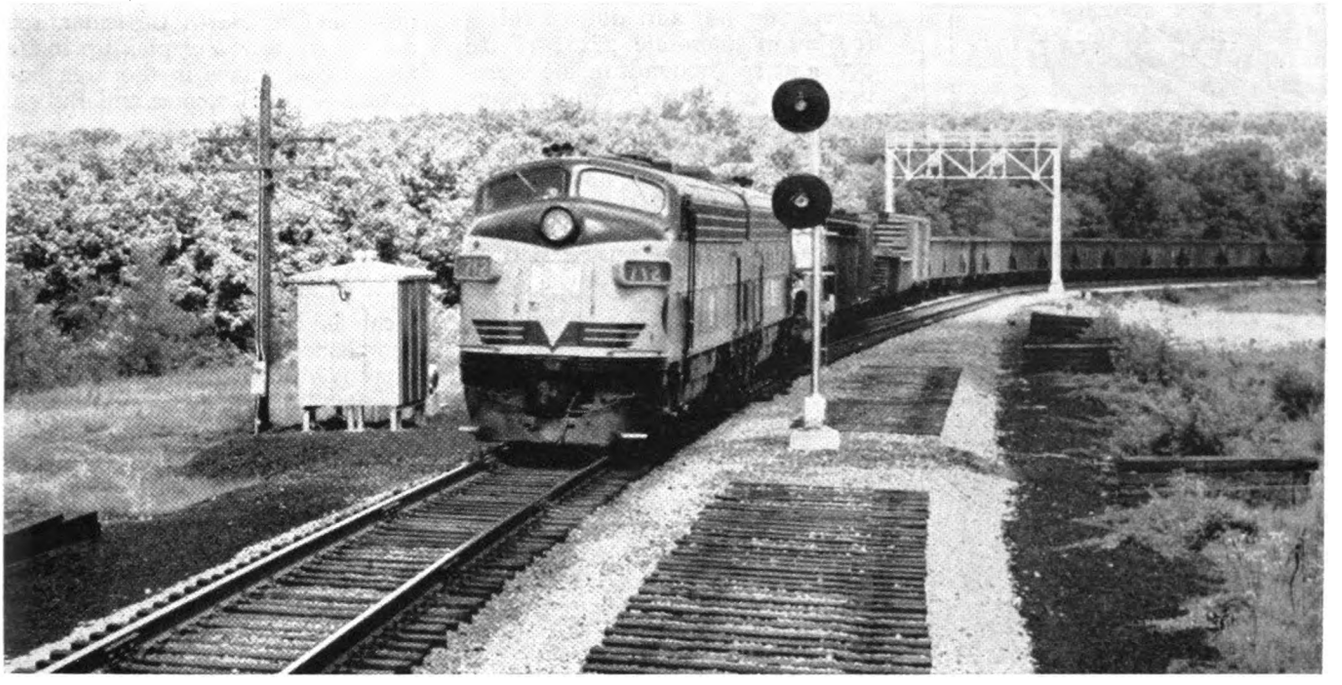


Bessemer Takes Up Second Track

and Installs Centralized Traffic Control

On 125 route miles, track changes permitted retirement of 63 miles of main track and 13 miles of sidings—Adequate track capacity was derived by new signaling system, which eliminates previous train delays—Advanced warning, displayed by signals, permits increase of 5 mph in maximum permissible speeds

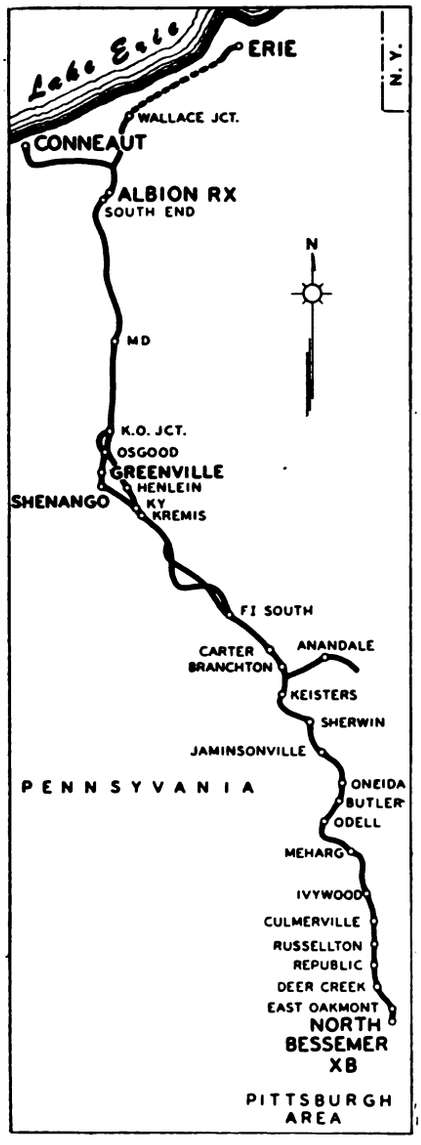
THE BESSEMER & LAKE ERIE is one of the principal rail links between the Great Lakes and the heavily industrialized Pittsburgh metropolitan area. An all-freight railroad, the B&LE's northern terminals are at Conneaut, Ohio, where extensive dock facilities are located; and at Erie, Pa., where there are several interchange connections. From these points the Bessemer extends south to North Bessemer, Pa. (near Pittsburgh), where it connects with the Union Railroad, an important local switching road serving steel mills and industries, and with other lines in the Pittburgh area.

The preponderance of the Bessemer's traffic is iron ore tonnage from the docks at Conneaut, being moved to Pittsburgh or Youngstown. Traffic to and from the latter point is interchanged with the Erie or Pennsylvania at Shenango, 55.7 miles south of Conneaut. Northward, the principal traffic is coal, most of which comes from mines in the area between North Bessemer and Butler, and is moved to interchange points or to the docks for lake shipment. Movement of limestone for the Pittsburgh steel mills is also important. This traffic funnels in three ways: it originates at a quarry at Annandale, on a B&LE branch; it is moved from the dock at Conneaut; and it is received in interchange from the Western Allegheny Railroad which connects with the Bessemer at Queen Junction, Pa.

The hub of operations at the north end of the railroad is a large yard located at Albion, Pa. On the 125 route miles between Albion and North Bessemer, the B&LE has installed centralized traffic control on 184.7 miles of track. Of this total, 19.6 miles is signaled in one direction only, 157 miles is signaled in each direction, and there are 8.2 miles of non-signaled passing sidings.

This CTC project is an extension of the installation previously in service between Filer and Meadville Junction, 42 road miles. On the remainder of the railroad, there was no automatic signaling; train movements were authorized by manual block. The 1956 CTC installation permitted retirement of a total of 63 miles of main track and 13 miles of sidings. However, some portions of the previous second main track were converted to sidings with hand-throw switches, used by road switcher crews to serve house tracks at Grove City, 2 miles; Fredonia, 1.5 miles; Conneautville, 1.5 miles; and Springboro, 1.5 miles, totaling 6.5 miles.

This railroad traverses rather rough country with numerous



curves, up hill and down, with a maximum main-line grade of 0.6 per cent southbound, in the direction of the heavy ore tonnage movement. A locomotive consisting of four diesel units, rated at a total of 6,000 h.p., handles about 13,000 gross tons in this direction. The maximum permissible train speed is 45 mph, with numerous restrictions on curves and in some towns.

Pattern of Train Movements

Train movements fall into three general groups: transfer moves, through freights, and road switchers. North of Albion, train operation is in the nature of transfer moves, to and from Erie, 23 miles, and to and from Conneaut, 14 miles. Southward road trains are dispatched from Albion; northward they are broken up at that point. When a loaded ore boat is due at Conneaut, cars must be on hand to unload the ore as a continuous operation. Loaded southward ore trains move out of Albion about three hours apart, and during the season of open navigation on the Great Lakes about nine daily freight trains are operated in each direction. The average number of loaded ore cars handled in a 24-hour period may range up to 800 or more.

Northward, throughout the year, one fast symbol train is operated, with scheduled connections at Shenango with the Erie, and at Wallace Junction, Pa., with the Nickel Plate. The road switcher crews move out of North Bessemer, set out empty cars and pick up loads at the coal mines in the area between North Bessemer and Butler.

Modern Coded Track Circuits

An important feature of this B&LE project is the use of a modern form of d.c. coded track circuit equipment, by means of which the local field signal controls are accomplished entirely by rail circuits, thereby obviating the need for line-wire control circuits. Track circuit code at the rate of 180 per minute establishes control for the Clear aspect; 120 code for the Approach-Medium aspect, and 75 code for the Approach aspect. Absence of code, or the presence of steady energy, results in display of the most restrictive speed.

In territories signaled for train operation in both directions, track circuits are of the reversible coded type, normally energized with non-coded energy. Coded energy is applied to the rails in the direction opposite that of train operation when the entering signal is cleared or the block is occupied. The non-coded energy is applied for block indication and locking purposes. The signal lamps on controlled signals are normally lighted. Intermediate automatic signals are block lighted. Approach indications in double-track territory are secured by means of reverse code which feeds in the same direction as the trains operate. The pulsations of this reverse code and of the signal

Train Performance Improved

Despite the 63-mile reduction in its main track, the installation of a CTC system has enabled the Bessemer to improve its train movement performance. Now, as before, southward loaded trains are given preference, and these are moving at a higher average speed than previously. Under the former manual block system, trains approached block stations at reduced speed, prepared to stop, until the home signal aspect was visible to the engineman. At present, under CTC, train movements are authorized not only by home signals, but also from corresponding approach signals, so that, in every case the enginemen have advance information, and, therefore, no unnecessary speed reduction is required when approaching any signal. The new system also includes complete automatic block protection against trains ahead, broken rails, cars on foulings and spur track switches. Thus, the enginemen have confidence that they can, with safety, hold their trains consistently nearer to the maximum authorized speed. That the new signaling permits a higher safe speed was the primary factor in a decision to raise the maximum speed from 40 to 45 m.p.h. This, in turn, has enabled the loaded ore trains to make better time.

With about three-hour southward through train spacing, there is plenty of opportunity to use the power sidings and double track sections to expedite northward train movement, which in most of the cases equals or betters previous performance. Road-switcher crews also reflect improved performance. Under the previous train order and manual block operation, a road-switcher would be given authority to use a section of main track in such a manner as to get into the clear well before the anticipated arrival time of a through train. If the through train was unexpectedly delayed, the road-switcher wasted time because the dispatcher lacked a means of communicating with its crew. Now, all hand-throw main track switches have electric lock protection (except in 20 m.p.h. territory), and indications on the dispatcher's panel show the location and progress of every train on main track. With this protection and information, the dispatcher can work closely with each road-switcher crew to save time. This has enabled savings of 20 minutes or more in single moves by road-switcher crews. Since these crews can perform more expeditiously, better service to shippers results.

control code are intermittently spaced. Time locking, rather than approach locking, is used so that no reverse coding or line wire circuits are required for locking purposes. In single-track territory track-occupancy indications are controlled to reflect an entire station-to-station block. No line wires were required for extensions of track-occupancy controls from intermediate track circuits to field coding stations.

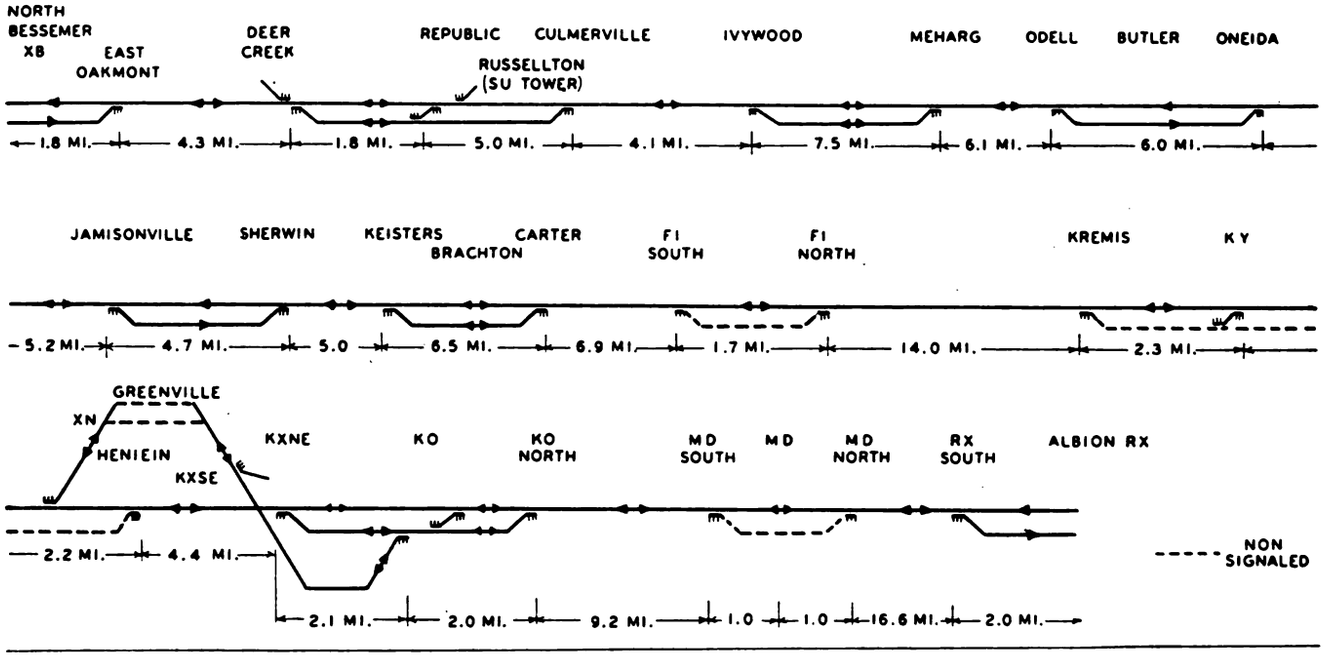
Special Starting Signal

A special starting signal has been installed to meet operating requirements peculiar to Curtisville, a single point on the line. At Curtisville yard, northward trains customarily set out or pick up cars on trackage which is beyond the range of vision of the next northward CTC controlled signal. Thus a further movement northward, after such work, may encounter a Stop indication when the signal is visible. Such a stop would however, block important street crossings, and for this reason a special starting signal is located to the right of northward track just south of Curtisville road crossing. This starting signal displays the letter "S" whenever the northward home signal at Culmerville is displaying a proceed aspect.

Protection at Hand-Throw Switches

Another important element of this project is the protection afforded at hand-throw main track switches and crossovers. In this CTC territory there is a total of 68 main track hand-throw switches leading to spurs serving industries, mines, or freight houses. At each of these main track switches, the previous conventional stand was replaced with a Style T-21 hand-throw switch stand. A lift-type derail, located at the clearance point, is pipe-connected to a lock-bar operating lever stand, on the ends of the ties about 9 ft. from the points of the switch. Pipe connections from this stand extend to the lock plunger in the T-21 stand at the switch. The lock-bar operating stand, which operates the derail and the T-21 lock rod, includes a Style SL-25 electric lock.

For a move from main track into a spur, control of the release of an electric switch lock is automatic.



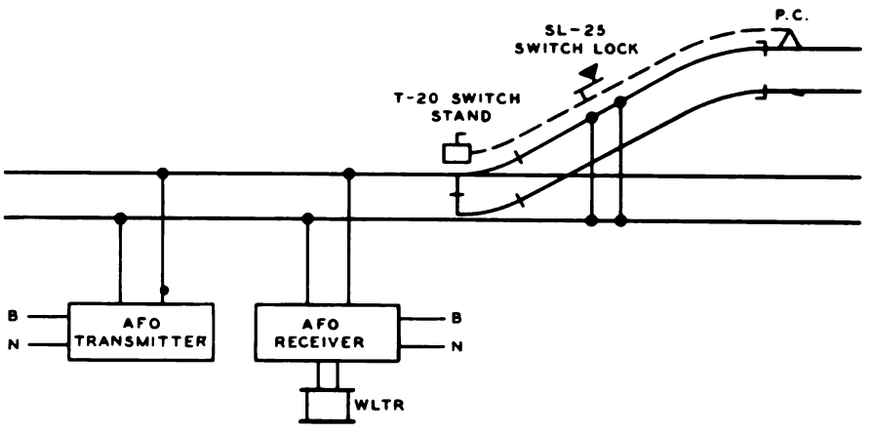
	Double Track Signaled in Each Direction	Single Track	Double Track Signaled in One Direction Only	Non-Signaled Passing Siding
XB to E. Oakmont	..	..	3.54	..
E. Oakmont to Deer Creek	..	4.36	..	..
Deer Creek to Republic	3.44	..	..	..
Republic to Culmerville	10.22	..	..	..
Culmerville to Ivywood	..	3.93	..	..
Ivywood to Meharg	14.92	..	..	..
Meharg to Odell	..	6.25	..	..
Odell to Oneida	..	..	12.26	..
Oneida to Jamisonville	..	5.00	..	..
Jamisonville to Sherwin	9.56	..	..	..
Sherwin to Keisters	..	5.12	..	..
Keisters to Carter	12.68	..	..	..
Carter to FI South End	..	6.61	..	..
FI South End to FI North End		1.68	..	1.68
FI North End to Kremis	..	14.01	..	..
Kremis to KY	..	2.38	..	2.38
KY to Henlein	..	2.14	..	2.14
Henlein to KX South End	..	4.39	..	..
KX South End to KX North End		0.44	..	..
KX North End to KO	3.92	..	..	..
KO to KO North End	4.12	..	..	..
KO North End to MD South End		9.15	..	..
MD South End to MD	..	1.48	..	1.48
MD to MD North End	..	0.50	..	0.50
MD North End to RX South End		16.60	..	..
RX South End to RX	..	..	3.76	..
Road Mileage KY to KO via Shenango:				
KY to XN	..	4.27	..	..
XN to GV (Operated under Yard Rules)	4.00	..	..	..
GV to OW	..	2.85	..	..
OW to KO	..	3.00	..	..
	62.86	94.16	19.56	8.18

Total Track Mileage. 184.76

However, for a move from a spur to a main track, the dispatcher controls release of the electric switch lock. When a switch engine crew is to serve such a siding, and a release of the electric lock has been secured, a trainman operates the lock-bar operating stand which removes the derail from the track, and pulls the lock plunger from the T-21 stand at the switch. Then the trainman throws the T-21 stand to operate the switch. This arrangement serves two purposes: (1) to place operation of derail and switch on separate stands, thereby reducing the required physical effort; and (2) to permit the derail to be removed independent of the switch operation, thereby permitting "flying switches" to be made.

At 13 crossovers between the two main tracks, the previous switch stands were replaced by Style T-21 stands including Style SL-25 electric locks. At 14 crossovers between a main track and secondary house tracks or sidings, the old switch stand on the main track switch was replaced with a T-21 stand. In such cases the operating lock rod stand controls a bolt lock on the siding end.

One stand operates derail and another operates the switch



Overlay circuit eliminates a separate track circuit for lock

Audio-Frequency Overlay Track Circuits

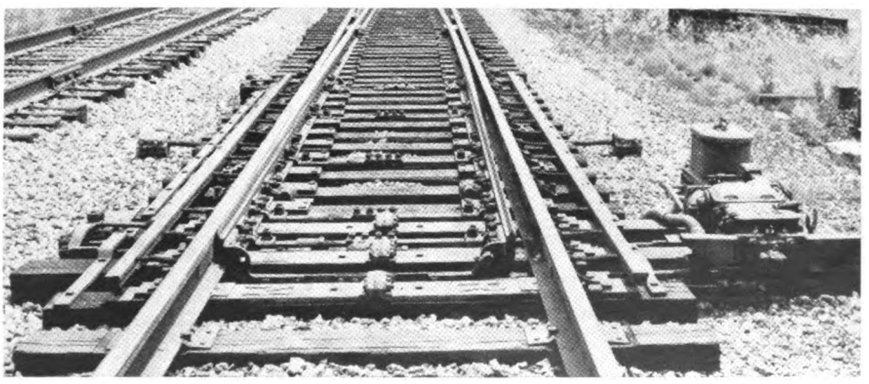
A new first, applied extensively on this project is the audio frequency overlay (AFO) track circuit which is used for the automatic release of the electric locks on hand-throw switches. Instead of employing separate short releasing track circuits, the AFO circuit is superimposed on the existing track circuits with no mutual interference. Using audio frequency overlay equipment has eliminated the need for insulated joints at these sidings and at the same time has reduced the number of track connections by one half.

Output of the audio frequency transmitter is applied directly to the rails. The receiver, tuned to the selected frequency, receives the signal, and operates the track relay WLTR. When a train is to enter such a turnout, the locomotive stops within approximately 120 ft. of the switch. This shunts the AFO circuit, and WLTR releases, allowing the lock magnet to be energized when the padlock is removed from the lock latch. Hermetically sealed junction-type transistors are used in the transmitter and receiver, eliminating the need for vacuum tubes.

The power switch machines on this project are of the Style A-21 electric-pneumatic type with dual-control levers for hand operation during special switching movements. Several factors motivated the choice of electro-pneumatic in preference to electric switch machines for this project. Rail weights on the Bessemer vary from 130 lb. upward to 155 lb., and the switch points on the No. 20 turnouts are 39 ft. long. The electro-pneumatic machines are able to move these heavy switch points with sufficient snap to crush ice, chunks of coal or twigs which may be fouling the points.

Each switch machine has two cylinders, one each for operating the switch to the normal and to the reverse position. The cylinders are 6 in. in diameter and the stroke is 11 in. The air pressure is controlled between a maximum of 85 and a minimum of 70 lb. The air valve at each switch is turned down so that, under normal conditions, the switch goes over without banging. On the other hand, if the switch hangs or does not start easily, the pressure builds up to snap the points over.

At each single switch the compressed air is furnished by a duplicate set of air compressors, each rated at 4.2 cubic feet per minute. At layouts, including a single switch and a crossover, the compressors are rated at 9.2 cubic feet. If the pressure falls to 70 lb., the No. 1 compressor begins to operate until the pressure is increased to 85 lb. If the No. 1 compressor fails to



Switch machines are dual-control, electro-pneumatic

NAME	INDICATIONS	ASPECTS	NAME	INDICATIONS	ASPECTS
CLEAR	PROCEED	G R; G R DARK NUMBER	MEDIUM APPROACH	PROCEED AT MEDIUM SPEED PREPARING TO STOP AT NEXT SIGNAL	R FY
APPROACH LIMITED	PROCEED APPROACHING NEXT SIGNAL AT LIMITED SPEED	G FY; G FY NUMBER	SLOW CLEAR	PROCEED, SLOW SPEED WITHIN INTERLOCKING LIMITS	G
LIMITED CLEAR	PROCEED, LIMITED SPEED WITHIN INTERLOCKING LIMITS	G Y	SLOW APPROACH	PROCEED PREPARING TO STOP AT NEXT SIGNAL. SLOW SPEED WITHIN INTERLOCKING LIMITS	FY
APPROACH MEDIUM	PROCEED APPROACHING NEXT SIGNAL AT MEDIUM SPEED	Y G; Y G NUMBER	RESTRICTING	PROCEED AT RESTRICTED SPEED	R Y; R Y NUMBER Y
MEDIUM CLEAR	PROCEED, MEDIUM SPEED WITHIN INTERLOCKING LIMITS	R FG; FG	STOP	STOP	R R; R DARK NUMBER R
MEDIUM APPROACH MEDIUM	PROCEED, MEDIUM SPEED WITHIN INTERLOCKING LIMITS APPROACHING NEXT SIGNAL AT MEDIUM SPEED	R G	FY=FLASHING YELLOW FG=FLASHING GREEN		
APPROACH	PROCEED PREPARING TO STOP AT NEXT SIGNAL. TRAIN EXCEEDING MEDIUM SPEED MUST AT ONCE REDUCE TO THAT SPEED	Y R; Y DARK NUMBER			

Flashing Aspects Save One "Arm"—The aspects and indications as developed by the B&LE for use on this CTC are shown in chart herewith. By maximum use of flashing aspects, it was possible to utilize "two-arm" signaling to provide all of the aspects required, without going to "three-arm" signaling. The system provides a limited-speed aspect for diverging moves over No. 20 turnouts at 40 mph; medium-speed aspect for diverging moves over No. 16 turnouts at 30 mph; and 15 mph for diverging moves over No. 11 turnouts.

start, or if the pressure falls to 60 lb., then the No. 2 compressor cuts in and cuts out at 75 lb. In the meantime, a low-pressure indication is sent in to the CTC machine in the dispatcher's office.

The compressor motors operate on 220-volt a.c., each 4.2-cubic feet compressor being operated by a 1-hp., and each 9.2-cubic feet compressor by a 2-hp. motor. In case the a.c. power is out of service, the supply of compressed air in a reservoir, starting at 70-lb. pressure, will operate a single switch a total of 20 times, which is more than the number of times that any switch would normally be operated for train service in a 24-hour period. A further standby is that the dual control lever can be used to operate each switch by hand if all other means fail.

Adjustable rail braces and insulated gage plates ⅝-in. thick and 7 in. wide, are used on three ties under each switch. On two of these ties the plates extend under and are attached to the switch machines, thus preventing lost motion.

Electric Snow Melters

Each of the power switch layouts in this project is equipped with a set of electric snow melters which are controlled by the dispatcher through the CTC system. Each heater coil is enclosed in a metal pad, 3 in. wide by 15 in. long by ¼ in. thick, which is held flat against the gauge side of the web of the rail by a bolt through the web. Each switch has 24 such heater units, each of which is rated at 500 watts. Starting from the switch point, the first 8 units are energized at 220 volts. The remaining 16 units are connected in series-multiple to operate at 55 volts on each unit. Based on weather reports and phone reports from railroad employes along the line, the dispatcher determines when snow storms are expected or have started. He then sends out CTC controls to energize the electric switch heaters. In general the heaters are turned on during any low-temperature period, especially over weekends.

At each power switch layout the relays, rectifiers and battery are located in a sheet-metal instrument house. Each house is equipped with a 1500-watt electric heater which, in cold weather, is automatically controlled by a thermostat to keep the temperature in the house at about 32 deg. F. A small 15-watt electric heater coil is located in the controller compartment of each switch machine.

Snow melter coils, ¼ in. thick, 3 in. wide and 15 in. long, are bolted to the gage side of web of rail

Telephone Communications

On the right side of the control panel on the CTC machine, there is a cabinet section which holds the sending keys for the selectors of the telephone train dispatching circuit for Bessemer trackage north and south of the CTC territory. Thus the dispatcher has within reach all the facilities for authorizing trains over the whole railroad.

The two line wires for the CTC line coding system are used also for a telephone circuit connecting telephones in the instrument houses at the various controlled locations. This telephone equipment is used by the signal maintenance forces when communicating with the dispatcher or with each other.

This centralized traffic control project was planned and installed under the jurisdiction of J. E. Yewell, chief engineer, and under the immediate supervision of G. R. Pflasterer, signal engineer. The major items of material, as well as the detail circuit plans, were furnished by the Union Switch and Signal Division-Westinghouse Air Brake Company, which also handled the field construction.