SIXTH VOLUME

From January, 1913, to December, 1913

The Signal Engineer

Published by

Simmons-Boardman Publishing Co.

Chicago New York Cleveland London

1913

A. C. Track Circuits on the Norfolk & Western

Describing the Recent Single Track Alternating Current Signaling Installation Through Elkhorn Tunnel

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The Norfolk & Western Railway placed in service on July 17, 1912, an installation of A. C. track circuits at Elkhorn Tunnel, W. Va., to overcome the efforts of foreign current in the D. C. track circuits, which had become very troublesome at this point.

This is a single-track tunnel 3,250 ft. long. It is on a two per cent grade, which extends from a point about 400 ft. their first installation by gravity batteries. When it was put in the tunnel circuit could be operated by three cells of gravity battery in multiple. Since then the coal operators near-by have been gradually installing electric apparatus for handling their mine cars, and serious foreign current troubles have been encountered as a result of the proximity of this electric power. These were first overcome by using more

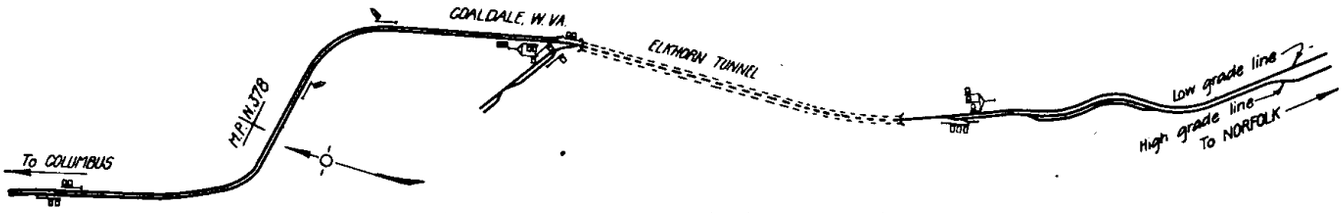


Fig. 1. Showing the Location of the Signals and the Tunnel.

east of the tunnel, four miles west. From this same point eastward are two lines, the old main line, on which the grade is two per cent and the low-grade line, which has a grade of one per cent. The double track from the west extends to the mouth of the tunnel and the two lines east are battery and higher resistance relays and finally by dividing the circuit and placing the batteries in the center of the tunnel. Clearing relays were tried, but these soon became so corroded by the gases from passing engines that they became inoperative and had to be discontinued. Finally, it

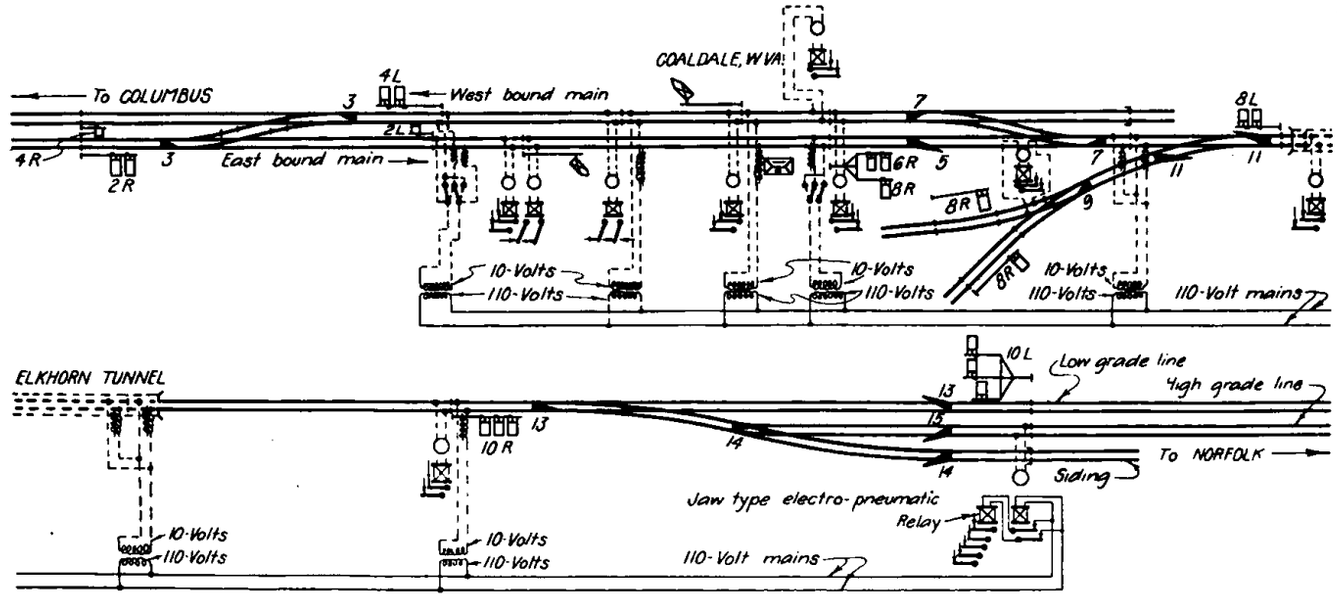


Fig. 2. The Track Circuit Diagram for the Section of Track Shown in Fig. 1.

operated as double track, except in emergencies, although they are provided with single-track automatic signals. These two lines converge at Bluestone Junction, about two miles east of the tunnel, from which point double track is used.

On account of the poor circulation of air in the tunnel, and the fact that east-bound trains cannot move very fast and must work full power, fans are used to blow the smoke ahead of them. The switches and signals are operated by a 17-lever electro-pneumatic interlocking machine, which was first installed in 1902 and remodeled in 1909. The main air line for the operation of the switches and signals on the east side of the tunnel is run on the wall through the tunnel, while the cables carrying the operating wires are carried on the pole line across the mountain.

The track circuits at this point have been handled since became necessary to install A. C. track circuits to obviate these troubles.

There are 17 electro-pneumatic signals in this installation, controlled from the interlocking, and two 110-volt A. C. electric signals controlled automatically. These are placed between the home signals at the tunnel and the crossover between the main lines, which is 5,300 ft. west of the home signals. The east-bound automatic signal is placed in this position to prevent stopping an east-bound train at the crossover when another train is standing at the tunnel waiting for west-bound traffic to clear the tunnel, which is very frequently the case.

The two-arm signal No. 8L, at the west end of the tunnel, on account of the difficulty in seeing it, encountered by enginemen coming through the tunnel, is not controlled by

the track circuits, and is used only as a shifting signal into the Coaldale Coal & Coke Company's operation. The west-bound automatic signal is placed about 800 ft. from the west portal of the tunnel and the control of signal 10L at the east end is carried to it and through an overlap 1,500 ft. beyond.

The crossover west of the tunnel was not included in the original installation, but was connected up when the plant was remodeled. At that time it was only 2,400 ft. from the tunnel signals. However, in 1911 it was removed to its present location, and it became necessary to place the automatic signals between it and the home signals to shorten the blocks for east-ound trains and give better protection to west-bound trains.

All of the electro-pneumatic signals are of the two-position, lower quadrant type, and the two electric signals are three-position, upper quadrant.

Power for the A. C. apparatus is generated by two 6 in. x 6 in. Giles steam engines, direct connected to 10 K. V. A., 12-pole, 600 R. P. M., 125-volt, 60-cycle, single-phase alternators with belted exciters using steam at 100-lb. pressure from the same boilers which supply power to operate the tunnel fans. These are duplicate sets, one being used to supply the power and the other for use when repairs are necessary, or in case of emergency.

A two-panel switchboard is provided, one panel for each generator, each being supplied with an A. C. voltmeter and ammeter, and a D. C. ammeter for the exciter, and an 80-ampere overload circuit breaker. Both exciter and generator rheostats are mounted on the back of the board, and lamps and connections are provided for synchronizing the machine. The panels are of black enameled slate 1½ in. thick, and mounted on iron pipe frames. There are three 250-volt, 100-ampere, D. P. S. T. feeder switches on each panel.

The power is generated at 115-volts and supplied to both east and west ends of the plant by two lines of No. 6 B. & S. hard-drawn weatherproof copper wire, strung on the telegraph department's pole line. The transformer in the tunnel is supplied by two No. 12 B. & S. rubber-covered copper wires run in iron-armored conduit, supported on the wall of the tunnel by iron brackets. Current for lighting the boiler and engine rooms and interlocking tower and for charging the interlocking battery through a 30-ampere mercury arc rectifier is taken from these mains.

The transformers for supplying track circuits are one K. V. A. capacity, 110-volts primary, and having taps on the secondary for 6, 8, 10, 12 and 15 volts. They are connected to the supply mains through single-pole insulator type porcelain cutouts. Leads are taken from the secondaries through double-pole knife switches and reactance coils to the track circuits.

Track relays are of the galvanometer type, working in two positions, except the two controlling the automatic signals, which are three-position. Line relays are of the vane type, wound for 110-volt operation. On the indicator circuit at the east end of the tunnel where more contacts are necessary than are provided in the ordinary relay on account of the two lines of single-track automatic signals which start at this point, there is a jaw-type electro-pneumatic relay having eight front and seven back contacts. This relay is operated by 110-volt current taken from the supply mains through the contacts on the track relays and no other circuits are controlled directly by this track relay.

The two 110-volt electric signals are the U. S. & S. Company's Stlyle "S," operated by induction motors. All signals on the installation are lighted by 10-watt, 110-volt carbon filament lamps, connected directly to the supply mains.

The A. C. track circuits have given excellent service since their installation and are bound to work very satisfactorily under circuit conditions would would have rendered D. C. circuits inoperative.

NEW HAVEN OFFICERS' SALUTATORY.*

On September 2, 1913, Howard Elliott, one of the signers of this statement, arrived in New Haven after thirty-three years' service with the Chicago, Burlington & Quincy and Northern Pacific roads. On the same day J. H. Hustis, the other signer of this statement, arrived after thirty-five years' service with the New York Central and Boston & Albany roads.

We have both come into the management of the New Haven road to work with and alongside of you.

We have no purpose except to maintain, operate and improve the property so that it may do its work with safety to you and the traveling public, and with efficiency and economy for the shippers and owners.

We hope to make our service for this company our life work.

To-day we are all involved in this awful casualty, and the men, as well as the management, and the public, are in great distress over it.

Terrible as it is, we must face it with courage, keep our heads, and do our duty.

We are fellow employees—our duties and responsibilities only varying in degree. Each one of us has a great responsibility to the public, to his fellow employees and to the thousands of owners of securities. We need your help, and we wish to help you. Each must help the other if this railroad is to be run safely.

The work of the great army of employees is most important, because you are engaged in the detailed work of maintaining the road and in operating trains under the rules and regulations laid down by the public authorities and by the management.

Upon the officers there is imposed by law the duty to adopt and enforce every reasonable rule and practice which experience has shown will help to protect life and preserve property. This is a duty that cannot be shirked, and the management must perform it with firmness and without hesitation.

No railroad can obtain safe operation that does not have the earnest and loyal support of its men in all reasonable efforts to protect and perform the service. There is no question of your loyalty. This loyalty can now be shown in no more practical way than by observing the existing rules and by adopting and accepting cordially any further rules and regulations that make for safety.

It is urged that all employees read and re-read the rules in the timetables and in the books governing the operation of stations, trains, yards, signals, shops, tracks, inspection and care of equipment, in fact everything pertaining to operation, and that they confer with one another and with the officers as to the best means of promoting safety.

Take the case of the accident on the morning of September 2. The public will discuss, and properly so, improved signals and stronger equipment, both of which are necessary and desirable as a help in preventing or lessening the horrors of an accident of this kind.

This accident should not, however, and would not have occurred had the rules of the railroad been observed strictly, and good judgment, born of experience, been displayed. The men on the colliding trains were all of sufficient intelligence and experience to understand their duties and were of good habits so far as is known. Certainly their appearance indicated that to be the case. It is believed they are men of sincere purpose and high character, as are the great body of men in engine and train service—men who would not intentionally do a wrong and who take a pride in their work. They all had proper rest, or had been given opportunity for taking it, and were familiar with the piece of road over which they were running. The airbrakes and the signals performed their functions. The conditions of that morning had been duplicated many times before, and there was nothing unusual about it, except that a heavy holiday business was

*This document, which explains itself, was issued by Messrs. Howard Elliott and J. H. Hustis, president and vice-president of the New York, New Haven & Hartford, on September 6, four days after the disastrous collision at North Haven. Being in some respects of unique character it is reprinted here in full.—Editor.

A. C. Automatic Signaling on the N. & W.

Describing Two Recent Installations in Which There Are a Number of Interesting Features

By J. A. BEODDY
General Signal Inspector Norfolk & Western

The Norfolk & Western, during the past year, has installed two more sections of A. C. signals on double-track system operated line. These are between Bridge No. 7, a drawbridge about eight miles west of Norfolk, Va., over the south branch of the Elizabeth River, and Suffolk, Va., and between Nottaway, Va., and Burkeville, Va.

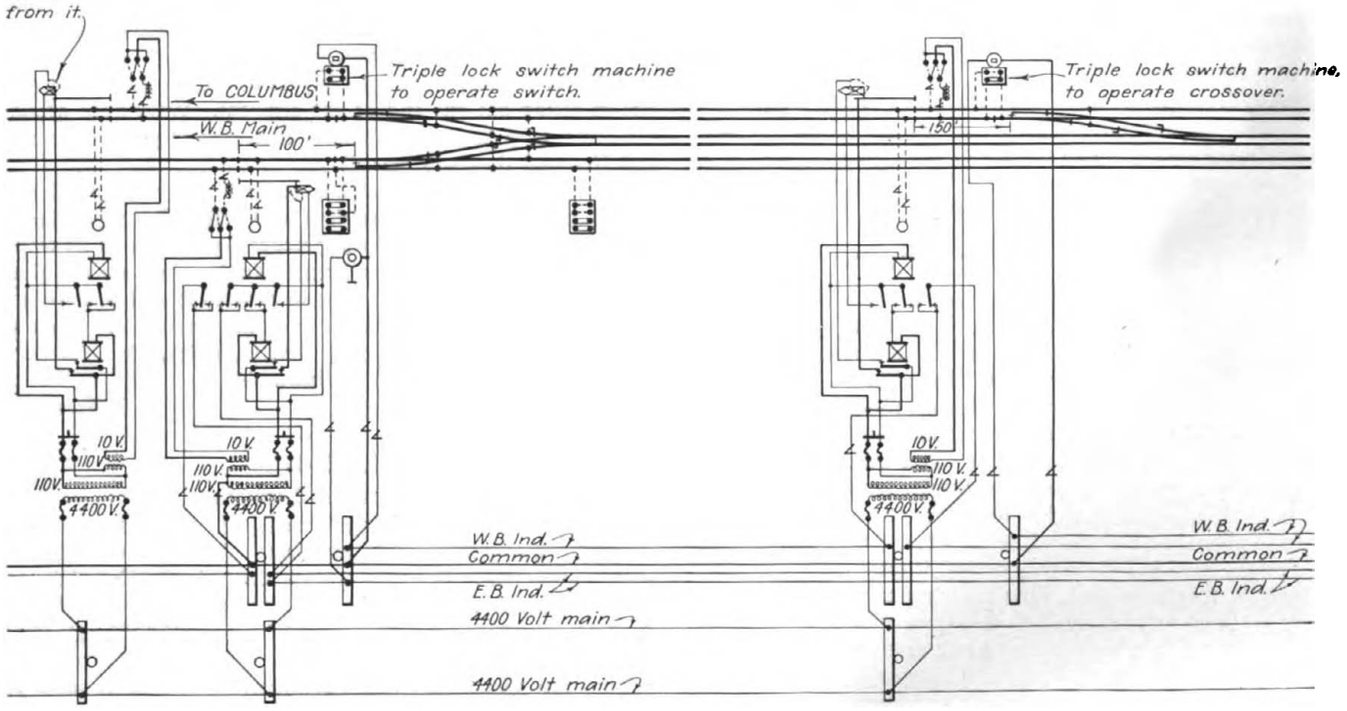
It was decided to use A. C. signals with 4,400-volt, 25-cycle, single-phase transmission on both of these installations, and to make provision for extending the first one westward and the other in both directions.

The distance from Bridge No. 7 to Suffolk is 16 miles and is a perfect tangent. There are two middle sidings, one at Yadkin and one at Juniper, each of which is 10,000 ft. long, with crossovers to both main lines in the middle. Forty signals are installed, the locations at the middle sidings being the standard N. & W. arrangement, and the other signals spaced as near 4,500 ft. apart as conditions will permit.

The distance from Nottaway to Burkeville is 10 miles, with the division yards and terminals at Crewe half way between. In this installation are 26 signals spaced as near 4,500 ft. apart as local conditions will permit. As the switches at the entrances of the eastbound and westbound yards are left lined up for freight movements into the yards, except when passenger trains are due, the signals governing the movements over these switches have two arms, the top arm governing the straight or passenger train movement, and the bottom arm being clear when the switches are lined up and the route is clear into the yard, so that full protection is given passenger movement and no delay caused to freight movement by stopping at the automatic signals.

The signals between Bridge No. 7 and Suffolk were placed in service late in 1912, and those between Nottaway and Burkeville, May 5, 1913. All the apparatus and construction is the same in both installations.

Power for the Bridge No. 7-to-Suffolk signals is obtained from the Norfolk Railway & Light Company, whose transmission line is just across the Elizabeth River at the drawbridge. It is transmitted under the river in a submarine cable, which is protected by fuses and oil switches at each end. At Crewe the necessary power is taken from the generators at the division shops. In each case 2,300-volt, three-phase, 60-cycle current is used to drive a frequency converter set consisting of a 20 horsepower, 2,300-volt, 60-cycle, three-phase induction motor, direct connected to a 15-K. V. A., 440-volt, 25-cycle, single-phase, 720-R. P. M. alternator, and a 5/8-K. W., 125-volt exciter. Two of these sets are installed in each power house. One of them is sufficient for the present work and the other is used for an emergency set; but when more signals are added, both sets will be run in multiple, and a third set provided for emergencies. The 440-volt current is stepped up by 10-to-1 transformers of 15 K. V. A. capacity for the transmission line.



Standard Arrangement of Alternating Current

Switchboard equipment consists of a 1½-in. thick blue Vermont marble panel, with the necessary switches, instruments, synchronizing lamps and plugs, and an electrostatic ground detector. Both the generator and exciter rheostat are mounted on the back of the board, which is supported upon an iron pipe framework eight feet from the wall. The oil switches for the 2,300 and 4,400 volt mains are mounted upon a pipe framework six feet behind the switchboard, and operated from the handles through cranks and ¾-in. pipe connections, so that no high-tension wires need be brought to the board, except those to the ground detector, which is mounted on a bracket to one side and the wires dropped to it from the ceiling where they are out of

the way of any person working on the switchboard. The compensators for the 2,300-volt motors are mounted on an iron pipe framework at the side of the switchboard, and a small transformer connected to one phase of the 2,300-volt mains supplies current for lighting the power house and for the no-voltage trip coils on these. The 4,400-volt oil switches are provided with overload tripping coils operated by a current transformer in the 4,400-volt mains. The station apparatus is protected by a graded shunt resistance, 4,151-5,700-volt lightning arrester which is supplied with choke coils and disconnecting switches.

All of the wiring inside the power house is installed in iron-armored insulated conduit, and high-tension wires are provided with special rubber insulation.

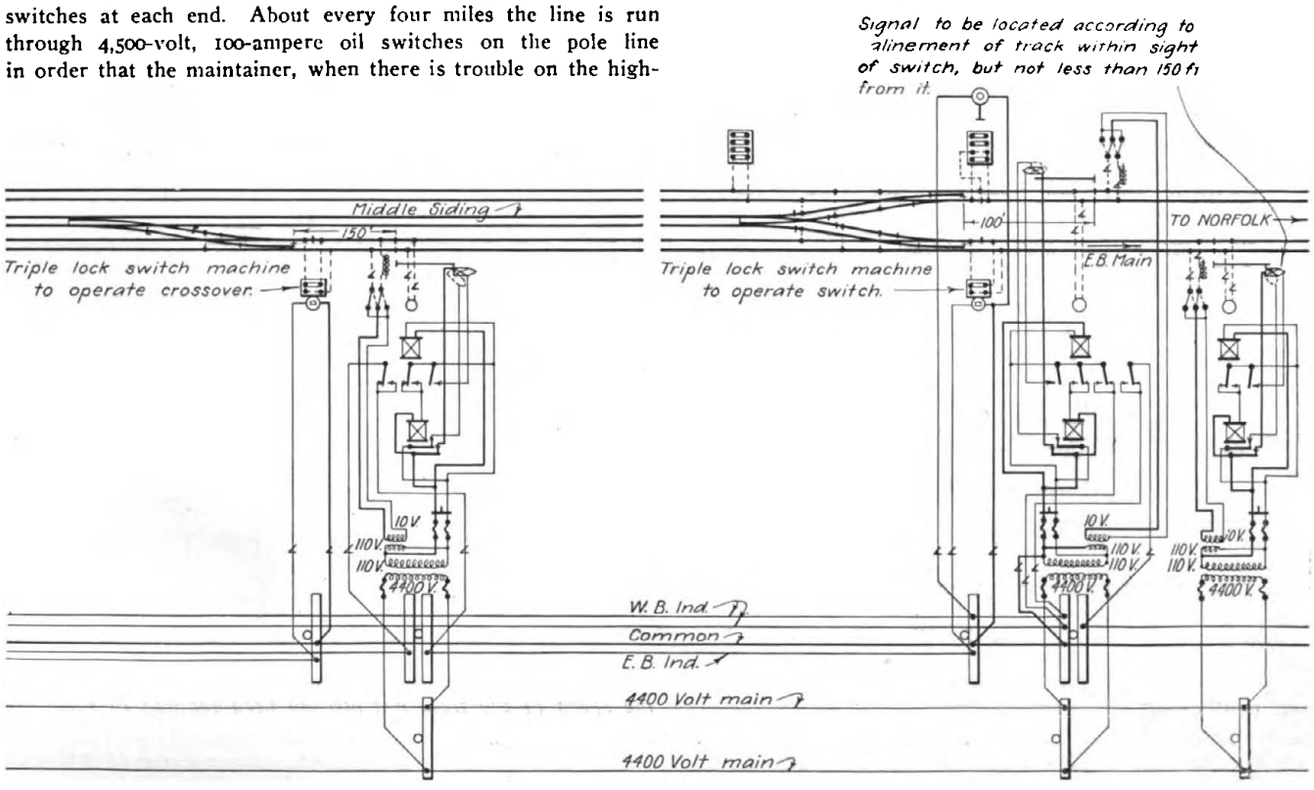
The transmission line is run on the railway company's pole line. No. 2 hard-drawn bare copper wire is used and run on top-groove, triple-petticoat, 10,000-volt glass insulators, on a separate cross-arm at the top of the pole. The transmission line wires are 24 in. apart and the other signal wires for indicators, lights, etc., are carried on a cross-arm two gains below this. Where the line crosses a canal where there is a drawbridge, and it cannot be placed overhead, it is carried in a submarine cable designed for 5,000-volt service, which is provided with oil switches at each end. About every four miles the line is run through 4,500-volt, 100-ampere oil switches on the pole line in order that the maintainer, when there is trouble on the high-tension line, may go to the nearest one between the trouble and the power house and disconnect the section of line without putting all the signals on the installation out of service. Graded shunt resistance lightning arresters for 4,400-volt service are used on the high-tension line. These are placed in wooden boxes on the poles about two miles apart.

A General Electric Type "H" one-K. V. A. transformer is installed at each signal location. The primary coils are wound for 4,400 volts, with five and 10 per cent taps to compensate for line drop, where necessary. These are connected to the high-tension line through 6,600-volt primary cut-outs, with fuse holders installed in wooden boxes on the cross-arm. The fuse holders are removed and installed where required with a hook having a two-foot handle.

All signals are the Style "S" one-arm, three-position, upper-quadrant type, manufactured by the Union Switch & Signal Company, and are operated by induction motors. They have the regular battery cases in which are placed the relays, track transformers, switches, lightning arresters, etc., thus eliminating, except in special cases, any separate housing for this apparatus. The signals are lighted by 110-volt 10-watt carbon filament lamps.

The tracks are 100-lb. rail bonded with two No. 6 B. & S. copper wires per joint. They are ballasted with crushed slag, and a pressure of four volts at the transformer is sufficient in most cases to operate the circuits, but they are usually operated at six volts, so that no trouble may be experienced in wet weather. The track circuits are supplied by a ⅛-K. V. A. air-cooled transformer, having a primary coil wound for 110 volts and secondary with taps for two, four, six, eight, 10 and 12 volts. This is connected to the 110-volt mains for the line transformer. A reactance coil is used between the track transformer and the rails.

All track relays are the galvanometer type, working in three positions. The signals are equipped with pole changers, thus eliminating the use of line wire for the distant indication. A 110-volt, vane-type slow-releasing relay, controlled by the track relay, is used for the signal-operating circuit to prevent the slot releasing while the track relay shifts from the home to the distant position. These vane-type relays are also used wherever line relays are necessary.



Signals and Circuits on the Norfolk & Western.

One-hundred-and-ten-volt, vane-type, illuminated switch indicators are used at all main-line switches. These are lighted by 110-volt, 10-watt carbon filament lamps, the current for the lamps being brought by line wires from the nearest transformer.

All construction work is N. & W. standard; fibre conduit, with cast-iron bootlegs and terminal boxes, being used throughout. Joints in the conduit are of the socket type, and are wrapped with thoroughly pitched burlap, and a metal clamp is placed over this. All wire leading from the pole line to the signals and for signal wiring is No. 14 B. & S. rubber-covered solid copper; while No. 9 stranded rubber-covered wire is used for track connections.

At Bridge No. 7 a mercury-arc rectifier is installed to charge the batteries for the bridge signals and the D. C. circuits at the drawbridge. Before the installation of the A. C. signals, these were handled by primary battery.