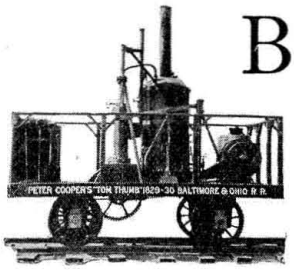
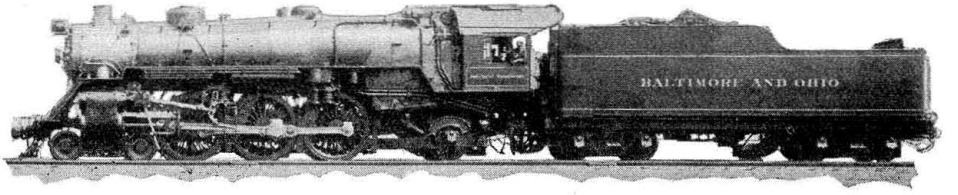



# B. & O. Celebrates Completion of First 100 Years of Service

## "Fair of the Iron Horse" includes interesting exhibits of track, bridges, signals and locomotives




THE Centenary Exhibition of the Baltimore & Ohio was held near Baltimore, Md., starting September 17, and closing October 15, during which time over 1,250,000 people visited the exhibits. In an address at the opening of the centenary just before the pageant was first shown, Daniel Willard, president of the B. & O. said in part:

"One hundred years ago this year a small group of Baltimore business men decided to build a railroad from Baltimore to the Ohio river for general transportation purposes. A charter was secured from the Maryland legislature. A company was organized, money was raised and construction was begun. The Baltimore & Ohio, as we know it today, is the result of that beginning, plus the continuous growth of one hundred years.

"In the pageant which will move past the reviewing stand, you will see some of the different forms of transportation which preceded the railroad, followed by a reproduction of a part of the civic parade and pageant that marked the laying of the 'The First Stone,' July 4, 1828. You also will see moving, with its own power, an accurate reproduction of the first steam locomotive built in America, and following it you will see examples, most of them originals of each distinctive type of locomotive used on the Baltimore & Ohio during the last century.

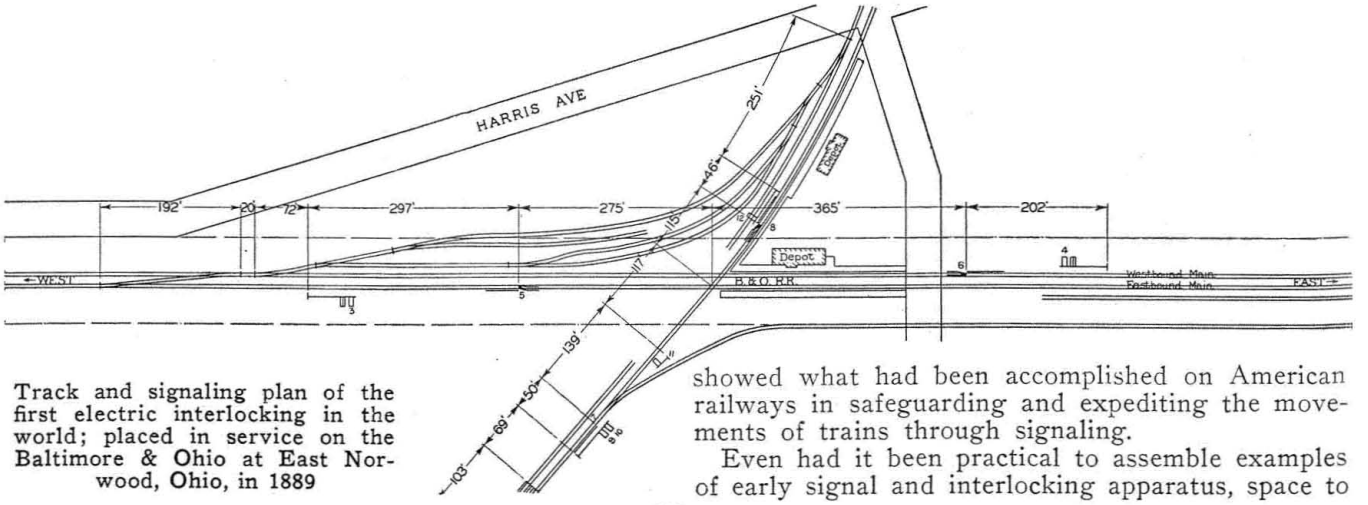
"A number of other railroad companies in the United States, Canada and England have kindly sent to this 'Fair of the Iron Horse' examples of their early as well as of their modern practice. We are under special obligations to the Great Western Railway Company of England for sending us one of their most modern passenger locomotives, the King George V.

"While we shall show by actual example how the railroad track, bridges, cars and locomotives have developed during the passage of a century, I venture to hope that we have not wholly neglected those higher values which rest upon a basis of sympathetic human relations and understanding. A railroad is more than a lot of materials made up into tracks, cars and locomotives. A railroad also connotes a group of human beings, all more or less skilled, some highly so, and all inspired with a feeling of loyalty toward each other and to the property with which they are connected. Such measure of success as has been achieved by the Baltimore & Ohio during its long career has been due in no small degree to the ability of its management and to the loyalty and co-operation of its employees in all grades of service."

### Features of the Signaling Exhibit

The Hall of Transportation, a permanent brick building 500 ft. by 60 ft., housed the main exhibits of track, bridge and signal equipment together with the models of early locomotives, cars, etc. Two smaller buildings housed the exhibits of communication facilities, baggage service, post office equipment and accounting. Tracks in the rear of the main hall were provided for the car and locomotive exhibits. The pageant, a daily feature of the centenary, including numerous floats, cars, locomotives, etc.; was operated over standard gage track requiring over two hours to pass in review before the grandstand.

This "Fair of the Iron Horse" was so extensive that the catalogue giving a brief explanation of the many exhibits contained 172 pages. It is, therefore, evident that space is not available here to dwell upon any except the exhibits devoted to signaling, which showed what had been accomplished on American railways in safeguarding and expediting the movements of trains through signaling.

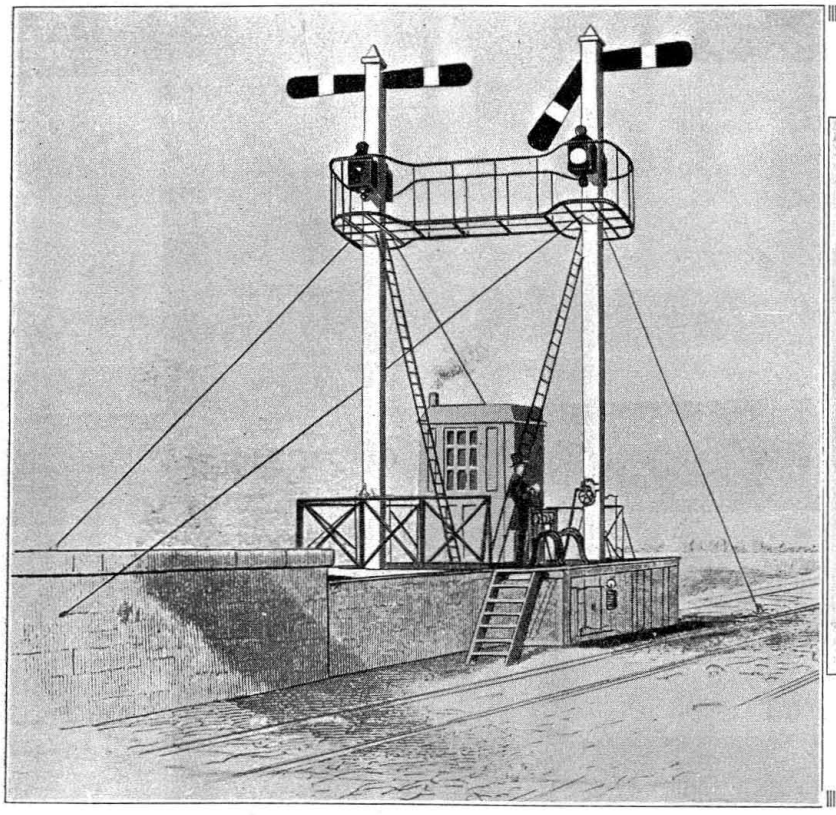



**Track and signaling plan of the first electric interlocking in the world; placed in service on the Baltimore & Ohio at East Norwood, Ohio, in 1889**

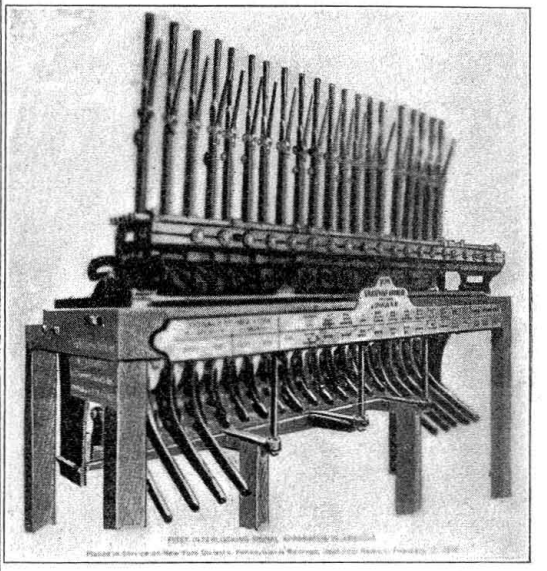
Even had it been practical to assemble examples of early signal and interlocking apparatus, space to

exhibit such a display was not available. Drawings and photographs, artistically colored, were used therefore to illustrate in chronological order the development of signaling from the crude signal of 1834 to the highly perfected signal systems of the present day. Each picture was 20 in. by 24 in. and was mounted in one of a series of 90 frames to form the exhibit. A few of the pictures, chosen as the most interesting from an historical standpoint, are reproduced herewith. Signals of full size were also shown in operation representing the four types of present-day signals—the semaphore and the three "daylight" light signals, namely, color-light, position-light and color-position-light signals. Highway crossing signals in full size were also shown, including the flashing-light and wig-wag types.

The pictures and drawings really told the story of the development of signaling and what little explanation was necessary to assist the average layman to understand the exhibit was printed in large type legible at a distance of 15 ft. The exhibit was divided into several divisions such as, fixed signals, train dispatching, manual block, interlocking, etc. An abstract of the printed explanation forming a part of the exhibit is given in the following:



*Left—The first installation of mechanical interlocking was placed in service in England at Bricklayers Arms Junction in 1843.*



*First Saxby & Farmer mechanical interlocking machine with latch locking installed in America was placed in service at East Newark Junction, N. J., in 1875, and is still in existance.*

### Fixed Signals

The illustration in this division showed the evolution of the fixed signal from the first fixed railway signal used in England in 1834 to those of the present day. The first signal was a rotating crossbar and lamp signal used by signal men to warn trains of danger ahead. It has its counterpart in the present-day rotating crossbar and lamp signal used by policemen to direct street traffic.

The semaphore type, introduced in 1841, so completely met the requirements of railway signaling that in a short time it came into general use. The early signals of the automatic block system, which was an American invention, were of the disc type, which later made way for the electro-pneumatic and the electric motor semaphore.

A revolution in the type of fixed signal followed the general use of electric lighting. First the oil lamp of the semaphore was replaced by the electric light. Next it was found that the colors of electrically-illuminated signals could be readily distinguished by *daylight*. The color *daylight* signal then came into use, displaying the same aspects by day as by night—red, yellow and green lights.

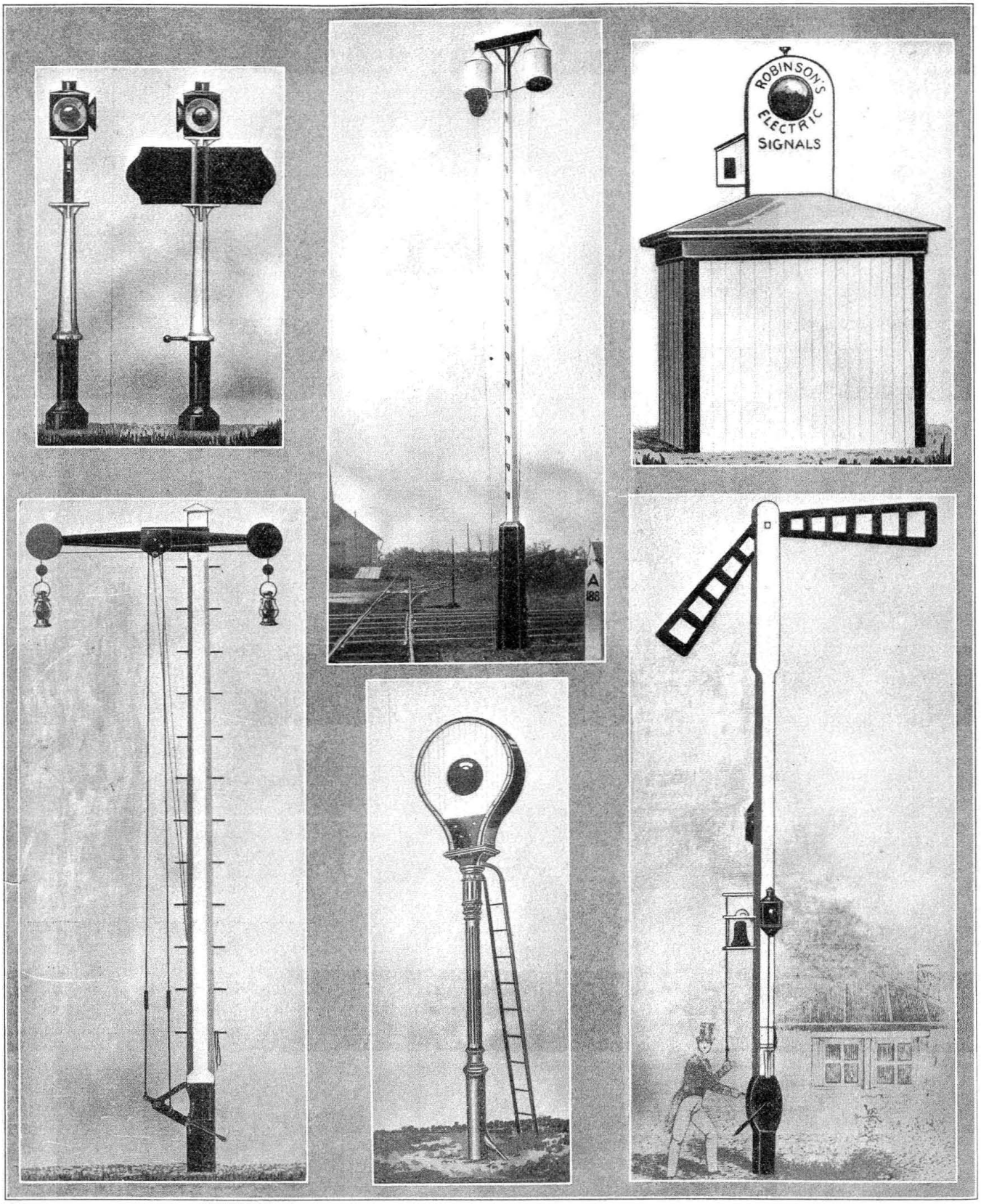
In 1915, a unique type of light signal came into use, the position-light signal. This type was developed to give its indication by position and not by color, thus retaining the distinctive feature of the semaphore signal, which is a position signal with three unmistakable daylight aspects, shown by the horizontal, inclined or vertical position of the semaphore arm.

The next development was the color-position-light signal. This signal displays its aspects by combining the aspects of the color and the position-light signals. Two colored lights are used for each aspect, and these lights are shown in horizontal, inclined or vertical rows. This signal was introduced by the Baltimore & Ohio in 1921.

### Train Dispatching

The purpose of train dispatching is to direct the movements of trains so that they may move with maximum safety and minimum delay. The directing of train movements is accomplished through the use of instructions, 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.

Two forms of train orders are in use: form 31, which, as it requires a written receipt, compels the train to stop; form 19, on the other hand, may be delivered to the train while in motion. Train dis-




Photographs and sketches of early signaling as shown at the Baltimore & Ohio centenary

Upper left—Crossbar and lamp signal placed in service on the Liverpool & Manchester Railway, [England] in 1834.

Lower left—Tilting crossbar signal of 1857, installed on many roads in United States as railway grade crossing signal; now obsolete.

Upper center—Ball signal placed in service on Great Western Railway [England] in 1837.

Lower center—Enclosed disc, Banjo type signal electrically operated; first automatic signal introduced on a railroad in the United States in 1871 by Thomas S. Hall.

Upper right—Enclosed disc type of automatic signal installed in 1872 at Irvineton, Pa., by Dr. William Robinson. First automatic block signal to be controlled by a track circuit.

Lower right—Semaphore signal introduced on the railways of England in 1841 by C. H. Gregory.

patching on our railroads requires a force of over 5,000 train dispatchers. It is estimated that they issue nearly 50,000,000 train orders a year.

Train dispatching may be said to be approaching the third stage of its development. The first stage was prior to the use of the electric telegraph in 1851. This was the "time table" stage as then the time table was the sole authority for the movements of trains and railroads were all single track. Trains had the right to run as long as they could move on schedule time. When delayed, the inferior train was required to protect its movement by sending out a flagman ahead of it. It was during this stage that the visual signal was used by at least one road in signaling information from terminal to terminal as to the movement of the train.

The New Castle & Frenchtown Railroad, one of America's pioneer roads, ran from New Castle, Del., on the Delaware river, to Frenchtown, Md., near Chesapeake Bay, a distance of 17 miles. In 1832 when the motive power was changed from horses to locomotives, a system of visual signals was put into use for sending information from terminal to terminal as to the movement of the train. This was 12 years before the invention in 1844 of the electric telegraph.

These visual signals, located about three miles apart, were ball signals hoisted on poles about 30 ft. high. When the train started, the flagman at the terminal hoisted a white ball to the top of the pole. The flagman at the second station, observing the position of the signal through a telescope, hoisted the white signal ball at his station to a few feet from the top of the pole. The flagmen at the other stations repeated this signal so that at New Castle, it was known that the train had started from Frenchtown within a few minutes after it had left there. If the train was delayed, a black ball was hoisted in place of the white ball.

This primitive method of signaling the movement of the train by visual signals was limited to dispatching or sending out of the trains as no means were then available for quickly reaching the trains with instructions for directing their movements.

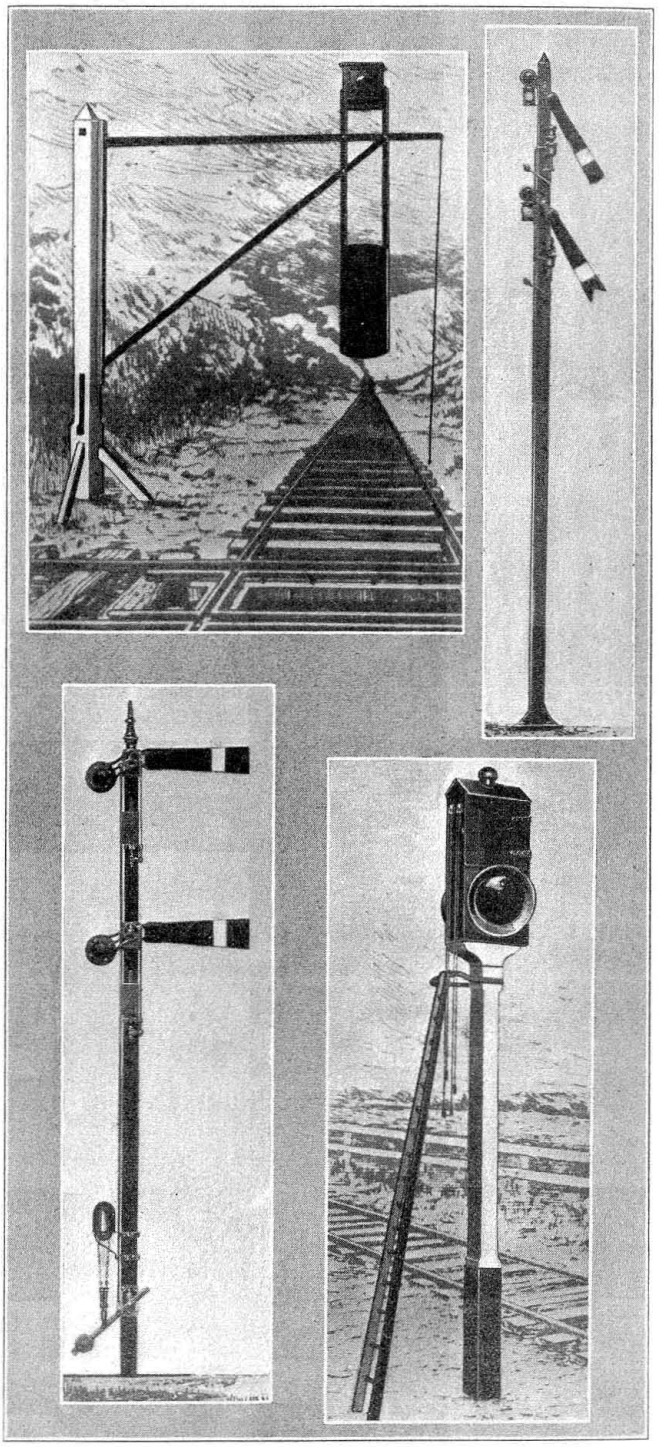
Train dispatching entered its second stage in 1851, when the electric telegraph came into use for sending train orders. This may be termed the "train order" stage on account of its extensive use in directing train movements. Next came the telephone in 1907 so that today the train dispatcher has the telegraph, the telephone and even the radio at his service if he needs it.

Increasing consideration is now being given to the method of conveying instructions entirely by signal indication to the engineman of the moving train. When the train order is superseded by the unmistakable indication of the signal, train dispatching will enter its third or "signal indication" stage and it is one that offers great possibilities for further safeguarding and expediting train movements.

### Manual Block System

The term "block system" is used to designate the method by which, through the use of the telegraph, telephone or electric bells, or by automatic apparatus, each train on a railroad is forbidden to pass a certain point (the entrance to a block section) until the preceding train on the same track has passed out of the block section.

The block system was developed to meet the demand for safe travel by rail. At first when trains were few, the signals were much the same as the signals used today by policemen for controlling street traffic. Signalmen were stationed along the railroad at hazardous locations such as curves and tunnels, with crude types of signals for warning the trains of danger ahead. These men were called policemen,



Upper left—Gate signal of 1860, used for many years as railway grade crossing signal, now obsolete

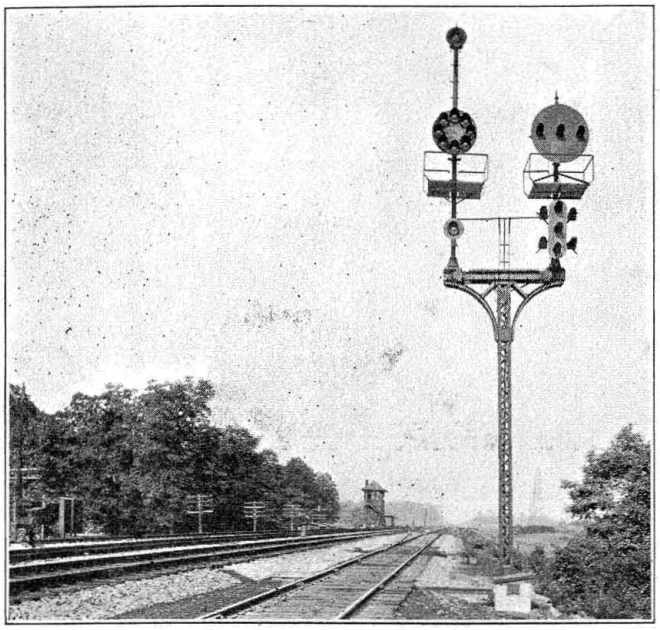
Upper right—Semaphore signal of 1881, electro-pneumatically operated. First automatic semaphore signal, used also as interlocking signal

Lower left—Type of first automatic semaphore signal operated and controlled electrically. Introduced in the United States in 1893

Lower right—Banner box signal installed in 1863 between Philadelphia, Pa., and Trenton, N. J. First type of manual block signal put in service in the United States

no doubt, because they acted as the guardians of the rail.

As trains increased in number, the signals were used to maintain a *time* interval between trains. The time interval, however, failed to promote safety as too often it proved misleading. The next step was to maintain a *space* interval between trains moving on the same track, which was done by dividing the track into block sections by the use of signals for regulating the movement of trains through these sections. The signals are manually operated upon information by telegraph, telephone or electric bells. This method of operation, known as the manual block



**Niles Junction, Ohio—Right-hand bracket Pennsylvania position-light signal Left-hand bracket Baltimore & Ohio color-position-light signal**

system, guards against the collision hazard.

The first block system in America was put in use in 1863-64 on the line between Kensington (Philadelphia), Pa., and Trenton, N. J., following a disastrous rear collision at night of eastbound trains carrying soldiers from the seat of war to New York and New England. This block system provided for maintaining a *space* interval between trains. The earliest authentic record of block regulations that has been found is dated November 12, 1869. These regulations issued by F. Wolcott Jackson, general superintendent of the New Jersey Railroad (Jersey City, New Brunswick), gave the rules under which the space interval was to be maintained.

The block signal at each station consisted of a box mounted on a post with two red flannel banners, one for each direction, which were dropped in front of a white surface or a white light for the "stop" indication. (See illustration under Fixed Signals, "Banner Box Signal of 1863.") The banner box signal was superseded by the semaphore signal. One of the early types was a station block signal with the arms for controlling train movements in both directions both mounted on the same post.

The block stations were provided with telegraphic apparatus and an independent wire extended from block station to block station. The operator at a block station was required to make a record of every train that passed his station, the exact time that the train passed and the time that notice was received from the next station that the train had passed it. The maintenance of a space interval between trains which was made the basis in 1863 of the first American block system, is the basis of all present day block signaling, as the safety of train operation depends upon maintaining a space interval between trains.

### Automatic Block System

The automatic block system was invented in America and developed on American railroads. Its primary function is to reduce the collision hazard by providing a *space* interval between trains. The length of this space—the block section—is dependent upon traffic requirements. The most common length is one mile.

When a train enters a block section, the signal or signals governing the section automatically move to the stop position and remain in the stop position until the train passes out of the section that controls the signals. The signals are thus automatically controlled, not by human agency but automatically, by the passage of the train into and through the block section through the medium of the track circuit. Dr. William Robinson invented and put the first closed track circuit in use in 1872.

### Mechanical Interlocking

Interlocking is an arrangement of switch and signal appliances so interconnected (interlocked) that their movements must succeed each other in a predetermined order. The purpose of interlocking is to provide a *safe path* for the movement of trains through switches, junctions, railroad grade crossings, terminals and over draw bridges.

The first step toward a modern interlocking machine was made in England in 1843 by the installation of a machine at Bricklayer's Arms Junction in which the signals were moved by stirrups and the switches, by levers. The switchman while working the switches with his hands, worked the signals with his feet. No interlocking was used between signals and switches.

The first real interlocking machine was brought into use in England by John Saxby in 1856. This interlocking machine was the forerunner of the well known type of Saxby & Farmer mechanical interlocking so extensively used not only in England but also in the United States.

The first installation in the United States of an American interlocking machine was made in 1874 at Spuyten Duyvil, New York, N. Y. The first installation in the United States of an interlocking machine fitted with "latch" locking was made in 1875 at East Newark Junction, N. J. This was a Saxby & Farmer machine made in England, equipped with "latch" locking, a requisite of all modern types of interlocking machines. The original machine is still in existence.

### Power Interlocking

On American railways the tendency is toward the use of power interlocking of either the electro-pneumatic, electric or electro-mechanical types. The first mechanical interlocking plants at Spuyten Duyvil and at East Newark Junction have both been replaced with power interlocking.

In an electric interlocking system man-power is replaced by electric power for moving the switches and signals and electricity is used to control their movement. Power operation as a labor saving device

has many marked advantages over manual operation. Electric interlocking was invented by the late John D. Taylor of Chillicothe, Ohio. In the Baltimore & Ohio shops, at Chillicothe, Mr. Taylor constructed the first electric interlocking machine and apparatus which he installed at East Norwood, Ohio, on the Baltimore & Ohio Southwestern in 1889.

One of the pictures in the exhibit showed one of the original electro-pneumatic switch movements installed at the Jersey City Station in 1891.

### Train Operation by Signal Indication

Train operation by signal indication is a method of directing the movement of trains by the indications of fixed signals without the use of written train orders. The method is not new, as for 45 years it has given satisfactory service on a single track line crossing the Louisville Bridge at Louisville, Ky. In 1882, the trains in and out of Louisville over the line totalled 150 a day. To direct their movements by time tables and train orders was difficult, if not impossible, because standard time had not then come into use. Trains were scheduled on the local time of the four roads and each one had a different time standard.

**Train Operation by Signal Indication, Baltimore & Ohio—Cumberland division, Millers to Orleans Road, W. Va., 25.05 miles**

ECONOMIC ADVANTAGES

| | |
|---|---|
| Saving of annual interest charges at 5 per cent by postponing fourth track construction | $ 81,000 |
| Less increased annual maintenance and interest charges for signal installation of 1914 (there was no increase in operating charges) | 6,000 |
| Annual net saving in interest charges (an annual saving of $3,000 per road-mile) | 75,000 |
| Saving in interest charges for 13-yr. period 1914 to 1927 | 975,000 |

The difficulties in the situation brought the space interval method into use. Six manual block sections were established and a special dispatcher at the bridge station controlled the territory by directing the movement of trains through the operators at the six block stations. The successful operation of this system for nearly half a century has been due no doubt to the fact that the trains have been operated by the space interval or block signal method. Time tables and train orders were thrown into the discard and trains operated entirely by signal indication.

Today it is common practice on two and four-track lines to direct the movement of trains by the signal indications of the block and interlocking signals. In addition, on a number of heavy traffic roads, train operation by signal indication provides for the use of one or more of the tracks in both directions. The advantages of the method may be summed up as follows:

Signal indications are instructions given by the aspects of fixed signals. Instructions given by signals 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. The signal aspects are few in number and may be regarded as instructions reduced to the minimum and in standard form, and hence, there is little opportunity for misunderstanding. The instructions conveyed by the signals are given at the point where they are to be executed and there is no lapse of time in which to forget them.

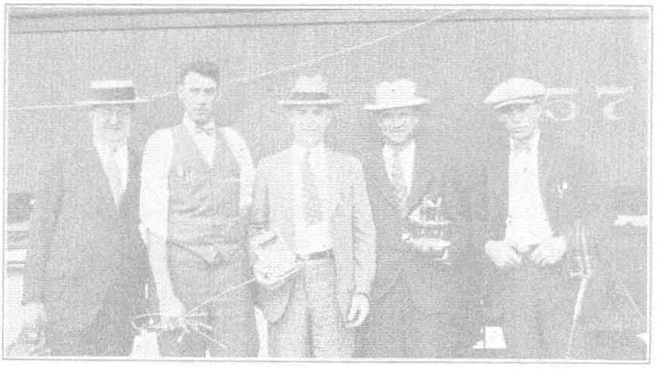
Since 1914 the B. & O. has operated 25 miles of main line three-track road by signal indication. The five manual block sections were superseded by an automatic block system providing 23 block sections, with the middle track equipped with controlled manual block for train movements in *either* direction. All trains are operated under signal indication. This signal installation, by materially increasing traffic capacity, has postponed the construction of a fourth track, estimated to cost $1,620,000.

Other sections of the exhibit on automatic highway crossing protection, car retarders and train control were also well illustrated and explained in detail, but are not given here, as the reader is familiar with recent developments of such apparatus. This exhibit of the progress of signaling on the railroads in the last century was prepared in co-operation with the Union Switch & Signal Company and the General Railway Signal Company.

## The Union Pacific Signaling School

DURING the past summer season the Union Pacific conducted a school for maintainers and signal construction forces, in order to give these men the latest information on the care of signal mechanisms, batteries, lamps, the application of welded bonds, and to study the causes of signal failures. A special car fitted as a class room, was transferred from point to point on the railroad so that each man in the signal department could attend a full day's session without much traveling.

A Union Pacific coach, with the regular coach seats removed, was equipped with mechanisms, meters, switch instruments, relays, a black-board for problems and detailed explanation and a silver screen for use in connection with projector slides and moving pictures. The first school was held at Grand Island, Neb., July 25 and the last at Salina, Kan., August 20, having spent from two to four days on each division with stops at Sidney, Neb., La Salle, Colo., Laramie, Evanston, and Green River, Wyo., and Topeka, Kan.



Some of the associate instructors
Left to right: W. J. Pierson, F. F. Seeberger, A. S. Knox, C. S. Baker and F. J. Baker

Classes started about 9:00 a. m. each morning, lasting until 5:00 or 6:00 p. m. A regular program was followed throughout the trip with slight variations. An opening talk was made by F. W. Pfleging, signal engineer Union Pacific, explaining the object of the classes and giving the past 15 years record of signal performance on the Union Pacific showing the increase in the number of signals, increase in the number of signal movements, increase in the amount of traffic, and the remarkable decrease in the number of signal