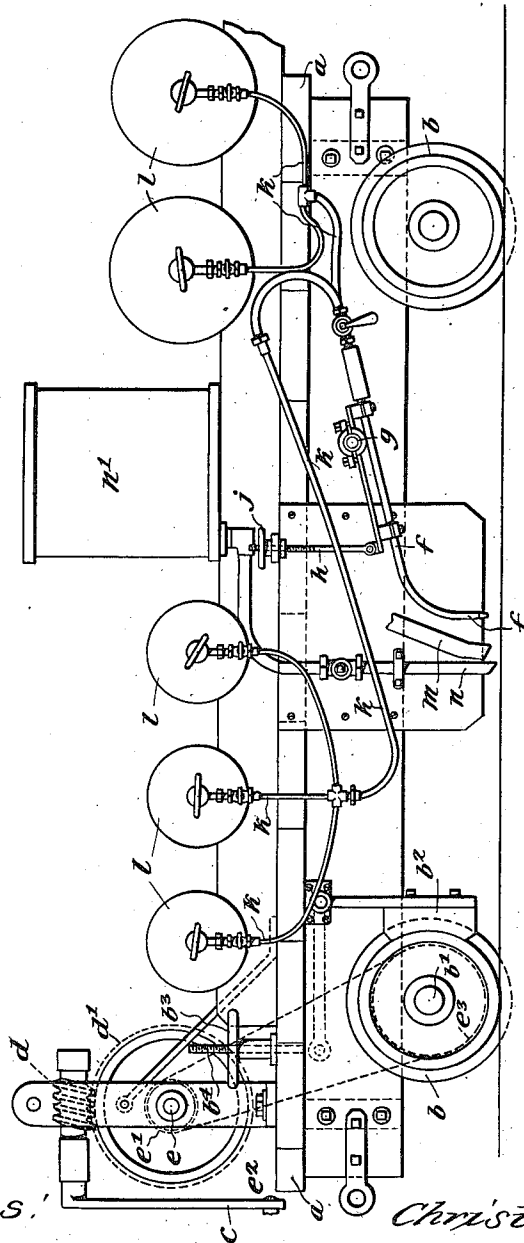


C. P. SANDBERG.
HEAT-TREATMENT OF TRACK RAILS.
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Witnesses:
Norris L. Sumby.
C. H. Keeler

Inventor:
Christer P. Sandberg
by Samuel L. Norris,
Attorney

UNITED STATES PATENT OFFICE.

CHRISTER PETER SANDBERG, OF LONDON, ENGLAND.

HEAT TREATMENT OF TRACK-RAILS.

1,277,262.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, CHRISTER PETER SANDBERG, a subject of the King of Great Britain, residing in London, England, have
5 invented a certain new and useful Heat Treatment of Track-Rails, of which the following is a specification.

This invention relates to subjecting track rails, especially tramway rails, *in situ*, to
10 heat treatment adapted to harden or temper the head or wearing surface so as to prolong the life of the rail, and for the purposes of the invention the term "rails" includes switches, points, crossings or the like.

15 In my United States Patent No. 1178352 dated the 4th day of April 1916 I have described a process of hardening the head of a steel rail to a depth sufficient materially to prolong the life of the rail by cooling the
20 head moderately rapidly through the critical range of temperature by means of an elastic fluid or vapor or atomized liquid, care being taken that the temperature to which the steel is cooled is such that any heat remain-
25 ing in the mass will not raise it again to the critical temperature.

The process has hitherto been applied either to rails in the heated condition in which they leave the rolls or to re-heated
30 rails. In other words, the rails treated have been in a condition in which they may be said to be reservoirs of heat, that is to say, a condition in which the rate of cooling of the portion under treatment has been in-
35 fluenced by the low gradient of temperature difference between the parts of the mass.

I have since discovered that the applica-
tion of this process to track rails when they show more or less wear allows continued use
40 of rails which would otherwise have to be discarded, but the cost of taking up the rails and treating them is so great that there is little or no advantage as compared with laying new rails. The process of the pres-
45 ent invention, however, is less costly, since the rails are treated *in situ*. Furthermore, I find that there is considerable advantage in treating new rails *in situ*, instead of treating them before they are laid; for the
50 strains set up in the rails during transport and laying, involving loading and unloading, bending to proper curvature, making fished joints, and the like, seriously affect the hardened portion of the head.

55 It was obvious that in treating rails *in situ* it would be impossible to heat the whole

of the rail and that it would be necessary to heat the rail in very small sections. It could not be foreseen, however, that this is not in itself sufficient; it is of the essence
60 of the invention that the heating shall not be applied section by section, step by step, but in continuous progression from end to end of the rail, in order that the necessary homogeneity may be attained. Nor could it
65 be foretold whether the required rate of cooling could be attained when the heat was thus applied locally to the steel, that is to say when the rail to be treated was only heated a small portion at a time so that there
70 was a steep gradient of temperature between the small portion heated above the critical temperature and the whole of the rest of the mass. Analogy indicated that under such
75 conditions, the rate of cooling would be much too rapid; for it is known that by locally heating the surface of a steel plate or other article to the requisite temperature, discontinuing the heating before the rest of
80 the mass has become unduly heated by conduction and allowing the whole to cool, an extremely hard skin or face sharply differentiated in structure from the rest of the mass is produced, showing that, even when
85 unaided by artificial means, the cooling is so rapid that a thin skin of very hard structure is produced.

Indeed, it has been shown that when an electric arc, impinging upon a steel surface which is to be hardened, is caused to travel
90 continuously over the surface followed immediately by a jet of cooling agent directed upon the heated spot, the heat penetrates only to a slight depth and that it is necessary that the heated spot should be surrounded
95 by metal to take up by compression the expansion of the said spot, as otherwise cracks and distortion would ensue.

It may be remarked here that such a skin-hardened surface, when subjected to shock
100 as for instance the blow of a hammer, owing to the sharp differentiation in structure, is apt to crack or chip off from the main body of the article, as also happens with ordinary
105 case hardened articles.

I have found that under proper conditions it is readily possible to attain the desired rate of cooling directly to produce the requisite hard structure in the head of the rail
110 when the heat is applied locally over its whole width, if the temperature of the head to a comparatively considerable depth is

raised above the critical range by a source of heat, such as a flame low in oxygen or otherwise insufficiently hot to burn or melt the steel in carrying out the process.

- 5 My experiments have also proved that when the heat is applied locally to a comparatively considerable depth in the head of the rail in the manner described and the steel is cooled with water, the hard structure
10 is formed to a considerable depth in the steel and gradually merges through various intermediate structures to the normal pearlitic structure of the main body; this hard structure, though capable of turning the edge of
15 a chisel, is still sufficiently tough to resist severe shock without sign of cracking or chipping, without any subsequent tempering.

The following facts illustrate the importance of the thickness of the hardened layer.

- 20 A piece of rail was divided into three portions.

No. 1 was not treated in any way.

No. 2 was treated to produce a hard skin 1/10" thick.

- 25 No. 3 was treated according to the present invention to produce a hard surface 1/2" thick and below that gradually merging into the normal structure of the mass.

- An impression test was then taken on each
30 piece by forcing a hard steel ball 19 mm. diameter into the surface of the several portions under a pressure of 50 tons (a usual specification test for rails), with the following results:—

- 35 No. 1. An impression was made of a depth of 3.6 mm.

No. 2. An impression was made of a depth of 3.4 mm.

- 40 No. 3. No impression at all, but the ball was crushed.

This shows very clearly the difference in resistance to crushing between a thin and thick hardened layer on the surface of the rail, for whereas No. 2 showed very little improvement over the untreated rail, the ball could make no impression on No. 3 and in fact was itself destroyed, although the hardness at the surfaces of Nos. 2 and 3 was the same.

- Another difficulty that had to be overcome in treating rails *in situ* was that due to expansion and contraction of the rails owing to the heating and cooling of them. This has been completely overcome, in the first
55 place by heating only a very small length of the head at one time, and in the second place by completely cooling the rail immediately after treatment, so that the heat is not conducted to the web and the flange or base of
60 the rail. For the latter purpose, where the rail is first cooled by air, after the temperature has been reduced below the critical, it is at once completely cooled by water or the like.

Still another difficulty in connection with

tramway rails was to prevent the destruction of the paving blocks, whether of wood or stone, immediately adjacent to the treated rail. At first these were destroyed by the heat, but it was found by experiment that
70 by covering them with a suitable non-conducting material such as clay, sheet asbestos or the like, they were completely protected and not affected by the heat in any way.

It is to be understood that what is aimed
75 at in the present invention is not in any sense to produce a mere skin hardening effect, but to produce a rail having a hard structure to a depth which is variable at will within certain limits, and which does
80 not cease suddenly but merges gradually into the normal structure of the main body of the steel comprised in the rail.

In carrying out the invention, to heat the rail or its surface any suitable source of heat
85 may be employed, such as a gas or oil or spirit flame, a gas flame of medium heat being generally preferable as care must be taken that while it should be possible where required to heat the steel well below the surface, it is not caused to burn, melt or flow.
90 An ordinary blow pipe flame or an oxy-acetylene flame low in oxygen, is for instance, suitable; or, for the same purpose, a very hot flame may be employed with a
95 shield or sheath of more or less refractory material interposed between the flame and the rail.

Whether, an intermediate, tougher structure or a very hard, less tough structure is
100 to be formed in the rail it is necessary to heat the steel until a layer of comparatively considerable depth has been raised above the critical range. In the first case, this is necessary to obviate the formation of a very hard
105 structure in the rail owing to the rapid conduction of the heat to the rest of the mass; and in the second case it is necessary to permit, on cooling, of the production in the rail of the gradual change in structure from very
110 hard at the surface to the normal pearlitic in the main mass, as distinguished from the sharp differentiation produced when only a thin skin is very rapidly heated with a very hot flame.

To temper the rail or to produce an intermediate structure therein, the rail may be cooled in the manner described in my prior patent above referred to, or, where a very hard structure is to be produced the rail may
120 be cooled with water, brine or the like.

The processes of heating and cooling are in practice carried on continuously. For this purpose the source of heat, such as the burner or burners, and the cooling agent
125 are gradually moved along the rail.

The burner or burners and the cooling devices are so arranged that the cooling medium, whether air or water or otherwise, is directed on to the rail as closely behind the
130

flame or flames of the burner or burners as possible and where water is employed an air jet may if desired be interposed between the flame and the water to maintain the rail free of water at the point where the flame is actually playing upon it, or to prevent the collection of water in the groove of the rail at that point. If desired, also a jet of air or water may be caused to impinge on the rail in advance of the flame, to prevent the heating of the rail too far in advance, as, for instance, in joining up to a place where the rail has been already treated.

One great advantage of the process is that it tends to take out of the head of the rail the strains produced therein by rolling, straightening and bending.

Suitable apparatus for practising the invention forms the subject of my application for United States Letters Patent Serial No. 186,042 of even date herewith.

A simple and convenient form of said apparatus is, however, illustrated in the accompanying drawings, the single figure of which is a side elevation.

In the construction disclosed a platform *a* is suitably mounted on flanged wheels *b* adapted to run in the rails and upon the platform is mounted gearing adapted to be operated by hand to move the car along. As shown, the gearing comprises a handle *c*, worm *d* rotated thereby, worm-wheel *d*¹, shaft *e*, chain-wheel *e*¹ thereon, and chain *e*² driving direct on to the chain-wheel *e*³ on the driving axle *b*¹. A brake *b*² operated by the hand-wheel *b*³ and screw stem *b*⁴ is, preferably, provided on the car. Upon the car or truck and preferably between the wheels is arranged a burner of suitable construction. As shown, this consists of a blow pipe *f*, which, for the purpose of regulating or adjusting the distance of the jet above the rail is mounted upon a pivot *g* about which the burner *f* can be turned by means of the screw stem *h* and regulating wheel *j*. The burner *f* is connected by flexible piping *k* with gas cylinders *l* carried upon the car or truck to supply the burner.

Behind the burner *f* is arranged an air jet *m* for the purpose of blowing air on to the heated rail, and behind the air jet is arranged a water jet *n*, for directing water on to the rail. The air jet *m* may be supplied with air from a blower operated either by hand or automatically and carried on the car *a* in any convenient position or arranged independently thereof. Such blower may conveniently be electrically driven. The water jet *n* may be supplied with water from a tank *n*¹ on the car, as shown, or from an independent source such as an ordinary water cart or hydrant in the road.

In operation, the car is moved forward slowly, the burner projecting a flame on to the rail to heat it and the heated rail being

cooled by the air or water, or both, blown on to it as the car travels slowly.

When both rails are to be treated at once, similar apparatus may be arranged at both sides of the car.

Having thus described the nature of the said invention and the best means I know of carrying the same into practical effect, I claim:—

1. A method of hardening or tempering track rails *in situ* so as to produce in the head of the rail a hard structure which extends from the wearing surface into the mass of metal and merges gradually into the normal structure of the main body of the steel, which method consists in moving slowly and continuously along the surface of the rail a source of heat adapted to direct the heat against a very small portion of the wearing surface but to heat said surface over its whole width and to heat the head of the rail to a desired, and in any case considerable, depth to a temperature above the critical range and directing a cooling medium on to the rail immediately in the rear of the source of heat to cool the rail to a temperature below the critical.

2. A method of hardening or tempering track rails *in situ* so as to produce in the head of the rail a hard structure which extends from the wearing surface into the mass of metal and merges gradually into the normal structure of the main body of the steel, which method consists in moving slowly and continuously along the surface of the rail a source of heat adapted to direct the heat against a very small portion of the wearing surface but to heat said surface over its whole width and to heat the head of the rail to a desired, and in any case considerable, depth to a temperature above the critical range and cooling the rail moderately rapidly immediately in the rear of the source of heat to a temperature below the critical by means of a flow of cooling agent.

3. A method of hardening or tempering track rails *in situ* so as to produce in the head of the rail a hard structure which extends from the wearing surface into the mass of metal and merges gradually into the normal structure of the main body of the steel, which method consists in moving slowly and continuously along the surface of the rail a source of heat adapted to direct the heat against a very small portion of the wearing surface but to heat said surface over its whole width and to heat the head of the rail to a desired, and in any case, considerable, depth to a temperature above the critical range and cooling the rail immediately in the rear of the source of heat.

4. A method of hardening or tempering track rails *in situ* so as to produce in the head of the rail a hard structure which extends from the wearing surface into the

mass of metal and merges gradually into
the normal structure of the main body of
the steel, which method consists in moving
slowly and continuously along the surface
5 of the rail a source of heat adapted to direct
the heat against a very small portion of the
wearing surface but to heat said surface
over its whole width and to heat the head
of the rail to a desired, and in any case,
10 considerable, depth to a temperature above
the critical range and cooling the rail im-

mediately in the rear of the source of heat
by directing at the same time and in close
succession a blast of elastic fluid and a jet
of cooling liquid on to the rail.

In testimony whereof I have signed my
name to this specification in the presence of
two subscribing witnesses.

CHRISTER PETER SANDBERG.

Witnesses:

E. S. ORMSBY,

L. M. NEWLANDS.