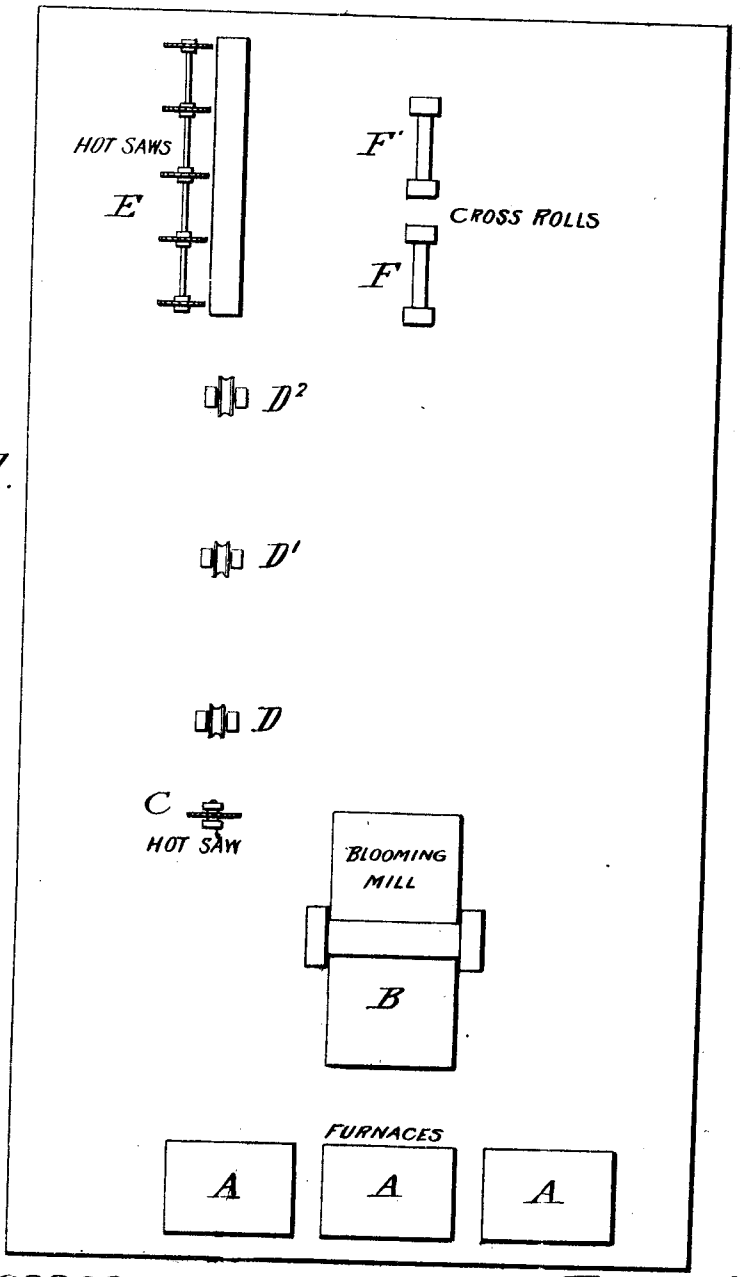
A. C. CUNNINGHAM.
MANUFACTURE OF CAR AXLES.
APPLICATION FILED DEC. 21, 1909.

1,068,630.

Patented July 29, 1913.

2 SHEETS—SHEET 1.

Fig. 1.



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2 SHEETS—SHEET 2.

Fig. 3.

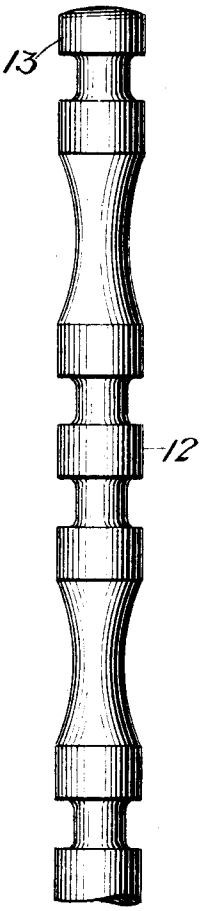


Fig. 4.

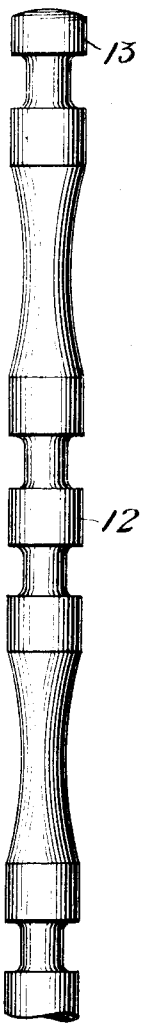


Fig. 5.

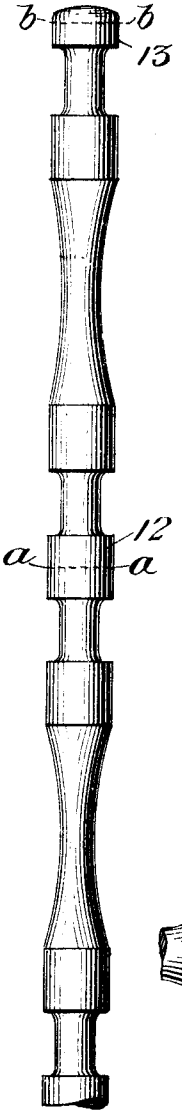


Fig. 6.



Fig. 7.

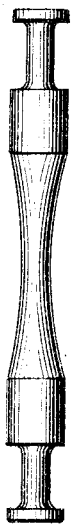
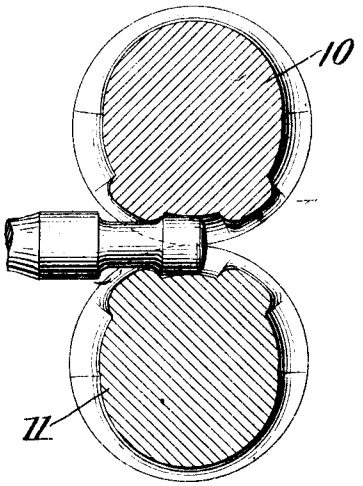


Fig. 2.



Witnesses.

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[illegible]

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UNITED STATES PATENT OFFICE.

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MANUFACTURE OF CAR-AXLES.

1,068,630. Specification of Letters Patent. Patented July 29, 1913.

Application filed December 21, 1909. Serial No. 534,324.

To all whom it may concern:

Be it known that I, ANDREW C. CUNNINGHAM, a citizen of the United States, and resident of Norfolk, county of Norfolk, and State of Virginia, have invented certain new and useful Improvements in the Manufacture of Car-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.

This invention relates to the manufacture of car axles of the standard type and in particular to methods of rolling such axles according to which a round or billet is passed longitudinally through several trains of rolls, or through several separate passes of the same rolls, the rolls taking the form of dies that impress into the round the desired pattern. The dies effect a lengthening and reduction of the round at the same time that the desired shape is being gradually produced by the successively acting passes. In methods of this character, which embody no rolling other than a longitudinal one, considerable difficulty arises in giving to the axle its proper final shape, and the requisite straightening out and hardening of the formed axle is usually effected by means of a complicated and unsatisfactory process that is entirely independent of the rolling operation and forms an entirely separate step, necessitating various manipulations of the partially formed axle and several heatings of the latter. Again, axles manufactured in this way do not have the requisite hardness at the exterior surfaces, and the structure of the steel through the axle as a whole is not uniform, which is often due to the fact that the article is forged after rolling, and that it is well nigh impossible to obtain a uniform hardness throughout the length of the axle.

The object of the present invention is to obviate these defects in the present unsatisfactory methods of producing rolled axles, and to furnish a method which provides in a simple and effective way for the straightening, hardening and finishing of the axles after they have been rolled longitudinally and while they retain the original heat, so that the entire process of longitudinally rolling the axles to produce a close approximation of the final shape, and also of straightening, hardening and finishing such axles takes place without using any heat other than that which is given by the furnaces out of which the original ingots are taken prior to the division of each ingot into the billets or rounds, from which the axles are fashioned.

According to this invention the straightening, hardening and finishing of the partially formed axles is effected by cross rolls of appropriate form through which they are passed when they come out of the last longitudinal train, and this operation takes place at a time when the axles have just the proper heat for the hardening process. It is also proposed to temper the axles during the cross rolling so that great hardness and toughness will be obtained by the simultaneous condensing action of the cross rolls and the hardening that is derived from the blast of air, water or other fluid that is directed against the axle at this stage of the proceeding, and it will be manifest that in this way a considerable simplification of the process as a whole is obtained, the axle being then ready for turning down in a lathe though it has been found that in this latter operation it is only necessary to remove an extremely small amount of the surface metal. It is also apparent that this not only brings about great economy in the use of the steel but prevents the removal of the greater part of the hardest metal, viz. the metal at the surface of the axle. In carrying out the process it is preferable to produce a number of axles from the same round or billet which axles are connected during the longitudinal rolling, but cut apart for the cross rolling and finishing, and this simultaneous forming of a number of axles can also be carried out at a single heat, as above indicated.

In the accompanying drawing; Figure 1 is a diagrammatic plan view of a rolling mill plant such as is used in carrying out the improved method; Fig. 2 is a transverse section through a train of rolls for longitudinal rolling; Figs. 3, 4 and 5 illustrate the round as it appears at different stages of the longitudinal rolling; Fig. 6 shows the partially formed axle as it appears after passing through the straightening and hardening cross rolls; and Fig. 7 shows the finished axle, as it appears after its final machining.

Referring particularly to Fig. 1, I prefer to carry on the manufacture of the axles in a plant comprising furnaces A, a blooming mill B, to form the hot ingots into billets or rounds of the requisite size and

shape; a hot saw C, to cut off the crop end of the round mills D, D′ and D², to effect the longitudinal rolling of the round; hot saws E, by which the partially formed axles in the round are cut away from each other; and cross rolls F, F′, which effect the hardening and finishing of the separate axles. It is to be understood, however, that I do not limit myself to the use of any special apparatus and that the general arrangement of the plant is capable of wide modification. The form of the furnaces, blooming mill, and hot saws is entirely immaterial to the invention, and the mills D, D′, D², which may be varied in number and arrangement, only need to have the general characteristics shown in Fig. 2, that is to say, the upper and lower rolls 10, 11, through which the round is passed axially, need only be provided with such projections and depressions as to impress in the round the shape that is desired at the corresponding stage in the operation. Cross rolls are well known in the art, and it is therefore unnecessary to describe in detail the construction of my cross rolls F, F′, but it might be remarked that a satisfactory form of such rolls, together with the tempering devices associated therewith, is illustrated in my Patent No. 938,827, dated Nov. 2, 1909.

In carrying out the improved method, the ingots are transferred from the furnaces A to the blooming mill B, by means of which they are formed in a well known way into suitable rounds of the requisite length and diameter, such rounds being turned out of the blooming mill while still at a comparatively high heat. As each round is taken out of this mill, it is passed to the hot saw C, which cuts off the crop end. The round then starts through the series of rolls D, D′, D², which are preferably in alinement, as shown. Assuming for purposes of description that a car axle of simple form is to be made, although an axle with as many shoulders and diameters as desired would be made in the same way, the passage of the round through the first mill D only gives it a rough approximation of the final finished axle. This makes an easy draft on the hot metal and prevents cracks and fracture. It is not necessary to limit the original round to a length that will produce one axle, but it is preferable to have it long enough to produce two or more, as above indicated, and in this case the rolls are of such size and shape as to impress in the round a number of continuous patterns, so that after passing through the first mill, for instance, the round takes the form shown in Fig. 3. It will be noted that the roughly formed axles shown in this figure are connected by a portion 12, and that at the extreme end of the round there is a smooth portion 13. The partly shaped round then passes onto the next mill D′ and is further lengthened and reduced and brought toward the final shape; in this second mill the junctions between the different diameters may be made on easy curves or fillets to avoid fracture of the metal, and the round will be given the form shown in Fig. 4. The shaped bar then passes to the third mill D², where the junctions between the different diameters or the fillets, may be made sharp or as close to the form desired as possible, as shown in Fig. 5. Of course, as many mills of this kind may be used as desired in order to make the draft or distortion on the hot metal sufficiently easy and to perfect the junctions between the different diameters. After the round has had one or more axle shapes rolled into it by the several longitudinal mills it is passed to the group or hot saws E where it is sawed into its individual axles. The end (13) of the first or leading axle, the junctions (12) between the axles, and the end of the last axle (not shown), are purposely made of extra length as, compared with the finished machined axle, as this saves fine adjustment in placing the round in position for hot sawing and gives surplus length for finishing the axle to length in a lathe. The various cylinders or shaped portions are also made of lengths which permit the desired machining to produce a finished axle of the required dimensions. The surplus at the ends also allows for variation in shrinkage due to the variation in temperature, as does also the making of the various cylinders and shaped portions somewhat larger than the machined dimensions. The axles, as they come from the last mill D² and from the hot saws E, need not be perfectly straight or truly round; for a tempered axle it is preferable that they should be of an elliptical or flattened section, in which case the passes of the longitudinal rolls are made of appropriate profile. When the round reaches the hot saws E it will retain sufficient heat to permit the proper operation of the latter and after the individual axles have been severed from each other (Fig. 6) they pass to the finishing and tempering cross rolls F, F′, by which they are straightened and the various cross sections made truly round; at the same time, the axle can be tempered if desired, by directing against it, while it is being straightened and condensed by the cross rolls, a blast of air, water, oil or other fluid, as will be well understood in the art, the axle retaining sufficient heat to undergo this operation properly. In this way the shaping, finishing and tempering of a number of axles rolled longitudinally while connected together in a single round, may be effected at a single heat, and there is therefore not only a great simplification of the operation as a whole but also great uniformity and density in the finished axle, which will be found

to be perfectly straight and of great hardness, ductility and strength. The surplus which is left on the end of the axles when the latter are severed from each other and cut along the lines *a*, *a*, and *b*, *b* indicated on Fig. 5, is of advantage in the finishing rolls for preserving the final collar, that is subsequently machined, from being fractured, and in keeping the end perfectly straight and protecting it during tempering. After the axle has been straightened, rounded and tempered, if desired, and has taken the form shown in Fig. 6, it is ready for its final machining, which will give it the shape illustrated in Fig. 7. By carrying out the process in the manner described the machining is reduced to a minimum, and the waste or scrap is made almost negligible; this also has the result that a maximum amount of the most highly refined metal, to wit, that at the surface of the axle, is retained.

The longitudinal rolls D, D′, D² may have a single groove or pass, in which case they will be changed for each different pattern of axle, or they may have several grooves or passes, each for a different pattern of axle, which will permit different patterns to be made without changing the rolls, or different patterns may be made successively at the same rolling. In the latter case the finishing and tempering passes will have rolls corresponding to the patterns of the axles that are being rolled.

The degree of temper depends on the difference of initial and final heat, and also on the rate of cooling, the latter being influenced by the temperature of the cooling medium. The hardest tempers are produced from the highest initial heats, and mercury will produce a much harder temper than oil. Cold water will also produce a much harder temper than boiling water.

According to this process the temper of the different parts of the axle can be varied if desired. The journal can be made hard, the wheel seat more moderate, and the central portion of the axle, which is subject to the greatest bending strains, still softer. This is done by varying the time of application of the different parts of the blast, and also by the duration of the time of application of the different parts; also, I can go still farther, and vary the temperature of the different parts of the blast. All this, it is apparent, is very simple in application. As a result the axle may be of uniform or varying temper, as desired, on longitudinal elements, and of uniformly varying temper on radial elements.

What I claim is:—

A method of rolling car axles which comprises passing a suitable round or billet longitudinally through a series of rolls that impress into it a pattern approximating that of the finished axle, and then straightening and finishing the axle by passing it in a transverse direction through suitable cross rolls; substantially as described.

In testimony whereof I affix my signature, in presence of two witnesses.

ANDREW C. CUNNINGHAM

Witnesses:
C. D. THURBER,
ELLIS B. NOYES