June 20, 1933. G. LANGFORD 1,914,439

METHOD OF HOT STRAIGHTENING

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Fig. 1.

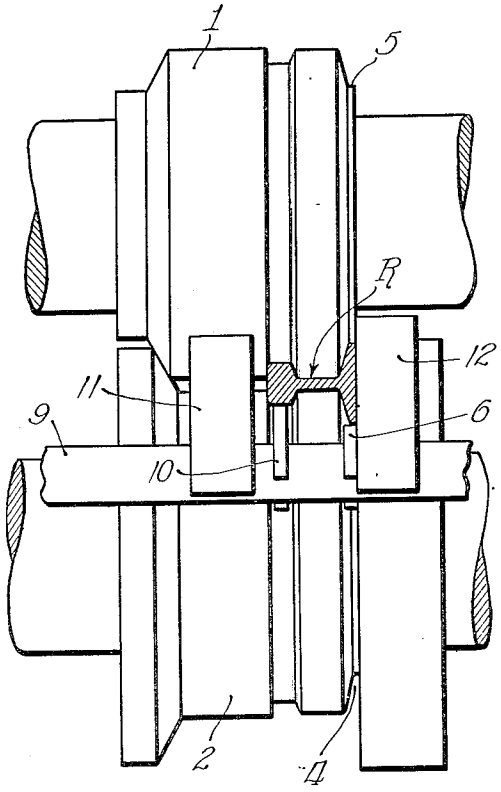
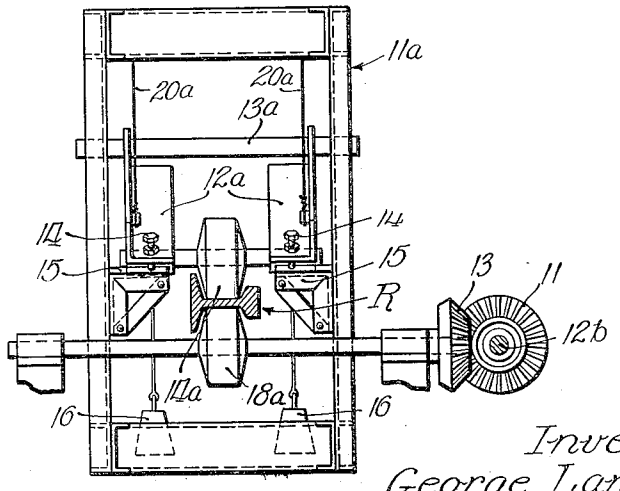


Fig. 2.



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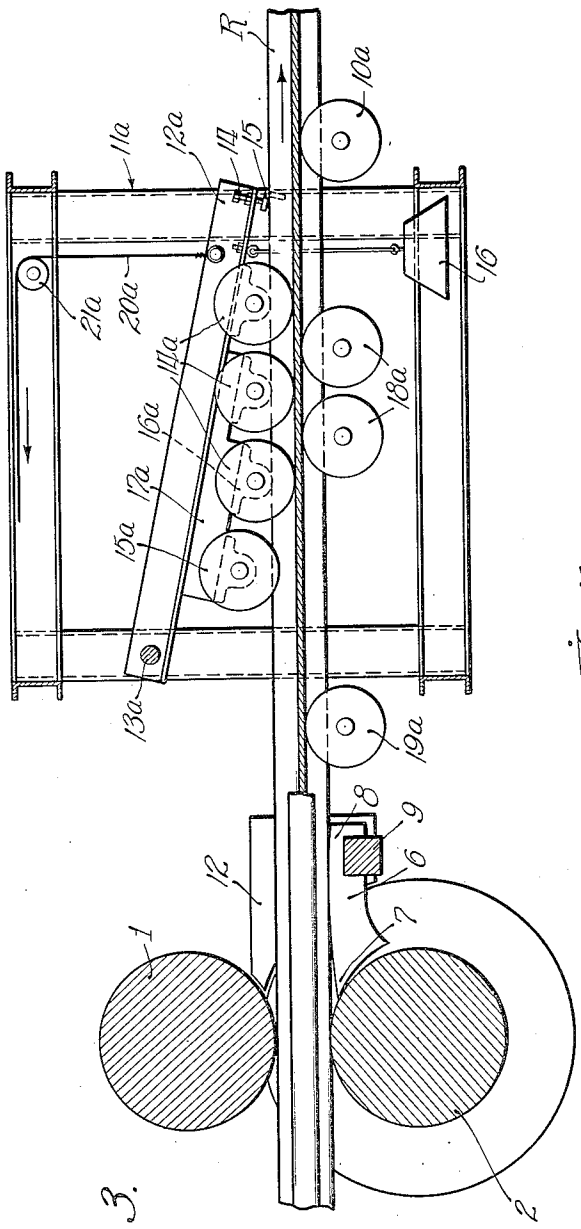


Fig. 3.

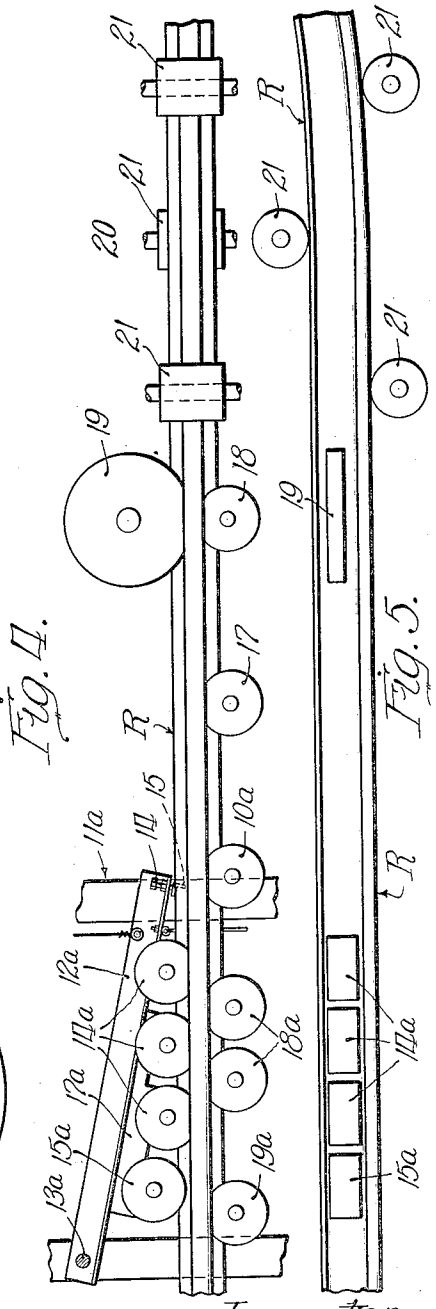


Fig. 4.

Fig. 5.

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UNITED STATES PATENT OFFICE

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METHOD OF HOT STRAIGHTENING

Application filed January 6, 1930. Serial No. 418,843.

My invention relates to a method for hot working and straightening rolled steel shapes, and has to do more particularly with the production of railroad rails.

The straightening of small rolled sections presents no great difficulty as compared with large sections particularly when the latter have thin and unbalanced parts; for example, rods, small rounds, flats, and merchant shapes are less difficult to straighten than similar large sections. The latter in turn are simpler than small I-beams, angles and light rails, nor do any of the above require such precise straightness as is called for in heavy railroad rails. Methods used on small simple sections have not proven applicable to large and complicated sections best represented by heavy railroad rails, and it is for the successful straightening of heavy rails that my invention is particularly adapted.

In straightening a rail, two types of crookedness are to be considered: long "bends" or sweeps and short "kinks". Where any considerable range of sweep is tolerated kinks are given no tolerance. The latter are very difficult to straighten out, furthermore straightening out a kink is the severest form of punishment that may be inflicted upon a cold rail. To straighten a bend or kink in a rail, it must be given permanent set opposite the bend, which ruptures the internal structure of the steel in amount proportional to the amount of permanent set given it per unit of length. A long bend or sweep may be straightened by several slight deflections throughout its length, but a kink requires a less number and greater deflection thereby occasioning greater internal rupture of the steel. The internal strains thus set up are a cause of breakage of the rail in track. A rail head must have some hardness to resist abrasion and hardness is conducive to brittleness which is accentuated by internal strains would make the rail unsafe for fast moving trains. The end of a rail is its most sensitive part for there is more or less pounding there under the train wheels. The two ends of a rail must, therefore, be treated with special care. Straightening an end kink cold is severe punishment for a rail. Specifications and inspection realize this.

A kinky rail even when made straight is not considered safe for speed main line use and is not accepted as first quality. To the best of my knowledge no method has ever successfully straightened kinky rail without setting up strains in the steel. Therefore to be entirely successful any method of straightening must not only remove kinks and bends but do it in such a manner as to avoid setting-up strains in the steel. This my invention accomplishes. For the reasons given, it can be seen that the straightening of rails is full of grave uncertainties. Whether a finished rail is straight or not can be readily seen by a trained eye, but just what happens to the steel's internal structure from the punishment necessitated by cold-straightening short bends or kinks which might cause the breakage of rail in track, can not be so readily detected.

The common method of cold straightening rails, now in common use, employs press and gag. The part of the rail to be straightened is laid across two anvil blocks and a gag, pushed down by a reciprocating hammer head, deflects the rail and straightens it. This permanent deflection subjects the rail to internal stress and it is this dangerous feature that manufacturers and users of rails are so anxious to avoid.

The main object of my invention is to straighten rails "hot", above a temperature of 1000 degrees Fahrenheit, or as soon as possible after they leave the rolls. Another object is to straighten rails while plastic and easily deformed. Naturally the temperature of a freshly rolled rail falls when exposed to atmospheric temperature, and my aim is to straighten the rail, particularly short "line" bends, before it loses so much of its final rolling temperature as to lose its plasticity whereof the elastic limit of the steel rises and bends must be deflected beyond straight alignment to be made permanently straight. As my purpose is to straighten bends in the rail selectively, avoiding substantial bending pressure on straight por-

tions of the rail which requires that there must be no appreciable deflection of bent portions of the rail beyond straight alignment, my process employs high temperatures, as near the final rolling temperature as is practical. Preferably my straightening means would be close to the roll finishing pass so as to be in the straightening means before the rail finally leaves the rolls, but inasmuch as it is generally considered bad mill practice to present any possible obstacle to the free delivery of steel from rolls, the straightening means may be placed so that the rail will not enter it until the rolling is completed.

The inherent difficulty in the straightening of cold steel is its springiness. To be straightened, a bend must be deflected not merely to a straight line but beyond it, as the steel will spring back when the bending pressure is removed. Bends occur in various directions, also they may not have uniform curvature throughout their lengths; therefore a piece to be straightened must have some parts of its length deflected in one direction beyond straight alignment and other parts deflected in the opposite direction in varying amounts. The amount of opposing deflection required to straighten a bend increases as the distance between the supports increases. Shortening the spacing between supports reduces the opposing deflection required to straighten a bend on the shortened spacing. My invention employs short spacing of supports, having as its main object the reduction of opposing deflection to as near zero as conditions of practice will permit. To attain this object more perfectly, I choose the simplest way by doing the work upon the steel while it is hot and in a plastic state, and when most of its springiness is absent. The soft condition of the steel and the short spacing between straightening supports so reduce the amount of opposing deflection beyond straight alignment required to make a bend straight that the bend may be made straight by deflecting it so little beyond straight alignment that for all practical purposes it may be considered as deflected only to straight alignment compared with any other form of straightening known in the prior art.

Further objects and advantages of my invention will appear from the detail description.

In the drawings:—

Fig. 1 is an elevation of a pair of finishing rolls of a rolling mill, a rail formed by such rolls being shown in section;

Fig. 2 is an end view of a straightening means constructed in accordance with my invention, looking at the delivery end thereof, the rail being shown in section;

Fig. 3 is a sectional view lengthwise through the straightening means and the finishing rolls, the rail being shown as partly broken away and in section, parts being shown in elevation;

Fig. 4 is a semi-diagrammatic side view illustrating a modified form of my invention;

Fig. 5 is a diagrammatic plan view of the form illustrated in Fig. 4.

A description of modern practice, in so far as it has to do with hot straightening, is herewith presented so that a better understanding may be had of the novelty of my invention. Steel rails, beams, and other heavy sections for which my invention is particularly fitted, are rolled from blooms of section roughly 9″ or more square, a dozen or so passes through shaped rolls being required to reduce the bloom to a finished rail. Blooms are rolled in a number of passes from cast steel ingots of varying sizes approximately 18″ square and 7′ long. As the hot finished rail emerges from the last rolling pass, it is guided laterally, by side guards, and vertically, by guides. Fig. 1 is an end outlet view of a pair of finishing rolls 1 and 2 with a finished hot rail R emerging from the rolls upon its side, as is common practice. The roll bearings, housing, and driving mechanism are not shown.

Fig. 1 is the top roll and 2 the bottom roll. 4 is the closed flange groove in the bottom roll, and 5 the open flange recess in the top roll. Steel wedged in a closed groove would wrap around the roll and so a flange guide 6 is used to receive the rail flange, its point 7 (Fig. 3) resting upon the bottom roll 2 and its heel 8 seating upon a rigid rest bar 9. Similarly a head guide 10 receives the head portion of the rail R which latter is thus delivered horizontally on the two guides 10 and 6. To hold the rail laterally, a head guard 11 and a flange guard 12 are fastened rigidly to the rest bar 9. In order to hold the rail in alignment laterally as it leaves the rolls, it is customary to draft the head portion a trifle more than the flange portion to secure slightly more head elongation so that the rail will crowd against the flange guard 12. This being set in accurate alignment insures lateral straightness to more or less extent. To avoid confusion over the fact that a rail is rolled upon its side and is used in a different position, in speaking of straightness, "surface" refers to kinks or bends vertically when in use or laterally when rolled. "Line" refers to kinks laterally when in use and vertically when rolled. "Surface" and "line" are very common terms used in straightening. It can be seen from the description of the Figs. 1 and 3 that "surface" delivered is more positive for straightness than "line" delivered in that in the former the rail bears against the rigid flange guard 12 and in the latter it bears upon the slender guards 10 and 6 with no provision for preventing upward curling, which frequently occurs to some extent.

The problem of straightening, therefore, becomes one more of "line" than of "surface" and it is to the straightening of "line" that my invention is particularly directed. After rolling, in ordinary practice, the rail is run along a roller conveyor table to the hot-saw and cut to length. It then passes through a cambering machine and is delivered upon a hot-bed where it lies until cool. The cambering machine is well known in the art and may be of either vertical roller or horizontal roller type. The cambering machine bends the rail to a predetermined curve, the head surface being convex and flange surface concave. Were it not for this curve or camber, the rail when cold would have a similar reverse curve, head concave and flange convex, seeing that the chunky head cools more slowly than the thin broad flange. This cambering machine is sometimes incorrectly called a hot-straightener, but it is in reality only a bending machine unable to remove kinks from line or surface, since the rollers must be spaced an appreciable distance apart to camber the rail. The final step of the prior art in hot-straightening is carried out on a cooling bed of supporting rails. The cambered rail is delivered from the cambering machine onto the cooling bed. When the rail has reached its recalescence point it is then turned over upon its other side so that any line bends will have a chance to settle while cooling. When cold, the rail is further straightened in a gagging press.

In my invention, the rail is straightened at a temperature over 1000 degrees Fahrenheit, the purpose being to straighten it as near to the rolling temperature as possible while the steel is plastic. The more plastic the steel, the less is the resistance to deflection, my preferred means providing for little or no deflection to accomplish this straightening. As my invention is directed to a method of hot straightening while the steel of the rail is as plastic and as low in its elastic limit as the final rolling temperature permits, the rail is straightened as soon as possible after it leaves the rolls. The elastic limit of steel and resistance to bending increases very rapidy with decrease of temperature, and it is essential in my process that the steel be hot when straightened. After the long rail length is rolled it is straightened and hot-sawed into the several rail lengths, which latter are then surface cambered in the ordinary way to counteract the reverse curve which would otherwise result after cooling. As far as I am aware, I am the first to attempt straightening short as well as long bends in a rail hot. Hitherto it has been generally held that short bends in a steel rail could not be straightened hot because of the danger of deforming the rail while the steel was in a plastic condition.

Referring to Figs. 2 and 3, my straightening machine comprises a main frame 11*a* of suitable construction, and a roller frame, comprising angle arms 12*a* mounted at one end for swinging movement, on a rod 13*a* extending transversely of frame 11*a* at the entrance end thereof.

Three straightening rollers 14*a*, and a guide roller 15*a*, are mounted in bearing blocks 16*a* carried by blocks 17*a* suitably secured to arms 12*a*. Two lower rollers 18*a* are suitably supported beneath rollers 14*a* and in staggered relation thereto. Rollers 18*a* are aligned with conveyor table rollers 19*a* and 10*a*. Roller 10*a* is driven in a suitable manner, as by means of a bevel gear 11 secured on a driven shaft 12*b* (Fig. 2) and meshing with a bevel gear 13 secured on the roller shaft. Rollers 18*a* and 19*a* are also preferably driven from shaft 12*b* in the same manner as roller 10*a*. The two sets of rollers 14*a* and 18*a* define between them a passage for reception of the web of rail R, and the machine is disposed adjacent the finishing rolls 1 and 2 to receive the hot rail delivered therefrom, as in Fig. 3.

The important straightening elements are the rollers 14*a* staggered over the bottom rollers 18*a* and all five of these rollers are made as small as possible consistent with strength, and are placed very close together, this being essential to reduce the opposing deflection required to straighten a bend, to as near zero as possible, thereby enabling the machine not only to remove short bends but to remove them without material straightening pressure upon straight portions of the rail. Considering the two lower rollers 18*a* as supports and the roller between and above them as the means for applying pressure on an upward bend, it can be seen that making the lower rollers as small as possible so as to place them close together and shorten the distance between supports as much as possible, results in a minimum of opposing deflection to straighten a bend across the shortened supports. This minimized opposing deflection together with the plastic state of the hot steel, reduces opposing deflection to a negligible amount, so that the rollers may be set for straight alignment and not for appreciable and predetermined opposing deflection. This so minimizes the straightening pressure and deflection that any marking or distortion of the rail section is avoided, resulting in a very simple and effective method of putting the rail while hot into a much improved condition for cold straightening, the latter being confined mostly to correcting the rail for warpage and inaccuracies of cambering found in the rail after it has cooled. Each roller may be adjusted up or down by shims under the bearings or set screws, or in any other suitable manner. The arms 12*a* carrying the rollers, and which are hinged at 13*a*, are limited in their down-

ward movement by set screws 14 carried thereby which contact stops 15 secured to frame 11*a*. The arms 12*a* are yieldingly urged downward by weights 16 suspended therefrom. The upper set of rollers may be raised as a unit clear of the rail, at any time, by cables 20*a* passing over sheaves 21*a* suitably mounted on frame 11*a*, these cables leading to a suitable station, or in any other suitable manner.

The roller 15*a* serves to take the blow of the rail as it enters the machine. The operation of the machine is as follows:

A gauge bar corresponding to the thickness of the rail web is laid across the table rollers 19*a* and 10*a* and the bottom straightening rollers 18*a* are raised in any suitable manner until the four rollers are in alignment. The upper rollers 14*a* are then lowered upon the gauge bar and adjusted in their bearings so that they all bear evenly thereon, the set screws 14 being set to the stops 15 so that when the gauge bar is removed the rollers are all in correct alignment. As a hot rail passes through the machine, the rollers will straighten out any kink equal to or greater than the distance between the two bottom rollers 18*a*. If the pressure upon the rail is too great, the weights can be lightened or the set screws 14 tightened up to slightly raise the rollers 14*a* in unison, the top rollers being undriven except by the friction of the moving rail driven by the rollers 18*a*. Should any of the rollers 14*a* be so misaligned vertically that it does not press upon the rail web, it will stop revolving thus indicating that it is misaligned and it can then be quickly aligned by tightening it down by shim or set screw. Should any troublesome rail jam in the machine, all of the top rolls can be raised instantly by the cables and lowered immediately after the rail is past, all of the rollers being again in perfect alignment because of the set screws 14 resting upon the stops 15.

What I claim is:

The method of hot straightening a short line bend or kink in a steel railroad rail, consisting in applying pressure transversely and progressively along the convex surface of the bend across supports spaced apart no more than the length of the bend, said pressure providing for deflection of the bend to substantially not more than straight alignment, and being applied while the rail is at a temperature of not less than 1300 degrees Fahrenheit.

In witness whereof, I hereunto subscribe my name this 31st day of December, 1929.

GEORGE LANGFORD.