Coded Track Circuits for C.T.C. and Cab Signaling

Discussion of circuits installed on the Rock Island for train movements in either directions on each track

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In the two-direction territories, the direction of traffic over a section of track between two stations is established by C.T.C. control, and the direction last used remains in effect until changed. Normally the track circuits are fed steadily-flowing energy in the direction of traffic. This use of steadily energized track controls serves several purposes: (1) to extinguish the lamps in the automatic signals normally; (2) cut off coded a-c. cab signal feed to the track circuits normally; (3) the steady energy, when feeding throughout the length of a station-to-station traffic section, causes information to be transmitted to the C.T.C. machine to indicate that that section is unoccupied and that the traffic direction is released.

When a C.T.C. controlled semi-automatic entrance signal for a traffic section is cleared, or if a train enters such a section, then the steadily-flowing energy in the track circuits ceases, and each track circuit is fed d-c. code to control the wayside signals and a-c. code to control the cab signals, these codes being fed in the direction opposite to the direction of traffic. Simultaneously the lamps in the intermediate automatic block signals are lighted.

A complete section of track and circuits between two control points is illustrated on sheets 1 to 5 inclusive. The circuits are drawn to show traffic established eastward, that is, from signal R52 to R58, with the signals in Stop position. For the purpose of explaining the traffic-direction control circuits of a section, sheets 1 and 5 only, are required. Steady energy is being fed to the west end of track circuit A52T, over front contacts of R52CTP relay. This relay is energized by a circuit which starts with battery B through a contact of R52HS (time code operated signal control) relay normal, 52WFS (time code operated west end traffic) relay normal, 373SPP (special polar) relay normal, R52ES (eastward directional route) relay up, R52S (eastward directional stick) relay down, and 51TP relay up to coil R52CTP. By-passes are provided for R52HS and 51TP should these relays be open for movement into the siding.

By means of relayed circuits, to be explained later, this steady energy is fed eastward through intermediate track and signal locations to energize bridging line relay C372ETP of conventional track circuit C372ETP at signal R58. Relay C372ETP up, energizes its slow-release Front-Contact repeater relay L58TFP, slow release to insure its hold up on either steady or coding action of C372ETP. The relay L58TFP up, opens circuit for L58CTP, thus preventing transmission of coded energy in the opposite direction on bridging line cirsuit 72ETP. Relay L58TFP up also closes the circuit to Terminal 4 of LCS unit, and sends time code indication to the control machine to pick up relay 52ETK (traffic section east end track repeater). Relay 52ETK up energizes 52EFK (eastward traffic indicator) through 52LPR (traffic lever repeater) relay normal, to light the blue light on the arrow pointing East, and to hold up 52ETK; also to take out amber light BEK as an indication that the traffic section is unlocked and unoccupied.

Signal R52 is cleared, for main-line movement, by the control operator sending time code control to reverse relay R52HS. This opens the circuit to R52CTP, cutting steady energy off the west end of track section A52T. By relayed action, line bridging relay C372ETP drops at signal R58. This releases L58TFP which transmits time code over Terminal 4 to the machine to release 52ETK. Relay 52ETK down, lights the amber light BEK, showing that the traffic circuits are locked, and also opens 52LPR circuit to effect locking. At signal R58, relay L58TFP released also closes circuit to L58CTP through the normal position of 52EFS (time code operated east end traffic direction relay), L58S (westward directional stick relay) down, conflicting signals L58 and L56 at stop, and time locking released (NPS relays up) and detector track repeaters up, operating L58CTP on 75,120 or 180 code depending on position of signal R58.

Route Network

This code is relayed to A52WT, which responds to the code received. Relay A52WT coding, picks up R52TFP. This relay up, through 52WFS normal and A52WT, coding to back contact, picks up R52TBP, slow release back contact repeater of A52WT. It will be noticed that TFP relays are energized on either steady or coded energy, TBP relays are energized by coded action only. Relay R52TBP up allows A52WT to transmit energy to the decoding transformer to pick up slow-acting relay R52H, also R52D providing code is 180. In circuits not shown relays R52H up and R52HS reversed, complete a route-agreement network including 51TP and 51NWP up to energize route agreement relay R52HSP. Relay R52HSP up, opens R52NPS (signal normal repeating stick relay incorporating time locking) to open the switch locking circuits also to close the signal network circuits to clear signal R52. The network circuits are not shown, as they are of conventional design. The use of a double network has the advantage of not breaking down the switch locking unless the route can be ob-

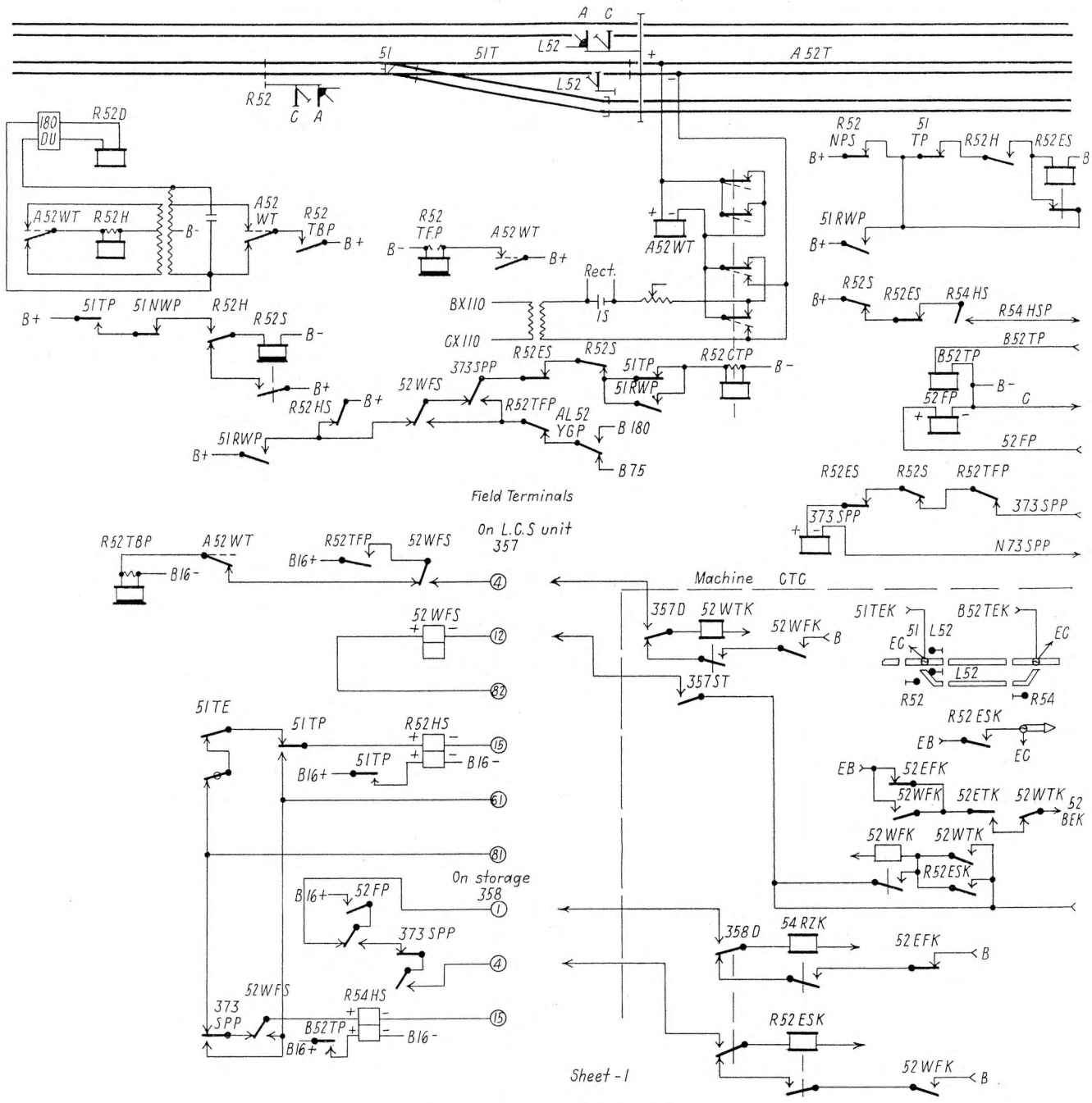
*This discussion of typical circuits is a continuation of an article starting on page 198 of the April issue of Railway Signaling which should be read first in order to understand the purposes for the circuits explained in the article herewith by Mr. Schmidt.

tained; and does not allow the signal to clear until the switch locking is in effect. This produces the same safety formerly obtained by the mechanical locking of levers.

Relay R52NPS down, drops R52ES, opening R52CTP circuit so that if the signal control relay R52HS is restored to normal by the operator, steady energy cannot be transmitted to unlock the traffic circuits, until the expiration of the time locking to pick up R52NPS.

When the train passes signal R52, 51NWP and R52H up (H still energized by code received at signal L52). Relay R52S is slow release to bridge transfer of contact on R52H as the train passes signal L52, shorting the track to drop A52WT, also R52TFP, R52TBP, R52H and R52D. Also 51TP down, restores R52HS normal through its second coil, enforcing stick signaling without the usual TPS relay. Relay R52HS normal, opens R52HSP circuit, to pick up R52NPS, through 51TP down, releasing the time locking. Assuming R52HS is not reversed by operator for a following train, R52CTP cannot pick up to place steady energy on track eastward until the train has passed the next signal.

Then this code will be received in pick up R52H; this picks up R52ES, and drops R52S to close R52CTP circuit. Relay R52CTP sends steady energy east against code coming west to pick up L58TFP, at signal R58, during the off periods of the code coming west. Relay L58TFP up, cuts off code coming west as well as other action previously described. Assuming a following train, if first train was still within the signal block, the route-agreement relay circuit would be completed through R52S rather than through R52H to clear the call-on signal. If the first train was beyond the next signal, code would be received upon the reversal of R52HS, and circuits would be completed as shunting track 51T to drop 51TP (track repeater relay), also open signal network circuit. Relay 51TP down opens the pick up circuit of R52ES, energizes R52S through



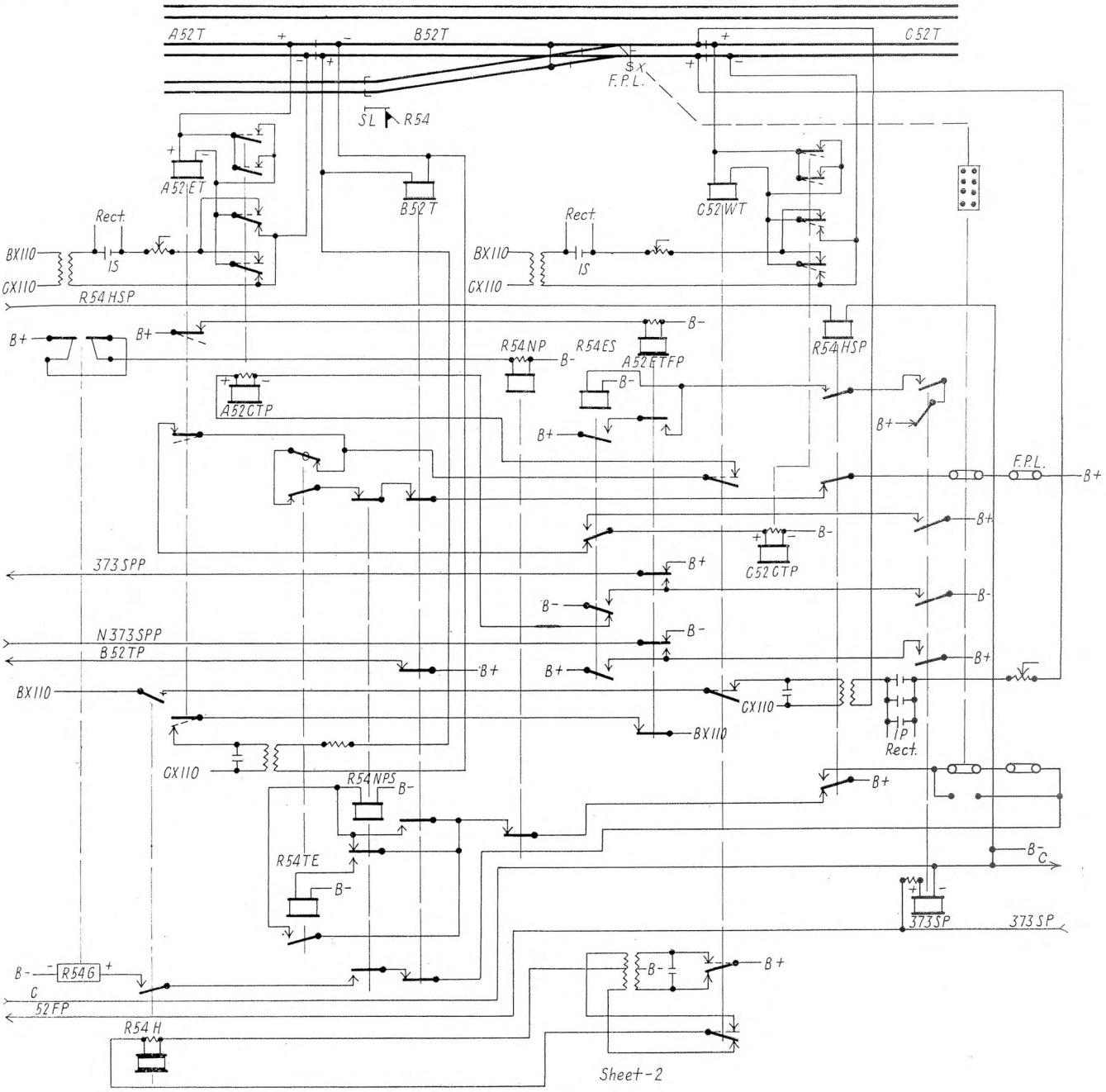
Sheet 1 of the typical circuits

previously described to clear signal R52 for the following train.

When circuits have been restored with steady energy flowing east throughout the block, traffic direction may be reversed by the operator turning traffic lever F52 to the opposite upper quadrant. This closes a circuit to R plus coil of 52LPR, through F52 push button contact, 52ETK up, and contact W made by reversal of the lever. Relay LPR is of the polar-stick type, remaining in the position last poled. Poled reverse, it drops 52EFK to take out the eastward blue light, and 52EFK relay down drops 52ETK. Lamp BEK does not light account 52EFK and 52WFK both down. Lever F52, through push button contacts, closes the starting circuits for field stations 357 and 348. Station 357 transmits a long impulse due to closed circuit through LPR reversed, and applies plus energy through Terminal 12 to 52WFS to reverse that relay, this changes R52CTP from steadily energized to coding relay.

Station 348 transmits a short impulse, due to open circuit (LPR not normal), and applies minus energy through Terminal 12 to reverse relay 52EFS. This energizes L58CTP, steady, to send steady energy west to energize A52WT and R52TFP; also cutting off coded energy flowing east. Relay R52TFP up, through 52WFS reverse, sends time code to the machine through Terminal 4, station 357 to pick up 52WTK in the machine. Relay 52WTK up through LPR reverse picks up 52WFK to light the blue light on the westward arrow, and to hold up 52WTK. Relay 52WTK up unlocks the traffic locking in the machine.

The traffic locking circuit in the control machine has special features to insure that traffic indications will agree with the field conditions. Assuming FK contacts were omitted from the TK hold up circuit, then with traffic lined east and 52ETK up, the operator lines traffic west; control codes are transmitted and because of time code station preference 52WTK indication up, is received first. At this instant, before station 348 can transmit a time code indication to drop out 52ETK, the operator lines the traffic east, and immediately gets a blue light for eastward movement, although, at that time, field conditions are actually

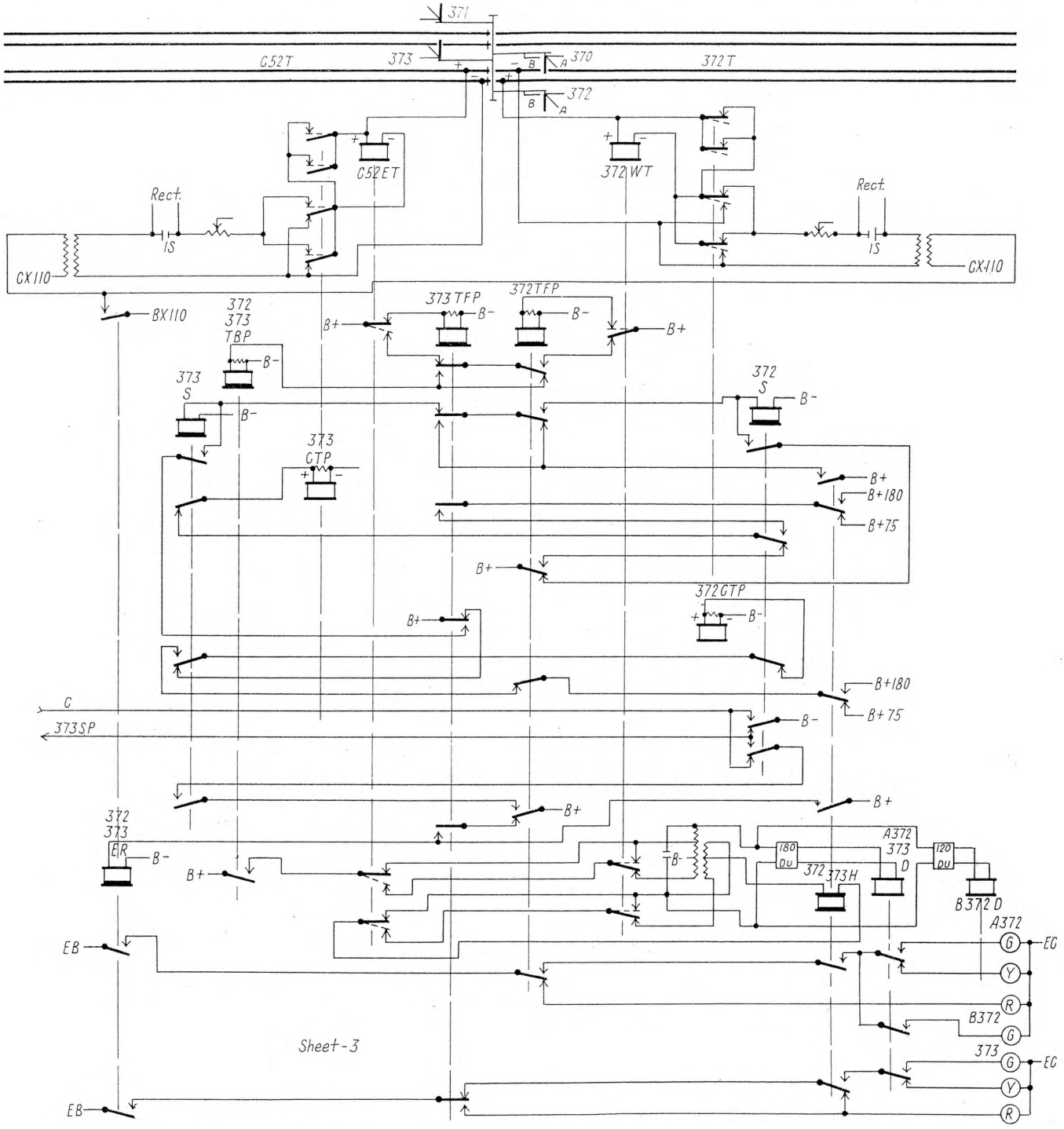


Sheet 2 of the typical circuits

set up for a westward movement. Assuming the circuit from F52 push button, through 52EFK and 52WFK down, to 52ETK down and R plus; or through 52WTK down and N plus were omitted. Operator lines traffic west, and before indications are received again he lines traffic east. Upon completion of field circuit action, the traffic light would indicate westward traffic established, the traffic lever would be set for eastward movement. Further operation of the lever would not result in agreement of the light and the lever; therefore, this circuit insures that when traffic is not established the LPR relay will follow the movement of traffic lever.

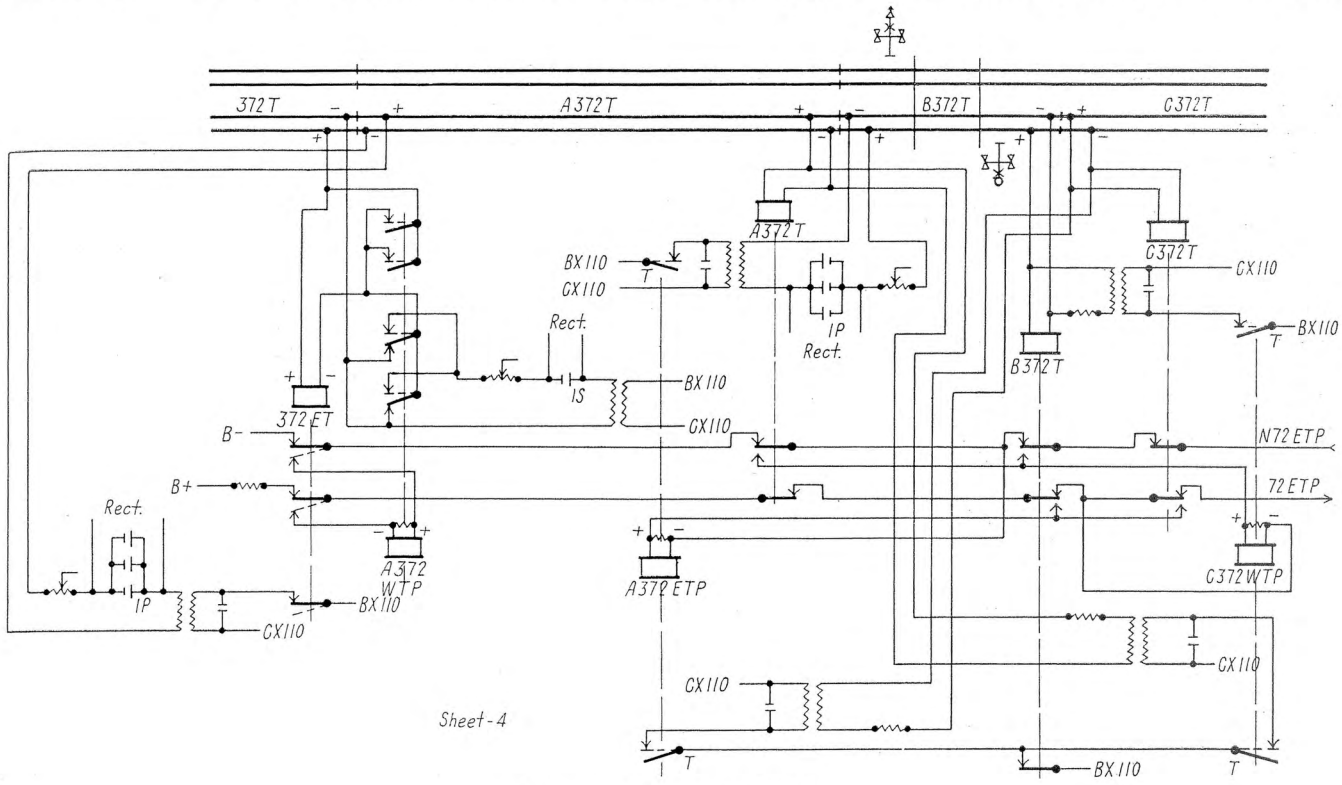
Resuming discussion of the field circuit; with the traffic lined westward, steady energy flowing west from signal R58 over front contacts of L58CTP is cut off by the operator's reversal of time code relay normal contacts of L56HS or L58HS in the CTP circuit. Absence of steady energy at the west end, drops A52WT and R52TFP. Relay R52TFP down, closes the coded circuit to R52CTP to send coded energy east to clear westbound signals L56 or L58 at the east end.

To follow intermediate circuit action, sheets 1, 2, 3, 4 and 5 should be placed in numbered order from left to right. Assuming L52 signal at stop, R52CTP will be coding 75 through AL52YGP down, to send coded energy east over track A52T to be received by A52ET relay, sheet 2. Relay A52ET coding, picks up A52ETFP, also codes C52CTP. Battery through siding switch and FPL normal, R54HSP (R54 time code reverse repeater relay) down, B52T up, R54NPS up, R54TE (time-element relay) down, A52ET coding, R54ES down to coil of C52CTP. Re-



Sheet 3 of the typical circuits

lay A52ETFP up, over line wires, poles 373SPP normal, sheet 1; C52CTP coding 75 to track C52T is received by C52ET relay, sheet 3. ilar circuits to those described for signal R52 with 51T down. When the train enters C372 track section, it drops C372T, sheet 4, and opens line reversed by 372S down, picks up 373SP, sheet 2, (373 stick repeater) and 52FP, sheet 1, (traffic repeater) on reversed polarity. Relay C52T has



Sheet 4 of the typical circuits

Relay C52ET coding, picks up 373TFP. Battery through C52ET coding down, 373TFP up, 372TFP down, picks up 372,373TBP. Battery through TBP up, coding contacts of C52ET, 372WT down and decoding equipment picks up 372,373H; also A372,373D if code were 180. The H relay up picks up 372,373ER (light and cab current relay), EB through ER up, 373TFP up, H up, D down, lights yellow light signal 373. Battery through H up, 372TFP down, 373TFP up, picks up 373S. Then 180 code through H up, 372TFP down, 373S up, 372S down, picks up 372CTP to code 180 east over track 372T to energize 372ET relay, sheet 4.

Three conventional track circuits are in service at this point for highway crossing protection. A double-break line circuit through coding front contact of 372ET, over line, through A372T, B372T, C372T up, over line, through L58CTP down, sheet 5, energizes C372ETP at signal R58, and bridges code over conventional track circuits. Relay C327ETP coding, picks up L58TFP, L58TBP, L58H and L58D to display green signal AL58 or BL56 in a manner similar to that described for clearing signal R52.

Assuming that the route is lined for and the train passes signal AL58. Relay 57T and repeaters actuate sim-

circuit to C372ETP, sheet 5. Relay C372ETP down actuates similar circuits as described for A52WT on eastward move from signal R52. Relay C372T down, also energizes coding line relay A372ETP, sheet 4, to apply coded a-c. to track circuits C372T and B372T feeding toward the train, to energize the cab signal. Relay A372T has coded a-c. applied to the west end whenever 372ET is coding, a-c. code is applied to track section 372T, sheet 3; when ER relay is up, and 372CTP coding.

When the head end of the train passes signal 373, then C52ET drops, this drops 373TFP, TBP, H and D (if energized). Battery through 373TFP down, 373S up provides hold up for 373S. Relay 373TFP down, with 372TFP down, provides circuit for ER relay, when H drops, to continue signal lighting. Relay 373TFP down takes out yellow light, and energizes red light of signal 373. When the train clears track 372T, 372CTP which has continued coding, as previously described, except changed to 75 code by dropping of H relay, sends code east to energize C372ETP, sheet 5. This drops L58S to permit steady current to flow west, providing a signal has not been recleared, to cut off code flowing east from signal 373, sheet 3, by picking up 372TFP relay. Battery through 372TFP up, 373S up, with polarity

westward a-c. code applied whenever C52CTP coding, sheet 2; B52T whenever A52ET coding, A52T whenever R52CTP coding, sheet 1. Train continues westward enters B52T, B52T drops C52CTP, and B52TP, sheet 1. Train enters A52T, drops A52ET and A52ETFP. Relay A52ETFP cuts the cab current off B52T, also by double-break line circuit through B plus 373SP up, and A52ETFP down to wire N373SPP, and B minus, similar; to wire 373SPP, energizes relay 373SPP up reverse, sheet 1; through R52TFP down, R52S down, and R52ES up. Battery 16 through 52FP and 373SPP both up, reverse, sends time code over terminal 4, station 358, to machine to pick up R52ESK. This lights blue light on the track panel near signal R54, indicating that traffic may be lined eastward for movement from siding, signal R54.

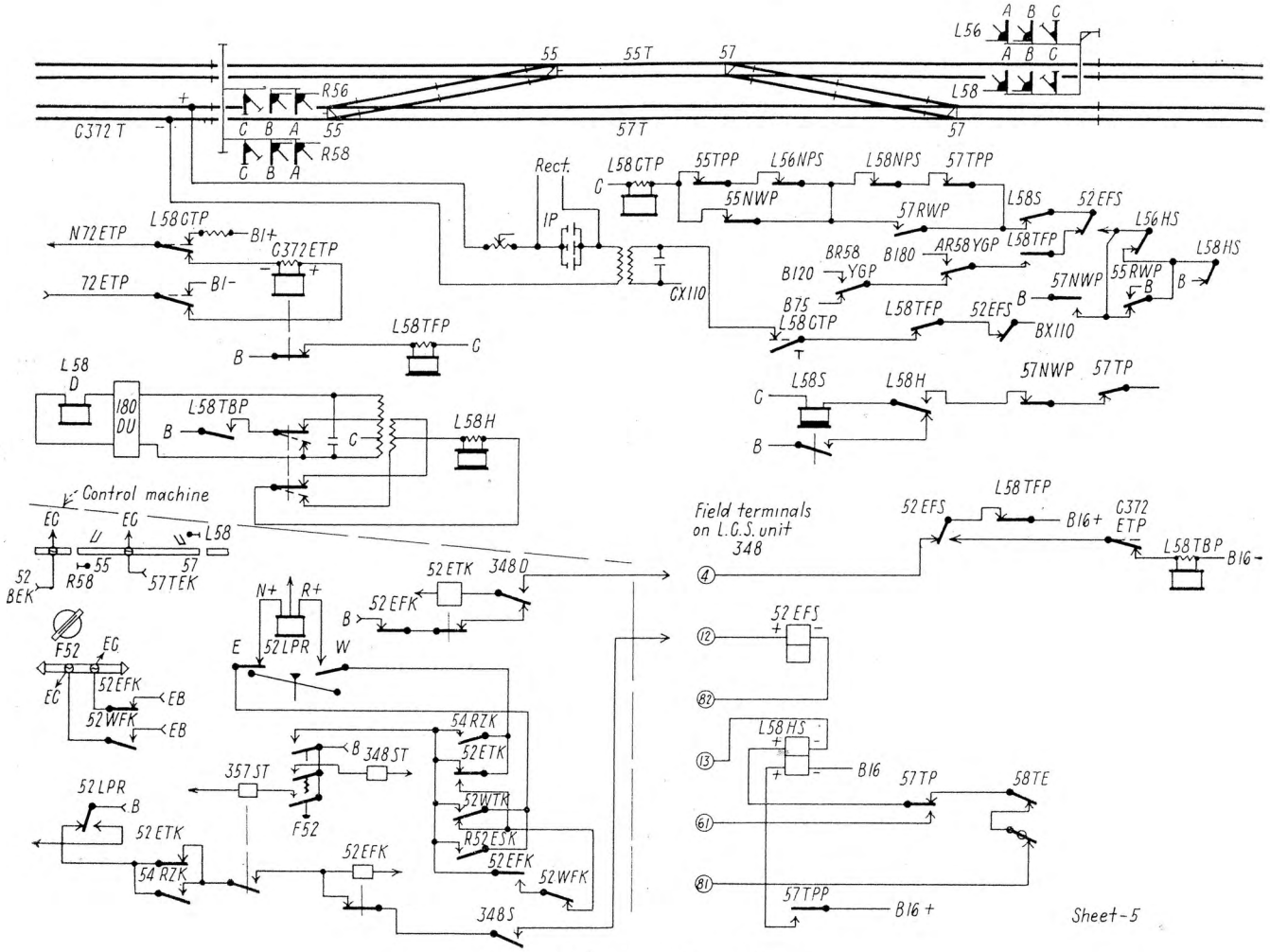
Assuming a train on the siding and the operator wishes to clear signal R54. Traffic lever F52 is lined eastward. In the control machine, B through push button contact F52, R52ESK up, lever contact E closed, poles LPR normal and by time code poles 52WFS, sheet 1; and 52EFS, sheet 5; normal. In the machine, 52WFK drops out, also R52ESK; extinguishing both blue lights. At the west end, sheet 1, 52WFS normal does not cut off coding R52CTP supplying cab signal current to westward

main line train, for 373SPP is poled reversed. At the east end, sheet 5, L58CTP changes from steady to coding energy, when 52EFS poled normal, to code 372WT, sheet 3, to pick up TBP, H, ER and S relays, and also to clear signal 372. Relay 372S up, pole-changes the 373SP circuit, to pole change 373SP, sheet 2, and 52FP, sheet 1, up and normal. Battery 16 through 52FP up, normal; to Terminal 1, unit 358, sends time code to machine to pick up 54RZK. Battery through LPR normal, 54RZK up picks up 52EFK to light eastward blue traffic light and hold up 54RZK. Then 52EFK restores amber light BEK, extinguished when 52WFK dropped out. With eastward traffic established, operator reverses R54 signal lever and by time code action Relay 373S down opens 373SP circuit, this drops 373SP, sheet 2, to cut steady energy off C52CTP to allow code to feed west from signal 372, sheet 3, to pick up R54H, sheet 2. Relay 373SP down, does not drop out R54ES because of the stick circuit through A52ETFP down, also does not change circuit 373SPP because of by-passes established by R54ES up. On sheet 1, 52FP down, to Terminal 1, unit 358, sends time code to machine to drop 54RZK, thus preventing any change in the traffic circuits until 52ETK picks up. On sheet 2, R54HSP has opened the circuit of C52CTP to prevent steady energy flowing east, should westward main line train clear at signal R52, HSP also drops R54NPS.

The westward train clearing B52T and send indication to the machine that the section is clear and traffic circuits are unlocked and may be restored to the position as drawn.

Attention is suggested to the circuits at a typical intermediate signal location, sheet 3. It will be noticed that the TBP, ER, H and D relays as well as all the decoding equipment are common to the intermediate signals in both directions.

Also that when signals are not clear or track occupied, i.e., when steady energy is flowing, only two relays are energized at the location, the TFP and opposite CTP; also that the signal lights are out. On sheet 4, a two-wire line circuit serves to bridge coding or steady energy around conventional track circuits, as well as apply a-c. coded cab signal energy to these



Sheet 5 of the typical circuits

Terminal 15, unit 358, reverses relay R54HS, through 52WFS normal and 373SPP up. Battery through R52S down, R52ES up, R54HS reversed picks up R54HSP, sheet 2. Battery through 373SP up and normal and R54HSP up, picks up R54ES. Battery through 373SP up, R54ES up, picks up C52CTP to send steady energy east when rear of main line train clears C52T to drop 373S, sheet 3. allows signal R54 to clear. Battery through R54HSP up, spring switch and FPL normal or switch reversed, B52T up, R54NPS down, R54H up to searchlight mechanism.

If no move from the siding is involved, and traffic is lined west. Westward train clears A52T, sheet 1, relay R52CTP codes east to drop 373S, sheet 3. Steady energy flows west from 373CTP to pick up R52TFP, track sections in either direction. Under certain conditions of traffic reversal, both batteries are applied to this line in a closed series circuit for a short interval. To limit the current flow, a five-ohm limiting resistance was placed in the plus wire from each line battery. Cab signal a-c. track circuits are approach energized whenever possible, without the installation of additional equipment.