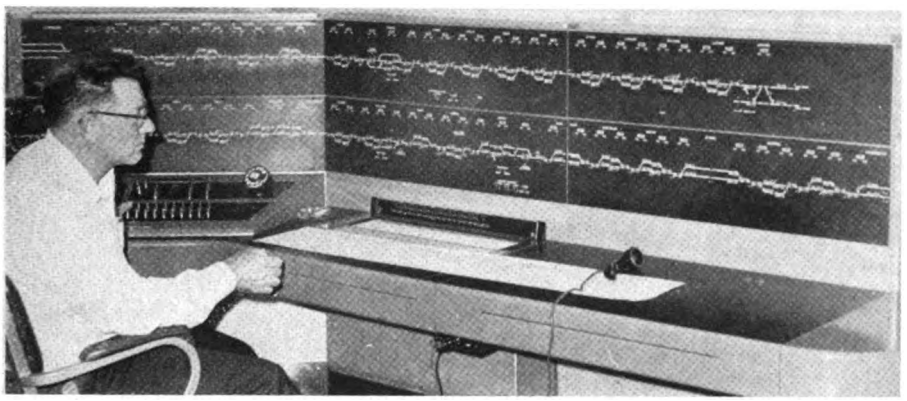
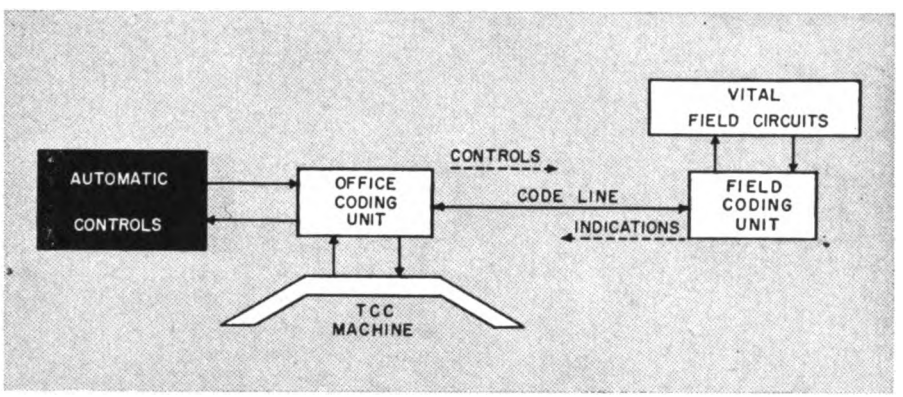
AUTOMATIC DISPATCHING

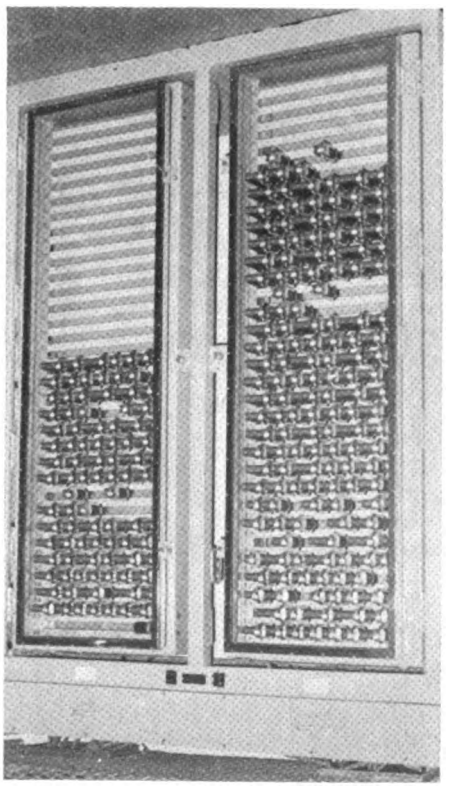


TCC Machine



Block Diagram

In the Field



Automatic Control Relays

Automatic Train Dispatching, the Southern Pacific's term for their new CTC control system, frees the train dispatcher from the tedious operation of clearing every controlled signal for every train. Under the watchful eye of the dispatcher, who observes the train movements with the aid of the control machine's indication lights, trains progress themselves through the territory, automatically making meets as they arise. The monitoring dispatcher, however, can seize control of any location at any time to effect a movement he may desire. The dispatcher, thus freed from purely mechanical operations, is able to concentrate on overall operations and extraordinary moves. The operation of the system was described briefly in the January 1962 RS&C, p. 22.

While other efforts have been made to develop similar automatic systems, successful application on the Southern Pacific was the result of an idea conceived by H. B. Garrett, signal engineer. After several discussions with his staff, Mr. Garrett outlined the results desired, and engineers were assigned to develop the circuits. Those who were active in the design of the system were:

N. W. Stickney, assistant to the signal engineer

A. G. Kaemper, chief signal designer

J. F. Herbert, CTC engineer

In the opinion of Mr. Garrett, they did "a very good job." He was successful in selling the idea to his management, which resulted in the necessary money being allocated to make the installation. The automatic train dispatching system has proved to be a "greater help than first anticipated."

The first section of the SP's 2,435 miles of CTC to receive the automatic controls was a 523-mile segment from El Paso to Yuma. It is being extended 114 miles from Yuma to Thermal, Calif. A 102-mile section of CTC now being installed between Fresno and Bakersfield, Calif., will incorporate the automatic feature when installed.

The El Paso-Yuma CTC is divided into two parts: El Paso to Tucson, and Tucson to Yuma. Each part is controlled by a separate Traffic Control Center (TCC) machine, both located at Tucson. The TCC machine has pushbuttons whereby the operator first selects the location to be controlled by pushing numbered buttons, and

The automatic train dispatching system has proved to be "greater help than first anticipated."

en controls the switches and signals that location with the same push-ıttons used for all the locations. The stallation of the automatic controls :gan shortly after the completion of ıe CTC installation and was placed service about one year afterwards. Two differences between TCC ma-ıines and standard miniature lever ɔntrol machines are relevant: First, ıe switch and signal nomenclature re-eats at each location. For example, s an eastward train progresses along ıe main track it will pass signal 2RA nd over switch 1 as it enters and :aves each station. In the controls for hese signals and switches, the switch r signal unit number, 2RA, for exam-ıle, is preceded by the location num-ıer, leading to such designations as '6-2RA, 77-2RA, 78-2RA for the loca-ions 76, 77 and 78. The second dif-erence is that the indication relays ıt the office control the outgoing con-rol codes. The indication relays are ɔnnected, through location relays, to he registry unit. Relays in the registry ınit "follow" the pushbuttons on the ɔntrol console (that is, these relays ·etain, by means of a stick circuit, the information selected by the momentary ɔperation of a pushbutton). When in ıutomatic control, the indication relays ıre disconnected from the registry unit and are operated by the automatic control relays.

The automatic controls consist of seven racks of relays, all located at the Tucson office. The G-type relay is a small non-vital relay. These automatic control relays interpret the incoming indications, determine what field action should be taken, and cause the control code to be sent to the field to effect that action.

In the control machine, relay ADSP formerly used for fleeting now effects the transfer from manual to automatic control both at the office and in the field. Each location (a "location" generally being synonymous with the end of a siding) can be transferred individually from manual to automatic control or vice versa. However, the automatic controls for the station-leaving signal are dependent upon the automatic controls for the station-entering signal, so that if the train dispatcher manually controls a station-entering signal he must also manually control the station-leaving signal.

As a train leaves a station, it initiates the clearing of the next station-entering signal. As soon as this initiation has been accomplished, the clearing of the succeeding station-leaving signal is initiated. No further signal clearing takes place until the train leaves the next station. These signals will always clear far enough in advance so that the train will always receive a proceed indication if traffic conditions allow.

The essence of the automatic meet-making is that as each train leaves a station, it establishes a circuit condition that would route an opposing train into the siding of the second station ahead. This acts to cause the first of two opposing trains to take the siding and allows the second train to hold the main. The net result is a minimum of delay to both trains. Following movements are permitted to leave a station provided that no opposing train has initiated the clearing of the station-leaving signal of the second siding in advance.

On the next three pages (p. 24-26) including one folded over is the circuit diagram showing a typical application of the automatic controls. A word description of the operation of the circuits, provided by the designers, accompanies the drawing. A table of relay nomenclature has been provided (p. 28) for those not familiar with it. Note: Since these circuits are all non-vital, track and block indicating relays are **normally down** and are picked up when a train occupies the track circuit. The safety of the entire system is protected within the field circuits, and track relays there are normally picked up.

It should also be emphasized that the circuits shown here do not directly throw the switches and clear the signals, but merely start the CTC code going to the field to perform the required operation. Therefore, the signal clearing relays 2LA, 2LB, 2RA and 2RB have stick circuits which keep these relays energized under conditions when the wayside signal would have changed to stop. This is particularly true of the signal clear stick repeater relays LGKS and RGKS. The relay-2ADSP, contacts of which appear in many of the circuits, controls the transfer from manual to automatic dispatching. In tracing the circuits, it should be kept in mind that this relay will be picked up as long as the location denoted by the prefix number is in automatic operation.

To facilitate an understanding of the circuits we will first, briefly, consider the operation of the signals as a train traverses the system.

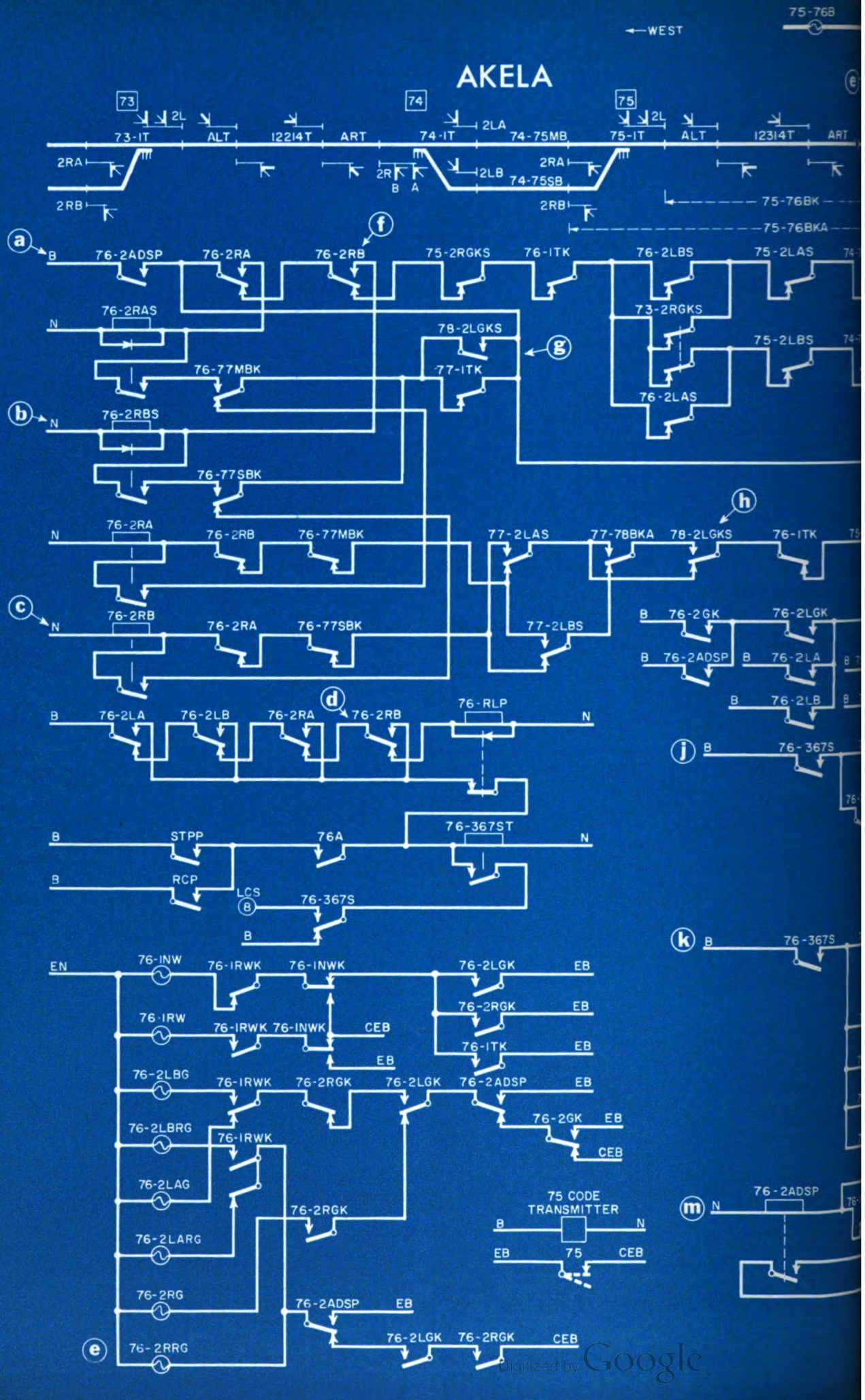
Consider an eastward train about to leave station 73: As the train passes a 73-2R signal in the clear position and enters the detector track circuit 73-1T, the clearing of signal 74-2RA will be initiated. If no opposing control has been established, the clearing of signal 75-2RA will then be initiated. Similarly, when this same train passes signal 75-2RA, the clearing of signal 76-2RA will be initiated, followed at once by 77-2RA. Trains moving in the opposite direction will initiate the clearing of signals from the same relative positions and in the same sequence.

Let us now consider the circuit control for a meet at Dona, with the eastward train entering the siding at location 76. The circuit used to direct this eastward train to the siding is that of relay 76-2RB **(c)***. A westward train leaving location 80 would establish the preliminary condition which would select Dona as the meeting point for an eastward train ready to leave location 75.

When a westbound train leaves 80, it will cause signal 79-2LA to clear and 79-2LGKS to pick up, followed quickly by the clearing of signal 78-2LA, which would cause 78-2LGKS to pick up. (78-2LGKS is a stick repeater of the relay which clears signals 78-2LA or -2LB.) Contacts of 78-2LGKS **(h)** will then cause 76-2RB to be selected, rather than 76-2RA,

**The heavy-faced letter in parenthesis refers to the circled letter on the circuit diagram. It is intended as an aid to locating specific portions of the circuits.*

Circuits for automatic dispatching are on next three pages (24-26) and text continues on page 27.



ıen the eastward train leaves 75.

We can trace the circuit to 76-2RB ɔm battery **(a)**, over the front con-ct of 76-2ADSP (up for automatic ɔeration), down at the junction and 'er a front contact of 75-76 BKA (up hen any track circuit from 75-1T to 3-1T inclusive is occupied, and the ımediate cause of 76-2RB operating), back contact of 76-2LGKS (down ıce neither opposing signal at 76 has ɔen cleared), a front contact of 75-RGKS (up when either leaving sig-ıl at 75 is cleared), a back contact ' 76-1TK (down with 76-1T unoccu-ied), the front contact of 78-2LGKS, ack contact of 77-78BKA (track cir-uits 77-1T to 78-1T inclusive unoccu-ied), 77-2LBS (siding entering signal t 77 not clear), 76-77SBK (siding at)ona not occupied), and 76-2RA (con-icting signal at 76 not cleared), to ıe coil of relay 76-2RB. This relay ⁄ill pick up, and then be stuck up over s own front contact, a back contact f 76-77SBK (siding at Dona unoccu-ied), and a parallel circuit **(g)** onsisting of a back contact of 77-1TK nd a front contact of 78-2LGKS. Re-ıy 78-2LGKS, as mentioned earlier, ıicked up when a westward train left 0, and will remain up until the west-vard train clears 77-1T. The purpose f this parallel combination is to open he stick circuit to 76-2RBS and 76-2RAS only when an eastward train eaves location 77. It is the eastward rain entering the siding (76-77SB) hat will open the stick circuit to 76-2RB, which cannot pick up again until he siding is clear. A front contact of 76-2RB **(f)** completes the circuit to 76-2RBS **(b)**. (76-2RBS remains en-ergized as long as the siding is occu-pied, and establishes the preliminary condition which will later energize re-lay 77-2RB to reverse switch 77-1 and clear signal 77-2RB to allow the east-ward train to leave the siding. Relay 76-2RBS will be released when the eastward train occupies 77-1T.)

When relay 76-2RB **(c)** picks up, it opens a back contact **(d)** to de-en-ergize 76-RLP, and closes a front con-tact to send energy to 76-367ST, the code start relay. The energy to the code start relay is cut off quickly at the end of the retardation time of 76-RLP.

The code storage relay (76-367S) and the signal clearing relay (76-2RB) determine which way the switch will throw and which signal will clear. In the case described, energy would pass over the front contact of 76-367S **(j)**, a back contact of 76-2LB, the front contacts of 76-2RB and 76-2ADSP to terminal 3 on the Line Coding Stor-age (LCS) unit. This will cause the code being sent to the field location to control switch 76-1 to reverse.

Similarly, energy will pass over front contacts of 76-367S **(k)** and 76-2RB to LCS terminal 7 to cause the code to clear signal 76-2R. Whether it is the A or B signal that clears is determined by the field circuits from the position of switch 76-1. In these code sending circuits, during automatic control the manual controls are made ineffective by the open back contacts of 76-2ADSP. Thus we have described how the circuits will automatically route the eastward train into the siding at Dona.

Meanwhile, as the westward train left location 78, it established circuits that would clear signal 77-2LA to route this train to the main track at Dona. Relay 77-2LA **(u)**, which controls this signal, will be energized by a cir-cuit very similar to that just described for signal 76-2RB. Current would pass from the battery **(t)**, over the front contact of 77-2ADSP, down at the junction, over the front contact of 77-78BKA (block occupied), the back contact of 77-2RGKS, the front con-tact of 78-2LGKS, and a back contact of 77-1TK.

The circuit then continues either over the front contacts of 75-2RGKS and 75-76BKA and the back contact of 76-2RAS, or over the back contact of 75-2RGKS and the back contact of 76-2RAS, depending upon where the eastward train is at this time. (Until the eastward train is in the clear on the siding, these two relays will be up; afterwards they will be down.) The circuit to 77-2LA then continues over 76-77MBK down and 77-2LB down, thus energizing 77-2LA and ini-tiating the clearing of signal 77-2LA. Relay 77-2LAS will then be picked up over a front contact of 77-2LA **(s)**. Relay 77-2LAS will be stuck up until the westward train enters track 76-1T.

The westward train will next be ap-proaching the station-leaving signal at Dona, 76-2LA. The clearing of this signal will be initiated by relay 76-2LA **(n)**. The circuit to this relay starts at battery **(a)**, passes over a front contact of 76-2ADSP (up for automat-ic operation), the back contacts of 76-2RA and 76-2RB (opposing signals at location 76), the back contact of 75-2RGKS (no opposing signal clear at location 75), a back contact of 76-1TK (detector track unoccupied), and then branches into a parallel net-work. The top branch checks the main track route and the lower branch checks the siding at Akela.

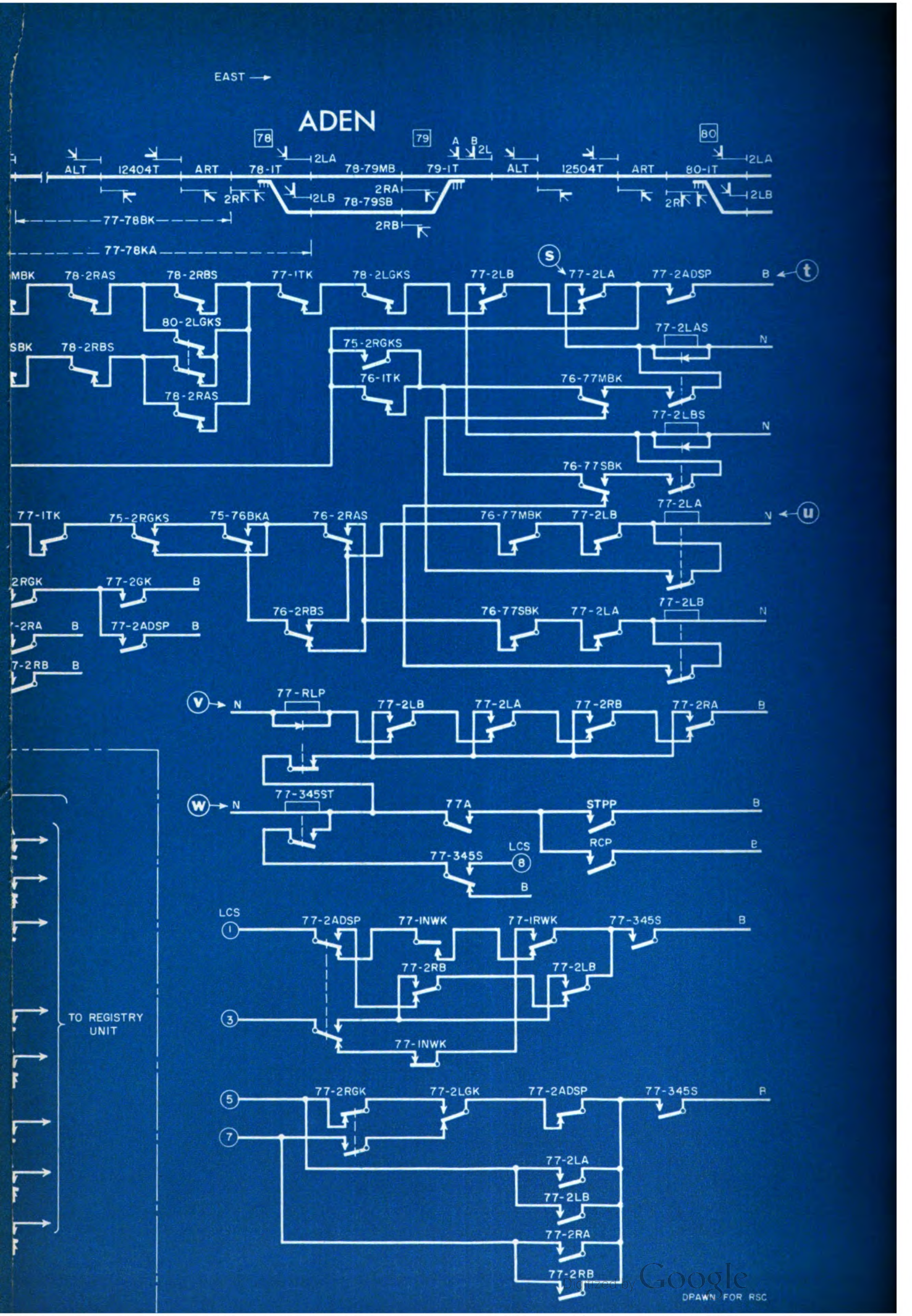
The top branch passes over the back contacts of 76-2LBS or 73-2RGKS. These two contacts prevent a second westward train from leaving Dona if a meet is already set up at Akela. The remaining three contacts in the branch check that the main track at Akela is unoccupied (74-75MBK down) and that no signals are cleared into this track (75-2LAS and 74-2RAS down). The lower branch of the par-allel network checks the siding at Akela in a similar manner.

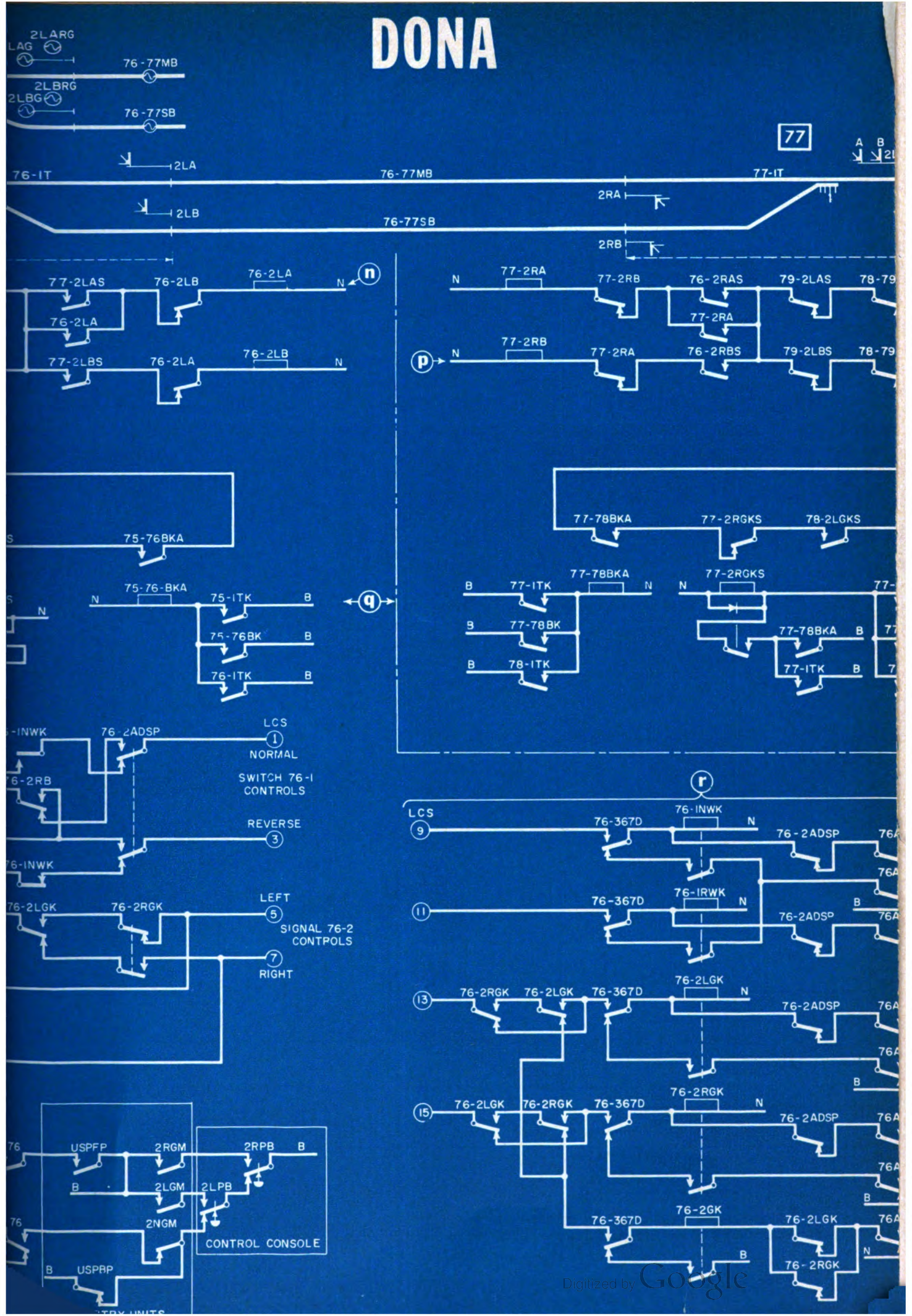
The circuit to 76-2LA then passes over the front contact of 77-2LAS. This relay picks up when signal 77-2LA is initiated to clear and is stuck up by the occupancy of the main track section, 76-77MB, at Dona. 77-2LAS provides the preliminary infor-mation that a train is to enter the main track at Dona, and therefore signal 76-2LA will need to clear to allow the train to leave the station. A stick cir-cuit (76-2LA) has been placed around the front contact of 77-2LAS to pre-vent the release of 76-2LA if a train is in the 76-77MB section and location 77 is transferred to manual operation, which would remove energy from 77-2LAS.

The remaining contact in this cir-cuit, the back contact of 76-2LB, checks that the conflicting signal is not being initiated to clear. Until the eastward train was in the clear on the siding, this circuit to relay 76-2LA had been held open at the back con-tacts of 76-2RB, 75-2RGKS, and 76-1TK. As soon as the eastward train is in the siding and clear of track 76-1T, these relays will release and signal 76-2LA will clear to let the westbound train proceed.

The eastward train, still in the sid-ing at Dona, will depart at signal 77-2RB. The clearing of this signal will be initiated by relay 77-2RB **(p)**. The circuit to the relay was held open by 77-2LA **(s)**, 78-2LGKS, and 77-1TK. As soon as the westward train clears detector track circuit 77-1T, 77-1TK and 78-2LGKS will close their back contacts. 77-2LA will have closed its back contact when the westward train entered track 76-77MB. This will complete the circuit to relay 77-2RB, which will pick up and pulse 77-345ST **(w)** through relay 77-RLP **(v)** to start the code to reverse switch 77-1 and clear signal 77-2RB. As this train enters block 77-78, relay 77-78BKA will pick up, signal 78-2RA will clear, then sig-nal 79-2RA clears, and so on as the train progresses.

Relays 75-76BKA and 77-78BKA **(q)** repeat the track indicating relay for the entire block between sidings, and include the detector track circuits at both ends. No time locking indication is provided under automatic oper-ation. The time indication is a flashing-red light beside the signal symbol. This light 2RRG **(e)** is lighted steady red when the location is in automatic operation. Otherwise the indication lights operate under automatic train dispatching the same as under manual




DONA
2LARG
LAG
76-77MB
2LBRG
2LBG
76-77SB
77
A
B
2L
76-IT
2LA
76-77MB
77-IT
2RA
2LB
76-77SB
2RB
77-2LAS
76-2LB
76-2LA
N
n
76-2LA
77-2LBS
76-2LA
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76-2RAS
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77-2RGKS
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75-76-BKA
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77-ITK
77-78BKA
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77-2RGKS
77-
B
77-78BK
77-78BKA
B
B
78-ITK
77-ITK
B
75-76BK
B
76-ITK
B
-INWK
76-2ADSP
LCS
1
NORMAL
SWITCH 76-1
CONTROLS
6-2RB
REVERSE
3
6-INWK
76-2LGK
76-2RGK
LEFT
5
SIGNAL 76-2
CONTPOLS
7
RIGHT
r
LCS
9
76-INWK
76-367D
N
76-2ADSP
76A
76A
11
76-IRWK
76-367D
N
B
76-2ADSP
76A
13
76-2LGK
76-2RGK
76-2LGK
76-367D
N
76-2ADSP
76A
76A
B
15
76-2RGK
76-2LGK
76-2RGK
76-367D
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76-2ADSP
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76-367D
76-2LGK
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B
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76
USPFP
2RGM
2RPB
B
B
2LGM
2LPB
76
2NGM
CONTROL CONSOLE
B
USPBP
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control. The circuit at **(r)** illustrates how the indication relays are disconnected from the registry unit for automatic operation. The automatic control relay 76-2ADSP **(m)** was formerly used to control fleeting, with switches normal and signals clear right or left. It was revised so that it would not be necessary to normal the switch (jumper around 76-1RWK) and clear a signal (B supplied on the relay side of 2RGM) in order to place the station in automatic operation. **RSC**

RELAY NOMENCLATURE

A	Location repeater relay
ADSP	Automatic dispatching stick repeater
BK	Block indicating relay
BKA	Block indicating repeater relay (including detector tracks at both ends)
*D	Decoding relay
LA	Left main track (A) signal control relay
LAS	Stick repeater of LA
LB	Left siding (B) signal control relay
LBS	Stick repeater of LB
LKG	Left signal clear indicating relay
LGKS	Stick repeater of LKG
MBK	Main block (at station) indicating relay
NWK	Normal switch indicating relay
RA	Right main track (A) signal control relay
RAS	Stick repeater of RA
RB	Right siding (B) signal control relay
RBS	Stick repeater of RB
RCP	Recall repeater
RGK	Right signal clear indicating relay
RGKS	Stick repeater of RGK
RLP	Route lever repeater relay
RWK	Reverse switch indicating relay
SBK	Siding block indicating relay
*ST	Code starting relay
STPP	Second repeater of code start relay
TK	Track indicating relay (detector track here)
USPBP	Fleeting pushbutton back repeater
USPFP	Fleeting pushbutton front repeater

The prefix number indentifies the particular location and unit involved.
*Three digit prefix here refers to code assignment.

SP Has Over 30 Years' CTC System Operation

Southern Pacific's new CTC control, termed automatic train dispatching, is the latest step taken by the railroad covering over 30 years' utilization of traffic control systems. SP Lines has 2,435 miles of CTC in service, and 102 miles of CTC is being installed between Fresno and Bakersfield, Calif. Thus the road's major single-track mainlines are under traffic control.

One of the first centralized traffic control installations on the SP was made between Stockton and Brighton, Calif. (El Pinal to Polk), covering 37 miles of single track and three miles of double track. Installed in 1930, CTC enabled the SP to postpone indefinitely an estimated $2.5 expenditure for double tracking this portion of the Stockton-Sacramento line, which had traffic peaks of 46 trains daily, plus numerous mainline switching moves.

During World War II, Southern Pacific made some key CTC installations in heavy grade and curve territories that considerably relieved traffic congestion. On two such intallations, SP used the practice of "no red with a green" on a two-unit signal, such as a station-entering signal. If the line-up is for a through move on the mainline with a green aspect in the top unit, then the lamp in the lower unit is not lighted. SP's thinking was that a clear aspect should not include a red light because an engineman might see this red light before he saw the green, and thus confuse him. The lamp in the lower unit is lighted in combination with that in the top unit only when a diverging route is set up, or as red-over-red for the absolute stop aspect.

A special feature of the Alhambra (Los Angeles)-Colton, Calif., CTC installed in 1948 was that in an instrument house at the end of each siding, there is a small controll panel with a switch lever and a signal lever, as well as a master lever which is normally sealed in the out-of-service position. In case of CTC code line trouble or other emergency, train operation can be carried on as usual by CTC control, by placing a man at each instrument house to operate these levers under the direction of the dispatcher.

On this same 50-mile CTC project, the length of main track opposite a siding is cut into two or more track circuits, and each siding has two or more track circuits. One purpose of this track circuit arrangement is to secure "two-track circuit" release of the detector locking. A train must first occupy an OS track circuit and then occupy the next preceding track circuit. This procedure prevents incorrect operation of a switch if an OS section is inadvertently shunted and a switch control set out which, under some other methods of control, might release the locking with a train approaching.

The SP's 98-mile Klamath Falls-Crescent Lake, Ore., CTC installation in 1953 ran through the heart of the Cascade mountains. A part of this installation was the addition of several thousand feet of slide detector fence where the railroad runs along the bottom of a ridge of land by Klamath Lake. The fence is divided into 1,000-ft sections for control purposes. The breaking of the fence by a rock or landslide not only sets the signals (governing into the area) at "Stop" but sends an indication to the dispatcher's CTC control machine. The maintainer must repair the fence and reset the controls before signals will clear for train movements. Small rocks sometimes break the fence but do not fall on the track, and in these instances the maintainer has spent considerable time looking for the break. To enable him to locate the break more quickly, the SP mounted "pilot" lights on top of the instrument cases (2,000 ft apart) which are lighted when the fence breaks.

Although SP practice has been to install track motor car indicators in CTC territory, they purchased highway trucks for signal maintainers working in the Indio, Calif-Yuma, Ariz., traffic control territory (122 miles) completed in 1956. Based on extensive records and experience, the estimated cost of including this system of motor car indicators in the Indio-Araz Junction section would be about $120,000. An investigation showed that highway motor trucks could be purchased for use of these employees for about $90,000. On most all of this territory the track is not far from an improved highway, therefore the signal and track maintenance can be done effectively by use of these trucks. Accordingly the trucks were purchased for this purpose, and have proved to be satisfactory and economical. Between Indio and Yuma, each maintainer has from 22 to 28 miles of CTC. **RSC**