If the diameter of the wheel is 33 inches, and the weight it carries, including its own weight, is 10,000 pounds, and if, in addition we assume G^1 as 2,000 pounds and h^1 as 19 feet, we have

$$d = \frac{43}{v}$$

this may be written, if v is expressed in miles per hour:

$$(2) \qquad d = \frac{29.4}{v}$$

This equation is shown graphically in Fig. 2 (a).

If we consider a locomotive drive wheel, 6 feet in diameter, carrying a weight of 25,000 pounds, the equation (1) becomes

$$(3) \qquad d = \frac{40.6}{v}$$

where v is in miles per hour and d is in feet. This equation is shown graphically in Fig. 2 (b).

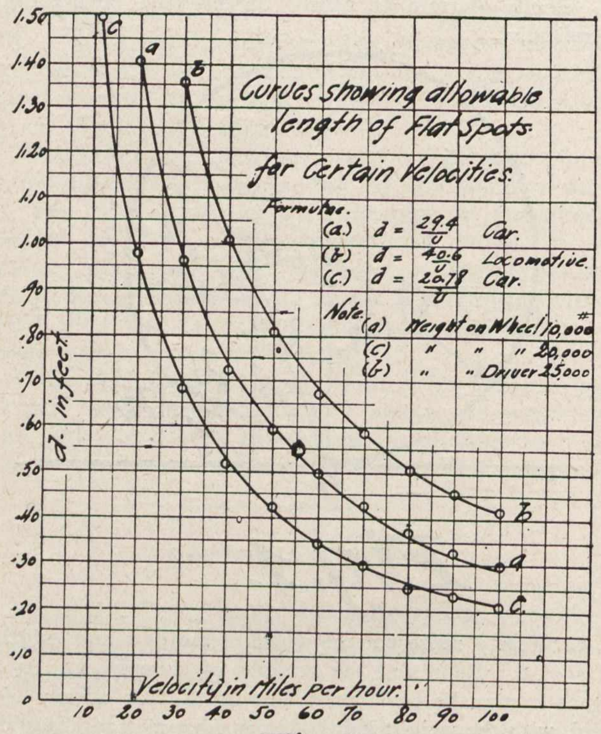

Fig. 2.

In working out the above relation between d and v no account has been taken of the action of gravity in bringing the mass down upon the rail with increased energy. The distance, equal to the distance of A below the center, approximately h/4, is so small that one might expect beforehand that the kinetic energy would be increased but little. Adding the term to account for this kinetic energy of the fall,

$\frac{M}{2}\frac{(2gh)}{4}$, equal to $\frac{Mgd^2}{4D}$, equation (1) may be written,

$$(4) \qquad d^2 = \frac{4D^2G'h'}{M}\left(\frac{1}{2v^2+gD}\right)$$

Reducing as was done in obtaining equation (2) this becomes

$$(5) \qquad d = \frac{29.16}{\sqrt{v^2+20.77}}$$

Substituting values of v, from 10 miles per hour to 100 miles per hour, in equations (2) and (5) the following values of d are obtained:

TABLE I.

v in miles per hour	Value of d in feet. (2) Wt. on wheel 10,000 lbs.	(2) Wt. on wheel 20,000 lbs.	(5)	Approximate value of d in inches. Using a factor of safety of 5. Weight 10,000	Weight 20,000	Using a factor of safety of 10. Weight 10,000	Weight 20,000
10	2.90	2.07	2.67	6.96	4.92	3.48	2.46
20	1.42	.98	1.43	3.36	2.36	1.68	1.18
30	.96	.68	.97	2.30	1.64	1.15	.82
40	.73	.52	.72	1.75	1.24	.87	.62
50	.59	.42	.586	1.41	1.00	.70	.50
60	.49	.34	.49	1.17	.82	.58	.41
70	.42	.30	.42	1.00	.72	.50	.36
80	.36	.25	.36	.86	.60	.43	.30
90	.32	.23	.33	.76	.55	.38	.27
100	.29	.21	.29	.69	.50	.34	.25

It is evident from the results shown in the above table that the results obtained from equation (5) are not very different from those obtained from equation (2). In the case of Table II. a similar statement might be made regarding equations (3) and (6), so that it is shown that the added kinetic energy acquired in falling throught the distance h/4 may be neglected.

For the locomotive wheel the equation corresponding to (5) becomes, using the same values as those used in obtaining equation (3):

$$(6) \qquad d = \frac{40.62}{\sqrt{v^2+45.31}}$$

Substituting values of v in miles per hour in equations (3) and (6), the following values of d are obtained:

TABLE II.

V in Miles Per Hour.	Values of D in Feet. Equation (3)	Equation (6)	Approximate Values of D in Inches, Using a Factor of Safety of 10.
10	4.06	3.37	4.87
20	2.03	1.92	2.43
30	1.35	1.32	1.62
40	1.01	1.00	1.21
50	.81	.805	.97
60	.67	.67	.80
70	.58	.57	.69
80	.50	.50	.600
90	.45	.45	.540
100	.41	.44	.49

In the above discussion the probability of the wheel jumping from one corner of the flat spot to the other, without falling through the height h/4, has not been considered. Such action, due to the inertia of the car, could only take place at high velocities, and its effect would probably be to reduce the impact between wheel and rail. It should be added that flat spots are not likely to be found absolutely flat, as assumed in the analysis, but rounded or worn off at the corners. For such cases the distance of fall of the axle is less than h/4, so that the kinetic energy of the impact is less than that given by the analysis.

The wheels as rotating bodies have been considered as having their mass concentrated at the center and rotating instantaneously about the point of contact of wheel and rail. The wheel is, in fact, a compound pendulum and the radius at which the mass should be considered as being concentrated is a little greater than D/2. The additional kinetic energy introduced in equations (2) and (9) by such a consideration would scarcely produce any difference in the estimated length of flat spot.

The writer is not aware that any analysis has ever been published that shows what is attempted in this paper. It is hoped that experimental data may soon be at hand to confirm or deny the results here given.

An electro-magnet has been successfully used in recovering a broken drill from the bottom of a borehole.

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*Beta.