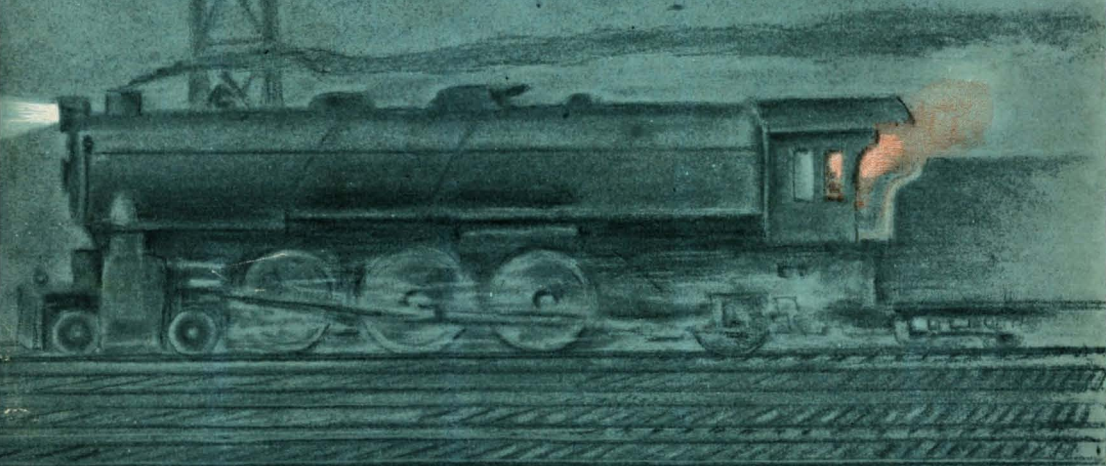


The Signal in the Cab



BULLETIN N°144



R SCHOLLER - 30

Union Switch & Signal Co.

SWISSVALE, PA.

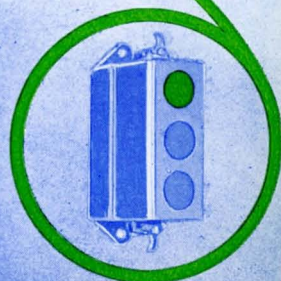
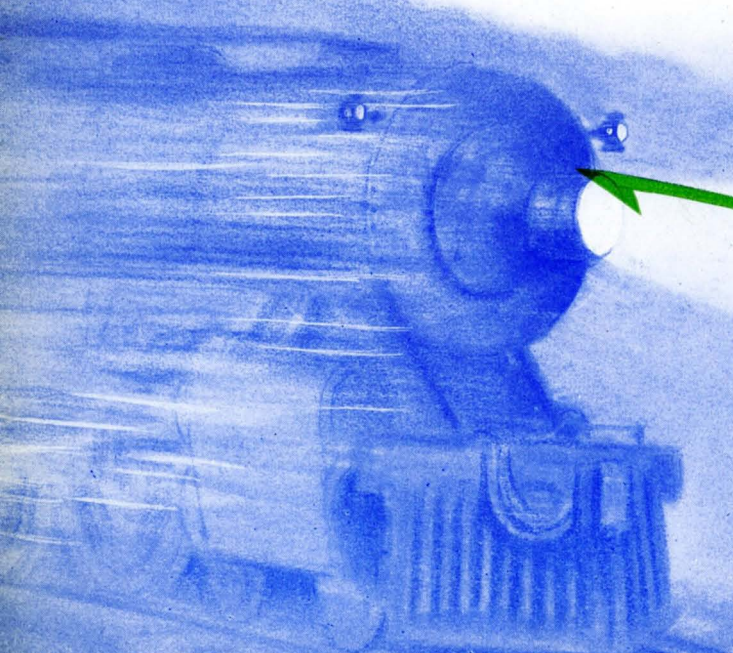
BULLETIN No. 144

EXTENDING CAB SIGNALING

"The intensive development of automatic train control, caused by the two orders of the Interstate Commerce Commission in 1922-1924, brought as a by-product continuous cab signaling, which is considered by many authorities as being of even more practical benefit in the normal protection and operation of trains than the primary function fulfilled by the train control system, i.e., the application of the brakes automatically.

"The cab signal affords a continuous indication of the occupancy of the track ahead and provides protection at all times against such hazards as a switch being opened or a car drifting out to foul the main track even after the train has entered the automatic block in question. Another great advantage is the increased safety of train operation afforded during fogs or storms when the engineman cannot readily observe, and sometimes entirely misses, the wayside signals. A reduction in speed at such times to permit the engineman to 'find' the wayside signals often causes serious delays, whereas with cab signals, trains can make the regular schedules with full knowledge of the signal indications. These advantages of cab signaling have been appreciated by the 18 roads which have incorporated such equipment with their automatic train control, and several roads, * * * have voluntarily made extensive installations beyond those required by the Commission. * * *

"As time goes on, it is quite likely that continuous cab signaling, which was at one time considered only as an adjunct, will be the primary consideration in many installations made to provide increased safety of train operation, over and above automatic block signals."—*Editorial Railway Age, May 10, 1930.*



*The Signal
in the
Cab*

Union Switch & Signal Company

SWISSVALE, PENNSYLVANIA

1881



1930

The Signal in the Cab

Each step in the development of signaling, from the old "high-ball" to the present continuously controlled cab signal, has produced further economies in the existing systems. Signaling, by its reduction of operating time, has been one of the chief factors in producing new economies.

A handicap which the enginemen of trains have had to combat in maintaining schedules is the possibility of an obscured view of the wayside signal. Fog, storm, smoke from passing trains, all play an important part in curtailing the engineman's view of the wayside signal; his view of it is fleeting and sometimes uncertain and may be misinterpreted.

Therefore, the Continuous System of Cab Signaling was developed by the Union Switch & Signal Company to provide a signal that the engineman may *always* see, and which gives a *continuous* indication of the conditions ahead and *instantly* shows any change in those conditions regardless of the location of the train with respect to wayside signals. Clear, accurate, instant information is *continuously* before the engineman in the cab.



Maximum protection is obtained in the hazardous situation which may arise when traffic conditions in advance become more restrictive after the train has passed a wayside switch location, and such as may occur when a switch is opened in advance of a train. The cab signal changes instantaneously to show the changed condition ahead to the engineman.

An early recognition of these principles resulted in the use of a cab signal on the locomotive as part of the first continuous system of automatic train control. Cab Signals, *continuously controlled and constantly visible*, have since formed an intimate part of the continuous system of train control and have shown so many operating advantages and elements of increased safety that the use of continuously controlled cab signals, without the addition of automatic brake control, is fast gaining favor. Such installations are now being made on a large scale by the Pennsylvania Railroad on its main line between New York and Washington, and also between Altoona and Pittsburgh. The Central Railroad of New Jersey recently also has placed in service continuous cab signals and train control without wayside signals between Matawan, N. J. and Atlantic Highlands, while the Richmond, Fredericksburg and Potomac has just completed an 18-mile voluntary extension to its continuous cab signal and train control system between Washington and Richmond.

In commenting on the Continuous Cab Signal System, the Interstate Commerce Commission in its report of November 26, 1928, states:



“Cab Signals are without a doubt an important development in the art of signaling. They place the signal indication immediately in front of the engineman where it cannot be obscured by snow, fog, smoke or other obstructions and where a combination of visible and audible indication is used, it is without a doubt a valuable addition to the signal system.”

The track mileage now equipped for continuous cab signal operation, if connected, would provide for a three track road from New York to Omaha and for a double track road from Omaha to San Francisco. The locomotive mileage protected by continuous cab signals exceeds 5,000,000 per month. Over 6,700 miles of track and 4,243 locomotives and multiple unit electric cars are equipped with the “Union” Continuous Cab Signal System.

While three-indication continuous cab signals were used in the Lewistown Branch installation on the Pennsylvania Railroad, it was the opinion that a four-indication continuous cab signal should be provided for future installations. Development work was carried on by the Union Switch & Signal Company for the purpose of providing a continuous cab signal with four indications which would be universally applicable to steam and electric d-c. or a-c. propulsion railroads. The Coded Continuous Cab Signal System was the result, and was first placed in service on the West Jersey & Seashore between Camden and Atlantic City on March 20, 1927. This system is a definite advance in the art of continuous control in that the current characteristics used

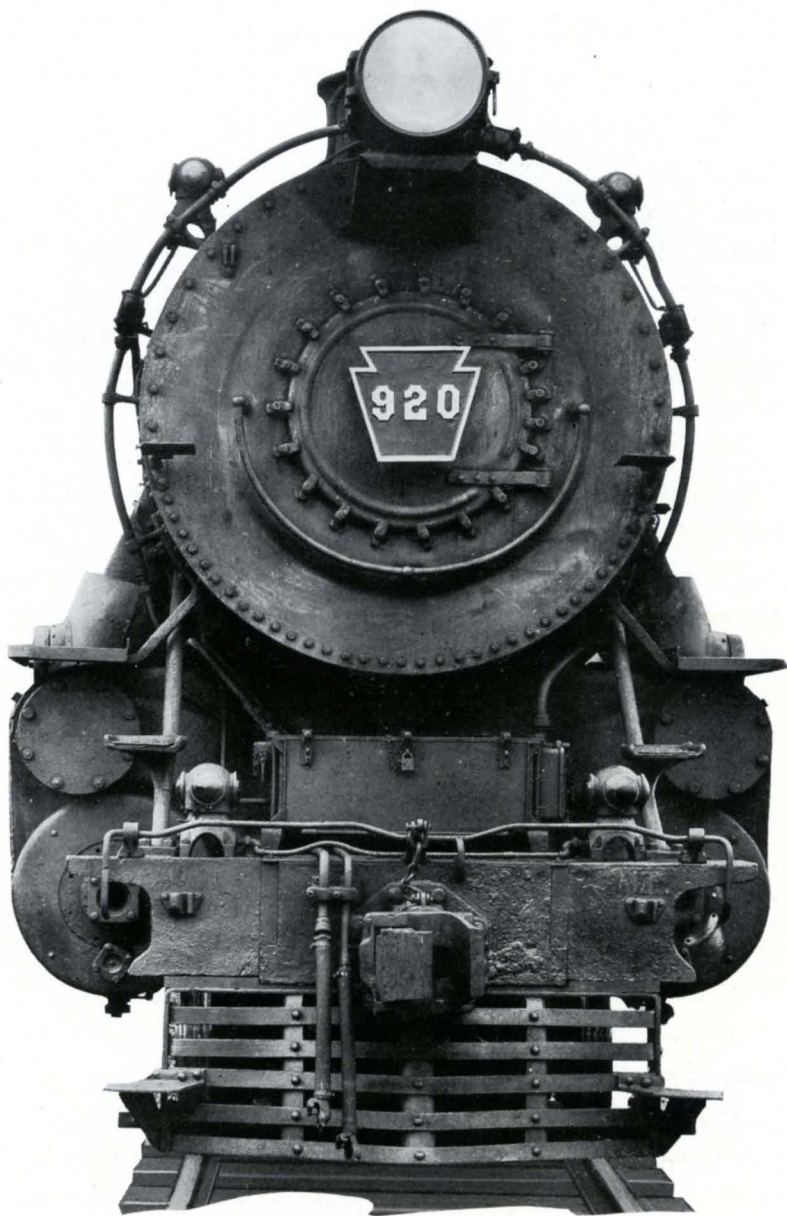


for transmitting indications to the moving trains are of a distinctive character not heretofore employed.

In the Coded Continuous Cab Signal System, the signal indications aboard the locomotive are controlled by coding the track circuit current; that is, by alternately opening and closing the circuit supplying the electric current to the track rails. The number of interruptions per minute, or the "code," determines which of the four signal indications will be displayed in the cab of the locomotive.

This results in the safest known method of signaling. By its safety it improves the morale of the engine crew. The signal can always be seen, no matter what the weather conditions or wayside conditions happen to be, and the constant information given to the engine crew shows the conditions ahead as they exist at every instant. It is a signal that cannot be passed or be misinterpreted: *it rides in the cab and is continuously before the fireman as well as the engineman.*

The Coded Continuous System is now extensively installed on the Pennsylvania Railroad; New York, New Haven & Hartford Railroad; Long Island Railroad, in the electric zone; Reading Company; Central Railroad of New Jersey; and on the West Jersey and Seashore Railroad, both as a continuous system of automatic stop with forestaller and as a cab signal system with warning whistle and acknowledger. The many divisions on these railroads over which the coded continuous system is now in service have earned an enviable reputation for safety and reliability of operation.



Front End Mounting of Equipment Box



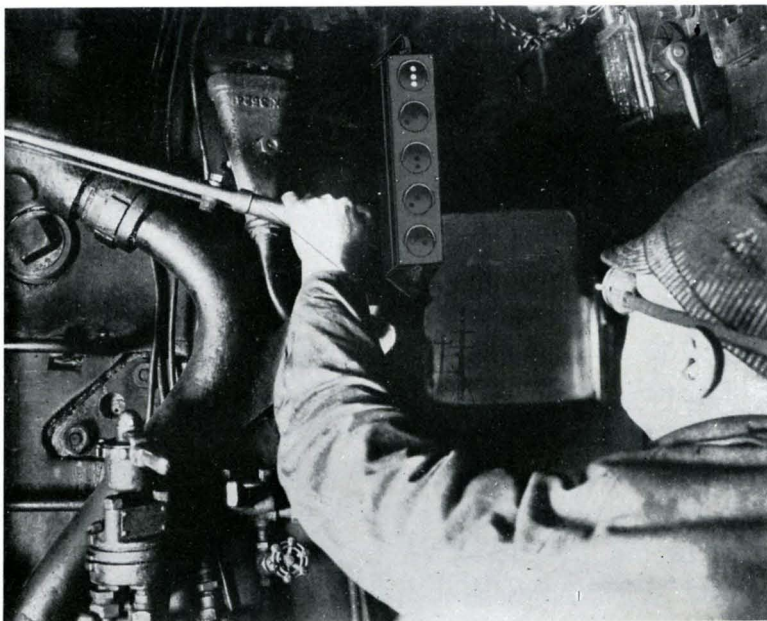
Cab Signal Development on the Pennsylvania

Soon after the Interstate Commerce Commission issued its first train control order in 1922, the Pennsylvania Railroad placed in service on July 11, 1923 an installation of the three speed continuous train control manufactured by the Union Switch & Signal Company. This installation, on the Lewistown Branch, was 45 miles long and 13 locomotives were equipped. The continuously controlled cab signal was included in this installation as a part of the train control system and quickly proved to be a new development of major importance in the signal field.

The Pennsylvania, before starting the succeeding automatic train stop installations which were required by the Commission, decided on their association with modern a-c. automatic block signaling, using position light signals. For the operation of these systems, 100-cycle power was chosen to secure a system universally applicable to both electric and steam railroad operation and to avoid the possibility of interference from 60 or 25 cycle commercial or power circuits.

Track Capacity is Increased

The increase in safety, provided by the Continuously Controlled Cab Signal, however, has not sacrificed track capacity; on the other hand, track capacity has been substantially increased. Any changed conditions on the track ahead are instantly reflected in the cab. Delay time in a restricted block may be appreciably



A Four Indication Position Light Cab Signal

decreased, therefore, because a change to a more favorable indication permits the engineman to increase the train speed before the next wayside signal is reached. The visibility of the signal in the cab also permits scheduled speed with safety under unfavorable weather conditions.

The "Union" Coded Continuous Cab Signaling System is the only system that makes possible a four indication cab signal. It is immune to inductive or leakage interference from high tension or heavy current-carrying lines along the right-of-way, and to inductive interference from propulsion currents. It may be applied to a multiple or single track signaling system whose track circuits are either direct current or alter-



nating current of any frequency. It may be installed on electrified roads having direct or alternating propulsion current; on roads operating steam locomotives over electrified and non-electrified territory, and on roads using either electric locomotives or multiple-unit electric cars.

It may be applied to these types of installations as the Coded Continuous Cab Signaling System, or by the addition of certain pneumatic apparatus on the locomotive, it may be installed as the Coded Continuous System of Automatic Stop with or without the forestaller; by other additions of pneumatic apparatus and a governor it may be made to enforce one, two or three speed limits; all of this may be done without changing the Coded Continuous Cab Signal System.

How the Coded Continuous Cab Signal System Functions

Assume that a train is about to enter the first of four blocks, the fourth being occupied. As the engineman accepts the "clear" indication of the wayside signal, the "clear" indication on the cab signal appears in the engine cab. When the train enters the second block the "approach-restricting" indication of the wayside signal appears as the "approach-restricting" aspect of the cab signal and at the same time a warning whistle blows. This whistle will continue to blow until the engineman acknowledges the change to a more restrictive indication by the operation of the acknowledging lever. The engineman then reduces the speed of his train. When the train enters the third block the "approach" indi-

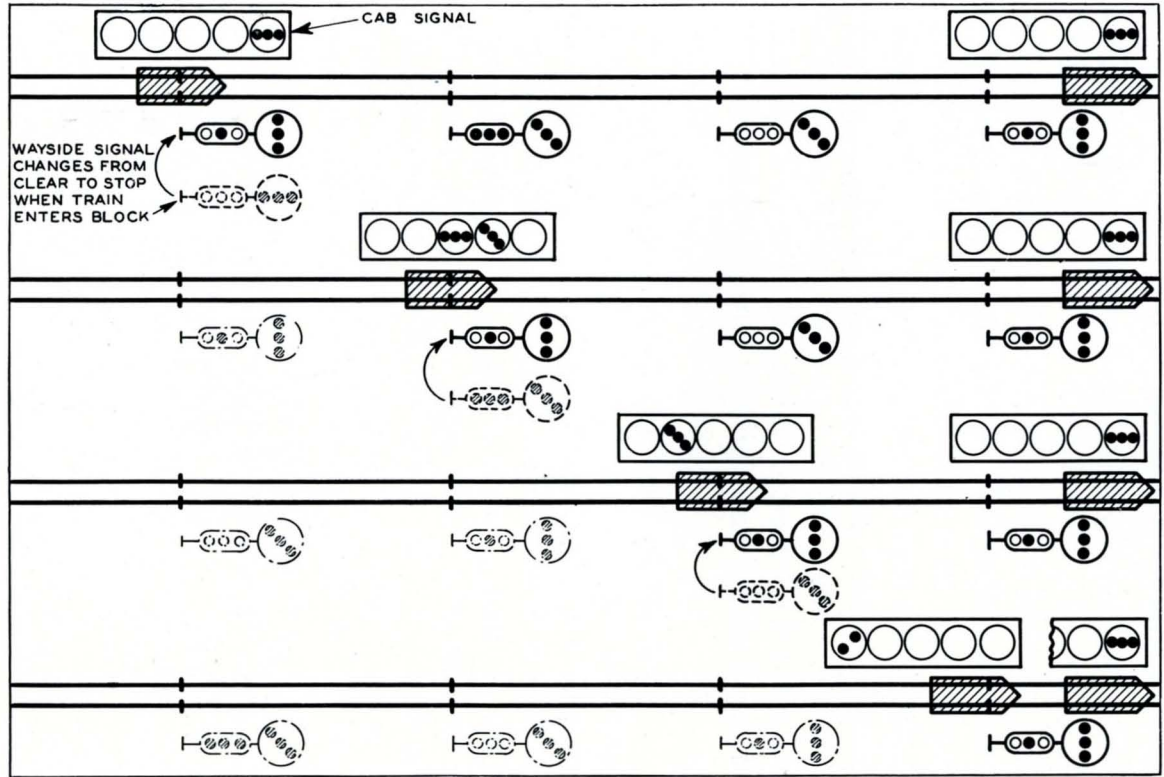


Figure 1. The Four Indications as Transmitted From Track to Cab





cation of the wayside signal appears on the cab signal and the warning whistle blows indicating that the signal has again changed to a more restrictive indication. The engineman again reduces the speed of his train. If the train enters the fourth or occupied block there will be another change in the cab signal indication, this time to "caution-slow speed," and the warning whistle will blow until acknowledged by the engineman. This change warns the engineman of the fact that the block which he is entering is occupied and that he must reduce his train speed to the limits set by the rules and be prepared to stop short of any obstruction. (See Fig. 1).

Thus it can be seen that the engineman has before him in the cab an indication of the conditions of the block in which he is running, continuously controlled by the conditions ahead. Should the conditions ahead change in such a way as to affect the block in which he is running after he has passed the wayside signal, the engineman will be made aware of the change instantly. If the indication displayed by the cab signal changes to a less favorable one he must demonstrate his alertness to the change by the operation of the acknowledging switch. If the change is from a less favorable indication to one more favorable he may accelerate his train accordingly. If the cab signal shows "caution-slow-speed" and changes to a more favorable indication, the train is required by rule to run its length before accelerating in order to guard against the possibility of a broken rail having caused the signal to indicate "caution-slow-speed."



Equipment for Coded Continuous Cab Signal

The equipment used for the Coded Continuous Cab Signal System may be divided into two parts, that along the wayside and that on the engine.

The continuous indication in the cab is maintained by a 100-cycle track circuit current, fed into the running rails at the exit end of each block and interrupted a definite number of times per minute according to the conditions ahead. This current induces a voltage in apparatus carried on the engine and so causes other engine-carried apparatus to function to repeat the signal indication to the engineman.

The mechanism in the wayside system which interrupts the 100-cycle current and feeds it to the rails is called the code transmitter, and it consists of several contacts operated by cams. The circuit from the 100-cycle source to the track is made through one or another of these contacts, depending upon the condition ahead. Therefore, when the code transmitter is operating, the 100-cycle track circuit current is interrupted at a certain rate called the code frequency.

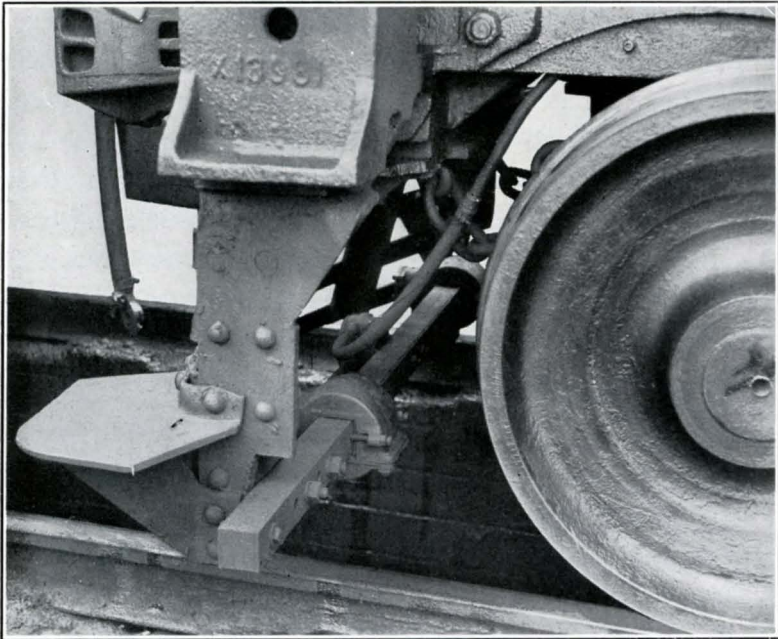
If the condition of a block is "clear," the code frequency is 180 per minute; if "approach-restricting," 120 per minute; if "approach," 80 per minute. If the block is occupied, the coded current is shunted by the train ahead and does not reach the following train, giving the "caution-slow-speed" indication in the cab. This indication is given also if the 100-cycle track circuit current is flowing, but uncoded.



The Engine Equipment

On the engine are: the receiver; the amplifier set, the acknowledging and decoding relay group and the decoder (all contained in the equipment box); the cab signal and warning whistle; the dynamotor or dual-voltage headlight generator; the acknowledging switch, and the main switch.

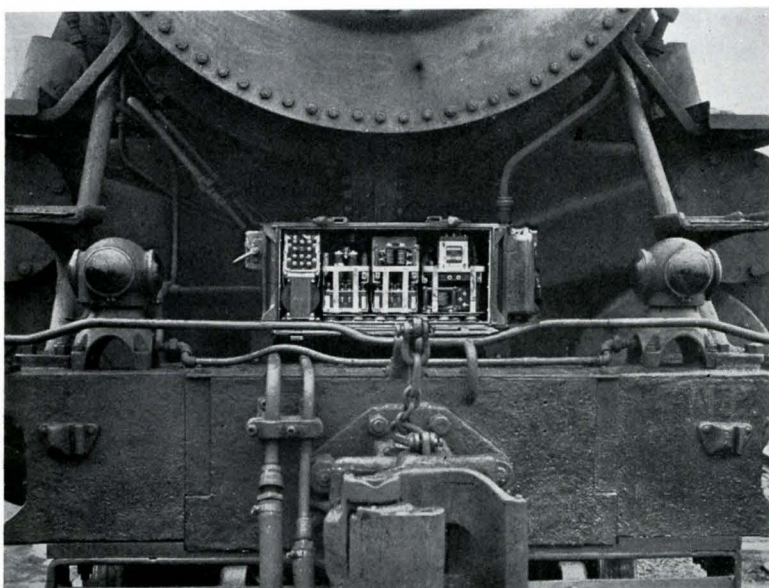
The receiver is the means by which the control is transmitted from the rails to the apparatus on the engine. It is made up of a laminated iron bar, on which are two coils connected so that the voltages induced in them by the normal 100-cycle track circuit currents are additive. It is mounted ahead of the front truck



The Receiver is Mounted Ahead of the Forward Wheels

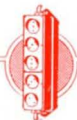


when the engine is equipped for forward running, but when it is desired to equip an engine for reverse running, all that is required is another receiver back of the last pair of wheels on the rear of the tender, and a reversing switch, operated by the reverse lever on steam locomotives and by the plug switch on multiple unit electric cars.



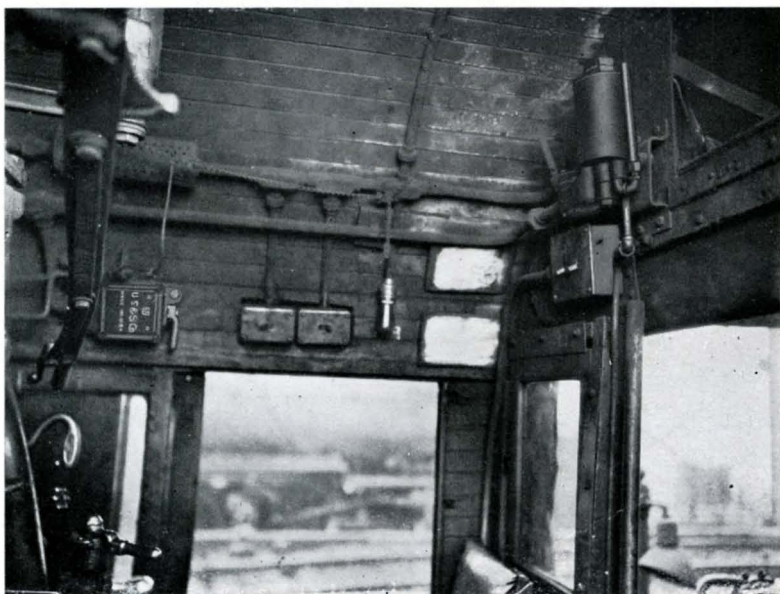
Interior of the Equipment Box

The equipment box is mounted usually on the pilot deck of the locomotive, although it may be mounted elsewhere if more convenient. It is equipped with shock absorbing platforms to eliminate the effect of vibration on the apparatus. The various parts of the equipment contained in the box are so mounted that any part may be removed without handling the others. The external



and local connections are made by means of plugs and cables whose male and female connections are arranged in such a manner that the proper connections are guaranteed.

The voltage induced in the receiver coils is delivered to the amplifier which in turn delivers to the electrical apparatus on the engine a greatly increased amount of electrical power for its reliable and safe operation. The amplifier is provided with two tubes similar to the tubes used in radio, but sturdier and adapted to higher current values. Both tubes are of the same type, are interchangeable, and are coupled by a transformer having a secondary winding with taps for the adjustment of amplification. An electrical filter is built into the amplifier, which suppresses all frequencies except that of 100



The Acknowledging Switch and Warning Whistle in the Cab



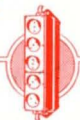
cycles, and renders the apparatus immune to interference from other frequencies.

The master relay and the master relay transformer are built into the amplifier unit. The master relay transformer transmits power at the proper code frequencies to the master relay. A condenser is connected around the primary winding and test jacks are provided in both the primary and secondary circuits of this transformer.

The master relay, which pole changes at code frequency the 32-volt direct current that is supplied to the primary winding of the decoding transformer, is operated by the master relay transformer. In order to provide protection against arcing at the master relay contacts, a condenser is placed across them to act as a spark arrester.

The decoder comprises a decoding transformer with the reactors and condensers necessary to tune the decoding relay circuits to their proper code frequencies. The tuning of these circuits is such that when the "clear" code frequency of 180 cycles per minute is present, the circuits to the "clear" and "approach" decoding relays are energized; when the "approach-restricting" code frequency of 120 cycles per minute is present, the "approach-restricting" and "approach" decoding circuits are energized. When the "approach" code frequency of 80 cycles per minute is present, only the approach decoding relay is energized. When there is no 100-cycle current flowing or when the 100-cycle current is not coded, none of the decoding relay circuits are energized.

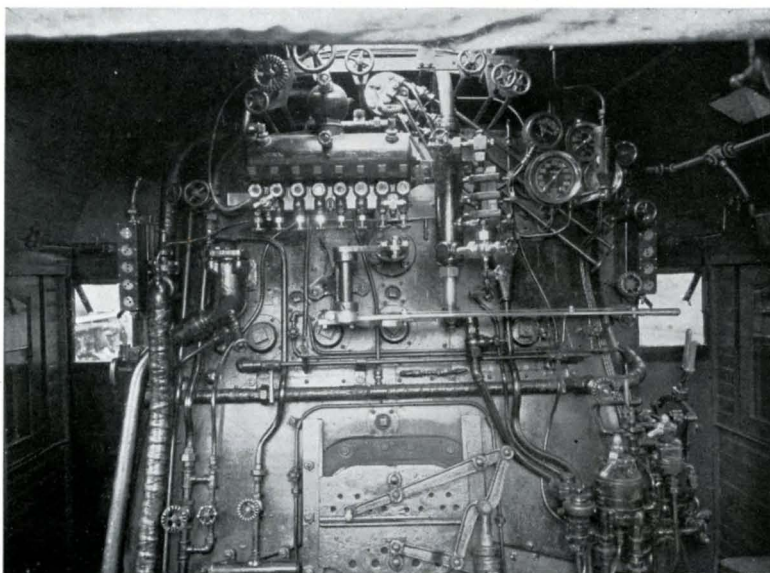
The dynamotor or dual-voltage turbo-generator furnishes current at 350 volts for the plate circuits of



the tubes, receiving power from the headlight generator at 32 volts.

The cab signals controlled by the decoding relays, indicate the track conditions ahead by means of color-light or position-light aspects within the engine cab. These signals may be provided for both engineman and fireman. The cab signal is placed in such a position in the cab that it is in line with the engineman's vision as he watches the trackway ahead.

The acknowledging switch is located within convenient reach of the engineman. Reversing it causes the warning whistle to cease sounding, but it sounds again on any subsequent change to a more restrictive indication.



Four Indication Position Light Cab Signals for Engineman and Fireman

The Horseshoe Curve on the
Pennsylvania Railroad Over
Which Trains are Operated
by Coded Continuous
Cab Signals

*Photo Courtesy
Pennsylvania Railroad*







Wayside Circuits

How the Proper Code Frequency is Fed to the Rails

As long as a block is unoccupied, the code transmitter does not operate. The track relay will be energized from the track transformer and a circuit will be made through the primary of the track transformer over the front contacts of a slow-acting relay and over the back contacts of a relay called the "VR" relay. The "VR" relay will be de-energized because it is "approach-controlled" over the back contacts of the track relay. The motor of the code transmitter will be de-energized because its circuit includes a front contact of the "VR" relay.

On the entrance of a train into a block, the track relay will be de-energized to close its back contact to pick up the "VR" relay. This starts the code transmitter. If the indication of the block entered is "clear," that portion of the track circuit ahead of the train will now be energized with 100-cycle current interrupted 180 times per minute over the "clear" code contact of the code transmitter.

If the track relay of the second block in advance of the block just entered by the train is de-energized the approaching train will receive an "approach-restricting" indication, because the track relay immediately in advance of the train will be reversed, assuming that a three-position relay is used. Under these conditions, the current for the primary of the track transformer is interrupted 120 times a minute by the contacts of the



code transmitter, thus transmitting to the rails over which the engine is passing an interrupted current of the "approach-restricting" code frequency.

When the track relay in the first block in advance is de-energized, the corresponding slow-acting relay will be de-energized and the "approach" contact will be selected on the code transmitter so that the track circuit current will be interrupted 80 times a minute and the "approach" indication will appear in the engine cab.

When an engine enters an occupied block, the track circuit current is shunted by the train ahead, and does not reach the following train, with the result that the "caution-slow-speed" indication appears in the cab. It can be seen that, any condition such as a broken rail or an obstruction that will short-circuit the track circuit will cause this most restrictive indication to be displayed by the cab signal. If the 100-cycle current is uncoded, the "caution-slow-speed" indication will be received in the cab.

Two different conditions have been met in the design of the wayside circuits:

(a) Where the track relays and cab signal apparatus are operated by 100-cycle current.

(b) Where 100-cycle current is supplied for cab signal operation and the track relays are operated either by direct current or by alternating current of some frequency such as 60 cycles or 25 cycles.

In the first case, where the track relays and cab signal apparatus are operated by 100-cycle current, the



front contacts of the code transmitter serve the dual purpose of coding the current for the operation of the cab signal apparatus and for controlling the energy required to pick up the track relay after the train has passed out of the block. When the train leaves the block, the first impulse of the 100-cycle current will pick up the track relay and restore the track circuit to the proper condition, thereby de-energizing the "VR" relay and stopping the code transmitter.

In the second case, where a separate frequency is used for the track relays, this frequency is carried to the back contacts of the code transmitter and is supplied to the rails during the interval that the 100-cycle current is not flowing. The track current, therefore, will consist of 100-cycle current and current at some other frequency, alternately applied. Since the engine equipment does not respond to impulses of current at frequencies other than 100-cycles, a separate frequency in the interrupted period of the 100-cycle current will have no effect on the engine equipment. The total effect on the engine equipment is simply the effect of the interrupted 100-cycle current. When the train leaves the block, the first impulse of the separate frequency will pick up the track relay and restore the track circuit to the proper condition thereby de-energizing the "VR" relay and stopping the code transmitter.

It can be seen from the above, therefore, that except for the slight change of the circuits to and from the code transmitter, the track circuit functions in identically the same manner in which it would function if only one frequency were used.



Cab Signaling on the Pennsylvania

The extent to which cab signals are in service on the Pennsylvania Railroad is shown by the following table:

From	To	Miles of Road	Miles of Track	Locomotives Equipped
Manhattan Transfer	Millham Jct.	46.9	197.29	280*
Philadelphia	Washington	132.0	392.00	165 Steam Loco. 1 Elec. Loco.
Baltimore	Harrisburg	81.5	163.00	125
Harrisburg	Altoona	130.4	490.20	350
Camden, N. J.	Atlantic City	56.4	112.80	134
Pittsburgh	Columbus	189.4	445.59	294
Columbus, O.	Indianapolis, Ind.	187.0	352.00	126
Long Island R. R.		47.0	85.20	48 Steam Loco. 250 Elec. Cars
Under Construction				
Millham Jct.	Philadelphia	35.00	141.00	
Altoona	Pittsburgh	112.29	464.00	360
Phila. District—Multiple Unit Elec. Cars		200
Total		1017.89	2843.08	2333

*Sixty-three of these 280 locomotives were equipped for operation over the New York and Long Branch R. R.

The Altoona to Pittsburgh district is now being equipped with the Coded Continuous Cab Signal System. It is between these two points that all Pennsylvania trains have to cross the Allegheny mountains. All steam locomotives and electric units operating in the territory between Manhattan Transfer, N. J. and Washington, D. C. are now being equipped with continuous cab signals.

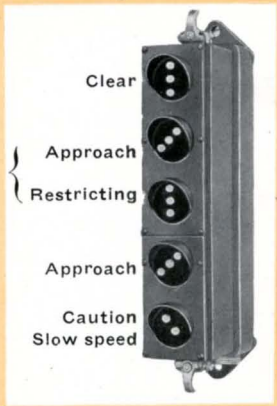
Map of Pennsylvania System
Showing Extent of Coded
Continuous Cab Signal
Territory

PENNSYLVANIA



P.R.R.
 Four Indication Continuously Controlled Cab Signals with continuous automatic stop. Code System.
 Voluntary installations, coded continuous cab signaling.
 Steam and electric locomotives and multiple-unit electric cars.

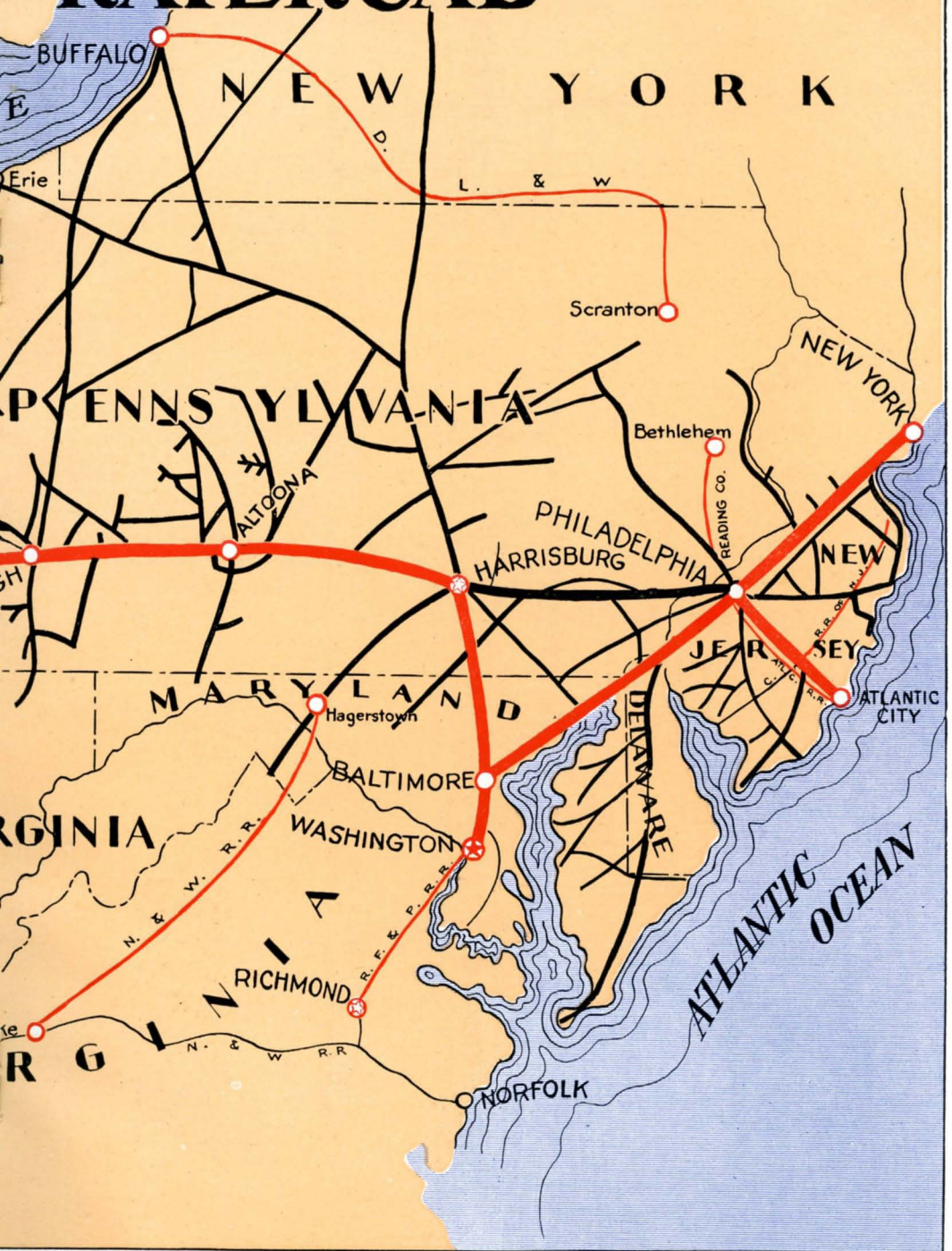
P.C.C. & ST.L.
 Same as on P.R.R., except all steam locomotives.
W.J. & S.
 Four Indication Continuously Controlled Cab Signals with continuous automatic stop. Code System.

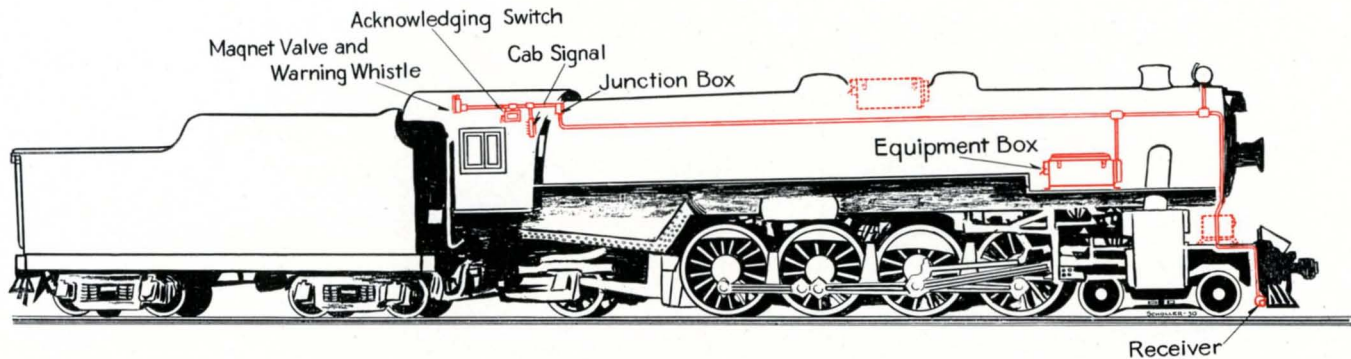


- Clear
- Approach
- Restricting
- Approach
- Caution Slow speed

Roan
 V I

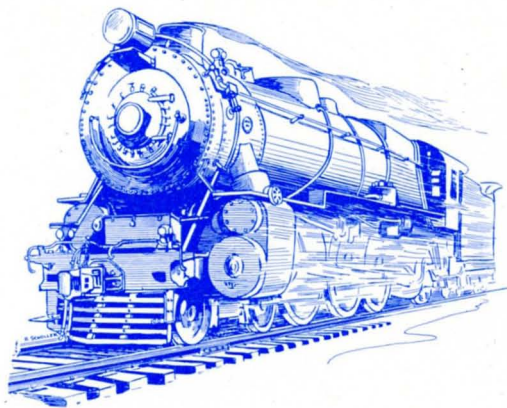
RAILROAD





Only a Few Parts Need Be Added to a Locomotive for Cab Signal Operation
 The Equipment Box is Ordinarily Mounted in One of the Three Positions Shown By the Full and Dotted Lines
 There is No Contact Between the Receiver and the Rails

*"Union" Cab Signal Installations
on Various Railroad
Systems*

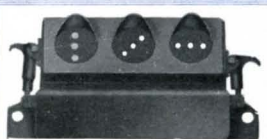


LONG ISLAND RAILROAD



Three Indication Continuously Controlled Cab Signals with continuous automatic stop. Code System.

Multiple-unit electric cars, steam and electric locomotives.



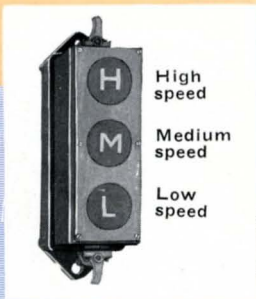
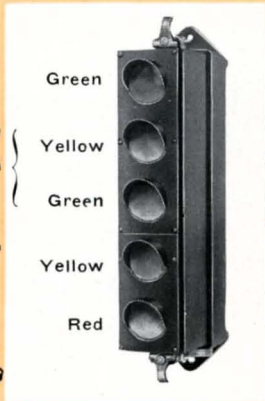
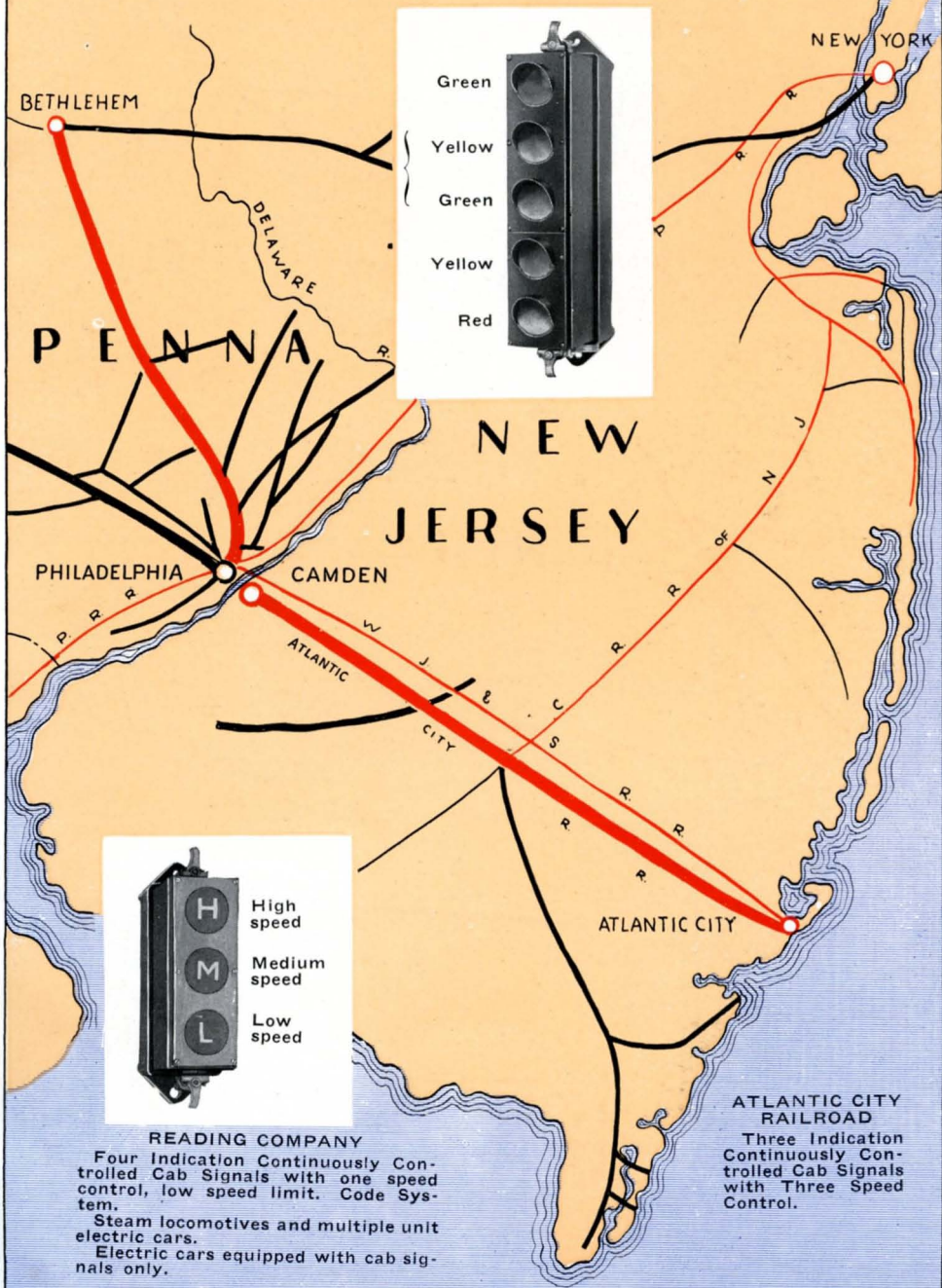
Green
Yellow
Red
Electric Cars



Green
Yellow
Red

Steam and Electric Locomotives

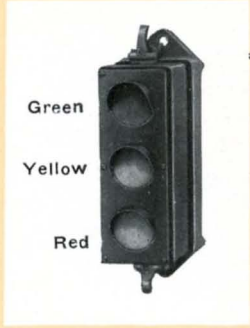
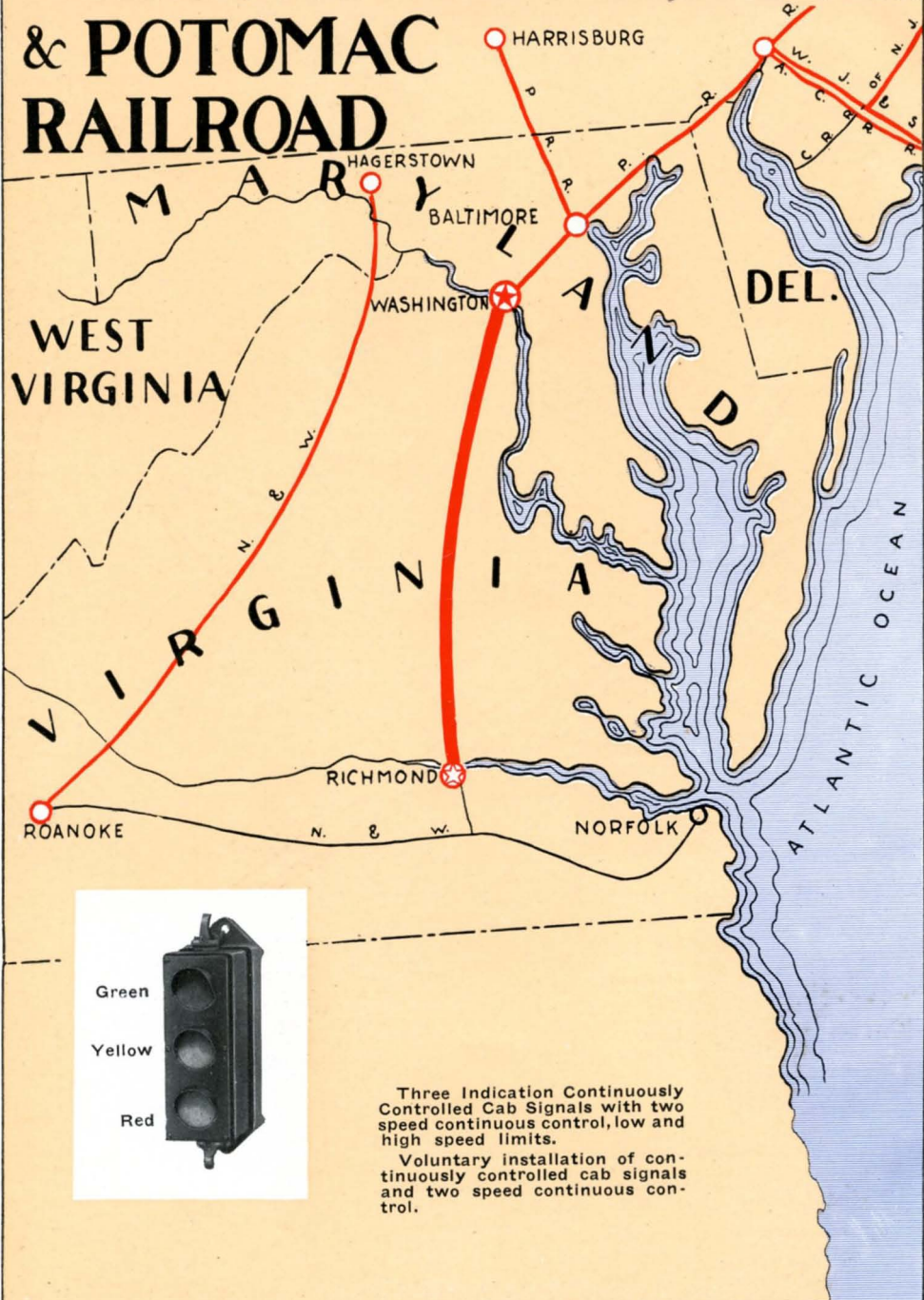
READING COMPANY



READING COMPANY
 Four Indication Continuously Controlled Cab Signals with one speed control, low speed limit. Code System.
 Steam locomotives and multiple unit electric cars.
 Electric cars equipped with cab signals only.

ATLANTIC CITY RAILROAD
 Three Indication Continuously Controlled Cab Signals with Three Speed Control.

RICHMOND FREDERICKSBURG & POTOMAC RAILROAD



Three Indication Continuously Controlled Cab Signals with two speed continuous control, low and high speed limits.
Voluntary installation of continuously controlled cab signals and two speed continuous control.

ATCHISON TOPEKA & SANTA FE RAILWAY

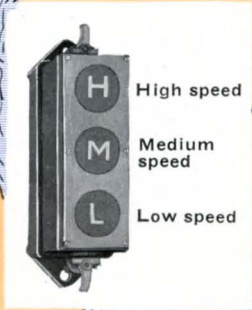
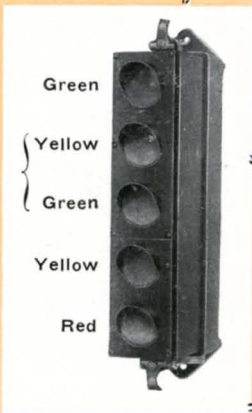
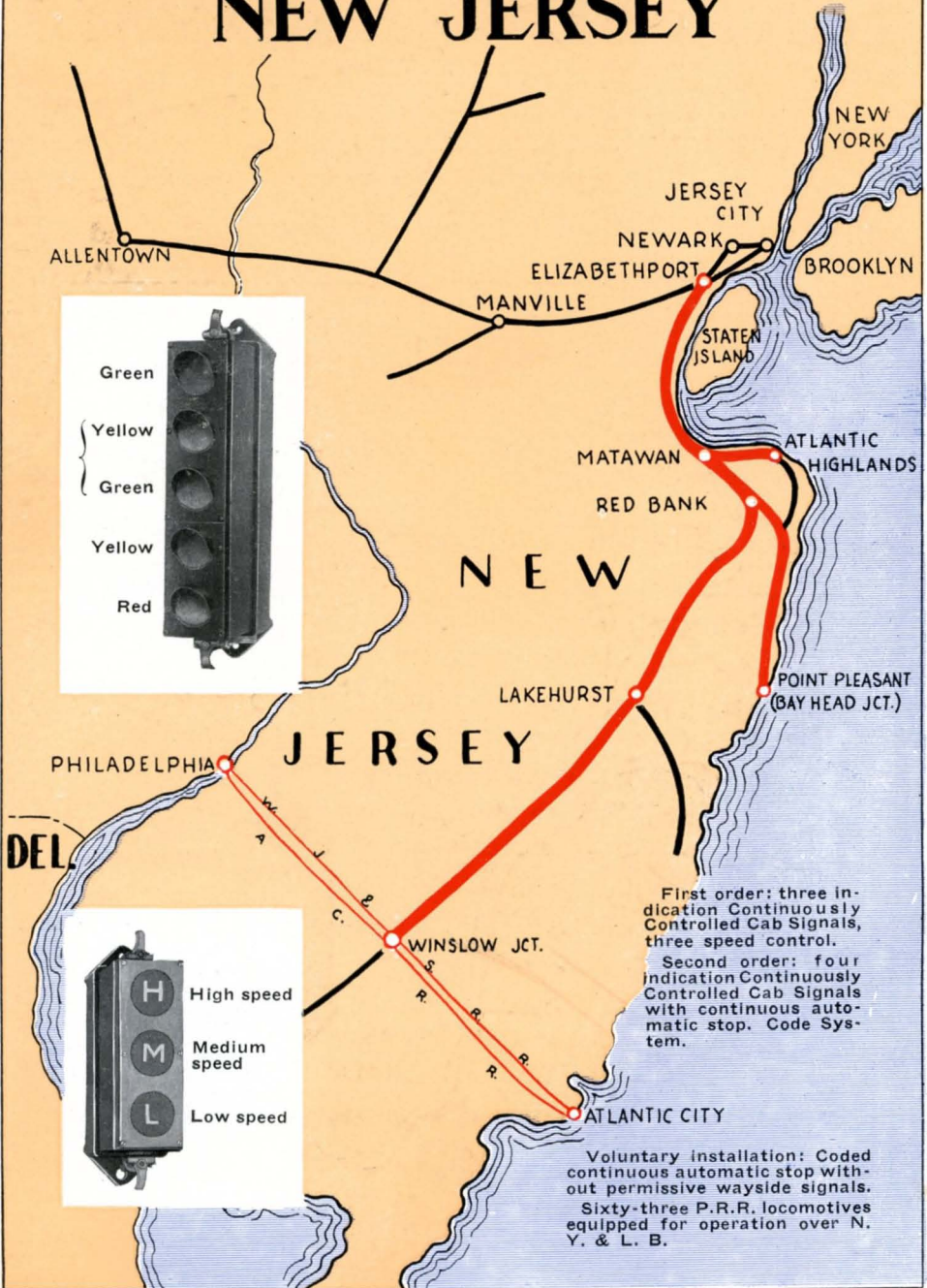


Three Indication Continuously Controlled Cab Signals with three speed control.

Operation without permissive wayside signals.

All tracks operated in both directions by signal indication.

CENTRAL RAILROAD OF NEW JERSEY



First order: three indication Continuously Controlled Cab Signals, three speed control.

Second order: four indication Continuously Controlled Cab Signals with continuous automatic stop. Code System.

Voluntary installation: Coded continuous automatic stop without permissive wayside signals.

Sixty-three P.R.R. locomotives equipped for operation over N. Y. & L. B.

DELAWARE LACKAWANA & WESTERN RAILROAD



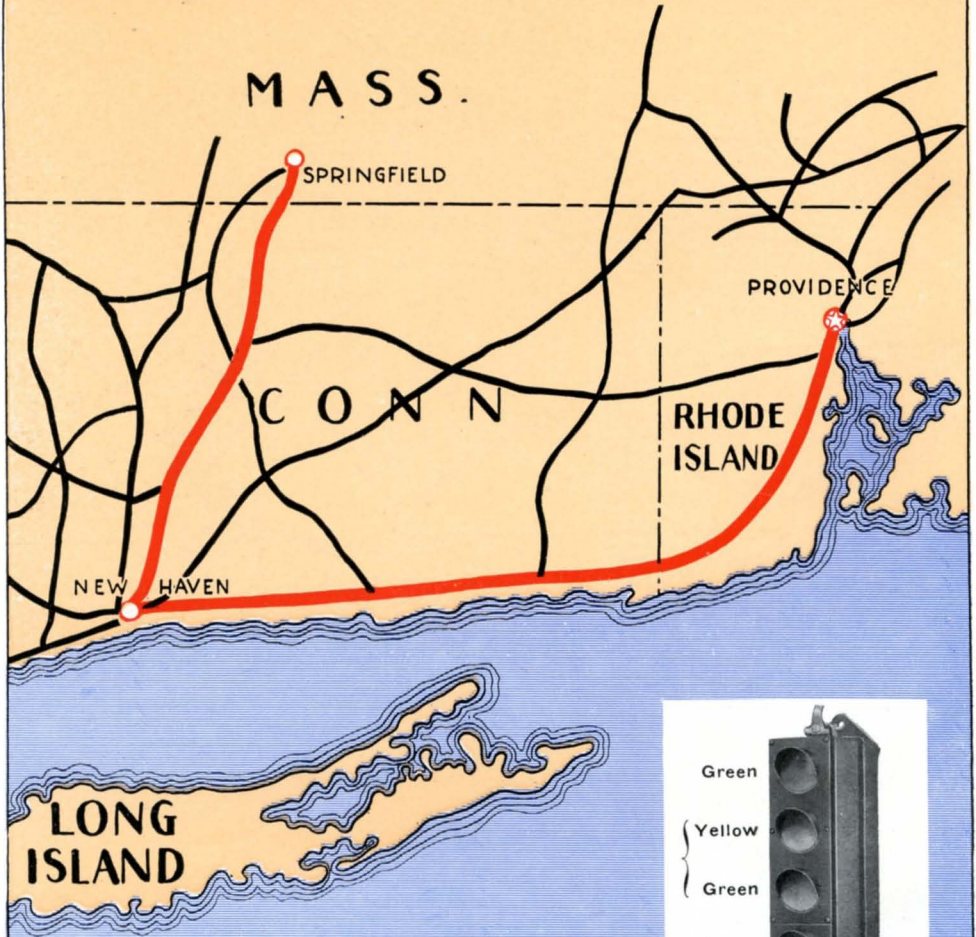
Green

Yellow



Two Indication Continuously
Controlled Cab Signals with one
speed control, low speed limit.

NEW YORK - NEW HAVEN & HARTFORD RAILROAD



Green
Lunar
White



Type Used Between
Springfield & New Haven

Continuously Controlled
Cab Signals.

First order: continuous
automatic stop, two indica-
tion. New Haven to
Springfield.

Second order: continu-
ous automatic stop, four
indication. Code System.

Green

Yellow

Green

Yellow

Lunar

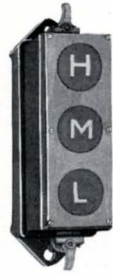
White



Type Used Between
New Haven &
Providence

NORFOLK & WESTERN RAILWAY

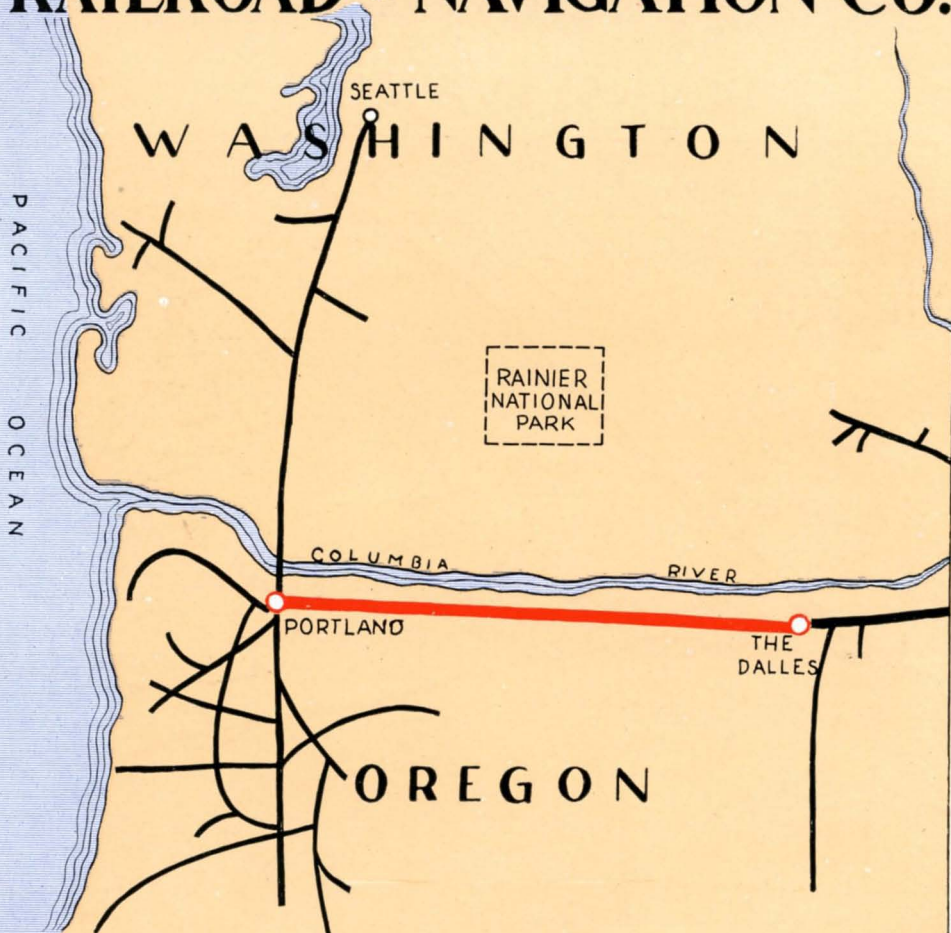
PENNSYLVANIA



High speed
Medium speed
Low speed

Three Indication Continuously Controlled Cab Signals.
First order: three speed continuous control.
Second order: two speed continuous control, low and medium speed.
Four C. & O. locomotives equipped with three indication cab signals and two speed continuous control for operation between Lochlaird and Glasgow.

OREGON WASHINGTON RAILROAD & NAVIGATION CO.



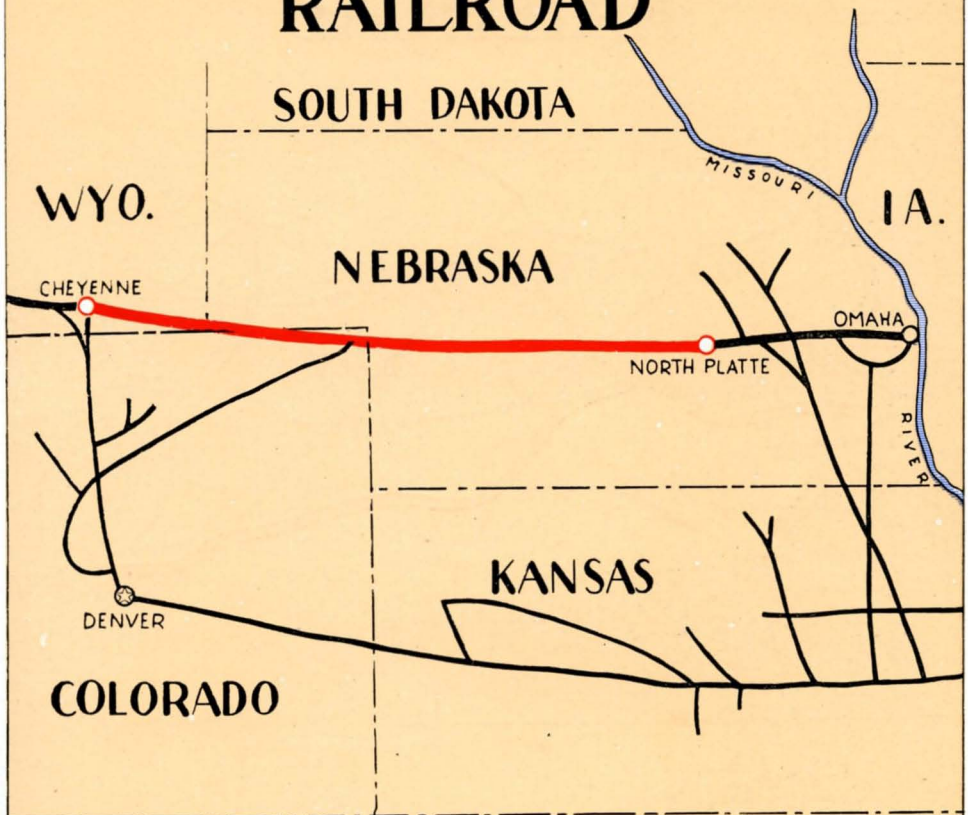
Green

Red



Two Indication Continuously Controlled Cab
Signals with one speed control, low speed limit.

UNION PACIFIC RAILROAD



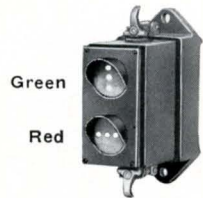
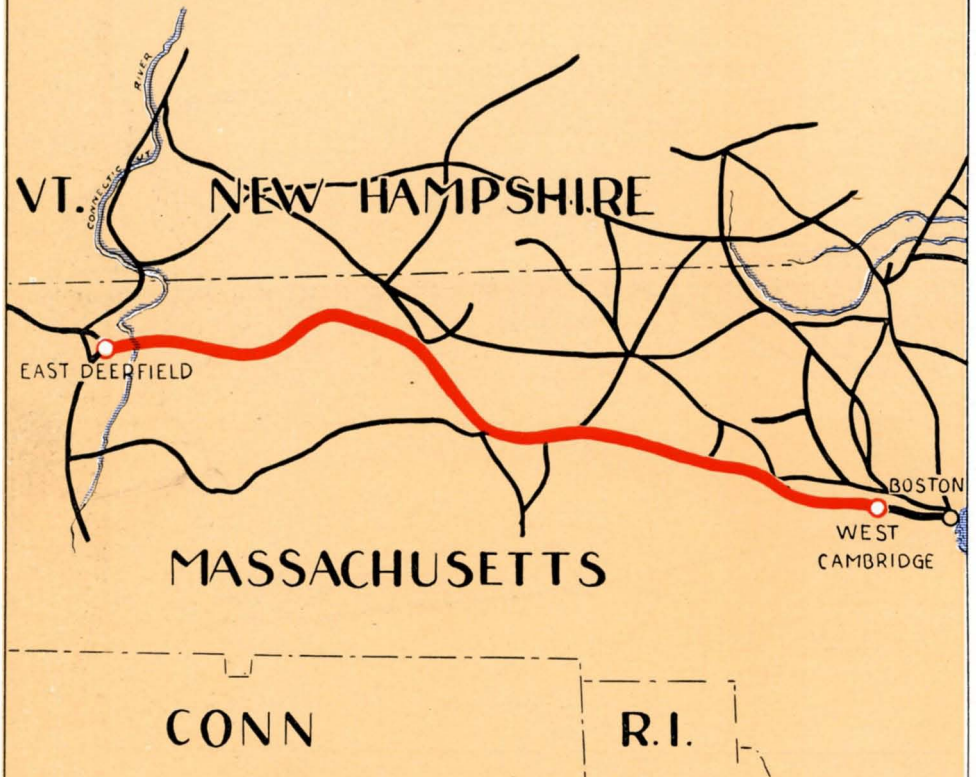
Green

Red



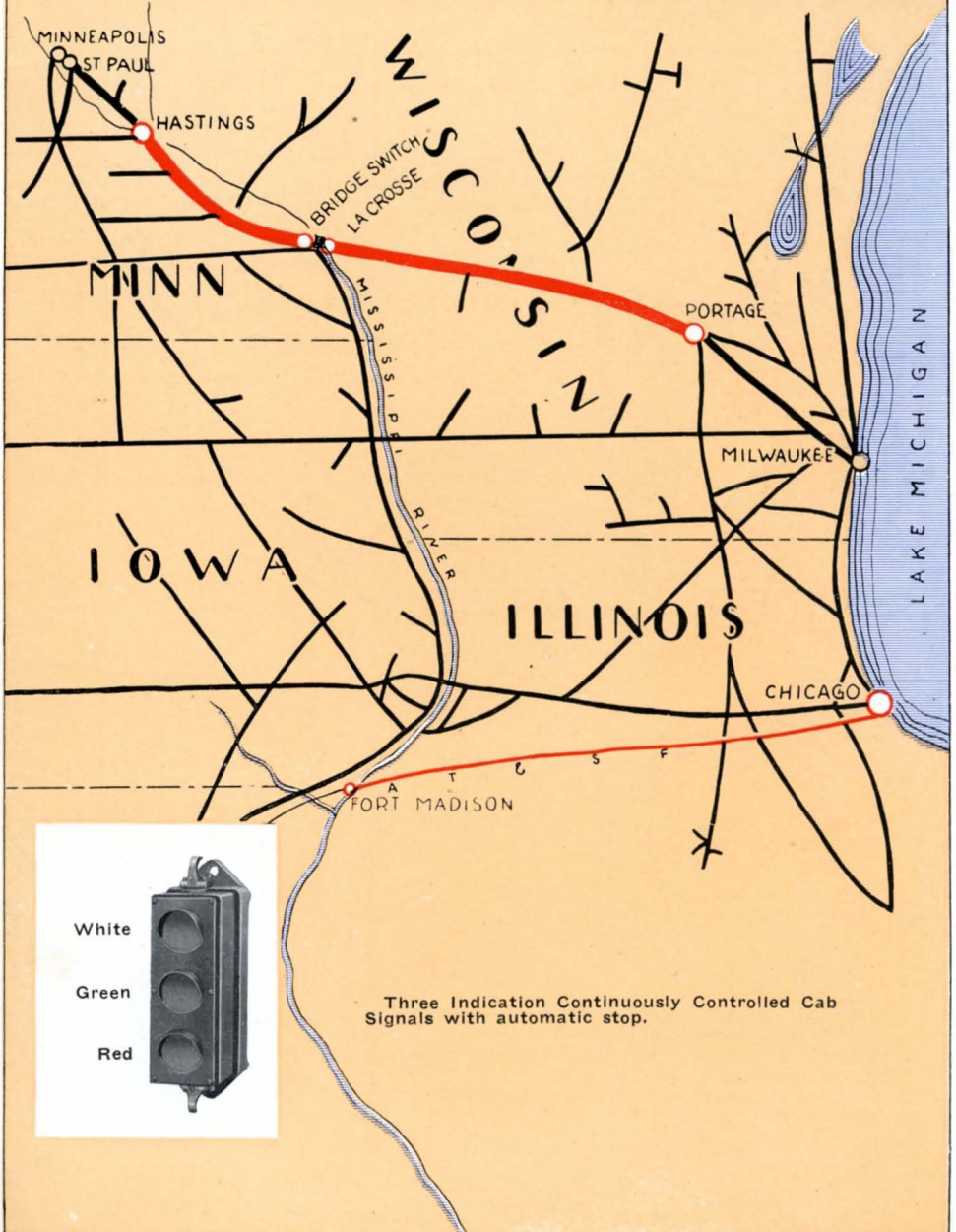
Two Indication Continuously Controlled Cab
Signals with one speed control, low speed limit.

BOSTON & MAINE RAILROAD



Two Indication Continuously Controlled Cab
Signals with automatic stop.
Color-position-light type cab signal.

CHICAGO MILWAUKEE ST. PAUL & PACIFIC RAILROAD



White

Green

Red



Three Indication Continuously Controlled Cab Signals with automatic stop.

ILLINOIS CENTRAL SYSTEM



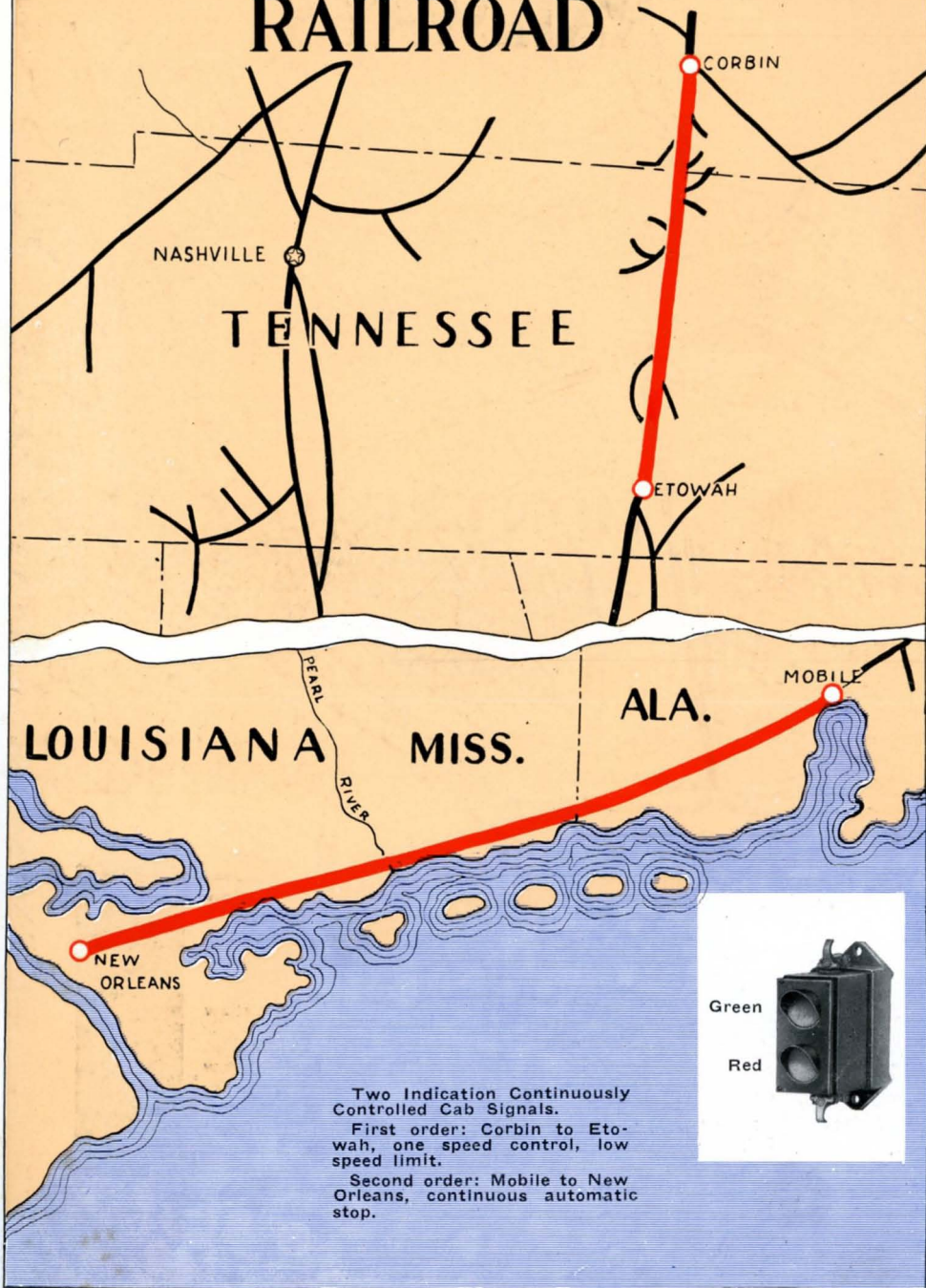
Two Indication Continuously Controlled Cab Signals with continuous automatic stop. Operation without permissive wayside signals. First installation: Double track. Second installation: Fort Dodge to Waterloo, single track.

Green

Red



LOUISVILLE & NASHVILLE RAILROAD



Two Indication Continuously
Controlled Cab Signals.

First order: Corbin to Etowah, one speed control, low speed limit.

Second order: Mobile to New Orleans, continuous automatic stop.

Green

Red

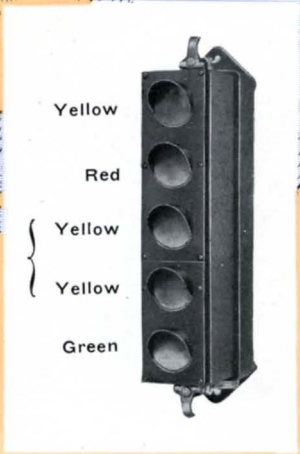


CANADIAN NATIONAL RAILWAYS



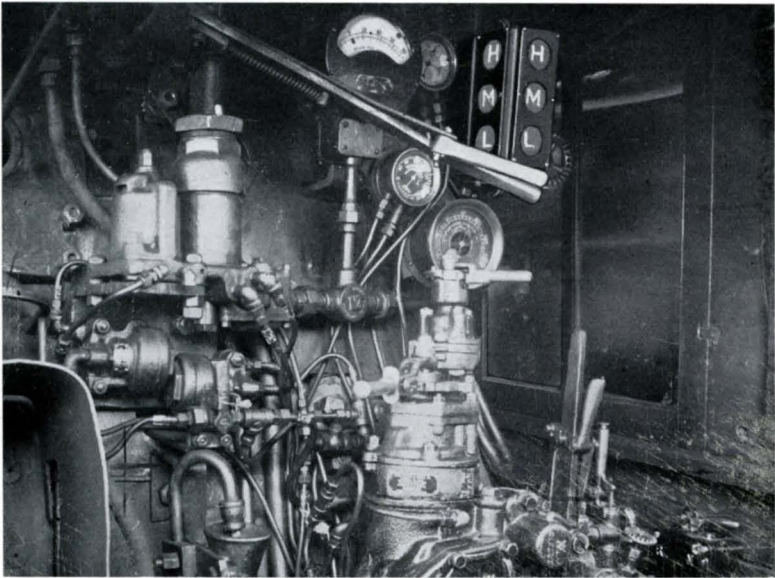
Four Indication Continuously Controlled Cab Signals with three speed control, high, medium, and low speed limits. Code system.

Electric locomotives and multiple unit cars equipped for operation through Mt. Royal Tunnel.

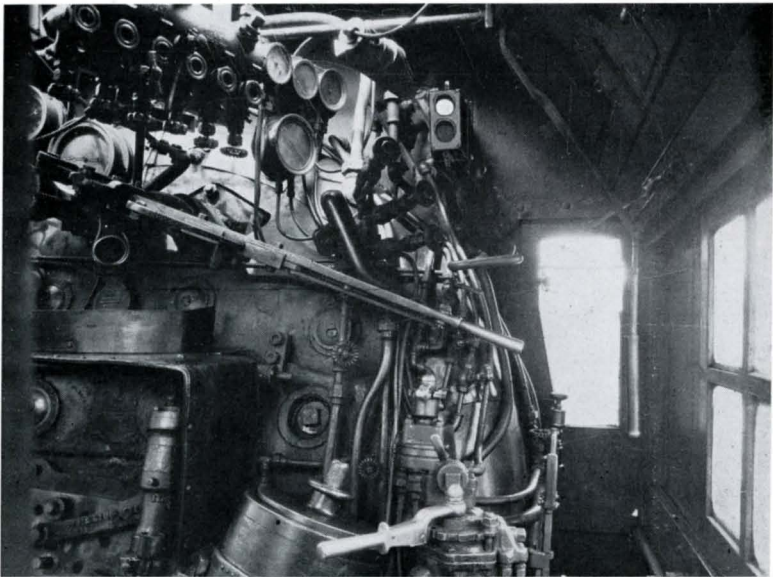


*"Union" Signals
in the Cab*

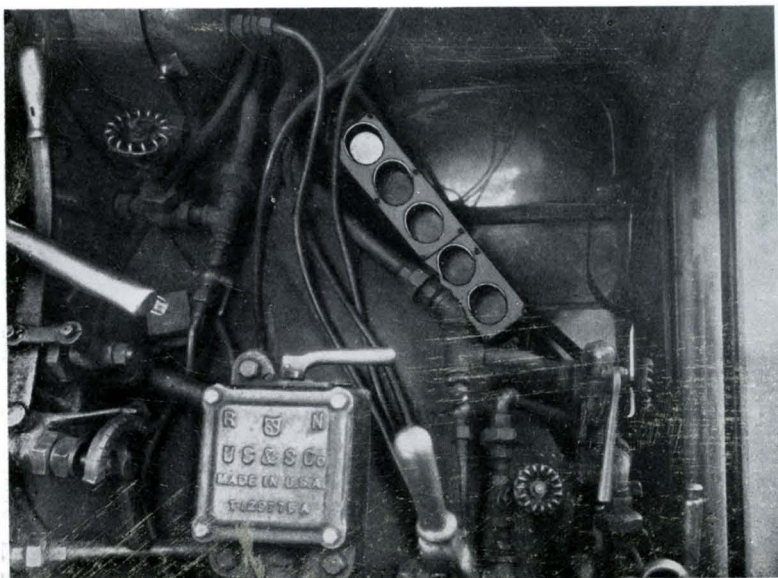




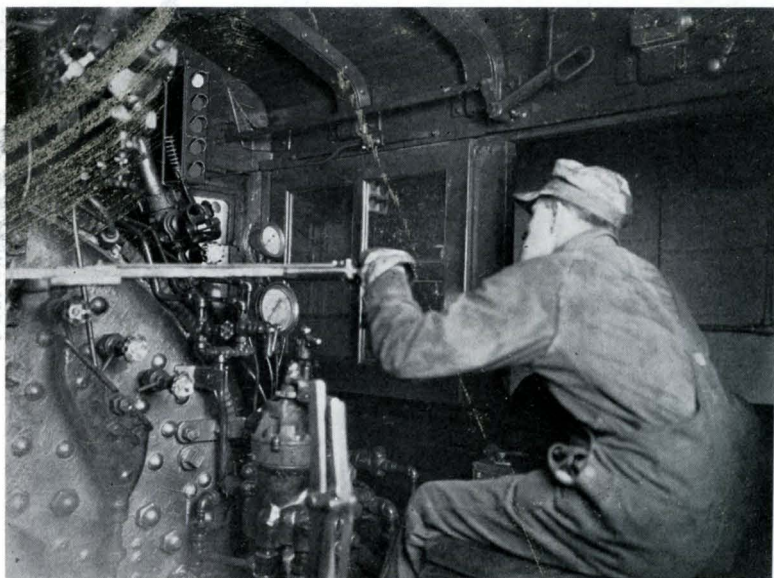
Cab Signal Giving Speed Indications



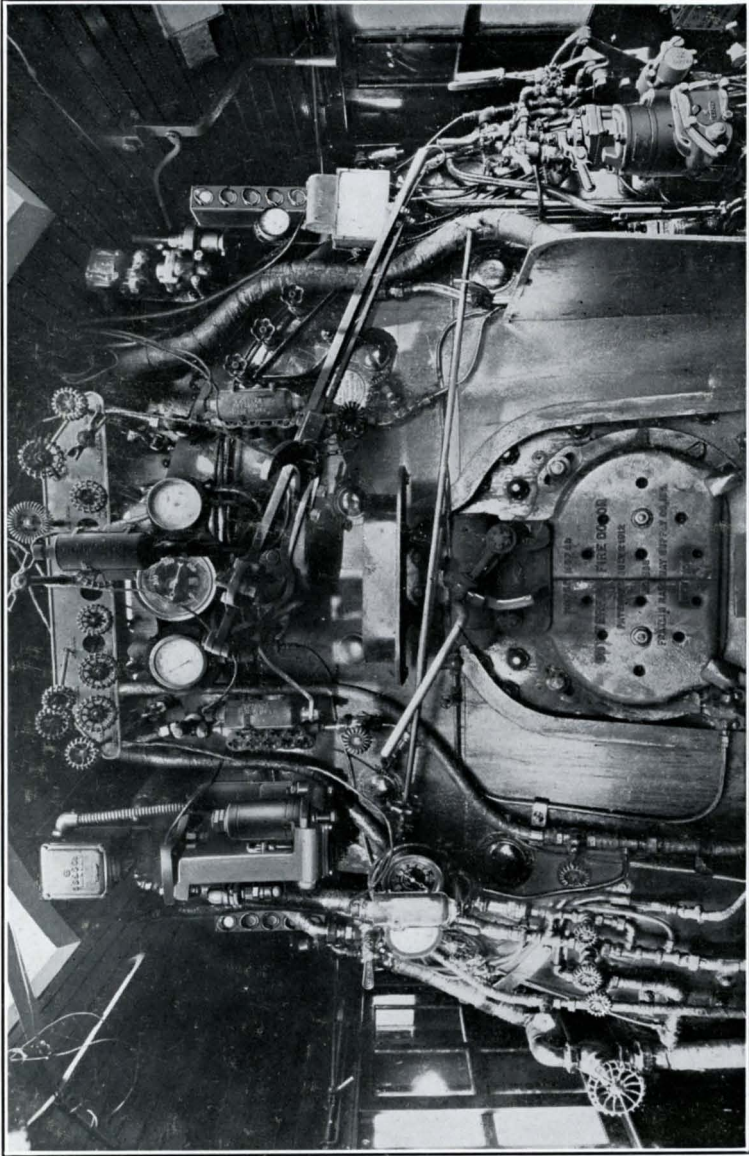
A Two Indication Cab Signal on Engineman's Side



Four Indication Color Light Cab Signal Mounted Diagonally



Four Indication Color Light Cab Signal Mounted Vertically



Four Indication Color Light Cab Signals Mounted on Both Sides of Cab

UNION CAB SIGNAL EQUIPMENTS FURNISHED ON I. C. C. ORDER 13413

Railroad	No. Equipped Locos.*	Road Miles	Track Miles	From	To
A. T. & S. F.	93	102.70 72.90	210.40 145.80	Chillicothe, Ill. Pequot, Ill.	Ft. Madison, Ia. Chillicothe, Ill.
Atlantic City	55	55.20	113.00	Camden, N. J.	Atlantic City, N. J.
Boston & Maine	174	99.50	203.90	W. Cambridge, Mass.	E. Deerfield, Mass.
C. R. R. of N. J.	130 63†	65.60 50.10	65.60 104.20	Red Bank, N. J. Elizabethport, N. J.	Winslow Jet., N. J. Bay Head, N. J.
C. M. St. P. & P.	103 ...	108.10 104.40	216.20 208.80	Bridge Switch La Crosse, Wis.	Hastings, Minn. Portage, Wis.
D. L. & W.	219 ...	141.00 115.55	282.00 264.48	Elmira, N. Y. Elmira, N. Y.	East Buffalo Scranton, Pa.
Ill. Central	137 ...	121.80 97.60	243.60 97.60	Champaign, Ill. Waterloo, Ia.	Branch Jet., Ill. Ft. Dodge, Ia.
Long Island	327 ...	20.80 26.20	32.80 52.40	"H" Tower, Harold Avenue Jamaica	Pt. Washington—Whitestone Landing Babylon
L. & N.	52 45	161.70 136.20	161.70 140.40	Corbin, Ky. Mobile, Ala.	Etowah, Tenn. New Orleans
N. Y. N. H. & H.	37 151	59.80 105.00	119.60 216.88	Air Line Jet. New Haven	Springfield Providence

UNION CAB SIGNAL EQUIPMENTS FURNISHED ON I. C. C. ORDER 13413 (Continued)

Railroad	No. Equipped Locos.*	Road Miles	Track Miles	From	To
N. & W.	100 4 ‡	106.10 132.60	106.10 135.10	Hagerstown, Md. Roanoke, Va.	Shenandoah, Va. Shenandoah, Va.
O. W. R. R. & N.	38	84.00	86.50	Portland, Ore.	The Dalles, Ore.
Penn. R. R.	162 260	81.50 130.40	163.00 490.20	Baltimore, Md. Harrisburg, Pa.	Harrisburg, Pa. Altoona, Pa.
P. C. C. & St. L.	154 398	187.00 157.41	352.00 382.59	Columbus, Ohio Pittsburgh, Pa.	Indianapolis, Ind. Newark, O.
Reading Co.	150	45.74	91.48	Bethlehem, Pa.	Jenkintown, Pa.
R. F. & P.	77	101.60	203.20	Richmond, Va.	"AF" Block Station, Va.
Union Pacific	107 31	102.00 123.00	204.00 246.00	Sidney, Neb. No. Platte, Neb.	Cheyenne, Wyo. Sidney, Neb.
W. J. & S.	136	56.40	112.80	Camden, N. J.	Atlantic City, N. J.
Total	3,203	2,951.90	5,452.33		

*—Locomotives include, steam and electric locomotives, and multiple unit electric cars.

†—63 P. R. R. Locomotives operating over New York & Long Branch.

‡—4 C. & O. Locomotives operating over Norfolk & Western from Lochlaird to Glasgow.

LOCOMOTIVE EQUIPMENT FURNISHED FOR VOLUNTARY INSTALLATIONS

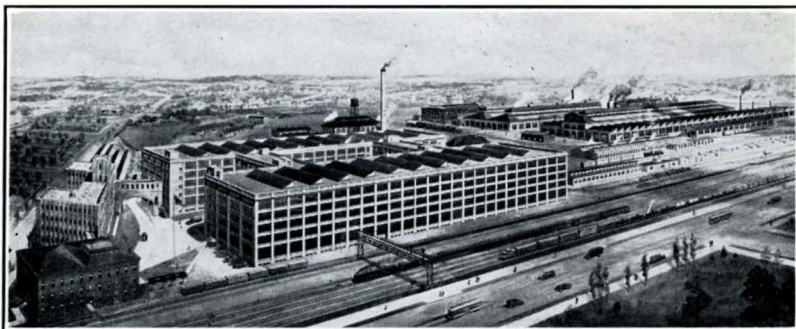
Railroad	No. Equipped Locos.	Road Miles	Track Miles	From	To
P. R. R.	231	46.90	197.29	Manhattan Transfer Philadelphia Newark, O. Matawan, N. J. { NA Tower } AF Tower	Millham Jet. Washington Columbus, O. Atlantic Highlands, N. J. Richmond, Va. Potomac Bridge
	241	132.00	392.00		
	...	31.99	63.00		
C. R. R. of N. J.	...	10.60	10.60		
R. F. & P.	...	9.00	18.00		
Total	472	230.49	680.89		

UNDER CONSTRUCTION

P. R. R.	...	35.00	141.00	Millham Jet. Altoona, Pa. Philadelphia District Montreal	Philadelphia Pittsburgh, Pa. St. Laurent
	360	112.29	464.00		
	200		
C. N. Ry.	8	5.00	10.00		
Total	568	152.29	615.00		

TOTALS

I. C. C. Order 13413	3203	2,951.90	5,452.33		
Voluntary Install. Completed	472	230.49	680.89		
Voluntary Install. Under Cons.	568	152.29	615.00		
Grand Total	4,243	3,379.68	6,748.22		



Union Switch & Signal Company

GENERAL OFFICE AND WORKS: SWISSVALE, PENNA.

Floor Space: Over 1,000,000 Sq. Ft.

Designers, Manufacturers and Engineer-Constructors
of Electro-pneumatic, Electric, Electro-mechanical and Mechanical
Railway Signal and Interlocking Appliances.

Automatic, Semi-automatic, and
Manually-operated Block Signals.

Coded Continuous Cab Signaling Systems.

Electro-pneumatic, Electric, Electro-mechanical,
and Mechanical Interlockings; Automatic Train Control,
Car Retarder, Highway Crossing Protection,
and Centralized Traffic Control.

Railroad, Automobile, and General Forgings and Castings.

Commercial and Engineering Departments
Prepared to Handle all Problems Arising in the Field of Signal Engineering.

Plans and Estimates on Application.

DISTRICT OFFICES

NEW YORK.....	WESTINGHOUSE BUILDING
CHICAGO.....	PEOPLES GAS BUILDING
ST. LOUIS.....	RAILWAY EXCHANGE BUILDING
SAN FRANCISCO.....	MATSON BUILDING
MONTREAL.....	DOMINION SQUARE BUILDING

Represented in Argentina and South Africa by the In-
ternational General Electric Company. Represented
in Australia by the McKenzie & Holland (Australia)
Pty. Ltd., Melbourne and Brisbane.

