The Use of Signals for Better Train Operation

A Comparison of the Time Interval and the Space Interval Methods Used for Handling Train Movements on American Railroads

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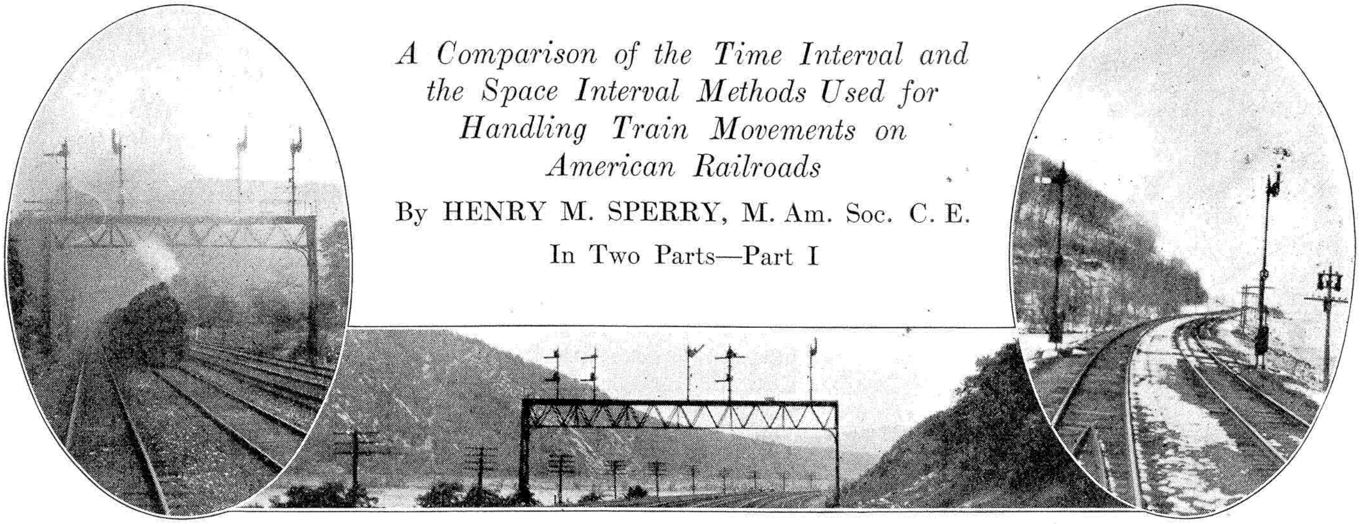
In Two Parts—Part I



Train Operation by Signal Indication Through the Mountains and on the Plains

ON the railroads of the United States two principal methods of directing train operation are in use: *a* the Time Interval Method, and *b* the Space Interval Method.

The first part of this article will describe briefly these two principal methods, and a comparison of the two methods will be made. This comparison will show that due to inherent disadvantages the time interval method is not efficient for directing train movements. On the other hand, the advantages of the space interval method are such that it is *the* method that permits of efficient train operation.

The increasing costs of labor and of fuel emphasize more than ever the need for the greatest possible efficiency in train operation.

The second part of the article will describe train operation by signal indication and point out the marked advantages of this method of directing train movements.

Time Interval Method

Train operation under the time interval method is directed by (*a*) time tables; (*b*) train orders and train order signals, and (*c*) train despatching. The time table is the primary authority for the movement of regular trains. Train orders are the authority for movements not provided for by time tables, and for regular time-table trains when, because of delays, the time table must be modified or temporarily suspended. The movement of trains according to time tables and rules which specify a minimum number of minutes between trains moving in the same direction is the distinctive feature of the time interval method. For trains not carrying passengers this interval is usually five minutes; for trains carrying passengers it is ten minutes.

Time Tables

As defined by the American Railroad Association's Standard Code, the time table is "The authority for the movement of regular trains, subject to the rules. It contains classified schedules for trains, with special instructions relating thereto." The authority for the movement of an extra train on single track is a written order from the train despatcher, customarily sent by telegraph or telephone; in common parlance, "train orders." On a double-track line extra trains may be run without formal train orders. In this case the only serious complication is the necessity for keeping slow trains out of the way of those which run faster, and this is usually provided for by a general rule that extras thus run without formal order shall clear the main track ten minutes before the time at which a following faster train is due, by the time table, to arrive. If the extra is a fast train it is *not* run without a despatcher's order.

Prior to the use of the telegraph in train operation, the time table was the sole authority for train movements. Had it been possible to run all trains in exact accordance with the time table, operation of trains would have been a comparatively simple matter. It was not possible, even in the early days, when every road had light traffic, to avoid serious delays to trains; and without electrical communication the art of railroad operation would have been dwarfed in its infancy. The use of the telegraph for authorizing movements not provided for by the time table first made it possible to transport passengers and freight without intolerable delays.

Train Orders

The train order, therefore, came into use to supplement the time table. It is defined by the Standard Code as follows: "For movements not provided for in the time table train orders will be issued by authority and over the signature of the [superintendent]. They must contain neither information nor instructions not essential to such movements. They must be brief and clear; in the prescribed forms when applicable; and without erasure, alteration or interlineation. Figures in train orders must not be surrounded by brackets, circles or other characters."

The Standard Code embodies explicit rules and contains forms designed to insure uniformity of practice in the preparation, transmission and delivery of train orders. Train order forms may be grouped into three general classes:

(*a*) *For directing train movements* the orders in use are: the meet, the pass, the right, the time, and the hold orders.

(*b*) *For designating the kind of trains* to be run: the section, the extra, or the work extra orders are used.

(*c*) *For modifying orders:* the annulling or the superseding orders are used.

It will be noted that the principal class is that for directing train movements (*a*).

Train Order Signals

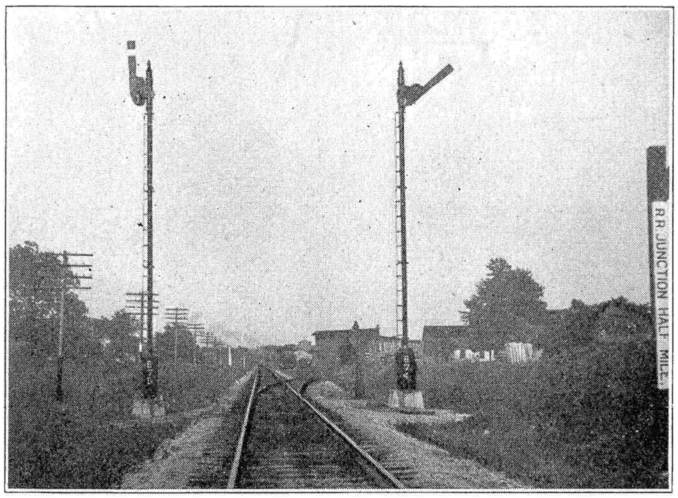
The usual type of station train order signal is the two-arm semaphore signal, one arm for movements in one direction and the other for movements in the opposite direction; each arm capable of being displayed in either one of two positions; one position indicating "stop" to approaching trains and requiring them to stop for train orders to be delivered to them; the other position indicating "proceed," to be displayed when there are no orders to be delivered to trains moving in the direction to which that arm applies.

Train Despatching

Train despatching may be defined as the art of directing train movements. It is to the credit of the American train despatcher that he has been able so skillfully to meet the constantly increasing requirements of transportation.[1]

Directing Train Movements

The directing of train movements is accomplished through the use of general rules, local rules, time tables, train orders and train order signals. Under the space interval method there is, in addition, the use of block and interlocking signals.



Single Track Signaling. The Arm at 45 Deg. Indicates that Train Order Signal at Station Ahead Is "Red"

Directing train movements may be considered broadly under two general heads—(*a*) the preparation and transmission, and (*b*) the delivery of instructions, rules, time tables and train orders. This division under two heads is to show the marked difference between the preparation and delivery of instructions, rules and time tables on the one hand, and the preparation and delivery of train orders on the other. In the first class we have what may be termed permanent elements, whereas train orders are of a temporary nature.

Instructions, rules and time tables are the *plans* for conducting train operation. They must be prepared and delivered in advance of the time of their use. Train orders, on the contrary, are to meet the ever-changing needs which cannot be provided for in advance and must be often made on the spur of the moment. If train operation could be conducted by time tables without delay it would not be necessary to use train orders; such mathematical precision being impossible, train orders and train despatching are essential in efficient train operation. As stated, train orders differ from instructions, rules and time tables as to the time available for their preparation and delivery. There is ample time for handling instructions, rules and time tables; but train orders must often be formulated and transmitted with the utmost speed. The despatching is not efficient if the handling of the train orders causes delay. This may be true even if the order reduces a prospective loss of time, as where the delay would have been still further reduced had there been no delay in the handling of the order. The delivery of the instructions, rules and time tables is a simple matter, for it can be made days in advance of the movements to which they apply. The delivery of train orders, however, is an entirely different matter, for delivery must be made to *trains in operation*; hence, the *method* of delivery should not cause loss of time.

The *delivery* of the order is of vital importance, as is evident from the very specific rules provided. A train order of Form 31 is delivered to, and its receipt acknowledged in writing by the persons to whom it is addressed. (The engineman usually is an exception; to avoid the loss of time which would be involved in requiring him to go to the station office it is provided that his copy may be delivered to him by the conductor.)

The Form 19 train order is required to be signed for only by the station operator. He is held personally responsible for the delivery of the "19" order, but the form does not require the signature of the conductor or the engineman or any other acknowledgment by signature to the despatcher.

Because of this difference in delivery, a moving train is required to stop for a "31" order, but need only slacken speed for a "19" order. If the order should authorize the train to continue its journey, then the delivery of the "31" order, requiring the train to stop, causes a useless delay that might have been avoided by the use of the "19" order. The disadvantages connected with the stopping of trains simply to give them instructions under which they may proceed will be more fully considered under the Space Interval Method.

William Nichols in his excellent book on "Train Operation" says: "The use of the '19' form is not restricted by the Standard Code. However, some roads prohibit its use for restricting the superiority of a train. There has been and still is, no doubt, considerable prejudice against the '19' form order. This is generally because of not thoroughly understanding the difference between the '31' and '19' forms, so far as safety is concerned. With a proper clearance card made for the purpose, and with a few restrictions placed upon its use, it is as safe [as the '31'] and certainly is far the best order for the prompt movement of trains."

John F. Mackie, formerly secretary-editor, Train Despatchers' Association of America, and a veteran railroad operating officer, in his article on "Train Rules and Train Despatching, Past and Present," declares the crux of the whole matter to be the delivery of the order. "There is increased assurance of delivery of the '19' form because of the requirements that the operator shall personally deliver the order to both the engineman and conductor. He is, therefore, out on the platform prepared to make the delivery. * * * He is an active, instead of a passive, agent in the delivery of the order."[2]

The Space Interval Method

Train operation under the space interval method is directed by:

(*a*) Time tables; (*b*) train orders and train order signals; (*c*) train despatching, and (*d*) the block system. Trains are operated under the space interval method by

[1]See Appendix at end of article, for the Principlles of Train Despatching, from book on "Telegraph as Applied to Train Movements," by J. J. Turner, vice-president of the Pennsylvania System.

[2]Proceedings Central Railway Club, September, 1916.

time table, train orders and train despatching, the same as in the time interval method. In addition, there are block signals. Although trains are moved under time tables, the block signals enforce an interval of space between trains moving in the same direction, wholly regardless of the time interval. This is the distinctive feature of the space interval method, and is the basis of the block system. The time interval is maintained by attendants, with watches or clocks, at stations. Suppose, under this system, the prescribed interval be ten minutes. At the expiration of that length of time after the departure of the last preceding train the attendant displays to a train a proceed signal; but if the preceding train has been unexpectedly stopped at some obscure point between this and the next station, this proceed signal is deceptive; it does not remove the danger of a collision under such circumstances, and this danger has to be provided against by the flagging rules. But if the space interval system is in effect, the station agent, instead of allowing a train to proceed at the end of a period of 10 minutes, holds it until he has been informed that the preceding train has actually arrived at the next station, whether the time be 10 minutes or 10 hours. Thus the time interval, in such a situation, is superseded, so far as concerns its function as a preventive of collisions. It becomes merely a convenience.

Time Tables

Under the time interval method, in order to comply with the five and ten-minute rule, trains must not be scheduled at intervals less than five [or ten] minutes. In the space interval method, however, trains may be scheduled at intervals determined by the time required for them to move through the block sections. The passenger service on the express tracks of the Interborough subway, New York City, is a notable example of moving trains under close intervals. There, under the automatic block system, with sections less than 900 feet long, ten-car passenger trains, moving at 35 to 40 miles an hour, are allowed to follow one another at intervals of one minute and 48 seconds. Without the block system, the time interval system, dependent for safety on the flagman, would be out of the question. Before a flagman could get off his train to start back with his stop signals the time interval would be used up.

Train Orders

In the space interval method there is a decrease in the number of train orders issued, and of those which are issued a larger number are on Form 19, as compared with Form 31. The decreased use of the written train order is fully considered under Train Operation by Signal Indication. The "19" order keeps trains moving, and obviates one of the most undesirable features of train operation, as heretofore extensively practiced, the stopping of trains for the sole purpose of giving them written train orders.

Eliminating the unnecessary stopping of trains, saves fuel and water and the cost of the wear and tear on cars and engines for these useless stops. Every unnecessary stop creates an unnecessary hazard. By eliminating unnecessary stops, unnecessary hazards are eliminated. Every unnecessary stop is an unnecessary delay, not only to the train that is required to stop, but often to other trains as well.[3]

The St. Louis-San Francisco Railroad has made an estimate of the economy effected by the elimination of useless stops by the use of the "19," instead of the "31" order, and reports an annual saving of $29,630, as follows:

ESTIMATED MONTHLY SAVING; AVERAGE TRAINS PER DAY, 27½

Reduction of overtime, 5 hours a day, at $4.18 an hour	$ 647.90
Saving one-half ton coal per freight train per trip, at $3.25 a ton	1,511.25
Saving in wear and tear in not stopping "long-drags" for orders, $10 per day	310.00
Saving per month	$2,479.15

Or an annual saving of $29,630, which is equal to interest at five per cent on an investment of $592,596.

Train Order Signals

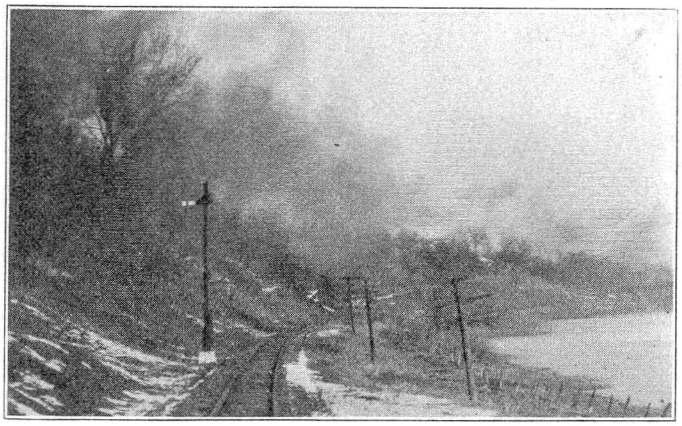
The two-position train order signal, heretofore referred to, *has but a limited use in directing train movements.* It is used only to indicate "stop" for orders; or "proceed" when there are no orders. There is an increasing demand for a signal that can be used in place of, not merely as an adjunct to, written train orders. A signal is needed to direct trains to (*a*) "Take siding," (*b*) "Hold main," or proceed on main track regardless of superior trains.

On double-track roads equipped with block and interlocking signals, train movements at the interlocking stations are directed by the interlocking signals.

At non-interlocked passing-sidings there is a need for a signal to indicate "take siding," or "hold main." The Erie Railroad (one of the first to meet this need) uses for this purpose a three-position semaphore train order signal giving three indications: "proceed," "take siding," and "stop."[4]

Train Despatching

The principal purpose of train despatching as already suggested in the discussion of the time interval system is to so direct the operations of trains that they may move with maximum safety and minimum delay. Train despatching has reached a higher level of efficiency under the space interval method than was possible under the time interval method. This has been accomplished by the use of: (*a*) the automatic block system; (*b*) the "19" train order, and (*c*) signal indications in place of written train orders.



A.C. Signaling Along the Mississippi

The train despatcher directs the movement of trains as if his division were a great interlocking plant. He sends his instructions or orders to the signalmen at the block and interlocking stations; these signalmen in turn direct the movement of trains by signal indications. It is thus possible to move maximum traffic with a minimum delay. The *written* order, with its delays and opportunities for error, is replaced by the fixed signal with its instantaneous operation and unmistakable indications. A despatcher can order a signal cleared, can get it cleared and receive the station operators' assurance that the object is accomplished in less than one minute; whereas, a

[3]See "Increased Efficiency by Use of Train-Order Form Nineteen," by T. H. Meeks, *Railway Age*, February 1, 1918.

[4]See "The Use of Signals For Train Operation" on the Erie Railroad in the *Railway Signal Engineer* for July, 1918, page 205.

train order would require several minutes for transmission and transcription, to say nothing of the delay to the train and the time required by the trainmen for reading it.

The Block System

The Interstate Commerce Commission defined the block system at length in its seventeenth annual report (December, 1903). The following is quoted from this report:

"The term 'block system' shall be taken to mean the methods and rules by means of which the movement of railroad trains (cars or engines) may be regulated in such a manner that an interval of space of absolute length may be at all times maintained between the rear end of a train and the forward end of train next following."[5]

The Block Signal and Train Control Board defined the block system as:

"Any method of maintaining an interval of space between trains moving on railroad. Primarily the term refers to the spacing of trains moving on the same track in the same direction, but in practice it is used, on single track lines, both for this purpose and for the protection from each other of trains moving in opposite directions toward each other."[6]

This last definition is a clear statement of the object of the block system, which is to maintain *"an interval of space between trains moving on a railroad."*

The Standard Code gives definitions, requisites, and rules for the three block systems: the manual, the controlled manual, and the automatic. The manual block system is "a series of consecutive blocks, governed by block signals operated manually, upon information by telegraph, telephone or other means of communication." The controlled manual is "a series of consecutive blocks governed by block signals, controlled by continuous track circuits, operated manually upon information by telegraph, telephone or other means of communication, and so constructed as to require the co-operation of the signalmen at both ends of the block to display a clear or a permissive block signal." The automatic is "a series of consecutive blocks governed by block signals operated by electric, pneumatic or other agency actuated by a train, or by certain conditions affecting the use of a block."

Time Interval vs. Space Interval; Comparison of the Two Methods

The character of the interval between trains moving in the same direction is the principal difference between these two methods.

In the time interval method, the interval between trains is maintained at stations usually situated at varying distances apart. This time interval, on most railroads, for trains not carrying passengers is five minutes; for trains carrying passengers it is ten minutes. This time interval, as provided by rule, is to allow time for a flagman to protect the rear of a standing train by red flag or red light; and also by torpedoes and fusees. In the space interval method the interval between trains, whatever their class or character, is a *space* interval for all trains. Fixed signals provide for this space interval. The space intervals are called blocks.

The Operating Efficiency of the Two Methods

As has been shown, it is necessary with the time interval method to allow a larger time margin between train movements than is required with the space interval method. On account of this larger time margin, the time interval method is correspondingly less efficient than the space interval.

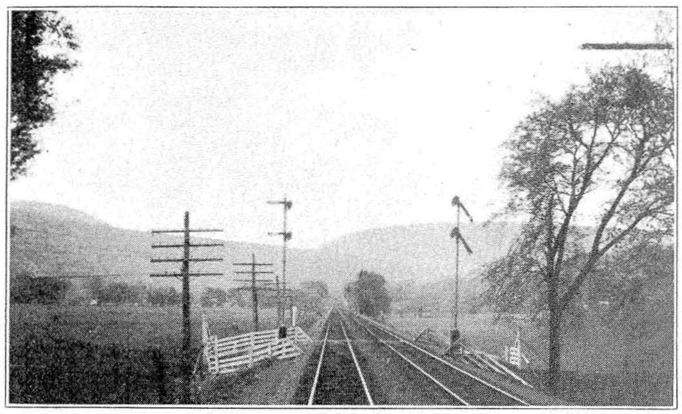
Both delays and hazards are reduced to the minimum in the space interval method, and its superior efficiency is obvious. Operation at maximum track capacity is not possible under the time interval method. Operation at maximum track capacity under the space interval method *is* possible.

The Relative Safety Factor of the Two Methods

In the time interval method two types of fixed signals are used—train order signals and interlocking signals; these signals not being used to space trains.

The protection of trains depends upon the rules requiring trains to keep a certain number of minutes apart, and upon the flagman's signals for the protection of standing or slow-moving trains.

The Interstate Commerce Commission in a report to Congress,[7] describing the limitations of the time interval method, says: "Without the block system, the right of a train to proceed depends (a) on the class of the train as regards other trains, (b) on the time, as shown in the time table, and (c) on the vigilance of the engineman in seeing that the preceding train is out of his way. Under the block system these otherwise vital features become matters merely of convenience or expediency. With no block system rear collisions are provided against by flag or lantern signal, but the failure of this safeguard is notorious. It fails both from the negligence of flagmen to carry out or display the signal and of enginemen to heed it when it is given. On a single-track line, in addition to these uncertainties, the men in charge of trains have the burden of considering their rights as against trains coming from the opposite direction, which are of two or more different classes, and the superiority of which, as related to their train, may vary from hour to hour, or may be varied by telegraphic orders from the train despatcher at any stage of the train's journey. Butting collisions, due to confusion in these things—to mistakes in reading the time table, to wrong telegraphic orders, to non-delivery of orders, to forgetting orders, and other blunders—are as notorious as are rear collisions from flagmen's failures.



Double Track D.C. Signaling in New York

"On either double track or single track we have on the one hand (in the block system) fixed signals, situated at known locations, few and simple requirements, and few men to share the responsibility of any given operation. On the other hand, we have in the old system, signals (as flags), not fixed but to be encountered at unexpected places, or no signals at all, compelling dependence on the time tables, watches, and confusing rules of superiority.

[5]Seventeenth Annual Report, 1903, p. 345, Sec. 14.
[6]Interstate Commerce Commission; First Annual Report of the Block Signal and Train Control Board (1908), p. 71.

[7]Report of the Interstate Commerce Commission on Block Signal Systems; Senate Document No. 342. 1907; p. 11.

Responsibility is divided among a larger number of men."

In the space interval (block system) method three classes of signals are used—(1) train order signals, (2) interlocking signals, and (3) block signals. The first two have the same functions as under the time interval system; but the interlocking signals (where they are part of a block system) are used also for spacing trains. The block system, of course, is not absolute perfection, and every road keeps in force the rule requiring flagmen to protect standing or slow-moving trains by hand signals (flags, lanterns, torpedoes and fusees).

"The block system provides that each engineman may, with perfect safety, start and run his train by the sole authority of a visible signal, fixed on a post at the side of the road, which gives him the exclusive right to the track for a given distance (to the next block signal) without limitation as to the time to be spent in getting there, or the speed. The system provides all necessary security against collision, with no question about the importance of the train, or the priority of any other train. So far as safety is concerned, all trains are of the same class."[8]

To maintain between trains a safe and satisfactory interval of *space*—in other words, to prevent collisions—and to do it wholly by means of time—by the use of clocks and watches—would require a station with a clock (and an attendant) every few hundred feet, and it would be imperfect even then, for the theory of the time interval system requires a length of time sufficient for a flagman to go back and flag. Hence, the inherent weakness of the system. A complete system should have stations, say 1,000 feet apart, and it should have flagmen capable of always going back 1,000 feet, in, say, two minutes. A mere glance at a situation like this makes evident the weakness of the system.

Automatic clocks have been tried, but they only serve to show in stronger light the fundamental insufficiency of any time-interval system. A clock on a 20-foot post at the side of the road was in use for a short time on the Fall Brook Coal Company's railroad in central New York some 25 or 30 years ago. Being set at zero by every passing train it would show to the next train how many minutes had elapsed since the passage of the car wheels which acted to start the hands from zero. But on a crooked road, or on any road in time of dense fog, it would be necessary, in order to give the enginemen the necessary confidence, to locate the clocks very close together. This might answer for slow trains—provided the clocks were well cared for and reliable, and provided discipline of enginemen was very good, but for fast trains the short space interval would be a hindrance without two or more distant (cautionary) signals; for a fast train must have a long stretch of track in which to reduce its speed after receiving warning of the train ahead, and with suitable distant signals the space interval with its superior simplicity would be as feasible as the clock interval. And all this ignores one of the important virtues of the automatic block system—its function of detecting broken rails.

Relative Safety of the Three Block Systems

The Manual Block System: (*a*) A man-operated system. (*b*) The signals are operated *entirely* on information transmitted by telegraph, telephone or electric bell code. (*c*) The correct operation of the system is entirely dependent *upon human agency without mechanical check.*

The Controlled Manual: (*a*) A man-operated system. (*b*) The signals are operated on information transmitted by telegraph, telephone, or bell code. (*c*) The correct operation of the system is dependent *upon human agency, checked by track circuits* throughout the length of the block section.

The Automatic Block System: (*a*) A power-operated system. (*b*) The signals are operated by "electric, pneumatic, or other agency." (*c*) The operation of the instruments in the system is controlled, not by human agency, but by the passage of the train into and through the block section, through the medium of the continuous track circuits.

From a safety standpoint, the control of the signals by the train is the vital point of difference between the systems. In the manual block system the *train does not control the operation of the signals,* for no mechanical check is provided, when the block is occupied by a train, to prevent the display of the clear signal behind it. In the controlled manual system the train but partly controls the signals. In the automatic block system the *train completely controls them.*

Relative Operating Efficiency of the Three Systems

Delays of trains reduce the capacity of the tracks, therefore the operating efficiency of the three block systems may be measured by the relative amount of train delays directly chargeable to block operation.

Train delays chargeable to block operation are unavoidable if the block sections are too long for the movement of trains as frequently as the terminal is ready to send them out.

The ideal method for determining the length of block sections to insure operating efficiency is by taking the required time interval between trains—the frequency required by the volume of traffic which it is desired to move—and making the *time* lengths of the block sections such as will permit of train movements under clear signals. Measured in time the block lengths will be the same, but measured in distance the block lengths will vary with the speed; e. g., the short block on an up grade may be the equivalent of a much longer block on a down grade. Or, further, the block in which a station or other stop is made must be shorter in length than one in which no stop is made.[9]

In the two manual block systems this ideal method is often disregarded because of the tendency, when locating block stations, to give first consideration to the cost of wages of signalmen. This consideration for wage cost is at present a constant disturbing element because of the eight-hour law requirement of three signalmen at each block station. When the wage cost is made the first consideration and block stations are placed at passenger stations to utilize the men at these stations as block operators, the result is often a series of blocks that vary so greatly in length, both as to distance and time, that the time of trains is limited by the *longest* block. Long intervals between trains are thus inevitable.

In the automatic block system the ideal method can be followed, as the wage cost for block operators need not be considered. The block section lengths and the location of the signals can be arranged for moving trains at maximum track capacity.

The following is an interesting comparison of a manual block system installed on a double-track division of 139.5 miles that was later changed to an automatic block system with marked improvement in operating efficiency.

Under the manual block system there were 46 block stations and 90 blocks. The average length of blocks was 3.1 miles, but with great differences in their lengths. The shortest block was .39 miles in length and the longest 7.27 miles; 58 blocks ranging from .39 to 4 miles; 16 blocks from 4 to 5 miles; 12 blocks from 5 to 6 miles; 2

[8]Senate Document No. 342, p. 11.

[9]See Report of Committee X—Signaling Practice; Journal of the Railway Signal Association, March, 1919, p. 42.

blocks 6.89 miles, and 2 blocks 7.27 miles in length.

Under the automatic block, since introduced, there were 296 blocks installed having an average length of .94 of a mile.[10]

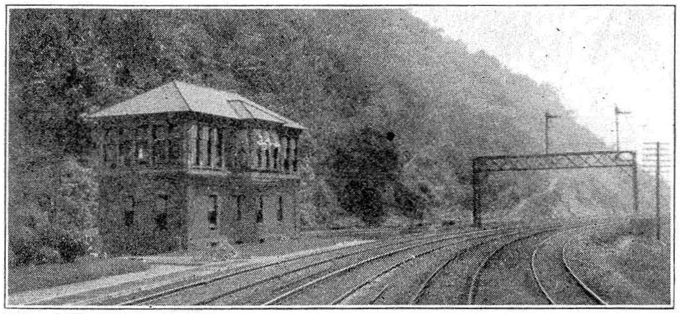
The elimination of delays chargeable to operation under the manual block was one hour and forty minutes per freight train, or a saving in time per train of 15 per cent.

By the improved operating efficiency the saving of expense in train operation was enough to pay for the automatic block *in less than four years.*

Conclusions

In a final analysis of the three block systems to determine which is the most efficient from an operating standpoint, it is necessary to place them on an *equal basis as to track capacity.* Assuming block sections one mile in length, the manual block is the lowest in first cost. The controlled manual is the highest in first cost (installation); but both systems are so high in cost of operation that it is the exception to find either the manual or the controlled manual with the number of block sections necessary for maximum track capacity.

On the contrary, the first cost of the automatic block (somewhat less than the first cost of the controlled manual) is the lowest of the three systems in cost of operation.



Interlockings Judiciously Located Help to Facilitate Traffic

The automatic block shows the greatest operating efficiency per dollar of investment.

Appendix

Principles of Train Despatching

The principles of train despatching were clearly set forth years ago by J. J. Turner in his book on "The Telegraph as Applied to Train Movement," in the following terse paragraphs:

"First. That to prevent conflicting instructions and to insure safety, no more than one man can despatch trains on the same track at the same time."—Complied with by a rule to that effect.

"Second. That the despatcher be kept fully advised of all delays, present or prospective, and the position of every train on the road."—Complied with by reports from stations and terminals.

"Third. That orders must be so clearly expressed as to render a misunderstanding of their meaning impossible."—Complied with by the use of rules and forms of the Standard Code.

"Fourth. That the despatcher must know that they are in the hands of some reliable party for delivery."—Complied with by the acknowledgment of the operator giving his initials and office call.

"Fifth. That it is as near certain as anything human can be, that the party who is to deliver them will stop the train to which they are addressed."—Complied with at each train order office, by the use of a fixed signal which shall indicate "stop" when trains are to stop for train orders.

"Sixth. That when delivered to trainmen, they read just as they did when sent by the despatcher."—Complied with by the receiving operator, who repeats the completed order to despatcher for verification.

"Seventh. That the instructions given to both trains are identical."—Complied with by the use of the duplicate order system.

"Eighth. That the train whose rights are extended must not be moved against the train whose rights are curtailed, without notice to the latter."—Complied with by sending the order first to the train whose right is restricted before completing the order to the train whose right is extended.

"Ninth. That men who are to act upon orders, acknowledge their receipt."—Complied with by rules relating to "31" and "19" orders.

"Tenth. That men using them know that they are doing so with the full knowledge and authority of the despatcher."—Complied with by the response 'Correct" from the train despatcher.

"Eleventh. That trains running against other trains under special orders must be able to recognize each other."—Complied with by giving the number of the engine of every train mentioned in the order, or by train number indicators.

"Twelfth. That a complete record be kept of each transaction."—Complied with by use of the despatcher's order book.

[10]Erie Railroad, Susquehanna Division.

ACCIDENT BULLETIN NO. 73

THE Interstate Commerce Commission has issued its quarterly Accident Bulletin, Number 73, dated April 19, 1920, giving statistics of railroad accidents in the United States in the months of July, August and September, 1919. The total number of persons killed in train accidents in the quarter under review was 156, and of injured 2247; and the total number of casualties on the railroads of the country from all causes, in that quarter, was 43,180, as shown in the table below. The term "other persons" includes, under the head of trespassers, some employees.

A comparison with the corresponding quarters of 1918 and 1917 appears, as follows:

CASUALTIES IN THREE MONTHS—JULY, AUGUST, SEPTEMBER

	1919		1918		1917	
In Train Accidents—	Killed	Injured	Killed	Injured	Killed	Injured
Passengers	17	1,294	129	1,118	39	1,406
Employees	126	904	153	939	108	995
Other persons	13	49	66	90	48	160
Total	156	2,247	348	2,147	195	2,561
In Train-service Accidents—						
All classes	1,607	12,491	2,081	14,299	2,524	16,309
Total	1,763	14,738	2,429	16,446	2,719	18,870
In Non-train Accidents	116	26,563	171	29,180	122	31,967
Grand total	1,879	41,301	2,600	45,626	2,841	50,837

The number of collisions reported during the quarter was 2072, of derailments 4120, and of other train accidents 899, and the total damage to railway property was $6,403,750. This sum is no less than 32.6 per cent more than the corresponding total for the quarter immediately preceding; a difference entirely consistent with the well-known fact that the second quarter of the year always shows a lighter accident record than either of the other three quarters.

Reports of investigations of train accidents made by the Bureau of Safety are now printed in a separate publication and the present bulletin consists of only 13 pages.