

# RAILROAD SIGNALS



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## **Introduction**

This document has been prepared to help better understand the background of railroad signaling and to indicate the types of equipment used by today's rail properties and the corresponding cable applications.

The background section gives a brief history of the signal systems employed today. It is noteworthy that the essential elements of signaling have not changed for generations, much of the material used for background is over 40 years old. However, the culture of the business is very strong, and knowledge of the history could provide useful insight into the thought process of a signal engineer.

The "Components" Section highlights the basic operation of assorted appurtenances used in a signal control system, their purpose, and more importantly what cable is typically used, and why. It is expected that this document will evolve over time, with the intent of providing cross references among our major rail customers and their respective cable usage.

Finally, the "Glossary" provides a comprehensive lexicon of terms often used by a signal engineer.

## Railroad Signaling Background

The first railway signals consisted of a variety of simple wayside mechanical devices, usually of fixed location. They were developed because of the danger that station employees after receiving telegraph instructions to stop a train to deliver orders might become engaged in other routine station duties and forget to signal the train by hand.



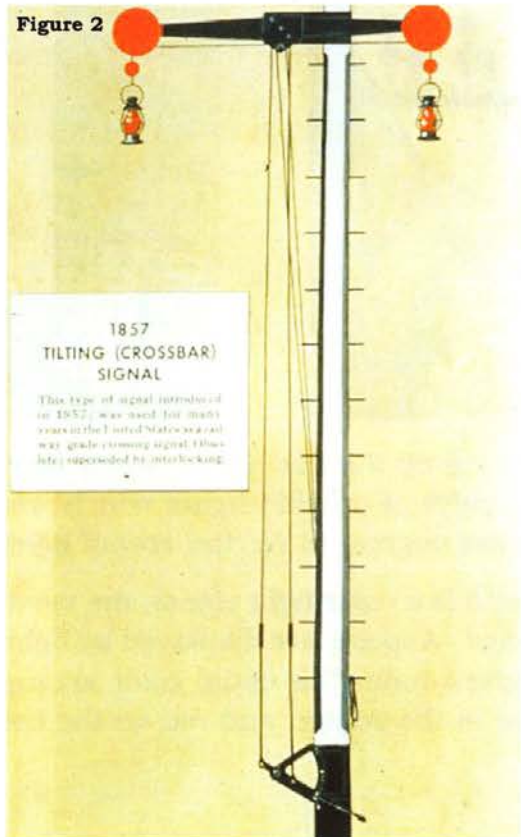
The "Ball Signal" shown in Figure 1 illustrates, as a matter of historical interest, one of the earliest methods used in conjunction with time-table operation to convey information as to location and departure of trains. Although primitive in this day and age, considerable ingenuity was required to design, construct and operate such a system. This type of signal was still used in rare instances 100 years later.

It is from this signal that the well known railroad term "highball" was derived.

The fixed signal could be set to stop position immediately upon receipt of instructions and thus serve to reduce possibility of human error. The signal, which the operator used to advise trains that orders were to be picked up, was called a train order signal. To facilitate operations at night, the Tilting Crossbar (Figure 2) was soon introduced, using lanterns in lieu of a ball.

The advantages of fixed signals soon became apparent to prevent collision or accidents at important points such as railway junctions, crossing of other railways or at grade (diamonds) and at moveable bridges. It was not long before railroads recognized the importance of developing fixed wayside signals which were both reliable in operation and uniform in appearance to ensure engine men properly understood the information conveyed by the signal.

After a number of experiments, a semaphore type signal was developed. The semaphore signal consisted of a moveable arm mounted on a mast situated beside the track over which it governed train movements. See Figure 3. The arm was free to pivot to three positions. The common positions were horizontal ( $0^\circ$ ), an intermediate position ( $45^\circ$ ), and a vertical position ( $90^\circ$ ). Standard meanings were given to the various positions assumed by the arm. The horizontal position meant stop. The  $45^\circ$  position





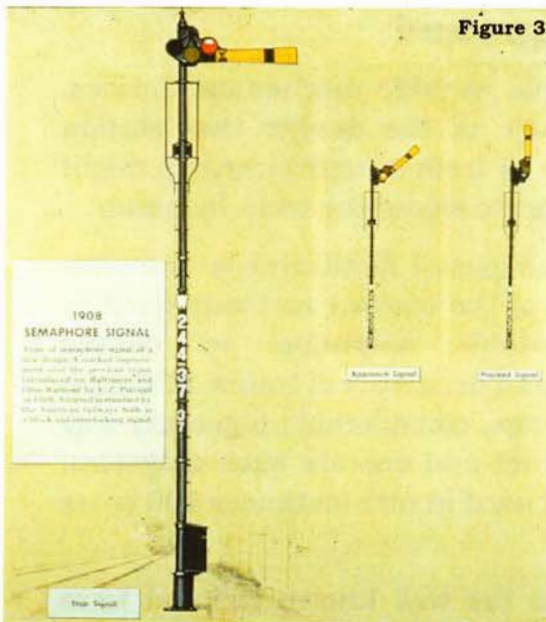


Figure 3

meant proceed with caution, prepared to stop. The 90° vertical position meant proceed.

Lights were used with semaphore signals to provide night indications. The lights were of various colors to correspond with the position of the semaphore arm. With the arm in the vertical position, a green light was simultaneously displayed. The horizontal position caused the red light to be displayed, and when the semaphore assumed the 45° position the yellow light was displayed.

These early signals were manually operated, and night indications were provided by an oil lamp and the use of colored lenses. As technology progressed, electric motors were used to drive the

semaphore arm, and oil lamps were also replaced. In addition to semaphore signals, a system of light signals was devised to provide distinctive visual indications by day and by night. This was accomplished by using lights of different colors or by placing the lights so their positions could be varied, or further, by providing a combination of color position lights. In general, the light signals conveyed the same indications as those displayed by the semaphore signals. The shape and design of the semaphore arm blade was also used to convey certain information according to individual railroad practice.



Figure 4

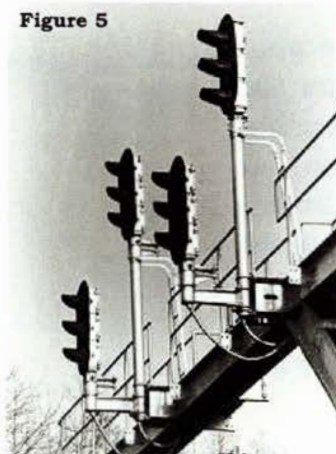


Figure 5

The semaphore is rarely found today, having been replaced by the position light signal, used extensively on Amtrak's Northeast Corridor and the Long Island Rail Road, and color signals, both "searchlight" and "color light".

Figure 4 provides an example of a position light signal. A combination of positions and use of colored lenses in a similar type signal could transform it to a color position light signal. Aspects are

displayed by the use of the center light in combination with any of the three pairs of outside lights which would produce either a horizontal, forty five degree, or vertical row of lights.

Figure 5 is a color light signal, the most widely used signal type in North America. Aspects are displayed by lighting only one of the three lights at any given time. The usual color arrangement is the green light on top, yellow in the center, and red on the bottom.



Figure 6



Figure 6 shows a searchlight light signal. Aspects are displayed by changing the colors behind the outer lens to display either the red, yellow, or green aspect.

For various reasons, the selection of one or two of the previously mentioned signals usually predominated on a given railroad.

## Interlockings

AREMA defines interlocking as “An arrangement of signals and signal appliances so interconnected that their movements must succeed each other in proper sequence and for which interlocking rules are in effect. It may be operated manually or automatically”.

Figure 7 shows a track diagram of Spuyten Duyvil, the first American mechanically operated interlocking, circa 1874.

At first, interlocking was used mainly to provide protection to trains approaching moveable bridges or at crossing of other railways at grade. The control of the signals was so arranged that a signal could not be cleared unless the bridge was first mechanically locked in place and the rails of the track were properly aligned and locked. At diamond crossings of other railways at grade, the signals were so interconnected that one signal could not be cleared unless all signals governing conflicting routes were at stop and no conflicting movements were being made. If a train unintentionally passed an interlocking signal at stop, a derail placed in advance of the signal would cause the train to be derailed rather than risk collision, or accident at an open drawbridge.

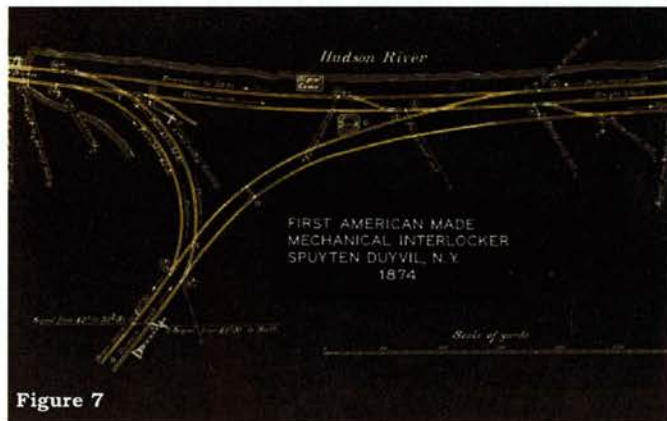


Figure 7

Eventually, interlockings were installed at junctions and in terminals where networks of tracks, switches and signals were involved. These interlockings were controlled from an interlocking machine in a centrally located cabin or tower by manual operation of



Figure 8

mechanically interlocked levers which were pipe connected to the nearby switches, signals and derails. These earliest interlocking plants were manually operated, and the interlocking between levers in the control machine and signals and appliances in the field was accomplished entirely by mechanical means.

The development of interlocking progressed from mechanical through electro-mechanical, electro-pneumatic,



and electric interlocking up to the present day all-relay and solid state systems. When the need arose to control field functions some distance from the control machine, relay circuits were developed in which all locking was done by electrical circuiting rather than by means of mechanical locking. Figure 8 captures a "leverman" controlling La Salle Street Terminal in Chicago a century ago.

Today, the three general types of interlocking are, namely, local control, remote control and automatic. Local and remote control use either individual lever type or route type control machines. Automatic interlocking does not require a control machine.

## Automatic Interlocking

AREMA defines automatic interlocking as: "An arrangement of signals, with or without signal appliances, which functions through the exercise of inherent powers as distinguished from those whose functions are controlled manually, and which are so interconnected by means of electric circuits that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication".

Provision is generally made at automatic interlockings whereby a train which may be stopped at a home signal on one line due to a train standing on the approach circuit of the crossing line and not ready to proceed over the crossing, may send a trainman to the crossing and by operating a device, cause the signals already cleared for the standing train to assume the stop position, and thereby allow those for the second train to assume a proceed position after a predetermined time has elapsed. In other cases, a trainman proceeds to the crossing and opens a switch which disconnects the signal control system placing all signals at stop, and then advances the train over the crossing in accordance with established rules. Figure 9 displays a typical "At Grade" interlocking.

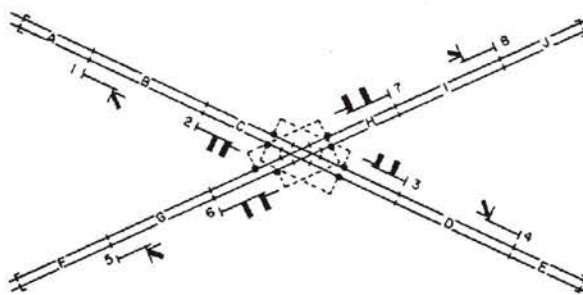


Figure 9 - Typical At-Grade Automatic Interlocking

## Block Signaling

The absolute permissive block system is an automatic block system in which the block extends from siding to siding for opposing train movements. The fixed signals governing the entrance into the block display a stop indication when the block is occupied by an opposing train. This absolutely prevents opposing movements between adjacent sidings. The section between sidings is divided into two or more blocks and the signaling is arranged to provide for following movements. The trains are kept a safe distance apart by intermediate signals placed at suitable intervals. In this system, undue train delays are



eliminated by allowing following movements, while safety is still maintained by preventing opposing movements.

In both automatic and absolute permissive block systems, authority for train movement is granted by time-table modified by train orders, the signals provide a safety check.

When an automatic block signal system is used on single track, the signal control circuits are designed to prevent the display of signal aspects that would permit opposing trains to enter a block at the same time. Figure 10 illustrates an absolute permissive block signal system. The signals are normally green. The block extends from siding to siding for opposing movements. The signals at the siding switches are "absolute" Stop Signals.

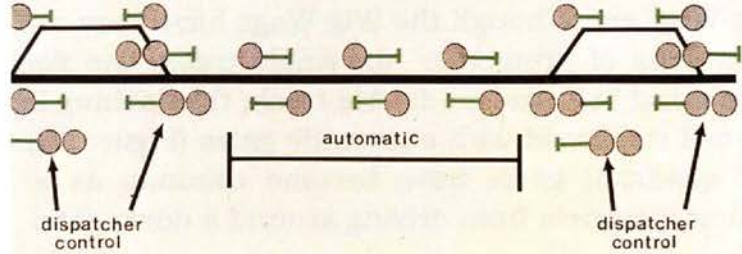


Figure 10

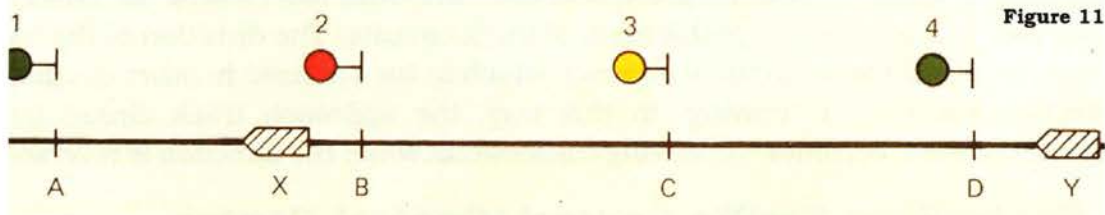


Figure 11

In Figure 11, a green aspect indicates that at least two blocks in advance of such signal are unoccupied. A signal displaying a yellow aspect indicates that only the block immediately in advance of the signal is unoccupied and that the train must be prepared to stop at the next signal. A red aspect indicates that the block in advance of the signal is occupied and that the train must stop, then proceed at restricted speed.

## Early Highway Grade Crossing Protection

In the early part of the century, crossing protection consisted of manually operated gates. These gates were originally operated by wire or pipe connections and later by electric motors, but were still manually controlled.

With the invention of the track circuit, automatic protection became possible. The first automatic protection consisted of a bell and was soon followed by an illuminated danger sign which was controlled by the train itself when within the limits of the track circuits approaching the crossing.

With increased traffic both by rail and road, and the opening of more roads, a better type protection was required. The Wig-Wag, Figure 12, was developed and gave



Figure 12



the public a better visual signal. The swing of the Wig-Wag banner became the symbol of automatic highway crossing protection. The public still call the crossing protection a "Wig-Wag" even though the Wig-Wags have been replaced by a better type of protection -on single track, the flashing light signals and bell, and on double track, the flashing light signals and bell combined with automatic gates (Figure 13). Recently, four quadrant gates have become common as a means to prevent motorists from driving around a down gate.

The circuits which control crossing protections are so designed that the protection must operate when a train is approaching the crossing or is on the crossing. The circuits are further arranged to stop the protection operating after the rear of the train passes completely over the crossing.



As trains operate in either direction, the same feature of protection must be provided for train movements in both directions. The circuiting must detect the direction of the train in order to stop the protection after the train has cleared the crossing. This is accomplished by the use of a combination of track circuits. The direction of the train determines the sequence of track circuit occupancy which in turn is used in other circuits to detect the direction the train is moving. In this way, the approach track circuit for a movement, say east to west, becomes the leaving track circuit when the direction is reversed.

## **Centralized Traffic Control/Control Center**

AREMA has defined Centralized Traffic Control (CTC) as a "method of train operation in which the movement of trains is directed by Signal Indications without requiring the use of train orders and without superiority of trains."

Considered in terms of its components, it could also be described as a combination of block signaling and interlockings, coordinated with a train dispatching system to form an integrated system for protection and government of train movements.

Centralized Traffic Control is an expansion of Automatic Block Signaling to include the following groups of equipment.

- **Control Machine** - The control machine is equipped with levers or push buttons for the operation of switches, signals and other remotely controlled apparatus. It also has a system of indication lights and devices which show the position of switches and signals and the location of trains in the controlled section. An automatic train recorder is usually used in conjunction with the control machine to provide a permanent record of train movements.
- **Control Office Application Equipment** - This is the portion of the code system at the control office used in making up control codes for transmission to the field locations. It is also used to interpret and control the display, on the control machine, of the information contained in the indication codes transmitted from the field locations.
- **Control Wires** - A set of control wires extend from the control machine through the entire territory governed by the machine. Over these wires are transmitted the



control codes for actuating switches, signals, etc. in the controlled section. The indication codes which report conditions at the field location are also returned to the machine over these same wires.

- Field Application Equipment - This is the portion of the code system located at the various field locations. It is used to carry out the controls contained in the codes received from the control office. This equipment is also used to transmit indication codes to the control office.
- Equipment at the controlled Location - This consists of power switches, signals, etc. and the instrumentation required for their operation and control.
- The control machine can be located adjacent to, or at some distance from, the installation it controls. This machine provides the means for initiating the desired controls and for displaying the indications which keep the dispatcher informed as to train movements and track conditions. A method of control is provided for all power switches (and, if desired, all electrically locked hand operated switches).

A typical control center consists of a control console, a display panel which is either part of or separate from the console, recorders, and the necessary communication facilities.

The operation of a typical control console is straight-forward as well as convenient. For example, to request a function at a given location, the operator merely selects that location and function by pressing the appropriate buttons on the console. The information thus requested is displayed on the track diagram in the form of flashing lights and is sent to the field by pressing the start button. After the start button is pressed, the requested information remains flashing on - the track diagram until an indication is received from the field that the request has been carried out. At this point the flashing lights become steady, accurately portraying field conditions. When a change occurs in the field, the information is sent to the control center and the appropriate indication is displayed on the panel. The actual method of transmitting control and indication information between office and field locations depends on the type of code system used. The field circuiting, however, is reasonably standard.

It is worthwhile to note that the control system only requests field functions and displays field conditions. The fail-safe circuiting is in the field. In other words, an incorrect request, or a request to the wrong location, could be sent to the field, but the field circuiting would only permit a change if it was safe.

## **Signal Components and Cable Applications**

This section will outline the basic components of a rail signal system and highlight typical cable requirements for each device.

Today's signaling system circuits are designed with train and passenger safety as the paramount consideration. Any equipment or circuit failure that might occur results in a safe effect upon train movement. This is accomplished, for example, by causing the governing signal to indication either **Stop** or more restrictive aspect than actual track conditions warrant when a system failure occurs.

To accomplish this objective, specially designed, highly reliable equipment and circuits are used. The basic special component used is a vital relay. The vital relays are used in circuits that are called vital circuits, because the circuits' actions directly affect the



movement of trains. Examples of such circuits are track circuits, and circuits that control wayside signal aspects and the movement of track switches. Another special component critical to system safety is the vital signal cable.

Utilizing the characteristics of vital components, vital circuits are formed using the closed-circuit principal. The closed-circuit principle established the opening of the control circuit and de-energizing of the controlled vital relay coil as the circuits' safe condition. Should a component or equipment item in the circuit controlling a vital relay coil fail to perform correctly, the controlled vital relay either de-energizes or cannot energize, enforcing a safe (stop) condition on the rails. The vital circuits can therefore be said to enforce a fail-safe train movement condition, with train stopping being the safe condition.

The quality and durability of these specialized components is critical to the operational reliability and safety of the railroad signal system.

## Track Circuits

### DC Track Circuits

As a result of numerous accidents, the desirability of providing a positive means to indicate the presence of a train began to receive very serious consideration and from this need, the track circuit was born.

The primary function of a track circuit is to detect the presence of a train and also provide a means of detecting broken rail.

The conventional dc circuit was invented in 1872 by William Robinson. Since that time the circuit has remained basically unchanged except for improved equipment which has upgraded the operating characteristics.

The track circuit is the most important link in the signal system. It is the medium of connection between the train and the signal or other device provided for the protection of the train. The control of the signals is accomplished through the Track Circuit.

A track circuit is essentially a simple series circuit, with a power source at one end and a relay (or receiver) at the other end. The rails of a track circuit provide the path for the flow of current from the battery. Bond wires are applied to rail joints to insure a path of low and uniform resistance between adjoining rail.

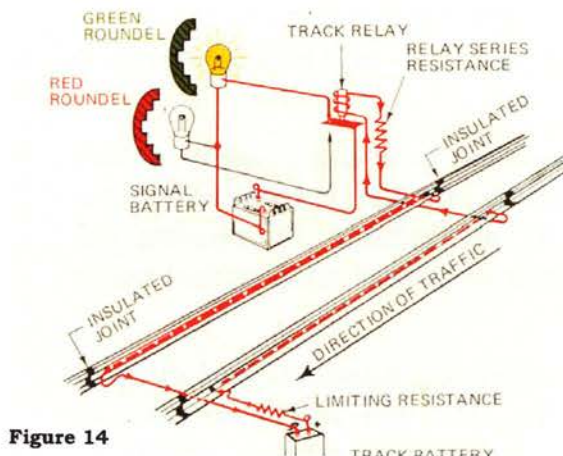


Figure 14

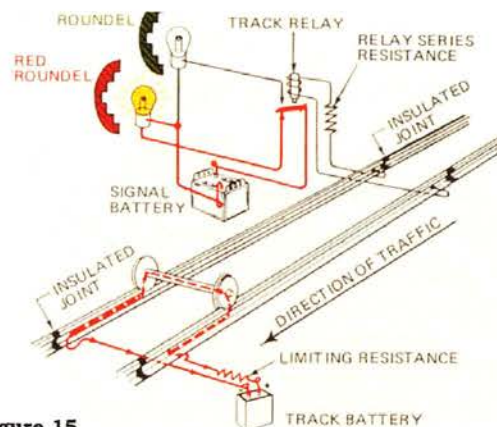


Figure 15



Figures 14 and 15 display a track circuit energized (unoccupied) and de-energized (occupied) as indicated by their respective green and red aspects.

When a train enters a track section the wheels and axles place a shunt on the track circuit. This creates a short circuit, causing the relay to de-energize.

The track is divided into sections, each section being insulated from the adjoining section by insulated joints. Figures 16 and 17 illustrate an insulated joint which simply provides



Figure 16

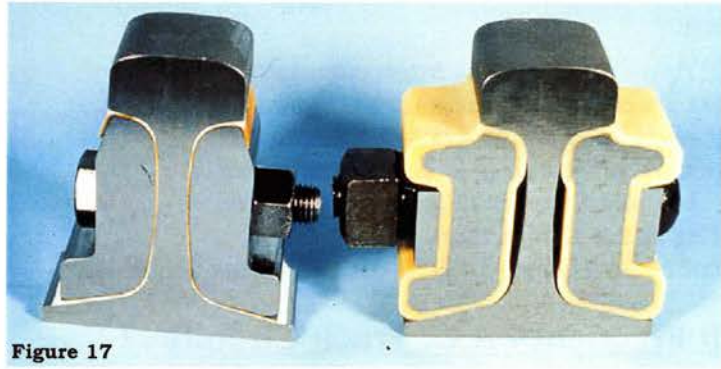


Figure 17

electrical isolation between sections of rail. It is typically here that track circuit connections and impedance bond connections are made. The sections vary in length as required.

The track circuit is not so much a train detection device as it is an absence of train device. A failure of any component will cause the relay to de-energize in response to either a short or open circuit, causing the system to indicate the presence of a train as a fail safe measure.

*Cable Application* - Most track circuits use Duplex Track Wire, to connect the feed and relay ends to their respective instrument houses. Alternately a 2 conductor cable may be used with a junction box or "bootleg" as a termination point.

*Typical Stock Usage:* 113-12-3933, Duplex Track Wire

## Power Frequency A.C. Track Circuits

AC track circuits are necessary because DC track circuits are susceptible to interference when the running rails are also used as the return for traction power current. For this reason, DC circuits are not used in rail rapid transit. Most modern rail rapid transit systems use some form of track circuit.

The power frequency (PF) AC track circuit is energized by an alternating electrical current with a frequency in the range of 50 to 150 hertz. Except for the type of current and apparatus used, the AC track circuit is similar in operation to the DC track circuit described above.

Figure 18 shows a simple power-frequency AC track circuit. As with the DC circuit, the AC track circuit consists of a block or length of track which is defined at each end by insulated joints in one or both of the running rails. The AC signal source (usually a transformer) is connected to the rails at one end of the track circuit while the receiver (a relay) is connected to the other end. In addition to the signal source and the receiver, the AC track



circuit contains a pair of impedance bonds at each pair of insulated joints. The impedance bond is a center-tapped inductance which is connected across the rails on both sides of the insulated joints. The center taps of the pair of impedance bonds are connected together as shown.

**Cable Application** - Most track circuits use Duplex Track Wire, to connect the feed and relay ends to their respective instrument houses. Alternately a 2 conductor cable may be used with a junction box or "bootleg" as a termination point.

**Typical Stock Usage:** 113-12-3933, Duplex Track Wire

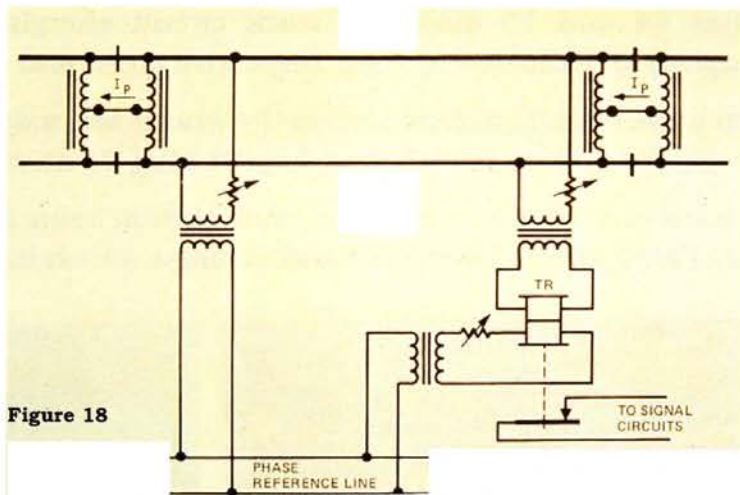


Figure 18

## High Frequency A.C. Track Circuits

Some AC track circuits use a current that alternates at a frequency in the range of 500 hertz - 5 K hertz. Because this frequency range corresponds roughly to the spectrum of audible sound, these circuits are sometimes called audio frequency track circuits.

High-frequency AC track circuits eliminate the need for insulated joints in the running rails. Because insulated joints are expensive to install and to maintain, eliminating them leads to a significant cost reduction. Eliminating insulated joints also allows the track circuit to operate with the continuous welded rails being used in some newer installations.

Figure 19 shows a simple high-frequency AC track circuit. Since no insulated joints are used in the running rails, the ends of the block established by special transformers are connected to the rails.

The transformer winding attached to the rails is usually a single turn of heavy copper bar stock. The transformer core is often a toroid. The other transformer winding is tuned to resonate at the operating frequency by a capacitor. The transmitter is the AC signal source and provides electrical energy at the operating frequency in the audio frequency range. The receiver in this case is not simply a relay, as with the DC and PF track circuits, but an electronic circuit which responds to the electrical signal provided by the transmitter. The receiver may be used to actuate a relay which performs functions like those in the d.c. or power-frequency a.c. track circuits.

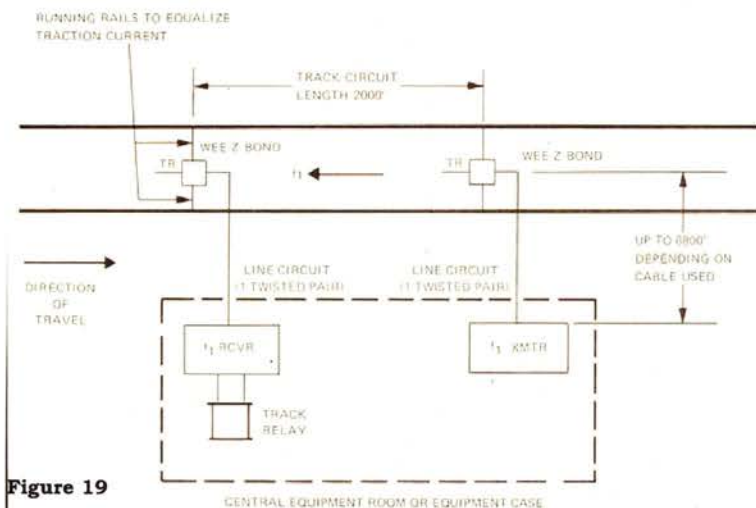


Figure 19



*Cable Application* - Audio Frequency track circuits, used on a number of transit properties, and Audio Frequency Overlays (AFO) used primarily for highway crossing activation, use a #14 twisted (often shielded) pair, either as a single or in a multi pair cable. For these applications, a duplex construction is not necessary, due to the need for passive filtering and/or amplification near the rail termination. The field end of these cables is typically terminated in a junction box.

*Typical Stock Usage:* Manufactured Special

## Impedance Bonds

The purpose of the impedance bonds is to provide continuity between the track circuits for the DC traction power and to distribute the traction current between the two running rails. The impedance bonds do this while still maintaining a relatively high impedance at the signaling frequencies between the two rails and between adjacent track circuits, allowing the track circuits to operate properly.

Impedance bonds come in a variety of shapes and sizes, depending upon the voltage (and therefore the ampacity) of the traction power system and the frequency (and therefore the impedance) of the track circuit. Large PF Bonds (Figure 20) are typically used with low voltage (high current) traction power systems in conjunction with low frequency (60/100 hz) track circuits. Small AF bonds (Figure 21, also known as Wee Zee bonds, a GRS (now Alstom) trade name) are typically used with high frequency (500-5000 hz) track circuits, regardless of traction power voltage. A third type of bond, the mini bond (not shown, mini bond is a US&S trade name) is used on high voltage (11-5/25kV) systems, such as the Northeast Corridor.



Figure 20

The impedance bond requires traction return wire to connect the side leads to the rails and to connect the center taps of the each pair of impedance bonds. Further, at approximately every other joint location, the center taps of adjacent tracks are interconnected for the purpose of equalizing the traction return current among the available rails. This is known as "cross bonding". Finally, at traction substations, the center taps are connected to the

sub station return grid. This is referred to as the Sub Station Return.

*Cable Application* - Side lead connections, cross bonds and sub station returns are in traction cable suitable in size for current requirements and are always installed in multiple' ie: 2x500 MCM, for reliability and safety.

*Typical Stock Usage:* 113-12-2842, 113-12-2846, 113-12-2850, 113-12-2854, Traction Power Cable



Figure 21



## Wayside Signals



Figure 22

There are three general classes of light signals commonly in use on most railroads, color light signals and search-light signals and position light signals. Although the two types differ in construction and operation they all perform the same function namely, to convey operating information to train crews by means of colored light aspects. The color light signal is used predominantly in new constructions and is highlighted herein.

The color light signal has the units arranged vertically as shown in Figure 22. Each unit has its own lens and lamp. The lenses are colored to give the desired aspect. Signals may consist of one, two, or three units, however, the most common is the three unit signal arranged with the green unit on top, yellow in the center, and red on the bottom. Each lens is equipped with a hood, and the signal units are equipped with a dark background. The hood shields the lens from the sun's rays and the effects of weather. The dark background is provided to accent the effect of the light to achieve maximum visibility.

Figure 23

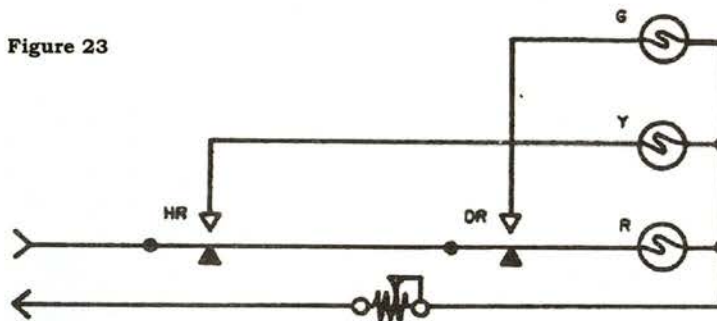


Figure 23 shows a typical lighting circuit for a color light signal. With signal control relays HR and DR de-energized a red aspect is displayed. If the HR is energized a yellow aspect is displayed, and with the HR de-energized and the DR energized a green aspect will be displayed.

### Cable Application -

Most properties will use 18W bulbs operated nominally at 10VDC at the signal head. Signals may be located 500 feet or more from the control house. To avoid excessive line loss, railroads have standardized on a 5c#9, 5c#6 or 5c#4 cable to accommodate 4 working wires and a spare conductor

### Typical Usage:

206-11-6245, 206-11-6925, Vital Signal Cable

## Highway Grade Crossings

Whenever a highway or roadway crosses a railway track, some means of protection or warning is essential to reduce the danger of collision between a train and highway traffic using the crossing.

Protection at highway grade crossings was first afforded by placing conspicuous signs at the crossing. Use of the locomotive whistle and bell was also required to alert roadway traffic of an approaching train. At some crossings where vehicular traffic was relatively heavy, crossing watchmen were used along with these signs. The watchman usually flagged the traffic with a red flag or light to warn the public of an approaching train.



## Flashers

Because of increased traffic, both by rail and road, and the opening of more roads, a better type of protection was required. With the advent of the track circuit, automatic control of crossing protections by the train itself eventually became possible. The first automatic protection consisted of a bell at the crossing and was soon followed by an illuminated danger sign, which was controlled by the train when within the limits of the approach track circuit.

Figure 24



The wig-wag was then developed and gave the public a better visual signal by displaying a moving banner by day and a moving or flashing red light by night. The wig-wag has since been replaced by a more modern type of protection - on single track the flashing light signal (Figure 24), and on double track the flashing light signal combined with automatic gates.

The circuits which control crossing protection are so designed that the protection must operate when a train is approaching the crossing or is on the crossing. The circuits are further arranged to stop the protection operating after the rear of the train passes completely over the crossing. As trains operate in either direction, the same feature of protection must be provided for train movements in both directions. The circuiting must detect the direction of the train in order to stop the protection after the train has cleared the crossing. This is accomplished by the use of a combination of track circuits. The direction of the train determines the sequence of track circuit occupancy which in turn is used in other circuits to detect the direction the train is moving. In this way, the approach track circuit for a movement, say east to west, becomes the leaving track circuit when the direction of a train is reversed. Alternating flashers are used to provide the visual warning to highway traffic of an approaching train.

*Cable Application* - The lamps in these units are typically 10 volts 18 watts and are operated within 10% of their rated voltage. Each set of flashers has a 3 wire control circuit and on mast is usually equipped with a bell requiring 2 working wires. Most properties use a 5c#9 or 5c#6. Together with the signal lighting described above, these cable constructions are often simply referred to as lighting cable.

*Typical Usage:* 206-11-6245, 206-11-6925, Vital Signal Cable

## Gates

Where two or more main tracks cross a section of highway and in some single track locations, flashing light signals as previously discussed are not considered adequate protection. Therefore, short arm gates and gate mechanisms (Figure 25) are installed in conjunction with the flashing lights. The main purpose of installing gates at a highway crossing is to place a barrier across the road which prevents vehicular traffic from occupying the crossing after one train passes if there is another train approaching on the second track.



Figure 25



*Cable Application* - The circuitry for the gate is dependant upon the manufacturer, but most employ a 4 wire control and indication circuit. Gates may be mounted on independent masts or on flasher masts or cantilever masts. Lighting circuits are required for the flashers and tip lights as indicated above. 7C#6 is most commonly used for gate applications.

*Typical Usage:* 206-11-6887, Vital Signal Cable

The gate mechanism (Figure 26) consists of 4 essential elements, the motor (used to drive the gate up, gravity drives it down), the gear train, the circuit controller and the hold clear mechanism.

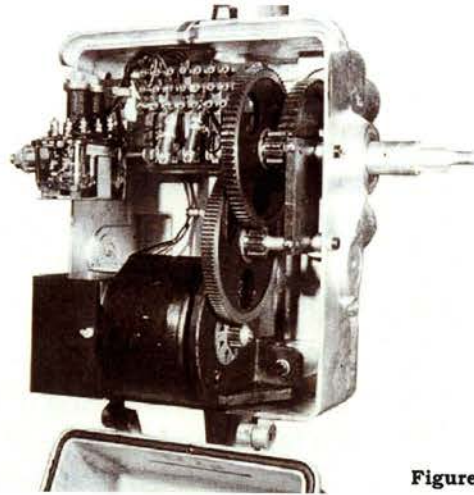


Figure 26

## Track Switches

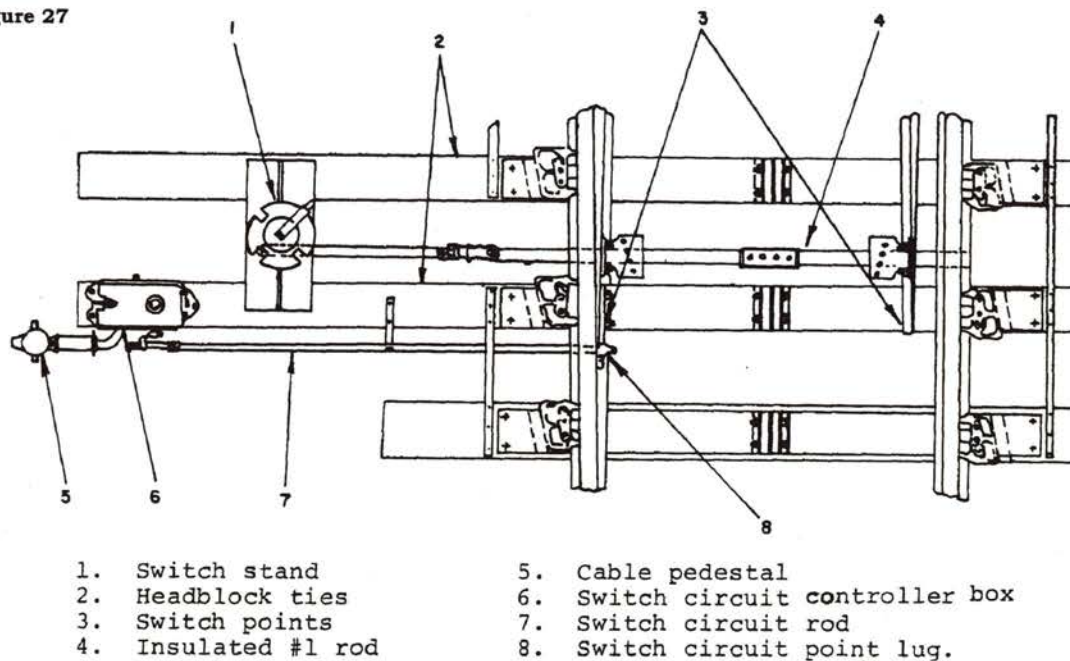
### Switch Circuit Controllers

Without track switches a railroad could not function. Switches in freight yards provide the means to establish a route to the many storage tracks. On single track main line they allow trains to meet and pass by use of a side track, entry to which is governed by track switches, and on double track they allow trains to cross between tracks.

In signaled territory, where a proceed signal is the authority for train movements over a track switch, the position of the switch must be verified by the signal system before displaying a proceed aspect.



Figure 27



Switches are equipped with Switch Circuit Controllers (Figure 27, Item 6) which mechanically determine the position of the switch point. The circuit which controls the signal are broken through contacts in the controller. These contacts are positioned mechanically by a rod connected to the switch point. Should the point be in a position which makes train movements over them unsafe, the contacts will be open and the signal will be put to red.

*Cable Application* - Switch Controllers are typically connected to the nearest control location by underground signal cable, typically 5c#14.

*Typical Usage*: 206-11-6885, Vital Signal Cable

## Electric Locks

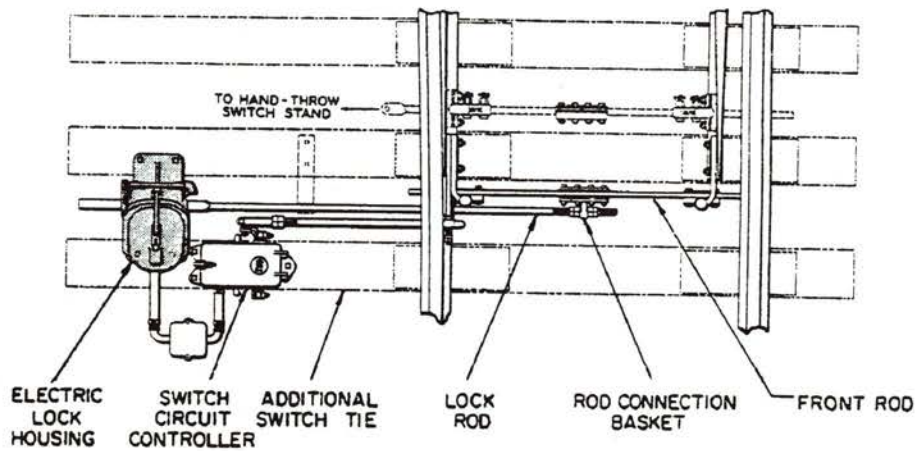
To prevent the hand throw switches from being operated when main line train movements might be affected, the hand throw switch location is modified to include a device named the Electric Switch Lock.

AREMA defines an electric lock as: "An electric lock connected with a switch movement to prevent its operation until released".

The use of an electric lock does not eliminate the manual positioning of the switch points but holds the points locked mechanically in the normal position by means of a lock rod connected between the switch points and the electric lock mechanism. See Figure 28. To release the lock rod, a relay within the mechanism housing must be energized which in turn permits a plunger which fits through a hole in the lock rod to be extracted. This relay will not be energized if movement of the switch points could jeopardize the safe passage of trains over the switch. Use of electric locking on switches is not limited to interlockings only. They may also be applied in block signal systems, etc.



Figure 28



To meet all railway requirements, electric lock housings are made in various heights. The most commonly used is the high type. The high type is used in all normal installations. The other types would be used at locations where there is restricted train clearance such as between two main tracks or between a main track and a siding.

The electric lock housing is divided into two compartments. One of these compartments is locked with a switch lock and is used by the trainmen. The other compartment is used only by the signalmen and is locked with a signal lock. The signalmen's compartment contains the operating mechanism.

The mechanism is simply a plunger which when de-energized, or locked, simply drops through a hole in the lock rod, preventing the movement of the switch, see Figure 29.

*Cable Application* - Switch Controllers are typically connected to the nearest control location by underground signal cable, typically 7c#14.

*Typical Usage:* 206-11-6887, Vital Signal Cable

### Switch and Lock Movements

Where remote operation and protection of a switch is required, a switch machine, also known as a Switch and Lock Movement is used. These are often dual control machines powered by an electric motor, with levers for hand throw operation. In some areas, machines may not have the hand throw feature. Power operated switch machines are normally controlled from a centrally located control panel where one operator can control a large number of switches over a wide- spread area, but often may also have local control.

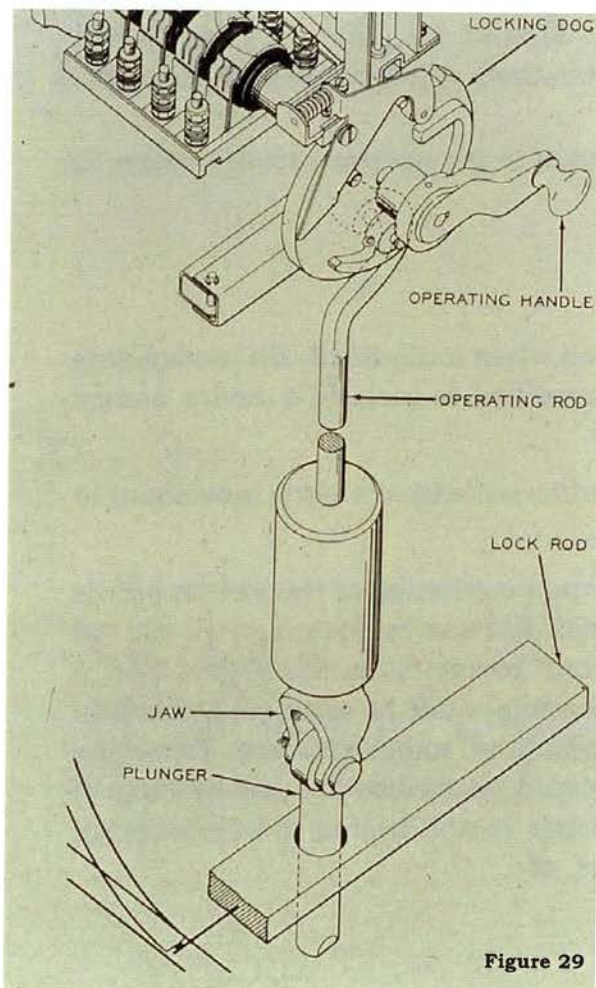
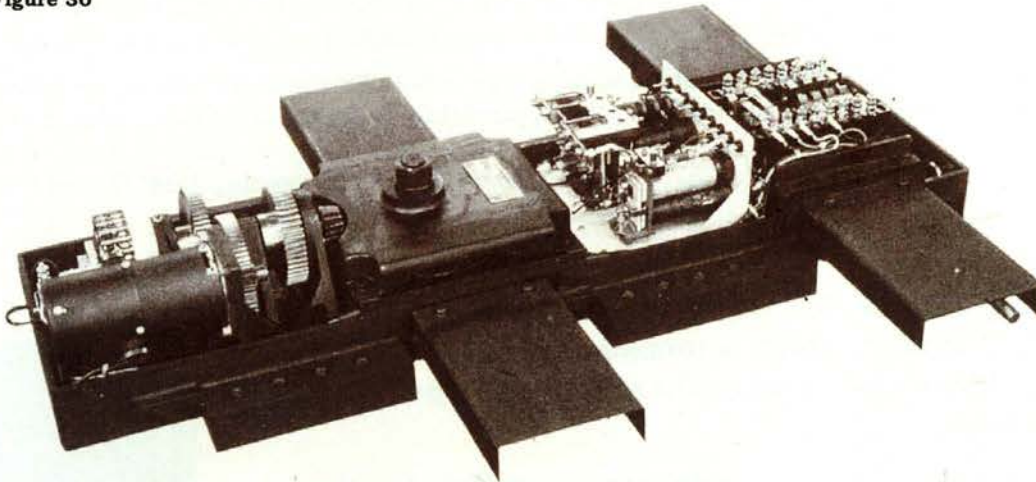


Figure 29

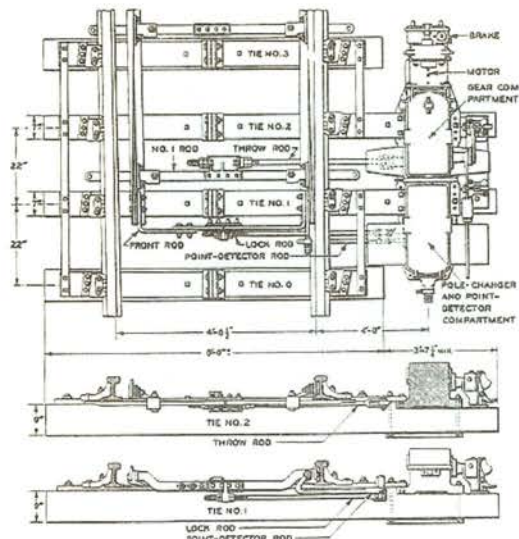


As illustrated below (Figure 30), the machine is divided into three basic compartments:

- Figure 30**



The switch machine as illustrated in Figure 31 is securely bolted to the ties and is connected to the switch points by three rods.



17



- Throw Rod; moves the switch points from one position to the other.
- Lock Rod; moved by the switch points and is used to lock the points in either the full normal or full reverse position.
- Point Detector Rod; moved by the switch points and detects the position of the points. The point detector rod is always connected to the normally closed point.

The throw rod is connected to the No. 1 rod through an apparatus called the “adjustment bracket” or “basket”. The throw of the switch points is adjusted at the basket. The lock rod is connected to the front rod, and locks or holds the switch points in the normal or reverse position. The point detector rod is connected in the same manner as the point detector rod of a switch circuit controller, through a point lug installed on the normally closed point.

*Cable Application* – Many properties will use separate cables for the motor circuit and the indication circuits, for example a 5c#6 and a 7c#14. Others, particularly transit agencies, will use a composite cable.

*Typical Usage:* 206-11-6245 and 206-11-6887, 206-11-6254 (composite), Vital Signal Cable

## Trip Stops

The trip stop (Figure 32), in its basic operation, is an absolute stop system which automatically stops a train attempting to pass a signal when the signal aspect prohibits such movement.

The most common form of trip stop operates by the mechanical engagement between a trip arm on the wayside and an arm on the train, connected to the train’s brake system. Figure 33 shows the wayside trip arm up or “stop” position. The arm simply lowers upon clearing of the signal, allowing the train to pass.

*Cable Application* – The most common form of trip stop is an Electric Stop, which operates in the same fashion as the switch machine previously described.

*Typical Usage:* 206-11-6245 and 206-22-6887, 206-11-6254 (composite), Vital Signal Cable

Figure 32



Figure 33





## Other Devices

### Power Supply

The majority of signal control houses do not require a significant amount of power. Power distribution is often a power drop from a local utility, but many transit agencies maintain their own signal power distribution system, often redundant. Some properties will use a standard signal cable; 3c#6 or larger conductor, if required. Some railroads have changed to a stranded construction with an EP/PVC insulation.

*Cable Application* – 3c#6, 3c#4 or 3c#2. *Typical Usage*: 206-11-6243, 206-11-6373, 206-11-6130, Vital Signal Cable, or 112-10-3854, 112-10-3864, 112-10-3874, EP/PVC

### Hot Box Detectors (Hot Wheel Detectors)

Hot journals (hot boxes) occur when inadequate bearing lubrication or mechanical flaws cause a significant increase in wheel bearing friction which in turn results in an increase of the wheel bearing temperature. As the bearing temperature rises to an abnormally high level the lubricating oil can smoke or catch fire and bearing failure may result. Such failures constitute a major cause of car derailments, thereby endangering life, destroying property and resulting in costly delays and reconstruction.



Hot box detector systems were developed to detect overheated bearings on moving trains prior to bearing failure, and thereby eliminate the possibility of train derailments.

Journal boxes emit infrared energy and wayside scanners are used to detect this radiation. When these sensors (scanners) receive the infrared energy, it is converted into an electrical signal and the information is transmitted to a central office, wayside location and/or directly to the train.

Most hot box detector locations are equipped with dragging equipment detectors. Any dragging equipment on the train, such as chains broken brake hoses, etc., strike the paddles of the system and cause a distinctive mark on the hot box detector tape at the point where the detection occurred.

*Cable Application* – The wiring is highly dependent upon the manufacturer, but telephone and/or fiber for telemetry are a common requirement.

*Typical Usage*: Manufactured Special.





## Dragging Equipment Detectors

Dragging equipment detectors may be used at entrances to yards or other points. These detectors, when hit by dragging equipment, affect the control circuit of signals in the vicinity to bring trains to a stop. They are also used in conjunction with Hot Box Detectors.

*Cable Application* – DED's are typically connected to the nearest control location by underground signal cable, typically 5c#14.

*Typical Usage:* 206-11-6885, Vital Signal Cable

## Slide Fence

Slide detectors are used at points where rock or landslides present unusual operating hazards. When a falling rock or slide hits a detector, a circuit is broken which puts signals at stop.

*Cable Application* – A slide fence will typically be constructed with copperweld line wire

*Typical Usage:* 509-55-5062, Copperweld Line Wire



## Express Cable

Express cable is the term used for those cables which carry an array of controls and/or indications from one control house to another and are not dedicated to the control of any single device. These runs are most commonly between interlocking locations but are also used within interlocking limits at more complicated locations.

*Cable Application* – Express cable is almost always a multi-conductor #14. The most common conductor counts are 12, 19, 27, and 37

*Typical Usage:* 206-11-6892, 206-11-6899, 206-11-6907, 206-11-6910, Vital Signal Cable

## Communications Cable

The railroads have historically operated and maintained their own telecommunications infrastructure, a requirement dating to a time when there were no communications providers. Today, the railroads manage a communications infrastructure employing a wide variety of technologies, some of which is owned by outside providers. Accordingly the railroad's consumption of communications cable is not what it was. There s still a need for copper pairs for interconnections and remote locations. Transit properties also tend to maintain a copper communications infrastructure.

*Cable Application* – 6pr and 12 pr for local requirements, 25 pr, 50 pr, 100 pr for express runs

*Typical Usage:* 709-07-4006, 709-07-4012, 709-07-4025, 709-07-4050, 709-07-100, Communication Cable



## **Glossary of Terms**

### **-A-**

**AAR** Association of American Railroads

**ABS (or AB)** Automatic Block Signal System

#### **ABSOLUTE PERMISSIVE BLOCK SYSTEM (APB)**

A block signal system under which the block is usually from siding to siding for opposing movements and the fixed signals governing entrance into the block display an aspect indicating Stop when the block is occupied by an opposing train. For following movements, the section between sidings is divided into two or more blocks and train movements into these blocks, except the first one, are governed by intermediate fixed signals, cab signals, or both. The intermediate fixed signals usually display an aspect indicating Stop; then Proceed at Restricted Speed, and the cab signal displays an aspect indicating Proceed at Restricted Speed, as its most restrictive indication. (See also: Block)

**ABSOLUTE SIGNAL** (See Signal, Applications)

#### **APPROACH CIRCUIT**

A circuit generally used in connection with announcing the approach of trains at a block or interlocking station or to provide initial activation of a highway crossing warning system.

#### **APPROACH CLEARING CIRCUIT**

A term applied to a circuit used in connection with the operation of a signal in advance of an approaching train.

#### **APPROACH INDICATOR**

An indicator used to indicate the approach of a train.

**APPROACH LIGHTING** (See also: Continuous Lighting)

A method of lighting signals upon the approach of a train.

**APPROACH LOCKING** (See Electric Locking)

**APPROACH SIGNAL** (See Signal)

**AREMA** American Railroad Engineering and Maintenance Association

**ASPECT** (Signal Aspect) (See also: Lower (and Upper) Quadrant Aspect, Phantom Aspect)

The appearance of a fixed signal conveying an indication as viewed from the direction of an approaching train; the appearance of a cab signal conveying an indication as viewed by an observer in the cab.

#### **AUTOMATIC BLOCK SIGNAL SYSTEM**

A series of consecutive blocks governed by block signals, cab signals, or both, actuated by a train, or engine, or by certain conditions affecting the use of a block.



**NORMAL CLEAR**

A term used to express the normal indication of the signals in an automatic block system in which an indication to proceed is displayed except when the block is occupied.

**NORMAL STOP** (See also: Absolute Permissive Block System, Centralized Traffic Control, Overlap Block Signal System and Traffic Control System)

A term used to express the normal indication of the signals in an automatic block system in which the indication to proceed is given only upon the approach of a train to an unoccupied block.

**AUTOMATIC SWITCHING** (See also: Route Selection)

A term generally used to describe a system of controls for automatic operation of track switches whereby routes that are established by preliminary manual selection are automatically completed by the progress of cars or trains.

**AXLE COUNTER**

An automatic arrangement for detecting and counting car and locomotive axles that pass a given wayside location: usually makes use of a wheel detector.

**-B-**

**BACK CONTACT** (See Contact)

**BACK LIGHT** (Highway Grade Crossing Signal)

An auxiliary signal light used for indication in a direction opposite to that provided by the main unit.

**BACK LIGHT** (Signal)

The light from a signal electric lamp, visible through a small opening in the back of a light signal, used for checking the operation of the signal lamp.

**BALLAST RESISTANCE** (See also: Leakage Current)

The resistance offered by the ballast, ties, etc., to the flow of leakage current from one rail of a track circuit to the other.

**BELL** (Highway Grade Crossing)

An audible device at a highway grade crossing that provides a warning.

**BLOCK** (See also: Station)

A length of track of defined limits, the use of which by trains and engines is governed by block signals, cab signals, or both.

**ABSOLUTE**

A block in which no train is permitted to enter while it is occupied by another train.

**PERMISSIVE**

A block in manual or controlled manual territory, based on the principle that a train other than a passenger train may be permitted to follow a train other than a passenger train in the block.



**BLOCK INDICATOR** (See also: Switch Indicator, Track Indicator)

An indicator used to indicate the condition of a block.

**BLOCKING** (See also: Field Blocking, Office Blocking, Track Blocking)

A means to prevent display of a signal when it is desired to inhibit entry of a train movement into the block governed by the signal.

**BLOCK SIGNAL** (See Signal)

**BLOCK SIGNAL SYSTEM** (See also: Automatic Block Signal System, Manual Block Signal System)

A method of governing the movement of trains into or within one or more blocks by block signals or cab signals, or both.

**BLOCK SYSTEM**

A series of consecutive blocks.

**BLOCKING DEVICE** (See Lever Blocking Device)

**BOND** (See also: Impedance Bond)

**PLUG**

A bond wire to which plugs are welded and used instead channel pins.

**PROPULSION**

A conductor of low resistance providing a path for the return propulsion current at non-insulated joints.

**RAIL**

A metallic connection attached to adjacent rails to insure electrical conductivity.

**WELDED**

A bond which is welded to the rails.

**BOOTLEG**

A protection for track wires where the wires leave the conduit or ground near the rail.

**BRACKET SIGNAL** (See Signal, Types & Arrangements)

**BRAKING DISTANCE**

The maximum distance on any portion of any railroad which any train operating on such portion of railroad at its maximum authorized speed, will travel during a full service application of the brakes, between the point where such application is initiated and the point where the train comes to a stop.

**BUNGALOW** (See Housing)

**-C-**

**CAB**

The compartment of a locomotive from which the propelling power and power brakes of the train are manually controlled.



## **CAB INDICATOR**

### **AUDIBLE**

A device located in the cab designed to sound under predetermined conditions.

### **VISUAL**

A signal located in the cab indicating a condition affecting the movement of a train or engine.

**CAB SIGNAL** (See Signal)

### **CAB SIGNAL SYSTEM**

A system which provides for the automatic operation of cab signals.

### **CABLE POST**

An upright designed for supporting a cable.

**CANTILEVER** (See also: Mast)

A structure, consisting of a ground mast and a horizontal arm extending to one side, used to support one or more signals as required for multiple tracks, or one or more highway grade crossing signals.

**CAR RETARDER** (See Retarder)

**CASE** (See Housing)

**CENTRAL INSTRUMENT LOCATION** (See Housing)

**CENTRALIZED TRAFFIC CONTROL** (See also: Traffic Control System)

A term applied to a system of railroad operation by means of which the movement of trains over routes and through blocks on a designated section of track or tracks is directed by signals controlled from a designated point without requiring the use of train orders and without the superiority of trains.

### **CHANNEL PIN**

A tapered metal plug with one or two grooves used to fasten one or two bond wires to a rail.

### **CIRCUIT CONTROLLER**

A device for opening and closing electric circuits.

**MOVABLE BRIDGE** (See Also: Movable Bridge Coupler)

A device for opening and closing electric circuits between the stationary and movable bridge spans.

**SWITCH** (See also: Point Detector)

A device for opening and closing electric circuits operated by a rod connected to a switch, derail or movable point frog.

**CLASSIFICATION YARD** (See also: Hump Yard, Retarder Yard)

A yard in which cars are classified or grouped in accordance with requirements.

### **CLEAR**

Free from obstruction or other restricting feature.



**CLEAR BLOCK OR TRACK**

Unoccupied

**CLEAR SIGNAL**

The name of a signal aspect, the indication of which is defined in the operating instruction of the railroad.

**“TO CLEAR A SIGNAL”**

To permit or cause a signal to display an aspect, the indication of which is more favorable than STOP.

**CLEARANCE POINT** (See also: Fouling Point)

The location on a turnout at which the carrier's specified clearance is provided between tracks.

**CLEARANCE TRACK CIRCUIT** (See Track Circuit)**CLOSED CIRCUIT PRINCIPLE**

The principle of circuit design where a normally energized electric circuit which, on being interrupted or de-energized, will cause the controlled function to assume its most restrictive condition.

**CODE** (See also: Track Circuit, Standard Code)

The controlled pulsing of electrical energy in a line or track circuit, usually for the purpose of transmitting information. The pulses may be on/off or polarized, or both, and may also vary in duration.

**CODE LINE**

A non-vital line circuit, the principle purpose of which is to carry control and/or indication codes, such as for the supervisory control system portion of CTC.

**CODE SYSTEM** (See also: Application Unit)

The non-vital apparatus and circuits used for forming, transmitting, receiving and applying the codes of a supervisory control system.

**COMPOUND LENS** (See LENS)**COMPRESSED AIR BLOWER**

A winter switch protection device consisting of a motor-driven air compressor and a system of air jets placed along the switch points and stock rail in which sharp, intermittent blasts of highly compressed air at ambient temperature is used to blow snow from the critical zone between the stock rail and switch points.

**CONFLICTING MOVEMENTS**

Movements over conflicting routes.

**CONFLICTING ROUTES**

Two or more routes, opposing, converging, or intersecting, over which movements cannot be made simultaneously without possibility of collision.

**CONNECTING ROD** (See Switch Connecting Rod, Switch Rod)



**CONSOLE** (See Also: Machine)

An assemblage of manually operated levers or other devices for the control of signals, switches or other units, without mechanical interlocking, usually including a track diagram with indication lights.

**CONSTANT WARNING TIME DEVICE** (See also: Motion Sensitive Device)

A device used as a part of a highway grade crossing warning system to provide a relatively uniform warning time.

**CONTACT**

A conducting part which co-acts with another conducting part to open or close an electric circuit.

**BACK**

A part of a relay against which, when the relay is de-energized, the current carrying portion of the movable neutral member rests so as to form a continuous path for current.

**CLOSED**

A current-carrying member which is closed when the operating unit is in the normal position.

**DEPENDENT**

A contacting member designed to complete any one of two or three circuits, depending on whether a two or three-way device is considered.

**FRONT**

A part of a relay against which, when the relay is energized, the current-carrying portion of the movable neutral member is held so as to form a continuous path for current.

**HEEL** (See Dependent)**INDEPENDENT**

A contacting member designed to complete one circuit only.

**MAGNETIC BLOW OUT**

A contact which is fitted with a special device, such as a permanent magnet, to aid the interruption of any arc that is drawn upon contact Opening.

**NORMAL**

A term used to designate a current-carrying member when the operated unit is in the normal position.

**OPEN**

A current-carrying member which is open when the operating unit is in the normal position.

**POLAR**

A part of a relay against which the current-carrying portion of the movable polar member is held so as to form a continuous path for current.

**REVERSE**

A term used to designate a current-carrying member when the operated unit is in the reverse position.

**CONTACT RESISTANCE**

The resistance produced by the contact of two surfaces.

**CONTINUOUS CONTROL** (Cab Signal, Train Control, etc.) (See also: Intermittent Control)

A type of control in which the locomotive apparatus is constantly in operative relation with the track elements and is immediately responsive to a change of conditions in the controlling section which affects train movement.

**CONTROLLED POINT**

A location where signals or other functions or both of a traffic control system are controlled from the control machine.

**CONTROLLED SIDING** (See Siding)**COUPLER** (See Movable Bridge Coupler)**CROSSING SIGNS** (Also referred to as Crossbucks) See Highway Grade Crossing Sign.**CROSSING WARNING DEVICE** (See Highway Grade Crossing Warning Device, Highway Grade Crossing Signal)**CROSSOVER**

Two turnouts with the track between the frogs arranged to form a continuous passage between two nearby and generally parallel tracks.

**CTC**

Centralized Traffic Control.

**CUT-SECTION**

A location other than a signal location where two adjoining track circuits end within a block.

**-D-****DARK TERRITORY**

Non-signaled territory. (Colloquial)

**DEAD SECTION**

A section of track, either within a track circuit or between two track circuits, the rails of which are not part of a track circuit.

**DE-ENERGIZED POSITION**

The position assumed by the moving member of an electromagnetic device when the device is deprived of its operating current.

**DERAIL**

A device designed to cause rolling equipment to leave the rails.

**DETECTOR** (See also: Defect Detector)



**HIGH WATER**

**MOTION** (See Motion Sensitive Device)

**PRESENCE****SLIDE****WHEEL****HIGH-WIDE LOAD** (Clearance)

A device capable of detecting excessive heights or widths on a passing train with respect to accepted track structure clearances.

**HOT WHEEL**

A device capable of detecting abnormal heat in wheels on passing trains, generally caused by sticking brakes or set hand brakes.

**LOOSE WHEEL**

A device capable of detecting excessive lateral wheel movement on passing trains.

**OVERHEATED JOURNAL** (Hot Box)

A device capable of detecting abnormal heating in journal bearings on passing trains.

**DETECTOR LOCKING** (See Electric Locking)

**DETECTOR TRACK CIRCUIT** (See Track Circuit)

**DOUBLE BREAK**

A term used to describe the method of design in which both the positive and negative wires to the controlled device is opened by contacts of controlling device(s).

**DROP-AWAY**

The point at which all front contacts first open.

**DUAL CONTROL** (See also: Switch, Semi-Automatic Control)

A term applied to signal appliances provided with two authorized methods of operation.

**DWARF SIGNAL** (See Signal)

**DYNAMIC BRAKING** (See also: Brake Application)

A method of braking in which the motor is used as a generator and the kinetic energy of the apparatus is employed as the actuating means of exciting a retarding force.

**-E-****ELECTRIC LOCKING**

The combination of one or more electric locks and controlling circuits by means of which levers of an interlocking machine are locked, or the equivalent using circuits only, so that switches, signals, or other units operated in connection with signaling and interlocking, are secured against Operation under certain conditions.

## **APPROACH**

Electric locking effective while a train is approaching, within a specified distance, a signal displaying an aspect to proceed, and which prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the movement of any interlocked or electrically locked switch, movable point frog, or derail in the route governed by the signal, and which prevents an aspect to proceed from being displayed for any conflicting route.

## **DETECTOR LOCKING**

A method of locking which is effective when the detector track circuit (OS) is occupied. Detector Locking prevents the operation of any power operated switch, movable point frog or derail and the display of any signal indication more favorable than "Proceed at Restricted Speed" within the limits of the detector track circuit. Detector Locking is also referred to as Section Locking.

## **INDICATION LOCKING**

Electric locking which prevents manipulation of levers that would result in an unsafe condition for a train movement if a signal, switch, or other operative unit fails to make a movement corresponding to that of its controlling lever, or which directly prevents the operation of a signal, switch, or other operative unit, in case another unit which should operate first fails to make the required movement.

## **ROUTE** (See also: Sectional Release)

Electric locking, effective when a train passes a signal displaying an aspect for it to proceed, which prevents the movement of any switch, movable point frog, or derail in advance of the train within the route entered. It may be so arranged that as a train clears a track section of the route, the locking affecting that section is released.

## **SECTION**

Electric locking effective while a train occupies a given section of a route and adapted to prevent manipulation of levers that would endanger the train while it is within that section.

## **TIME**

A method of locking, either mechanical or electrical, which, after a signal has been caused to display an aspect to proceed, prevents, until after the expiration of a predetermined time interval after such signal has been caused to display its most restrictive aspect, the operation of any interlocked or electrically locked switch, movable point frog, or derail in the route governed by that signal, and which prevents an aspect to proceed from being displayed for any conflicting route.

## **TRAFFIC** (See also: Movable Bridge Locking)

Electric Locking which prevents the manipulation of levers or other devices for changing the direction of traffic into a section of track on which a route is lined, occupied, or locked.

## **ELECTRIC SWITCH LOCK** (See Lock)



**ELECTROPNEUMATIC RELAY**

A relay, the contacts of which are operated by air pressure.

**ELECTROPNEUMATIC SWITCH**

A track switch operated by an electro-pneumatic switch-and-lock movement.

**ELECTROPNEUMATIC VALVE**

A valve electrically operated which, when operated, will permit or prevent passage of air.

**ENGINE**

A unit propelled by any form of energy or a combination of such units operated from a single control, used in train or yard service.

**EP**

Electro pneumatic

**-F-****FACING POINT SWITCH**

A track switch, the points of which face traffic approaching in the direction for which the track is signaled.

**FAIL SAFE** (See also: Vital Circuit)

A term used to designate a railway signaling design principle, the objective of which is to eliminate the hazardous effects of a failure of a component or system.

**FALSE ACTIVATION**

Activation of the highway-railroad grade crossing warning system in response to a condition which requires correction or repair of the warning system, either in the control or track circuit. This is a safe failure of the system, in that it provides notice of warning as is required by fail-safe design techniques.

**FALSE PROCEED** (False Clear)

A failure of a system, device or appliance to indicate or function as intended which results in less restriction than is required.

**FIELD BLOCKING** (See also: Office Blocking)

Blocking which makes use of a vital relay located at the controlled point or remote controlled interlocking.

**FIXED SIGNAL** (See Signal)**FLASHER** (See Relay)**FLASHING LIGHT SIGNAL** (See Signal)**FLEETING**

A facility which provides for automatic clearing of controlled signals in one direction for successive trains.

**FOULING POINT** (See also: Clearance Point)

The location on a turnout back of the frog at which insulated joints or derails are placed at or beyond clearance point.

**FRA**

Federal Railroad Administration

**FROG**

A track structure used at the intersection of two running rails to provide support for wheels and passageways for their flanges, thus permitting wheels on either rail to cross the other.

**MOVABLE POINT**

A frog equipped with points which are movable in the same manner as the points of a switch.

**FRONT CONTACT** (See Contact)**FRONT ROD**

A rod connecting the points of a switch or movable point frog, by means of which the relative location of the points is maintained and to which the lock rod is attached.

**-G-****GAUGE** (of Track)

The distance between the gauge lines, measured at right angles thereto. (The standard gauge is 4 ft. 8-1/2 in.)

**GAUGE PLATE**

A metal plate, extending from rail to rail, used to maintain gauge of track.

**GATE:** (See Highway Grade Crossing Gate)**GRADE CROSSING** (See Highway Grade Crossing, Railroad Grade Crossing)**-H-****HAND OPERATED SWITCH**

A non-interlocked switch which can only be operated manually.

**HEAD BLOCK SIGNAL**

A home signal governing entrance into the block between sidings on single track.

**HEEL CONTACT** (See Contact)**HIGHWAY GRADE CROSSING**

An intersection of a highway with a railroad track at the same elevation.

**HIGHWAY GRADE CROSSING GATE**

A device which forms part of a Highway Grade Crossing Warning System that provides a visual warning and restricts access to the intersection of a Highway Grade Crossing.



**HIGHWAY GRADE CROSSING SIGN (CROSSBUCKS)**

A sign located at the intersection of a railroad-highway crossing at grade to warn highway traffic of the intersection.

**HIGHWAY GRADE CROSSING SIGNAL (See also: Signal (Application, Flashing-Light))**

That part of a Highway Grade Crossing Warning System used at the crossing that provides the visual warning to highway traffic.

**HIGHWAY GRADE CROSSING WARNING DEVICE (See Bell, Gate, Signal)****HIGHWAY GRADE CROSSING WARNING SYSTEM**

An interconnection of various devices and their controls used to indicate the approach and/or presence of a train at a highway grade crossing.

**HIGH VELOCITY SNOW BLOWER**

A winter switch protection device consisting of a motor-driven blower and a system of air ducts and nozzles placed along the switch points and stock rail in which a high velocity stream of air at ambient temperature is used to blow snow away from the critical areas of the track switch. Air distribution configuration may be of a "Horizontal Air Curtain" (HAC), or "Point End Nozzle (PEN) designs, or combinations thereof.

**HOLD CLEAR**

A term used to designate a device for holding a signal in any position other than its most restrictive.

**HOME SIGNAL (See Signal)****HOT AIR BLOWER SNOW MELTER (SNOW MELTER)**

A winter switch protection device consisting of a heat source, motor-driven blower and a system of air ducts and nozzles placed along the switch points and stock rail in which forced hot air is used to raise the temperature of the steel and surrounding air to melt snow and to evaporate moisture. May be of the combustion burner (oil or gas) or electric heating element designs.

**HOT BOX DETECTOR (See Detector)****HOUSING****HUMP (See Hump Yard)****HUMP SIGNAL CONTROLLER**

A device located at the hump which includes the hump signal control lever and may also include the trimmer signal control lever and signal indication lights.

**HUMP SPEED CONTROL (See also: Humping Speed)**

A system to provide the hump engine with information on the requested humping speed. This is displayed to the engine man and may also be directly interfaced to the locomotive controls.

**HUMP YARD** (See also: Classification Yard, Retarder Yard)

A railroad classification yard in which the classification of cars is accomplished by pushing them over a summit, known as a hump, beyond which they run by gravity and are switched into selected tracks.

**HUMPING SPEED**

The rate at which cars are pushed over the apex of hump for classification.

**-I-**

**ICC** (See also: FRA)

Interstate Commerce Commission

**ICEA**

Insulated Cable Engineers Association

**IEEE**

Institute of Electrical and Electronics Engineers

**IMPEDANCE BOND**

An iron core coil of low resistance and relatively high reactance, used on electrified railroad to provide a continuous path for the return propulsion current around insulated joints and to confine the alternating current signaling energy to its own track circuit.

**IN ADVANCE OF A SIGNAL**

A term used in defining the territory beyond a signal as seen from an approaching train.

**IN APPROACH OF A SIGNAL**

A term used in defining the territory to which a signal indication is conveyed.

**IN REAR OF A SIGNAL** (See In Approach of a Signal)

**INDICATION** (Signal)

The information conveyed by the aspect of a signal.

**INDICATION LOCKING** (See Electrical Locking)

**INDUCTOR** (Train Control) (See Roadway Element)

**INSULATED RAIL JOINT** (See also: Effective Joint)

A joint in which electrical insulation is provided between adjoining rails.

**INSULATION RESISTANCE**

The resistance offered by the insulation on any current-carrying part or conductor.

**INTERLOCKING**

An arrangement of signals interconnected that their interlocking limits, the control of other functions of the and signal appliances so movements must succeed each other in proper sequence and for which interlocking rules are in effect. It may be operated manually or automatically.



**AUTOMATIC**

An arrangement of signals, with or without other signal appliances, which functions through the exercise of inherent powers as distinguished from those whose functions are controlled manually, and which are so interconnected by means of electric circuits that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication.

**MANUAL**

An arrangement of signals and signal appliances operated from an interlocking machine and so interconnected by means of mechanical and/or electric locking that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication.

**INTERLOCKING LIMITS**

The tracks between the extreme opposing home signals of an interlocking.

**INTERLOCKING SIGNALS**

The fixed signals of an interlocking.

**INTERLOCKING STATION** (See Station)**INTERMITTENT CONTROL** (Cab Signal, Train Control, etc.) (See Continuous Control)

A type of control in which the locomotive apparatus is affected only at certain designated points, usually at signal locations.

**IRSE**

Institution of Railway Signal Engineers

**-L-****LEAKAGE CURRENT**

A stray electric current of relatively small value which flows through or across the surface of insulation when a voltage is impressed across the insulation.

**BALLAST**

The leakage current from one rail of a track circuit to the other through the ballast, ties, etc.

**LEAVE SIDING INDICATOR** (See also: Take Siding Indicator) An indicator used to convey instruction for a train to leave siding.

**LIGHTNING PROTECTION** (See Protection)**LINE CIRCUIT**

A term applied to signal circuit on an overhead or underground line.

**LOCK ELECTRIC** (See also: Electric Locking)

A device to prevent or restrict the movement of a lever, a switch, or a movable bridge, unless the locking member is withdrawn by an electrical device, such as an electromagnet, solenoid, or motor.

**ELECTRIC (Movable Bridge)**

An electric lock used in connection with a movable bridge to prevent its operation until released.

**ELECTRIC SWITCH**

An electric lock connected with a switch or switch movement to prevent its operation until released.

**FACING POINT**

A mechanical lock for a switch, derail or movable point frog, comprising a plunger stand and a plunger which engages a lock rod attached to the switch point to lock the operated unit.

**FORCED DROP**

An electric lock in which the locking member is mechanically forced down to the locked position.

**MOVABLE BRIDGE**

A device used to insure that a movable bridge is in proper position for the movement of trains.

**RAIL (Movable Bridge)**

A mechanical device used to insure that the movable bridge rails are in proper position for the movement of trains.

**LOCK ROD**

A rod, attached to the front rod or lug, through which a locking plunger may extend when the points or derail are in the normal or reverse position.

**LOCK ROD (FRA) (See also: Switch Connecting Rod)**

A rod, attached to the front rod or lug of a switch, movable point frog or derail, through which a locking plunger may extend when the switch points or derail are in the normal or reverse position.

**LOWER-QUADRANT**

One of the quarters of a vertical circle below its horizontal axis.

**LOWER QUADRANT ASPECT (See Upper Quadrant Aspect)****LUNAR WHITE**

One of the standard colors used in railroad signaling

**-M-****MACHINE (See Control, Interlocking, Switch)****CONTROL (See Console)****INTERLOCKING**

An assemblage of manually operated levers or equivalent devices, for the control of signals, switches or other units, and including mechanical or circuit locking or both to establish proper sequence of movements.



**SWITCH** (See Yard Switch Machine)

**MAIN TRACK**

A track, other than an auxiliary track, extending through yards and between stations, upon which trains are operated timetable or train order, or both, or the use of which is governed by block signals.

**MAIN TRACK (FRA)**

A track, other than auxiliary track, extending through yards and between stations, upon which trains are operated by timetable or train orders, or both, or the use of which is governed by block signals.

**MANUAL BLOCK SIGNAL SYSTEM**

A block or a series of consecutive blocks, governed by block signals operated manually, upon information by telegraph, telephone or other means of communication.

**MARKER LIGHT**

A light which by its color or position, or both, qualifies the signal aspect.

**MAST** (See also: Signal Mast)

**BRACKET**

A signal mast for mounting on the crosspiece of a bracket post.

**BRIDGE** (or Cantilever)

**GROUND**

A signal mast for mounting on a foundation at or near the track level.

**MECHANISM**

A term used for any mechanical or power-operated device for operating a signal or interlocking unit.

**MOTION SENSITIVE DEVICE**

A device used to sense the presence, motion and direction of travel of a train. A device used to detect the movement of a train.

**MOVABLE BRIDGE**

That section of a structure bridging a navigable waterway so designed that it may be displaced to permit passage of traffic on the waterway.

**MOVABLE BRIDGE COUPLER** (See also: Circuit Controller)

A device for engaging and disengaging signal or interlocking connections between the shore and movable bridge span.

**MOVABLE BRIDGE LOCKING**

The rail locks, bridge locks, bolt locks, circuit controllers, and electric locks used in providing interlocking protection at a movable bridge.

**MOVABLE POINT FROG** (See Frog)

**MPF**

Movable point frog.

**MUTCD**

Manual on Uniform Traffic Control Devices.

**-N-****NBS**

National Bureau of Standards.

**NEC**

National Electrical Code.

**NEMA**

National Electrical Manufacturers Association.

**NESC**

National Electrical Safety Code.

**NON-VITAL-CIRCUIT**

Any circuit the function of which does not affect the safety of train operation.

**NORMAL CLEAR** (or Stop) (See Automatic Block Signal System)

**NORMAL POSITION** (See also: REVERSE POSITION)

The position in which signal and other devices are assumed to normally lie, according to rule, convention or otherwise, i.e., Stop aspect displayed, switch set for main track devices energized or de-energized, etc.

**NUMBER PLATE**

A device fastened to signal apparatus for the purpose of identification.

**-O-**

**OFFICE BLOCKING** (Sometimes called MACHINE BLOCKING)

**OPEN WIRE LINE**

An overhead wire line consisting of single conductors as opposed to multiple-conductor cables.

**OPERATING CHARACTERISTICS** (Electrical Apparatus)

The measure of the electrical values at which the apparatus operates. (Drop-away, pick-up, working value, etc.)

**OPERATING ROD**

The rod by means of which motion is transmitted to apparatus. (See also: Switch Adjustment Bracket, Switch Connecting Rod)

**OPERATOR** (See Control Operator)

**OPPOSING SIGNALS**

Roadway signals which govern movements in opposite directions on the same track.



**OPPOSING TRAIN**

A train, the movement of which is in a direction opposite to and toward another train on the same track

**OUTLYING SWITCH**

A switch not included in a nearby interlocking or controlled point. It is not necessarily under the control of the operator or dispatcher.

**OVERLAP**

The distance the control of one signal extends into the territory which another signal, or signals, governs.

**OVERLAP BLOCK SIGNAL SYSTEM**

A block signal system in which the control of a signal, or signals, extends into the territory which another signal, or signals, governs, so that one or more opposing signals display an aspect indicating Stop.

**OVERTHROW**

Excess stroke of a switch operating rod.

**-P-**

**PERMISSIVE** (See Block)

**PHANTOM ASPECT**

An aspect displayed by a light signal, different from the aspect intended, caused by a light from an external source being reflected by the optical system of the signal.

**PICK PATH**

The portion of a circuit used to initially energize a relay coil.

**PICK-UP VALUE** (See also: Working Value)

The electrical value, when applied to an electromagnetic instrument, will cause the moving member to move to the position which will just close the front contacts or visually indicate its energized position.

**PINNACLE**

A casting which is placed on top of a mast or post.

**PIPE LINE****AIR**

A pipe line installed for the purpose of conducting compressed air.

**MECHANICAL**

A connection made with pipe with its supporting apparatus from the operating lever to the operated unit.

**PIPE PLUG**

A short section of rod, which is inserted in and riveted to the contiguous ends of pipe in a pipe line.

**PIPE ROLLER** (See also: Pipe Carrier)

A device for eliminating friction in a pipe line.

**PLUNGER**(Facing Point Lock)

That part of a facing point lock which secures the lock rod to the plunger stand when the switch is locked.

**POINT DETECTOR** (See also: Circuit Controller, Switch Connecting Rod)

A circuit controller which is part of the switch operating mechanism and operated by a rod connected to a switch, derail or movable point frog to indicate that the point is within a specified distance of the stock rail.

**POINT DETECTOR ROD** (See Switch Connecting Rod, Switch Rod)

**POINT LUG** (See also: Switch Point Lug)

A lug bolted to the web of a switch point rail, to which the switch circuit controller rod is attached.

**POLARIZED CIRCUIT**

A path in which the direction of flow of an electric current is reversed under certain conditions.

**POLE CHANGER**

A device by which the direction of current flow in an electrical circuit may be changed.

**POWER-OPERATED SWITCH** (See Switch)

**PRECONDITION**

To store information which will be acted on by an anticipated movement to cause a device or devices to function in a predetermined manner.

**-Q-**

**QUADRANT** (See Upper Quadrant, Lower Quadrant)

**-R-**

**RAILROAD GRADE CROSSING**

An intersection of two or more railroad tracks at the same elevation.

**REACTOR**

An electro-magnetic device, the primary purpose of which is to introduce inductive reactance into a circuit.

**RECEIVER** (Train Control, Cab Signal, etc.)

A device on a locomotive, so placed that it is in position to be influenced inductively or actuated by an automatic train stop, train control, or cab signal roadway element.

**RECTIFIER** (See battery charger or diode).



## **RELAY**

### **BIASED (Biased Neutral)**

A relay which will operate to its energized position by current of one polarity only, and will return to its de-energized position when current is removed.

### **CENTRIFUGAL**

An alternating current frequency selective relay in which the contacts are operated by a fly ball governor or centrifuge driven by an induction motor.

### **CODE FOLLOWING**

A relay which will follow or reproduce a code without distortion within practical limits.

### **DIFFERENTIAL**

A relay having windings operating in opposition.

### **DOUBLE-WINDING**

A relay having two separate windings.

### **FLASHER**

A relay so designed that, when energized, its contacts open and close at predetermined intervals.

### **FREQUENCY**

A relay designed to respond to alternating current of a predetermined frequency.

### **LIGHT OUT**

### **LINE**

A relay receiving its operating energy through conductors of which the track rails form no part.

### **MAGNETIC STICK**

A relay, the armature of which remains at full stroke in its last energized position when its control circuit is opened.

### **MOTOR TYPE**

A relay which operates on the principle of a motor.

### **NEUTRAL**

A relay which operates in response to a predetermined change of the current in the controlling circuit, irrespective of the direction of the current.

### **OVERLOAD**

A relay which operates to open contacts when the current through its control coils exceeds a predetermined value.

### **POLAR**

A relay which operates in response to a change in the direction of current in its controlling circuit and the armature of which may or may not remain at full stroke when its control circuit is interrupted.

**POLARIZED**

A neutral relay equipped with polar armatures and contacts.

**POLYPHASE**

An alternating current relay having two or more windings, operating on an induction motor principle, all windings of which must be properly energized.

**POWER**

A relay which functions at a predetermined value of the power.

**POWER TRANSFER**

A relay so connected to the normal source of power supply that the failure of such source of power supply causes the load to be transferred to another source of power

**QUICK DROP-AWAY**

A relay which, when the controlling circuit is opened or completely shunted, will release quicker than an ordinary relay.

**QUICK PICK-UP**

A relay which, when energy is applied, will pick up quicker than an ordinary relay.

**RETAINED NEUTRAL**

A neutral relay, the armature of which is retained in the energized position for a predetermined interval of open circuit during the reversal of current in the control coils.

**RETAINED NEUTRAL POLARIZED**

A polarized relay, the neutral armature of which is retained in the energized position for a predetermined interval of open circuit during the reversal of current in the control coils.

**SINGLE-ELEMENT**

A relay, usually alternating current, having a single winding.

**SINGLE-WINDING**

A relay having a single winding.

**SLOW DROP-AWAY (or Slow Release)**

A relay which, when the controlling circuit is opened or completely shunted, will release slower than an ordinary relay.

**SLOW PICK-UP**

A relay which, when energy is applied, will pick up slower than an ordinary relay.

**THERMAL**

A timing relay whose contacts are actuated by the heating effect of current flowing through its controlling element.

**THREE-POSITION**

A relay which operates in three positions.



**TIMING** (or Time Element, of Timer) (See also: Timer)

A relay which will not close its front contacts or open its back contacts, or both, until the expiration of definite time interval after the relay has been energized.

**TRACK**

A relay receiving all or part of its operating energy through conductors of which the track rails are an essential part.

**TRANSFORMER**

A relay in which the coils act as a transformer.

**TRIPLE-WINDING**

A relay having three separate windings.

**TWO-ELEMENT**

A relay, usually alternating current, having two separate windings, both of which must be properly energized to cause the relay to operate.

**TWO-POSITION**

A relay which operates in two positions.

**VANE TYPE**

A type of alternating current relay in which a light metal disc or vane moves in response to a change of the current in the controlling circuit.

**VITAL**

**VOLTAGE**

A relay which functions at a predetermined value of the voltage.

**RELAY CUT SECTION** (See Cut-Section)

**RELAY TYPE INTERLOCKING**

An arrangement of signals, with or without other signal appliances, operated either from a control machine or automatically, and interconnected by means of electric circuits employing relays so that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication.

**RELEASE VALUE**

The electrical value at which the movable member of an electromagnetic device will move to its de-energized position.

**REPEATER**

A device conveying information as to the condition of an operated unit.

**RESET DEVICE** (Train Control)

A device whereby the brakes may be released after an automatic train control brake application.

**RESTORING FEATURE**

An arrangement on a power-operated switch movement by means of which power is applied to restore the switch movement to full normal or to full reverse position, before the driving bar creeps sufficiently to unlock the switch with control lever in normal or reverse position.

**RETARDER**

A braking device built into a railway track to reduce the speed of cars. This can be done by means of brake shoes which, when set in position, press against the sides of the lower portions of the wheels.

**GROUP**

A retarder which is so located that it is the last retarder the cars pass through before going into a single group of classification tracks.

**INERT**

A non-powered non-releasable retardation device.

**INTERMEDIATE**

A retarder which is located between master or hump retarder and group retarder.

**MASTER**

A retarder or retarders located between the apex of the hump and the master switch or switches in a classification yard, and used specifically for car speed control.

**PULLER**

A small retarder on the classification track side of the apex of a hump used to gather slack between cars to facilitate the uncoupling operation.

**SKATE**

An inert or weight responsive retarder at the pullout end of the classification tracks to prevent humped cars from fouling the pullout track.

**TANGENT POINT**

A retarder located beyond tangent point at the entering end of classification tracks.

**WEIGHT RESPONSIVE**

A retarder which applies braking pressure proportional to the weight of the car.

**RETARDER BRAKE SHOE**

The expendable wearing part of a car retarder for applying braking pressure to car wheels.

**RETARDER CONTROL SYSTEM**

A system designed to control car movements, comprising car retarders together with such yard switch machines, skate machines, hump signals, trimmer signals and necessary control facilities as may be required.

**REVERSE POSITION** (See also: Normal Position)

The opposite to normal position

**ROD** (See Point Detector Rod, Switch Connecting Rod, Switch Rod)



**ROUNDEL** (See also: Lens)

A glass or similar product used in lens or reflector assemblies for spreading or deflecting, and/or coloring, the projected light beam into a pattern, dependent on the design.

**DEFLECTING**

**SPREAD**

**ROUTE** (See also: Conflicting Routes)

The course or way which is, or is to be, traveled.

**ROUTE LOCKING** (See Electric Locking)

**ROUTE SELECTION** (Automatic Switching for Classification Yards)

Term is applied to a desired track destination established for an individual cut of cars by operation of a push button or other selective device.

**RS&I**

Rules Standards and Instructions of Federal Railroad Administration.

**-S-**

**SAFE**

The condition of a system, device or appliance that results in an indication or function equal to or more restrictive than is intended.

**SECTION LOCKING** (See Electric Locking)

**SECTIONAL RELEASE**

A type of route locking in which directional stick relays unlock the route in sections. The purpose is to release switches or other devices in the route after the rear of a train movement has cleared them.

**SECTIONALIZING SWITCH**

A switch for disconnecting a section of an electrical circuit from the source of energy.

**SEMAPHORE SIGNAL**

A signal in which the day indications are given by the position of a semaphore arm.

**SEMI-AUTOMATIC CONTROL** (See also: Dual Control)

A control which is operated both manually and automatically.

**SHOE** (See Retarder Brake Shoe)

**SHUNT** (See also: Train Shunt Resistance, Switch Shunting Circuit)

A by-path in an electrical circuit.

**SHUNT WIRE**

A wire forming part of a shunt circuit.

**SHUNTING SENSITIVITY** (See also: Train Shunt Resistance)

Shunting sensitivity of a track circuit is:

### **1. NON-CODED TRACK CIRCUIT**

The maximum resistance in ohms which will cause the relay contacts to open when this resistance is placed between the rails at the most adverse shunting location.

### **2. CODED TRACK CIRCUIT**

The maximum resistance in ohms which will prevent the code responsive track relay from following the code when this resistance is placed between the rails at the most adverse shunting location.

**SIDE LIGHT** (See Back Light)

### **SIDING**

An auxiliary track for meeting or passing trains.

**SIGNAL** (See Disc Signal, Semaphore Signal, Slotted Mechanical Signal, Smashboard Signal, Wig-Wag Signal) (Historical)

**SIGNAL (Application)** (See also: Interlocking Signals)

### **ABSOLUTE**

A signal of an automatic block signal system that is capable of displaying "Stop" as opposed to "Stop and Proceed."

### **APPROACH**

A fixed signal used in connection with one or more signals to govern the approach thereto.

### **BLOCK**

A fixed signal at the entrance of a block to govern trains and engines entering and using that block.

### **CAB**

A signal located in engine control compartment or cab indicating a condition affecting the movement of train or engine and used in conjunction with interlocking signals and in conjunction with or in lieu of block signals.

### **DISTANT**

A signal of fixed location indicating a condition affecting the movement of a train or engine.

### **FIXED**

A signal of fixed location indicating a condition affecting the movement of a train or engine.

**GATE** (See Highway Grade Crossing Gate)

### **HEAD BLOCK**

### **HIGHWAY GRADE CROSSING**

An electrically operated signal used for the warning of highway traffic at railroad-highway grade crossings.



**HOLDING**

A fixed signal at the entrance of a route or block to govern trains or engines entering and using that route or block.

**HOME**

A fixed signal at the entrance of a route or block to govern trains or engines entering and using that route or block.

**HUMP**

A signal located near the summit in a hump yard which gives indication concerning movement to the classification tracks and indicates to the engine man the desired direction and speed of movement of his train.

**INTERMEDIATE****PERMISSIVE**

A signal on which the most restrictive aspect is Stop and Proceed, or Restricting.

**TRAIN ORDER**

A signal used to indicate to a train whether or not it will receive orders.

**TRIMMER** (or trim)

A signal located, near the summit in a hump yard, which gives indication concerning movements from the classification tracks toward the summit.

(See also: Interlocking Signals)

**SIGNAL (Method of Control)****AUTOMATIC**

A signal controlled automatically.

**NON-AUTOMATIC**

A signal controlled manually.

**NON-STICK****SEMI-AUTOMATIC**

A signal which is controlled both manually and automatically.

**STICK** (Semi-Automatic)

A signal so controlled that after automatically displaying a Stop aspect it will not again clear until its control lever is restored to normal and then to reverse, or until the control operator has performed other prescribed actions to permit a following train to proceed.

**SIGNAL (Types & Arrangements)** (See also: Switch Indicator, Switch Position Indicator).

A means of conveying information.

**BRACKET**

An arrangement whereby the signals for movements in the same direction on each of two or more tracks are mounted side by side on the same ground mast, using a cross piece rather than a cantilever arm. (See also: Mast)

**COLOR LIGHT**

A fixed signal in which the indications are given by the color of a light only.

**COLOR POSITION LIGHT**

A fixed signal in which the indications are given by color and the position of two or more lights.

**DWARF**

A low home signal

**FLASHING LIGHT**

A highway grade crossing signal, the indication of which is given by two horizontal red lights flashing alternately at predetermined intervals, or a fixed signal in which the aspects are given by color and by the flashing of one or more of the signal lights.

**FOUR-POSITION**

A light signal unit arranged to provide four aspects.

**LIGHT**

A fixed signal in which the indications are displayed by the color or position of a light or lights, or both.

**POSITION LIGHT**

A fixed signal in which the indications are given by the position of two or more lights.

**POT**

A small revolving fixed signal used as a substitute for a dwarf signal.

**SEARCHLIGHT**

A type of color light signal that uses a single lamp with a single lens or lens doublet to display up to three different aspects by placing a color cone or disc between the lamp and lens. The desired color is selected by energizing an electromagnetic mechanism. The aspect displayed is dependent upon the polarity of the applied power. De-energization of the mechanism will cause the signal to display its most restrictive aspect.

**THREE POSITION**

A semaphore arm or a light signal unit arranged to provide three aspects.

**TWO-POSITION**

A semaphore arm or a light signal unit arranged to provide two aspects.

**SIGNAL MAST** (See also: Mast)

An upright support from which signals are displayed.

**SIGNALS** (See Interlocking Limits, Interlocking Signals, Opposing Signals)**SKATE** (See also: Retarder, Skate Machine)

A sliding device placed on a rail to engage with a car wheel so as to provide continuous braking by sliding friction.



**SKATE MACHINE**

A mechanism electrically controlled and electrically or pneumatically operated, for placing a skate on, or removing it from, the rail.

Switch-and-lock movement.

**SPEED** (See Humping Speed)

**SPEED** (By Rule)

**LIMITED**

A speed not exceeding \* miles per hour.

**MEDIUM**

A speed not exceeding \* miles per hour.

**REDUCED**

Proceed prepared to stop short of train or obstruction.

**RESTRICTED**

Proceed prepared to stop short of train, obstruction, or switch not properly lined looking out for broken rail, not exceeding \* miles per hour, not to exceed a speed that will permit stopping within one-half the range of vision.

**SLOW**

A speed not exceeding \* miles per hour.

**YARD**

A speed that will permit stopping within one-half the range of vision.

\*Railroads may insert in definitions where asterisk is shown, suitable speed in miles per hour not exceeding 20 mph for Restricted Speed and/or Slow Speed, 40 mph for Medium Speed and 60 mph for Limited Speed.

**SPREAD** (See Roundel)

**SPRING SWITCH**

A switch equipped with a spring mechanism arranged to restore the switch points to normal position after having been trailed through.

**SPRING SWITCH PROTECTION**

An arrangement of circuits whereby proceed aspects of a signal cannot be displayed unless the switch and its controlling lever or equivalent device are in corresponding position.

**SQUEEZE-OUT**

A term generally used in conjunction with retarders, having reference to a situation where car wheel or wheels are lifted off track and ride retarder brake shoes due to excessive pressure as related to weight of car.

**SS**

Spring Switch

**SWITCH (Track)** (See also: Facing Point Switch, Interlocked Switch, Trailing Point Switch, Turnout)

A pair of switch points with their fastenings and operating rods providing the means for establishing a route from one track to another.

**DOUBLE-SLIP**

A combination of a crossing and two connecting tracks, located within the limits of the crossing, each being made up of a right-hand switch from one track and a left-hand switch from the other track, which unite to form the respective connecting tracks without additional frogs.

**DUAL CONTROL**

A power operated switch also equipped for hand operation.

**POWER-OPERATED** (See also: DUAL CONTROL)

A switch operated by some form of energy, usually electrical or pneumatic.

**SINGLE-SLIP** (See also: Dual Control Switch)

A combination of a crossing and a single connecting track, located within the limits of the crossing, and made up of a right-hand switch from the one track and a left-hand switch from the other track, which unite to form the connecting track without additional frogs.

**SPRING**

A switch equipped with a spring mechanism arranged to restore the switch points to normal position after having been trailed through

**SWITCH ADJUSTMENT BRACKET**

A device attached to the No. 1 rod to which the operating rod is connected and which permits the adjustment of a switch, derail or movable point frog.

**SWITCH-AND-LOCK MOVEMENT** (See also: Switch Machine)

A device, the complete operation of which performs the three functions of unlocking, operating, and locking a switch, movable point frog, or derail.

**SWITCH CONNECTING ROD** (See Lock Rod, Operating Rod, Point Detector Rod)

**SWITCH HEATER**

A winter switch protection device consisting of either gas combustion burners or electric heating elements fastened directly to the stock rail or switch point in which the heaters raise the temperature of the steel to melt snow and ice. Gas combustion burners may be of the direct-flame impingement or radiant designs. Electric heating elements may be of the tubular (Cal-rod), plate or pad designs.

**SWITCH INDICATOR** (See also: Block Indicator, Switch Position Indicator)

An indicator used at a non-interlocked switch to indicate the condition of a block.

**SWITCH LOCK** (See Lock)

**SWITCH MACHINE** (See Switch, power operated; Yard Switch Machine)



**SWITCH POINT**

A movable tapered track rail, the point of which is designed to fit against the stock rail.

**SWITCH POINT LUG** (See also: Point Lug)

A device attached to a switch point to which the front, head, or switch rod may be fastened.

**SWITCH POSITION INDICATOR**

A low two aspect horizontal color light signal with electric lamps for indicating position of switch or derail.

**SWITCH ROD** (See also: Front Rod, Head Rod)

A rod connecting the two points of a switch or movable point frog, by means of which the relative distance between the points is maintained.

**SWITCH SHUNTING CIRCUIT**

A shunting circuit which is closed through contacts of a switch circuit controller.

**SWITCH TARGET**

A device mechanically actuated by a switch stand, or a switch point, to indicate the position of the switch.

**-T-****TAKE SIDING INDICATOR** (See also: Leave Siding Indicator)

An indicator generally used to convey instruction to approaching trains to take siding.

**TALKER**

A device generally used in conjunction with defect detectors to communicate a verbal message by radio to trains.

**TIME** (See Acknowledge Time, Delay Time)**TIME LOCKING** (See Electric Locking)**TIME RELEASE** (See also: Locking)

A device used to prevent the operation of an operative unit until after the expiration of a predetermined time interval after the device has been actuated.

**TIMER** (See Relay)**TRACK BLOCK**

A block into which a signal cannot be cleared.

**TRACK BLOCKING**

Track blocking is a method of preventing the clearing of any controlled signal governing movements into a block section of track.

**TRACK CIRCUIT**

An electrical circuit which uses the track rails as the conductors between a transmit and receive device, the limits of which are commonly defined by the location of insulated joints. The primary purpose of the track circuit is to detect an occupancy or interruption. It may also be used to convey information.

**AC**

A track circuit using alternating current source, generally operating at or below 200 Hz.

**AUDIO FREQUENCY**

An electronic track circuit, generally modulated, operating in the audio frequency spectrum. This type of track circuit does not require use of insulated joints to define its limits.

**CLEARANCE**

A track circuit used to detect when cars have reached or cleared a predetermined point commonly used in classification yards.

**CODED**

A track circuit in which the energy is pulsed at predetermined rates.

**DC**

A track circuit which uses a low voltage direct current source.

**DETECTOR**

A track circuit used to detect track occupancy in a specific location.

**ELECTRONIC**

A circuit which performs the functions of a track circuit using electronic devices to transmit and receive information in the form of DC or AC pulses or at AC modulated frequencies.

**HIGH LEVEL AC DC**

Generally referring to a track circuit which employs relatively high alternating current voltage on rails, low impedance energy source, and transformer-rectifier unit between rails and direct current track relay.

**ISLAND**

A short, defined track circuit with spans a highway grade crossing.

**MOTION SENSITIVE**

An audio frequency track circuit, generally operating below 1000 HZ, primarily used to activate highway grade crossing warning systems

**OVERLAY**

An electronic track circuit, generally superimposed an existing track circuit.

**PHASE SELECTIVE**

A coded track circuit using a phase selective unit.

**PRIMARY-SECONDARY**

A special arrangement of DC track relay and a repeater relay used for increasing shunting sensitivity.



**TWO ELEMENT**

An AC track circuit consisting of two inputs at the receive end. One input is received from the rails. The second input must be derived from the same source of energy as the transmit end of the track circuit.

**TYPE C (Style C)**

A track circuit which uses an alternating current source and a DC detection relay at the feed end and a diode between the rails at the far end. (Also referred to as a Style C or AC/DC/

**TRACK CIRCUIT CONNECTOR**

A device used for connecting one or more wires to a rail.

**TRACK INDICATOR** (See also: Block Indicator, Switch Indicator)

An indicator used to indicate the condition of a given track section.

**TRAFFIC CONTROL SYSTEM** (See also: Centralized Traffic Control)

A block signal system under which train movements are authorized by block signals whose indications supersede the superiority of trains for both opposing and following movements on the same track.

**TRAFFIC LEVER**

A lever, or equivalent controlling device used as a check lever, crossing lever, detector lever, master lever, route lever, also to control another lever, group of levers or functions to establish traffic direction.

**TRAFFIC LOCKING** (See Electric Locking)**TRAILING MOVEMENT**

The movement of a train over the points of a switch which face in the direction in which the train is moving.

**TRAILING POINT SWITCH**

A track switch, the points of which face away from traffic approaching in the direction for which the track is signaled.

**TRAILING RELEASE** (See Sectional Release)**TRAIN**

An engine or more than one engine coupled, with or without cars, displaying markers.

**TRAIN CONTROL SYSTEM**

A system so arranged that its operation will automatically result in the following:

- A full service application of the brakes which will continue either until the train is brought to a stop, or, under control of the engine man, its speed is reduced to a predetermined rate.
- When operating under a speed restriction, an application of the brakes when the speed of the train exceeds the predetermined rate and which will continue until the speed is reduced to that rate.

**TRAIN SHUNT RESISTANCE**

The actual resistance in ohms from rail to rail through wheels and axles of a train, engine or car. This resistance will vary with rail and wheel surface conditions and with weight of equipment.

**TRAIN STOP SYSTEM**

A system so arranged that its operation will automatically result in the application of the brakes until the train has been brought to a stop.

**TRAP CIRCUIT** (See also: Dead Section)

A term applied to a circuit used at locations where it is desirable to protect a section of track but where it is impracticable to maintain a track circuit.

**TRIP**

The movement of an engine over all or any portion of automatic train stop, train control, or cab signal territory between the terminals for that engine; a movement in one direction.

**TRIP STOP** (See Roadway Element)**TURNOUT** (See also: Switch)

An arrangement of a switch and a frog with closure rails by means of which rolling stock may be diverted from one track to another.

**-U-****UNGROUNDING CIRCUIT** (See Floating Circuit)**UNSAFE**

The condition of a system, device or appliance that results in an indication or function less restrictive than is intended.

**UPPER-QUADRANT**

One of the quarters of a vertical circle above its horizontal axis.

**UPPER QUADRANT ASPECT** (See also: Lower Quadrant Aspect)**-V-****VALUE** (See Pick-up Value, Release Value, Working Value)**VITAL CIRCUIT** (See also: Fail Safe)

Any circuit the function of which affects the safety of train operation.

**VITAL RELAY**

A relay, meeting certain stringent specifications, so designed that the probability of its failing to return to the prescribed state upon de-energization is so low as to be considered practically nonexistent.

**-W-****WHEEL DETECTOR** (See also: Axle Counter)

A device capable of detecting the presence or passage of a wheel.



**WYE TRACK**

(See also: YARD Classification Yard, Hump Yard) A system of tracks within defined limits provided for the making up of trains, storing of cars and other purposes, over which movements not authorized by timetable, or by train order, may be made, subject to prescribed signals and rules,

or special instruction.

**-Y-**

**YARD SWITCH MACHINE**

A quick acting device electrically controlled and electrically or pneumatically operated, for positioning track switch points, and so arranged that accidental trailing of the switch points does not cause damage.

