Two-aspect absolute signals are used at the headblocks

Towns at which passing tracks are located

This Automatic Block Is Different

On 213 miles of single-track comparatively light traffic of only eight scheduled trains daily permits use of two-aspect absolute signaling, and thus simplifies the signal arrangement, and the use of a unique two-direction track code control system without line wires

A SIMPLIFIED SYSTEM of two-aspect absolute, single-track automatic block signaling, including an interesting development of two-way coded track circuits without line wires, has been installed by the Rock Island on 213 miles of single track between Houston and Waxahachie, Texas, which is a junction 30 miles south of Dallas. This 213 miles, known as the Burlington-Rock Island, is owned jointly by these railroads, and at present is operated by the Rock Island. This line is part of the Rock Island's north and south route between St. Paul-Minneapolis and Houston, via Dallas, as well as the Burlington's route between Denver and Houston. The handling of passenger and freight traffic between Houston and Dallas, 249 miles, is highly competitive with other railroads.

The Rock Island operates the Twin Star Rocket passenger train and one through freight each way daily. The Burlington operates the Zephyr passenger train and one through freight each way daily. Thus a total of only eight trains are scheduled daily.

No appreciable grades are encountered in either direction between Houston and Waxahachie, thus the line may be considered practically level, in so far as train operation is concerned. Furthermore, the curvature is very light, with long sections of tangent. The track is well constructed and maintained.

Why Signaling Was Needed

Previously, no signaling was in service on this 213 miles between Houston and Waxahachie. Automatic signaling was needed as protection on this line where passenger trains operated at speeds up to 79 m.p.h. and freights up to 50 m.p.h. Although the trains handle important traffic they are relatively few, only four passenger and four freights being scheduled daily. Train interference is at a minimum, no train being scheduled to overtake and pass another of the same direction, and there are only six scheduled meets between opposing trains at sidings between Houston and Waxahachie. The passenger trains make only two stops, one at Corsicana and the other at Teague. Because of few stops, and the track characteristics that permit trains to operate at high sustained speeds, they cover the 213 miles in relatively short time, thus further reducing track occupancy time and the chances for interference with other trains. Therefore, all factors considered, the Rock Island decided that a very simple arrangement of two-aspect signaling would be adequate from the standpoint of handling trains without delays, and that such a system could, therefore, be installed at a cost that would be justified on the basis of protection only for the relatively light traffic of eight trains daily.

Several years ago the Rock Island was faced with similar circumstances on 490 miles of single track on its important line west from Omaha to Denver, which likewise handles important trains, but total only 8 to 10 daily. For that project, the Rock Island devised a simplified automatic system using two-aspect station-to-station signals which, including approach signals, totaled only six signals in a siding-to-siding block, as shown in typical plan Fig. 1. The new signaling installed on the Houston-Waxahachie territory is a further development of the basic principles of the Omaha-Denver system.

Sidings Make Texas Job Different

First of all the Texas project was different with respect to sidings. Originally the sidings were short, and were spaced about 5 miles apart. Within recent years the freight trains have increased in length and have been reduced in number. Fewer passenger trains are operated and they stop at only a few large towns. Therefore, within recent years (prior to the signal project), every other siding, about 11 miles apart, was lengthened to hold about 125 cars. The remaining short sidings, which are at towns, were left in place as house tracks. The 14 long sidings are the only ones that are now used regularly for the meeting and passing of trains, therefore, these are the only sidings for which automatic signaling was installed. However, these long sidings are an average of 11 miles apart, and therefore the siding-to-siding absolute block (as used in Colorado shown in Fig. 1) was not satisfactory in the Texas project, because the spacing between following trains would be too great. Therefore, the distance between any two long sidings was cut into two absolute blocks, with the result that two-aspect absolute signals are located at "stations," not only at the ends of the long sidings but also at "stations" midway between these long sidings. Thus trains can follow at a spacing of roughly 5 to 6 miles, rather than 11 miles or more. Furthermore, this use of two blocks in a siding-to-siding section obviates the use of overlaps in station limits, which is a minor disadvantage in the Colorado layout as shown in Fig. 1.

Basis of the Block System

The basic layout of siding-to-siding, two-position signaling as used in Colorado, is shown in Fig. 1. Signals such as 8 at station A, and signal 5 at station B, are absolute stop signals to which Rule 292 applies. Such signals are normal-clear signals. In view of the fact that these are station-to-station signals, they display only two aspects, red for Stop and green for Proceed. No yellow aspect is provided on this signal because it is not controlled or located to display an Approach aspect for any signal ahead.

Station-entering signals such as signals 10 and 9 at station A are normal-danger permissive signals to which Rule 291 applies. Such signals are capable of displaying three aspects, green, yellow and red. The green aspect indicates that the block on the main track between this signal 9 and 11 is unoccupied and also that signal 11 is displaying a green aspect. The yellow on station-entering signal 9 is an Approach aspect to indicate that signal 11 is displaying the red aspect.

The distant signal, such as signal 7, is a normal permissive signal to which Rule 291 applies. It is capable of displaying three aspects. Red indicates Stop and then Proceed. The yellow and green aspects are track circuit controlled up to signal 9, and in addition the yellow is an Approach aspect indicating that signal 9 is displaying Red. Also signal 7 displays green to indicate that signal 9 is displaying yellow or green, and that the track is unoccupied between signal 7 and signal 11.

Two Absolute Blocks In Texas

On the Texas project the average distance from siding-to-siding is 11 miles, which is cut into two absolute blocks as shown in Fig. 2, thus absolute signals 8 and 9, with their respective distant signals 7 and 10, are located about half way between sidings A and B. Rule 292 applies to signals 8 and 9 and Rule 291 applies to signals 5 and 12.

No overlaps are used between station. Referring to Fig. 2, with an eastbound train approaching from the left, signal 15 will be red, and signal 14 will be clear, providing no trains are approaching from the opposite direction. When the eastbound train gets between signals 14 and 12, signals 13 and 14 display red, signal 15 clears, and signal 12 displays green if there are no opposing trains or trains in the same direction less than two signal blocks ahead. When the train passes signal 12, that signal, as well as signals 11, 9, 7 and 5, display red, and signal 3 at station B displays yellow. If there is a following train, signal 12 will not clear until the first train is by signal 8, and likewise signal 8 will not clear for the second train until the first train is by signal 4. When the first train is by signal 4, signal 3 displays a red aspect and signal 1 displays a yellow aspect. signal 2 displays a clear aspect if there are no opposing trains or trains in the same direction less than two signal blocks ahead.

In the event an eastbound train passed signal 12 and a westbound train passed signal 5 simultaneously, they would both be protected by signals 7, 8, 9 and 10 from a head-on collision.

In a station-to-station block, as for example between signal 8 at the station A and signal 5 at station B, the new signals are controlled by a new and unique adaption of track cir-

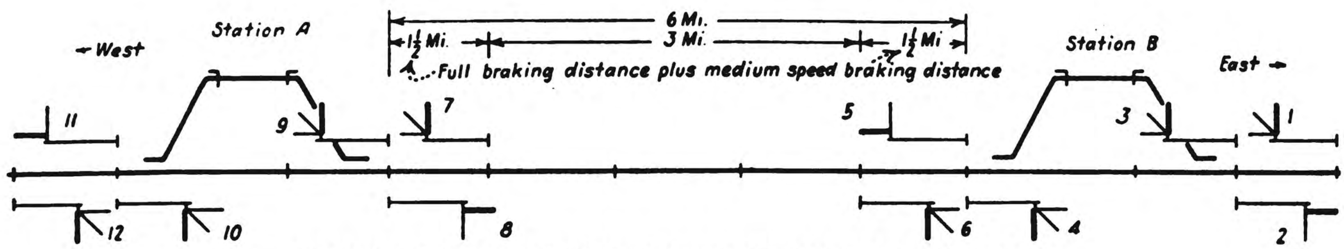


Fig. 1 Simplified automatic block using two-aspect station-to-station signals

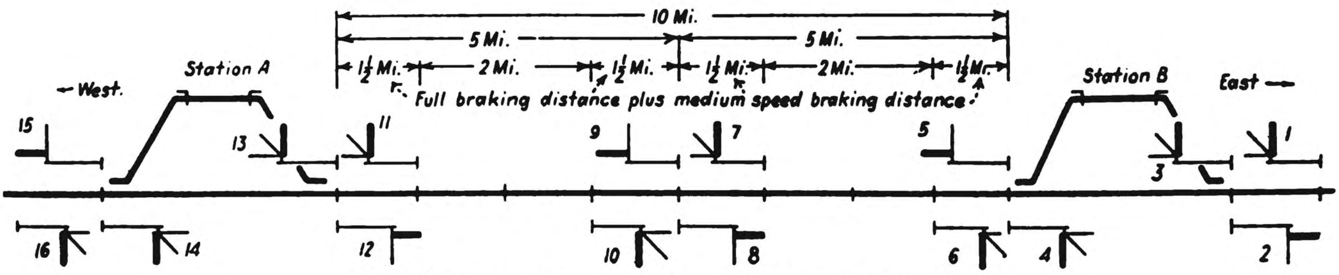
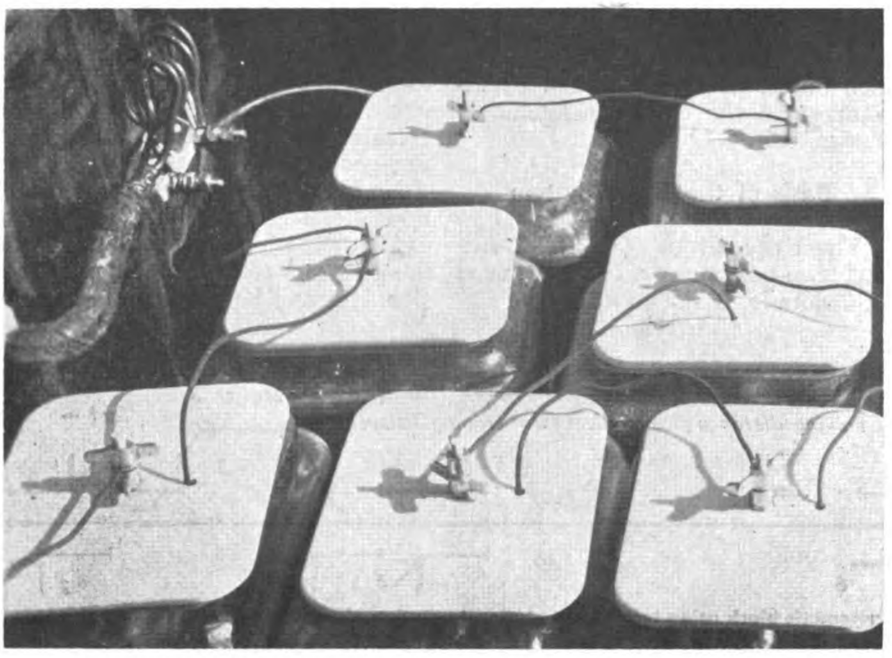


Fig. 2 Siding-to-siding section is cut into two absolute blocks


Primary battery is used where a.c. power is not available

cuits, without the use of line circuits. The commonly accepted term coded track circuits does not exactly apply to this new scheme because different rates of code, such as 75 or 180 per minute, are not used to control signals to display different aspects. In order to explain the Rock Island scheme, the term impulse may well be used. The absolute station-leaving signals, such as signal 5 and signal 8, are capable of displaying only two aspects. When no track circuit energy impulses are being received at such a signal, it displays Stop, but when impulses are being received, the signal displays green.

The track circuits on this Rock Island signaling are the double-end type, i.e., there is both a relay and a battery at both ends of every track circuit. With the system dormant, the relay is connected. But if the track circuit is to be fed from a given end, the contacts are operated to connect the battery rather than the relay. Thus the track circuits can be fed and operated in either one direction or the other. Looking at it another way, they can be fed first one way and then the other through a station-to-station block as a whole. There is nothing new about this either-direction double-end track circuit, the principle having been used in the Rock Island's Blue Island-Silvis territory for several years, as well as on numerous other roads.

The new feature on the Rock Island is that as applying to the control of station-leaving signals, such as signal 8 and 5, the track circuits for the station-to-station block are normally in operation in both directions to hold both such signals at the green aspect, thus in effect duplicating the function of two-line control circuits in a conventional single-track automatic block circuit scheme.

Starting the explanation as of a certain instant, say that an impulse of d.c. energy about 0.4 seconds duration is fed eastward from signal 8 on track circuit a, shown in Fig. 3, and is relayed through track circuit b, c, d and e. On receipt of this impulse the track relay at the east end of track circuit e is picked up and then released. While this relay is up a surge of energy is fed to the coil of a slow-release relay, and as long as the track relay is operated not less than a certain number of times per minute so that the slow-release relay gets shots at the rate of not less than the certain number of times per minute, the slow-release relay stays up, thus affecting controls to display the green aspect in signal 5.

In this scheme an eastward impulse goes through the track circuit of the entire station-to-station block which may include as many as 4 track circuits averaging 9,000 ft. long. Each time a pulse of energy ceases in a track circuit, some appreciable time is required to allow the relay to release and for the so-called "charge" to dissipate from the track circuit so that the feed of the pulse in the opposite direction will carry through. Thus the "off" period between eastward pulses must be of sufficient duration to allow time for these operations through all the track circuits going east, and in addition the same duration for the westward pulses to feed through the entire station-to-station block.

An important point is that the sending of a westward impulse from signal 5 does not depend on the receipt of an eastward impulse at that location. The eastward pulse must simply get there when it should, otherwise it will be opposing a westward impulse. Each impulse is of about 0.4 seconds duration, and depending on length of track circuit and overall station-to-station blocks and ballast conditions, the lengths of the "off" periods range from 2 seconds up to 3 seconds. The 0.4 secons on and 2 seconds off totals about 25 impulses per minute.

To Control Signal To Stop

The track circuit scheme on this Rock Island project holds a relay normally energized at signal 8 to cause that signal to display the green aspect, and a normally-energized relay at signal 5 causes that signal to display green. Thus these are practically equivalent to the normally-energized line relays in a conventional single-track automatic block system. Thus in the Rock Island scheme the basic controls are normally energized for both directions.

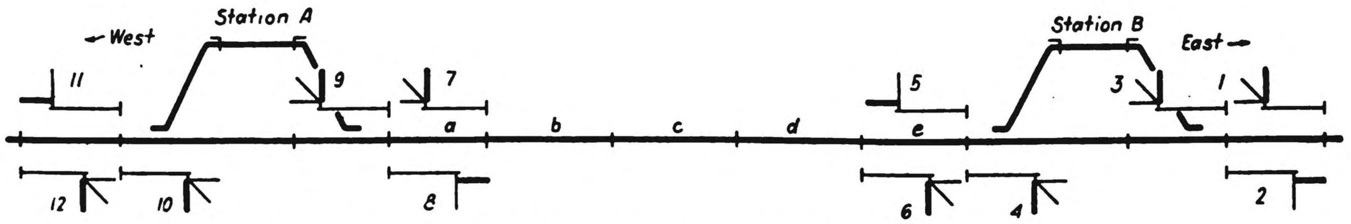


Fig. 3 Impulse of d.c. energy feeds through block to pick up and release track relay

While the controls of the signals are affected to display certain aspects, the signals are not lighted until the approach of trains.

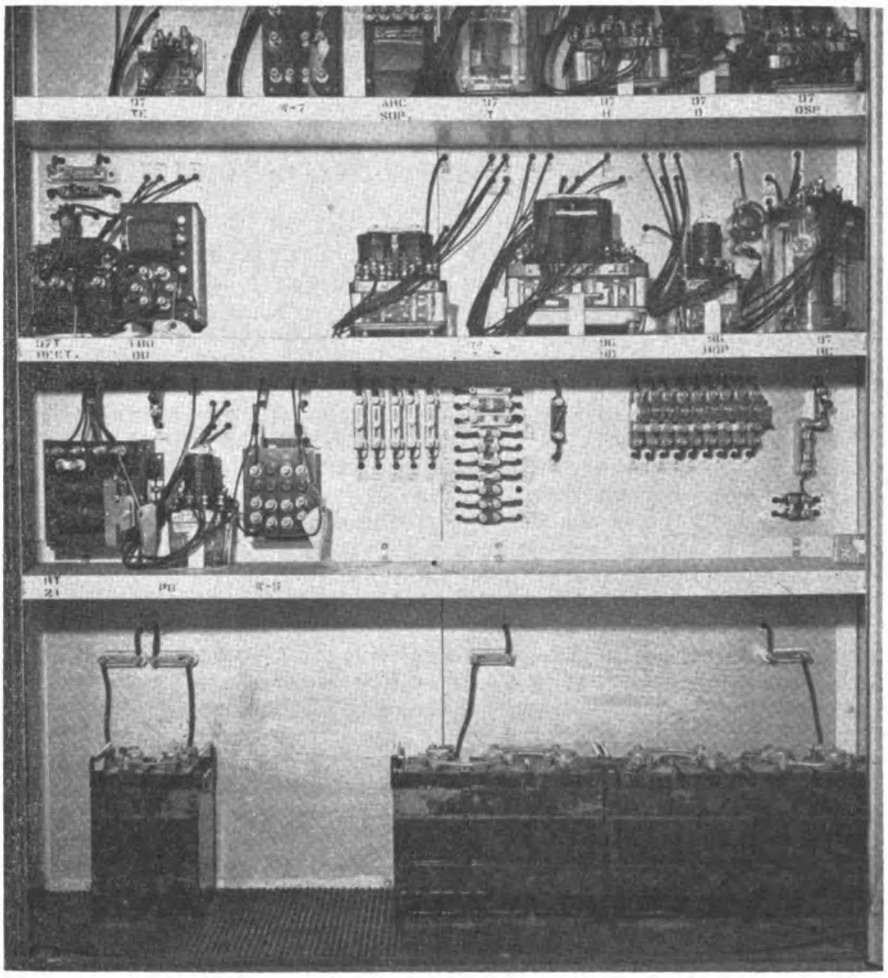
When an eastbound train enters the control limits of signal 8, the impulses feeding eastward from signal 8 to signal 5 are stopped and that signal displays the red aspect but the westward impulses feeding from signal 5 to signal 8 continue. Thus as applying to the control of station-leaving signals such as signals 8 and 5, the receipt of track circuit impulses establishes controls for the green aspect, but when no impulses are received the controls are set for the red aspect. As these station-leaving signals can display only red or green, this completes the discussion of the control of such signals.

Normally the circuits are in operation to establish controls for the signals to display the green aspect. If station-entering signal 9, however, is being held at the red aspect then the controls are changed so that distant signal 7 would display the yellow aspect but nevertheless the impulses must feed on eastward to control signal 5 for the green aspect. Briefly this result is accomplished by changing the polarity of the impulses being fed eastward in track circuit a from signal 9 to signal 7; this, however, does not change the polarity or character of the impulses which are fed on east from signal 7 to signal 5, nor does the change affect the impulses which are being fed westward from signal 5 to signal 8.

The absolute signals 8 and 9 and their respective distant signals (Fig. 2), at the center of the siding-to-siding distance, are normally dark. The controls are normally dead at these locations, except when a train approaches and sets up the controls for lighting the signals.

Power Supply

At both ends of all the long sidings commercial a.c. power is available, and is fed through transformers and rectifiers to charge storage batteries. At each signal a set of seven 120-a.h. Edison nickel-iron storage cells feeds the local relay circuits and acts as standby supply for the signal lamps, which are on constant lighting feed from a.c. At these locations each track circuit is fed by two cells of Edison 80 a.h. storage battery in series. At cut sections and, at signal between sidings, where no a.c. power is available, Edison 1000-a.h. primary batteries are used. Each track circuit is fed by two cells in multiple. At each signal the local relays and signal lamps are fed from a set of 14 cells of primary, on approach lighting control. On this project the rail joints are bonded with Ohio Brass Company rail-head pin-type bonds.



Interior of relay case at double intermediate location

On this territory between Houston and Waxahachie, train movements are now, and were previously, authorized by time table and train orders. Offices open continuously are at Waxahachie, Corsicana, Teague, Dobbin, and Houston. Offices open one trick are located at several other towns.

Telephones that can be connected to the dispatcher's circuit are located not only at the absolute signals at the ends of the long sidings but also at the absolute signals located half way between the long sidings.

This signaling was planned and constructed by the Rock Island forces under the direction of C. M. Bishop, signal engineer, and under the supervision of C. C. Healy, supervisor of construction and C. E. Hartvig, signal supervisor (now retired) on lines in Texas. The major items of signal equipment were furnished by the Union Switch & Signal Division of Westinghouse Air Brake Company.