not occur with molten ferro-manganese, and red-shortness is therefore practically impossible. The absorption of the manganese also proceeds more uniformly, the mixing being more complete, deoxidization is more energetic, and rephosphorization is precluded. Finally, a saving of time is effected by using molten material, the output of steel being, therefore, correspondingly increased.

SPECIFICATIONS FOR HEAT-TREATED CARBON STEEL AXLES, SHAFTS, AND SIMILAR PARTS.*

Process of Manufacture.

1. Steel under this specification shall be made by the open-hearth or other approved process.

Discard.

2. A sufficient amount of discard must be made from each ingot to insure freedom from piping and undue segregation.

Chemical Composition.

3. The steel shall conform to the following limits in chemical composition:

Carbon	Not over 0.60 per cent.
Manganese	0.40 to 0.80 per cent.
Phosphorus	Not over 0.05 per cent.
Sulphur	Not over 0.05 per cent.

Samples for Chemical Analysis.

4. Drillings shall be taken from the crop end of one axle, shaft, or similar part from each melt represented, parallel to the axis on any radius one-half the distance from the center to circumference, to determine whether the chemical composition of the heat is within the limits specified in Paragraph 3.

In addition to the complete analysis, the purchaser has a right to call for a phosphorus determination to be made from turnings from each tensile test specimen, and the phosphorus must show within the limits called for by Paragraph 3.

Tensile Test.

5. The steel shall conform to the following physical properties:

Ultimate strength, lb. per sq. in.	85,000
Elastic limit, lb. per sq. in.	50,000
Elongation in 2 in., per cent.	22
Reduction of area, per cent.	45

The elastic limit shall be determined by extensometer. Above 40,000 lbs. per sq. in., each increment of load shall be not more than 1,000 lbs. per sq. in.

Specimen for Tensile Test.

6. The test specimen, 0.5-in. diameter and 2-in. gauge length, shall be used to determine the physical properties as specified in Paragraph 5. Test specimens shall be taken from the crop end of one axle, shaft, or similar part, from each treating-plant heat; if more than one open-hearth heat is represented in a treating-plant heat, a test shall be taken from each open-hearth heat represented. A full-size prolongation shall be left on each axle, shaft, or similar part.

Cold Bend Test.

7. A cold bend test shall be made from the crop end of one axle, shaft, or similar part, from each treating-plant heat; if more than one open-hearth heat is represented in a treating-plant heat, a test shall be taken from each open-hearth heat represented. The test shall be made with a ½-in. square specimen, not exceeding 6 ins. in length, around a flat mandrel with edges of ½-in. radius, and the specimen shall bend, without fracture, 180 deg. around the said mandrel.

Location of Specimens for Tensile Test and Cold Bend Test.

8. Specimens for tensile test and cold bend test shall be taken parallel to the axis of the axle or shaft and on any radius one-half the distance from the center to the circumference.

Re-Testing.

9. In case the physical results obtained from any lot of axles, shafts, or similar parts, do not conform to those called for by Paragraphs 5 and 7, the manufacturer shall have the privilege of re-treating such parts, from which new tests shall be taken by the purchaser, and these shall govern the acceptance or rejection of the lot.

Heat Treatment.

10. Each axle, shaft, or similar part shall be allowed to cool after forging, shall then be re-heated to the proper temperature, quenched in some medium, allowed to cool, and then re-heated to the proper temperature for annealing.

Warped Axles or Shafts.

11. Warped axles or shafts or similar parts must be straightened hot; that is, at a temperature above 900 deg. Fahr. and before offering the parts for test.

Quality.

12. All axles, shafts, and similar parts shall be free from cracks, seams, flaws, or other injurious imperfections when finished. Those which show such defects while being finished by the purchaser will be rejected and returned to the manufacturer, who must pay return freight.

Finish.

13. All axles, shafts, and similar parts must be rough-turned with an allowance of ⅜ in. on surface for finishing, except on collar, which is to be left rough forged. Turning must be done on 60-deg. centers with clearance drilled at point.

Branding.

14. The heat number shall be stamped on the rough forged collar. After rough turning, the manufacturer's name, heat number, individual axle, or shaft number, and inspector's mark shall be stamped at place indicated by the purchaser, except at any point between the rough collars.

Inspection.

15. The inspector representing the purchaser shall have free entry, at all times while his contract is being executed, to all portions of the manufacturer's shop which concerns the manufacture of material ordered. All reasonable facilities shall be afforded to the inspector by the manufacturer to satisfy him that the axles, shafts and similar parts are being furnished in accordance with the specifications. All tests and inspection shall be made at the place of manufacture prior to shipment and free of cost to the purchaser. The purchaser shall have the right to make tests to govern the acceptance or rejection in their own test room, or elsewhere, as may be decided by the purchaser, such test, however, to be made at the expense of the purchaser and to be made prior to the shipment of the material. Unless otherwise arranged, any protest based on such tests must be made within six days, to be valid. Tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the mill.

*From Report of Committee to American Electric Railway Association, Oct. 9, 1911.