

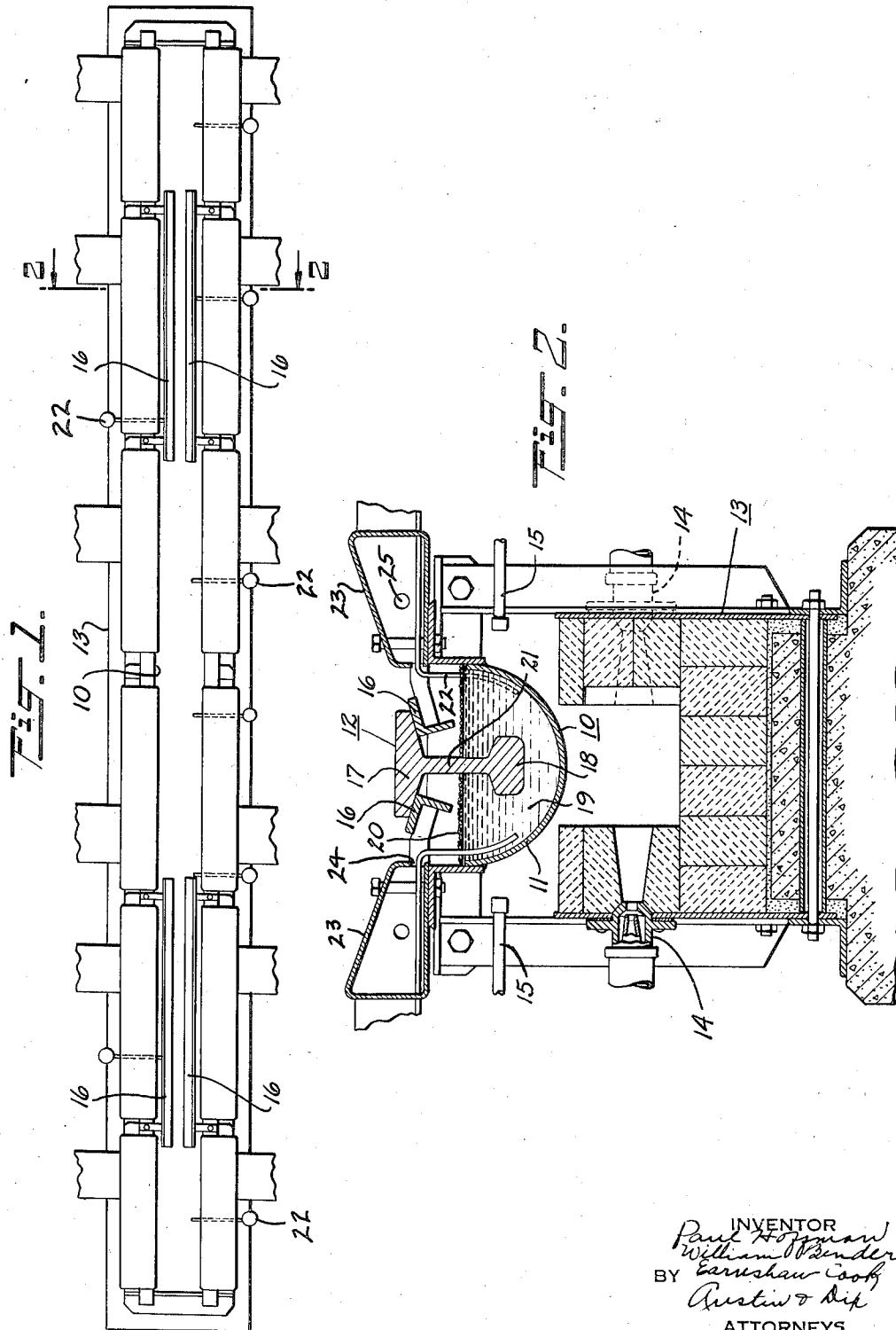
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HEAT TREATMENT OF FERROUS SECTIONS

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HEAT TREATMENT OF FERROUS SECTIONS

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6 Claims. (Cl. 148—21)

The invention relates, in general, to the heat treatment of ferrous metal shapes, and more particularly to the quenching at elevated temperatures of selected portions of formed steel shapes, such as the heads of steel rails.

This invention represents an improvement over the method disclosed in copending application Serial No. 374, filed January 4, 1935, which application discloses a method of heat treating railway track rails of standard specifications and characteristics.

One of the features of the invention consists in subjecting the steel rail or other ferrous metal shape, after heating to a temperature above its critical point, to the quenching action of a bath of molten material, such as lead or an alloy of lead, that can be maintained at a practically constant desired lower, but elevated temperature, without subjecting other portions of the shape to the direct action of the bath. This treatment promotes the formation, in both the quenched and unquenched portion of the shape, of distinct grain structure exhibiting desirable relative characteristics in said portions.

Important advantages of the present process as found, for example, in the heat treatment of rails, are to increase the wear-resisting properties of the head and to retain and enhance the toughness and tensile strength of the web and flange. This provides a rail having a traction surface exhibiting higher resistance to wear and a body free of internal stresses and strains to sufficiently withstand the stress and shocks. The operation of the process is easily controlled and, after the formed steel shape is heated to the desired initial temperature above the critical, the quenching temperature need not be closely maintained, nor need the time, that the submerged portion of the shape is subjected to the molten bath, be closely observed.

The present invention further contemplates the use of a lead pot of limited cross section so that the temperature may be easily controlled. It further contemplates the use of a lead pot having a cross section of such a shape as to provide substantially equal amounts of bath opposite the top face and side faces of the head of the rail.

The invention further contemplates the use of a pot of such shape as to promote the formation of eddy currents therein to assist in equalizing the temperature of the liquid and in extracting the heat from the submerged portion of the formed steel shape.

A further feature of the invention is the provision for reducing the cambering or warping of

the rail or other steel shape. This is accomplished by immersing the rail to approximately its neutral axis, and by the use of a layer of coke on the bath to heat insulate the base of the rail from the bath.

The invention further consists in the new and novel features of operation and the new and original combination of steps in the process hereinafter described and more particularly set forth in the claims.

Although the novel features which are characteristic of this invention will be more particularly set forth in the claims appended hereto, the invention itself, as to its objects and advantages and the manner in which it may be carried out, may be better understood by referring to the following description taken in connection with the accompanying drawing and forming a part thereof, in which

Fig. 1 represents a plan view of the bath; and Fig. 2 represents a cross section through the bath taken on the line 2—2 of Fig. 1.

In the following description, the improved process is disclosed particularly with respect to the treatment of railway track rails of standard specifications and characteristics, but it will be understood that any steel shape of practically any standard specification and many shapes made to particular specifications may be treated. Throughout the specification and in the claims, the various details will be identified by specific names for convenience, but they are intended to be as generic in their application as the art will permit.

Referring to the drawing, a preferred form of apparatus for carrying out the invention will be described. This apparatus comprises a lead pot or container 10 having a semi-circular wall 11 which may be conveniently made from a ten inch steel pipe. This pot is of sufficient length to accommodate the desired length of railway rail 12 or other steel shape, and is supported above an elongated furnace 13 having longitudinally arranged gas or oil burners 14 and longitudinally arranged air jets 15 for maintaining the temperature of the bath 10 at the desired value. These burners 14 and air jets 15 are located along both sides of the furnace and are arranged to give uniform heating action and uniform cooling action along the length of the furnace.

The bath is provided with suitable elongated supports 16, a pair being located at each end, on which the base flange 17 of the rail 12 being treated rests, as indicated. These supports permit the head 18 of the rail to pass into the bath

19, but engage the base of the rail and support the rail in proper position with the head centrally located in the bath and with the liquid level at the proper point on the rail.

5 Provision is made for close automatic temperature regulation. A series of thermocouples 22 are immersed at desired points along the length of the bath. These thermocouples are located preferably at points opposite the side of the rail head 18, where it is desired most closely to regulate the temperature.

Suitable controlling devices (not shown) governed by the thermocouples 22 automatically turn on the fuel burners 14 when the temperature of the bath drops below a certain predetermined value. These devices automatically turn off the fuel burners 14 when the temperature of the bath exceeds a certain predetermined value and, at the same time, automatically turn on the cooling jets 15 to bring back the bath to the desired temperature. Likewise, the controlling devices automatically turn on the fuel burners 14 and turn off the air jets 15 when the bath temperature falls below a predetermined value.

25 For removing any lead fumes or other obnoxious gases, a special exhaust system may be provided comprising a series of exhaust boxes, denoted, in general, by 23, connected to a suitable exhaust fan (not shown). The exhaust boxes are provided with slots 24 and holes 25 for carrying away any obnoxious gases which may be given off during the heat treatment operation. It will be understood that ordinarily, the bath temperatures used for heat treating steel rails are well below the volatilization points of the metals in the bath.

The material of the bath 19 may comprise an alloy of lead and antimony, $\frac{1}{2}$ lead and $\frac{1}{2}$ antimony by weight, having a melting point of about 477° F. These proportions provide a bath which is liquid at 500° F., which temperature has been found to be a desirable quenching temperature for steel rails.

Floating on the surface of the bath may be a layer 20 of coke or other carbonaceous material of, for example, one-half inch in thickness. This material reduces oxidation of the molten bath; prevents the bath from sticking to the rail and heat insulates the bath from the base flange of the rail.

50 To carry out the improved process, the rail 12 is heated in its entire section in a special heating furnace (not shown) to a temperature above its critical temperature, for example, to about 1500° F. After the rail 12 is thoroughly heated to this temperature, it is immersed in the bath with its head down and with its base flange 17 resting on the supports 16, as indicated in Fig. 1. The bath level is arranged so that the rail is immersed to its neutral axis on web 21 which may be about one inch below the bottom of the head for certain weights of rail.

After the rail is submerged in the bath for a sufficient length of time to give the desired change in structure, the rail may be removed from the bath and subjected as a whole to retarded cooling in air down to atmospheric temperature.

The particular temperature of the rail prior to quenching is not especially critical so long as it is above the so-called critical temperature, below which no consequential hardening could be effected. In the case of a 105 lb. rail, when the rail is brought to an initial or hardening temperature of 1500° F., it has been found that the temperature drops before quenching to about 1420° F. because of the time necessary for transporting

the rail from the heating furnace to the bath. With heavier rails the drop in temperature will, of course, be correspondingly less.

The temperature of the bath is not essentially critical, but it has been found that a temperature of 500° F. gives more desirable characteristics in the quenched and unquenched sections of the rail than the temperatures of 650° to 800° F. disclosed in the former application above referred to. With the lower quenching temperature, the head becomes somewhat harder and the other properties of entire rail are considerably improved.

As disclosed in our earlier application referred to above, the bath temperature should lie preferably above the blue and secondary brittleness ranges, and must lie below the critical point, or between the limits of, say, 400° F. and 1300° F. It will be noted from the examples given in this and in the earlier application that the preferred operating ranges lie below about 800° F. and above about 400° F.

When the rail is immersed, the temperature of the lead bath may rise from 150° to 250° F. in spite of the cooling action of the air jets, due to the stored heat in the rail. It may, therefore, be necessary to wait from 10 to 12 minutes after the rail is removed from the bath for the bath to cool off before immersing the next rail. The time for immersion of the rail in the bath is not critical, but it has been found that 5 to 10 minutes immersion gives excellent results.

Numerous advantages follow from the above method of heat treatment. Among others, adequate and uniform hardening throughout the quenched areas, including the wearing surfaces on the head, is obtained with a minimum of induced stresses and without increasing the hardness of, and yet retaining the toughness of, the base and web. The ductility of the base of the rail is actually increased, improving its shock-resisting properties and its machinability.

Furthermore, warpage and distortion are practically eliminated. Cambering or bending of the rail has been reduced by the present invention from $1\frac{1}{2}$ to 2 inches, obtained by the process in the prior co-pending application above referred to, to $\frac{1}{4}$ inch, or less, in 20 feet with the present improved process. The elimination of the cambering or bending of the rail when cold is apparently caused by the insulating layer of coke and, to some degree, by the immersion of the rail in the bath to the neutral axis or other point on the rail web. The long supports and the exhaust boxes appear to have a lesser effect in eliminating cambering and distortion.

More effective quenching action is obtained by the shape of the lead pot and by the use of relatively small amounts of bath material. When the rail is immersed in the bath material, the higher temperature of the rail causes eddy currents to be set up in the bath which helps maintain the different portions of the bath at uniform temperature and assists in extracting heat from the submerged portion of the rail. The relatively small amount of bath material, which may be as small as 5000 lbs., assists in providing easier temperature control.

The present process eliminates the hard martensitic carbide transformation in the head, direct transformation from austenite to the fine grained sorbitic pearlite and in the normalized base by direct transformation from austenite to pearlite. Furthermore, the quenching is com-

pleted at temperatures above the blue brittleness range, which is generally near 400° F.

The present invention is applicable to new rails, and also to old rails removed from track service, the rails in both cases being heated to the hardening temperature in the special heating furnace as above described. The present invention is also applicable to rails hot with the rolling heat in the rail mills. In this case, if desired, the rolling operation may be so controlled that the rails leave the mill hot bed at the desired initial temperature above the critical point, or, if allowed to cool below this point, they may be reheated to the necessary extent in a special furnace provided for this purpose.

If desired, special means may be provided for positively circulating the bath material to accelerate the heat flow from the rail, thereby increasing the quenching rate to obtain greater hardening. For example, an external circulatory system may be provided for withdrawing the molten bath from one end of the container and returning it, after cooling, to the other end of the container.

While certain novel features of the invention have been disclosed and are pointed out in the annexed claims, it will be understood that various omissions, substitutions and changes may be made by those skilled in the art without departing from the spirit of the invention.

What is claimed is:

1. The method of heat treating a rail which comprises raising the temperature of the entire rail to above its critical point, immersing the head of the rail in a bath of lead at an elevated temperature while permitting the base flange of the rail to cool in air, and covering said bath with a layer of carbonaceous material to minimize oxidation of the lead, to prevent the lead from sticking to the rail, and to reduce the cambering of the rail when it cools.

2. The method of heat treating a steel rail which comprises heating the entire rail to a temperature above the critical point, selectively immersing the head of the rail in a bath containing molten lead, while permitting the base flange of the rail to cool in air, said bath having a round cylindrical bottom wall and having a limited

cross sectional content so that substantially equal amounts of the bath are disposed at the bottom and sides of the head.

3. The method of selectively heat treating steel railway rails which comprises imparting to the entire section of the rail a temperature above its upper critical temperature, forthwith selectively immersing for a sustained period of at least five minutes the head of the rail in a lead antimony bath having a temperature range of about 500° to 650° F. while permitting the base flange of the rail to cool in air, cooling the bath and subjecting it to circulation, removing the rail from the bath and cooling the entire rail to atmospheric temperature, thereby to cause the constitution of said head to change from austenite to fine pearlite and the constitution of the unquenched part of the rail to change from austenite to a pearlite softer than said head, the bath temperature being considerably below the temperature of transformation in the head to offset the mass effect.

4. The method of selectively heat treating steel railway rails which comprises imparting to the entire section of the rail a temperature above its upper critical temperature, immersing the head of the rail in a molten metal bath having a temperature above about 400° F. but below about 800° F., while permitting the base flange of the rail to cool in air, for a time interval sufficient to cause the constitution of said head to change from austenite to fine pearlite and the constitution of the unquenched part of the rail to change from austenite to a pearlite softer than said head, cooling the bath and subjecting it to circulation, removing the rail from the bath and cooling the entire rail to atmospheric temperature, the bath temperature being considerably below the temperature of transformation in the head to offset the mass effect.

5. As an article of manufacture, a steel railway rail having the composition and hardened by the method substantially as defined in claim 3.

6. As an article of manufacture, a steel railway rail having the composition and hardened by the method substantially as defined in claim 4.

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