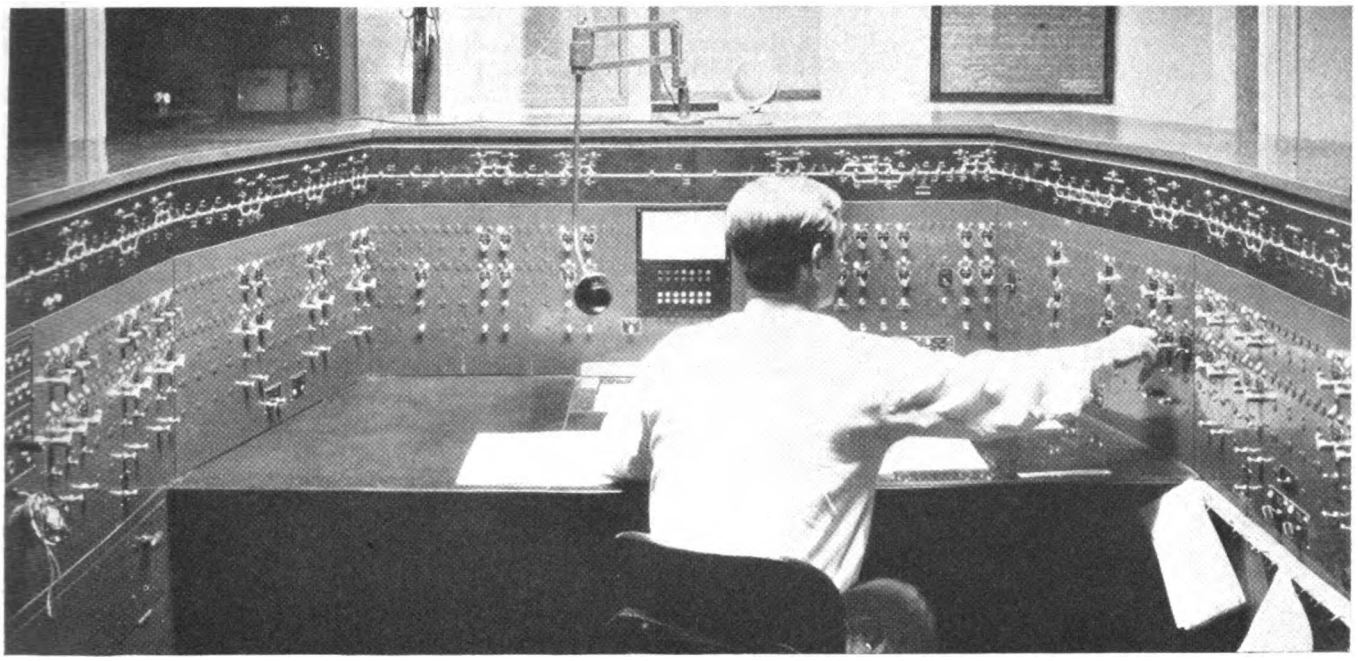


The control machine for the 96 mi. of centralized traffic control is in the dispatcher's office at Portsmouth, Ohio

C.T.C. Solves Operating Problem On Busy Single-Track Line

Norfolk and Western project, on 96 mi. of single track between Portsmouth, Ohio and Cincinnati saves train time and improves overall performance

As an aid in expediting train movements on a single track line having relatively heavy grades, handling up to 30 trains daily, the Norfolk and Western has installed centralized traffic control for a distance of 96 mi. between Clare Yard (Cincinnati), and Vera, just west of Portsmouth, Ohio. The Norfolk and Western has two or more main tracks on the 565 mi. from Norfolk, Va., west to Portsmouth, Ohio, from which there are two lines; one is 98 mi. of double track north to Columbus, Ohio, and the other 96 mi. west to Clare (Cincinnati). The N. & W. operates its passenger trains over the tracks of the Pennsylvania and Baltimore & Ohio from Clare to the Cincinnati Union Station, about 4 mi. The 96 mi. between Vera and Clare is single track which is now equipped with centralized traffic control, the control machine being located in the dispatcher's office at Portsmouth.

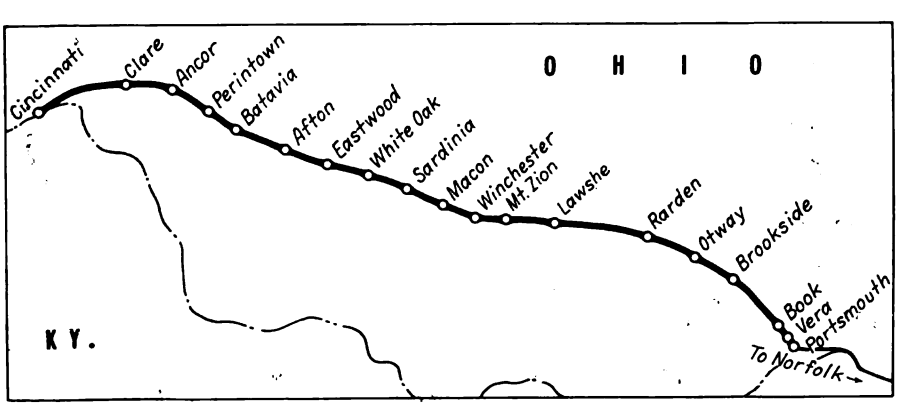


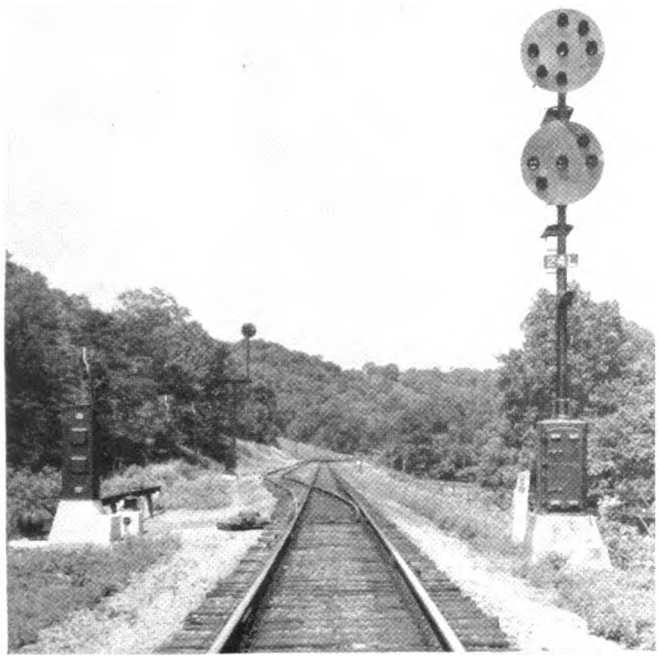
Fig. 1—Map showing the locations of sidings between Vera and Clare

Operating Problems on Grades

The operating problems caused by heavy traffic and grades on this line have been, to a considerable extent, relieved by the new centralized traffic control. This section of railroad formerly the Cincinnati, Portsmouth & Virginia, was acquired in 1901 by the Norfolk and Western as a means of extending its through route from the eastern seaboard into Cincinnati. This line traverses hilly country, 10 to 15 mi. north of the Ohio river.

From Portsmouth, on the Ohio river, the line follows up the Scioto river about 9 mi. to a point just east of McDermott. From there, the railroad follows up the valley of Scioto Brush Creek about 18 mi., then it crosses several ridges and rivers such as Ohio Brush Creek at Lawshe, White Oak Creek at White Oak, and East Fork of the Little Miami river at Williamsburg. From Batavia to Clare, the railroad runs, in general, down the valley of the East Fork of the Little Miami river to the Miami river which flows into the Ohio near Clare. The ruling grade for eastbound trains is 1.39 per cent for about 2.25 mi. between Lawshe and Peebles. Another eastbound grade of about 1.0 per cent average extends about 5.25 mi. between Batavia and Afton.

The maximum grade westbound is approximately 1.4 per cent for 4 mi. between Lawshe and Seaman. Formerly another heavy grade westbound of 1.11 per cent extended 1.5 mi. from Mineral Springs to Beaver Pond, but in 1948, a new line was built from Mineral Springs to Plum Run, 4.7 mi. on a maximum of 0.52 per cent grade and 2 deg. curvature. The old line via Beaver Pond has been retained in service and equipped with C.T.C. to serve as a second main track so that there are now two tracks, each of which are equipped for train movements in both directions. Trains with compound Mallet locomotives Class Y5 or Y6, handle 3,100 tons westbound or 2,900 tons eastbound. By doubling the hill westbound between Lawshe and Seaman, these locomotives can handle 6,200 tons.



Westward station-entering signal at the east end of the siding at Perintown

Important Traffic

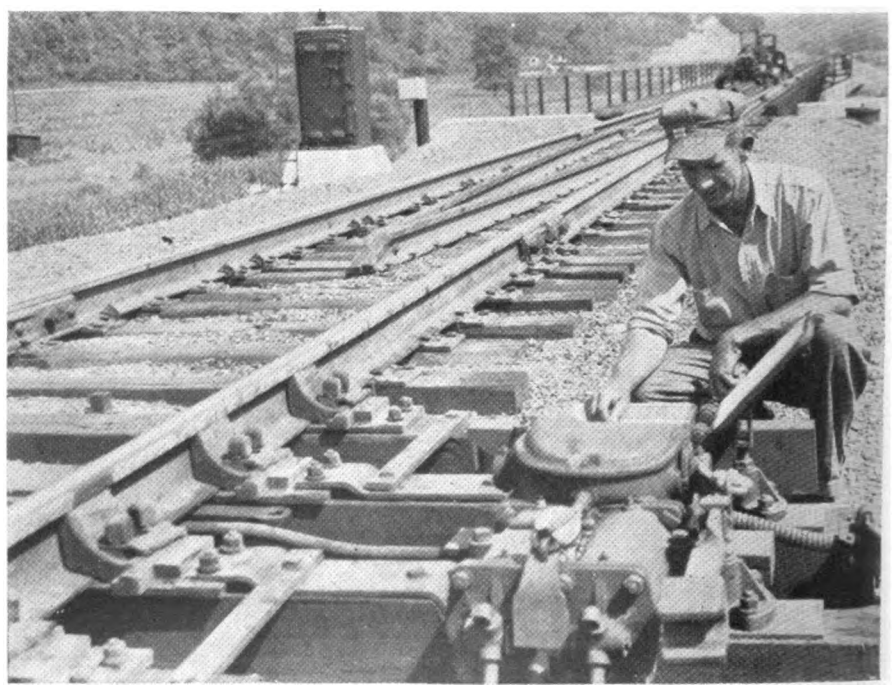
This line serves as the entry to Cincinnati for the entire Norfolk and Western, and, therefore, this Vera-Clare section handles not only good local business but also a large volume of through passenger and manifest freight traffic in both directions, as well as solid trains of coal westbound.

Four passenger trains are scheduled each direction daily, including one local and three through trains—the Pocahontas, the Cavalier and the new Powhatan Arrow which is an all-coach day train on a fast schedule in both directions between Norfolk and Cincinnati. Two local freights are operated daily, one between Portsmouth and Sardinia, and the other between Sardinia and Clare. Three scheduled manifest freight trains are operated eastbound and two westbound daily, in many instances each being operated in more than one section. These trains are given tonnage so that they can maintain a good average speed necessary to make the schedules.

The westbound coal is handled in solid trains at slower speeds, and this traffic varies up to 4 or 6 loaded trains westbound daily. Thus, the total number of trains, counting extras, may range from about 22 to 28 or more. The difficulties of keeping all these trains moving effectively on this single track is increased by the variations in the speeds of different classes of the trains, as well as the necessity to give certain trains preference.

Previously Automatic Block

The 96 mi. of single track between Vera and Clare was equipped with absolute permissive automatic block signaling in 1926. Train movements were authorized by timetable and train orders, with automatic block protection. In recent years, the development of C.T.C. has pointed the way



Signal maintainer, N. B. Lindamood inspecting an electro-pneumatic switch machine at Mineral Springs

to improvement in operation over automatic block in single track territories of heavy traffic density.

The new centralized traffic control includes power switch machines at the ends of sidings and the ends of the second track between Mineral Springs and Plum Run, and these switches as well as the signals at these locations are under the control of the dispatcher at Portsmouth. Accordingly, trains enter or leave sidings without stopping and all train movements are authorized by the signals, rather than, as previously, by time table and train orders. The time waiting on sidings has been reduced by affording the dispatcher a means for quickly advancing trains by signal indication when others are delayed unexpectedly. The benefits have been to overcome the physical handicaps and to improve train performance which has been highly satisfactory.

As explained by a dispatcher, the power switches and C.T.C. signals will save about 20 min. for a freight train when making a move out of a siding, then over a section of main track and into a siding at the next or some other town. This time saving is frequently the factor which permits the dispatcher to advance a train one or more sidings when otherwise it would be delayed 20 min. to 30 min.

Fewer Train Delays

With C.T.C., the dispatcher can cope with circumstances that otherwise would cause serious delays. In many such instances, delays to passenger trains can be avoided or minimized. The first train to arrive at a siding for a meet is run into the siding regardless of class. In numerous instances, the operation of a passenger train through a siding with little or no delay may save considerable delay for a freight train.

The maximum permissible speed for passenger trains varies from 50 to 65 m.p.h. but on some curves the speed is restricted to as low as 35 m.p.h. The Powhatan Arrow, which makes no intermediate station stops, makes the 96 mi. between Vera and Clare in 2 hr. 8 min. westbound and 1 hr. 56 min. eastbound. The maximum permissible speed for freight trains is 45 m.p.h. and this is restricted to about 28 m.p.h. on some curves. Manifest freight trains now make the eastbound run between Clare and Vera in about 3 hr. 10 min. and westbound in about 3 hr. 30 min. Westbound coal trains which double the hill, ordinarily make the run in less than 6 hours. On the whole, there has been not only a considerable saving in overall time between terminals but also the average performance is better especially in minimizing delays which otherwise would result when some train has trouble such as a hot box or broken coupling.

Longer Sidings

During recent years, many of the sidings had been lengthened so that the locations and car capacities are now as shown in the accompanying table. This table is based on car length of 45 ft. with 300 ft. of track length for locomotive, caboose and tolerance at the ends.

Two new sidings, each about 6,000 ft. long, were constructed at Mt. Zion, just west of Seaman which is the top of the 4 mi. of 1.4 per cent westward grade from Lawshe up to Seaman. At Mt. Zion, one of the new sidings is on the north side of the main track, and the other is on the south side. As an aid to trains which double the Lawshe-Seaman hill, a crossover was installed between the north siding and the main track at a point near the middle of the length of the siding. The switches at the ends of the sidings are power operated as a part of the C.T.C., and the switches for this crossover are hand-operated with electric locks.

Siding Capacities—Vera to Clare

Anchor	162	Cars
Perintown	142	"
Batavia	90	"
Afton	141	"
Eastwood	143	"
White Oak	123	"
Sardinia	140	"
Macon	104	"
Winchester	104	"
Mt. Zion	141 + 141	"
Lawshe	143	"
Rarden	142	"
Otway	144	"
Brookside	144	"
Book	144	"

Special Operation at Mt. Zion

Ordinarily when a westbound train doubles the hill, the locomotive with the first half pulls into the westward siding at Mt. Zion and leaves this half of the train east of the crossover. The locomotive uncouples, enters the main track and returns to Lawshe for the remainder of the train. When returning to Mt. Zion, the rear half of the train is stopped on the main track east of the crossover, the locomotive pulls the first half out of the siding and couples it to the rear half. Thus the train is then on the main track where it can get a better start to make the run between Mt. Zion and Winchester. On the siding at Mt. Zion the grade descends westward. Because cars left standing on this siding might start to roll, a switchpoint derail was installed on the siding at the west end. This derail is operated by a switch machine that is controlled by the same lever that controls the switch.

One purpose of the second siding at Mt. Zion, located on the south side of the track, is to improve the flexibility of train operation when a westbound train is doubling. Also, in numerous instances, the sidings at Mt. Zion are used effectively to advance freight trains from both directions to these sidings for meets with passenger trains.

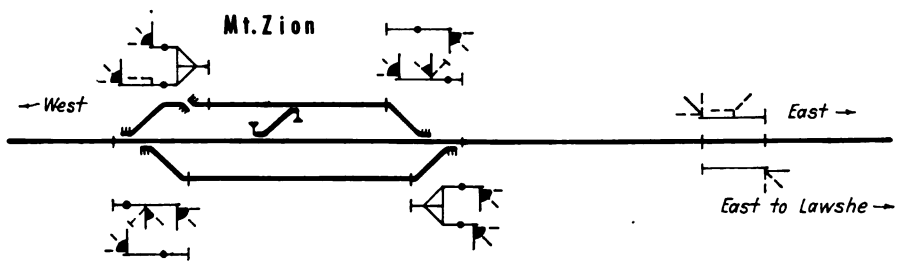


Fig 2—Track and signal layout at Mt. Zion

Special Signaling for Doubling

With timetable and train orders as used previously, a lot of time was lost when trains doubled the hill because the dispatcher had no means of knowing from minute to minute of the progress being made. Now, the track-occupancy lamps, on the dispatcher's C.T.C. machine, show the locations of the trains, and each move is authorized by indications of signals, which are controlled by the dispatcher on a minute-to-minute basis.

A special necessity when doubling a train is that an aspect must be displayed to authorize a locomotive to back down on portions of its own train which are occupying track circuits that automatically hold the signal at the Stop aspect. For example, when the rear half of a train is standing on the side track at Lawshe, the locomotive, backing down eastward, can be authorized to pass the signal by display of the restricted-speed aspect, which is a row of three lamps in the

left-hand 45-deg. angle. In order to control this aspect, the dispatcher not only sets the lever but also flips a small toggle switch, below the lever, before he pushes the code-starting button. The automatic controls at the field location include directional stick relays and time-element relays so that the restricted-speed aspect can be displayed on the signal, only when a train makes a westward move and then returns. Furthermore, a period of four minutes or more must elapse between the first move westward and the return.

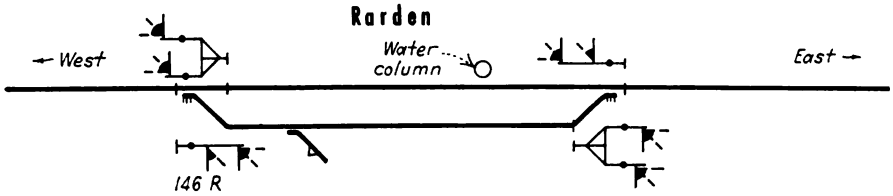


Fig. 3—Special signals at Rarden

Special Aspect at Water Stops

The sketch Fig. 3 shows the layout of the siding and signals at Rarden. When eastbound trains stop on the main track to take water, the rear of the train often extends beyond the switch at the west end of the siding. Accordingly, if the dispatcher has a westbound train waiting on the siding, or anticipates a meet at this point, he sends out a special control that in addition to clearing signal 146R, also causes a light to be displayed in a single lamp unit on a 5-ft. mast at the right of signal 146R. This special lamp is amber, and, when lighted, calls the engineer's attention to the word "Clear." This serves as an indication to the engineman of an eastbound train that he is not to stop until the rear of his train clears the siding switch. If he wants to take water, he must wait until the other train departs before backing up his train, so that his tender is opposite the water spout. Similar "Clear" signs are located at the east end of Rarden, and at Lawshe.

On account of the adverse grades, the freight trains are limited to tonnages which consist of not more than about 70 to 75 cars except for the eastbound trains of empty coal cars which may include up to about 125 cars. As listed in the table, most of the sidings have capacities of 80 to 133 cars. One reason for the extra length of sidings is to allow track lengths so that a train can enter a siding at the speed for which the turnout is designed, and, after the rear end is in the clear, still have track length in which to stop. Also the long sidings are an aid in permitting trains to make meets without either train being required to stop.

The turnouts at the ends of the power-operated sidings are No. 15 which are good for speeds up to 25 m.p.h. when entering or leaving. Each siding is equipped with a track circuit which enters into the control of the signals and also controls lamps on the C.T.C. machine to indicate track occupancy. The control is arranged so that the signal for entering a siding cannot be cleared if the siding is occupied. Thus when a Medium-Clear aspect is displayed, the engineman of an approaching train has confidence to pull his train into the siding at the speed for the turnout.

Approach-Medium Aspect

As advance information for enginemen to approach at that speed, the first signal in approach to each power siding switch is equipped with a second operating signal head. Such a distant signal displays the Approach-Medium aspect when the corresponding entering signal displays Medium-Clear.

A grade signal aspect is provided on each intermediate signal located on an ascending grade of more than 0.95 per cent. The most restrictive aspect of such a signal is a horizontal row of lights in the top unit, over a row of lights in the lower right-hand quadrant. This aspect authorizes trains to pass this signal without stopping, and proceed at restricted speed, prepared to stop short of train or obstruction.

The previous automatic block signaling included position-light signals which were retained in service in the new centralized traffic control. At the end of a siding, the main-track station-leaving and the leave-siding signal are both mounted on the platform of a bracket mast as shown in the track and signal plans.

Twelve hand-throw main track switches leading to house tracks, industries and storage tracks are located in the vicinity of Newtown and between there and Clare. In order to permit the local freight to continue switching in this area, without holding westbound trains at Ancor, a pair of C.T.C. lever controlled signals, 12L and 12R, is located east of Newtown. Switching moves can continue while a westbound through train is proceeding from Ancor. Then when the switching train clears the main track, the dispatcher can clear signal 12L to let the through train continue without stopping. On the other hand, if there is no westbound train approaching, and the local freight is ready to go east, the dispatcher clears eastward signal 12R.

Fewer Intermediates

In centralized traffic control the head-on protection for opposing moves between sidings is accomplished by the leave-station signals which are normally at stop, and are lever controlled. Accordingly in C.T.C., fewer intermediate signals are required than in the previous normal-clear automatic block, which, in some instances, required more intermediate signals to insure head-on protection. For example, between Lawshe and Seaman, 6 mi., there were previously five double locations of intermediate signals, as compared with only two now. Also between White Oak and Eastwood, about 4.6 mi., there were formerly four intermediates for each direction, compared with only two now. In the shorter station-to-station blocks, as for example 3.5 mi., between Macon and Sardinia, there were two double locations of intermediate signals compared with one now.

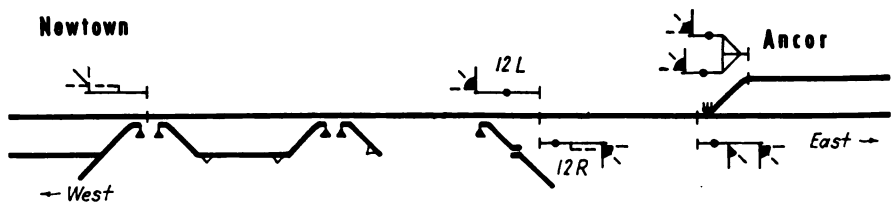


Fig. 4—Hold-out signals between Newton and Ancor

Electro-Pneumatic Switch Machines

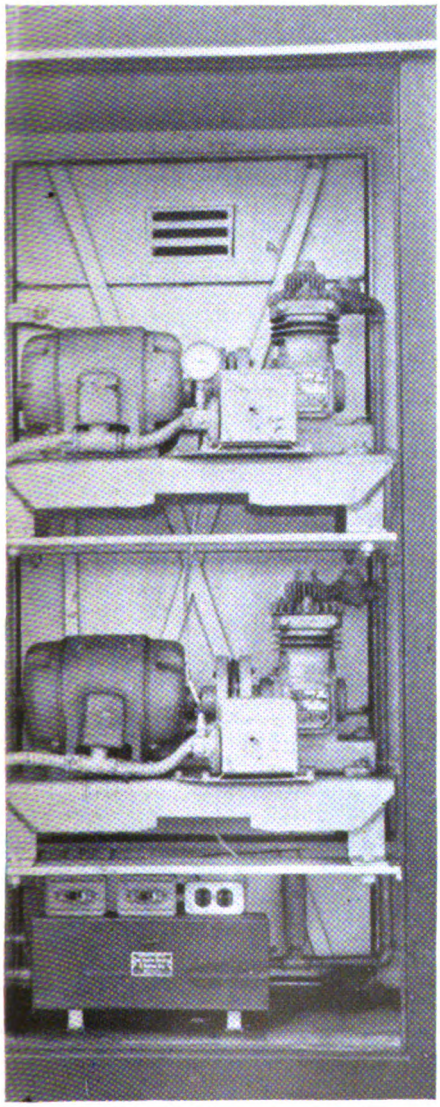
Each of the power switches is operated by a Type A-21 dual-control electro-pneumatic switch machine. When the selector lever is operated,

the air supply to the machine is cut off, the valve control circuits are opened, and an indication code is sent to the control office. Duplicate air compressors, each rated at 3.5 cu. ft. per min., are located at each siding switch to furnish air to operate the switch machine. Each compressor is driven by a 220-volt a.c. motor, rated at ¾-h.p. The compressors are controlled automatically; one being set to cut in at 55 lb. and cut out at 70 lb., while the other one cuts in at 45 lb. and out at 60 lb. Circuits are arranged in each duplicate compressor layout to initiate coding action to cause an audible and visual indication to be displayed at Portsmouth when air pressure drops below 45 lb.

New Hand-Throw Stands

Insulated gage plates 1 in. by 8 in. are used under the first two ties at each switch, and these plates extend and are attached to the switch machine, thereby preventing lost motion. Morden adjustable rail braces are used on a minimum of four ties.

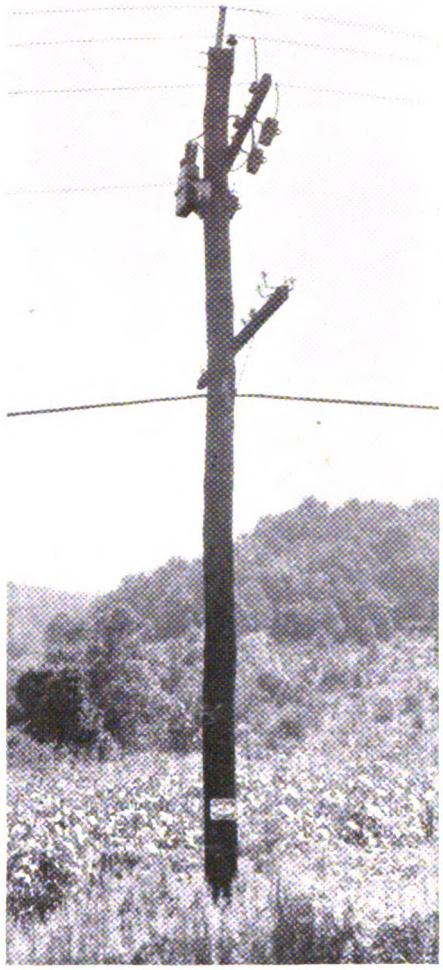
At various locations, house tracks and spurs are connected to the main track with hand-throw stands. At these locations the previous stands were replaced with T-21 hand-throw switch-and-lock movements including SL21 electric locks which locks the hand-throw levers in the normal position. At each of these locations a Hayes derail, located at the clearance point on the turnout, is pipe-connected to and operated by the T-21 stand. A telephone for communication with the dispatcher is located near each of these hand-throw switches.



At each power switch location there is a set of two air compressors rated at 3.5 cu. ft. p.m., driven by ¾ h.p. motors

Right — At locations subject to floods the instrument cases are mounted on high piles above the previous high-water level

Below—At the left of this pole opposite the crossarm there is 15 k.v.a. 4600-volt capacitor which improves the power factor on the power distribution circuit



Track Circuits and Local Controls A.C.

The previous automatic block signaling was straight a.c., including a.c. track circuits with Model 15 vane relays. These track circuits were retained in service except that d.c. track circuits are used where they also enter into the control of highway crossing signals. The 110-volt a.c. local line controls in the previous automatic signaling were retained in service. When installing the C.T.C., the Approach-Medium aspect was added on the intermediate signals in approach to sidings. By using a.c. from a transformer and d.c. from a rectifier, in combination with a 4 m.f. capacitor, the control of an Approach-Medium aspect as well as the track-occupancy indication of an intermediate track section are both handled over one wire and common.

The 4,400-volt, three-phase, 60-cycle power distribution line previously in service was continued in use. New surge-proof line transformers, 4,400/120 volt, rated at 3 kva. were installed at the end of each siding, and ¾ kva. at each intermediate signal. Ordinarily, an automatic substation at Seaman feeds the 4,400-volt power line in both directions, east to Vera and west to Clare. If the Seaman feed fails, then an automatic substation at Vera feeds west to Seaman, and one at Clare feeds east to Seaman.

At Rarden, which is about midway between Seaman and Vera, there is a three-phase 15-k.v.a. 4,600-volt capacitor which is used to improve the

(*Continued on page 753*)

C.T.C. on the N. & W.

(*Continued from page 745*)

power factor. On the west end a similar capacitor is located at Perintown. Indicator lamps on the C.T.C. machine show which sub-stations are feeding.

Rebuilt Pole Line

The pole line was rebuilt during the past few years, using 30-ft. Class 3 creosoted pine poles, spaced 130 ft. The 4,400-volt circuit is on No. 4 bare copper wire. The ground wire, which is on the top bracket, is three strands of No. 10 Copperweld. The line control circuits are on No. 10 Copperweld with braided covering. The two new line wires for the C.T.C. code are No. 8 Copperweld with plastic weatherproof coating known as Formix with Flamenal over all. This code line is transposed every eighth pole. As a means of reducing losses to the carrier and voice circuits, the cable drops for the C.T.C. code circuit are No. 14 wire with polyethylene insulation.

Interior of double instrument case at the signal and power switch location at a siding showing relays and equipment

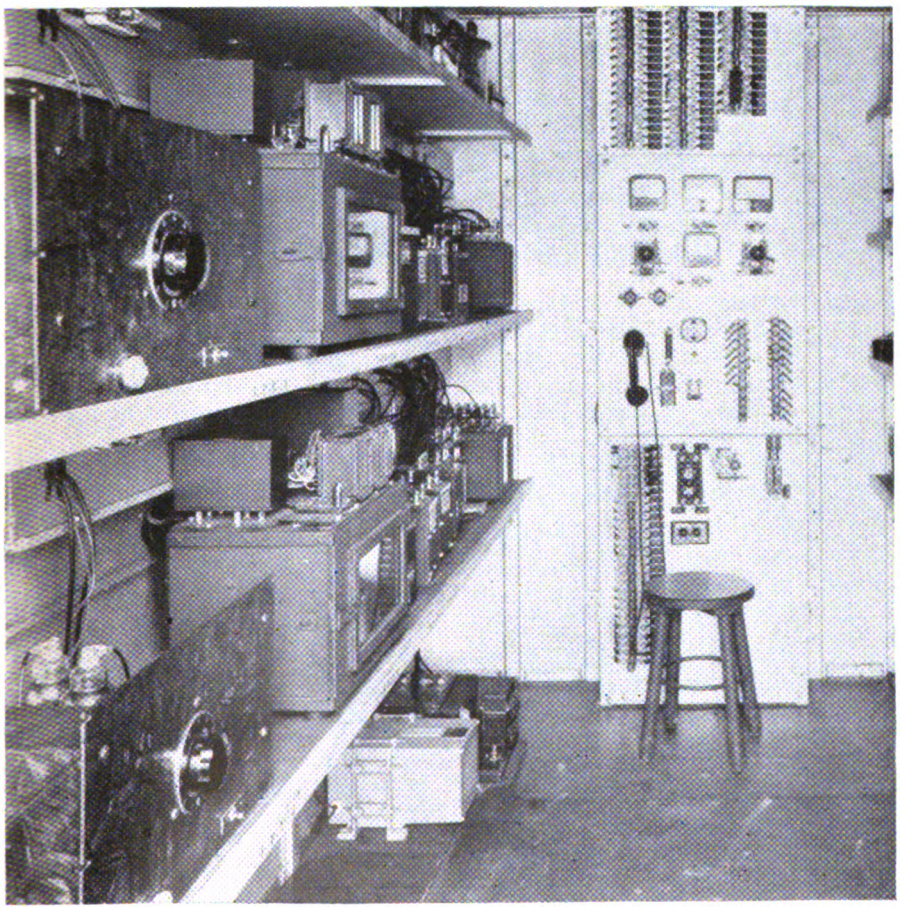
At all the principal stations, the code line is extended to a jack box in the office, so that if the code line wires break, a patch can be made around the break by utilizing one of the telephone line circuits.

Power Pack on Code Line

The C.T.C. code line is cut in two sections. The first section between Portsmouth and Winchester is handled by conventional d.c. codes, and the line wires in this section also handle carrier codes to and from Winchester where there is a coded carrier station, for the Winchester-Clare section. The carrier equipment in the control office and at Winchester are in duplicate and if one set fails, the circuit is switched to the standby set.

The C.T.C. code line circuit is fed at Portsmouth office and at Winchester by a power unit which consists of an arrangement of variable voltage transformers and electronic rectifiers in combination with the necessary filters. A Raytheon voltage stabilizer, rated at 500 watts, 115 volts, is used to regulate the voltage so that it does not vary more than 2 per cent. If the power pack in service should fail, the C.T.C. line is fed from a stand-by power pack, the cut over being automatic. At each field station, the d.c. power is supplied from a set of 8 cells of 40-a.h. storage battery.

This centralized traffic control was planned and installed by Norfolk and Western forces under the direction of J. A. Beoddy, superintendent of telegraph and signals, the major items of equipment being furnished by the Union Switch & Signal Company.



Instrument house showing power packs at left foreground