# Economics of Single Track Signals*

## Reconstruction of Installation Provides Block Spacing on Time Instead of Distance

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THE Chesapeake & Ohio is now completing a 125-mile single-track installation of automatic color-light signals and intermittent induction train control on the territory covered by I. C. C. Orders 1 and 2 between Orange, Va., and Clifton Forge. The old train control and signal installation installed by the railway in accordance with I. C. C. Order 1 has been of interest in many respects and many of the problems entering into the new installation may be of equal interest. As this installation is not yet completed it is too early to go into many details of the installation, but I do desire to bring to your attention some of the economic factors entering into the installation which may be of interest.

The problem before the railroad was primarily one of economics. The first installation had cost over a half-million dollars since the first experiments on train control were started in 1916. Naturally the railroad did not now desire to see all of this expense wasted, even though a portion of it had to be thrown aside.

The traffic in this territory is very light compared with that on the remainder of the Chesapeake & Ohio main lines. There are only three through and two local passenger, one express and three freight trains a day, or a total of nine trains in each direction daily over the majority of the territory, although between Gordonsville, Va., and Lindsay, 6 miles, the traffic amounts to 40 trains per day. But the traffic on the entire distance was not such as to warrant automatic signals as an economic proposition and hence all the trains in this territory were moved by a train order and manual block system before a train stop system was installed. It was natural, therefore, in meeting I. C. C. Orders 1 and 2 that the simplest kind of an automatic signal and train control installation should be considered.

### Installation Includes Grade Signals

Color-light signals and a ramp train control had been in service previously on 61 of the 125 miles now covered by both I. C. C. train control orders. There were many factors entering into the old installation which were not satisfactory so that in considering the new extension it was proposed to rearrange the old signaling, replace the old ramp train control system with an induction system and use as much of the old signal and train control layout as possible on the new 125-mile installation.

While color-light signals had been in use on the 61-mile section, there were three different types of lamp bulbs and wattages in service while a fourth type had been adopted as standard on the remainder of the railroad. The new installation will be of the same type throughout and agrees with the type on other parts of the system. This change will result in a standard stock of material and reduced costs of maintenance and operation. Furthermore, the ramp train control installation was not interchangeable on the 61 miles on either the wayside or the engine apparatus while the same type will be used on both wayside and engines on the new installation.

This territory is in a mountainous region with many curves, several tunnels and grades of 1.5 per cent. On account of the grades it is very desirable to have tonnage trains proceed by the automatic "Stop; then Proceed" signals without stopping. Some grade signals were in use on the old 40-mile installation, the indication being given by red over yellow lights for following movements when a block was occupied. On the new installation an enameled letter "G" has been used as a grade marker on those automatic signals on grades of 0.2 per cent and over on the 125-mile territory. One-half of the automatic signals in this new territory are grade signals.

### Variable Block Lengths are Based Upon a Time Interval

Probably the first and most important economic problem was the location of the signals and the length of blocks. Both operating and signal officers were of the opinion that the old signals between passing sidings were too close together, in many cases less than a mile apart, for the small amount of traffic using the line, especially since block signals were 1½ to 3 miles apart on other sections of the road with three to four times the traffic. The operating department recommended that the blocks be not over seven minutes apart and that they be located on a time basis, rather than a mileage basis, based on the slowest train on the division. Observers then rode different trains over the entire 125 miles and noted the time at the mile posts from passing siding to siding. From these records the intermediate signals were located. The block lengths varied from 1 to about 3 miles, depending upon the distance and grade between the passing sidings. By relocating the signals according to this basis it was found possible to retire about 60 automatic signals from the old 61-mile installation and relocate them on the new 64-mile territory with a considerable saving in capital account. It is of interest to state that where the new signals have been relocated on a time basis (which is now about 80 per cent completed) the operating results have been very satisfactory.

This system of locating signals has been used in subway work but usually the mileage basis has been used in laying out the ordinary automatic signal system. It is believed that the time basis should be given greater consideration in laying out new signal systems.

### Type of Power and Battery Installation

Twenty-one miles of the old installation was of the d.c. primary battery type and 40 miles was of the a.c. type. The d.c. section with train control, cost about $4,000 per mile and the a.c. cost over $8,000

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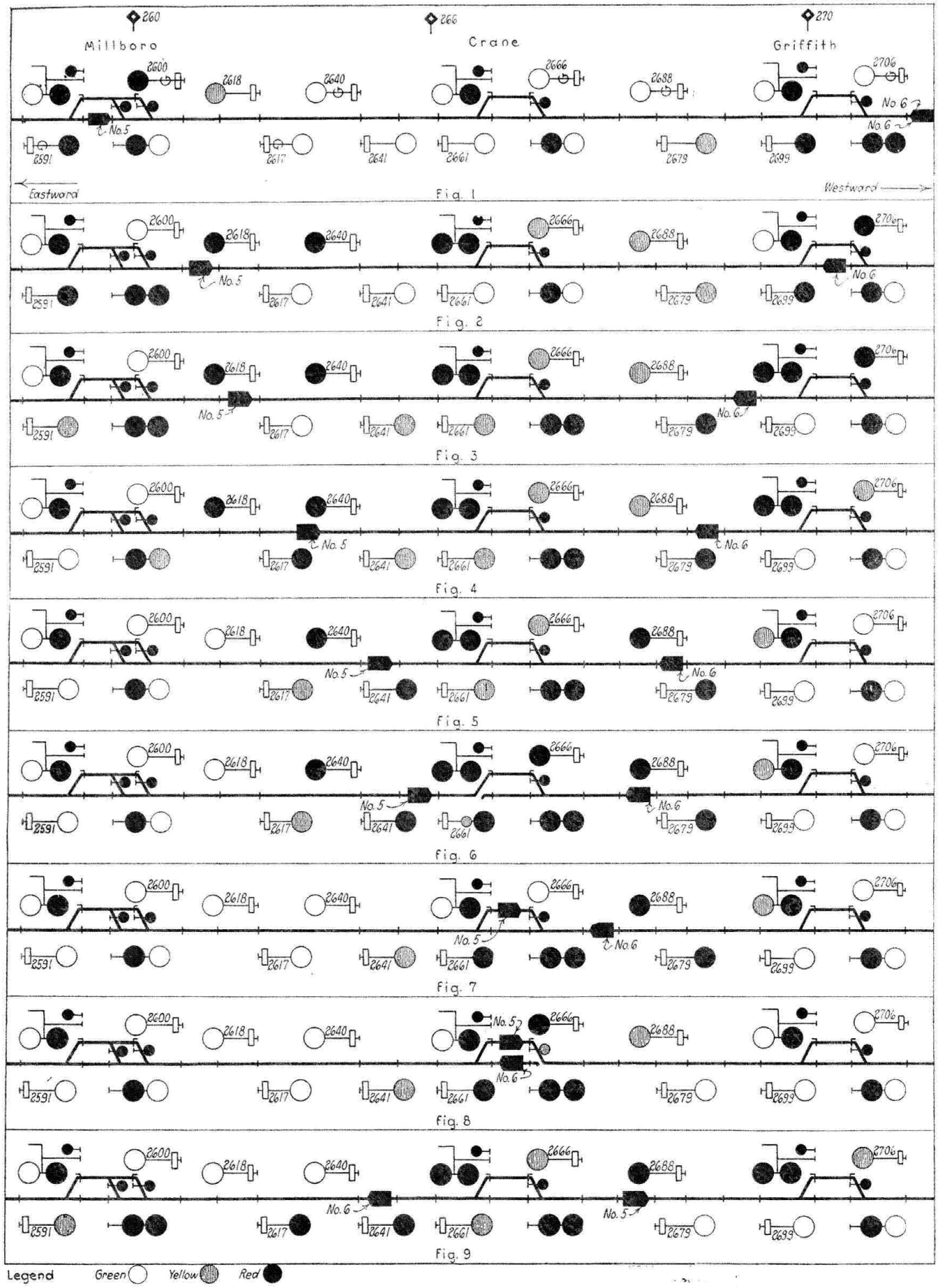


Figures 1 to 9 Inclusive Showing in Progressive Stages the Signal Indications in Advance of and in the Rear of Trains 5 and 6 Between Millboro, Va., and Griffith

per mile. The railroad was then confronted with the problem of either extending the primary d.c. system or the a.c. system. Both have their advantages. The signals were approach lighted on the 21 miles, except at a few signals. On the 40 miles the signals were continuously lighted. The main disadvantage to the a.c. system had been the lack of a reliable emergency power service. On a later automatic signal and interlocking installation the railway had adopted the a.c. floating system with primary battery track circuits and, as the service was both economical and reliable, it was finally decided to change out the old 61-mile installation to the a.c. floating system and make the entire 125 miles of one type with all signals normally a.c. and d.c. in emergency.

Data will be available later showing in detail the economy of the a.c. power system with primary reserve or with storage battery reserve. It is of interest to report at this time that all of the storage batteries used on the old train control engine equipment were furnished to the signal department for use as reserve batteries on a 50-mile portion of the new signal installation which made it unnecessary to obtain an equal number of new storage batteries.

## Typical Track and Signal Layout

The Chesapeake & Ohio has been one of the few railroads locating the absolute block signals on single track at the clearance point rather than beyond the head block at passing sidings. In order to show a typical passing siding with signals the accompanying drawings have been prepared showing the signaling between Millboro, Va., and Griffith. These show the signal indications for trains No. 5 and No. 6, which meet daily at Crane at 9 p. m.

It will be noted in Fig. 1, that Crane is 6 miles from Millboro, with two pair of intermediate signals, while Griffith is 4 miles from Crane with one pair of staggered signals about 5,870 ft. apart. On a time basis the first signal leaving a passing siding is much closer to the siding than the signal approaching the siding, as shown by the signals from Crane to Griffith. In nearly all cases one of the absolute signals at a passing siding location is on a bracket post or cantilever mast.

The automatic signals are of the one-light three-indication type, except that absolute signals are of the two-light three-indication type. Movements off the passing siding to the main line are protected by one-light dwarf signals. Signals whose indications are more favorable than "Stop" are equipped with a number plate.

Figures 1 to 9 inclusive show in progressive stages the signal indications in advance of and in the rear of trains No. 5 and 6 between Millboro and Griffith, the successive positions and signal indications being as follows:

Legend: Green ○ Yellow ◍ Red ●

Orange to Clifton Forge Virginia
Color Light Signals
Names, rules, aspects and indications

| | Automatic Block Signals | | | | | | | | Special Automatic Dwarf Signals | |
|---|---|---|---|---|---|---|---|---|---|---|
| Diagram | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Aspect |  |  |  |  |  |  |  |  |  |  |
| Given by | Two Red Lights | One Red Light And Number Plate | Red Light Over Yellow Light And Number Plate | Yellow Light Over Red Light | One Yellow Light and Number Plate | Green Light Over Red Light | One Green Light And Number Plate | Red Light Over Letter "G" And Number Plate | One Red Light | One Yellow Light |
| Name | Stop Signal | Stop and Proceed Signal | Permissive Signal | Approach Signal | | Clear Signal | | Grade Signal | Stop Signal | Approach Signal |
| Indication | Stop | Stop; Then Proceed | Proceed from Main Line to Siding at Slow Speed Prepared to Stop Short of Train or Obstruction | Approach Next Signal Prepared to Stop | | Proceed | | For Tonnage Freight Trains Proceed in Accordance With Rule 509-D | Stop | Approach Next Signal Prepared To Stop |
| Rule | 501-A | 501-AA | 501-G Special | 501-B | | 501-C | | 504-D | 501-A,Spec. | 501-B,Spec. |

**Fig. 10—Color-Light Signal Indications Used on the Chesapeake & Ohio Installation**

Figure 1 shows train No. 5 proceeding west on the main track at Millboro. It is protected by automatic signals *2591* at "Stop; then proceed" and 2571 (not shown on Fig. 1), at "Approach." Opposing automatic signal *2600* is at "Stop; then Proceed," and *2618* at "Approach." The westward automatic signals are at "Proceed." Opposing train No. 6 is proceeding east approaching Griffith. The opposing absolute signal is at "Stop," automatic signal *2699* is at "Stop; then Proceed" and *2679* at "Approach." The eastward automatic signals are at "Proceed." Train No. 6 meets train No. 5 at Crane, No. 6 passing by on the main line while No. 5 is in the siding.

Figure 2 shows train No. 5 approaching signal *2617* and protected by absolute "Stop" signals at Crane and Millboro. Train No. 6 is about to enter the absolute block between Griffith and Crane. Signal *2688* is 5,700 ft. from the eastbound absolute signal at Griffith and about 12,000 ft. from signal *2666*, although on a time basis the blocks are the same length. Westbound block *2679* is 11,500 ft. in length and the block in the rear 6,400 ft. in length.

Figure 3 shows trains Nos. 5 and 6 advancing toward "Approach" signal *2688* and "Clear" signal *2617*. The second signal in the rear of train No. 5, signal *2591*, has changed to "Approach" permitting following movements. Train No. 6 is still on the overlap of signal *2706* which is displaying the "Stop; then Proceed" indication. Both trains are now protected by absolute "Stop" signals for opposing and following train movements. Note that two "Approach" signals, or a so-called "Double Distant," are in the rear of the absolute "Stop" signals at Crane.

Figure 4 shows train No. 5 advanced into the block of *2617* and No. 6 advanced beyond the overlap of signal *2706*. Both trains are still protected by absolute "Stop" signals at Crane for opposing movements and with a "Stop; then Proceed" signal for No. 5 and an absolute "Stop" signal for No. 6 for following movements. On account of the mountain grades signals *2617* and *2688* are equipped with the letter

"G" which permits tonnage trains to pass without a stop being made. Note that 7 out of the 12 automatic signals shown are grade signals, also note that two "Approach" signals are still in the rear of the absolute "Stop" signals at Crane.

Figure 5 shows trains No. 5 and 6 approaching Crane, the meeting point, with signals *2666* and *2661* at "Approach" and protected by opposing absolute "Stop" signals and "Stop; then Proceed" and "Approach" following signals.

Figure 6 shows train No. 5 about to enter the east end of Crane passing siding, proceeding by signal *2661*, now a permissive signal on a "Red over Yellow" indication without stopping. Signal *2666* is now at "Stop; then Proceed," due to No. 5 being on the overlap circuit and the siding switch being reversed. Train No. 6 approaches signal *2666* prepared to stop due to receiving an "Approach" indication at signal *2688*. All entering signals at passing sidings are equipped with a second yellow light for providing a movement into the siding without a stop at a red signal. This yellow light is normally out and is only displayed when the passing siding switch is reversed. If No. 6 arrives ahead of No. 5, the siding switch is reversed by the trainman of No. 6.

Figure 7 shows train No. 5 in Crane siding. Signal *2666* is at "Proceed" for train No. 6, which now has clear signals ahead. No. 5 waits on the siding until No. 6 passes and the westward absolute signal at Crane is at "Proceed." This indicates that the block to Griffith is clear and it is proper to reverse the switch and obtain the "Approach" signal indication for the movement through the absolute block.

Figure 8 shows train No. 6 proceeding eastward with clear signals while train No. 5 comes out of the siding on an "Approach" indication. The westward absolute signal at Crane is at "Stop," protecting following movements for No. 5 while the eastward absolute signal at Griffith will go to "Stop" for protection against opposing movements as soon as No. 5 passes the dwarf signal at the entrance to the absolute block.

Figure 9 shows Nos. 5 and 6 past the meeting point at Crane, both on main line track, and protected by absolute "Stop" signals for opposing and following movements. As the trains proceed through the automatic blocks the signals will protect them as shown on the previous diagrams.

### Signal Indications Employed

The color-light signal indications used on this installation are shown in Fig. 10. They are based on the old A. R. A. code, are few in number, and have been in use satisfactorily on sections of the new work already in service. Figure 10, diagram 1, shows the "Stop" indication, one of the most important indications in the book of rules. In the past the absolute signal was marked by a painted letter "A" but only one light was used as on all automatic signals. The bottom light is always red and is simply used as a marker. The absence of one or more of the two lights is an imperfectly displayed signal and indicates "Stop."

Diagram 2, Fig. 10, is the "Stop; then Proceed," automatic signal indication, while diagram 3 is the special permissive signal only provided for trains entering the passing sidings. "Approach Signals" are shown in diagrams 4 and 5. The two clear signals, the grade signal and the two dwarf signal indications are shown in diagrams 6, 7, 8, 9 and 10.

These diagrams have been made for the purpose of educating the trainmen and other employees operating over the signal territory. It is believed that this method of instructing the employees will be of greater value than the more simple methods used in the past.

### Economy of Automatic Signaling

While it is too early to know the economic benefits derived from this installation it is known that, in addition to the increased safety of train operation, it will be possible to close up some of the telegraph offices, reduce the number of written train orders, lengthen the maintainer's sections, reduce the capital investment charges on the old signal territory and provide a more reliable signal and train control system. Completion of this stretch of automatic signaling gives the Chesapeake & Ohio a line which is 100 per cent signaled between Washington, D. C., and Cincinnati, Ohio, a distance of 598 miles.

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# I. C. C. Issues Two Quarterly Summaries of Accident Reports

THE regular quarterly summaries of accident investigations by the Interstate Commerce Commission for the three months periods ending September, 1925 (No. 25), and December, 1925 (No. 26), have been issued recently. The first bulletin covers 18 collisions and 11 derailments. A total of 22 collisions and 20 derailments are covered in the second bulletin. Several of the reports in the quarterly summaries have been abstracted already in *Railway Signaling*. Lack of space prohibits the publication of all the summarized reports.

The complete list as given in the index of the first publication (No. 25) follows:

ACCIDENTS INVESTIGATED, JULY, AUGUST AND SEPTEMBER, 1925

| | | | | | |
|---|---|---|---|---|---|
| 1165 | Missouri Pacific | Morton, Ark. | July | 4 | D |
| 1167 | East St. Louis & Suburban | Granby, Ill. | July | 7 | C |
| 1168 | Western Pacific | Shafter, Nev. | July | 13 | D |
| 1169 | Atlantic Coast Line | Kirkland, N. C. | July | 16 | D |
| 1170 | Lehigh & Hudson River | Greycourt, N. Y. | July | 17 | D |
| 1171 | Southern Pacific | Sudden, Cal. | July | 19 | C |
| 1172 | Central Vermont | Burlington, Vt. | July | 23 | C |
| 1173 | Reading | Carlisle Jct., Pa. | July | 25 | C |
| 1174 | Ann Arbor | Lake George, Mich. | July | 29 | C |
| 1175 | Wabash | Tolona, Ill. | July | 29 | D |
| 1176 | Southern | Juliette, Ga. | Aug. | 2 | D |
| 1212 | Southern | Juliette, Ga. | Aug. | 2 | C |
| 1177 | Chicago Great Western | St. Joseph, Mo. | Aug. | 6 | C |
| 1178 | Kan., O. & G. and Tex. & P. | Denison, Tex. | Aug. | 17 | C |
| 1179 | C., B. & Q. | Hannibal, Mo. | Aug. | 17 | C |
| 1180 | Detroit United Lines | Sunny, Mich. | Aug. | 19 | C |
| 1181 | Denver & R. G. W. | Granite, Colo. | Aug. | 20 | C |
| 1182 | Erie | Conesus Lake Jct., N. Y. | Aug. | 22 | D |
| 1183 | Minn., St. Paul & S. S. M. | Grays Lake, Ill. | Aug. | 22 | C |
| 1184 | Pennsylvania | Braeburn, Pa. | Aug. | 27 | D |
| 1185 | Colorado & Southern | Mayne, Colo. | Aug. | 30 | C |
| 1186 | Pennsylvania | Wilmington, Del. | Aug. | 31 | C |
| 1187 | Chesapeake & Ohio | Vanceburg, Ky. | Sept. | 15 | C |
| 1188 | Atlantic Coast Line | Tennille, Ala. | Sept. | 17 | D |
| 1189 | Pittsburgh & W. Va. | Mingo, Ohio | Sept. | 18 | C |
| 1190 | Nash., C. & St. Louis | Chickamauga, Tenn. | Sept. | 24 | C |
| 1191 | Central of Georgia | Orchard Hill, Ga. | Sept. | 26 | D |
| 1192 | Atlantic Coast Line | Newark, Ga. | Sept. | 27 | C |
| 1193 | Baltimore & Ohio | Philadelphia, Pa. | Sept. | 29 | D |

The full list shown in the index of the second bulletin (No. 26) is as follows:

ACCIDENTS INVESTIGATED, OCTOBER, NOVEMBER AND DECEMBER, 1925

| | | | | | |
|---|---|---|---|---|---|
| 1194 | Southern | Rutherfordton, N. C. | Oct. | 1 | D |
| 1195 | Atlanta, Birmingham & Atlantic | Parkwood, Ala. | Oct. | 3 | D |
| 1196 | Houston & Texas Central (Southern Pacific Lines) | Bryan, Tex. | Oct. | 4 | C |
| 1197 | Florida East Coast | Eau Gallie, Fla. | Oct. | 4 | C |
| 1198 | Lehigh Valley | Geneva Junction | Oct. | 5 | D |
| 1199 | Southern Pacific | Sparks, Nev. | Oct. | 6 | C |
| 1200 | New York, New Haven & Hartford | Glenbrook, Conn. | Oct. | 6 | D |
| 1201 | Virginian | Rock, W. Va. | Oct. | 8 | C |
| 1202 | New York Central | Belle Isle, N. Y. | Oct. | 9 | C |
| 1203 | Pennsylvania | Ellendale, Del. | Oct. | 10 | D |
| 1204 | Atlantic Coast Line | Mango, Fla. | Oct. | 10 | C |
| 1205 | Oregon-Washington R. R. & Nav. Co. (U. P. System) | Blalock, Ore. | Oct. | 10 | D |