(No Model.)

J. COFFIN.

PROCESS OF AND APPARATUS FOR TOUGHENING STEEL AXLES.

No. 367,961. Patented Aug. 9, 1887.

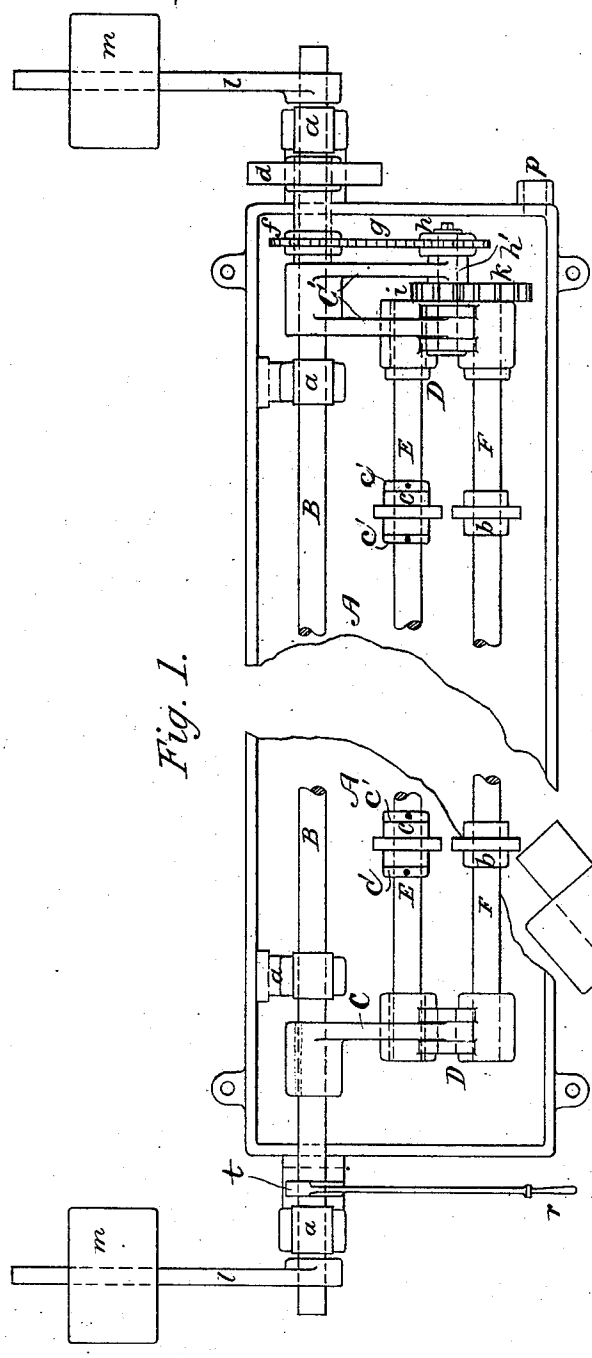


Fig. 1.

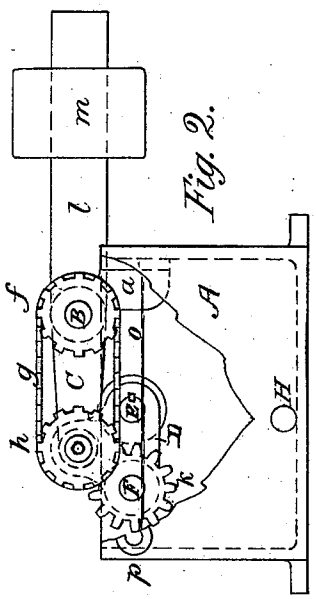


Fig. 2.

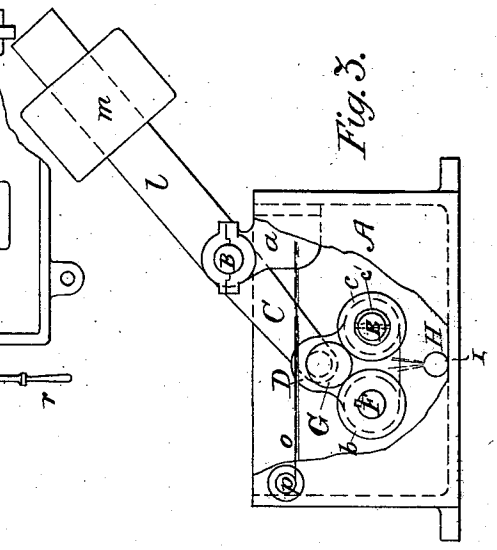


Fig. 3.

Witnesses
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UNITED STATES PATENT OFFICE.

JOHN COFFIN, OF JOHNSTOWN, PENNSYLVANIA.

PROCESS OF AND APPARATUS FOR TOUGHENING STEEL AXLES.

SPECIFICATION forming part of Letters Patent No. 367,961, dated August 9, 1887.

Application filed December 11, 1886. Serial No. 221,312. (No model.)

To all whom it may concern:

Be it known that I, JOHN COFFIN, of Johnstown, in the county of Cambria and State of Pennsylvania, have invented certain new and useful Improvements in Process of and Apparatus for Toughening Steel Axles; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to a process of and apparatus for the treatment of steel axles after they have been forged into form, whereby the metal of the axles is toughened and their strength to resist percussive and torsional strains greatly increased.

My process consists, essentially, in first cooling off the forged axle and then reheating it evenly, so that a proper degree of heat will be evenly diffused throughout its body or material, then exposing the heated axle to a bath of cold water in an apparatus that will revolve the axle in this body of water, which is maintained at a proper temperature, and while the axle is revolving in the bath subject it throughout its length to a copious spray of water-jets, that dissipates the heat thrown off by it, and, finally, at a proper stage of the cooling process, that leaves a heated core in the axle, it is removed and allowed to cool off in the open air, the passage of caloric from the interior of the partly-cooled axle through the chilled shell effecting a rearrangement of the molecules in such relation to each other as a structural mass as to produce a high degree of cohesive and torsional strength and consequent durability of the axle so treated.

With the object just stated in view, I provide an apparatus that will rapidly rotate the axle in a bath of water, furnish a spray of fresh cold water to impinge upon, and rapidly change the temperature of the water envelope that is heated by contact and consequent absorption of caloric from the revolving axle, and, further, that will permit the axle to be elevated from the water bath, or alternately raised and lowered in this bath, as will be hereinafter specifically described with reference to annexed drawings and also pointed out in the claims.

In the drawings making a part of this specification, Figure 1 is a plan view of the bosh and attached mechanism. Fig. 2 is an end elevation of the device, with mechanism in position to receive a heated axle. Fig. 3 is an end elevation of the bosh, with an axle in position to be operated upon by jets and wave currents of cold water.

In the manufacture of steel axles as heretofore conducted it is very difficult to finish the axle from the power-hammer with a good structural arrangement of its component molecules, as the high heat given to its body to permit rapid manipulation has a tendency to disarrange and render non-homogeneous the atomic body of the axle finished under such methods of manipulation.

To correct the defects incident to ordinary processes of manufacture, I have devised my improved process of reheating and rapid partial cooling of the surface a proper depth, leaving the heart or core of the metallic mass in an incandescent condition.

To assure the equal cooling of the body of the axle, and thus prevent or overcome any tendency to spring or warp that would result from an uneven contraction of the surface, I have provided a mechanical device that will rotate the submerged axle rapidly, and in order to keep the water bath at a proper temperature, and also prevent spheroidal formation due to ebullition, I furnish the bosh or water bath with a spray-pipe that projects numerous jets of cold water upon and around the revolving axle. I keep the axle in this cooling-bath until the outside becomes black. The heat of the center of the axle should be sufficient to raise the outer surface of the body to a low red heat in the dark. I then place the axle upon a support that will afford a free circulation of air completely around the body and permit it to cool evenly and slowly, protected from drafts of air.

I will now proceed to describe the apparatus by which a uniform and rapid "shell-chill" is given the reheated axle.

Referring to the drawings, A represents the water-tank or bosh. It is also a supporting-frame for the operative mechanism by which the axle is rotated and vibrated vertically in the aqueous bath.

a a are bracket-arms that are furnished with perforated bosses or boxes that support and permit the rotation of the shaft B.

C' C are projecting arms that are rigidly secured to the shaft B by their hubs. These arms pivotally support upon their free ends the swinging hangers D D. The hangers D D are provided at their lower ends with perforated bearings for the reception of the shafts E and F. The shaft F is loosely supported in its bearings, free to turn or rotate therein. The shaft E is keyed or otherwise firmly attached in place to its supporting-boxes, that are formed integral with appropriate arms of the bifurcated hangers D D. Upon the shaft F the hubbed disks or wheels *b b* are secured with their peripheries concentric with this shaft. The position given these wheels *b b* is shown in Fig. 1. The wheels *c c*, that are loosely mounted upon the shaft E, are held directly opposite their mated wheels *b b* by the fixed collars *c'*, which prevent a lateral displacement, but permit free rotative movement on their supporting-shaft E. The distance between the shafts F and E is such that the peripheries of the wheels *b b c c* are near each other, but do not have actual contact. The tight and loose pairs of wheels *b c b c* form a cradle or support for the axle G to be operated upon, it being placed to rest between their opposed curved edges, as shown at G in Fig. 3.

Upon the shaft B the pulley *d* is mounted, and upon the same sleeve or extended hub to which this pulley is affixed the sprocket-wheel *f* is also rigidly secured. The sprocket-wheel *h* is fixed to the outer end of the short shaft *h'*, that is journaled and has its bearings in the boxes formed on the free ends of the twin arms C'. The endless chain *g* is placed upon the wheels *f* and *h*, as shown in Fig. 1, and serves to transmit motion from the pulley to the shafts E F, as will be explained. Upon the shaft *h'* the gear-wheel *i* is also mounted between the boxes on the outer ends of the bracket-arms C'. The gear-wheel *i* meshes with a mated pinion, *k*, that is fastened upon the outer end of the shaft F.

The arms *l* are attached to the outer ends of the shaft B, and they have adjustable counterpoise-weights *m*, movably secured upon them. At *t*, Fig. 1, the lever or handle *r* is fixed upon the shaft B, to permit by a vertical vibration the oscillation of the superimposed axle G and its sustaining-cradle.

At I in Figs. 2 and 3 the spray-pipe H is located. It is extended longitudinally through the lower portion of the bosh A, and is attached by one of its ends to a feed-water pipe that communicates with a reservoir or other assured water-supply that will deliver water continuously under proper head or pressure. The height to which water is carried in the bosh A is shown at *o* in Figs. 2 and 3, and is maintained at that level by the overflow or outlet pipe *p*, that conducts the outflow of water to a sewer or other water-conduit. The pipe H is perforated through its top surface at proper intervals from end to end, and these orifices are of such size as to permit strong jets of water to be forcibly ejected upwardly to impinge upon the surface of the submerged axle when it is in position upon the cradle, hereinbefore described.

When rotary motion is given the pulley *d* by a belt connected to a pulley on a line-shaft or any other source of power, the heated axle G, that is placed between the edges of the supporting-wheels *b c b c*, will have rotary motion given it, and the sprays or jets of water issuing from the pipe H will impinge upon the surface of this axle. The wave action created by alternately raising and lowering the axle G and its supports in the bosh A, together with the spray of the jets just described, will rapidly cool the exterior surface of the rotating axle by reason of the agitation of the aqueous bath and the constant change of the water composing it. By rotating the axle rapidly its surface is cooled evenly and the tendency to warp or bend is corrected.

I would further explain that I prefer to take an axle from the hammer after it is forged complete and allow it to cool until it is black, it being best to permit the carbon to pass into the unhardening state. When it is reheated, the expansion and consequent separation of the component molecules will accomplish a rearrangement of these atomic particles of matter. The axle, when reheated, is raised to a temperature corresponding to a low orange color, care being taken to prevent scale forming to any extent. This heat is proper for a steel axle that contains from twenty-five to thirty per cent. of carbon. The axle, when it is heated to the temperature just stated, is removed and deposited on the cradle formed by the revolving wheels *b c b c*, they being in motion, and the cradle raised by depressing the counterpoise-weights *l*, as seen in Fig. 2. The axle G is then submerged in the water-bath and brought into contact with the spraying-jets from the pipe H. After an immersion and agitation in the bath for a period of from ten to twenty seconds it is removed. If the water has been of sufficiently low temperature, a preferred average being from 50° to 60° Fahrenheit, the axle will when removed, if the conditions have been complied with, assume a black color or unheated appearance upon its exterior surface. This chill, however, is only a shell of not over one-half the distance to the center of the axle, the core or heart of the axle being still highly heated. The axle, being laid upon a level surface that is dry, is now allowed to gradually cool by contact with the air without exposure to drafts of the same that might cool it unequally and cause it to spring or warp lengthwise. The concentrated heat that remains in the center or core of the axle when removed from the water bath will be sufficient to raise the exterior chilled surface to a low red heat in the dark if the process is properly conducted.

I do not desire to confine myself to the precise apparatus and manner of manipulation herein described, as other mechanism may be

employed to attain the desired results; nor do I wish to be restricted to the exact handling of the axle as herein described, as the same results may be obtained by heating the axle and entirely cooling it in the spray bath, and then reheating the same gradually in a furnace until the entire body shows a low red heat when in the dark. I prefer the first method, as it insures more satisfactory results, and at the same time can be conducted more rapidly.

Other slight changes might be made in the mechanism, material composing the bath, and manipulation of the same without exceeding the scope or violating the spirit of my invention—as, for instance, oil, or a mixture of oil, soda, and water, or salt and water, may be substituted for an unmixed water bath. I do not therefore wish to strictly confine myself to the exact methods, liquids, and apparatus shown and described.

I am aware that it is old in hardening files to provide the tank containing the liquid with paddle-wheels adapted to agitate the liquid while the files are immersed therein; also, that it is old in hardening and tempering metals to employ a heating-chamber and underneath the bed of same a cistern containing oil or other liquid, into which the heated article can be lowered without removing it from the device upon which it was supported while in the furnace, and hence I make no claim to such construction.

Having fully described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. The process of toughening steel axles after they have been forged, consisting in first cooling the axle completely after it leaves the forging-hammer, then reheating it, and partially cooling the same by revolving it under water or other suitable cooling mixture, liquid, or medium, the said cooling medium being agitated by means of submerged jets or other means, and then removing this axle while there is sufficient heat remaining in the interior of its body to raise the outer surface to a low red color in the dark, substantially as set forth.

2. The process herein described of toughening a steel axle, consisting in cooling it off after it has been forged, then reheating it and partially cooling in water or other suitable mixture or medium, which is agitated by means of submerged jets or other circulating devices, and, finally, removing it from the cooling-bath while there is sufficient heat remaining in it to bring the whole to a red heat in the dark, substantially as set forth.

3. In apparatus to cool axles, consisting, essentially, of a water trough or bosh, a cradle or support for holding the axle within said trough or bosh, a lever for elevating and lowering said cradle, and device for rotating the axle, substantially as set forth.

4. In apparatus for cooling axles, the combination, with a water trough or bosh, and liquid-supply pipe having openings through which jets of liquid are forced, of a vertically-movable cradle adapted to support the axle, and devices for rotating the axle while on said cradle, substantially as set forth.

5. In an apparatus for cooling axles, the combination, with a water trough or bosh, a water-supply pipe, and a vertical movable cradle located within said trough, of devices for rotating the axle, substantially as and for the purpose set forth.

6. An apparatus for cooling hot steel axles, consisting, essentially, of a bosh or water-tank, a bracket-supported shaft that is provided with fixed arms that have adjustable weights located thereon, a loose driving-pulley mounted on this shaft, a sprocket-wheel fast to the same sleeve upon which the drive-pulley is mounted, two arms that are affixed to the weighted shaft, two forked depending bracket-arms attached to the ends of these projecting arms, two parallel shafts secured in these depending brackets, one shaft fixed in place, the other free to revolve, a short shaft supporting a sprocket-wheel and a gear-wheel, a chain to connect the sprocket-wheels, a twin gear-wheel to mesh with the first gear-wheel, two sets of opposed bearing-wheels mounted on the parallel shafts, and a lever to move the weighted shafts, and thus oscillate the axle-bearing and rotating mechanism, substantially as set forth.

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

JOHN COFFIN.

Witnesses:
J. G. Cox,
W. A. Spahr.