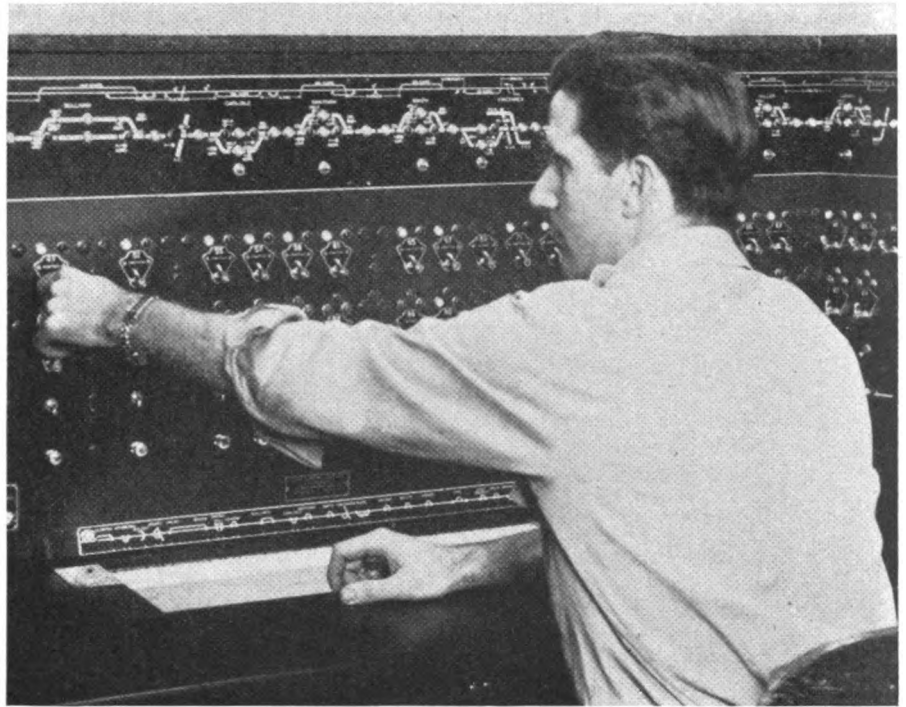


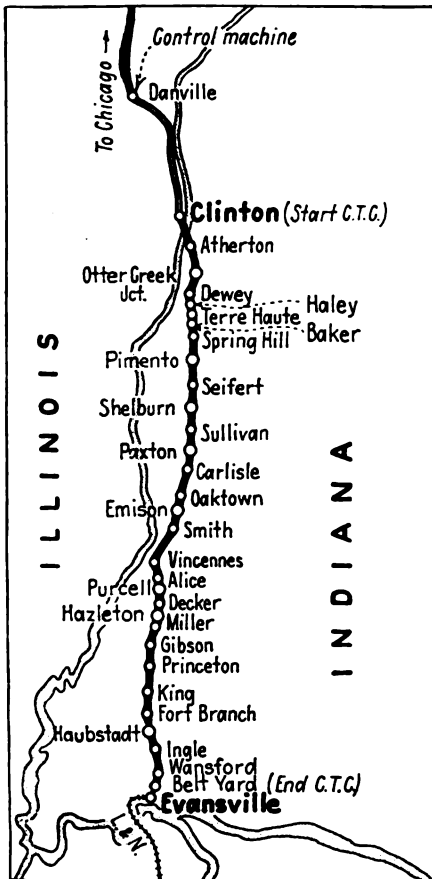
Dispatcher at the control machine in Danville, Ill.



Project on a 122-mi. single-track bottle-neck solves problem of congestion on 287-mi. route between Chicago and Evansville, Ind.

# C.T.C.

## Keeps 'em Rollin' on C. & E. I.



Map of the C.T.C. territory

A REDUCTION of about 1 hr. 40 min. in the average running time of all through freight trains—this is but one of the accomplishments resulting from a recent installation of centralized traffic control on 122 mi. of single track of the Chicago & Eastern Illinois, between Clinton, Ind., and Belt Yard, on its main line between Chicago and Evansville. The control machine is located at division headquarters, in Danville, Ill., 40 mi. north of Clinton, as shown in the accompanying map.

### Through Rolling Country

From Chicago, the main line of the C. & E.I. extends south practically in a straight line to Danville, Terre Haute, Vincennes and Evansville, 287 mi. The railroad traverses a rolling terrain, with light grades and curvature, and parallels the Illinois-Indiana border for practically the entire distance, following closely the banks of the Wabash river from Danville to Vincennes.

Double track is in service on the 163 mi. from Chicago to Clinton, and single track on the remaining 124 mi. to Evansville. It is on the latter section that C.T.C. has been installed on 122 mi. between Clinton and Belt

Yards at Evansville. Train movements in this territory were formerly governed by automatic block, timetable and train orders.

All grades are under 1 per cent and what curvature there is ranges up to 1 and 2 deg., with a few 3 and 4-deg. curves. The maximum tonnage ratings northward are 3,000 tons from Evansville to Vincennes, 3,200 tons from Vincennes to Seifert, and 4,200 tons from Seifert to Clinton. The maximum tonnage ratings southward are 4,200 tons from Clinton to Terre Haute and 3,000 tons from Terre Haute to Evansville.

### A Congested Territory

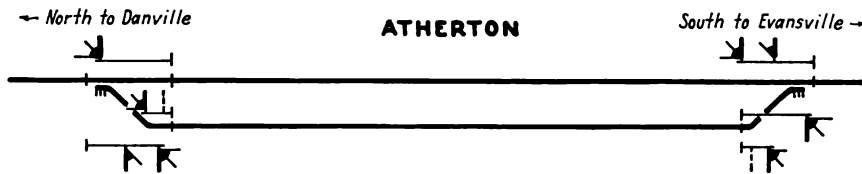
The traffic in this territory normally averages about 40 trains daily. Trains are bunched during certain hours of the day, particularly between Clinton and Terre Haute and between Vincennes and Evansville, and 8 or 9 trains within a distance of 50 mi. is not uncommon. The territory is especially busy between 4:00 and 9:00 p.m. and between 11:00 p.m. and 3:00 a.m., when numerous passenger trains are on the line.

There are an average of 17 passenger trains daily, most of which provide through service between Chicago and Florida and other points in the

south, via the Louisville & Nashville at Evansville. Freight movement over this territory is predominantly north,

to authorize trains to meet on close time. For example, on March 16, southbound passenger train No. 95

the passenger train cleared the south end at 4:14 a.m. The dispatcher, under train-order operation, would have probably held No. 52 at King for the meet, with considerable delay to that train resulting.



Typical C.T.C. controlled passing track at Atherton

### Track Changes

Sixteen passing tracks were equipped with power switch machines and controlled signals. Nine of these sidings were extended to increase the capacity to at least 105 cars. The passing tracks at Otter Creek Jct., Pimento, Shelburn, Paxton, Emison, Purcell, Hazleton and Haubstadt were

the C. & E.I. handling a considerable amount of tonnage from the Louisville & Nashville for delivery in Chicago. Much of this consists of perishables from Florida and other southern points.

### Big Coal Business

Approximately 35 per cent of the C. & E.I.'s freight business is coal, a good bit of which originates between Clinton and Evansville. Consequently, there are numerous spurs and sidings leading to coal mines. The operation of local freight trains, which do a considerable amount of switching between these mines and the main line, was a problem in keeping through trains moving, prior to the installation of C.T.C. Thus, the primary purpose of this installation was to relieve the congestion caused by these conditions and by the bunching of passenger trains.

### Operating Benefits

The safety of train operation and track capacity have been increased. Passenger train schedules have been improved and substantial savings effected in operating costs. By means of indication lamps on the track diagram of the control machine at Danville, the dispatcher watches the progress of all trains in the territory, and can control the signals and switches

arrived at the north end of Carlisle at 3:03 a.m., taking the siding; northbound passenger train No. 94 arrived at the south end of Carlisle at 3:02 a.m.; the two trains passed each other at 3:05 a.m.; No. 95 cleared the south end at 3:06 a.m., and No. 94 cleared the north end also at 3:06 a.m., making a non-stop meet. Under train-order operation, No. 95 would have stopped at either Sullivan, Oaktown or Smith, thrown the switch, entered the siding and waited for No. 94, thus losing from 10 to 15 min. or more.

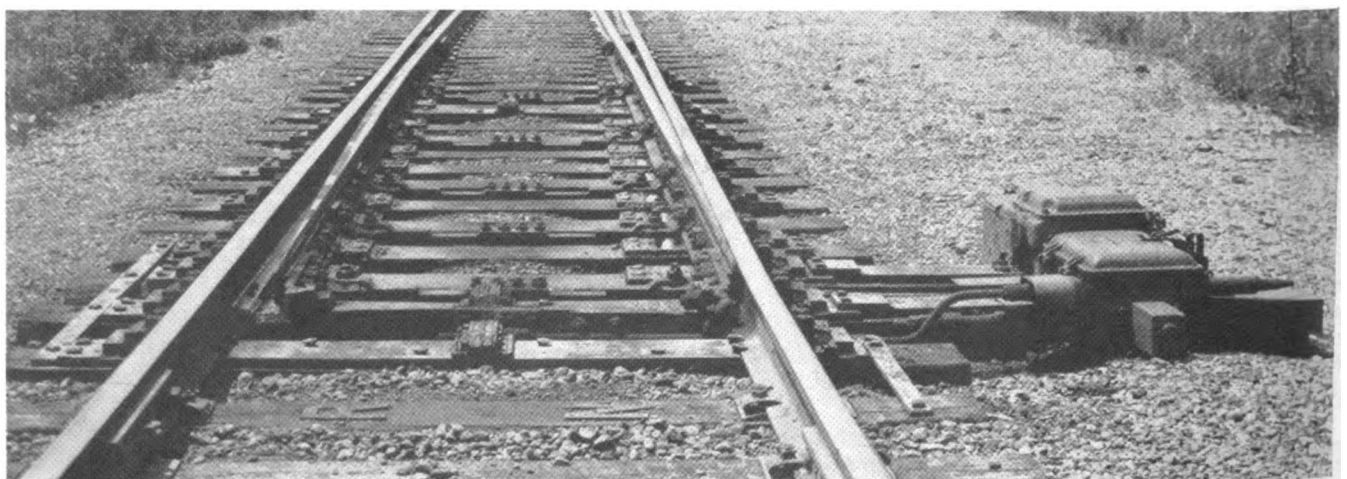
Another example of a non-stop meet, involving southbound passenger train No. 97 and northbound passenger train No. 96, occurred at Oaktown on the same date. Train No. 97 arrived at the north end of the siding at 12:30 a.m., taking the siding; train No. 96 arrived at the south end at the same time; the trains passed each other at 12:31 a.m., No. 97 clearing the south end and No. 96 clearing the north end simultaneously at 12:32 a.m. With train orders, No. 97 would probably have been held at Carlisle for the meet, losing approximately 20 min.

On March 8, northbound freight train No. 52 arrived at the south end of Gibson at 4:10 a.m., and entered the siding. Southbound passenger train No. 95 arrived at the north end at 4:12 a.m., making a non-stop meet with the freight train. The freight cleared the north end at 4:16 a.m., and

Table of Car Capacities of Passing Tracks in C.T.C. Territory Between Clinton, Ind., and Belt Yard

Location	Number of Cars
Atherton	105
Dewey	121
Spring Hill	85
Seifert	105
Sullivan	140
Carlisle	105
Oaktown	105
Smith	105
Vincennes	72
Alice	161
Decker	105
Miller	105
Gibson	120
King	60
Fort Branch	64
Ingle	105

discontinued as such. The passing tracks at Otter Creek Jct., Shelburn, Purcell, Hazleton and Haubstadt were retained for storage of cars with hand-throw switches at each end, and the other four were converted to spurs with an electrically-locked hand-throw switch on the main line. Thus, where passing tracks were formerly spaced an average of about 4 mi. apart, they



The power switch machines are the Style-M-22B, dual control, for operation on 24 volts d.c.

are now spaced on an average of 6 mi. apart.

Prior to the installation of C.T.C., No. 10 and a few No. 12 turnouts were in service on the main-line hand-throw switches. Where power switch machines were installed, these were changed to No. 16 turnouts with 30-ft. points, these layouts being signaled for 15 m.p.h. diverging movements. All main-line hand-throw switches were equipped with Style-SL-6A electric locks, there being 72 such switches. At some locations, such as King, where two switches are sufficiently close, one lock serves both switches by use of an arrangement of pipe connections and cranks.

The siding at Sullivan is an important point for meets and as a coaling and watering point. A Style-B mechanical switch and lock movement was formerly in service at the south end of the siding and a spring switch at the north end. As part of the project, the turnouts were changed to No. 16's and power switch machines and controlled signals installed.

A spring switch with a facing-point lock, was in service at the end-of-double track at Clinton, train movements over which were governed by automatic signals. The spring switch was retained in service, but as part of the project, control of the signals was transferred to the C.T.C. machine.

### Switch Machines and Signals

The power switch machines are Style-M-22B, dual-control, for operation on 24 volts d.c. The high signals at the ends of the sidings and at the intermediate locations are the Style-P-5 color-light type, and the dwarf signals on the sidings are the three-aspect Style-N-2 color-light type. The high station-leaving signals have a single head and the station-entering signals have two heads. The top head governs movements on the main line and the lower head movements from the main line to the siding.

The high signals at the ends of the sidings are mounted 18 ft. above the top of the foundation, and the intermediate automatic signals 14 ft. Where necessary to locate a high signal between the main track and a siding, the siding was moved over to an 18-ft. center. Masts, ladders and base-of-mast cases from the old Style-T-2 and Style-S semaphore signals were reused. Where unnecessary to relocate intermediate locations, existing foundations were reused for the new signals. New signal foundations, however, are the Permacrete precast type.

The automatic intermediate signals are spaced an average of 10,000 ft. The old automatic block line control circuits employed one common wire

**Typical C.T.C. controlled station-entering signal with two color-light type heads**



and one additional wire for the control of signals in each direction. Two of these wires were retained for use on the new two-wire circuits for the control of the new intermediate signals, the third wire being salvaged. The intermediate signals are approach lighted. The signals are equipped with rebased 18 + 3.5-watt double-filament lamps. The signals at the ends of the sidings are continuously lighted, except during a power failure, when they are approach lighted.

### Control Machine at Division Headquarters

The control machine for the territory is located in the dispatcher's office, at division headquarters, in Danville, Ill., 40 mi. north of the nearest controlled point at Clinton. The machine is "U"-shaped, and includes the conventional arrangement of switch, signal and lock levers, indication lamps, track and signal diagram and automatic train graph. There are 33 switch levers for the control of 33 switches, 37 signal levers for the con-

trol of 108 signals, and 8 lock levers for the control of 8 electric locks on hand-throw switches in the field.

For control purposes, the territory is divided into two sections, namely, Clinton-Alice and Alice-Belt Yard. Controls are transmitted from the machine to these sections, and indications are returned, by the Union Switch & Signal Company's Type-L, Form 506A time code system, employing coded carrier control. The code line is divided into three sections, designated as "A," "B" and "C", with field normal and standby coded carrier control units located at Clinton and Alice for conversion of the carrier frequencies to conventional d.c. line circuit codes and vice versa.

One set of carrier frequencies, 14 kc. for controls and 20 kc. for indications, are transmitted over the "A" line between Danville and Clinton for the "B" line between Clinton and Alice. A second set of carrier frequencies, 12 kc. for controls and 18 kc. for indications, is transmitted from Danville to Alice over the "A" and "B" lines for the "C" line between

Alice and Belt Yard. The two C.T.C. sections are thus controlled independently over one pair of line wires.

### Many Crossings in Territory

At Princeton, Ind., a crossing with the Southern is protected by an automatic interlocking. In Vincennes, there is one with the Pennsylvania and another with the Baltimore & Ohio. At Sullivan, an automatic interlocking protects a crossing with the Illinois Central. At Spring Hill, there are three crossings, two with the Milwaukee and one with the New York Central. One of the Milwaukee crossings and the N.Y.C. crossing are controlled from a mechanical plant maintained by the Milwaukee. The other Milwaukee crossing is protected by an electric plant, remotely controlled from the same tower. There are two crossings in Terre Haute, one with the Pennsylvania and the other with the New York Central. The Pennsylvania crossing is protected by an electric interlocking maintained by that road, and the N.Y.C. crossing, known as Haley, is protected by an electric plant maintained by the C. & E. I. At Dewey, a crossing with the Milwaukee is protected by a mechanical plant maintained by that road.

All of these interlockings, except that of the Pennsylvania in Terre Haute, are shown on the C.T.C. panel, and the control machine has levers for the C. & E.I. home signals at the plants, except the automatic plants. These signals cannot be cleared by the towermen at the crossings unless C.T.C. consent has been received, thus coordinating the functions of the C.T.C. system with the interlockings.

### In Terre Haute

Because of a congested 3.5-mi. switching area through Terre Haute, 14 mi. south of Clinton, the signals and switches between Haley and Baker are direct-wire controlled by a B-30 table-lever machine, located in a new one-story brick building at Wabash avenue. All hand-throw switches leading from the main line to yards and various industry tracks are equipped with electric locks, except

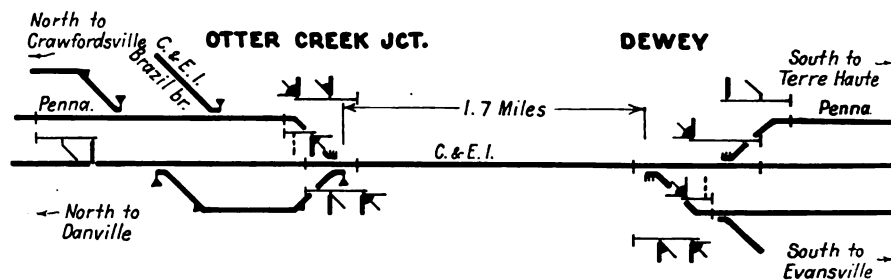
between Locust street and Crawford street, in which territory there is a 20 m.p.h. speed limit. Train movements in the entire section are governed by signal indication, the same as in the rest of the C.T.C. territory. A discussion, covering the signaling facilities in Terre Haute, as well as the special direct-wire circuits employed to control them, will be published in a separate article in a forthcoming issue of *Railway Signaling*.

The Pennsylvania operates about 12 trains daily over the C. & E.I., between Dewey and Otter Creek Jct.,

switches, except that they have a take-siding indicator below the bottom arm. If the dispatcher wishes a train to take siding, he controls the signal to display an aspect of red-over-yellow-over-S. This is authority for the train to proceed at restricted speed to the siding switch, stop and open the switch and enter the siding.

### Procedure of Construction

Material for the project was received and distributed from Terre Haute, and construction was carried



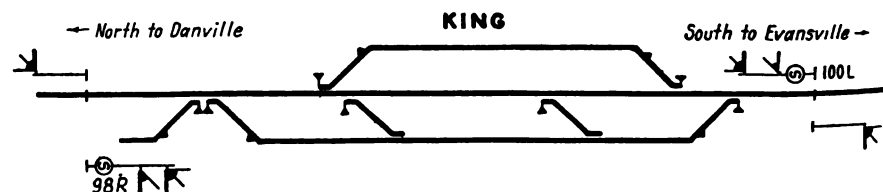
Track and signal layout between Otter Creek Jct. and Dewey

1.7 mi. At Dewey, the junction switch is equipped with a power switch, as shown in the accompanying diagram. A power machine and controlled signals were also installed at Otter Creek Jct.

### Layout at King

At King, power switches were not installed at the ends of the sidings. The hand-throw stands were retained and electric locks installed. Trains in

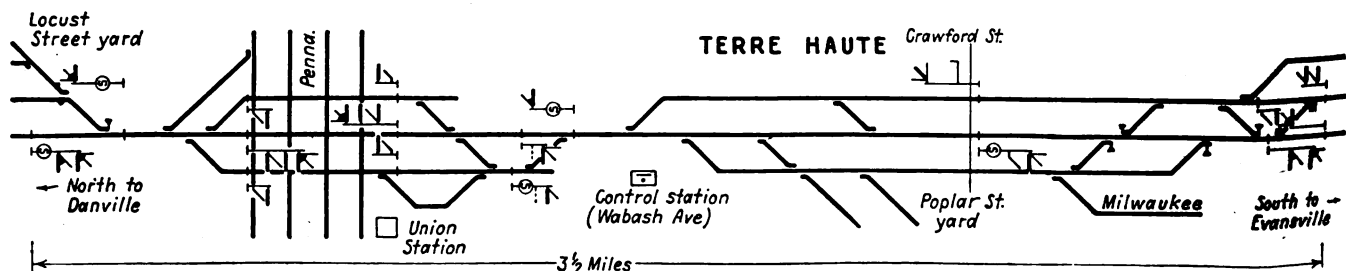
out by four small signal gangs, and one line gang, each consisting of about six men, a foreman and cook. No gang was confined to any one duty, except the line gang, which made all the necessary pole-line changes. Signal foremen included C. Bennett, L. M. Truby, P. L. White and J. Bennett. The line foreman was F. Dahlquist. The project was divided into four sections, namely, from Belt Yard-Alice, Alice-Sullivan, Sullivan-Baker and Haley-Clinton.



Layout at King, showing signals 98R and 100L with take-siding indicators

either direction, however, may be directed by signal indication to take siding at this point. Southward signal 98R and northward signal 100L are the same as the station-entering signals at sidings equipped with power

The first step included the relocation of intermediate signal locations in each section. This was followed by the installation of the switch machines, electric locks and signals. The signals were then controlled temporarily by



The signals and switches in Terre Haute are controlled separately from a machine at Wabash avenue

A.P.B. circuits until time to cut the section over to C.T.C. operation from the control machine.

The old three-wire A.P.B. line circuits were then converted to two-wire circuits for the control of the new intermediate signals. As soon as these circuits were ready, the electric switch locks were cut in service. With the section ready for C.T.C. operation, men were stationed at the bungalows in the field on the designated day, when they cut out the A.P.B. circuits, cut the switch machines in service and transferred the controls to the machine at Danville. This procedure was followed on the entire project, thus enabling the new facilities to be placed in service as each of the five sections became ready.

The territory is divided into eight maintenance sections, maintained by the following men: George Harwood, R. D. Smith, Paul Newman, Thomas McRoberts, O. Pritchett, A. O. Boren, J. R. Brownley, Bailey Duncan and Thomas Carrol.

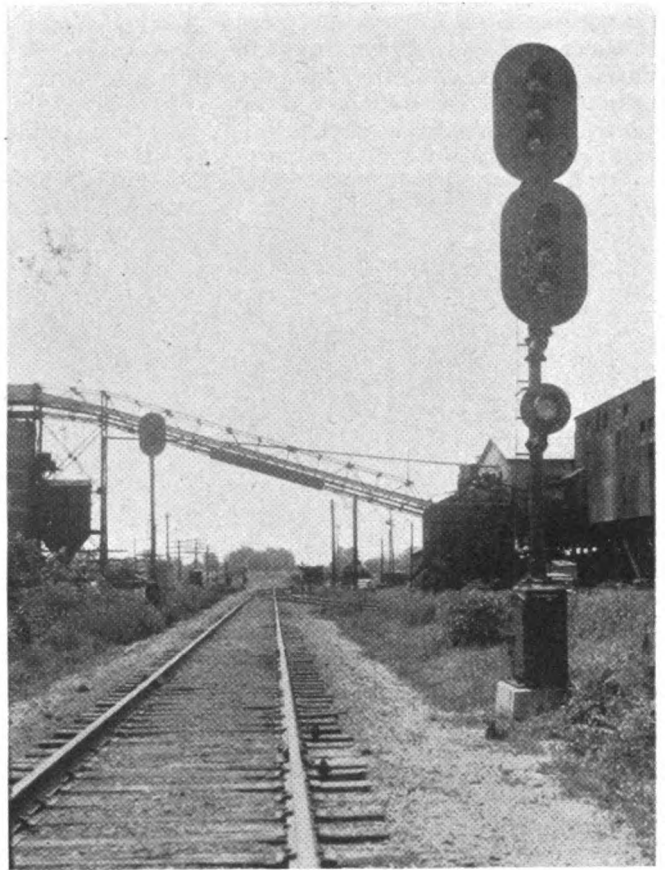
### Special C.T.C. Instruction for Employees

This being the first C.T.C. installation on the C. & E.I., complete arrangements were made to give all maintainers, helpers and others 75 hr. of instruction on the technical details of C.T.C. A special instruction car, with complete field and office coding equipment, was set up for this purpose at Danville, the instruction being under the guidance of Lewis L. Hunt, service engineer, assigned to this project by the Union Switch & Signal Company, assisted by William Grabbs, leading signal maintainer of the C. & E.I.

To simplify and make instruction in circuit operation as clear as possible, Mr. Hunt designed an arrangement in which large drawings of all office and field unit circuits are mounted on hinged panel boards, each about 5 ft. wide and 4 ft. high, at one end of the car. All relay contacts on the mounted circuit are movable, to facilitate explanation while instructing. Each panel includes an average of 200 such contacts which are picked up or dropped by means of dowel sticks behind the panels, and which extend slightly below the bottom of the boards for handling. This elaborate and useful arrangement was built by Mr. Grabbs.

For instruction of trainmen on operation in C.T.C. territory, a complete station-to-station section of a panel, complete with signal and switch levers, was set up in an office in Danville. Miniature wayside signals, switches, tracks and trains are located immediately in front of the panel, the

Signal 98R at King, showing take-siding indicator below bottom head



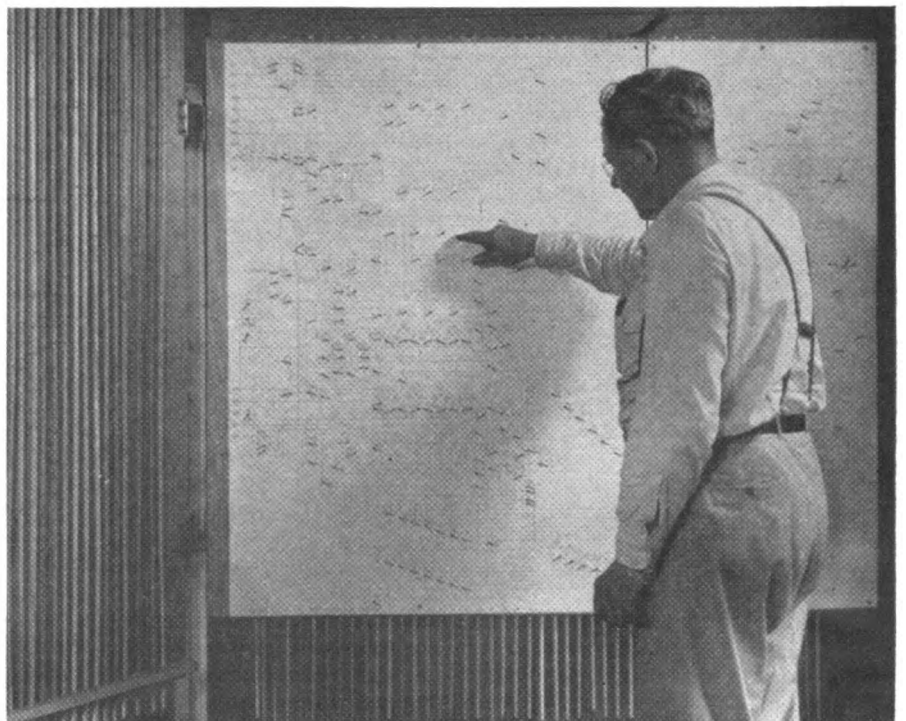
signals and switches being controlled from the panel and the trains being moved over the track by hand.

### Power Supply

Power for the territory is purchased from local public utilities at 220 volts, 60 cycles, and is transformed to 110

volts through W-10 transformers in the bungalows and instrument cases. The power line runs along the railroad only where required, and is on two No. 10 double-braided weather-proof copper wires.

At each field location, a set of 5 cells of Exide, Gould or Edison 80-a.h. storage battery, on floating



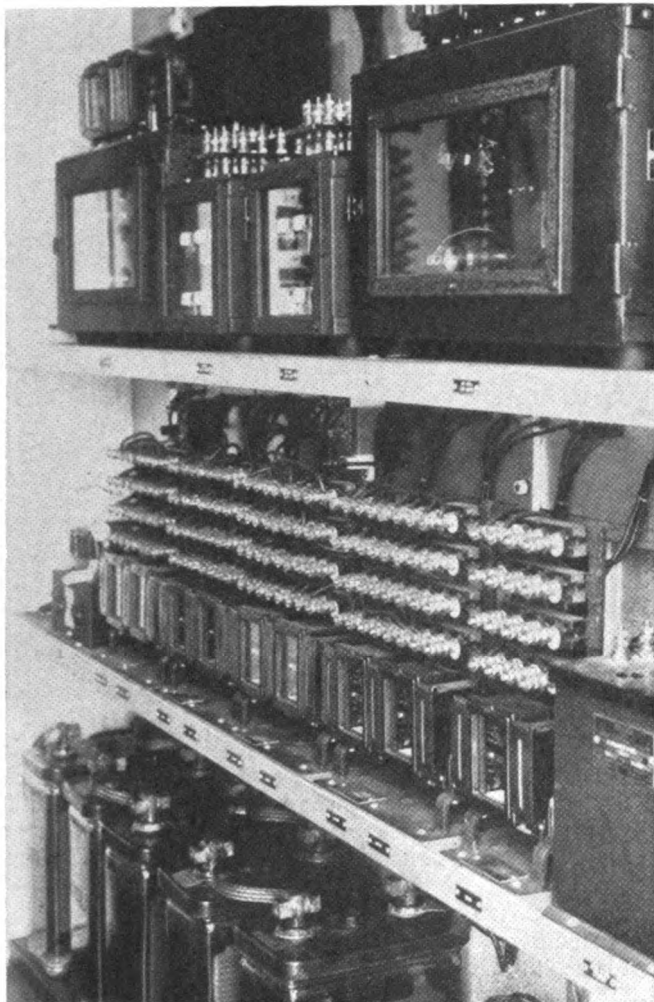
Leading maintainer, W. Grabbs, at panel-board circuit drawing used for instruction

charge from an RX-11 rectifier, feeds the line circuits for the control of the intermediate signals. In addition, 8 cells of Gould NPE-407 120-a.h. storage battery, on floating charge from

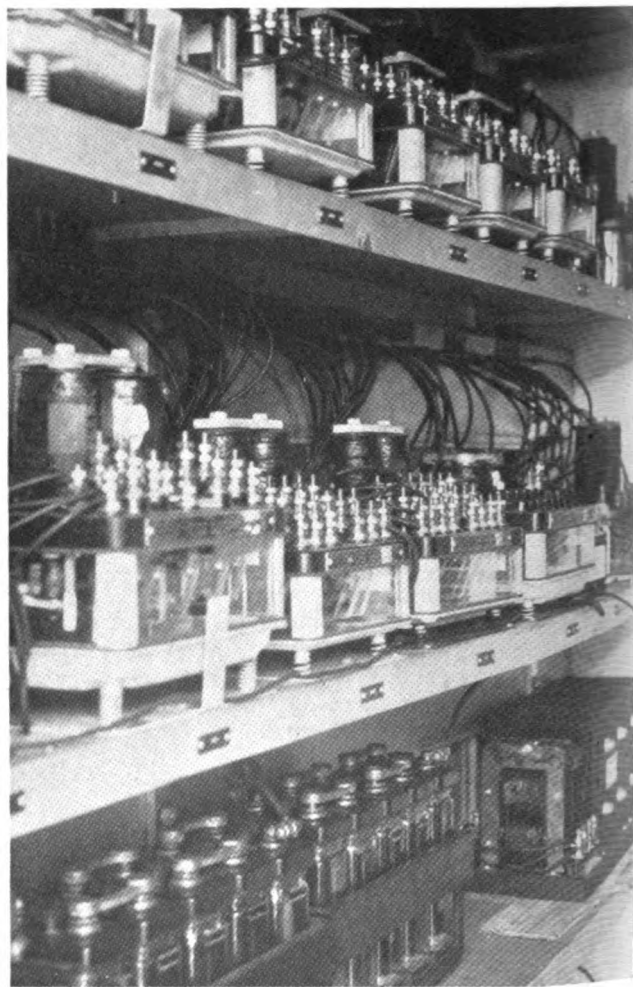
there is a lesser amount of equipment, sheet-metal instrument cases and base-of-mast signal cases are used. Instrument cases are mounted on poured concrete foundations and bungalows

The "A" and "C" sections of the code line are on two No. 9 Copperweld 40 per cent conductivity durawire conductors and the "B" section is on two No. 8 conductors of the same type. This line is transposed for voice frequency only, using standard Western Union transposition schemes. The line is protected against lightning by Western Railroad Supply Company Type-0275 heavy-duty rare-gas lightning arresters.

Other line control circuits are on No. 10 double-braided weatherproof copper and Copperweld wire. Line circuits are tied to Hemingway No. 42 double-skirt glass insulators on the pole line. Line drops are made up of No. 14 rubber covered insulated copper wire. Line taps and splices are made with Nicopress sleeves. Parkway cable for the project was furnished by Kerite and Okonite, No. 9 conductors being used for track connections, and No. 12 and No. 14 con-



**Left—Coding equipment and storage battery on one side of interior of an instrument house in field**



**Right—Relays and more storage battery on opposite side of interior of the housing**

an RT-42 rectifier, feed the local code functions, and 5 cells of the same type battery are used for standby lighting. These two sets of cells in series also feed the power switch machines. The C.T.C. code line is fed by 85 cells of Exide BTMP-3 9.2-a.h. storage battery at Clinton and 75 cells of the same type battery at Alice. This battery is on floating charge from Style-RP-81 copper-oxide rectifiers.

Conventional d.c. track circuits are used, OS sections being equipped with quick-acting DN-11 relays, pick-up of which is adjusted to 112 milliamperes. Edison 500-a.h. copper oxide primary battery is used on the regular track circuits, and Eveready and Edison 500-a.h. carbon-type high-voltage primary battery is used on the OS track circuits.

The relays, transformers, coding equipment and battery at each power switch location in the field are sheltered in a welded sheet-metal instrument house, each of which is equipped with a maintainer's call lamp with a clear Fresnel lens. Elsewhere, where

are mounted on heavy creosoted-timber ties. At certain locations along the Wabash river, the bungalows are raised several feet above the ground on the timbers as protection against high water in the event of a flood. This practice is followed at the north and south ends of King.

ductors for control and lighting circuits. Instrument cases and bungalows are wired with 19-strand No. 16 flexible insulated wire. Line control and track circuits are protected by Electric Service Corporation crystal-valve arresters. Rail through the territory is 112 lb., bonded with Cadweld head-



Bungalow on high timbers at the north end of King for flood protection

type bonds. The Rail Joint Company's four-bolt, continuous-type insulated joints are used throughout.

This C.T.C. project was installed under the supervision of V. Van Vleit and R. D. Simms, signal supervisors,

under the direction of G. P. Neal, superintendent signals and telegraph, W. N. Donahue, signal inspector, assisting. The major items of equipment were furnished by the Union Switch & Signal Company.

## Accident at Switch

ON December 30, the head brakeman of an eastbound freight train on a siding at Ranch, Tex., on the Texas & Pacific, opened a hand-throw siding switch immediately ahead of an approaching westbound freight train, and, therefore, it headed into the siding and struck the locomotive of the standing train. The following information was included in a report by the Interstate Commerce Commission.

This territory is equipped with single-track automatic block signaling, including dwarf signals on the sidings which are known as block indicators. Rule 512 reads:

"512. Block indicator signals are provided in certain automatic block system territory to indicate the condition of the block in which the switch is located and to govern movements to the main track.

"Color-light block indicator signals governing movements from sidings or auxiliary tracks to the main track are located immediately to the right of the track they control approximately at the clearance point; a red light indicating there is a train or engine in or closely approaching that block.

"At switches where these signals are installed, the indication must be

observed before a movement is made to the main track. The switch must not be opened or the main track obstructed while the signal indicates that a train or engine is in or approaching that block, except under flag protection."

The investigation disclosed that the front brakeman of Extra 657 East had read train order No. 98, and he understood that, under the provisions of the order, his train was required to enter the siding at Ranch at the west switch and to remain into clear on the siding until No. 67 (the westbound train) had cleared the east switch. The front brakeman operated the west siding switch for his train to enter the siding, and he boarded the tender as the engine entered the siding. Soon after his train stopped on the siding near the east switch, the front brakeman proceeded from the tender to the engine cab, then dismounted and proceeded to the east switch. He said that when he passed the block-indicator signal, located at the clearance point of the turnout, he observed that this signal was displaying a red aspect, which indicated that the block was occupied. However, when he saw the reflection of the headlight of No. 67 as it was closely approaching he became confused with reference to the position of the switch. Then he operated the switch and, immediately afterward realized that he had erroneously lined it for entry to the siding, but the engine of No. 67 entered the turnout before he could operate the switch to normal position. The engineer and fireman were in their respective positions on the engine.

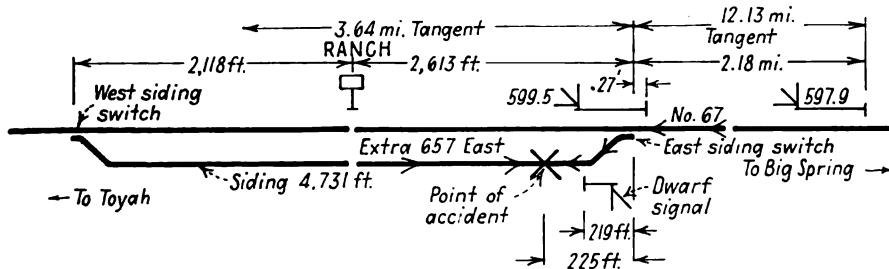
In addition to the present accident, during the past 16 years, the Commission has investigated 20 accidents which resulted from the opening of switches immediately in front of approaching trains, similar to the accident under discussion. These accidents resulted in the death of 31 and the injury of 427 persons. If the east siding-switch at Ranch had been provided with electric switch locking, it would not have been possible to operate the switch immediately in front of No. 67.

It is found that this accident was caused by a switch being opened immediately in front of an approaching train.

It is recommended that the Texas & Pacific install electric switch locking at main-track hand-operated switches in automatic block signal territory.

Washington, D. C., February 11, 1948.

By the Commission, Commissioner Patterson.



Track and signal layout where accident occurred, showing point of accident