has been removed, such hardened portions extending longitudinally of the rail and gradually tapering back from each end of the rail.

21. A new steel rail having a tread surface comprising an exposed undecarburized portion adjacent each end only of the rail, at least a portion of such undecarburized portion being hardened by heat treatment.

22. A steel rail having upon the head thereof a tread surface comprising an exposed and hardened undecarburized portion adjacent each end of the rail, such hardened portions comprising areas extending longitudinally of the head of the rail and narrower than the width of said head.

23. A steel rail having upon the head thereof a tread surface comprising an exposed and hardened undecarburized metal portion narrower than the width of said head and extending longitudinally of the latter, and tread portions adjacent opposite sides of such hardened undecarburized portion and also extending longitudinally of the head of said rail, said last-named tread portions consisting of thin layers of decarburized metal overlying undecarburized metal.

24. A rail for service in track, said rail normally having a decarburized layer extending over the tread surface, but having an end thereof heated and subsequently upset in a vertical direction while hot by force applied to the end of said rail, and the decarburized layer removed by grinding for a distance of at least one foot back from the end of the rail.

25. A rail for service in track, said rail normally having a surface layer of decarburized metal but having an end thereof heated and subsequently upset in a vertical direction while hot by force applied to the end of said rail sufficient to upset the end of said rail in a vertical direction an amount approximately equal to the depth of the layer of decarburized metal, and the decarburized layer removed by grinding for a distance at least one foot back of the end of the rail with but slight change in the level of the tread surface.

26. A steel rail having upon the head thereof a tread surface comprising an exposed and hardened undecarburized portion adjacent an end thereof, such hardened portion comprising an area extending longitudinally of the head of the rail and spaced from both longitudinal edges of the head but closer to one of said edges than the other.

27. A method of treating a steel rail which comprises preparing an undecarburized tread surface strip considerably narrower than the head of said rail and spaced from both longitudinal edges of the head of said rail, at least a longitudinal portion of said strip being hardened; the preparation of said strip including the step of heating and cooling at least a longitudinal portion of said strip to harden the same, and the step of removing a decarburized surface layer in the form of a strip from the tread of said rail.

28. A method of treating a steel rail which comprises preparing an undecarburized tread surface strip considerably narrower than the head of said rail and spaced from both edges of the head of said rail but closer to one of said edges than the other, at least a longitudinal portion of said strip being hardened; the preparation of said strip including the step of heating and cooling at least a longitudinal portion of said strip to harden the same, and the step of removing a decarburized surface layer in the form of a strip from the tread of said rail.

HARRY S. GEORGE.