

from 2:00 p. m. to 5:30 p. m. and the evening session from 7:30 p. m. to 10:30 p. m. The afternoon session will be devoted to a discussion of the automatic train control problem, a paper being presented by W. B. Murray, chief engineer, Miller Train Control Corporation, touching on some of the problems to be solved in connection with the application of automatic train control as it affects the signal, mechanical, maintenance of way and operating departments and with respect to its effect on track capacity, the use of speed control devices, etc. A large turnout is expected from officers of the various departments affected by such installation, a number having

signified their intention to be present, among them members of the former Automatic Train Control Committee of the United States Railroad Administration. The automatic train control problem is one that must be faced and studied carefully in view of the fact that the Transportation Act authorizes the Interstate Commerce Commission to order in such installations when, in its opinion, this is deemed necessary.

The evening session will be devoted to matters pertaining to maintenance subjects for signalmen, at which time subjects of interest to maintainers, not now ready to be announced, will be presented.

The Use of Signals for Better Train Operation

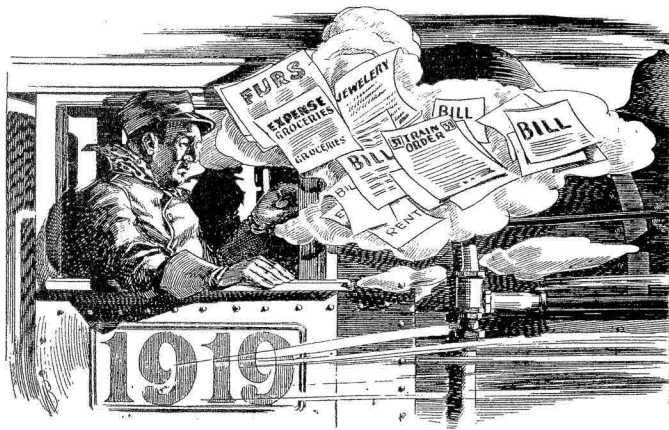
Train Orders vs. Signal Indication; Single-Track Operation Without Written Train Orders

By HENRY M. SPERRY, M. Am. Soc. C. E.

In Two Parts—Part II

THE first part of this article contained a condensed description of our two principal methods of directing train operation: (a) the time interval method (clocks, time tables and train orders, with the flagman as a necessary adjunct) and (b) the space interval method or block system (an absolute interval of space between trains); this as a preliminary to the study of the problem of train operation by signal indication. On double-track roads this problem was never a serious one, except as it has been complicated by attempts to operate the system with incomplete facilities, as, for example, allowing second-class trains to clear superior trains at sidings midway between block stations. On single-track roads progress in the solution of the problem has been slow.

This second part will describe in some detail the actual work of the train dispatcher under the two methods.



Bad Company for a Train Order

Under the first and time-honored method, the train dispatcher's whole day, so far as it manifests itself outwardly, is devoted to the preparation of written orders, getting them delivered to conductors and enginemen and making for himself a satisfactory record that each act has been completed infallibly.

Under the second method of direction by signal indication, the dispatcher is relieved of his chief burden, that of avoiding "small errors which produce great horrors," and the whole business of train operation is *simplified, accel-*

erated and made safer. These commonplace terms are so familiar that we become careless of their significance, but each one of them signifies, in itself, an element of importance on every busy railroad; for the dispatcher's office is the nerve center of the whole money-earning machine, and its smooth and unobstructed action should never be regarded as of minor importance. That it should function perfectly at all times is as important in its field as that the general manager's brain should always be alert to every act and every neglect of his dozen subordinate officers. The dispatcher's work should be *simplified* in every possible detail and to the last degree, so as to reduce internal friction—if I may borrow a mechanical term. Everything possible should be done to enable him to make every move in the least possible *time*, because losses of minutes at his desk may and often do result in losses of dollars out on the road. The prime duty of making train movement *safer* goes without saying. This essay is addressed mainly to the question of economy; but, fortunately, the pursuit of economical financial results and of greater security to the lives and limbs of passengers and employees can be treated as a single pursuit. There is no incompatibility and there should be no division of purpose.

Train Orders vs. Signal Indications

Train orders are written instructions that must be delivered to the conductor and engineman of the train. They must be correctly prepared, transmitted, delivered and understood. *They must not be forgotten.* On railroads *not* equipped with controlled manual or automatic block systems, safety of operation depends entirely upon the human element, for there is no check, either electrical or mechanical, to prevent an improper train movement should an error occur in the preparation of the order or should the order be misunderstood or forgotten.

Signal indications are instructions given by the aspects of fixed roadside signals. The subject is here dealt with as it relates to railroads equipped with the controlled manual or the automatic block signal system. Instructions given by signal indications require less effort in preparation and transmittal than do written instructions. *They are delivered to the engineman through the medium of the signal.* The language of the signal is easy to understand and difficult to forget.

Because the aspects are few in number, there is little opportunity for misunderstanding. Of more importance,

*The first part was published in the July issue of the *Railway Signal Engineer*, page 270.

the instructions conveyed by the signal are given at the point where they are to be executed, and no lapse of time in which to forget them is possible.

Safety of operation under signal indications does not depend entirely upon the human element as in the time interval method.

Comparison of the Two Methods

Psychologists tell us that the strength of a mental impression is greatest at the time it is received and grows weaker with the lapse of time. In the train order method, especially with the more important class of orders, the necessary lapse of time between the receipt and the execution of the order is an element of weakness.

For example, take a train order of Form A, reading: "No. 1 meet No. 2 at B." This order, as is often the case, may be for execution at a siding many miles distant. At the time that the train is to execute the order the engineman's mental impression of the order should be strong and clear. Because of the lapse of time—perhaps an hour or more—and the multitude of subsequent impressions, the train order impression is too often weak and blurred. This point has been well brought out in a recent article by George Bradshaw, supervisor of safety of the Pere Marquette Railroad, in which he exhorts enginemen to take care not to confuse their mental impression of an important train order with other impressions not relating to it. He presents a picture which is a striking illustration of what may flash through the mind of an engineman during the lapse of time incident to the train order method.

The train order calls for deferred action; the signal indication calls for immediate action. The movement required by a train order is seldom made upon receipt of the order. The signal indication is a "do-it-now" order.

Train operation by the train order method requires the delivery of the order to the train. If the train is in motion it must slacken speed or stop to receive the train order. The signal indication method, on the contrary, does not require the train either to slacken speed or to stop.

The train order method, when it thus retards the movement of trains, causes loss of time to cars, engines and men. Furthermore, it unnecessarily obstructs the particular sections of track occupied by the delayed trains, and it requires the consumption of additional fuel to regain the normal speed. The train order method therefore reduces the railroads' output of transportation, and increases train costs. To produce and sell transportation a railroad must keep its trains moving; hence any method that unnecessarily retards or stops the movement of trains tends to destroy production.

American Railway Association's Rules for Train Operation by Signal Indication

Without the block system train order method, as usually operated, is a means both of safety and convenience (convenience with important drawbacks, which are customarily regarded as necessary evils). As soon as regular trains are much behind time they must be moved regardless of the time table. This necessitates the use of despatchers' orders to keep the trains out of each other's way—to give them the right to the road. This is a safety function. But with block signals the trains, without dependence on the despatcher, are prevented from running into one another. The despatcher's function is not so distinctively an element of safety, but his orders continue to be necessary as a convenience, for as long as passenger trains are superior to freight trains, delayed passenger trains will cause delays to freight trains, and delayed freights will delay still other freights. It is the despatcher who must reduce or prevent these delays. If trains were

all of the same class, and the absolute block system were universal, there would be no need of the despatcher for safety and very little need for convenience.

When we speak of train operation by signal indication we mean the use of fixed roadside signals, not only as (1) the means of preventing a train from colliding with the preceding train, or as (2) a means of indicating to a train which of two or more diverging routes it shall take, but also, in addition to either or both of these, as a means (3) of indicating, at the will of the despatcher, under certain circumstances, whether or not a train shall actually make every move which the signals, if not controlled by the despatcher, would permit it to make.

For example, an automatic block signal indicates to an approaching freight train that it may proceed from B to C. The road is clear. But the despatcher desires to have the train enter a side track half way between B and C for the purpose of allowing a passenger train to pass and run ahead of the freight. To carry out his purpose he causes the automatic block signal to give a modified indication. He uses the signal, where under former methods he would use the time-consuming process of a written order conveyed by wire to a station operator.

Train operation by signal indication is not new. As early as 1903 the subject was under consideration by a committee of the American Railway Association. The problem at that time was stated as follows:

"The term 'operation without train orders' is, of course, something of a misnomer. The system contemplates rather a change in the manner of delivering orders, the method of working under them, and the relief of the engine and train crews from the frequent necessity of performing more or less complicated arithmetical problems in order to determine exactly what their orders are. With a train scheduled at a certain time for every station on a division and with an order requiring it to run 1 hour and 30 minutes late from a certain point, the possibilities of error in the calculation of time are large. The fact also that freight trains are required to keep out of the way of trains of a superior class running in the same direction involves either undesirable delays in waiting at passing stations or the taking of long chances in getting to the next passing point.

"The plan in brief is, on double track, to allow all trains to proceed under a block signal showing clear, without regard to any train of superior class that may be following. The rule on the time table covering this point is: 'The right of any train to proceed will be indicated by the position of the train order or block signal. A clear signal will give to any train for which it is displayed the right to proceed in advance of first-class trains without train orders.' The control of the train is thus vested in the despatcher. The conductor, while he is not relieved of responsibility and is required to keep himself informed as to trains of superior class, is, nevertheless, relieved of the necessity of guessing whether he has time to make a certain passing point or of asking of the despatcher permission to do so. There is, therefore, a simplification of the work of despatching, and the conductor has only to push his train along until warned by a signal against him of the necessity of making for a siding."

The American Railway Association, by the adoption in October, 1903, of Rules D-251, D-254, officially recognized train operation by signal indication on double track. The title of the rules is:

"Governing the movement of trains with the current of traffic on double track by means of block signals."

In April, 1904, Rules D-261-D-264 were added for the movement of trains *against* the current of traffic on double track by means of block signals.

Train Operation by Signal Indication on the Burlington Road

The Chicago, Burlington & Quincy Railroad, as early as 1900, began operating trains on double track between Chicago and Burlington "with the current of traffic by block signals" and without written train orders. The rules were few and simple. After several years' trial the net results were summed up as follows:

"A large saving in the time of getting trains over the road, due to the absence of any necessity for waiting for a train of superior class which may or may not be on time; a simplification in train despatching, owing to the lack of a necessity on the part of the conductor to state that he has time to make one station farther on and to secure the despatcher's order to proceed; and a measure of safety due to getting rid of the mathematical and chronological computation above referred to.

"It was formerly required on the Burlington that freight trains should keep out of the time of the fast mail by an interval of 10 minutes; of the time of an ordinary passenger train by an interval of five minutes. Of this responsibility the conductor of the freight is now relieved. On a busy section, as between Chicago and Mendota (83 miles), it is estimated that there is a saving of one-third in delays to trains."

The late F. C. Rice, general inspector of transportation of the Chicago, Burlington & Quincy, the man mainly responsible for the introduction of this method of moving trains, said in 1911: "Our scheme of running trains on double track by block signals has fulfilled our most sanguine expectations. It has saved our company a great many dollars, I am sure, over the delayful practices of train rules and train despatching. We have not had an accident of any sort resulting from the change in practice—not a life lost nor a person injured."

Economic Value of Train Operation by Signal Indication

On *double track* it is now the general practice to run extra trains without train orders. Many roads are also using a distinctive form of signal at non-interlocking switches for directing trains to "hold main" or "take siding." A most notable step in this direction was made by the Erie Railroad on the Susquehanna division in 1910 by the use at non-interlocked switches of signals giving the three indications, "hold main," "take siding," or "stop."¹¹

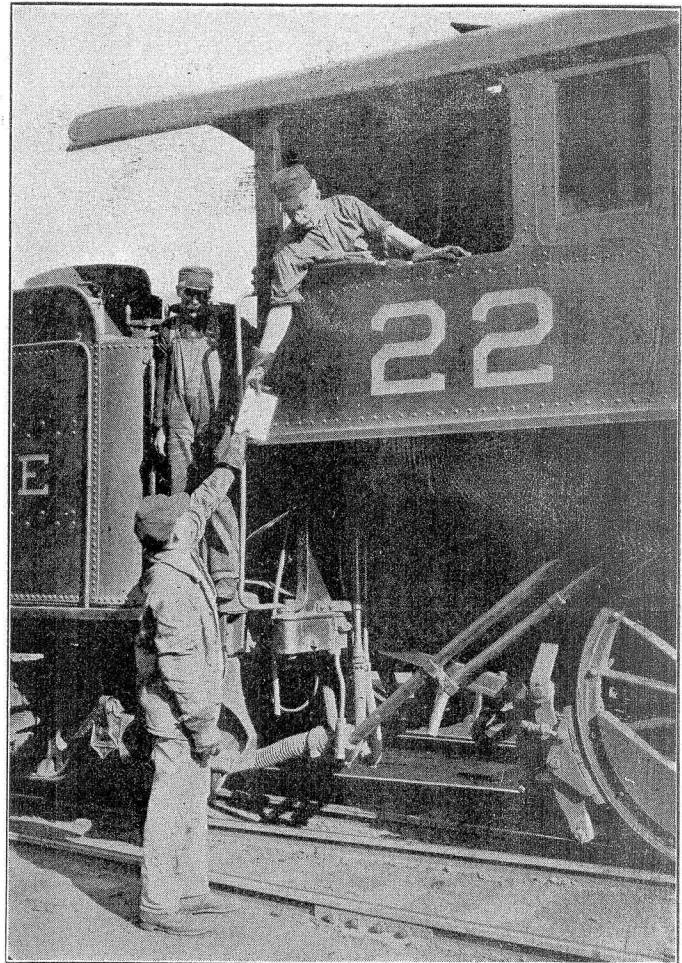
J. J. Turner,¹² in his book on "The Telegraph as Applied to Train Movement," as early as 1885 set forth the advantages of train operation by signal indication on *single track*. Mr. Turner quotes an article by E. W. McKenna¹³ on "A New Theory of Train Movement," from which the following is taken:

"Assume a blocked section of single-track railroad 25 miles in length after the following method: The passing sidings are five miles apart and arranged on either side of the main track and joining the main track in front of a signal station, the double-track rule 'keep to the right' to apply in the use of these sidings. The junctions of the sidings with the main track should overlap¹⁴—that is, run by each other—so that trains from both sidings can move into the main track simultaneously.

"The four switches of the passing sidings to be controlled by the operator in the signal station are operated by the electro-hydro-pneumatic process, by which switches can be set at any distance from the point where

the power is applied. This station may be on a crooked piece of line and the switches at the remote ends of the sidings not in the vision of the operator. Hence that he may know, first, the position of the switches at every movement back and forth, the switches will telegraph him their position; and, second, to prevent him from throwing the switch under a moving train, the train itself by action of a track circuit will lock the switch in the position it is in when the first contact of the train closes the circuit, and keep it locked until the train has cleared the switch.¹⁵

"The procedure will then be as follows: In the block section there will be five blocks averaging five miles each in length. At one of the termini will be located the despatcher. Priority in rights of trains of a superior over



Handing Up an Order

an inferior class, as well as all questions connected with the movements, will rest absolutely in the hands of the train despatcher.

"A train approaching a signal station from either direction when one mile distant will announce itself by closing a circuit and setting an indicator. Upon this the operator will report to the train despatcher, 'train from east.' If the train from the west is to be passed the despatcher will respond, 'side track,' and the operator will signify his understanding by repeating the same word and will set the switch leading into the passing siding.

"To place the matter more fully in the hands of the

¹¹See "Train Operation by Signal Indication," for description of the Erie practice. H. M. Sperry, N. Y.

¹²Now vice-president of the Pennsylvania system.

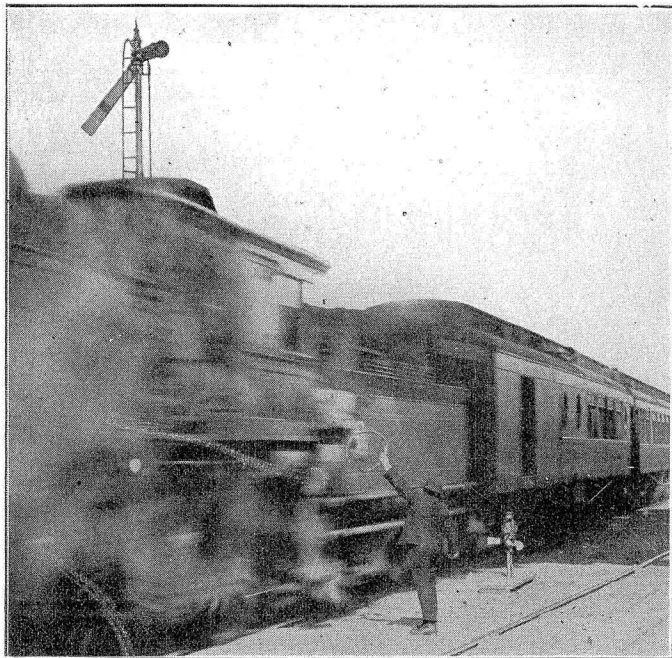
¹³Formerly vice-president of the Chicago, Milwaukee & St. Paul.

¹⁴See article by F. L. Loree, "Lap Sidings on the Cleveland & Pittsburgh," *Railroad Gazette*, September 13, 1901.

¹⁵Outlying switches are now operated electrically by low-voltage switch machines. These machines are for operating switches located at a long distance from the station. They will operate a switch in 35 seconds on 20 volts from a primary or secondary battery.

man who does the thinking for all these train-runners and to protect him against the possible mistakes of his operators in displaying the wrong signal, it is proposed to lock the main clearing signals at danger, by electricity, under the control of the despatcher, so that an operator cannot clear a train even when instructed to do so until the train despatcher opens the circuit that locks the signal.

"What advantages follow this? First, the elimination of the danger of accident connected with the present system. The factors that produce disaster in the handling of train orders have been discussed. They are the despatcher, the operator, the conductor and the engineer; any one of these four can produce an accident. By elimi-



Delivering a "19" Train Order

nating any one or more of these factors you make the responsibility concrete, for an individual responsibility fills its office better than a divided one.

"Accidents have been known where a conductor in doubt as to a point sits in his caboose and depends on 'Jim' in the engine to understand it. Jim is befogged on the same question, but depends on 'Bill' in the caboose, and the result of this division of responsibility is disaster.

"Under the theory discussed, the thinking is all done by one man, the responsibility all rests upon one man, and he has under his absolute control all the appliances for carrying out the system and has only in a small degree to depend upon the intelligence and assistance of the operators and trainmen.

"The next proposition is the economies accomplished by saving of delays to trains. Upon this 25 miles of track assume that 100 trains pass daily; it is not an extravagant calculation to assume that 100 orders are issued daily. A delay of four minutes for the manipulation of each order is equal to 400 minutes, or 6 hours and 40 minutes a day. In this time a train moving at the rate of 20 miles an hour will travel $133\frac{1}{3}$ miles. Multiply this by 365 days and it produces 47,650 train miles, which is certainly an addition to efficient motive-power capacity."¹⁶

¹⁶The I. C. C. abstract for 1918 (Class 1 roads) shows a gross revenue per freight train mile of \$5.33. At this rate 47,650 freight train miles will total \$253,974.50. For a 100-mile division the amount will be four times this, or \$1,014,898.

Mr. McKenna summed up the value of this method of operating a railroad as follows:

"Its capacity can be increased from 25 to 40 per cent, its train movement simplified and expedited, and a largely increased mileage produced from its motive power, with a reduction of expenses in the wear and tear of equipment and consumption of fuel entailed by the frequent and unnecessary stoppages of trains, and in addition thereto the safety factor is largely increased."

Single Track Operation Without Written Train Orders

A number of isolated installations of automatic block signals on short lengths of single track are in use today for operating trains by signal indication. As yet there is no such installation in the United States extending over an entire single-track division."

With the notable improvements that have been made in automatic block signaling for single track, the day is close at hand when trains will be "safely moved on single track without train orders and with but few train rules."

The following description of the operation of a single-track road in India by signal indication and without written train orders tends to confirm the above statement:

"Until recently traffic on the East Indian Railway has been handled without any officer corresponding to the American train despatcher, dependence being placed entirely on the station masters or agents using block instruments on single-track lines. It has been found that under this system frequent unnecessary delays to freight trains resulted from the desire of the agents to avoid the necessity of explaining delays to passenger trains.

"In order to relieve this situation a centralized control system has been installed. The movement of trains is placed under the control of an officer called a train



Instructions Given by Signal Arms; No Paper; No Slackening of Speed
"Proceed, Regardless of Following Superior Trains"

controller, who directs the station masters by telephone as to which train may be held and which sent forward. The system differs only slightly from that in use on many double-track lines in England, where controllers or despatchers direct block operators as to the movements of trains. On the Indian railways the station masters direct the signalmen as to the throwing of switches and setting of signals.

"On the single-track line between Allahabad and Tundla, a distance of 262.5 miles, traffic consists of 21 trains each way in 24 hours, freight trains having a length of about 1,500 ft., with a possible load of 850 tons, and the passenger trains consisting in some case of 12 coaches.

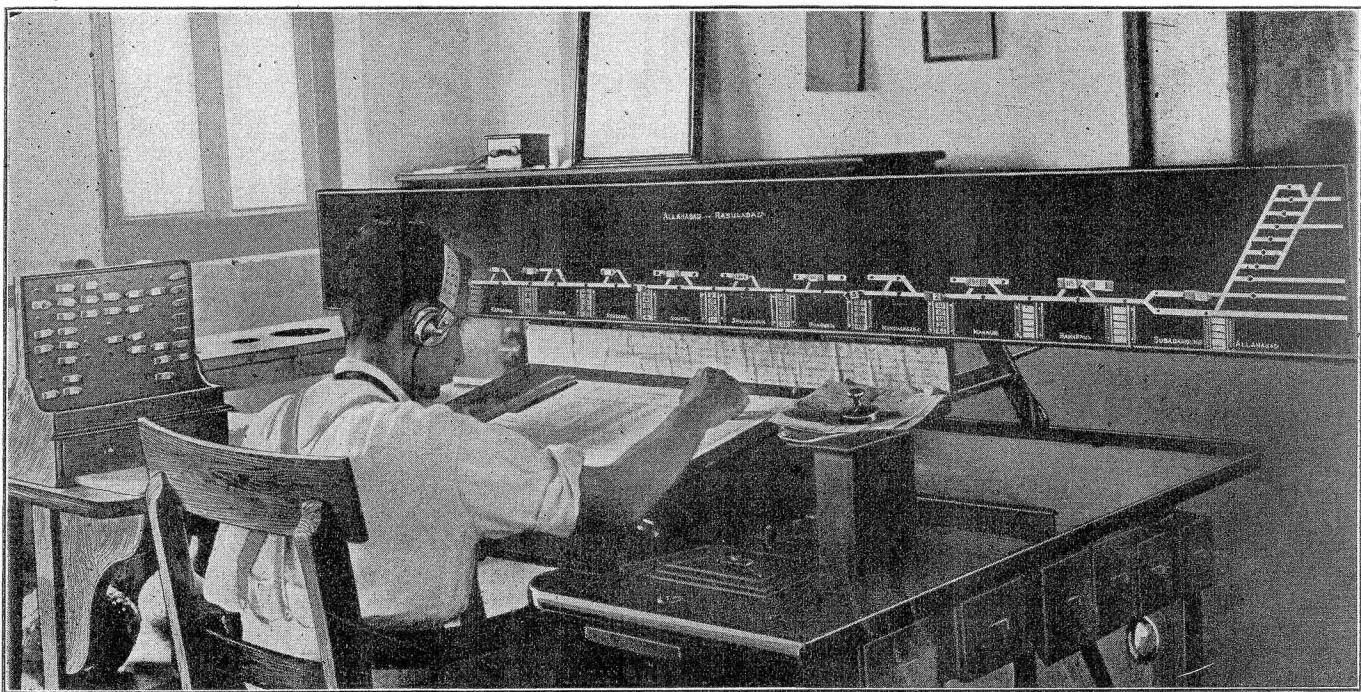
"This section is divided into four control districts, ranging in length from 57 miles to 86 miles, each in charge of a controller throughout the 24 hours, these men working in three shifts of eight hours each. In place of the train sheet in use by American dispatchers, these Indian railway controllers make use of a plug board¹⁷ and a graphic sheet or chart. When a train enters the section the controller takes a plug from the board and inserts it in a socket on the diagram corresponding to the terminal station. As it progresses from station to station its arrival and departure are reported by telephone to the controller, who shifts the plug correspondingly. Each plug is marked with the number of the train

the three charts each day form a complete record for the district superintendent.

"The installation of this system has effected important operating economies. The number of trains operated has increased 10 per cent, as indicated by the monthly summaries, the increase in the number of through freight trains for these periods being 15 to 35 per cent. In spite of this increased number of trains, the average time on the road was decreased 10 to 15 per cent."¹⁹

The important economies obtained on the East Indian Railway constitute a most favorable showing for single-track operation by signal indication, or operation without written train orders.

Another record of single-track operation by signal indication—a very remarkable one and not to be lost sight of—was the operation by the Jeffersonville, Madison & Indianapolis in 1882 of 225 trains a day over the Louisville bridge and adjacent tracks entirely by signals without the use of written train orders. This handling of a heavy



Graphic Train Sheet and Hand Operated Track Model
Train Dispatcher's Office, East Indian Railway, Allahabad

it represents, and its color indicates the class of the train. A station is not permitted to accept or despatch a train without orders of the controller, but ordinary single-track block operation remains in force. When a train is to be sidetracked the controller instructs the station as to which siding is to be used, and as long as the train remains on that siding its plug on the controller's board is left at that point.

"The permanent record of the movement of trains is made on a chart or printed form, showing the list of stations in a column at the left, and with vertical rulings representing five-minute intervals for a period of eight hours, and a horizontal line opposite each station.¹⁸ Different colored pencils are used for different classes of trains with which lines are drawn across this diagram, the intersections of these lines with the horizontal lines indicating the time at which each train passed the given stations. As each chart represents eight hours' work,

traffic entirely by signals when the science of signaling had not reached its present high development was a most notable performance.

With the present development of the science of signaling, the equipment of a single-track division of a railroad with automatic block signals, interlocking signals and telephone train despatching for directing the movements of trains by signal indication without the use of written train orders, is in every detail simple and feasible, and can be carried out under arrangements which have the approval of the most conservative railroad authorities.

A single-track railroad thus equipped will fully meet the requirements of the block signal system described in a handbook, "Train Operation," written by William Nichols, for 10 years chairman of the board of examiners, Southern Pacific Company.

Mr. Nichols describes this block system as follows:

¹⁷J. J. Turner, in "The Telegraph as Applied to Train Movement" (1885), describes the use of a plug board in train despatching on a busy piece of single track railroad. E. W. McKenna, in 1882, devised this board and put it into use. Mr. McKenna was at that time superintendent of the Jeffersonville, Madison & Indianapolis, now a part of the Pittsburgh, Cincinnati, Chicago & St. Louis. The plug board is a crude track model.

¹⁸See article by L. C. Fritch (now vice-president of the Chicago, Rock Island & Pacific Railroad), "Train Dispatcher's Graphic Chart," used on the Ohio & Mississippi Railway in 1891.—Engineering News, September 5, 1891.

¹⁹See *Railway Signal Engineer*, July, 1917.

"With a proper block system, with signals to govern train movements in and out of sidings, trains may be safely moved on single track without train orders and with but few train rules."

Operating Efficiency

The efforts that have been made to increase operating efficiency have largely been in the direction of:

1. Increasing the tractive power of the locomotive.
2. Increasing car capacity.
3. Increasing track facilities by the addition of second, third and fourth main tracks, longer passing sidings and larger yards and terminals.
4. By the electrification of steam-operated roads.

These improvements, which require large expenditures, may fail to show an adequate return if the means for directing train operation does not keep trains moving.

Progress

The progress chart (Fig. 1) visualizes the progress made in equipping the railroads of the United States with block signals.²⁰ The relative progress of the two block systems, measured in miles of track, is shown in detail in the following table of the 12-year period from 1907 to 1919:

TABLE I—INCREASE IN TWELVE YEARS

	1907, January 1	1919, January 1	Total increase	Avg. annual increase
	Miles of track—		Miles of track—	
Manual block system.....	51,689	69,830	18,145	1,512
Automatic block system.....	12,745	59,458	46,713	3,893

The average annual increase of 3,893 miles of track of the automatic block signal is $2\frac{1}{2}$ times the average annual increase of the manual block. In other words, for every mile of manual block installed, $2\frac{1}{2}$ miles of automatic block was installed. From the standpoint of comparative progress this rate of increase of the automatic block over the manual block might be regarded as satisfactory. Yet it is not satisfactory when compared with the average annual increase of main-track mileage.

On January 1, 1918, the total miles of track of the roads equipped with automatic block signals was 57,084 miles. Deduct this from the total of 267,574 miles of main track in 1918 and there remains a balance of 210,490 miles of main track Class I roads²¹ not equipped with automatic block signals.

Table II shows the relative progress of main-track mileage and block-system mileage for six years, 1912 to 1918.

TABLE II—AVERAGE ANNUAL INCREASE, 1912-1918

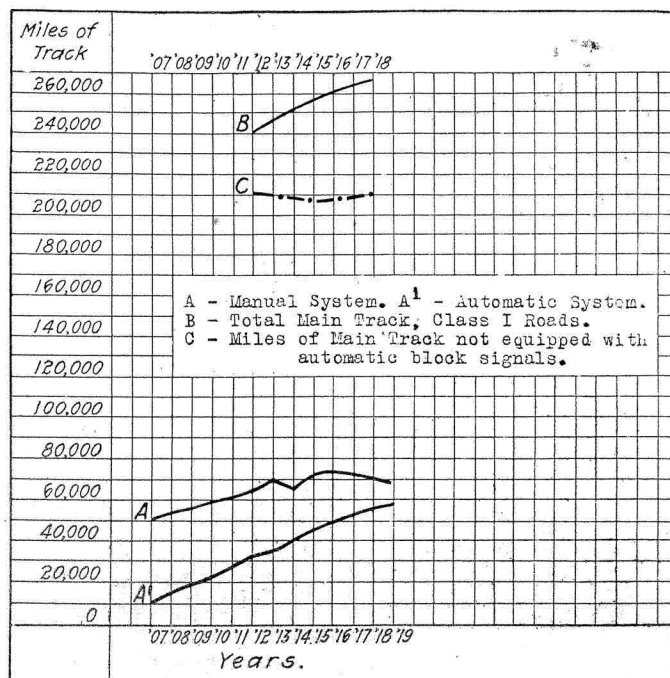
	1912, January 1	1918, January 1	Total increase	Avg. annual increase
	Miles of track—		Miles of track—	
Main track Class I roads.....	246,747	26,574	20,827	3,471
Manual block system.....	66,072	71,493	5,421	904
Automatic block system.....	33,425	57,084	23,659	3,943
Main track not equipped with automatic block system.....	213,322	210,400

*Estimated as of January 1, 1912.

The significant point in this table is that the average annual increase for the automatic block system, 3,943 miles, is only 472 miles in excess of the average annual increase for main-track Class I roads (3,879 miles). Therefore, unless there is a marked increase in the annual mileage of the automatic block system, the main-track mileage and automatic block mileage will continue to run nearly parallel with each other. It is acknowledged universally that the automatic block system is the ideal system of signaling for economizing track facilities and promoting prompt movement of trains, and also the best preventive of collisions. And its usefulness is not confined to lines of dense traffic. It is in use on

some lines where the volume of traffic is not to be classed as heavy; but its value is evident, and is appreciated as definitely on such lines as on those which are more constantly busy.

Any railroad which aims to give the public the best possible service has a duty not only to keep up with "the state of the art" according to the very easy standards



Progress Chart, Railroads of the United States

in this respect which are laid down by the courts, but to establish the *highest possible standards*. Establishing high standards at large expense may sometimes seem, because of the indifference, ignorance or hostility of legislatures and municipal and other authorities, to be a thankless task, and it is not to be denied that some of the difficulties are hard to remove. But there is still to be kept in mind the broad view, looking well to the future, that high standards of safety and efficiency do afford the most satisfactory ultimate results.

Transportation is the carriage of persons and commodities from one place to another. Transportation means movement. Movement, to be efficient, must be directed. The means for directing movement must be efficient. Automatic block signals constitute the ideal means for the direction of movement—that is, for the *direction of train operation*.

LOANS FOR A'S AND B'S

THE Association of Railway Executives submitted to the Interstate Commerce Commission on June 26, the preliminary report of its special committee making recommendations, requested by the commission, as to the application of various carriers for loans from that part of the \$300,000,000 loan fund provided by the transportation act which the commission has decided to use to aid the railroads in acquiring new equipment. Some roads spending part of the loan on signaling are:

Chicago & Western Indiana, completion of two yards, automatic block signals, interlockers, tools, \$1,805,000; Gulf Coast Lines, yards and sidings, shops, shop machinery, heavier rail, \$200,000; Gulf, Mobile & Northern, interlockers, heavier rail, \$73,000; Northern Pacific, additional yard tracks, sidings, interlockers, engine houses, shop buildings, shop machinery, tools, car sheds, \$2,400,000; Texas & Pacific, new yards, and engine facilities, additional passing tracks, shop machinery, train despatching circuits, water supply, \$1,688,000.

²⁰The Progress Chart was prepared from statistics of the Interstate Commerce Commission.

²¹Class I roads are those having each an annual operating revenue above \$1,000,000.