Railway Signaling

Demands for Modern Signaling*

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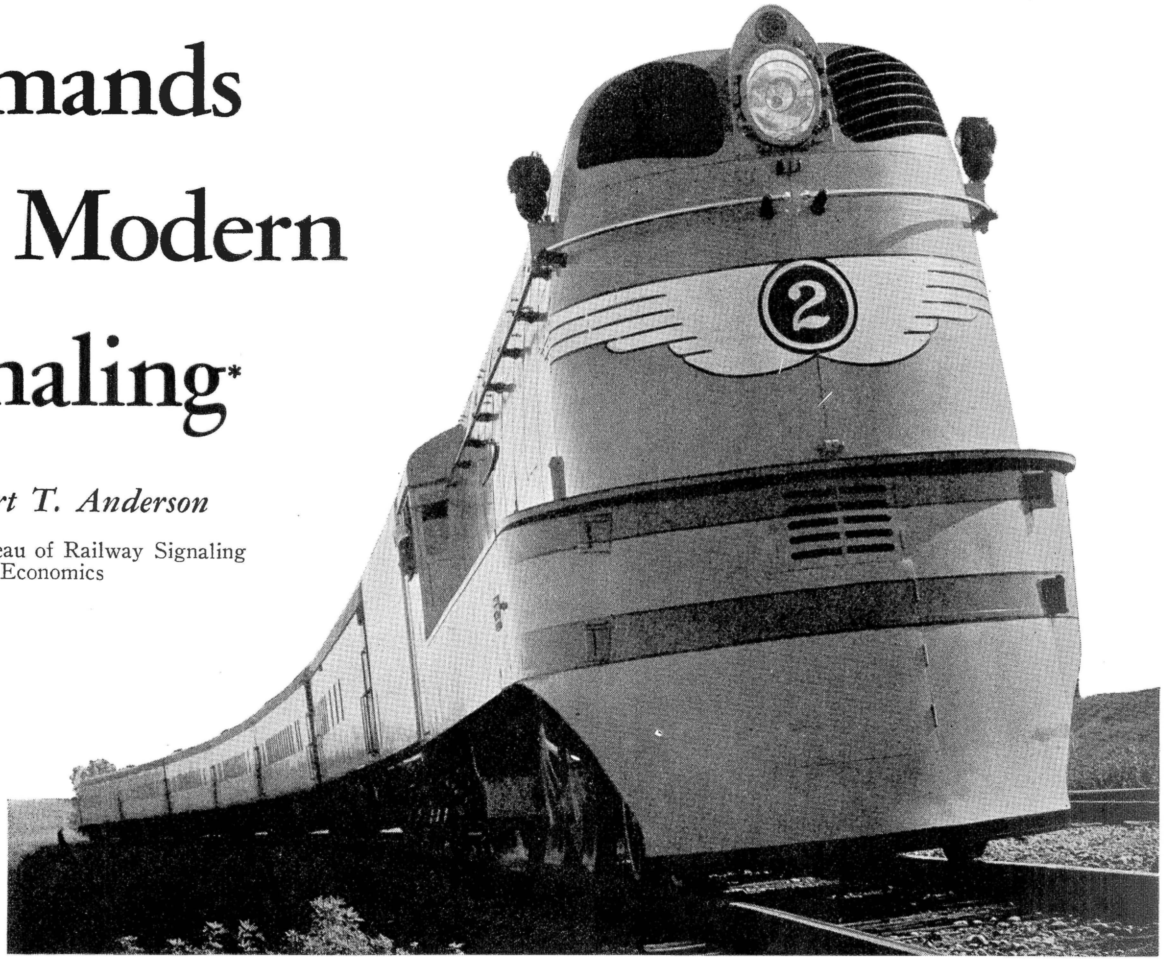

The Hiawatha on the Milwaukee

Faster train speeds necessitate longer stopping distances—need for multiple-aspects, centralized control and cab signals

THE NEW era in railroad transportation, brought about by streamlining, air-conditioning, 100 m.p.h. speeds, shortened schedules, 5,000 h.p. locomotives, 152-lb. rail, and increased comfort and speed to the public, has created new problems for the motive power, engineering, maintenance of way, signal, and operating departments of the railroads. Fortunately, the signaling art has kept pace with railroad progress. In fact, many of the new signal developments brought about by the intensive research carried on by the signal and engineering committees of the Association of American Railroads in conjunction with signal companies antedate the new era in railroading. While safety was undoubtedly the original purpose for which signaling was installed, for many years the safety feature has been taken for granted and signaling has been more often installed to facilitate train operation, improve operating efficiency and decrease the cost of transportation.

Thus, in recent years, signaling devices have been installed to expedite traffic, reduce delays and produce the desired operating results and savings without sacrificing—indeed, while increasing—safety. The introduction of remote control, centralized traffic control, directing trains by signal indication, car retarders, modern interlockings, automatic interlockings, spring switches, etc., has produced economies, increased safety, and decreased operating costs.

The changing railway and reduced traffic conditions since 1929 have resulted in curtailed operating expenses and many railroads have adopted those signaling devices which proved of economic benefit. The response of the traveling and shipping public in the past two years to the faster schedules indicates that there is a great demand for expedited traffic and increased comfort in travel and we now have higher train speeds, both freight and passenger, on a greater number of regular scheduled runs than ever before in the history of American railroading and without parallel in the world.

The recent 12-1/5-hr. run on the Burlington's new "Denver Zephyr" between Chicago and Denver at a record speed of over 83 m.p.h. for 1,017 miles and at a top speed of 116 m.p.h.; 88.9 m.p.h. for 41.5 miles on the Milwaukee's "Hiawatha"; 83.7 m.p.h. for 202.4 miles on the Santa Fe's "Super-Chief"; and 66.2 m.p.h. for 1,048 miles on the Union Pacific's Streamliner, "City of Denver"; these last three cases being regular scheduled runs, indicate a few of the high

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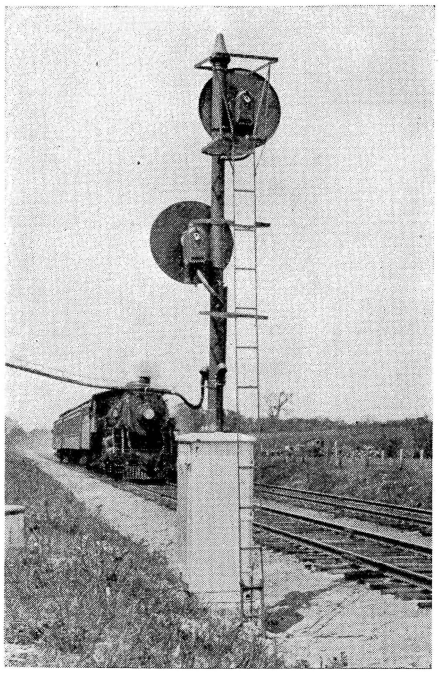
speed trains. Freight train speeds have increased nearly 50 per cent in recent years and high-speed freight train runs are averaging 42 m.p.h. for distances over 500 miles so as to provide faster over-night freight service. Practically all of the high-speed mileage is on territory equipped with automatic block signals, two-thirds of the railways with high-speed trains are equipped with automatic train control or cab signals, and practically all of the railways have either centralized traffic control or train operation by signal indication without the superiority of trains.

The day of the 1,250 h.p. locomotive, 20 m.p.h. average running speed for freight trains, and 40 m.p.h for passenger trains, the practice in 1910,



Multiple-aspect automatic signal on the Boston & Maine

is out of the question in this era of modern railroading when 60 m.p.h. freight and 100 m.p.h. passenger trains are the daily practice. A few writers in the press are talking of 125-mile speeds provided the motive power and track engineers can arrange for this service. It is probable that this tendency to raise the speed limits as equipment and track facilities are provided, will continue, and the signal departments will be required to design their systems to suit the higher speed operations demanded by competitive conditions.

Freight Trains a Real Problem

Probably the first factor involved in high-speed train operation is increased stopping distance. While this problem has been given more attention with the advent of the light-weight train, actually it is the high-speed freight train which is the determining factor, as not only the speed but also the length and the weight of these trains have been increased. In general, the question of stopping distance is one which must be determined by each railroad, depending on the varying speed and weight of the trains, the grades and curves involved, slow orders, and local conditions.

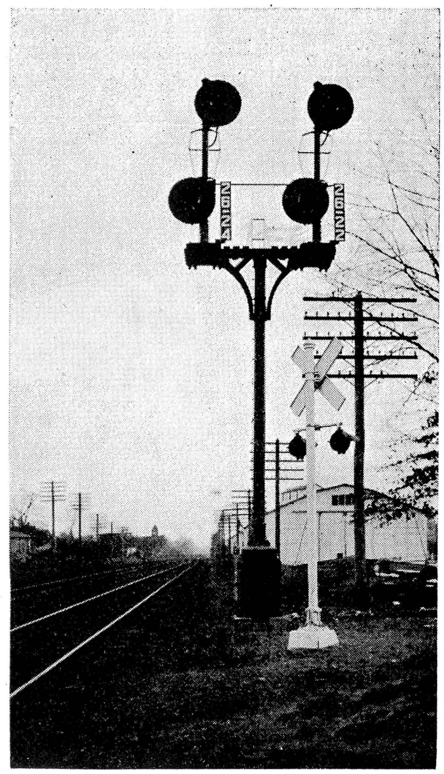
It is at this point that the railroad must determine whether to locate or relocate the signals for longer block lengths so as to provide safety with the higher speeds or select a system of signaling, two-block, three-block, four-block, etc., which will result in a reasonable spacing of trains and the highest possible average speed with the existing trackage. Generally the increased stopping distance has been provided by locating or relocating the signals but this practice results in extending the spacing between following trains with consequent decrease in track capacity. While some railroads do not consider this an important factor, it will be of increasing importance as traffic increases with improved business conditions, and in many cases even today it is a factor of consequence at "bottle-neck" locations.

System of Signal Indications

The simplest form of modern wayside signaling is that provided by a system of two-block three-indication signals, named "clear," "approach" and "stop." If passenger trains are run in a number of sections, or are scheduled close together, or if freight trains are run in fleets, with the longer block spacing, this may result in an excessive interval between trains. It may also result in delays to following trains and in uneven operation due to the brake applications necessary to comply with the indication of successive "approach" signals. Brake applications on long freight trains frequently require a stop. On the other hand, if the traffic density is not too great, this system of two-block three-indication signals may be entirely satisfactory.

The next step is a system of three-block four-indication signals, named "clear," "approach-medium," "approach" and "stop." This system provides a shorter interval between trains, less delay, smoother operation, fewer stops, particularly for freight trains, and a higher average train speed. Similarly, a system of four-block five-indication signals provides an increase in average speed and flexibility of operation over a three-block system. It will thus be seen that the signal system to be adopted should provide for the most economical operation possible, considering all the factors involved in each particular study.

The railroads operating high-speed trains have solved this problem in each of the ways just mentioned. The

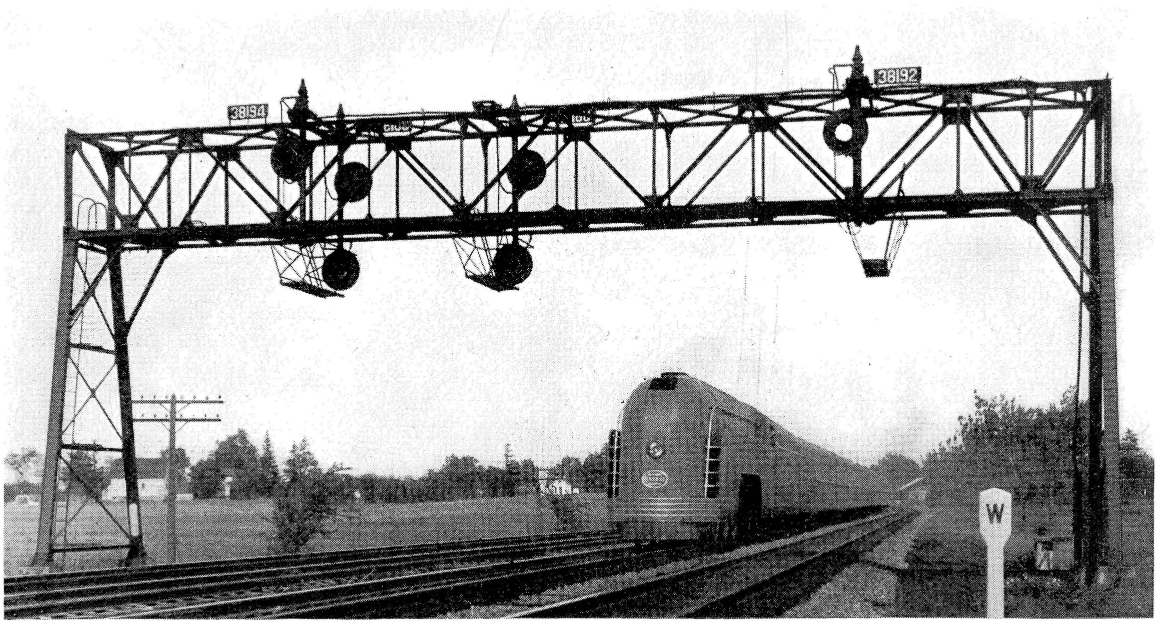


Four-aspect signaling on the Erie to replace old semaphores is typical of changes made on several roads

Chicago, Burlington & Quincy made extensive changes in block lengths between Chicago and St. Paul, and Chicago and Denver, particularly on the signaling installed 15 to 25 years ago. The Chicago, Milwaukee, St. Paul & Pacific made similar changes, and in addition in their heavy traffic territory near Chicago, propose to shorten the blocks and provide three-block four-indication signaling. The Chicago & North Western replaced some disc signals with three-indication color-light signals and in their heavy suburban traffic territory provided three-block four-indication signaling. The Pennsylvania provided 8,500-ft. blocks with two-block three-indication signals and added three-block four-indication signals for 90 m.p.h. speeds. The Union Pacific increased the block lengths on a two-block three-indication system. The Missouri Pacific installed over 100 miles of new color-light signaling where manual block was formerly in operation. The Erie installed some new two-block three-indication color-light signals on an up-grade track and three-block four-indication signals on the down-grade replacing old semaphore type signals, while the Santa Fe is adding a fourth indication at special locations between Chicago and Los Angeles. The Boston & Maine and the New York Central have installed four-block five-indication signals in heavy traffic territory in order to expedite traffic and reduce delays.

Increased Track Capacity

The advantages to these railways in adopting three or more block signaling may be more clearly understood if it is pointed out that with 8,000-ft. blocks, trains running on clear signals with a two-block three-indication system will be spaced at least 16,000 ft. apart, while with a three-block four-indication system, they may be spaced approximately 12,000 ft. apart (one-fourth less distance), and with a four-block five-indication system, may be spaced approximately 10,667 ft. apart (one-third less distance).



The "Mercury" of the New York Central Lines is a new high-speed train operated between Detroit and Cleveland—Illustration shows train on four-aspect signal territory

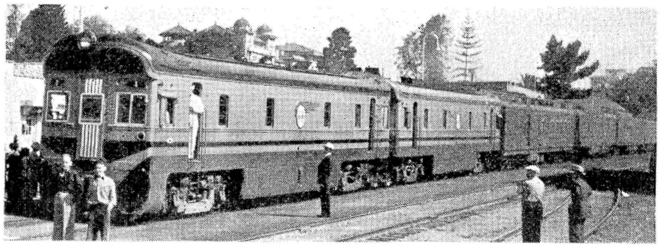
Where trains of varying speed are operated over the same tracks, the signal system should be so designed that each class of train may be moved on as close headway as the stopping distance and safe operating conditions will permit. The signal changes which merely involve the increase of block lengths are adequate for the safe operation of high-speed trains, but they must not impose too great a burden upon the operation of the lower speed trains which often provide the largest part of the railroad's revenue. If there are many trains operating in the 20-45 m.p.h. class, the use of longer blocks, in order to obtain stopping distance for high-speed trains, very materially reduces the capacity of the line. The real solution is to increase the number of restrictive indications by going to three or four-block signaling as required by the local operating conditions. Modern signaling, as designed for safe high-speed train operation, should not be permitted to restrict efficient train operation.

Reducing Delays

While block length is an important factor, there is another phase of high-speed train operation which is equally important and that is the elimination of delay time on the 1,000 or 2,000-mile route in order to maintain the high average train speeds of 55-85 m.p.h. The cruising speeds of 90-100-110 m.p.h. now in operation demand not only the most modern locomotives, equipment, and roadway, but also the most modern signaling designed to reduce the delay time for meets and passes to a minimum. Years ago with longer schedules, stops for non-interlocked railroad grade crossings, stops for slow-downs for train orders for meets and passes, delays for hand operation of switches, slow-down for 15 m.p.h. crossover movements and movements into sidings were taken as a matter of course. Now, it is a question of absolute minimum delay time in order to maintain the high-speed schedule. Trains must be diverted from one track to another, over longer crossovers, and into sidings at higher authorized speeds protected with power interlockings and modern signaling by means of centralized traffic control, remote control, and modern interlocking facilities, saving every second possible.

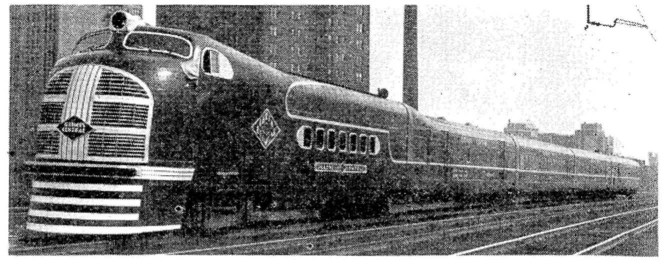
An equally important factor in saving delay time to the high-speed trains is the elimination of delays to the slower-speed trains on the high-speed routes. This factor is not so important with one high-speed train in operation with slower trains, as the schedules of the slower traffic can normally be adjusted to suit the new operation. But as the number of high-speed trains increase, the proper handling of the slower traffic becomes more of a problem. Facilities must be available for the slower trains to clear the high-speed trains with a minimum delay, and if the high-speed schedules are disrupted the slower trains must be kept moving without delays. Adequate passing facilities and train operation by signal indication will be of great help in keeping all trains moving.

Centralized traffic control is the most efficient and effective method of directing train movements, providing frequent and immediate "OS" information as to train movements and aiding the supervision of train movements, a very important factor in high-speed train operation. It provides for instantly changing meeting and passing points, aiding the operation of slower trains, facilitating peak train movements—in short, providing maximum track capacity. It conserves capital by making possible a greater use of existing facilities at lower cost and I have yet to learn of any of the 165 installations now in service where the actual results have not been more than anticipated and the operation favorably commented upon by those di-



The Santa Fe's diesel-powered Super-Chief

rectly connected with the system. As stated by one operating officer, "I believe it is the greatest development towards expediting train movements and reducing operating costs that we have seen in the past 25 years or more." It is the most modern way to direct train movements and its further adoption in high-speed territory merits greater consideration by operating officers of the railroads.



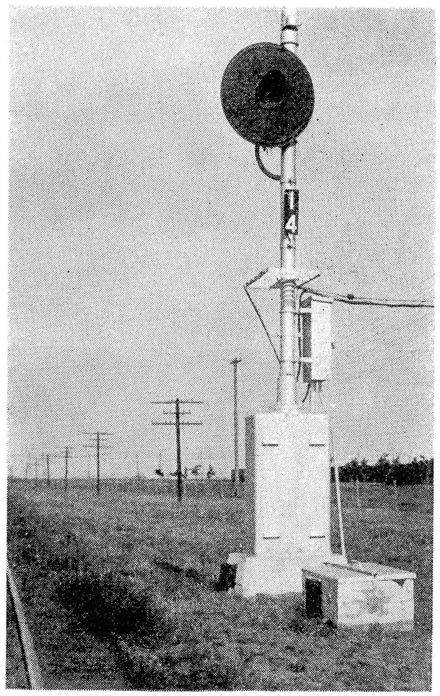
The Illinois Central's Green Diamond

Cab Signals Improve Train Operation

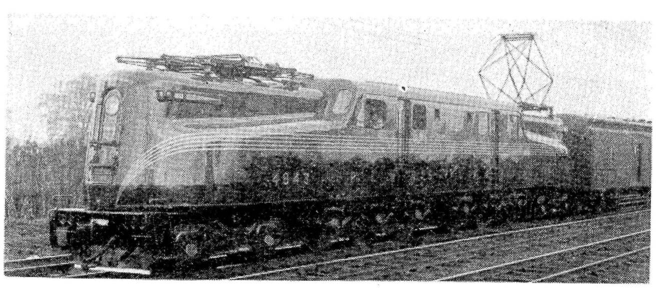
The operation of high-speed passenger trains in automatic train control and cab signal territory made it necessary to provide modern light-weight train control and cab signal equipment to suit the requirements of the various systems. The majority of the high-speed runs from Chicago to St. Paul, Chicago to St. Louis, Chicago to the West Coast, Chicago to New York and Boston, and New York to Washington and Richmond, are in train control or cab signal territory. Of particular interest are the Union Pacific Streamliners which are equipped with two types of speed control and cab signals, a cab signal system only, and an automatic stop system for interchangeable operation over four railroads in train control and cab signal territory.

As quoted by one operating official, "Cab signals provide a greater margin of safety than wayside signals, especially in bad weather, but do not in any respect shorten the so-called 'stopping distance' required for safe operation." High-speed trains operating at 90-100 m.p.h. and over, pass the wayside signals in a very short time and without question the use of cab signals visible continuously in the cab under all weather conditions are of great benefit in maintaining safe train operation and more nearly perfect schedules. Train control and cab signal devices have proved by over ten years service their reliability under actual operating conditions and provide the most modern type of protection for high-speed train operation.

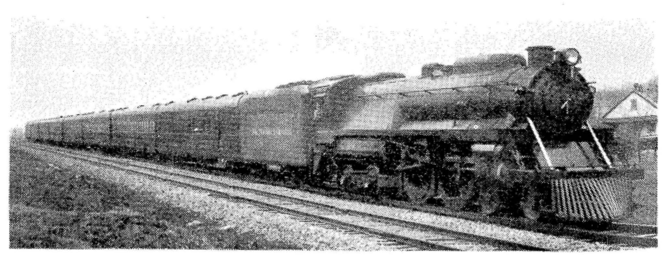
The operation of the block signal system on 143,000 miles of track, train operation by signal indication without normally requiring the use of train orders on 36,000 miles of track, automatic train control and cab signals on 20,000 miles of track, highway grade crossing devices at 30,000 crossings, interlocking devices at 4,000 railway grade crossings, and thousands of power operated switches and signals, etc., are safeguarding train movements and account in a great measure for the unequalled safety record of the U.S.A. railroads to make railroad travel the safest in the world.



Home signal at automatic interlocking on the Santa Fe



A Pennsylvania streamline electric locomotive



The Alton's Abraham Lincoln