Mechanical and Engineering Section.

Testing and Inspection of Railroad Supplies.*

BY ROBERT JOB.

Chemist of the Philadelphia & Reading Railway Company.

In the time at our disposal to-night it will be impossible to give more than a very brief outline of some of the more important testing regularly carried on by the Philadelphia & Reading Railway.

The main object of the Test Department is to determine the kind and quality of material most efficient and economical for any given purpose, and then by means of routine tests to hold shipments fully up to the desired standard. The plan usually followed is to get together all the information obtainable regarding the particular article to be investigated, decide through study of service tests just what properties are essential to the greatest efficiency, and then work out specifications which will enable the manufacturer to understand thoroughly just what kind of material is desired and what tests must be met to insure acceptance of shipments.

These proposed specifications are referred by the Purchasing Agent to the manufacturers for their criticism, the replies are sent to the Chemist, and a final draft is then prepared with any changes necessary, submitted again if needful to the manufacturers and finally to the First Vice-President for approval.

Orders are then placed in accordance with the new standard, and on receipt of each shipment a sample is selected at random and forwarded for test. If the sample is not in accordance with the specifications the shipment is rejected, and the freight is paid by the shipper. In this manner inferior material is weeded out from the good, and discarded.

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*Read by title.

Iron in one form or another is, of course, an important item of railroad supplies. Bar iron, and the better grades for bolts and for staybolts come under this head, and also rivets, steam pipes, boiler flues, chain, iron castings, wheels, etc.

The quality is determined in part with the so-called "test machine," by which the tenacity and ductility of the metal are measured;—the cold bending test develops any cold-shortness, if present, and the hot bend any red-shortness or failure to bend when red-hot. If too much sulphur is present the iron will crack on bending hot, while excess of phosphorus will cause cold-shortness. More than a trace of copper will prevent proper welding,—and too little working in the rolls, or finishing at too high a temperature will result in brittleness, and be indicated by the bright granular condition of the fractured surfaces, instead of the long, ropy, fibrous appearance indicative of toughness and strength.

The pig-iron used for making cylinders and other castings must be low in phosphorus or the metal will be weak and brittle,—not too high in manganese and sulphur or it cannot be machined,—and close-grained and compact to insure strength and impermeability. Analyses are made of samples from each carload of pig-iron to hold it to the proper quality, and the foundry practice has been carefully studied, and treatment is applied to render the iron tough, strong and ductile.

Tests of cast-iron wheels for freight cars are made at the place of manufacture and involve measurements and weight and general inspection, and a "drop test" made by allowing a weight of 140 lbs. to fall upon the wheel from a height of twelve feet a specified number of times, depending upon the weight and size of the wheel,—twelve blows for the usual 33" wheel.

Materials of steel are of great importance, since they include such products as boiler steel, axles, rails, splice plates, springs, piston rods, crank pins, castings, general forgings, building material, etc. In fact, the very stability of the structures, the engines, and equipment depends in large degree upon the quality of the steel and iron. In the case of boiler steel, a test piece is taken from every sheet and given a tensile test to ensure the desired strength and ductility, freedom from flaws, etc.; a bending test is made after quenching, to avoid possibility of brittle-

ness, and also chemical analysis to determine and bar out more than a certain proportion of phosphorus and sulphur.

Steel rails, splice plates, axles, piston rods, crank pins, and springs, are inspected at the manufacturing plant. Each spring is pressed down solid in a testing machine, and must also have a certain height under a given load, be of correct design, etc. Also an analysis is made of one spring of every 200 to determine whether the steel may be depended upon to give good service.

Axles in addition to the usual surface inspection and measurement are subjected to a drop test to ensure freedom from brittleness, and they are also held to a definite composition to enable them to support the loads and give reliable service. Rails likewise have composition specified to secure proper hardness and toughness, and a drop test is made upon a rail-butt from each heat from the top of an ingot, allowing a 2000 lb. weight fall a distance of twenty feet striking the rail midway between two supports four feet apart. If the steel is brittle and unsafe for use, owing to defective manufacture, pipes, flaws, etc., this 40,000 foot-pound blow speedily renders the fact evident and breaks the rail, sometimes into splinters. In some cases, especially when steel has given poor service, it is necessary to make a microscopic investigation of the structure of the metal to find out the exact conditions of heat-treatment received in course of manufacture, for as is well known, good steel can be completely ruined by incorrect heat-treatment. If the steel was overheated or burned, and thus was rendered brittle and untrustworthy, the fact is clearly shown by the microscopic structure.

Passing now from iron and steel, we may mention protective coatings for metal or wood. Paints to-day are used in enormous quantity, and it is of great importance to obtain the utmost durability not merely in order to afford the necessary protection and appearance, but also to reduce labor costs and to avoid the need of frequent shopping of equipment and consequent withdrawal from urgent service. The paints are separated into their constituents and the purity or efficiency of each is determined. The linseed oil must not be of poor quality or adulterated with fish oil, mineral oil, corn oil, etc.; turpentine must be really turpentine and not benzine; and japan must be up to the specified strength and quality.

"Hot boxes" are generally due to difficulty with oil, wool-waste, or bearings, and each of these materials are held to a definite standard. A week often passes without a single hot-box upon any of the passenger equipment of the Reading.

Wool-waste for freight service must contain at least sixty-five per cent. of pure wool and be of fair length of thread, or the waste after short service would lose its elasticity and fail to remain in contact with the journal, thus cutting off the feeding of the oil to the axle.

The oil must have correct flashing and burning points, be of proper viscosity and have enough fat oil to make the mixture adhere to the steel. Signal oil must be of standard composition and quality so that the wick in the lamp will hold the flame in a gale of wind; headlight oil must not explode even when hot and jolted.

Also each kind of machinery must be lubricated with oil adapted to its weight and speed,—or loss of power, heating, or rapid wear will result, with heavy bills for maintenance or repairs.

Air-brake hose must stand a pressure of 400 lbs. per square inch, and the rubber must be tested to prove whether or not it is so adulterated with shoddy, mineral matter, paraffine, tar, etc., that its life will be gone and it will be useless within a few months. The battery materials to operate the electric track signals with which our tracks are protected must be found so free from impurities that the service rendered will be absolutely reliable.

Portland cement is very largely used in construction work, and gives excellent results when the quality is good. It may, however, be unsound and cause the work gradually to disintegrate, or it may be shipped out by the manufacturer while it is too fresh,—not properly aerated,—and if used then the concrete would not prove lasting but would crack and weaken; in these cases careful tests indicate the quality, and they often keep from service material which would have caused failure and perhaps accident.

The water supplies, both for steam and for drinking purposes, also require careful attention. The former must be of a character that will not corrode the boiler, nor on the other hand fill it with scale and necessitate frequent cleaning of the flues,

and waste of fuel, since scale one-eighth inch thick means a loss of fuel of twenty-two per cent.; also, the character of the water must be so regulated when necessary by treatment, that foaming and liability of explosion will not be possible.

Every water supply upon the Reading is tested from time to time; bad waters have been abandoned, and other supplies substituted, or, if nothing better is available, treatment is applied to neutralize the injurious results which otherwise would follow.

Every water used as a drinking supply in stations or upon cars has also been carefully analyzed to be certain that it is as free as possible from contamination.

Whenever desirable, bacteriological examinations are made to determine whether a water supply in some locality may have become contaminated and caused typhoid fever or other disease which developed.

Tin plate and roofing tin sometimes have so thin a coating of tin or composition that rusting begins after exposure of a day or two upon a roof, and we have actually received shipments in which the thickness of the tin coating averaged less than $\frac{3}{100,000}$ of an inch. Such material of course has little practical value other than that of the steel sheets of which it is composed, and the latter could be secured at far less cost than probably would be charged for the so-called "tin plate."

Insulated signal wire is tested to determine whether the copper is pure, and the rubber and other insulation of standard quality.

Soap must be free from excess of alkali, salt, and other impurities, and must not be adulterated with clay or other "fillers," and must not contain more than a definite proportion of water.

Enough instances have now been cited to convey some idea of the great variety of tests and inspections regularly made by the Test Department. In addition to such routine work, investigations are made upon materials which may have given unsatisfactory service, or which apparently have not been exactly adapted to the conditions under which they were used, in order to determine just why the failure occurred, or the service was defective, and the data thus obtained often results in revision of specifications with consequent improvement.

Investigations are also made to devise new methods for use

or renewal of waste materials or to develop new processes, large savings having been effected through such work.

The preservation of wood is a subject of the greatest importance to every railroad, and a very careful investigation has been made of all processes used and results obtained both in this country and abroad; also tree-planting upon the land at our disposal has been looked into thoroughly and estimates obtained as to the cost and ultimate return from such investment under our conditions of place and climate.

From the foregoing brief account of work of the Test Department, the fact will, I think, be evident that a persistent and earnest effort is being made to secure the grades of material best adapted to the various purposes, and such effort naturally results in relatively great durability of material, and thus in great ultimate economy combined with a high degree of safety and of efficiency in the service.

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