

Signal Indications Direct Trains on the Paducah & Illinois

Entire railroad, involving five junctions and bridge over the Ohio river, included in dispatcher-controlled system

By J. H. Schubert

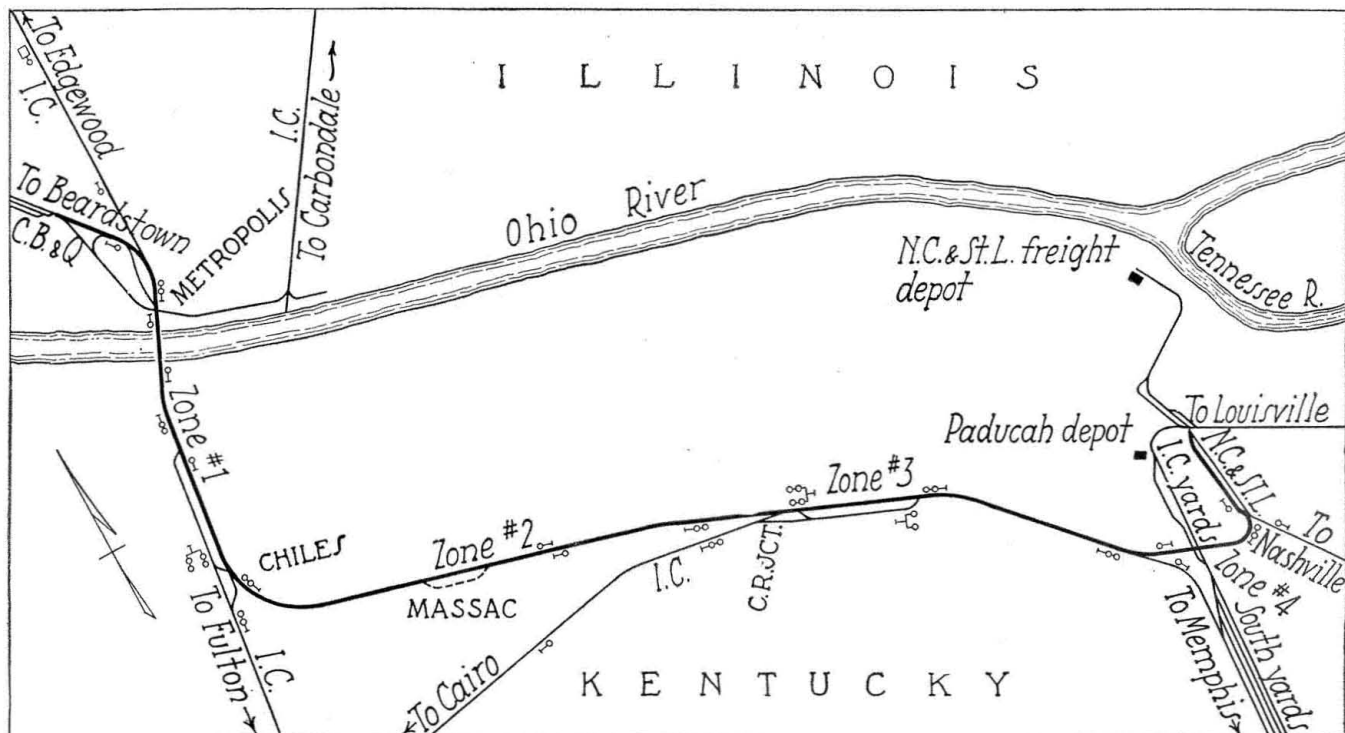
Signal Engineer, Nashville, Chattanooga & St. Louis

THE Paducah & Illinois has recently placed in service an installation of the Union Switch & Signal Company's dispatcher-controlled signal system by means of which train movements are directed by signal indication on the entire railroad, which includes about 15 miles of single-track line involving a bridge over the Ohio river and five junctions with the several roads which use this bridge. The Paducah & Illinois, owned jointly by the Nashville, Chattanooga & St. Louis, Chicago, Burlington & Quincy, and Illinois Central, was organized to construct and operate the bridge across the Ohio river at Metropolis, Ill., as well as the connections with the existing lines at Metropolis and Paducah, Ky. The bridge over the Ohio river, as well as the piers, wing walls, etc., for the smaller bridges, were all constructed for two main tracks, however, only the one track was laid, and the line is operated as single track. The P. & I. property extends from the junction switches of the Illinois Central and the Burlington, just north of the station at Metropolis, to

At CR Junction looking west

Paducah, about 15 miles, and is maintained by the N. C. & St. L., which has jurisdiction over the operation, although the trains of the other roads operate over this territory.

In tonnage, the most important single commodity handled over the P. & I. is coal from the Western Kentucky fields, while diversified manufactured and agricultural products also form an important percentage of the traffic. Four passenger trains, and from 40 to 60 freight trains are being operated over the bridge daily, and this number is to be increased fol-



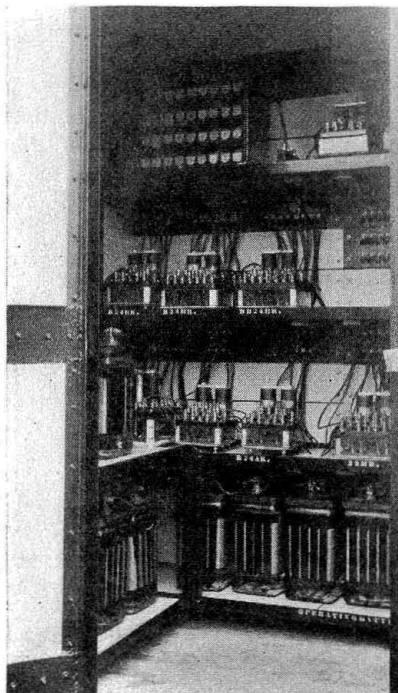
Map of the P. & I. showing the zone limits and signals

lowing a rearrangement of schedules and rerouting of through traffic over this bridge, which forms an important link in the new cut-off of the I. C. from Edgewood, Ill., to Fulton, Ky.

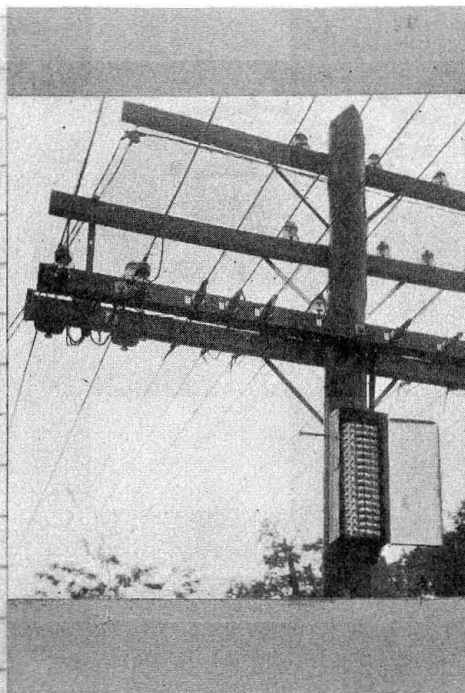
The Operating Problem

The direction of trains was handled previously by time table, train orders and a manual block with an absolute staff system, the staff being used between Metropolis and Chiles, which territory includes the bridge. The dispatcher was located at Bruceton, Tenn., and he also handled the dispatching of trains

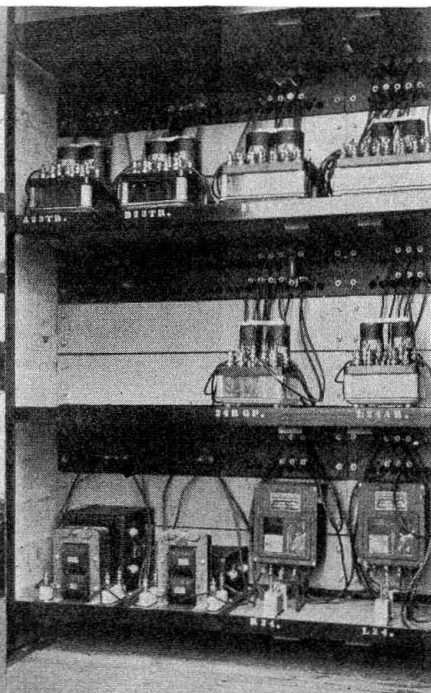
Under the old track layout, a train approaching a junction for movement over any route, blocked any movement over the same route from the opposite direction. As a result, almost all movements, particularly those between Metropolis, and Chiles, depended so much on the line-up of trains moving on the lines beyond the P. & I. property, that it was indeed difficult to prevent serious delays. Therefore, as a part of the new improvement, passing tracks were constructed at "CR" Junction and Chiles, and these are so located (as shown on the plan), that they can be used for the several routes involved, thus facilitating



Interior of one end of an instrument house



The arresters are located in a box on the pole



Interior of the other end of an instrument house

on the Paducah & Memphis division of the N. C. & St. L. Some of the trains were operated between Metropolis and Chiles, others between Metropolis and Paducah, while still others ran between Paducah and "CR" Junction, between "CR" Junction and South Yard, or between Paducah and Metropolis. Difficulty in securing information as to the exact time of the arrival of trains at the different junctions, as well as the routes to be taken while on the P. & I., introduced numerous delays to trains before entering on the P. & I. tracks. Other delays were caused by the inability to make following moves in the absolute block between Metropolis and Chiles, where the electric staff system was in service. An operator was employed on each trick at Metropolis, Chiles, "CR" Junction and South Yard, while under the new method of operation, operators, known as train controllers, are required only at the control office in Paducah.

Improvement in the Track Arrangement

Under the previous track arrangement the only passing track was located at Massac, as shown dotted on the track plan, and this was only long enough for 71 cars, and could be used by trains on only the one route. It was located in a sag with an ascending grade of 0.3 per cent, opposing a train pulling out in either direction. In view of these conditions it was decided to eliminate this passing track, so far as the operation of trains under the new system was concerned.

run-around or passing movements on the same or diverging routes. Number 18 turnouts were provided for all junctions and the ends of passing tracks, so as to permit train movements to be made at normal speed, thus reducing the time of occupying the main track.

Dispatcher-Controlled Signal System

With the new centralized-controlled system, the junction and passing track switches are power operated by electric switch machines, and all train movements are directed by signals which are located at the proper clearance points, the whole layout being divided into five zones, on each of which train movements may be directed independently. Zone 1 extends from Metropolis to Chiles, Zone 2 from Chiles to "CR" Junction, Zone 3 from "CR" to South Yard, Zone 4 from South Yard to P. & I. Junction, and Zone 5 from P. & I. Junction to the end of the territory.

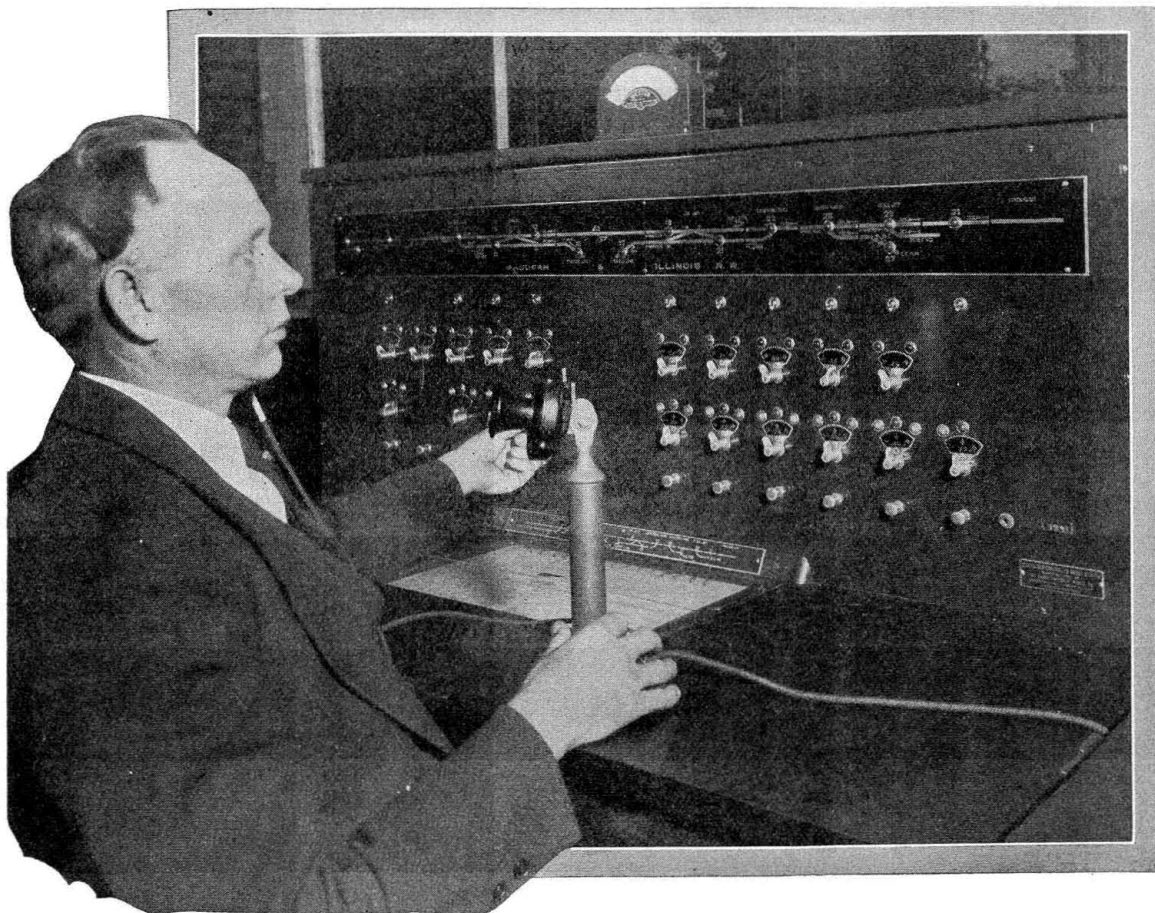
The control machine is located in the division headquarters building of the N. C. & St. L. which is close to the business section of Paducah, over two miles from the main line of the P. & I. The remote control of switches and signals at the 12 field stations is centralized in this board. The term "station" designates a group of associated devices, usually a switch and the opposing signals governing movement over the switch, which are controlled from one panel of the control board, each of which comprises

a section of the track model, a two-position switch lever, a three-position signal lever and a starting button arranged in order from top to bottom. One line circuit, comprising a single pair of wires, extends from the control office through each station in turn, and the operation of all functions is effected by suitably interrupting, or coding, the current in this circuit. The generating, transmitting, receiving and selecting of these codes are performed by relays, and for this reason, the system is called the "code relay" system. The control of any possible combination of

out and the red lamp above the signal lever is lighted. If the signal is clear, this red lamp is out and a green signal-indication lamp is lighted.

Operation of the System

From the various dispatchers of the connecting lines, the train controller receives information by telephone as to the approximate time of arrival of trains approaching the P. & I. railroad at the various junctions, and he receives instructions as to the routes to be taken by each train. When the approach



The control board in the office at Paducah

functions is accomplished by sending but one code; the reception of but one indication operates or verifies the indications of all functions at the station.

Automatic Train Graph

The location and progress of trains are indicated on the illuminated track model, and are registered automatically by a train graph which is located in a compartment recessed below the lever of the desk, at the bottom of the control board. A glass cover over this train sheet can be slid down to permit the train controller to make notations and connect up the lines to form a graphic train sheet. This graph instrument has a pen for each of the 15 indicating points, which automatically records the "OS" of trains when arriving and departing at the corresponding locations over the territory. The graph paper is 16-in. wide and advances at the rate of 3 in. an hour.

Indication lamps on the control board repeat the indication of each signal and position of each switch. Normally, two lamps are lighted on each panel, a yellow switch-indication lamp, and if the track is occupied, a red lamp in the track model. If the track is clear and the signals are at stop, the track lamp is

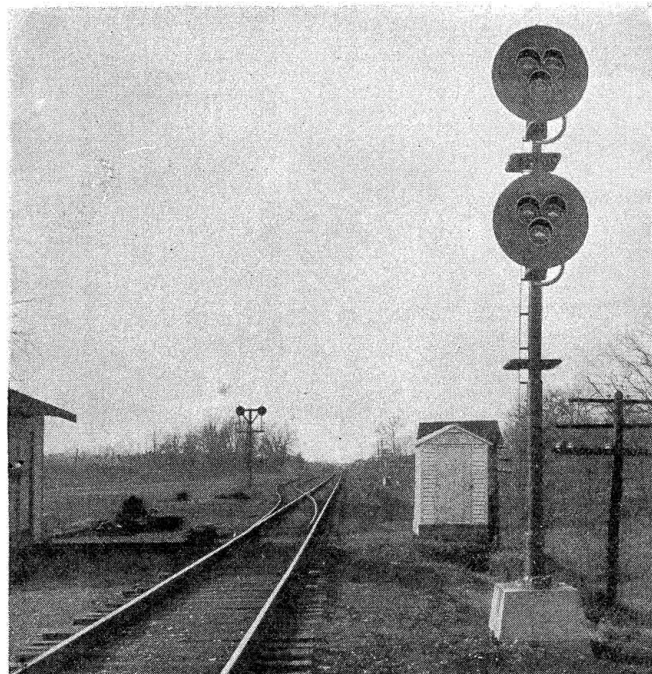
of a train is announced by the annunciator, the train controller informs the P. & I. dispatcher and is then instructed as to which movements are to be given preference, depending on the location and classes of other trains in the vicinity.

The switch and signal levers are normally on open circuit. The controller positions them according to the operations that he desires to perform and then presses the button, which starts the transmission of a code to select the station and panel. The control code includes a composite of the positions of both levers, and causes the station to send back an indication code as soon as the station operations are completed.

If the levers are not moved, the pressing of the starting button enables the controller to verify the indications without operating the station functions. In case the switch fails to complete its movement, a thermal cut-out is operated to de-energize the route relay, and this in turn will open the motor circuit. As soon as this occurs, an indication code is sent back which contains no switch indication. The controller may at once send a new code and restore the switch to its original position.

Several starting buttons may be operated in rapid succession, and the codes will be sent out consecutively. The operation of a starting button extinguishes the switch indication lamp. On receipt of the return indication, the remaining light of the panel is momentarily extinguished and when the indication code is completed, two lights appear simultaneously.

About six seconds is required to send out a code,



View looking west at the east end of the passing track at CR Junction

and about the same time is necessary to permit the change of apparatus in the field, including the operation of the switch and signals at that location, while about six seconds is required to return the indication to the office. Therefore, approximately 18 sec. is consumed from the time the train controller pushes his button until he gets the return indication that the switch is over and locked and that the signal is clear. This time is approximately six seconds shorter if no switch operation is required.

The safety of operation depends upon standard signaling devices at the field station. The code relay equipment at the field station operates four stick relays, two at a time, in the same code; one to set up a route (NWSR or RWSR) and one to establish the traffic direction (LHSR or RHSR). If both of the traffic-direction relays are de-energized, or if both of the route relays are de-energized, all signals at the station display a stop indication.

When the set up of the stick relays is changed, the standard signaling apparatus performs the sequence of operations necessary to bring the switch and signal into agreement with the control. For example, when a code is received at a station to reverse the route, and also to reverse the traffic directions, the first result is that the switch control is brought into disagreement with the switch. This de-energizes the KR relay and causes the signals to go to stop. Then if the approach and detector circuits are all clear, the switch reverses. As soon as the switch indication relay KR picks up in the reverse direction, the signal clears and an indication code is transmitted to the controller's office.

When a signal is clear and the approach section is occupied, the signal may be restored to "stop" and a switch control may be sent out, but the switch can-

not operate until the lapse of the time element. This time element starts when the signal goes to stop. This lapse of time is introduced by a time-element relay at each signal location.

If the controller attempts to change the position of a switch with the approach locking effective as described above, the switch indication light on the control board will remain dark until the time element has elapsed and the switch has moved, whereupon an indication will be received which will correspond to the position of the switch. When the detector circuit is occupied, the route set up may be changed by a code, but the switch will not operate until the train clears the detector track circuit.

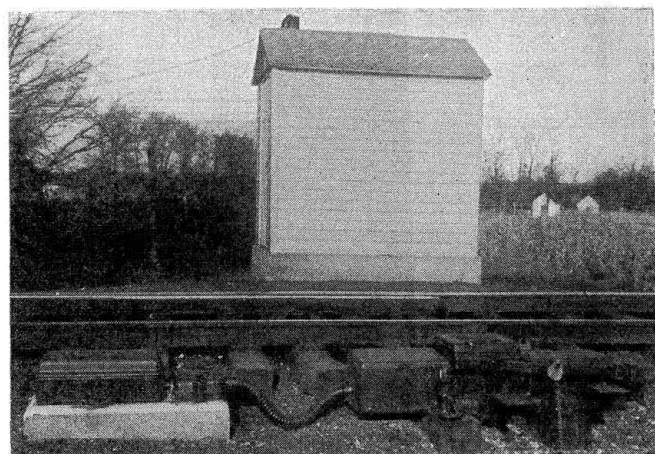
For local switching moves, manual operation of the switch is provided for by the "dual selector." Movement of the selector lever to the "hand throw" position puts all signals at stop and sends an "occupied track" code, which is held until the selector lever is restored to the "motor" position.

A toggle switch, located below the track light, selectively controls a track annunciator bell to ring when a train enters the corresponding track section. An approach annunciator bell, of a different tone from the track bell, rings whenever a train enters an approach section.

Control Units Interchangeable

The station code-relay equipment is self-contained in a relay case $17\frac{1}{2}$ in. wide, 12 in. high and 7 in. deep, weighing 45 lb. All 12 station units are identical, and the code adjustment for any station is made by connecting a jumper to any one of three terminals and a second jumper to any one of four terminals. This adjustment is in a detachable plug connector, by means of which the station wiring is connected to terminal sockets on the top plate of the station unit, so that it is a part of the station wiring. Any unit may be replaced by a spare unit by the simple process of removing the plug connector from the first unit and plugging it into the second unit.

However, the wiring of the code-relay unit in the Paducah office is different from that of the field station units, and it has a different plug connector. This



One of the all-metal instrument houses, and a switch machine in the foreground

unit is housed in the space back of the control board of the controller's cabinet. The office indication relays are mounted in racks in the lower portion of the same cabinet.

The line circuit connecting the control machine with the field stations is a normally closed circuit, energized at 80 volts from a 40-cell, 13.5-a.h. storage battery located in the Paducah office. The code

relay control units operate on a local battery of 16 volts, and with the exception of the indication relays, consume no energy except when coding. The indication lamps are standard 18-volt, telephone switch-board lamps operated on a-c. with a "power-off" relay connection to the office battery.

The electric switch machines are the Union Style M-20 with the dual control lever to permit manual operation when desired for switching movements. The motors are designed to operate the switches in 6 sec. Tie plates $\frac{3}{4}$ in. by 7 in. are provided on first and second ties and are braced with Stiles adjustable rail braces. The tie plates are extended on one side to the switch machine and bolted thereto, providing a rigid connection between the switch movement and the stock rail.

Outside Construction

The four switches in this territory leading to industry tracks are operated by switch stands, together with switch circuit controllers to provide the same protection as any switch in automatic block signal territory and in addition a pipe connected derail is used. The signals are the Style TR with $8\frac{3}{8}$ in. lenses and 8-volt, 18-watt lamps.

A 12-cell, 120-a.h. DMGO9 Exide storage battery is provided for each switch, and where there are two switches, such as at a crossover, a 16-cell battery is provided for the two switches. The entire battery is used for switch operation, and is split up by tap connections into four groups for the operation of other circuits. The line circuits are between battery 8 and common, the control machine between cells 8 and 24 and the emergency lighting for the signals on group 3 or 4. At distant signals where there are no switches, a set of 4 cells of Exide KXHS7 battery is used for line circuits and emergency lighting. Normally the signal lamps are burned on alternating current. One cell of Exide KXHS7 storage battery is used on each track circuit, except for the approach circuits on the tracks approaching the P. & I., in which case each is operated by three cells of 1,000 a.h. Edison primary battery connected in multiple.

Power for operating the signals normally and for charging the storage batteries is provided by a 440-volt, 60-cycle alternating feed circuit carried on two No. 6 copper wires covered with weatherproof protection. The line control circuits for the signals, as well as the two wires for the code circuits, are No. 10 copper with weatherproof covering. All these wires are carried on glass insulators mounted on a new crossarm placed on the existing communication pole line, where available, but 3,000 ft. of new pole line was built at certain places.

At each switch location all of the relays, batteries, rectifiers, etc., are housed in one small building made with sheet-iron, painted with aluminum paint. At distant signals or track feed locations sheet metal cases are used to house the instruments.

The lightning arresters are the Brach No. 111 Neon type, the line arresters being mounted in a sheet-metal box placed on the pole just below the crossarm, while the arresters for the track circuits are mounted in the instrument housing.

All track circuit connections and underground runs from the relay housing to signals or to switch machines are made with Okonite parkway cable. For track connections No. 9 single-conductor cable is run to terminals in a pot head near the rail and from this point four No. 6 copperweld bond wires extend to the rail where single $\frac{3}{8}$ in. pins are used to bond them into the rail. Control circuits are run in No.

9 13-conductor cables and feed circuits for switch operation are run in two-conductor No. 6 cables.

The installation was constructed by signal department forces of the Nashville, Chattanooga & St. Louis according to plans and standards for signal and interlocking construction on this road.

RULES

732. Block signals govern the use of the blocks and their indications supersede time-table superiority and take the place of train orders; they do not dispense with the use or the observance of other signals whenever and wherever they may be required.

733. As far as practicable, signals will be placed on signal masts to the right of the tracks they control.

734. Color-light signals should display lights for both day and night indication.

735. Home block signals are designated by the absence of a number plate.

736. Distant block signals are designated by a number plate on signal mast below the signal light and are numbered according to the mile posts, the last numeral showing the tenths of a mile from the mile post, odd numbers being used on signals governing south bound movements and even numbers on signals governing north bound movements.

737. When a block signal indicates Stop, one or more of the following conditions may exist:

- (a) Train or other obstruction in the block.
- (b) Main track switch open.
- (c) Car on siding within fouling distance of main track.
- (d) Broken rail.
- (e) Failure of the system.

738. Where home block signals are not provided to govern movements into or from a side track, such side track must not be used to meet or pass trains.

739. Telephones are located near the ends of all sidings; near isolated main track switches, and at other points as may be necessary, for transmitting and receiving instructions or information and conductors or enginemen will use, when necessary, to facilitate the movement of trains, stating number of train and location. To avoid misunderstanding, instructions or information received by telephone must be repeated to employee from whom received and names and occupations of employees stated. Reports made, or other communications had by telephone must not be considered as complete unless acknowledged by "All right."

TRAIN CONTROLLERS

740. A block record must be kept.

741. Appliances must be operated carefully; as directed by the rules, and only by those charged with that duty.

If any irregularity affecting their operation is detected the home block signals must be displayed to give their Stop indication until repairs are made.

742. When the route is set home block signals must be operated sufficiently in advance of approaching trains to avoid delay.

743. Control levers must be placed in normal position and marked with red lever markers with proper record thereon and should not be used when a track, switch or home block signal is undergoing repairs, or when a track is obstructed.

744. During cold weather the levers for power operated switches must be moved as often as may be necessary to keep connections from freezing.

745. If a home block signal fails to work properly its operation must be discontinued and a red lever marker with proper record thereon, kept attached to control lever until repaired.

746. If a switch fails to work properly, its use, except as trainmen are directed by train controller, must be discontinued and red lever markers with proper record thereon, kept attached to control levers for signals governing movements over such switch and also to control the lever for the switch, if power operated, until switch is repaired.

747. Train controllers must not, under any circumstances, "pick" the indication on lever for any switch or signal which has failed to operate properly.

748. Train controllers must observe whether the indications of the visible repeaters for switches and signals correspond to the position of the control levers.

749. Train controllers must not make nor give others permission to make any unauthorized repairs, alterations or additions to the control machine, signals, power operated or electrically locked switches.

Any defects in either must be promptly reported to

signal maintainer, signal engineer and superintendent. In addition, record must be made on prescribed form, which record must be kept on file and copy mailed to the signal engineer and superintendent.

750. If there is a derailment or if a switch is run through, or if any damage occurs to the track or signaling apparatus, the home block signals governing movements in the territory involved must be restored so as to display their Stop indication, red lever markers with proper record thereon attached to control levers for such signals, and no train or switching movement permitted until all parts of the signaling apparatus and track liable to consequent damage are known to be in a safe condition.

751. When switches or home block signals are undergoing repairs, signals must not be displayed for any movement which may be affected by such repairs, until it has been ascertained from the repairman that the switches are properly lined for such movement and that signals may be operated.

752. When it is safe to do so, power operated switches and home block signals must be operated on request of signal inspectors or signal maintainers.

753. A train controller receiving notice that a train has passed a point with any indications of conditions endangering that train, or any other train, or of an obstruction, must take such measures for the protection of trains as may be practicable.

754. Train controllers will be held responsible for the care of control machine and the supplies for it.

755. If a stop-signal is overrun or disregarded, the fact must be promptly reported to superintendent.

756. When a train controller relieves another, the one coming on duty must obtain from the one he relieves, exact information as to all movements then affected or controlled by the plant including all instructions not executed, and as to condition of the plant. He will also ascertain as to advices received as to prospective movements.

757. Should it be necessary to give a train permission to make a reverse movement, the train controller will place and leave in normal position control levers for home block signals governing movements into such limits and attach a red lever marker with proper record thereon. These red lever markers must not be removed nor another train admitted to such limits until a train given permission to make reverse movement has cleared block at a home block signal.

758. Should it be necessary to give a train permission to use main track to do work, the train controller must:

(a) Notify conductor within what limits and until what time main track may be so used. The working limits must extend from a home block signal to a home block signal governing movements in the opposite direction.

(b) After a train has entered working limits, place and leave in normal position control levers for home block signals governing movements over the designated working limits and attach red lever markers with record on each of train number; location of train; working limits and time granted. While red lever markers are attached, control levers must not be moved nor trains permitted to pass such signals without being instructed to have flagman precede the train while within the designated working limits.

(c) When the conductor reports work completed, the location of train, the location of governing signal, and, if dual control switch hand operated, that hand-throw lever has been locked to normal position and selector lever has been locked to normal position and selector lever has been locked to "motor operating position," or, if non-power operated switch used, that switch has been closed and locked, red lever markers on control levers must be removed.

(d) If additional time is requested, it may be granted if conditions permit, following same procedure as when first request was made.

759. In case of signal failure, or in an emergency, if no cause for holding train be known, the train controller may, after obtaining information that points of dual control switches are in proper position and safe for movement of train and that selector levers are in "motor operating position," and seeing that levers for such switches are in proper position, authorize train to pass a stop-signal and proceed as provided for in Rule 771.

760. Before cancelling permission to hand operate a dual control switch; permission to use the main track to do work; permission to enter main track from a side track by use of a non-power operated switch; or to pass a stop-signal, the train controller must fully instruct engineman or be advised by conductor that he has personally instructed engineman.

ENGINEMEN AND TRAINMEN

761. Enginemen and trainmen must obey the indications of the signals, as well as the instructions of the train controller, as all movements within centralized control signal system limits (except when means of communication have failed and movements are made under protection of flag as authorized by the rules), are under the control of the train controller.

762. Engineman, fireman, and trainmen when riding on engine, must communicate to each other by its name, the indications of all signals affecting the movement of their train as they come into view. The indications must be watched by engineman, if practicable until signals are passed; otherwise by fireman, or trainman on engine, and engineman will remind fireman or trainman, if necessary. If before a signal is passed it displays an indication other than that called to engineman, the fireman or trainman on engine must call change of indication to engineman as soon as it comes into view.

763. If a home block signal, permitting a train to proceed, is changed to a stop-signal before it is reached, the stop must be made at once. Such occurrence must be reported to the superintendent.

764. Signals should indicate stop as soon as any part of train has passed them and the rear trainmen must watch their indications.

765. Should an improper proceed signal indication be observed, it must be regarded as the most restrictive indication that can be given by that signal and reported to the train controller from the first available point of communication, and, in addition, a flagman must be left at the signal to notify all approaching trains that would be affected, until relieved by a signal department employe or by instructions from the train controller. Trains so notified will regard signal as if it were displaying its most restrictive indication.

(a) A signal indicating Stop, which is evidently out of order, must be reported to the train controller from the first available point of communication.

(b) A power operated switch known or thought to be out of order must be reported to the train controller from the first available point of communication, and, if necessary, a flagman must be left to notify all approaching trains that would be affected, until relieved by a signal department employe or by instructions from the train controller.

766. The train controller must be notified promptly in case of unusual delay.

767. When a train is being delayed at a Stop-signal and cause for such signal indication is not apparent, conductor or engineman must notify the train controller at once.

768. Except as provided for in Rule 770, a Stop and Proceed-signal must not be passed until train has stopped. After passing a Stop and Proceed-signal a train must proceed at slow speed to the next signal expecting to find one or more of the conditions mentioned in Rule 737.

769. If a train overruns a Stop and Proceed-signal, it will, after stopping, proceed as provided for in Rule 768.

770. When a grade indicator is attached to a distant block signal mast, trains which could not start after stopping, may pass a Stop and Proceed-signal without stopping, and then proceed as provided for in Rule 768.

771. A Stop-signal must not be passed until train has stopped and, if means of communication have not failed, permission to pass signal is obtained from the train controller. A train may then proceed under protection of flag to the next signal displaying a green light or a yellow light. After passing a Stop-signal a train must proceed at slow speed to the next signal expecting to find one or more of the conditions mentioned in Rule 737.

772. If a train overruns a Stop-signal, it must be protected in advance as well as to the rear. Engineman will, if possible, back the train to the governing side of the signal and then not proceed while signal indicates Stop, except as provided for in Rule 771. If train cannot be backed to governing side of signal, it may proceed as provided for in Rule 771.

773. A train having passed an approach-signal must be prepared to stop before passing next signal.

774. Trainmen must not give proceed hand signals which conflict with indications of block signals.

775. Trains must not proceed on hand signals as against indications of block signals.

776. When speed is restricted by rule, special instruction, bulletin, or otherwise, trains must respect such restriction, even though admitted to a clear block.

777. When there is an obstruction, notice must be given the train controller from the nearest available point of communication.

778. When two or more trains have been coupled and so move past a home block signal, if separated within block signal limits, the train controller must be notified.

779. All non-power operated switches are connected with the signals of the block in which they are located and will cause the signals on each side of switch that govern movements over the switch to indicate Stop when the switch point does not fit up to rail or when the switch is set for the movement into or from side track. When pipe-connected derrails are used in such turnouts, the normal position will be—to derail.

780. Running switches must not be made over power operated switches.

781. When taking siding, trains should, before stopping, pull beyond the home block signal governing movements from that end of siding and cars or engines should not be left between home block signals located near ends of sidings; otherwise, the signals at each end of block will indicate Stop, causing unnecessary delay to approaching trains.

782. Enginemen must not permit cinders from firebox or front end of engine, to be dropped on the tracks on which movements are governed by block signals, except at points designated by superintendent. Sand must not be used, ash pans cleaned, grates shaken, water wasted, or blow-off cocks opened, over the movable parts of switches.

783. Should it become necessary for a train to reverse movement, such movement must be under protection of flag, but, if means of communication have not failed, the nearest home block signal governing in that direction must not be passed without the permission of the train controller.

784. If any part of a train passes a home block signal near the end of a siding and then a reverse movement is made so that the train is again in rear of this signal, the train controller must be notified at once and before signal is again passed. After a reverse movement is made this signal must not be passed while indicating Stop except as provided for in Rule 771.

785. When necessary to operate a dual-control switch by use of hand-throw lever, the conductor must (except as provided for in Rule 786) obtain permission from the train controller to so operate switch, before placing selector lever in "hand operating position." When such permission has been obtained and the selector lever placed in hand operating position, the hand-throw lever may be operated in the usual manner.

A cast iron "N" on the first cross-tie ahead of switch

points indicates normal position of switch points. A cast iron "R" indicates reverse position of switch points.

(a) When the selector lever on a dual-control switch is placed in "hand operating position," all home block signals immediately adjacent to switch governed will indicate Stop.

(b) When through with the switch the hand-throw lever must be locked to normal position and selector lever locked to "motor operating position" and so reported promptly to the train controller by the conductor who will also advise the train controller the location of the train and the location of the governing signal.

786. Should it be necessary to operate a dual-control switch by the use of the hand-throw lever and means of communication with the train controller have failed, it may be operated in same manner as if permission from the train controller had been obtained. When through with use of switch, hand-throw lever must be locked to normal position and the selector lever locked to "motor operating position."

787. Where home block signals are not provided to govern movements into or from a side track, a train having entered such a side track and closed the main track switches must not proceed from such track except under protection of flag to the next signal displaying a green light or a yellow light. In addition, if means of communication have not failed, train must not open such main track switch or leave from such side track without the permission of the train controller.

788. Electrically locked switches are controlled from office of the train controller. To use: 1. Unlock joint locks on both boxes. 2. Open doors of both boxes. 3. Ask the train controller by use of the telephone for permission to use electric lock, which if granted, will be indicated by small semaphore arm in lower box in vertical position. 4. Throw lever in lower box to extreme left and operate switch in usual manner. 5. When through with switch and it is set to the main track and locked, throw lever in lower box back to extreme right and lock doors to both boxes. Switch will then be electrically locked.

789. To use main track to do work, the conductor must obtain permission, including working limits and time limit, from the train controller and then advise the engineman, or enginemen, of the limits so authorized. When work has been completed, or time limit has expired, the conductor must report to the train controller and state location of train and location of governing signal. More time must not be used nor movements made beyond the designated working limits without the permission of the train controller.



Southern Pacific train in the Sierra Nevada mountains, hauled by one of the New 4-8-8-2 type single-expansion articulated locomotives built by Baldwin