

# C.T.C. on the

Above—The control panel is located above the desk of the dispatcher in the office at Salt Lake City. Right—The view looking westward at the west end of Midvale. Extreme right —Dual control power switch machines were used and the switch layouts are well equipped with plates and braces.



EASTWARD from Salt Lake City, Utah, the main line of the Denver & Rio Grande Western is double track for 11 miles to Midvale, single track 32 miles to Provo, Utah, and then double track over the Wasatch Mountains 77 miles to Helper, Utah. The single-track section, Midvale to Provo, has been equipped with centralized traffic control since 1929. During recent years serious train delays have occurred on the Midvale-Salt Lake City section of double This territory handles six track. passenger trains and about 20 freight trains daily, in addition to 6 to 8 switch runs, totaling about 28 train movements daily. Three branch line mixed trains operate each way daily over portions of this main line territory. The uncertainty in the exact time of arrival or departure of trains was the major cause of the delays.

The principal freight yard, at

Roper, is located on the south side of the main line, the main line trains entering and leaving the east end of the yard at East Roper, which is 4 miles from Salt Lake City. Under the previous arrangement, an incoming westward freight train on the normally righthand track had to be stopped at East Roper to handle the crossover and yard entrance switch. Eastward departing freight trains pulled out of the yard lead onto the eastward main track through a spring switch. No automatic block signaling was in service, trains being operated by timetable and train orders.

On account of the volume of express, mail and baggage received in interchange at Salt Lake City, the time of departure of passenger trains from Salt Lake City was very indefinite. As a result, incoming westbound freight trains were frequently held on the main line at East Roper for extended periods because there was no satisfactory means of directing them to cross over and enter the yard on the time of the passenger trains. Likewise, eastward outbound trains were delayed, not only because of the difficulty of knowing exactly when the passenger trains were to depart, but also because the leaving time of the freight trains was sometimes delayed for reasons not anticipated.

An eastward passing track, long enough to hold a train of 150 cars, is located at Midvale. A small yard used for picking up and setting out agricultural and industrial products is also connected to this passing track. The local freights, as well as some of the through freights, pick up and set out cars at this yard. However, a serious handicap in advancing eastward freights from Roper to



## Denver & Rio Grande Western



this passing track at Midvale was the delay in getting such trains in and out of this track. As a result, it was practically useless as a siding because the train might as well be held in Roper yard until the line was clear for a run to some point beyond Midvale.

The preponderance of train movements is incoming in the morning and outgoing during the evening. As a result, although double track was available for the 11 miles from Salt Lake City to Midvale, it was readily apparent that delays in this section were excessive, as compared with the facility with which trains were being moved on the adjacent 32 miles of the C.T.C. single-track territory, Midvale to Provo. A study of the train operation led to the decision to install centralized traffic control on the Midvale to Roper section, including automatic signaling for eitherdirection operation on both tracks, as well as automatic blocks for righthand running on the Roper to Salt Lake City territory.

#### The New Layout

The new C.T.C. layout includes power switches for both ends of the passing track at Midvale, for a new No. 18 crossover at the west end of Midvale, and for the crossover and vard entrance switch at East Roper. The spring switch equipment, for the eastbound yard-leaving switch, was retained in service, because normally no reverse movements are made to enter the yard at this switch. Controlled signals are provided at each switch layout to direct trains by signals in each direction on all tracks. The power switches and signals are controlled by code line circuits from a machine located in the dispatcher's Installation on seven miles of double track approaching yards and terminal at Salt Lake City, Utah, facilitates train movements and improves safety

office at Salt Lake City, this machine being provided with a complete set of indication lamps to repeat the indications of the signals, the position of the switches and the location of trains occupying the track sections in and approaching the controlled territory.

This C.T.C. was placed in service on May 15, and the benefits in reducing train delays were readily realized. When an incoming westward freight is running closely ahead of a passenger train at Midvale, the freight can be run to Roper on the left-hand track, allowing the passenger train to run into Salt Lake City on the normally right-hand track.

Likewise, an eastward freight train can depart from Roper yard on close time ahead of an eastward passenger train. The freight train is run from Roper yard to Midvale on the righthand track, and, in the meantime, the passenger train is run around on the normally westward track. As a matter of fact, the tracks in this territory have lost their designation as eastward or westward main, each track now being used similar to a





Control equipment at outlying points is located in sheet metal houses

separate single-track line, depending on various routing of trains as may best be adapted to keep all trains moving, under the control of the dispatcher.

The passing track at Midvale can now be used to an advantage either to advance a train from Roper yard to Midvale or to hold a westward train in case the yard cannot accept it. The results accomplished with the C.T.C. system have been quite satisfactory, the time of each westward freight train having been reduced, on the average, 18 minutes. The time saving for eastward trains is accomplished by moving them out of the yard whenever they are ready to go, but this saving is not readily determined because no comparable record of departure delays is available.

### The Control System

The control of the power switches and the signals for directing train movements is accomplished by a control machine in the dispatcher's office at Salt Lake City, which has 6 levers for the control of 21 signals and 5 levers for the control of 3 single switches and 2 crossovers. The illuminated track diagram on the panels above the levers is equipped with miniature lamps indicating the location of trains on the sections of the controlled territory and the approaches. Lamps in the face of the levers repeat the position of each switch and the aspect displayed by each signal. As may be noted in the illustration, the control machine is mounted on the dispatcher's desk, just above the calling keys of the telephone train dispatching system extending over the entire division. Thus, with the train sheet on his table, the dispatcher has, within his reach, all the facilities to handle his work.

The control system used on this

project is the General Railway Signal Company's Type F, Class M, coded system, using three line code wires. On the face of the machine, the track diagram and levers for the control of field functions in one general locality are assembled on one panel 10 in. wide and 18 in. high. The coding equipment operating in connection with the switches and signals controlled by the panel is arranged in a case the same width as the panel, the case being so constructed that it can be pulled out to the rear of the machine for inspection. With this type of construction, the machine is made up of a series of units which are fitted together to form a compact machine. When changes or additions are made to the C.T.C. system, additional units can be inserted at any point as required, without changing existing units. As soon as practicable, additions are to be made to the Salt Lake City machine to include the control of the Midvale to Provo 32-mile territory of C.T.C., the existing unit-wire control being replaced by code control. The old unit-wire control machine at Lehi, for the present Midvale-Provo territory, will be eliminated, and then the control of the extended code machine at Salt Lake City will control the entire territory from Roper to Provo, 43 miles.

#### Construction of New Facilities

The switch machines on the Roper-Midvale territory are the Model 5D, equipped for operation on 24-volts d-c., and are provided with dualcontrol levers to permit hand operation when making switching movements. To prevent confusion on the part of trainmen when using the dual control, the handle of the selector lever is painted yellow and the handthrow lever red. Each machine is equipped with the usual lock rods and a point detector. The master relay is housed in the switch machine case, a spring suspension being used to offset the effects of vibration. A counter is provided on each switch machine and a record is kept of the number of operations each month. From the in service date of May 15 to June 23 the switch machines on the crossover at East Roper operated a complete cycle 274 times.

Each switch layout was rebuilt when installing a power machine. New No. 18 turnouts were installed, if not previously in service. A 1-in. by 8 in. insulated gage plate, with adjustable rail braces, was installed on each of the first three ties under the points, as well as on the tie ahead of the points. The plates on two ties extend and are attached to the switch machine so as to prevent any lost motion. The front rod is vertical and is a D. & R.G.W. development made by the Ramapo Ajax Corporation. The bearing, for the rod extending to the switch circuit controller or point detector, is cast as a part of the switch foot. The switchadjuster, attached to the head rod, is the enclosed Bossart type. On a No. 18 turnout on 110-lb. rail, with 24-ft. points, six tie rods are used. On account of the dry climate, hot sun and excessive amount of salt brine from refrigerator cars, there was a tendency for the insulation in the tie rods and gage plates to dry out and become brittle. Trouble from this source has been prevented by keeping a liberal coat of Arco



Special mounting of signals on bridges

Sealit on the edges of the fibre insulation.

Yard switches are connected to the passing track at Midvale, and, on account of prevailing winds, a car might be blown out on the passing track and on out onto the main line at the west end of the siding. It was, therefore, considered advisable to install a Hayes derail at clearance point on this siding. This derail is pipe connected to and operated by the switch machine which operates the west passing-track switch.

## Searchlight Type Signals Used

The signals on this project are the SA searchlight type, with 250-ohm coils operating on 10-volts d-c. Each unit is equipped with an 8-volt, double-filament lamp rated at 13+3.5 watts. In order to locate the signals properly for either direction on both tracks, the main line signals are mounted on overhead bridges, with the exception of one double automatic location where masts are used. The two leaving signals at the east end of Roper yard, 45L and 47L, are on high masts, and a dwarf, 33L, is used for the leaving signal at the east end of Midvale passing track. The signaling is arranged for train operation in either direction on both tracks, the only variation being that intermediate automatic signals No. 7398 and 7399 are provided for normal right-hand running, but automatics for lefthand running are not used at this location. However, at the other intermediate automatic block location, at Second Ave., automatics are provided for either direction on both tracks.

The positive stop signals are so designated by a reflectorized sign "P" mounted just below the signal unit. Each main line signal unit operates to display three aspectsred, yellow and green. As advance information, so that an engineman will know whether his train is to continue on the main track or be diverted over No. 18 turnouts, the distant signals, as for example No. 7399, present additional aspects, using two signal units, one above the other. For a straight through movement, the distant signal aspect is green over yellow; for a diverging move, yellow over green. All signals are normally dark, being controlled by approach-lighting circuits.

In order to facilitate the inspection and maintenance of the signals on bridges, a special arrangement was devised. For a single-unit signal, angle-iron supports extend across the base of the bridge girder and out 3 At field stations the coding equipment, relays and batteries are housed in welded sheet-metal buildings



ft. beyond the face of the bridge. A sheet-metal tread plate is placed on the angle irons and the signal is mounted on the plate, thus leaving space behind the signal for access to the mechanism. Where a second signal unit is used, it is mounted on a short mast on top of the upper bridge girders. With this arrangement, the vertical distance between the centers of the signals is 6 ft., and the horizontal distance in line with the track is 8 ft.

#### **Special Track Circuit Protection**

In order to insure prompt and reliable track circuit shunting, the primary-secondary relay scheme is used on all main line track circuits in this installation. These circuits are fast in shunting and slow to pick up, the pickup being timed to about 1.8 seconds. An added advantage of this arrangement is that correct operation of the signals is secured even with light engines running at high speeds. The point is that the locomotive always shunts the next track circuit before the track circuit which it is leaving can pick up. Therefore,

the signal at that location goes from green or yellow to red promptly and the signal in approach moves promptly from the red position directly to the yellow without a flash of the green. On an OS detector section where power switches are located, battery is fed at the switch end of the track circuit, and two track relays are used, one at the end of the circuit on the main line, and another at the end of the fouling on the turnout. This insures maximum broken rail protection on both the main track and turnout. Separate track circuits are used on all crossovers.

## **Instrument Housings**

At each of the field locations where switches and signals are involved, the instruments and battery are located in a sheet-metal house set on concrete foundations which were poured in place. The relays are the wall-mounted type attached to  $1\frac{1}{2}$ in. by 10 in. boards supported from upright channel iron with enough space behind the boards to run wires. The stepper and application units for the coder system are located on a shelf at the rear of the house. The battery is placed on the bottom shelf, which is 24 in. high, so as to allow plenty of space above the cells for maintenance of the battery. The relays are Type K, using retained-neutral polar relays for signals and polar relays as switch repeaters. To reduce the voltage on certain relays, a 150-ohm Ward Leonard resistor is used in series. In order to prevent burning out ribbons in relays in case of an accidental short on a circuit fed from a storage battery, fixed resistors rated at 5.6 ohms are used.

The arresters for signal-control circuits are the G.R.S. Model 1, Form B, and General Electric Thyrite signal arresters are used on the code line circuits. Three copper ground rods, 5% in. by 8 ft., are used at each location, one at the line pole, one at the case or house, and another midway, all being tied together. The houses were wired complete with the instruments in place at the factory of the General Railway Signal Company.

At each location including positive signals, or at industry tracks where a local train can be pocketed, a telephone is provided so that trainmen can call the dispatcher, and also for use of the maintainer when testing. At each of these locations the phone is located in the entry way to the sheet-metal instrument house, the outer door being locked with a standard switch padlock, and is, therefore, accessible to trainmen, while the inner door leading to the instrument house is locked with a signal department padlock. The telephones at these locations are connected to a special line circuit extending to the dispatcher's office, separate from the telephone train dispatcher system. This arrangement is a decided advantage, not only when making tests, but also when trainmen call the dispatcher.

## Pole Line and Power Supply

The line wires for the automatic signaling and C.T.C. are run on the bottom arm of the existing communication pole line. The two wires for the 550-volt a-c. power distribution are No. 4 hard-drawn weatherproof copper and are located on the two end pins on the north side of the pole. The three code control wires are No. 10 hard-drawn weatherproof copper and are run on the three pins adjacent to the power supply. At each location there is a G.R.S. aircooled line transformer rated at 250 v.a., which is protected with fused plug cutouts and G.E. expulsiontype arresters.



At the Salt Lake office the code line batteries and charging equipment are housed in cabinets

The a-c. floating system of power supply is used throughout, with Exide lead type battery charged by G.R.S. dry-plate rectifiers. At the Salt Lake City control office the control battery consists of 30 cells of type BTMH and the indication battery includes 25 cells of the same type, while a local battery includes 12 cells of the DMGO-7 type. At a typical field location, such as at East Roper, the switch operating battery consists of 15 DMGO-7 cells, and there are four sets of local battery of five cells each for various local circuits. One cell of DMGO-9 is used to feed each track circuit.

#### Cable and Wiring

The circuits between the instrument houses, switches, signals, etc., are in underground Kerite cable. The track connections are made with No. 9 single-conductor cable made up with 6/64-inch insulation, tape, and two wraps of jute. The No. 14 cables for control circuits are made up with 5/64-inch insulation, tape, two steel tapes and jute. Two-conductor No. 6 cable is used for feeds to the switch motors. At each steel instrument house the cables are brought up into a wiring space and to a terminal board at the right of the door, the outer protective covering being removed for a short space only, allowing just enough wire with the base insulation to make the connection to the terminal.

At switch machines, the underground cable is terminated in a junction box, and flexible single conductors extend through flexible conduit to the machine so as to absorb the vibration. At signals, or for signals on bridges, the underground cable is extended directly to the signal, with no junction box. Wherever a cable runs over the edge of a foundation or other sharp corner, and where line cable enters cable posts or relay boxes, it is protected by a piece of old air hose.

Shunt fouling connections, located between the switch point and frog, are made up using two No. 6 solid copper wires twisted and soldered for about 1 foot, in three places. These wires are bonded into the rail and are stapled to one side of a tie about 2 in. from the top.

As an important part of this construction project, automatically-controlled, flashing light crossing signals were installed at eight crossings in this territory and at one crossing on a branch line extending to Park City. The signals at the eight crossings on the Midvale-Roper territory are made up according to A.A.R. Standard No. 1654A, using the vertical illuminated STOP signs in addition to the flashing lights. A bell is provided on one of the signals at each crossing. At locations where a side street enters the highway near the crossing, a second set of flashers is directed along the side street.

An eight-lane highway, extending from Provo to Salt Lake City, crosses the single-track, Park City line. On account of the width of this highway, a special arrangement of crossing signals was used. The standard arrangement of flashinglight signals and STOP sign was mounted on the mast. In addition, flashing-light signals, mounted backto-back, were attached to a bracket arm extending over the highway, the better to display an aspect to automobile drivers in the inner lanes of traffic. The cantilever bracket arms are 8 ft. long and the signals clear the pavement 15 ft.

The field construction of this C.T.C. project was handled by the signal department forces of the Denver & Rio Grande Western, the major items of signaling material being furnished by the General Railway Signal Company.