Effect of Overlaps on Track Capacity With Three Position Signaling

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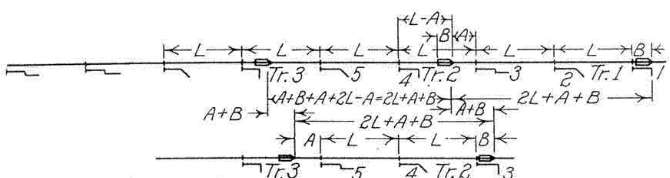
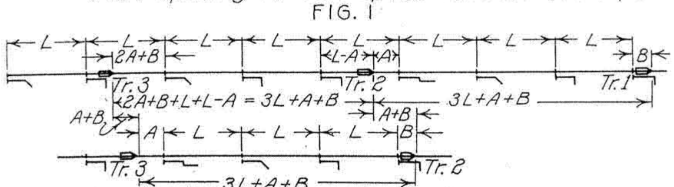
WITH the study of the application of automatic train control the question of overlaps is a live one. It is understood that the spacing of trains and consequent capacity of a line is affected, but little has been published on the subject. A study gives the results shown on the accompanying curves.

Take as a basis for comparison, two trains of the same characteristics traveling at full speed as close together as the signaling will permit allowing sufficient distance be-



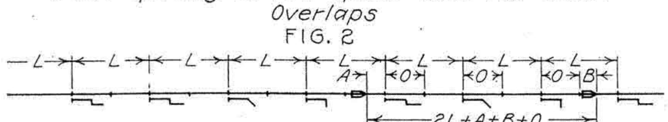
Train Spacing At Full Speed Without Overlaps

FIG. 1



Train Spacing At Full Speed With Full Block Overlaps

FIG. 2



Train Spacing At Full Speed With Fixed Block Overlap

FIG. 3

Diagram Illustrating Train Movements

tween the second train and the signal at full clear properly to observe the signal. Referring to Fig. 1, it will be noted that the trains are a distance apart of $2L + A + B$, where L equals the length of the block, A equals the distance required properly to observe the signals and B equals the length of the trains.

To demonstrate that the spacing of all trains is the same, the lower diagram is shown giving the position of trains No. 2 and No. 3 just as train No. 2 has passed signal *3*, which is the identical situation of trains No. 1 and No. 2 on the upper line. Train No. 2 on the upper line is at a point $(A + B)$ distance from its position on the lower line, and as trains No. 2 and No. 3 are traveling at the same speed, train No. 3 on the upper line will be the same distance, namely $(A + B)$, in the rear of its position on the lower line. This method of analysis can be carried back to the next train and it will be found that the train spacing will be the same.

Figure *2* shows the spacing of trains when a full block overlap is used. Using the method of analysis above, the minimum of spacing of trains is found to be $3L + A + B$. Figure *3* shows the spacing of trains when an overlap of fixed length is used. Here the minimum spacing of trains is $2L + A + B + O$, where O is the length of the overlap.

In computing the decrease in capacity of a line due to an overlap it is necessary to assume a line of length D. The capacity of the line without overlaps is then $\dfrac{D}{2L + A + B}$. The capacity of the same line with full block overlaps is $\dfrac{D}{3L + A + B}$ and the capacity with overlaps of fixed length is $\dfrac{D}{2L + A + B + O}$

The decrease in capacity comparing the D line with full block overlap with the same line without overlaps is

$$Y = 1 - \frac{\dfrac{D}{3L + A + B}}{\dfrac{D}{2L + A + B}}$$

$$Y = 1 - \frac{2L + A + B}{3L + A + B}$$

$$Y = 1 - \frac{2}{3} - \frac{\frac{1}{3}(A + B)}{3L + A + B}$$

$$Y = \frac{1}{3} - \frac{\frac{1}{3}(A + B)}{L + \frac{1}{3}(A + B)} \qquad \ldots\ldots\ldots\ldots (1)$$

It will be seen that Y is independent of the length of line D. By substituting the proper values in equation (1) the equation to meet any conditions can be made and curves plotted. Curves A, B, C and D are thus plotted, as shown in the diagram.

The equation for curve A, which is purely theoretical, but is shown, as it is the limit which cannot be exceeded by any combination in practice, is $Y = .333$.

The equation for curve B, where A equals 800 ft. and B equals 1,000 ft., is

$$Y = 0.333 - \frac{200}{L + 600}$$

The equation for curve C, where A equals 1,500 ft. and B equals 1,000 ft., is

$$Y = 0.333 - \frac{278}{L + 833}$$

The equation for curve D, where A equals 1,500 ft. and B equals 4,500 ft. is

$$Y = 0.333 - \frac{667}{L + 2000}$$

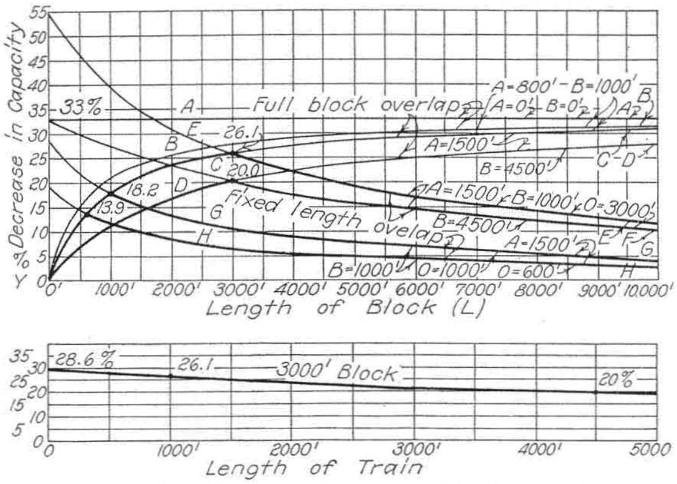
A comparison of curves C and D shows that the loss in capacity is less for long trains than for short trains, while a comparison of curves B and C indicates that a short distance assumed for seeing the signals has a greater effect on the capacity than a longer distance.

The decrease of capacity comparing a line with a fixed length overlap with the one without overlaps is—

$$Y = 1 - \frac{\dfrac{D}{2L+A+B+O}}{\dfrac{D}{2L+A+B}} = 1 - \frac{2L+A+B}{2L+A+B+O}$$

$$1 - \left(1 - \frac{O}{2L+A+B+O}\right) = \frac{O}{2L+A+B+O}$$

$$Y = \frac{\tfrac{1}{2}O}{L + \tfrac{1}{2}(A+B+O)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ (2)$$



Curves Showing the Effect on Track Capacity
Fig. 5. Percentage in Decrease of Capacity

Curves *E, F, G* and *H* are plotted by substituting proper value in equation (2). The equation for curve *E*, where *A* equals 1,500 ft., *B* equals 1,000 ft. and *O* equals 3,000 ft., is—

$$Y = \frac{1500}{L + 2750}$$

The equation for curve *F*, where *A* equals 1,500 ft., *B* equals 4,500 ft. and *O* equals 3,000 ft., is—

$$Y = \frac{1500}{L + 4500}$$

The equation for curve *G*, where *A* equals 1,500 ft., *B* equals 1,000 ft. and *O* equals 1,000 ft., is—

$$Y = \frac{500}{L + 1750}$$

The equation for curve *H*, where *A* equals 1,500 ft., *B* equals 1,000 ft. and *O* equals 600 ft., is—

$$Y = \frac{300}{L + 1550}$$

Curves *E, G* and *H* intersect curve *C* at points where the overlaps correspond with the block lengths. Curves *D* and *F* intersect in the same way. Generally in practice the curves to be used are a combination of the two series, that is, a full block will be used up to the point where the block equals the fixed overlap desired and then the fixed overlap will be used. This is shown by the heavy part of the curves.

Figure 5 shows a curve giving the variation of percentage decrease of capacity with various lengths of trains for a fixed overlap of 3,000 ft., *A* remaining 1,500 ft.

Demonstration of Regan Train Control

An operating demonstration of the Regan Automatic Train Control system of the intermittent electrical contact type as installed on the main line of the Chicago, Rock Island & Pacific between Blue Island and Joliet was made on February 13 for the benefit of railroad officers representing all departments which will be affected by train control installations. Speed control was demonstrated in connection with caution signal indications and the train was stopped automatically at locations where the signals indicated stop. On the return trip another locomotive equipped with the induction type of apparatus demonstrated the action of this type at four locations between Blue Island and Chicago.

N. R. A. A. Exhibitors

THE PRESENT status of plans for the exhibit of the National Railway Appliances Association, to be held on March 13 to 16, inclusive, forecasts the success of the exhibit of this association at Chicago. All available space in the Coliseum and annex has been assigned, but efforts are being made to take care of as many additional exhibitors as possible through the subdivision of space already assigned or through possible cancellations by some of the space holders. As the records now stand 174 firms have been assigned space. An abbreviated list of exhibitors is as follows:

Adams & Westlake Co., Chicago, booths 87, 88, 106 and 107.
Adams Motor & Mfg. Co., Chicago, booths 218 and 218½.
Air Reduction Sales Co., New York, booths 167, 167½ and 168.
American Abrasive Metals Co., Chicago, booth 172.
American Car & Foundry Co., Chicago, booths 203 and 212.
American Chain Co., Inc., Bridgeport, Conn., booths 81, 82 and 83.
American Kron Scale Co., New York, booth 125.
American Malleable Castings Assn., Cleveland, O., booths 181, 182 and 183.
American Railroad Signal Supervisory Assn., Chicago, booths 198 and 217.
American Railway Bridges & Building Assn., Chicago, booths 198 and 217.
American Steel & Wire Co., Chicago, booths 51½ and 52.
American Vulcanized Fibre Co., Pittsburgh, Pa., booth 126.
Argyle Railway Supply Co., Chicago, booth 163½.
Armco Culvert & Flume Mfrs. Assn., Middletown, O., booths 99 and 100.
Atkins & Co., E. C., Indianapolis, Ind., booth 219½.
Baker, R. & L. Co., Cleveland, O., booth 225.
Balkwill Manganese Crossing Co., Cleveland, O., booth 201 and 202.
Barrett Co., New York, booths 107½ and 108.
Barrett-Cravens Co., Chicago, booth 14.
Bethlehem Steel Co., Bethlehem, Pa., booths, 118, 119, 137 and 138.
Boss Nut Co., Chicago, booths 1 and 2.
Brach Mfg. Co., L. S., Newark, N. J., booth 3.
Bucyrus Co., South Milwaukee, Wis., booths 213 and 214.
Bryant Zinc Co., Chicago, booths 154 and 155.
Buda Co., Chicago, booths 61, 62, 63, 64 and 65.
Carbic Mfg. Co., Duluth, Minn., booth 15.
Challenge Co., Batavia, Ill., booth 109.
Chicago Bridge & Iron Works, Chicago, booths 33 and 34.
Chicago Flag & Decorating Co., Chicago, booth 189.
Chicago Malleable Castings Co., West Pullman, Chicago, booth 142.
Chicago Pneumatic Tool Co., Chicago, booths 200 and 215.
Chicago Railway Signal & Supply Co., Chicago, booths 77 and 78.
Central Electric Co., Chicago, booth 17.
Cleveland Railway Supply Co., Cleveland, O., booth 133.
Crerar, Adams & Co., Chicago, booth 28.
Chipman Chemical Engineering Co., Inc., New York, booth 90½.
Delco-Light Co., Dayton, O., booth 7.
Detroit Graphite Co., Chicago, booth 108½.
Detroit Steel Products Co., Detroit, Mich., booth 166.
Diamond State Fibre Co., Bridgeport, Pa., booth 51.
Dickinson, Paul, Inc., Chicago, booth 98.
Dilworth, Porter & Co., Inc., Pittsburgh, Pa., booth 27.
Direct Sales Co., Chicago, booth 156.
Duff Mfg. Co., Pittsburgh, Pa., booth 89½.
Edison Storage Battery Co., Orange, N. J., booth 20.
Edison, Thos. A., Inc., Bloomfield, N. J., booths 18 and 19.