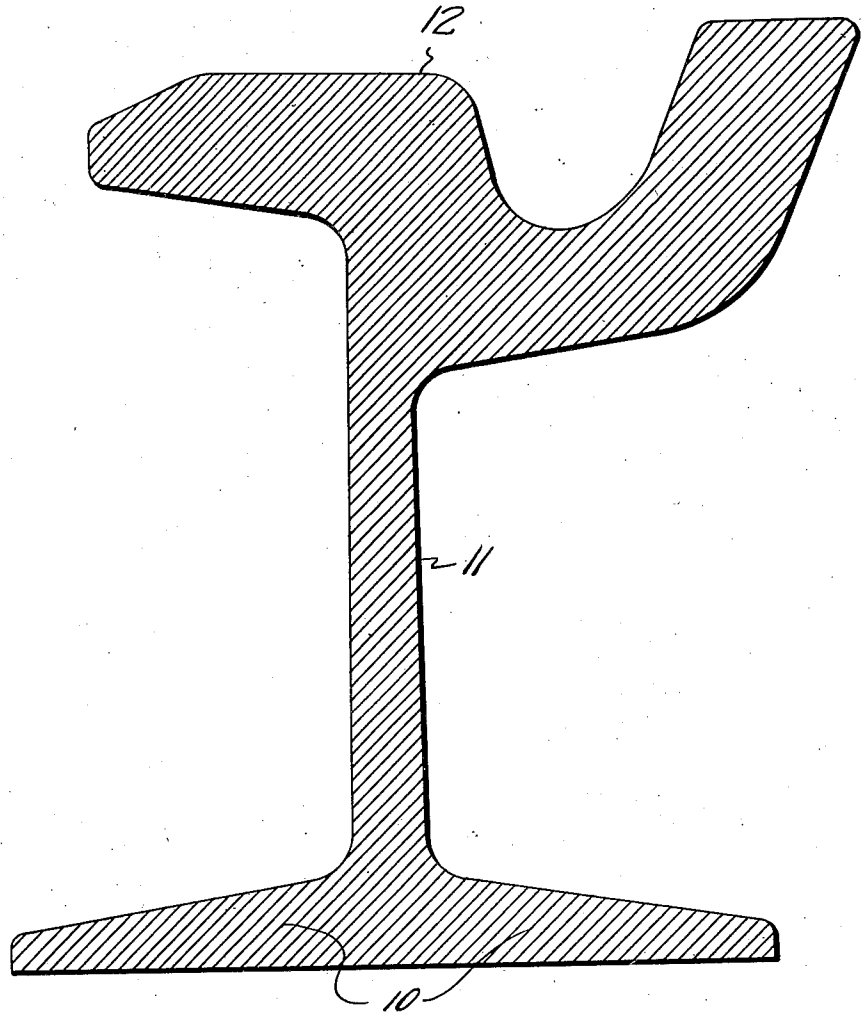
Feb. 23, 1932. E. F. KENNEY 1,846,684

HEAT TREATMENT OF RAILS

Filed Feb. 5, 1930



Inventor

Edward F. Kenney.

By R. S. C. Dougherty.

Attorney

Patented Feb. 23, 1932

1,846,684

UNITED STATES PATENT OFFICE

EDWARD F. KENNEY, OF BETHLEHEM, PENNSYLVANIA, ASSIGNOR TO BETHLEHEM STEEL COMPANY, A CORPORATION OF PENNSYLVANIA

HEAT TREATMENT OF RAILS

Application filed February 5, 1930. Serial No. 426,168.

My invention relates to the heat treatment of rails.

An important object of my invention is the prevention of permanent strains in the metal of the rail which tend to be produced therein during cooling, particularly during such rapid cooling as occurs during quenching.

My invention comprises cooling a rail from above the critical range in such manner that the temperature of the flanges and web are gradually lowered through the critical range and then, before the major mass of the metal in the head has cooled to the critical range, subjecting the head to rapid cooling in order to lower the temperature of the head metal rapidly through the critical range.

The object of such treatment is to obtain the enhanced properties resulting from a quenching operation in the head of the rail which obviously is the portion of the rail which is subject to the greatest stresses and wear in service. By first allowing the web and flanges to pass through the critical range before subjecting the rail to the rapid cooling action, it is possible to avoid stresses and strains which might be produced in the relatively thinner web and flange portions.

To illustrate my invention a specific embodiment thereof will now be described. The drawing gives a cross section, full size, of a rail to which this specific description applies. This rail weighs about 140 lbs. per yard and has a composition within the following ranges:

Carbon	Manganese	Phosphorus	Sulphur	Silicon
.62	1.32	.023	.044	.16
.72	1.43	.022	.042	.19
.68	.72	.023	.062	.13
.72	.79	.024	.060	.19
.74	.69	.023	.049	.26
.86	.81	.023	.057	.22

This section is of the well known "girder" type, such as is used in street railways and the like.

A rail of the cross section shown is produced in the rail mill in the usual way. It is allowed to cool on a cooling bed until substantially all of the metal of the web and flanges has dropped below the critical range. Obviously, because of the much greater thinness of the flanges 10, and web 11 as compared with head 12, the web and flanges will drop below the critical range before the major portion of the mass of metal of head 12 has reached the critical range. With the web and flanges thus cooled, but before the temperature of the major mass of metal in the head has dropped to the critical range, the rail is immersed in a water bath for a period of, say thirty seconds and is then immediately transferred to and immersed in a bath of molten lead having a temperature of about 1000° F. It is kept in this lead bath a period of four to five minutes. From the lead bath it is immediately transferred to a closed furnace which is maintained at a temperature of about 1000° F. where it is kept at a substantially uniform temperature for a period preferably of between one hour and one and one-half hours, although it may be kept in this furnace a somewhat greater length of time, say up to three hours. The rail is then withdrawn from the furnace and allowed to cool in the air.

The treatment just outlined comprises first the cooling of the rail gradually until the greater part of the metal in the web and flanges has passed through the critical range; second, the rapid reduction of temperature of the major mass of the metal in the head through the crtical range; third, the equalizing of the temperature of the metal in the rail; fourth, the "drawing" of the metal of the rail in the furnace, that is to say, producing a sorbitic or troostite-sorbitic micro-structure in the hardened metal of the head; and fifth, the cooling of the rail to atmospheric temperature.

The important feature of the invention, which is to be covered by the following claims, is the quenching of the rail after the web and flanges have been allowed to cool gradually through the critical range. By quenching through the critical range and then "drawing", the desired micro-structure is secured in the major mass of metal of the head and thereby greatly enhanced physical properties of such metal are obtained. By allowing the web and flanges to cool gradual-

ly through the critical range before subjecting the rail to the quenching operation dangerous stresses are prevented in these portions of the rail. This treatment is particularly valuable and finds its principal application in the treatment of rail sections having flanges and webs of relatively thin section. In the example which has been given flanges 10 and web 11 are relatively thin and contain much less metal than is possessed by head 12. If such a rail section with substantially its entire mass above the critical range, including the metal of the web and flanges, were to be quenched in a bath of water for a sufficient length of time to cause the entire mass of metal in the head to pass through the critical range, the web and flanges would be subjected to a quench entirely too drastic. Such treatment would necessarily produce strains and stresses in the thin web and flanges that would frequently be fatal to the rail. By first allowing the web and flanges to drop below the critical range these parts are saved from such damaging effects.

Obviously there are various departures from the practice outlined in the description of a particular example. While it is desirable to employ a lead bath for equalizing the temperature, or at least initiating the equalizing operation, it is obvious that such treatment may be omitted under some circumstances. The equalization may be effected in the "drawing" furnace, the lead bath being omitted. It is important in practice, however, to effect some sort of equalizing operation before the major mass of metal of the head has dropped to the blue heat zone.

When the rail is immersed in the lead bath, a goodly proportion of the head of the metal is still above the blue heat zone. While the rapid cooling operation has been sufficient to lower the temperature of the entire mass of the rail metal to temperatures below the critical range the interior of the head is still above the blue heat zone. It is desirable to effect the equalizing before this interior portion of the head has dropped through the blue heat zone. Obviously the furnace step might be omitted by leaving the rail in the lead bath long enough to accomplish the drawing operation therein. Instead of an immersion in the lead bath for a period of from four to five minutes the immersion would then be maintained for an hour or longer. Obviously the time periods given for rapid cooling, lead bath treatment, and drawing will vary somewhat with the particular section and weights of metal in the head of the particular rail section being treated. The figures given have been found to be effective for the particular section shown.

The best results have been obtained when the entire mass of the rail head has been rapidly cooled to the critical range but obviously my process is not limited to such treatment. For example, the rapid cooling operation may be so limited in duration that a substantial portion of the interior of the rail head is not rapidly cooled through the critical range but only the more external portions thereof.

Although it is desirable to employ the process on rails while they still retain the mill heat, it may be desirable at times to reheat and treat rails which have already been cooled to atmospheric temperatures. Obviously in such cases the rail may be heated above the critical range and then treated in accordance with the methods which have been set forth.

What I mean by the "blue-heat zone", as this expression is used in this disclosure, is that range of temperatures, below the critical range where steels in heating markedly increase in tensile strength and the elastic limit, and also markedly decrease in ductility. At temperatures, within this range, most steels when exposed to air take on a blue color, due to oxidation, but since, with some steels, this color is not readily apparent, I do not wish to be limited to the color as a means of determining or defining this zone.

By the expression "critical range" I mean that temperature range through which the steel must be cooled to effect a hardening thereof. This range will vary with the particular composition of the steel.

Having thus described my invention what I claim and desire to secure by Letters Patent is:

1. A process for the heat treatment of rails, comprising the steps of allowing the rail to cool gradually from the mill heat until substantially all of the metal of the web and flanges has cooled to a temperature below the critical range, and then, before the major mass of the head has cooled to the critical range, subjecting the entire rail to a cooling medium to lower the temperature of the head rapidly through the critical range.

2. A process for the heat treatment of rails, comprising the steps of allowing the rail to cool gradually from the mill heat until substantially all of the metal of the web has cooled to a temperature below the critical range, and then, before the major mass of the head has cooled to the critical range, subjecting the entire rail to rapid cooling to lower the temperature of the head rapidly through the critical range.

3. A process for the heat treatment of rails, comprising the steps of allowing the rail to cool gradually from the mill heat until substantially all of the metal of the flanges has cooled to a temperature below the critical range, and then, before the major mass of the head has cooled to the critical range, subjecting the entire rail to a cooling medium to lower the temperature of the head rapidly through the critical range.

4. A process for the heat treatment of rails,

comprising the steps of gradually cooling the web and flanges through the critical range and then, before the major mass of metal of the head has dropped to the critical range, subjecting the entire rail to an aqueous medium to rapidly lower the temperature of the head through the critical range.

5. A process for the heat treatment of rails, comprising the steps of allowing the rail to cool gradually from the mill heat until substantially all of the metal of the web and flanges has cooled to a temperature below the critical range an then, before the major mass of metal in the head has dropped to the critical range, immersing the entire rail in an aqueous bath, heating the rail to equalize the temperature at a temperature between the critical range and the blue heat zone before the major mass of the metal in the head has passed through the blue heat zone.

6. A process for the heat treatment of rails, comprising the steps of allowing the rail to cool gradually from the mill heat until at least a major portion of the metal of the web and flanges has cooled to a temperature below the critical range and then, while a substantial proportion of the head metal is still above the critical range, subjecting the entire rail to rapid cooling to rapidly lower the temperature of the metal of the head through the critical range.

In testimony whereof I hereunto affix my signature.

EDWARD F. KENNEY.