in reading the R-scale has but little effect on the location of the pivot-point on the diagonal. Each of the curves has been checked by calculations, and the mean error of the total readings was only 0.53 per cent. The V-scale, on which the results are usually sought, with reasonable care in reading, will give results correct to within two or three units in the third significant figure, an accuracy well within that of the original data. The selection of n, for instance, is an element which introduces an uncertainty largely in excess of this.

Other graphic solutions of this formula have been worked out, but they nearly all involve a set of diagrams, one for each value of n. So far as we know, there have been none where the entire range of all factors has been included as conveniently in one diagram.

(Continued from Page 84.)

The Brydges Engineering & Supply Company, are agents for Wm. Jacks & Company, of Glasgow, the contractors for the city at Winnipeg's high pressure station, and are prepared to design and fit similar installations in Western Canada.

The Stuart Machinery Company, had also a splendid exhibit of the lines of machinery which they handle. This company are Western agents for the McGregor Gourlay Co., of Galt; Georgian Bay Engineering Company, Midland, Ont.; Prescott Emery Wheel Company, Prescott, Ont.; Canadian Buffalo Forge Company, Montreal; the Maple Leaf Saw Works, Galt, Ont.; Frost Manufacturing Company, Galesburg, Ill.; Dodge Manufacturing Company, Toronto, Ont.; Canton Hughes Pump Company, Canton, Ohio; Beardmore Belting Co., Toronto, Electrical Construction Company, London; Stratford Mill Building Company.

The Stuart Machinery Company, not long ago had a bad fire, and their present accommodation is entirely too small, and it is the intention of the firm to erect in the near future a four-story building with all the modern conveniences for handling a large stock of machinery.

RAIL FAILURES DUE TO BURNS AND CRYSTALLIZATION, CAUSED BY SLIPPING OF ENGINE DRIVERS, BALTIMORE AND OHIO RAILROAD.*

By A. W. Thompson, Chief Engineer Maintenance of Way.

One of the less frequent causes of rail failures, and one concerning which there is very little published information, is that weakness in a rail due to the burning and crystallization of the metal by slipping of engine drivers. Undoubtedly this is deserving of more attention than it has been given in the past, as there are numerous instances on record of wrecks and derailments caused by broken rails of this class. The breaks are distinguished from other kinds and show very characteristic structure of the fracture. They occur in localities where there is unquestionably much slipping of the drivers, such as at points where an engine starts a train in pulling out from a station, and also in freight service at points where there may be a regular stop and back-up movement, as at a junction.

Such rails also might be found in yards where heavy cuts of cars are handled by a single switching engine. A probable cause for the scarcity of the latter class is the lighter weight of the switching engines in comparison with the weight of the usual road engine. The recent rapid advance in the loads on driving wheels of switching engines, particularly in the larger and better equipped yards, may result in more failed rails from this cause, especially in that part of the yard in which the push and pull method of operation may be used.

In the text of papers written upon other subjects allied to the rail question, casual mention has been quite often made of specific instances of rail which has failed from crystallization of the metal, but these discussions and records have never been isolated or carried to any definite conclusion concerning this particular subject. There must be records of this kind in the files of every railroad, and interest should be taken toward making these available to the American Railway Engineering and Maintenance of Way Association, and compiling them into comparative and intelligible form.

To furnish a beginning upon which to build, the following instances, taken from the experience of the Baltimore & Ohio Railroad, are compiled in concise form, these being selected because test of the physical and chemical properties was made of the broken rail in question. The first instance which has come to the writer's notice occurred at Salisbury Junction; a westbound passenger train, running at a speed of 40 miles per hour, being derailed while passing around a 6° 30′ curve.

This curve is to the right, with a grade descending at the rate of 1.25 feet per 100, both in the direction of traffic. At the time of the accident the temperature was 10 degrees above zero.

The rail causing the accident was 33 ft. long, A. S. C. E. section, 85 pounds per yard, rolled by the Cambria Steel Company in 1905, and laid during August of the same year; thus showing a service of about two and one-half years.

Failed Rail (Carnegie) Rolled 7-96. From Wreck at Shenandoah Junction.

The rail was in the low side of the curve, being jointed with a four-hole splice, and it broke into twelve pieces. The lengths of the pieces varied from 3 in to 24 ft., most of which were over 1½ ft. long. The attached photographs show a view of these pieces with the exception of the end pieces, which remained in the splice. At two points the breaks were square, as if sawed, but in the other cases the breaks were slanting, each in different directions. This was the only rail damaged in the accident. Gauge at point of accident was found to be 4 ft. 8⅞ in.; elevation of curve, 6¼ in.; both line and surface were good.

Microscopical tests of the rail later developed the fact that slight cracks existed in the base of the rail before the accident occurred, but these cracks were entirely too small to have been detected by even close examination with the eye before the rail became separated. The rail was inspected by track walker only a short time before the derailment took place.

The rail showed very little wear and the only marks which could be detected were those made by the slipping of the drivers of the engine. The frequency with which these marks occurred on this one rail was due to the fact that westbound freight engines stop nearly always in about this spot to back

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