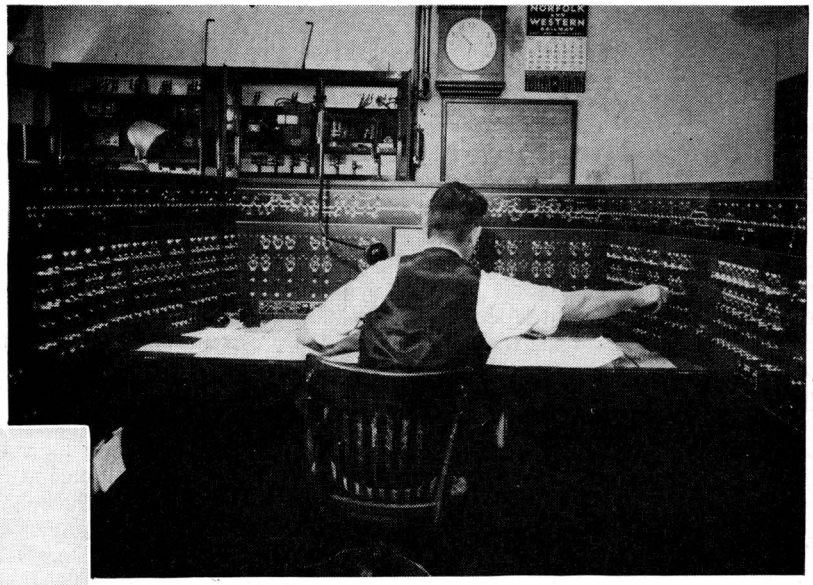


Right—The control machine for the territory between Bristol and Radford is in the dispatcher's office at Roanoke. Below—The main-track signal and the siding signal are on a high bracket mast

N. & W. Installs C. T. C. on 107 Miles

Saves train time and increases capacity of busy single-track line handling 10 passenger trains and 14 freights daily

As a means of facilitating train movements and securing maximum operating capacity of an existing single-track line, the Norfolk & Western has installed centralized traffic control on 1.2 mi. of double track and 106.7 mi. of single track between Radford, Va., and Bristol. On this territory, known locally as the Bristol line, train movements were formerly authorized by timetable and train orders, automatic signaling being provided as protection, and the siding switches were operated by hand-throw stands. With the C.T.C., the siding switches are operated by power machines, and signals at the sidings, under the control of the dispatcher, display aspects to authorize train movements.

This line between Radford and Bristol is a portion of a very old railroad known as the Virginia & Tennessee, built between 1854 and 1856. From Radford it extends in a southwest direction through valleys between the Appalachian and the Cumberland mountain ranges. Although there are no long, steep grades, there are numerous short rolling grades, as well as some ranging up to 1.4 per cent extending for as much as three miles. The curves are numerous, with many ranging up to 4 and 5 deg. and several up to 7 deg. Even so, the engineers who located the original line did commendable work, and present-day reconstruction to reduce grades and curvature through this territory would involve expenditures beyond what could be justified economically. Therefore, as the traffic gradually increased, the policy has been to leave the line and grade practically as constructed, but to apply modern improvements to facilitate train movements and increase the track capacity.

The track is constructed and maintained to withstand heavy traffic at maximum train speeds permitted by the curvature. All trains are operated by steam locomotives, which are designed not only to take the curves at safe speeds but also to take the trains around the curves and up and down the grades at a uniformly constant speed.

Heavy Traffic Moved

The territory is thickly populated, requiring local passenger-train service as well as local freight service. A map of the Norfolk & Western shows the importance of this Bristol line and other portions of the N. & W. as part of a through route, in cooperation with the Southern and other railroads, between eastern cities and Knoxville, Tenn.,

Chattanooga, Memphis, Birmingham, Ala., and New Orleans, La. A local passenger train, a mail and express train and three through passenger trains are operated each way daily. A local freight is operated each way daily, except Sunday and several time freights are operated as required. On the average, there are 10 passenger trains and about 14 freight trains daily over this territory, plus some intermediate shifting and shuttle service. Except for the locals, all the trains are operated in connection with other railroads in through schedule service, and, therefore, on-time operation is especially important.

Sidings Readjusted

Since the grades and curvature could not be improved readily to permit faster train speeds, the Norfolk & Western decided to install complete centralized traffic control as the best means of handling approximately 24 trains daily and maintaining uniformly fast schedules.

Not counting yard territories at Radford, Pulaski and Bristol, there were previously 25 sidings which were used regularly for meeting and passing trains. Within recent years, 10 of these sidings had been lengthened to capacities ranging from 103 to 132 cars. As part of the 1946 program, 4 more, at Clark, Rural Retreat, Atkins and Meadow View, were lengthened to hold 134 to 137 cars. These 14 long sidings, as well as 8 sidings with capacities ranging from 48 to 85 cars, were equipped with power switches and controlled signals in the C.T.C. system. This left 3 of the previous sidings. One of these, at Emory, was partially removed, leaving one switch leading to a spur. The 38-car siding at Wallace was left with hand-throw stands for use as a house track. A second of two sidings at Glade Spring was left with hand-throw stands. The locations and car capacities of the 22 C.T.C.-equipped sidings, as well as distances between the last switch of one siding and the first switch on the next, are indicated in a table herewith.

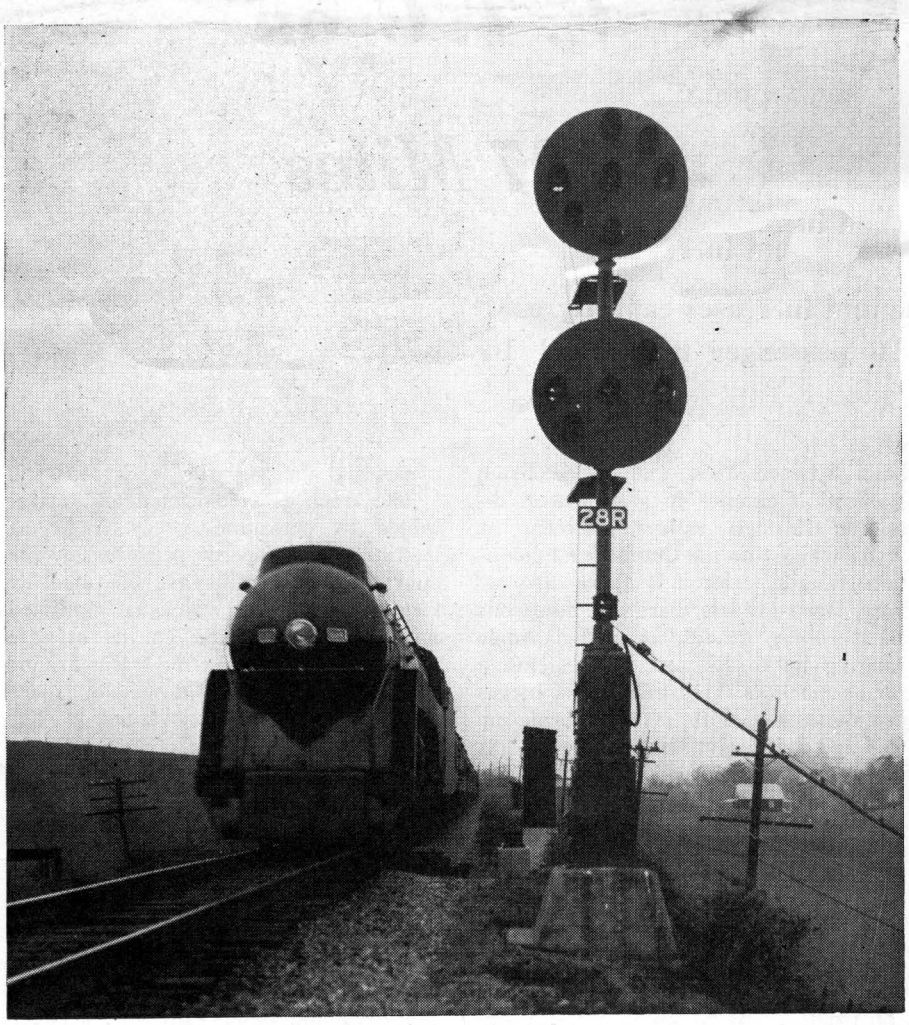
It will be noted that the distances between sidings are not uniform, this being a result of the fact that certain sidings were lengthened where practicable from the standpoint of minimum expense for cuts and fills. On the other hand, by applying power switches and signals to nearly all the sidings, 14 long ones and 8 shorter ones, the dispatcher has a very flexible range for making meets and passes on close timing. A more extensive program of rearranging sidings to reduce the number and to locate them on an exact time-distance train operation basis, would have been much more expensive than the policy adopted to equip all but three of the original 25 sidings.

Station	Car Capacity of Siding
2.9 mi.	
Melborn	141
3.2 mi.	
Wysor	130
1.4 mi.	
Wurno	85
2.4 mi.	
Pulaski	81
2.4 mi.	
Granite	80
2.7 mi.	
Clark	137
5.6 mi.	
Max Meadows	103
3.5 mi.	
Kent	73
2.7 mi.	
Wytheville	123
4.3 mi.	
Grubb	68
2.1 mi.	
Crockett	131
3.1 mi.	
Rural Retreat	137
2.5 mi.	
Grosclose	48
3.7 mi.	
Atkins	134
4.2 mi.	
Marion	126
5.0 mi.	
McMullin	72
2.4 mi.	
Seven Mile Ford	126
1.9 mi.	
Chilhowie	68
4.4 mi.	
Glade Spring	114
3.0 mi.	
Meadow View	135
3.6 mi.	
Hayter	129
2.8 mi.	
Abingdon	51
4.6 mi.	
Wyndale	132
6.5 mi.	
Bristol	Yard

On account of adverse grade conditions, ordinarily the through freight trains do not consist of more than 70 cars, but extra siding capacity was provided wherever possible, for several reasons. One is to allow sufficient track length for a train to 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 to stop from that speed. Long sidings are also a benefit in permitting trains to meet without either train being required to stop.

Semaphores to Light Signals

Previously this territory was equipped with automatic block signaling, including semaphore signals. As a part of the changeover, the semaphores were removed, the signals of the new C.T.C. system being of the position-light type. It is of interest that the Norfolk & Western does not use dwarf signals in C.T.C. territories. At the end of a siding, the main-track station-leaving sig-

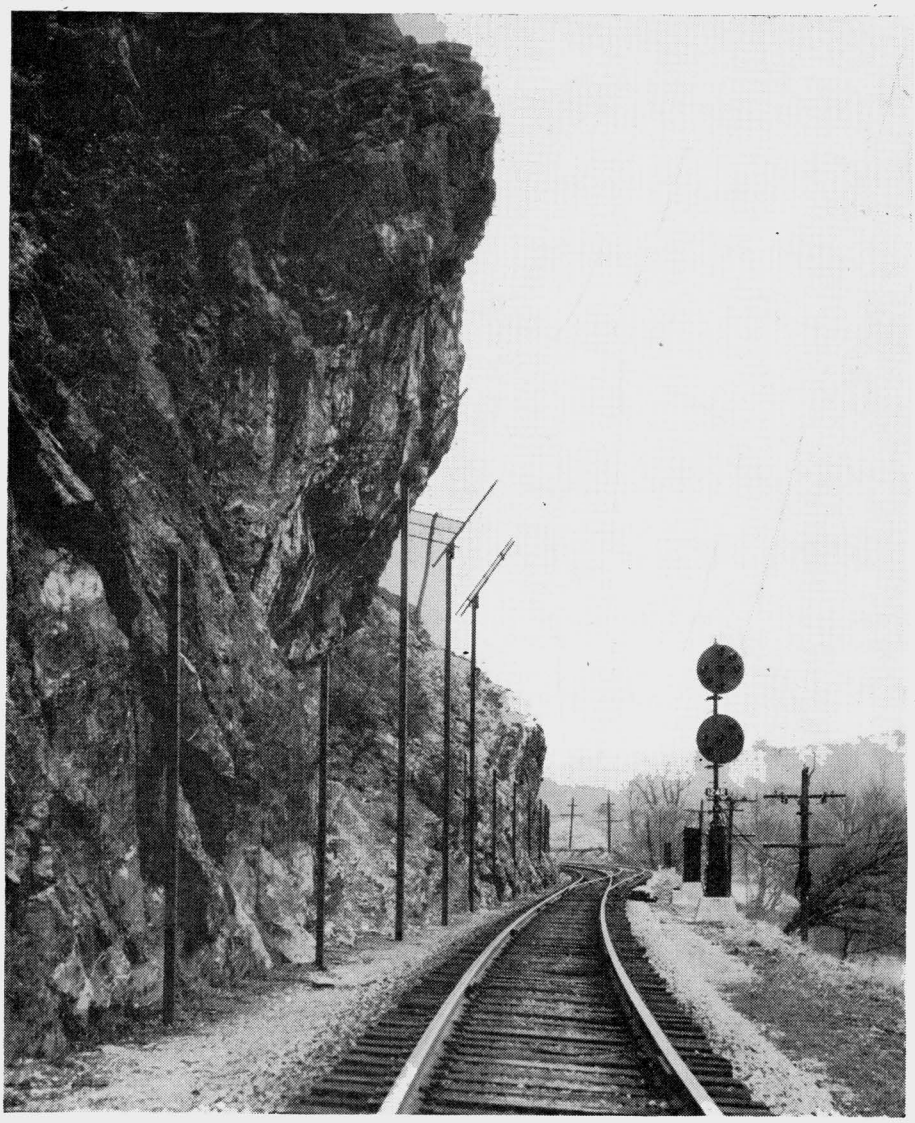


Westbound train at west end of Hayter siding

nal and the leave-siding signal are both mounted on the platform of a bracket mast, located to the right of the siding. These signals are the same type and size, the only difference being that the leave-siding signal is mounted 6 ft. lower than the main-track signal.

Each siding is equipped with track circuits which enter into the control of the signals and also control lamps on the control machine to indicate occupancy of the sidings. The controls are so arranged that the signal for entering a siding cannot be cleared if the siding is occupied. Thus, if such a signal displays a Medium-Clear aspect, the engineman has confidence to pull into the siding at the speed for which the turnout is designed, i.e., 30 m.p.h. for a No. 15 turnout. In order to direct trains to approach at this speed when entering a siding, a second operative signal head was installed on each signal in approach to a power switch in the facing direction. Such a distant signal displays the Approach - Medium aspect when the entering signal displays the Medium-Clear aspect.

On intermediate automatic signals located on ascending grades of more than 0.95 per cent, the most restrictive aspect is a horizontal row of lights in the top unit and a row of lights at 45 deg. in the lower right-hand quadrant. This is a grade signal aspect which authorizes trains to pass this signal without stopping, and proceed at restricted speed, prepared to stop short of train or obstruction.



Rock-slide fence protection at a high bluff

Slide-Detector Fences

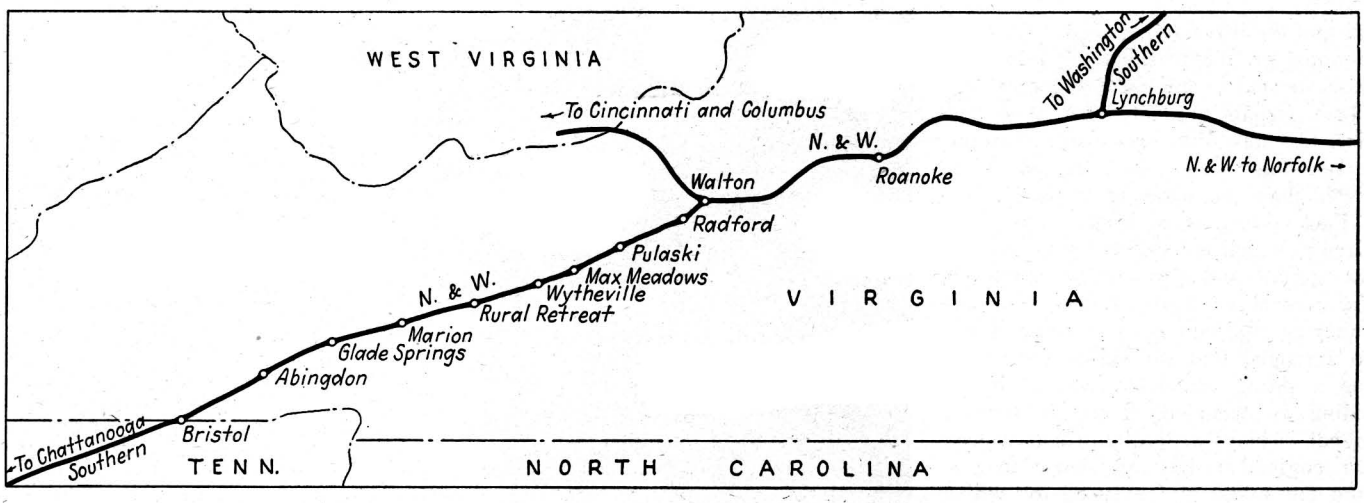
In order to arrange for numerous switching moves in the yard limits at Radford, Pulaski and Bristol, the switches and signals in the limits of these yards are controlled by separate small machines in the yard offices at these respective towns. The switches and signals outside these three yard limits, on the entire territory between Radford and Bristol, are controlled by one machine in the division dispatcher's office at Roanoke, Va., which is 43 mi. east of Radford. This machine is made up of one 5-ft. center panel and two 2.5-ft. wing panels at each end, thus totaling 15 ft. in length.

At locations in this C.T.C. territory where the track is close to rock bluffs, the Norfolk & Western has installed detector fences, as shown in an accompanying illustration. The posts are old rails, set in the ground, and extending as high as may seem necessary, depending on local conditions. Ordinary hog wire fencing extends from each end of the fence to a location near the center, the ends of the fencing being tied around sections of 1½-in. pipe. At the intermediate posts the wire is held loosely in loops. At the far ends, these pipes are attached by adjustment bolts, while at the center, they are held under tension by coil springs to keep the fence taut. From the pipe for each fence section a small wire cable extends to a trigger mechanism. At the center location there is a circuit controller, normally held in the closed position by a trigger, which is tripped when a rock strikes any section of the fence.

When the controller operates, the circuits are opened to set the signals at their most restrictive aspects. When a train arrives and stops at the signal, a member of the crew walks to the slide location to determine the damage, and to telephone the dispatcher. The maintainer must be called to restore the controller to its normal position.

The benefits accomplished by the centralized traffic control have been to increase the capacity of this single-track line and to expedite train movements by reducing delays on sidings. As a general rule, the through passenger trains were given preference before and, therefore, there has not been much chance for improvement other than advancing meets in case opposing trains are late. With C.T.C., the greatest improvement is in the operation of freight trains, because the dispatcher can direct them by signals to keep moving for close meets rather than waiting on sidings. The dispatcher reports that approximately 50 per cent of the meets are so well timed that neither train stops.

With the C.T.C., a passenger train which is received late can make up time in the territory. On the average, the through freights make the 108-mi. run either way between Radford and Bristol in about 3 hr., which is much better than under timetables and train orders. The C.T.C. is especially beneficial when anything goes wrong. For example, under train orders, if a train pulled a drawbar in a section where there was no operator on duty for 20 mi. each way, the road would be tied up for



Map showing location of the C. T. C. territory between Radford and Bristol

hours before trains could be moved normally again. Now, with C.T.C., as soon as a crew telephones that a drawbar is down, the dispatcher can hold the trains back as required. Then as soon as the difficulty is taken care of, all trains can be directed to get under way promptly.

This centralized traffic control was planned and installed by Norfolk & 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 Co.