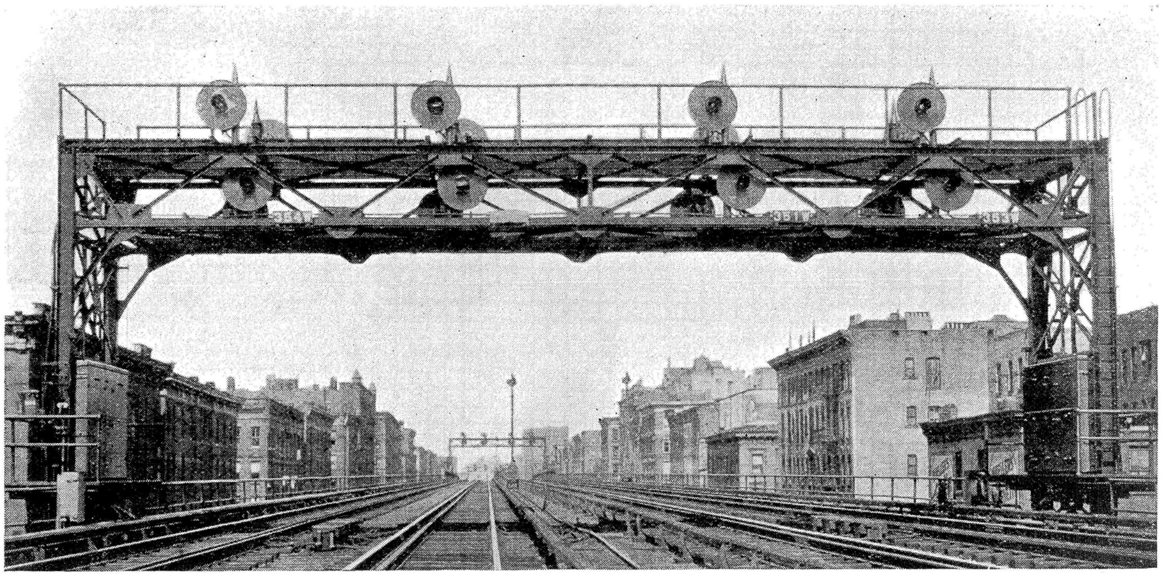
Railway Signaling



Multiple-aspect signaling on the Grand Central—Mott Haven territory

Multiple-Block Signaling*

An explanation of either-direction automatics and an increase in the number of aspects as means of facilitating train movements safely

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THE ELECTRIC DIVISION of the New York Central in New York City affords an excellent example of the benefits which can be effected in increasing track capacity and improving safety by providing multiple-aspects for signals and by either direction signaling on multiple-track territory.

The New York Central and the New Haven trains into and out of Grand Central Terminal at Forty Second street, involving through passenger, suburban, mail and express trains, are all handled between the terminal and Mott Haven, five miles, over a four-track line. The coach yards are located north of Mott Haven so that numerous empty train movements are made between this yard and the terminal. On certain peak traffic days, as many as 850 train movements are made on this territory, the total for August, 1929, being 21,800. The fact that trains are bunched during the morning and evening rush hours, further complicates operations. For example, between 7:00 and 8:00 a.m., 62 trains are scheduled through Mott Haven.

During 1928 and 1929 the situation was so serious that the stopping of a single train in the congested territory frequently caused delays to the extent that traffic did not again become normal for an hour or more. Train movements over Mott Haven Junction were so numerous that there was little opportunity to run the empty equipment across the plant to the coach yards, and, as a result, the empty trains were held out on the main line Track No. 1. In some instances, these trains occupied as much as two miles of track during the greater part of a forenoon, thus obstructing 25 per cent of the main trackage, as well as incurring expense equipment and crews standing idle.

Various means of providing additional tracks in this territory were investigated but none were practicable on account of the immense expenditures required. One proposition involved the construction of a new two-track tunnel beneath the existing Park Avenue tunnel to 96th street, and then continuing a new tunnel under the street and beneath Harlem river, coming to the surface in the vicinity of High Bridge. Another suggestion was the construction of a new line from the New Haven Yards in the Bronx, passing beneath Harlem river and south between Second and Third avenue to a new station on 42nd street, east of Third avenue.

Track Capacity Increased by Signaling

A study indicated that the necessary relief from congestion could be effected by the installation of proper signaling on the Mott Haven to Grand Central territory, and the reconstruction of the track layout and interlocking at Mott Haven Junction. The importance of the results needed, justified a relatively large expenditure for these improvements. At Mott Haven, changes were made in the track layout, so that prevailing routes of traffic during rush hours did not cross. Short crossovers and frogs, that limited safe speeds to 10 m.p.h., were replaced with easy angle switches and frogs to permit speeds of 30 m.p.h. Four interlockings in the vicinity of Mott Haven were combined into one new large plant, thus co-ordinating operations over a large territory so as to facilitate train movements. An entirely new system of automatic block signaling was installed on the four tracks between Mott Haven and Grand Central, using four-aspect, three-block signaling

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to direct train movements in either direction on all four tracks.

With this arrangement, as many tracks as are required can be used for trains in one direction or the other, depending on the preponderance of movements to be handled during peak periods of the day. The blocks are comparatively short, averaging from 750 ft. to 1,200 ft., so that following trains can be spaced closely and the safety of such operation, even at comparatively high speed, is provided by the multiple aspects of the signals which give an engineman information as to how he should control the speed for several blocks in advance.

The results effected by these track, signal, and interlocking improvements have been beyond those reasonably anticipated. The system has so increased the track capacity that all congestion has been eliminated and trains are operated without delays. Furthermore, the operation is so flexible that a train running a few minutes behind time can be handled promptly without disrupting the schedules of other trains. The operation of empty equipment into and out of the coach yards at Mott Haven has been expedited so as to eliminate lost time for crews and equipment.

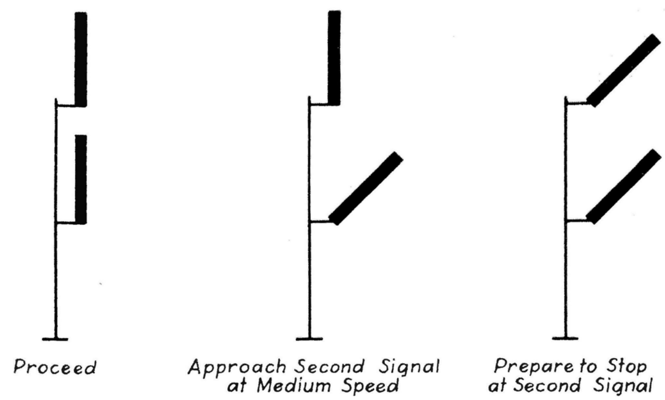
Important Factors of Multiple-Block Signaling

The novel feature of the improvements on the Mott Haven-Grand Central territory was the use of multiple-aspect automatic signaling which permitted the use of short blocks to reduce the spacing between following trains and yet gave specific instructions in the form of signal indications to an engineman as to what action to be taken at each of several successive signals while approaching a point where speed must be reduced or the train stopped. By this arrangement, trains can be kept moving at the highest possible rate of speed consistent with safety, depending on conditions ahead, thereby eliminating unnecessary delays or train stops.

This system is properly designated as multiple-block signaling not as four-block signaling. The same system can be used to include or omit aspects for two, three, four or more blocks, as may be required by local conditions affecting train speeds at certain points on the line, and by the number of trains operated during certain periods of the day.

The aspects and indications of the American Association of Railroads are based on each and all of the aspects being used as required. The two additional aspects, used on the installation between Mott Haven and Grand Central, are consistent with those of the Standard Code, and may similarly be included or omitted as required. Furthermore, a change can be made from block to block, changing from a two, three, four or five-block system and back again at the next location, without inconsistency. The indications required for special locations and conditions may be selected and used without their effectiveness being impaired by the use or non-use of other indications.

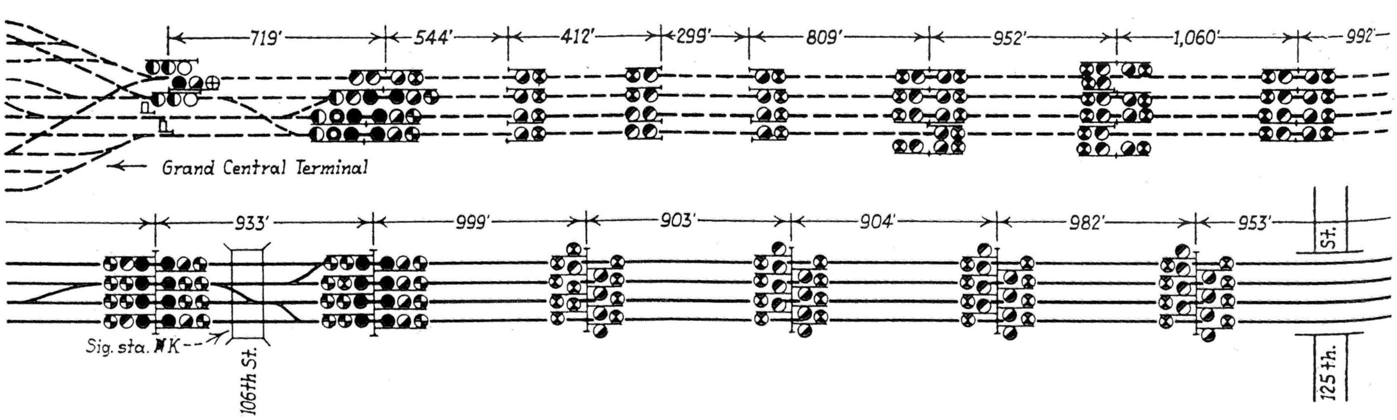
In preparing the detail plans for the proposed rearrangement there was a lack of definite information as to the distance required for retarding and stopping trains at various speeds. Differences in train weights and braking equipment were also factors to be considered. In 1929, the N.Y.C. made several hundred braking tests under different combinations of variables. The stopping and retarding curves plotted from these tests are so uniform and consistent with each other that it is possible to interpolate other curves to cover almost any make up of a train. To the established train-braking distances certain arbitrary factors of reliable operation are added to establish approach signal-distance curves, which are used for reference when locating signals, and when deciding upon the aspect to be used.



Aspects and indications supplementing the Standard Code

The New York Central tests were preceded by a series of tests in 1913 on the West Jersey & Sea Shore. The engineers of the Boston & Maine, using the Blackall-Park air brakes catechism, have calculated approach signal distance curves which correspond surprisingly with those established by the New York Central.

Frequently train crews run over two or more divisions and occasionally over two or more railroads. It is desirable that signal aspects and indications be as consistent as practicable for an entire system. The studies described and conclusions reached are applicable for practically all traffic operating conditions on steam railroads, and are also being applied on



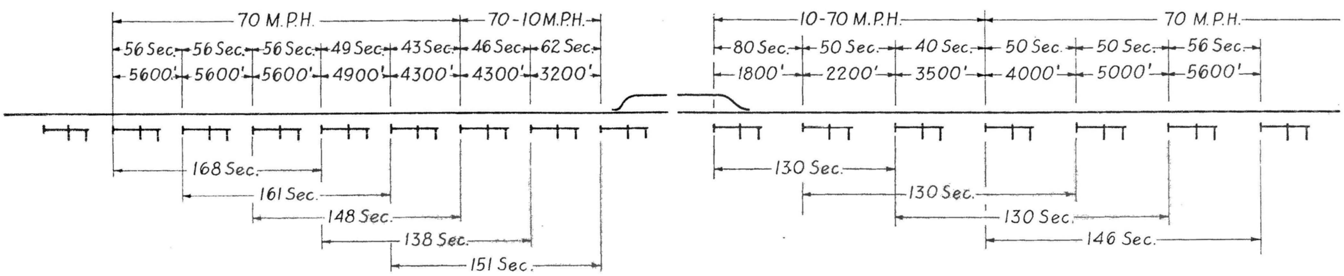
Track and signal plan of the multiple-aspect

the district beyond the Electric division. Plus or minus adjustments to signal distances, in accord with established formula, are necessary for descending or ascending grades.

Excessive length of blocks does not effect a relative saving in construction and maintenance costs and may cause excessive train delays if the rules are observed when a signal is unnecessarily in the stop position, or may, if to avoid excessive penalty the rules are disregarded, defeat the purpose of the signal system. In a recent case, a high-class long distance passenger train was delayed 20 minutes on account of one signal being at "Stop." The approach indication was passed 8,000 ft. before reaching the "Stop" signal and the "Advance slow-speed" block was 6,400 ft. long.

Automatic signal distances of approximately 8,000 ft. on level track should provide ample approach distances for almost any speed and weight of train. Short blocks with multiple aspects are valuable in increasing track capacity where trains are operated under close headway during certain periods of the day, and are of material benefit in keeping trains in motion and avoiding unnecessary delays when approaching a congested point. They materially reduce the time lost and increase the safety of operation when signals may be out of order. Reducing the block lengths one-half increases the track capacity 20 per cent.

Unequal signal blocks in high-speed territory are a handicap. Long blocks in or leaving low-speed territory may not effect the best results. The time required for a train to pass through a block should be used as a yard stick rather than lineal feet. The objective is to get trains through safely with minimum interference with other trains and without raising the maximum speed limits which had been established for definite reasons.



Sketch illustrating time required for a passenger train to stop and then accelerate to speed of 70 m.p.h.

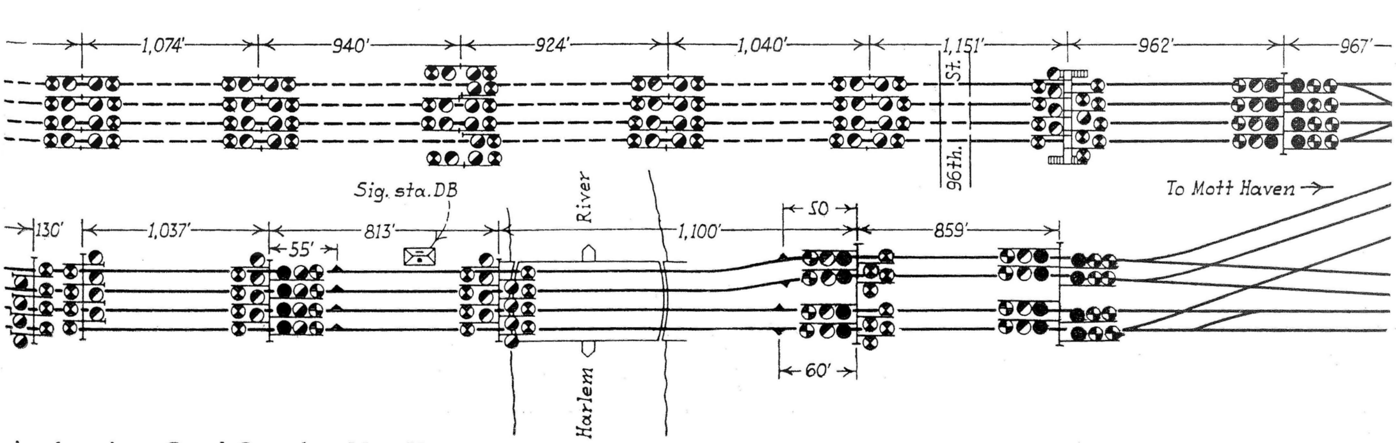
Higher average speeds, without higher maximums, are desirable. When a train is brought to a stop on a main track the flagman should get off to flag, and the train may not again be started until the flagman is recalled by the locomotive whistle. If the train-line air brake is applied on a long freight train and then an attempt made to release the brakes and proceed, there is a possibility of the brakes sticking on some of the rear cars, thereby causing the train to pull apart. Therefore, when the air brakes are applied on a long freight train, it is generally brought to a stop and the flagman sent back while the compressed air in train line is being pumped up to the required pressure, all of which involves a material delay.

Information to an engineman, as to what may be expected of him several blocks in advance, will often permit a train to be controlled in such a manner as to avoid an actual stop, thus resulting in a material saving in time and the avoiding of possible damage to equipment, when stopping and starting a heavy train.

Over-conservative railroad officers often hesitate to take advantage of new signal indications, feeling that the enginemen will not understand them. Experience and reason indicate that the engineman welcomes facilities which makes his work better and easier. New signal indications, if consistent with those previously given, are welcomed by enginemen, and full advantage is taken of the information conveyed.

Improved Signal Performance

In a territory handling such a heavy traffic, a failure of signal or interlocking equipment frequently causes delays to several trains, and it is important to explain that the improvements made in the performance of the signaling on this territory has been an important factor in the improved train operation. Considering the Electric division as a whole, there was, in 1930, an average of 27.4 cases each month in which a signal failed to operate properly, or one case in 77,000 signal operations. In 1934, this average was reduced to 3.5 cases each month, or one failure in 570,000 signal operations, an improvement of 700 per cent. In 1930 there was an average of 27 power interlocking failures each month, which, in 1934 was reduced to 7.4, or an improvement of 400 per cent. These improvements in the signaling performance were due in part to the modern signaling apparatus included in the new installation, and also on account of a reorganization of the signal department maintenance.



signal territory Grand Central to Mott Haven