Rio Grande has Longest C.T.C

The machine at Green River, Utah, controls 133 miles of C.T.C. on single track

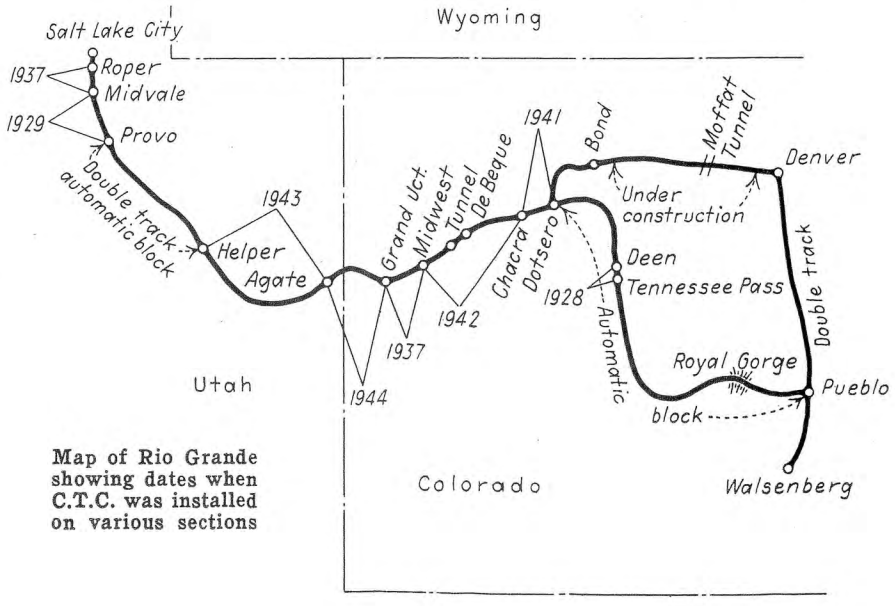
Territory between Dotsero, Colo., and Helper, Utah, includes 284 miles which is mostly single-track with heavy traffic

THE Rio Grande has recently completed the installation of centralized traffic control on 43.6 miles of single-track between Grand Junction, Colo., and Cottonwood, Utah, this being the final portion of a total of 284 miles of C.T.C. between Dotsero, Colo., and Helper, Utah, which is the longest continuous C.T.C. territory on any railroad.

Converging Lines at One End and Double-Track at the Other

Two lines from Denver converge at Dotsero, which is the east end of the C.T.C. One main-line of the Rio Grande extends from Denver south through Colorado Springs to Pueblo, then west through the Royal Gorge of the Arkansas river, over the Continental Divide at Tennessee Pass and down the Eagle River canyon to Dotsero. A second route extends west from Denver over the Continental Divide through the Moffat Tunnel, and down the Colorado river via Bond, Colo., to Dotsero, to connect with the Royal Gorge route. From Helper, Utah, the west end of the 284-mile C.T.C. territory, double-track extends westward over the Wasatch mountains on the route to Salt Lake City, Utah. Starting in 1937 with a short section, centralized traffic control has been applied from time to time on the portions between Dotsero and Helper where the greatest benefits would be accomplished, and finally, in 1944, the last gap was closed in the 284-mile continuous C.T.C. single-track mileage.

As previously mentioned, two routes converge at Dotsero. Grand Junction, 107.6 miles west of Dotsero is a division point. On the Royal



Map of Rio Grande showing dates when C.T.C. was installed on various sections

Gorge route, the engine district is between Grand Junction and Minturn, while on the Moffat Tunnel route the engine district is between Grand Junction and Bond. Trains from and to both routes are run through between Dotsero and Grand Junction, and, therefore, this section handles more train movements than on the territory west of Grand Junction to Helper. For example, before the war there were three scheduled passenger trains each way daily between Dotsero and Grand Junction, while there were two such trains each way daily west of Grand Junction. During the war, traffic increased. One of the through passenger trains in each direction is operated in two sections practically every day, and numerous extra passenger trains are operated as required. On the average, there are from 12 to 14 passenger trains, and 20 to 22 freight trains daily on the 107-mile section between Dotsero and Grand Junction. In addition, there are from 5 to 8 light engine helper moves between Dotsero and Funston, as will be discussed later. Between Grand Junction and Helper there are from 10 to 12 passenger trains and 20 to 22 freight trains, in addition to 5 or 6 mine run trains which use the main-line between Mounds and Helper.

Early Experience With C.T.C.

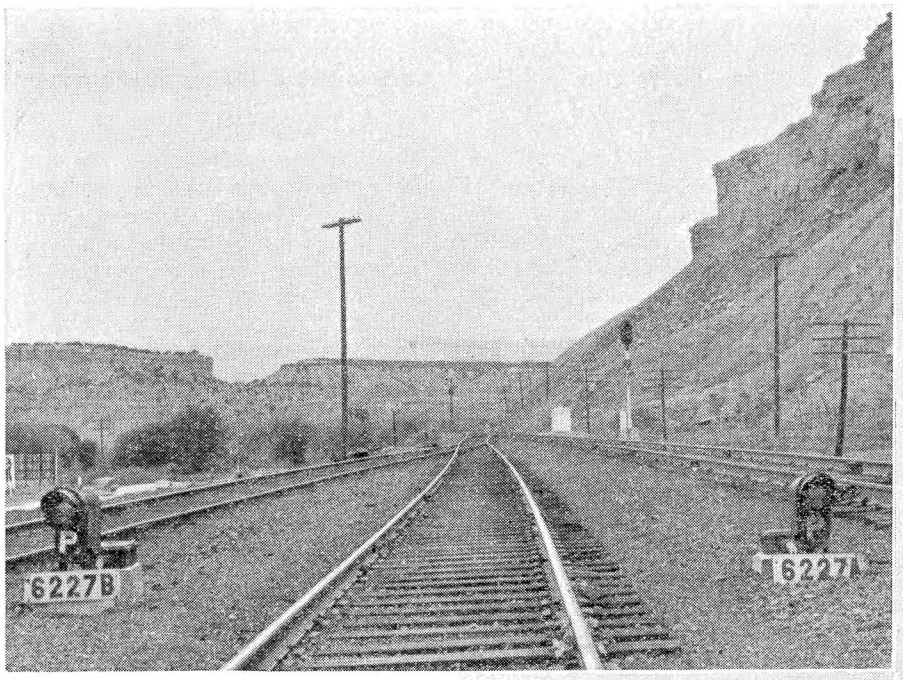
The Rio Grande has had experience with the benefits of centralized traffic control over a considerable number of years. Starting in 1928, a section 6.8 miles long between Tennessee Pass, Colo., and Deen was equipped with C.T.C., and the next year, 31.4 miles of single-track between Provo, Utah, and Midvale, was so equipped.

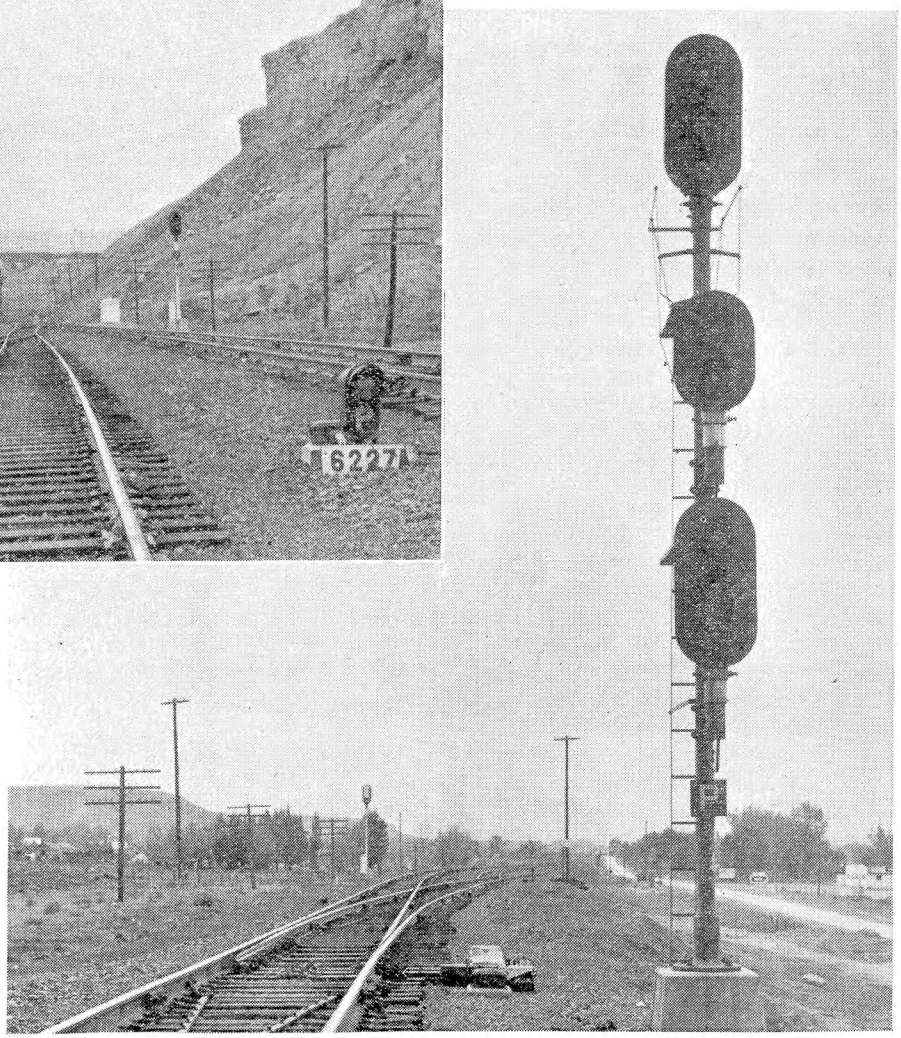
Insofar as the Dotsero-Helper territory is concerned, the first C.T.C. was installed in 1937, on 14 miles between Grand Junction and Palisade, the objective being to facilitate shipments of fruit at Palisade, Colo., as well as to expedite train movements into and out of the freight yard at Grand Junction.

Difficulties in Glenwood Canyon

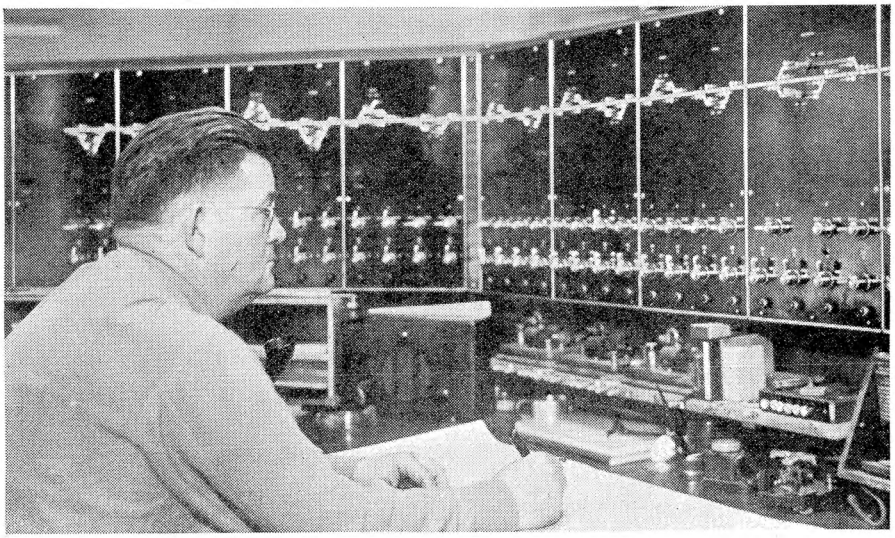
Between Dotsero and Funston, 19 miles, the railroad follows along the south bank of the Colorado river in the Glenwood canyon, passing through three tunnels, one of which is 1,700 ft. long. The grade ascends from Funston to Dotsero on an average of 1 per cent, with a maximum of 1.42 per cent. The curves are numerous and range up to 12 degrees, which require speed restrictions to 18 m.p.h. for freight trains and 27 m.p.h. for passenger trains. For many years this section of line in the Glenwood canyon had been the source of train delays, and, therefore, in order to relieve the congestion, centralized traffic control was installed in 1941 on 25.6 miles between Dotsero and Chacra, which is the first siding west of Funston. Also in 1941, C.T.C. was extended on 8.1 miles eastward from Midwest to Tunnel, which, added to the previous project, made 21.9 miles of C.T.C. eastward from Grand Junction to Tunnel. This left 59.8 miles between Tunnel and Chacra without C.T.C. In this territory, the railroad runs down the open valley of the Colorado river, the line being at river grade, which is about 1 per cent practically all the way. The curvature is comparatively light, not exceeding 6 degrees, and except for one curve is 7 degrees 30 minutes. As a result, this is fast track as compared with the section between Funston and Dotsero.

When the war caused rapid increases in traffic, experience showed





Left — View looking west at west end of parallel sidings in the new layout at Maxwell Below—View looking west at west end of parallel sidings showing the three-arm signal



Close-up view of part of the C.T.C. control machine in station at Green River

that there was very little if any difficulty in keeping the trains moving on the C.T.C. territories, but that, insofar as the Dotsero-Grand Junction territory was concerned, the major train delays were on the 59.8 miles between Chacra and Tunnel where timetables and train orders, as well as hand-throw passing track switches, were still in service. For this reason, centralized traffic control was authorized and installed on this section in 1942, thus completing the entire 107 miles between Dotsero and Grand Junction, the final section being placed in service on October 15, 1942.

Grand Junction to Helper

During 1942, traffic increased to more than double that for corresponding months of the year previous, and, therefore centralized traffic control was extended on the remaining single-track main-line as fast as possible during the years 1943 and 1944.

From Grand Junction west through Mack, about 20 miles, the railroad is in open level valley with light grades and curvature. Between Ruby, Colo., and Westwater, Utah, 15.3 miles, the railroad is along the north band of the Colorado river in the Ruby canyon. Although the curves are numerous, none exceeds 4 degrees and the grade is approximately 0.5 per cent. At Westwater, the railroad leaves the river and ascends the valley of a creek to Cottonwood, the grade being 1.10 per cent for 4.8 miles. This is the ruling grade westward between Grand Junction and Helper and limits the tonnage rating of the Class L-131 locomotives to 4,400 tons between Grand Junction and Mounds, as compared with 5,100 tons eastbound between Grand Junction and Funston, and with 3,500 tons between Funston and Dotsero.

Between Cottonwood and Green River, Utah, the railroad crosses rolling open desert country. The elevation above sea level is 4,340 ft. at Westwater, and 4,532 at Cottonwood, reaching a maximum of 5,160 ft. at Thompson, and then descends to 4,080 ft. at the crossing of the Green river at Green River, Utah, which is the lowest point on the Rio Grande. From this station, the grade goes over a ridge with an elevation of 4,832 ft. at Cliff and descending to 4,623 ft. at Woodside, where the railroad crosses the Price river. At Mounds the elevation is 5,546 ft. and from there the railroad ascends to the Price river at Farnham, with elevation of 5,313 ft.; then follows up the valley of the Price river, the elevation at Helper being 5,840 ft. Throughout this territory, the curvature is comparatively light. The maximum grade eastward is about 1 per cent for 25 miles between Green River and Thompson. The maximum grade westward is 1.11 per cent for about 11 miles between Woodside and Cedar.

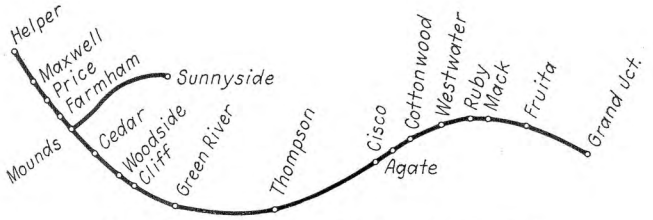
Helper to Agate in 1943

In 1942, in order to supply coal and coke for steel mills and other war industries in Provo, Utah, and San Bernardino, Cal., new coal mines were opened and existing mines were expanded in the Book Cliffs near Sunnyside, Utah, which is on a branch line that connects with the main-line at Mounds. A maximum of about 250 cars of coal are moved westbound and the same number of empty cars are moved eastbound daily over the main-track between Helper and Mounds. This traffic is handled by special mine run trains working out of Helper, and the number of these train movements may vary from 4 to 8 or more daily.

On account of this extra coal traffic, in addition to the regular through trains, the 1943 centralized traffic control was started at Helper and extended eastward, the entire 138 miles between Helper and Agate being completed that year. Starting in 1944, the remaining 48.9 miles between Agate and Grand Junction was equipped, thus completing centralized traffic control on the entire 284.5 miles between Dotsero and Helper, on September 1, 1944.

Turnouts and Siding Arrangements

Throughout all these projects, the Rio Grande has followed the practice of providing track arrangements by means of which centralized traffic control can most effectively minimize train delays. Where power switch machines were to be provided at the ends of sidings, the installation included new No. 15 turnouts with 33-ft. curved Sampson switch points, good for train speeds of 37 m.p.h. when making diverging movements. For a freight train of 75 cars, the difference between 15 m.p.h. and 37 m.p.h. for a train length saves 87.8 seconds.

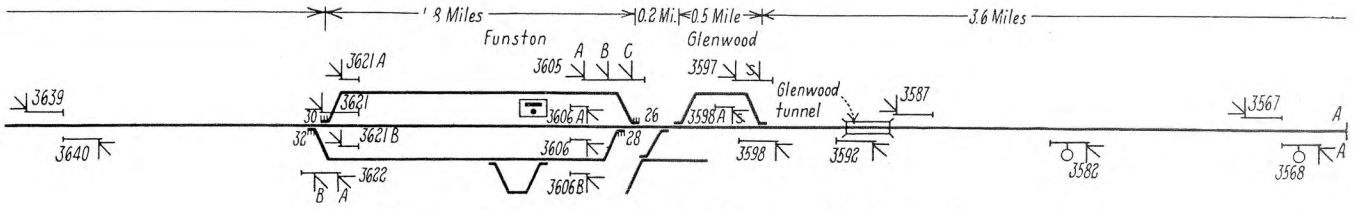


Map of the Helper-Grand Junction section

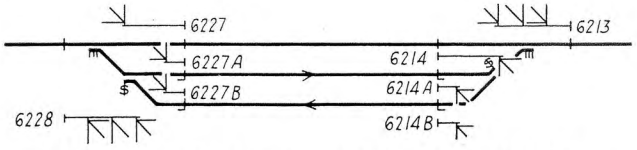
In these switch layouts the stock rails are 60 ft. long, thus eliminating rail joints in the switch area. The stock rails are milled, stocked and precurved at the factory to fit the Sampson switch points. Ramapo Type-M tie-rods and Type-MF front rods, are used as a means for minimizing the rolling of switch points. Adjustable rail braces and 1-in. by

8-in. insulated gage plates are used on three ties.

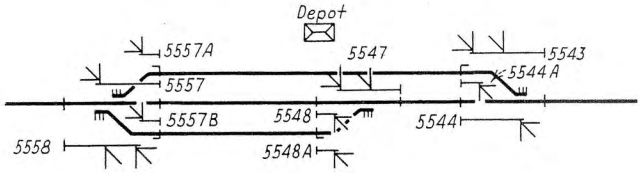
When preparing for the installation of C.T.C., various changes were made to eliminate as many main-line switches as possible, the reason being threefold; (1) to obviate the costs of maintenance and replacement of these switches on the basis of main track standards; (2) to avoid the necessity for electric locks on such switches, and (3) to simplify operations of trains with respect to such switches. A siding for loading sugar beets at Antlers was changed to connect with the passing track rather than the main line. The stock pens and loading tracks at Silt and De Beque were moved to connect with the passing track rather than the main line. Similar changes were made at Price. Between Funston and Palisade, three passing tracks were removed, at Gravel, Niger and Morris. Between Grand Junction and Helper, passing tracks were removed at Loma and Racey.



Track and signal layout through Funston and Glenwood



Layout of tracks, switches and signals at Maxwell



Track and signal layout at Green River

Layout at Funston

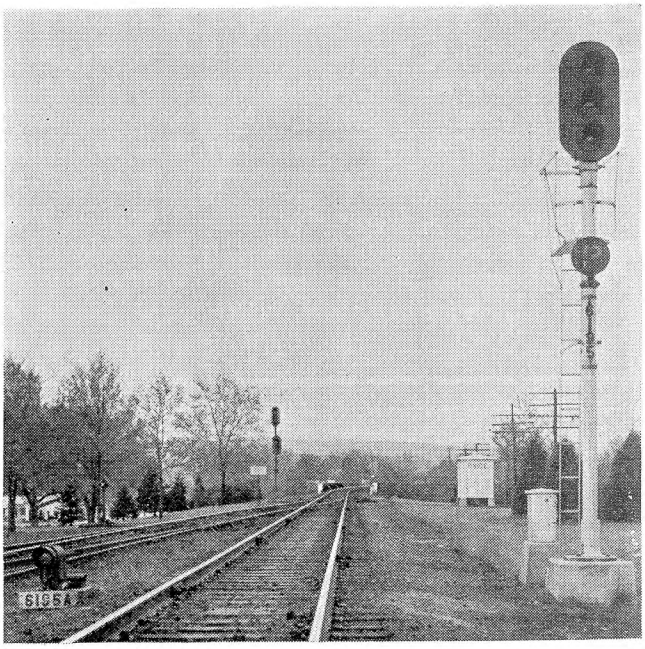
With but few exceptions the station layouts each include a single passing track. At Funston, eastbound trains stop to take coal and water. For an eastbound tonnage train being handled by one of the smaller locomotives, a helper is cut in at Funston. Thus trains consume extra time at Funston, and for this reason there are two sidings each holding about 153 cars, thus permitting flexibility in handling trains in either direction on each siding.

While an eastbound freight train is standing on the main line at Funston, the locomotive is sometimes cut off, run up ahead of the switches and back into the yard, to pick up or set out cars. Also, for some of the heavier trains, a helper locomotive is coupled ahead of the regular locomotive. When making such moves, the main line is occupied and the top or second signal of 3605 cannot be cleared for back-up moves against an occupied block. In order to authorize such moves, therefore, a third "arm" was provided, the normal aspect being red. With both switches normal, a yellow call-on aspect can be displayed for a locomotive to back down on a train.

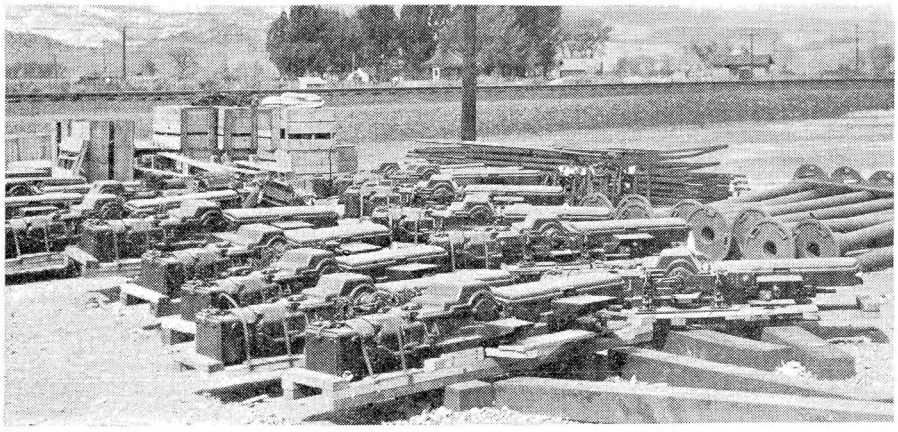
Parallel Sidings at Maxwell

At Maxwell, the first station east of Helper, there are two passing tracks on the south side of the main track. The one next the main track is for eastbound trains and the other is for westbound trains. The two main-track switches are equipped with electric switch machines, and the two inner switches with spring mechanisms, these switches being normally positioned to route eastward trains to the siding next to the main track and westward trains to the other siding. The station-entering signals, 6213 and 6228, each have three "arms." The upper "arm" displays three aspects applying to the main track. The second "arm" normally displays red, or, as applying to signal 6213, the second arm displays yellow under a red in the top arm to direct a train to enter the normal eastward siding, i.e., the one next to the main track.

If this siding is already occupied, and the dispatcher wants a second



Signaling at the west end of Price is typical of many of the single sidings



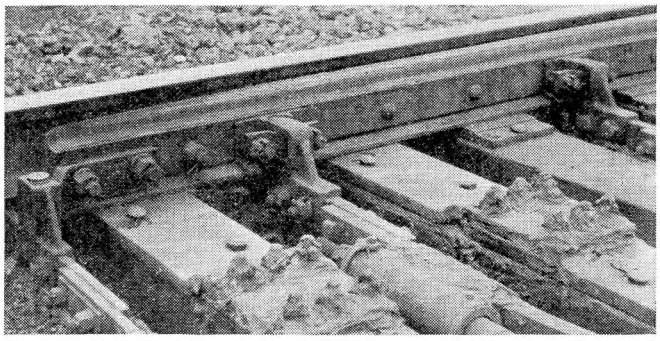
The signaling material was assembled at construction headquarters

eastbound train to use the second siding, he sends out a code to reverse the power switch and to control signal 6228 to display red in the top arm, red in the second arm, and a letter "S" in the upper unit of the bottom "arm." This aspect indicates that a train is to stop short of the signal, that the head brakeman is to throw the hand-throw spring switch at the west end of the second siding. Then signal 6228 presents an aspect of red over red over yellow. This arrangement of two parallel sidings has the advantage of using two switch machines, two spring switches and four main-track signals, as compared with a lap siding arrangement using four switch machines and six main-track signals.

C.T.C. Control Machines

Using the original C.T.C. control machine installed in the office at Grand Junction in 1937, new panels have been added as required when C.T.C. was extended, until now this one machine controls on 72 miles from De Beque through Grand Junction to Cottonwood. Similarly, panels have been added to the machine installed at Funston so that this office now handles the C.T.C. on 74 miles between Dotsero and De Beque. The new machine at Green River controls the 133 miles between Cottonwood and Helper. The chief dispatcher of the division is located at Grand Junction. A dispatcher on each trick at Grand Junction handles the C.T.C. machine for the Cottonwood-De Beque territory, and has jurisdiction of the controller-operator in charge of the C.T.C. machine at Funston. A dispatcher on each trick at Green River has charge of the C.T.C. machine for the Cottonwood-Helper territory, 133 miles.

The two end sections of the machine at Green River are at an angle with the center section, the total length of the machine being 15 ft. The dispatcher sits on a chair which is equipped with ball-bearing wheels similar to those used on a roller skate. These wheels fit in slots in two steel "rails," so that with very little effort the dispatcher can move back and forth to reach any of the levers of the machine without leaving his chair. The rails are made of ½ in. by 2 in. strap iron. At the ends, these "rails" are welded to two metal cross ties, thus forming a frame which lies loose on the floor, so that it can be moved if the dispatcher wants to sit closer to the desk of the machine.



New type of front and tie rods with the vertical pins

Benefits of the C.T.C.

Previously the train movements were authorized by timetable and train orders, with automatic block signal protection throughout. Now the train movements are authorized by the indications of signals controlled by the C.T.C. system. The track-occupancy indications on the C.T.C. control machines show the locations of and progress being made by trains. Based on this minute-to-minute information, the men in charge of the machines control the switches and signals to advance trains for close meets. The lengthened sidings, ranging from 100 to 154-car capacities, not only accommodate long trains when operated, but also with normal length trains of about 70 cars, permit numerous meets to be made without either train stopping.

With the previous timetable and train order operation, meets and passes had to be set up ahead of time. In the meanwhile, if some train did not make the progress anticipated, one or more other trains were delayed at the meeting points because the dispatcher had no means for changing orders soon enough to take advantage of the changing conditions. On the other hand, with the C.T.C., the trains keep going, enter sidings, and depart from sidings according to the aspect displayed by the signals. As a result, much time formerly wasted waiting on sidings, can now be used to keep trains moving. There have been so many changes in locomotives, traffic, and operating conditions since the first portion of the C.T.C. was placed

Statement of Train Performance Between Agate and Helper, July 20 to 26, 1943, Compared With March 24 to 30, 1944

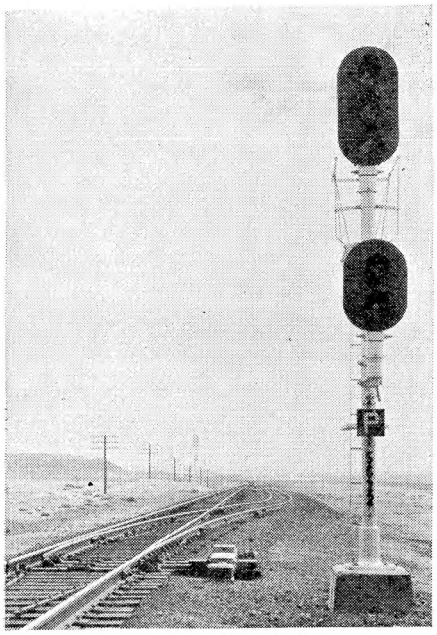
	Freight		Passenger	
Westward	Before	After	Before	After
Number of Trains	74	69	30	27
Elapsed Time	625 hr. 52 min.	436 hr. 11 min.	114 hr. 57 min.	101 hr. 11 min.
Mileage	9035.4	8424.9	3663.0	3296.7
Average Speed	14.4	19.3*	31.9	32.6
Average Time per Train	8 hr. 27 min.	6 hr. 20 min.	3 hr. 50 min.	3 hr. 45 min.
Eastward				
Number of Trains	66	67	29	32
Elapsed Time	459 hr. 31 min.	388 hr. 5 min.	108 hr. 9 min.	103 hr. 13 min.
Mileage	8058.6	8180.7	3540.9	3709.0
Average Speed	17.5	21.1	32.7	37.8
Average Time per Train	6 hr. 57 min.	5 hr. 47 min.	3 hr. 43 min.	3 hr. 14 min.

* If 23 hours deducted account 4 engine failures average speed would increase to 20.3.

in service that it is impossible to determine how much train time is being saved on the 284 miles of C.T.C. as a whole.

Traffic Increases

Approximately twice as much traffic was handled between Dotsero and Grand Junction in May, 1943, as in



At the west end of Desert

May, 1941. The increases amounted to 97.3 per cent in freight gross ton miles and 103.5 per cent in passenger car miles. In handling this heavily increased business, the Rio Grande was faced not only with the problem of arranging meets and passes on a single-track district, but also with making the best possible use of a limited supply of locomotives. This involved heavy loading of trains over this district, with smaller engines than had previously been used here. The result was that the average train speed over this district was reduced materially, but the efficiency in power utilization was improved. In spite of a 59 per cent increase in train miles per day (freight and passenger combined), the average productivity of freight locomotives on this district was increased by 16 per cent as measured by gross ton miles produced per pound of tractive effort per hour between terminals. Based on a study made in 1943, the average overall time of freight trains between Grand Junction and Dotsero was reduced about two hours as compared with corresponding months in 1941.

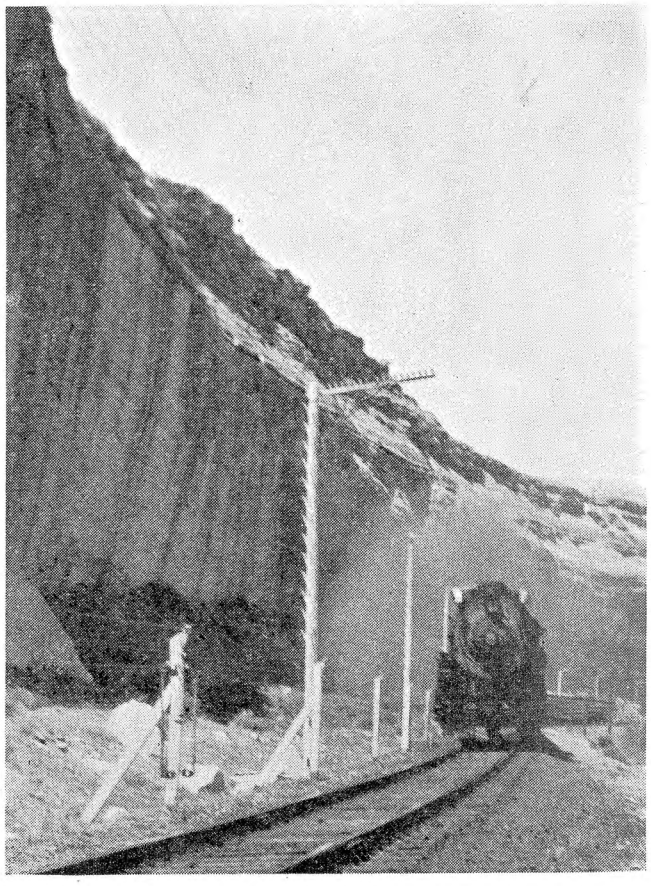
After the C.T.C. had been in service several months on the 126 miles between Helper and Cisco, a comparison was made of train operations for six days in July, 1943, as compared with a similar period in March, 1944. As shown in detail in the accompanying tables, the average speed of westbound through freight trains increased from 14.4 m.p.h. to 19.3 m.p.h., thus reducing the overall time from 8 hours 27 minutes to 6 hours 20 minutes. For eastbound through freight trains the average speed increased from 17.5 m.p.h. to 21.1 m.p.h., thus reducing the overall time from 6 hours 57 minutes to 5 hours 47 minutes. On the average westbound passenger trains saved 5 minutes and eastbound passenger trains 29 minutes. In addition to the through trains, an average of 4.5 local and short turn mine trains were operated in each direction daily, on which there was no appreciable saving in time while using the main line between Helper and Mounds.

If the eight passenger trains are on time, they are all on the territory between Cottonwood and Helper during the third trick. On one occasion recently, there were 21 trains on this 133 miles at one time, of which 9 were passenger and 12 freight trains. In the course of 3.5 hours 19 nonstop meets were made.

Coded Line C.T.C. Controls

The power switches and signals at the field locations are controlled by codes sent out from the office, and likewise indications on the control machine to repeat the operations of the switches and signals as well as track occupancy are sent into the office by codes. These codes are transmitted over three line wires using the General Railway Signal Company's Type-F Class-M coding system, by means of which control codes and indication codes can be transmitted simultaneously. The coding equipment on this installation is what is known as the 8-step size and can control as many as 32 single switch field locations or their equivalent, with 4 controls and 11 indications each.

In this system, a 48-ohm relay at each field station, i.e., each end of every passing track, is connected in series with the control line circuit. In previous installations of this character, if the control wire or the common wire of the code system is broken, the coding system as a whole is inoperative until the wire is repaired, or until the maintainer manually sectionalizes the line at a field station closer to the office than the break. In order to automatically maintain operation of the C.T.C. system on the sections between the office and a line wire break, a new arrangement of automatic sectionalizing was included in this Rio Grande project. At certain selected field stations, a 2,400-ohm neutral relay with its series resister is connected in multiple across the control line circuit. Under normal operation this relay is not ener-



Protection to detect falling rocks in the Ruby canyon

gized. In case a line wire is broken beyond one of these field stations, however, the 2,400-ohm relay is picked up, and, after a delay period of a few seconds, an automatic sectionalizing relay is picked up to terminate the C.T.C. line circuits at that point and return to service the sections between that station and the control office. This automatic sectionalizing is indicated by lamps on the control machine, so that the operator is informed of the circumstances and so that he can call the maintainer to repair the broken line circuit.

Signaling Changes

In 1927 and 1928, this territory was equipped with color-light automatic block signaling using absolute permissive controls. In this arrangement, a double location, including a signal for each direction, was located near the switch at each end of a siding. When converting to centralized traffic control, several changes and additions were required at each end of every siding, the entering signal, i.e., the one in approach to the facing points, was left in its previous location and a lower, two-aspect "arm" was added to direct moves when the switch was reversed for train to enter the siding. The departure signal was moved back to a new location at the right of the main track and opposite the clearance point on the turnout so that this signal would then be located properly to stop trains short of the switch or to direct trains to proceed to the next passing track. These signals were in all instances located immediately at the right of the main track, and, where necessary, the siding was shifted to get 19-ft. centers, thus providing proper clearance for the signal between the main line and the siding.

Electric lock on hand-throw switch

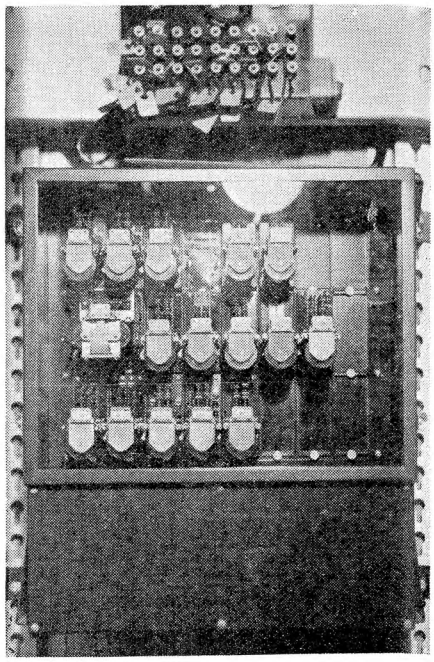
On the siding and opposite the clearance point, a searchlight-type color-light dwarf signal was installed. Such a signal displays three aspects, being red normally, and, when controlled by the operator, will display green if two or more automatic blocks are unoccupied, or yellow if only one block is unoccupied. This use of three-aspect dwarfs on the passing tracks, as compared with two aspect signals displaying only yellow as a proceed aspect, facilitates moves because when a green aspect is displayed an engineman can pull his train out and accelerate to normal speed promptly, without the necessity of running at reduced speed until he sees the next signal displaying a green aspect.

The signals on masts, i.e., the station-entering and the station-departure signals, display three aspects: Red for stop, yellow for approach, and green for clear. The bottom signal of a station-entering signal displays red normally or yellow under a red to direct a train to enter a siding. All signals governing movements over power switches are designated by a reflectorized marker displaying the letter "P."

Intermediate Automatic Signals Changed

In a C.T.C. project such as installed on the Rio Grande, the positive signals normally display the Stop aspect, and, furthermore, only one of two opposing station-leaving signals can display a Proceed aspect at one time. As a consequence, the spacing of intermediate automatic signals for proper braking distance to provide head-on protection was not necessary, as was previously the case with the former automatic block signals, all of which normally displayed the Clear aspect. When installing the C.T.C., therefore, the intermediate automatic block signals were relocated as necessary to provide better view, and some were removed, the purpose being to provide the most efficient spacing for following train movements and at the same time have a minimum block spacing of 6,500 ft., on the basis of level tangent track, with variations according with grades and curvature.

The original automatic signaling included conventional d-c. neutral track relays, with polarized line circuits using a line wire for each direction in connection with a common line wire. When changing over to C.T.C., the line wire circuits were retained but numerous changes were made in the track circuits.



Line code equipment in field station

Special Detector Track Circuits

The revision of the locations of signals at each end of every siding, as required for direction of train movements by signal indication, resulted in the introduction of a new detector circuit at each switch. In each of these layouts, battery is fed to the rails at the signal in approach to the facing points of the switch, the insulated joints and jumpers throughout the turnout being as shown in the accompanying sketch.

The battery feeds two track relays, one of which is connected to the rails at the station-departure signal on the main line and the other connected to the rails at the dwarf signal on the turnout. These track relays are quick acting and equipped with only two contacts. They are rated at 4 ohms with a 20-ohm resistance in series with the coil, and the normal current is 125 m.a. A 500-ohm d-c. neutral slow-pickup repeater relay, in the instrument house, is controlled through these track relays, with a double-wire double-break and double-shunt features. This arrangement provides good shunting characteristics, prevents picking up the repeater relay in instances of momentary loss of shunt, and provides maximum broken-rail protection.

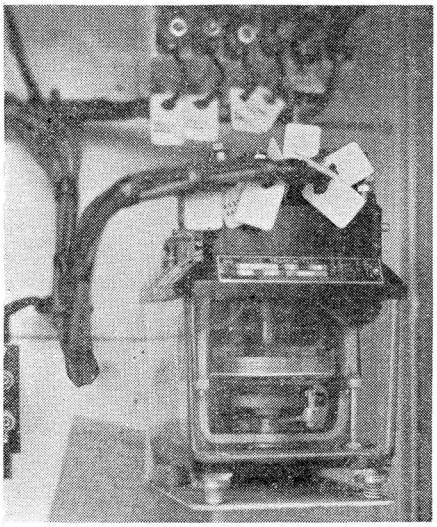
(Continued on page 632)

Rio Grande Has Longest C.T.C.

(Continued from page 636)

In the previous automatic signaling, the main line throughout the length of a passing track was two track circuits, using conventional d-c. neutral relays. As a part of the improvements, these two conventional track circuits were replaced with one d-c. coded track circuit. A code transmitter, rated at 5.5 ohms, 2.0 volts is driven constantly at the rate of 75 times each minute, from a storage cell which also feeds the coded energy to the rails. This low voltage transmitter is considered to be a new feature.

On the sections between sidings, new coded track circuits operating at



Track code transmitter

75 code, were installed wherever one such track circuit could be used to replace two more conventional d-c. track circuits, thus eliminating cut sections.

The electric locks on the hand-throw main line switches at house tracks, such as at De Beque, are controlled automatically. A special releasing track circuit, about 78 ft. long is located in approach to the facing point of each switch. When a train is to make a move into this house track, the train or a portion of it must be stopped in this releasing track circuit, and, when so done, the release is direct. Releasing the track circuit gives immediate release of the lock when a train is to enter the spur track.

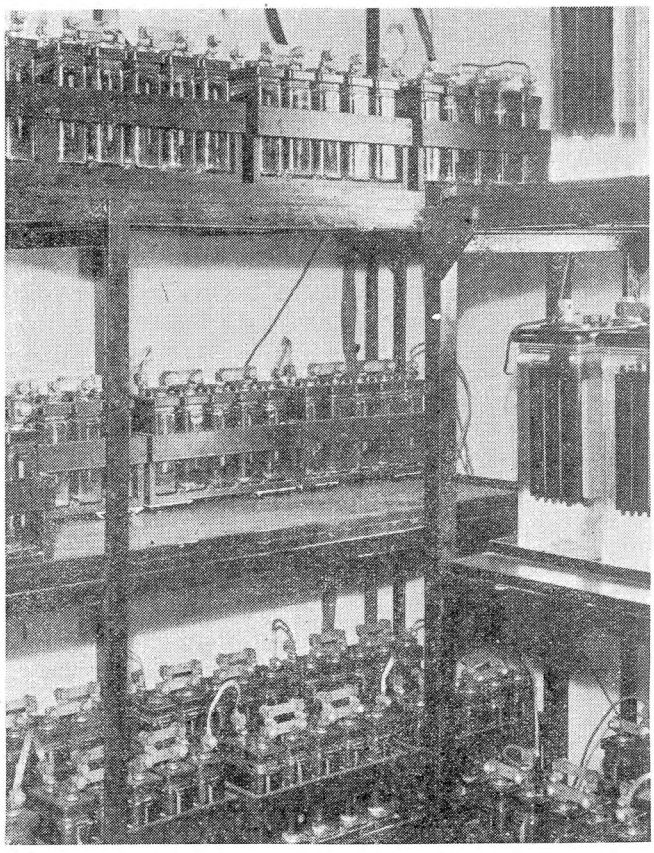
When a train on the house track is to enter the main track, the conductor telephones to the dispatcher for written authority; after receiving authority the dispatcher protects the intended move. The conductor then goes to the electric lock, and opens the door. This action does two things. First, the signals in approach from each direction are set at their most restrictive aspects, and, second, the release of a 3-min. clock-work time release is started. At the end of three minutes the electric lock is released. The coils of the electric lock is rated at 16 ohms, and it is fed from 1 cell of 72-a.h. lead storage battery.

In this installation, the signals, switch machines, relays, track circuits, etc., are of the d-c. type which are fed from storage battery charged by rectifiers supplied from an a-c. power distribution circuit. The batteries are of the Exide lead type, various capacities being used for different purposes. At each field location, the switch machine is operated from a set of 15 cells of three-plate battery rated at 38 a.h. on a 72-hr. rate. Twelve of these cells are used also to feed the line stepper of the line coding system. A set of four cells provides the local and line circuits, a set of five cells provides stand-by for light circuits and is rated at 174 a.h. Each of the cells, which operates a track code transmitter and feeds the coded energy to the rails, is rated at 290 a.h. Each of the conventional d-c. neutral track circuits is fed by an 87-a.h. storage cell.

At each power switch location the relays, rectifiers, batteries, line code apparatus, etc., are located in a 6-ft. by 8-ft. sheet-metal house. These houses were shipped in knocked down panel sections to field headquarters, where they were assembled and then all the wiring and instruments were installed. Instead of using one terminal board at one end of the house for all wires, separate boards are used on each side, thus reducing the insulated wire required. The complete wiring for such a house requires 1,975 ft. of No. 14 flexible for controls and 200 ft. of No. 10 for switch operating and lamp feed circuits. After the houses are complete, a Burro crane operating on the track is used to load the houses on cars as well as to set them on foundations at their field locations.

New underground cables of 3, 5, 7 and 19 conductors were installed as required. The track circuit conections are in single-conductor No. 9 cable from the house to a Raco boot-leg from which two-stranded bronze connections extend and are attached to the rail with Cadwell welded bonds. All underground cable has mummy finish with no metal coverings. The insulated wires and cables were furnished by the Kerite Insulated Wire & Cable Company. All line wire connections, as well as line drop connections from line wires to cables, were made with Nicro grip sleeves, thus avoiding the use of any solder in the field.

This centralized traffic control was planned and installed by signal forces of the Denver & Rio Grande Western under the direction of B. W. Molis, signal engineer, the major items of equipment being furnished by the General Railway Signal Company.



Storage batteries for the C.T.C. code line and the local circuits in the new Green River office