

# Locating Automatic Block Signals for Heavy Traffic\*

## Last of Two Installments, Treats of the Relation of Speed, Train Length and Headway to Signal Spacing

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THE train operating characteristics, including the accelerating and braking speeds as influencing the spacing of signals, was explained in detail with diagrams in the first installment of this article, published in the September issue of the *Railway Signal Engineer*.

At approximately 16 m.p.h. the car motors are connected in multiple and the rate of acceleration above this point varies with the speed, finally reaching the limiting speed when the tractive effort just balances the grade and train resistance. The acceleration rate at any speed above 16 m.p.h. is shown in Fig. 9. The curves are all straight lines and are derived by subtracting the train resistance plus the grade resistance balancing efforts from the tractive effort developed by the car motor. The rates of acceleration are determined thus: For example, assume that the train has reached a speed of 19 m.p.h. and continues on a +1 per cent grade; the rate of acceleration for the continuing movement is found by referring the point of intersection of the +1 per cent grade line with the 19 m.p.h. speed line, to the acceleration scale on the diagram which we observe to be 0.91 m.p.h. per second. Continually decreasing rates of acceleration are found by referring to the successive intersections as before until the speed of 33 m.p.h. is reached, which is the limiting speed for a +1 per cent grade.

Figure 9 serves added usefulness in determining negative rates of acceleration, that is, slowing up. For example, if a train be moving at a speed in excess of the limiting speed for the grade which it encounters, the train will slow up and the rate of slowing up is found thus: Assume the speed to be 40 m.p.h. and the grade entered to be +6 per cent, follow down the speed line for 40 m.p.h. until it intersects the dotted diagonal line for +6 per cent grade and project a horizontal line to the left and the acceleration is found to be 1.15 m.p.h. per second except that it is negative acceleration—now following down the dotted diagonal line and projecting the several intersection points to the left we find a continually decreasing rate of slowing up until 18½ m.p.h. speed is reached, which is the limiting speed for a +6 per cent grade.

### Train Length, Speed and Headway

Figure 10 shows the very intimate relation between train length, minimum headway and speed. The curves set forth the relation existing between speed, free running headway and length of train for a level track road with no signals, the same road equipped with a two block overlap signal system and the same road equipped with a one block overlap signal system.

We have previously mentioned that the ability to run trains depends on the ability to protect them, and in the

curves shown hereon consideration has been given to providing suitable braking distance, which has been assumed as emergency braking distance 50 per cent for the speed concerned. Curves *d, e, f, g, h* and *i* are based on the assumption that the signal system is two block indication and also include an element of time which is provided to allow for the signal equipment to change the indication after the preceding train had passed out of the control, and to allow for the identification of the signal by the following train. This time has been assumed at 2½ sec. in each case of a total of 5 seconds. The 2½ sec. time allowance for identification of the green signal provides a sighting distance proportional to the speed and this distance, as will be noted by referring to the inset curve, varies from 55 ft. at a speed of 15 m.p.h. to 185 ft. at 50 m.p.h.

Curve *A* establishes the relation existing between speed and headway when a train is considered as a point only

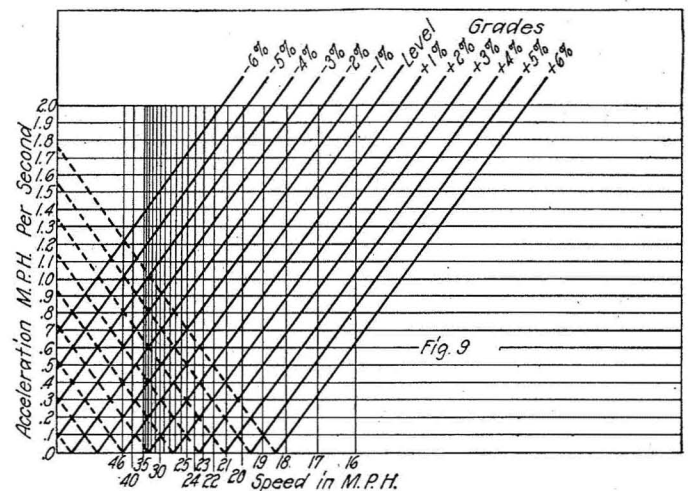


Fig. 9. Acceleration Above 16 M.P.H.

and is the only curve with zero point of origin. This is the fact, because at zero speed, zero train length requires no braking distance. When the element of speed is introduced we must also provide the element *braking distance* and the trains must be spaced apart. When the trains are separated by any distance, however small, time must be allowed for the train to run this distance, thereby introducing the element *headway*, which is found by referring to the intersection of the speed line with this curve to the scale at the bottom. For example, with a speed of 35 m.p.h. the headway will be 10 sec.

Curve *B* establishes the relation existing between speed and headway when the element of train length is introduced and for illustrative purposes a three-car train is assumed and the headway is found as before. Curve *B*,

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