

not delay through trains, as the train sign after going to "train" gives them plenty of time to clear the main line for operating through trains. To handle this scheme we have telephones located at the following places: Fort Worth yard office, Passenger station train shed, Signal 3462, Signal 3464, Signal 80, Signal 61, Signal 62, White Eagle refinery track, cement track, Saginaw tower, North Fort Worth tower.

What This Control Has Accomplished

The new control has made it possible for switch engines to work between Fort Worth and Saginaw without train orders. There are about five engines working each twenty-four hours, which alone is a big time saver. There are also a number of trains which arrive at Fort Worth from the South with stock. These trains set out their stock at North Fort Worth, pick up the loads and empties at North Fort Worth for the South and return to the first division point which is Cleburne. After a train arrives at Fort Worth the movements between Fort Worth and North Fort Worth and return are made without orders.

Another thing accomplished is a saving of time for through trains as none of the through trains have to stop to get orders against switch engines as they did before. It has also reduced the work of the dispatcher because he had a great amount of orders to issue before this control was effected. Before the control was put in be-

tween North Fort Worth and Saginaw, a switch engine would often meet a through train between these points at the staggered signals and the switch engine would have to back up to North Fort Worth. With the new control it is possible to handle these movements with dispatch and safety.

By giving the towerman control of both passing track switches at North Fort Worth, we are able to handle through trains through North Fort Worth without stopping them. The yard at this point is limited for room and the switch engine most always has the main line blocked with cars or is switching on it. The towermen now are able to put through trains through the passing track which moves them through this point and north-bound trains over the one per cent grade without stopping them. The turnouts of the passing tracks have No. 14 frogs and are safe for at least 30 miles per hour. The control has also cut out operators at North Fort Worth.

We have also been able to handle more switch engine moves between Fort Worth and North Fort Worth to make important transfers which could not be made before this control, as there were many times when the dispatcher could not put out orders for switch engines to move between these points on account of through trains having passed the last open telegraph station. This enables us to make frequent and important transfers necessary to be made at North Fort Worth.

Multiple Track Operation by Signal Indication

By J. E. SAUNDERS

Signal Engineer Delaware, Lackawanna & Western, Hoboken, N. J.

TRAIN operation by signal indication as defined by the train rules of the American Railway Association is the movement of trains with or against the current of traffic on two or more tracks "by block signals whose indications will supersede time-table superiority and will take the place of train orders."

Train operation by signal indication with the current of traffic is in use on all of the two and four-track lines of the Lackawanna, which comprises 51 per cent of its entire mileage. Reversible train movement on certain tracks, governed and protected entirely by signal indication, is also in operation on that portion of the road where traffic density is greatest. The scope of this paper is limited to the section last mentioned.

The Lackawanna passenger traffic through Hoboken terminal amounts to 70,000 persons on each week day. It requires 260 schedule trains to haul these people, most of whom are commuters. The Hoboken terminal has 14 platform tracks, now being increased to 17. Two large electro-pneumatic interlocking plants control train movement on three through tracks, increasing to four at the Bergen tunnels. An electro-pneumatic interlocking at West End controls train movements to and from Bergen tunnel and the junction of the two main lines, one double track westward through Boonton, and one three-track leading southwest to Morristown, Montclair and Gladstone. Practically 80 per cent of the passenger traffic comes over the last mentioned line, while most of the freight business is routed via Boonton.

The three-track line is unbroken from West End to Millburn, a distance of 14.8 miles, except at two drawbridges at the Hackensack and Passaic rivers, where but two tracks are available. Within this 14.8 miles are five electro-pneumatic interlockings, at West End, Lower Hackensack drawbridge, Harrison, Newark, Roseville

Avenue (where the Montclair branch joins the main line) and Orange; one electro-mechanical plant at South Orange, and two mechanical plants at Passaic drawbridge and Millburn. Automatic block signal protection is provided throughout.

Through passenger and suburban express trains run from Hoboken to Newark, at least, without stopping, usually at speeds of from 30 to 50 miles an hour. From Newark westward trains may continue without stopping, or during the rush hours make staggered stops, in order to utilize the outside tracks to their greatest capacity. The middle track is reserved for express trains. Freight trains are moved into and out of Harrison and Newark yards as well as various industrial sidings in the vicinity. The Passaic river drawbridge is double-decked to avoid interference between passenger and freight traffic.

Cause and Effect of Delays

It is essential to satisfactory service where traffic density is so great that trains run on time. A delay to one train rapidly becomes cumulative in its effect. A year in and year out record of Lackawanna suburban train movement shows 94 per cent of all trains on time. The cause for nearly 3 per cent of the delays is open drawbridges. It is interesting to note that a record of the past year shows that signals indicating stop caused only one-tenth of 1 per cent of the delays, and most of these were not due to signals being out of order.

Two hundred and twenty-eight trains is an ordinary week day record. This is an average of one train for each six and one-third minutes. As a matter of fact, these trains are bunched which requires that they run on the same track with a headway from two to six minutes during the rush hours of morning and evening. For an average length block (1,930 feet, from which

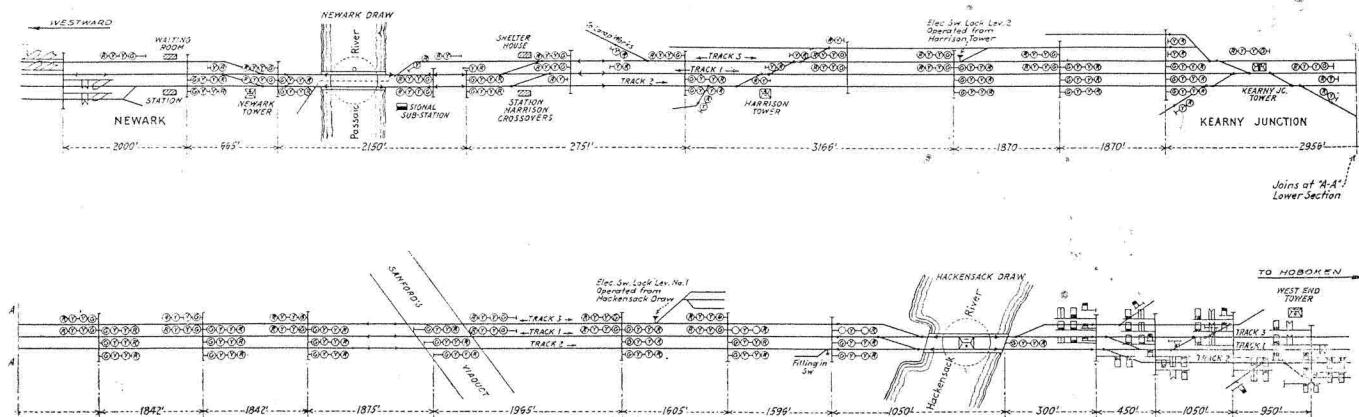
the variation is not great) trains on a two-minute headway must maintain minimum speeds as follows: Thirty-six miles an hour on "clear signal indication"; twenty-five miles an hour on "approach restricting" signal indication; 14.3 miles an hour on "approach" signal indications.

Special Arrangement to Handle Traffic

To handle this traffic on but three tracks it is absolutely necessary for eastward trains to move over certain tracks in the morning, and for westward trains to

ing interlocking plants. An automatic inter-control of levers at adjoining plants known as traffic locking, safeguards reversal of traffic. A signal cannot be cleared for a train to enter a section of track between interlocking plants which is occupied or about to be occupied by a train running in an opposite direction. The automatic signals between towers are controlled for one-way traffic, so that one train can follow another running in the same direction the same as on double track.

The instructions concerning the use of reversible



Signaling Plan for Handling a Heavy Commuter Traffic on the Lackawanna by Signal Indication

use the same tracks at night. Provision must, therefore, be made for the following routing of trains:

- Hoboken to West End: Tracks 1 and 2 reversible.
- West End to Hackensack bridge: Track 1 reversible.
- Hackensack bridge to Newark: Tracks 1 and 3 reversible.
- Track 2 also reversible over Hackensack and Passaic bridges.
- Newark to Millburn: Track 1 reversible.

The natural consequence is that two tracks from Millburn to Harrison and all three from Harrison to Hackensack bridge are used for eastward trains during the rush hours in the morning, and two tracks throughout used for westward trains during afternoon and evening. Thus three tracks are made to provide a capacity equivalent to four with undirectional train movement.

All train movements in this district are directed by train dispatchers located at Hoboken. Under normal conditions each scheduled passenger train has a regular track assignment. This may be varied by instruction of dispatchers and co-operation between levermen at adjoining

tracks by trains are very simple. "Current of traffic will be authorized only by interlocking signals. Enginemen will accept signal indications as per track assignment." There is also the following provision, "Interlocking home block signals at the entrance to each block must not be passed when indicating 'stop' without clearance card, Form B, issued by towerman, which will be authority for proceeding as per Rule 705." Rule 705 is the customary rule outlining engineman's responsibility when passing an automatic block signal which indicates "Stop, then Proceed."

To evaluate the facility provided by the reversible tracks through this district, we can compare the cost of reverse traffic signaling on one track with the cost of a fourth running track from Hackensack bridge to Millburn. To signal one track already providing protection for trains in one direction, for reverse train movements, would cost approximately \$90,000, while the cost of a fourth track would run into some millions.

Excellent Results for 35 Years on Burlington

By J. B. LATIMER

Signal Engineer, Chicago, Burlington & Quincy, Chicago

IN 1888 the first 19 miles of the main line of the Chicago, Burlington & Quincy, westward from Chicago, consisted of four main tracks, Canal street, Chicago to the station at Hawthorne, a distance of approximately 5.5 miles, and three tracks from Hawthorne to Downer's Grove, 14 miles farther. From Downer's Grove to West Burlington, Ia., 190 miles was double track.

In that year we installed two electro-pneumatic interlocking plants in the Chicago yard, one at Western and one at California avenues. The four track line had two tracks assigned to passenger and two to freight service. Mechanical interlocking plants were in service at Throop street and Wood street, east of Western avenue and at Hawthorne, west of California avenue. This made five interlocking plants in a distance of less than five miles

and it was decided to use them as block stations and operate trains by block signals in this territory. As it was all in Chicago yard limits, no orders were issued and trains were moved by signal indication only. Moving trains by signals soon demonstrated its advantages to our operating officers and in 1889 it was decided to extend the system to Aurora, 37 miles west of Chicago.

Regular stations were used for block stations, where practicable, but several special block cabins were built. There were seven blocks on the three track line between Hawthorne and Downer's Grove, averaging 1.75 miles long, and eight blocks on the double track between Downer's Grove and Aurora, averaging two miles long. These block signals remained in service until replaced by automatics in 1914—25 years of faithful service.